

DRAFT

**SUPPLEMENTAL GROUNDWATER INVESTIGATION
OPERABLE UNIT NO. 10
(SITE 35, CAMP GEIGER AREA FUEL FARM)**

**MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA**

CONTRACT TASK ORDER 0232

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LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|-------------------------|---|
| $\mu\text{g}/\text{kg}$ | Microgram per Kilogram |
| $\mu\text{g}/\text{L}$ | Microgram per Liter |
| AOC | Area of Concern |
| AQTESOLV | Aquifer Test Solver Program |
| ARARs | Applicable or Relevant and Appropriate Requirements |
| AST | Aboveground Storage Tank |
| ASTM | American Society for Testing Materials |
| AT | Averaging Time |
| ATEC | ATEC Associates, Inc. |
| Baker | Baker Environmental, Inc. |
| BCF | Biological Concentration Factor |
| bgs | Below Ground Surface |
| BRA | Baseline Risk Assessment |
| BTEX | Benzene, Toluene, Ethylbenzene, and Total Xylenes |
| BW | Body Weight |
| CDI | Chronic Daily Intake |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CLEAN | Comprehensive Long-Term Environmental Action Navy |
| Commarforlant? | |
| CLP | Contract Laboratory Program |
| COPC | Contaminant of Potential Concern |
| CRAVE | Carcinogen Risk Assessment Verification Endeavor |
| CRDL | Contract Required Detection Limit |
| CRQL | Contract Required Quantitation Limit |
| CSA | Comprehensive Site Assessment |
| CSF | Carcinogenic Slope Factor |
| DEE | Dichloroethne |
| DDT | Diphenyltrichloroethane |
| DoN | Department of the Navy |
| ED | Exposure Duration |
| EF | Exposure Frequency |
| Eh | Oxidation Reduction Potential |
| EMD | Environmental Management Division |
| EPA | Environmental Protection Agency (U.S.) |
| ESE | Environmental Science and Engineering, Inc. |
| ET | Exposure Time |
| ESP | Explanation of Significant Differences |
| ft/d | Feet Per Day |
| ft ² /d | Square Feet Per Day |
| FFA | Federal Facilities Agreement |

LIST OF ACRONYMS AND ABBREVIATIONS
(continued)

| | |
|-----------|---|
| FID | Flame Ionization Detector |
| f_{oc} | Sediment Particle Grain Size |
| FS | Feasibility Study |
| FSAP | Field Sampling and Analysis Plan |
| FFS | Focused Feasibility Study |
| gpm | Gallons per Minute |
| GC | Gas Chromatograph |
| h | Hydraulic Gradient |
| HA | Health Advisory |
| HASP | Health and Safety Plan |
| HEAST | Health Effects Assessment Summary Tables |
| HHAG | Human Health Assessment Group |
| HI | Hazard Index |
| HQW | High Quality Water |
| Heartland | Heartland Environmental Services, Inc. |
| i | Hydraulic Gradient |
| IAS | Initial Assessment Study |
| ICR | Incremental Cancer Risk |
| ID | Inside Diameter |
| IDW | Investigative Derived Wastes |
| IR | Ingestion Rate |
| IRA | Interim Remedial Action |
| IRIS | Integrated Risk Information System |
| IRP | Installation Restoration Program |
| K | Hydraulic Conductivity |
| K_{oc} | Organic Carbon Partition Coefficient |
| K_{ow} | Octanol-Water Partition Coefficient |
| K_p | Permeability Constant |
| Kg | Kilogram |
| LANTDIV | Naval Facilities Engineering Command, Atlantic Division |
| LAW | Law Engineering |
| LOAEL | Lowest-observed-adverse -Effect Level |
| LUST | Leaking Underground Storage Tank |
| Lanier | Lanier Surveying, Inc. |
| MCAS | Marine Corps Air Station |
| MCB | Marine Corps Base |
| MCL | Maximum Contaminant Level |
| MF | Modifying Factor |
| mg/kg | Milligram per Kilogram |
| mg/L | Milligrams per Liter |
| mgd | Million Gallons per Day |

LIST OF ACRONYMS AND ABBREVIATIONS
(continued)

| | |
|----------|--|
| MI | Mobility Index |
| msl | Mean Sea Level |
| MTBE | Methyl-tertiary-butyl-ether |
| MW | Monitoring Well |
| NAOC | Northern Area of Concern |
| NC DEHNR | North Carolina Department of Environment, Health and Natural Resources |
| NC DOT | North Carolina Department of Transportation |
| NCMFC | North Carolina Marine Fisheries Commission |
| NCSPCS | North Carolina State Plane Coordinate System |
| NCWQS | North Carolina Water Quality Standards |
| NEHC | Navy Environmental Health Center |
| NOAEL | No-Observed-Adverse-Effect-Level |
| NOEL | No-Observed-Effect-Level |
| NPL | National Priorities List |
| NTU | Nephelometric Turbidity Unit |
| NUS | NUS Corporation |
| O&G | Oil and Grease |
| OU | Operable Unit |
| OHM | OHM Corporation |
| PAH | Polynuclear Aromatic Hydrocarbon |
| PC | Permeability Constant |
| PCB | Polychlorinated Biphenyls |
| pH | Measure of Acidity/alkalinity |
| PID | Photoionization Detector |
| PVC | Polyvinyl Chloride |
| QA/QC | Quality Assurance/Quality Control |
| RA | Risk Assessment |
| RAA | Remedial Action Alternative |
| RBC | Risk-Based Concentration |
| RCRA | Resource Conservation and Recovery Act |
| RfD | Reference Dose |
| RI/FS | Remedial Investigation/Feasibility Study |
| RI | Remedial Investigation |
| RME | Reasonable Maximum Exposure |
| ROD | Record of Decision |
| ROW | Right-of-Way |
| S | Storativity, Water Solubility |
| SA | Skin Area |
| SAOC | Southern Area of Concern |
| SC | Commercial Shell fishing |

LIST OF ACRONYMS AND ABBREVIATIONS
(continued)

| | |
|--------|---|
| SCFM | Standard Cubic Feet Per Minute |
| SCS | Soil Conservation Service |
| SGI | Supplemental Groundwater Investigation |
| SI | Site Inspection |
| SOP | Standard Operating Procedures |
| SVOC | Semivolatile Organic Compound |
| | |
| TW | Temporary Monitoring Well |
| T | Transmissivity |
| TAL | Target Analyte List |
| TCE | Trichloroethene |
| TCL | Target Compound List |
| TCLP | Toxicity Characteristic Leaching Procedure |
| TDS | Total Dissolved Solids |
| TN | Tennessee |
| TPH | Total Petroleum Hydrocarbons |
| Tracer | Tracer Research Corporation |
| TSS | Total Suspended Solids |
| TICS | Tentatively Identified Compounds |
| | |
| UCL | Upper Confidence Limit |
| UF | Uncertainty Factor |
| USEPA | United States Environmental Protection Agency |
| USGS | United States Geological Survey |
| UST | Underground Storage Tank |
| | |
| VOC | Volatile Organic Compound |
| VP | Vapor Pressure |
| | |
| WAR | Water and Air Research, Inc. |
| WOE | Weight of Evidence |
| WS | Wilderness Society |
| | |
| °F | Degrees Fahrenheit |

EXECUTIVE SUMMARY

Introduction

This Report has been prepared by Baker Environmental, Inc. (Baker) to serve as a report on the Supplemental Groundwater Investigation (SGI) that was conducted at Operable Unit (OU) No.10, Site 35-Camp Geiger Area Fuel Farm during the summer of 1995, and spring and summer of 1996. This report includes a summary of field activities and analytical results, an evaluation of the nature and extent of site related contamination, a qualitative risk assessment, and conclusions. It has been submitted to USEPA Region IV; the NC DEHNR; MCB, Camp Lejeune Environmental Management Department (EMD); the Navy Environmental Health Center (NEHC); the Agency for Toxic Substances and Disease Registry; and to the Naval Facilities Engineering Command, Atlantic Division (LANTDIV) for their review.

Purpose of the Supplemental Groundwater Investigation

The SGI had two primary purposes as follows; fill data gaps identified in the RI Report; and gather additional soil and groundwater data that would support the implementation of an in-situ air sparging pilot test. The specific objectives of the SGI included the following:

- Extend the Remedial Investigation (RI) south of Fifth Street as needed to define the extent and locate sources of solvent related groundwater contamination in the surficial aquifer.
- Gather additional inorganic groundwater samples from existing wells, screened in the surficial aquifer and sampled during the RI, through the use of a low-flow pumping technique in order to more accurately quantify total metals contamination.
- Resample surface soils and sediments to replace data that was rejected during the validation of the RI sample results.
- Collect sediment samples along Brinson Creek and analyze for TPH (EPA Methods 5030 and 3550) to determine the extent of organic contamination that was "masked by tentatively identified compounds" (tics) under the RI.
- Collect soil and groundwater samples from the northeast side of Brinson Creek to determine if Brinson Creek is acting as a barrier to groundwater contamination that may be migrating off site.
- Collect groundwater, soil and lithologic data from an area downgradient of the former Fuel Farm and adjacent to Brinson Creek to support the implementation of an in-situ air sparging pilot test.

Site Location and Description

Camp Lejeune is located in Onslow County, North Carolina near the city of Jacksonville. It currently covers approximately 234 square miles and is bisected by the New River. Camp Geiger is located at the extreme northwest corner of Camp Lejeune and contains a mixture of troop housing, personnel support and training facilities. Camp Geiger is roughly bounded by Brinson Creek to the

north and northeast, the abandoned Seaboard Railroad right of way to the east, Curtis Road to the south, and U. S. Route 17 to the west.

Site 35, Camp Geiger Area Fuel Farm refers a former fuel storage and dispensing facility that was located just north of the intersection of Fourth and "G" Streets. The Fuel Farm consisted primarily of five, 15,000-gallon aboveground storage tanks (ASTs), a pump house, a fuel loading/unloading pad, an oil water separator, and a distribution island situated just north of the intersection of Fourth and "G" Streets. The facility actively served Camp Geiger and the New River Air Station from 1945 to the Spring of 1995, when it was demolished to make way for a six-lane divided highway proposed by the North Carolina Department of Transportation (NCDOT)

Results of previous investigations have expanded the study area beyond the confines of the former Fuel Farm. The RI study area encompassed approximately 50 adjacent acres and the SGI expanded the study area to 150 acres. For clarity, the study area was broken down into the following areas of concern:

Northern Area of Concern (NAOC) - This area encompasses approximately 10 acres and is located in the northeast corner of the SGI study area, immediately adjacent to the former Fuel Farm. Approximately six acres of this area are on the northeast side of Brinson Creek and are owned by Onslow County. The remaining four acres are on the southwest side of Brinson Creek on Activity property.

RI Study Area - This area encompasses approximately 50 acres immediately surrounding the former Fuel Farm facility

Southern Area of Concern (SAOC) - This area encompasses approximately 90 acres located between, Fifth and Ninth Streets south of the former Fuel Farm .

Site History

During the lifetime of the facility several releases of product occurred. Reports of a release from an underground distribution line near one of the ASTs date back to 1957-58. Apparently, the leak occurred as the result of damage to a dispensing pump. On another occasion, a leak in an underground line at the station was reportedly responsible for the loss of roughly 30 gallons per day of gasoline over an unspecified period (Law, 1992). The leaking line was subsequently sealed and replaced. In April 1990, an undetermined amount of fuel was discovered by Camp Geiger personnel along two unnamed drainage channels north of the Fuel Farm. Apparently, the source of the fuel, believed to diesel or jet fuel, was an unauthorized discharge from a tanker truck.

Previous investigations have been conducted by Water and Air Research, Inc (WAR), Environmental Science and Engineering (ESE), NUS Corporation (NUS), Law Engineering (Law), and Baker Environmental, Inc. (Baker).

SGI Field Investigation

The SGI field program consisted of the following activities: a soil screening investigation; a groundwater screening investigation; a groundwater investigation that occurred in two rounds

(Round 3 and 4); a sediment investigation; a site survey; and investigative derived waste (IDW) handling. SGI field activities occurred periodically between July 25, 1995 and October 9, 1996.

Soil Screening Investigation

During the soil screening investigation borings were advanced in the NAOC and SAOC for the purpose of lithologic description, monitoring well installation and sample collection. Soils samples that were collected were analyzed by an on-site mobile laboratory for cis-1,2-dichloroethene, trans-1,2-dichloroethene; and trichloroethene.

Groundwater Screening Investigation

Groundwater screening activities included temporary well installation and sampling for the purpose of meeting the following location-specific objectives.

- NAOC - Activity property (northeast side of Brinson Creek)
Determine if Brinson Creek is acting as a hydraulic barrier to fuel and solvent-related groundwater contamination migrating off-site onto Onslow County property.
- NAOC - Activity property (southwest side of Brinson Creek)
Provide a detailed vertical profile and determine the horizontal extent of solvent and fuel-related groundwater contamination downgradient of the Fuel Farm at the boundary of the Brinson Creek wetland.
- SAOC - Activity property (area between Fifth Street and Ninth Street)
Sufficiently define the horizontal extent of solvent-related groundwater contamination in the upper and lower portions of the surficial aquifer south of Fifth Street to effectively locate permanent monitoring wells. Groundwater samples that were collected were analyzed by an on-site mobile laboratory for cis-1,2-dichloroethene; trans-1,2-dichloroethene and trichloroethene.

Groundwater Investigation

The groundwater investigation at the site consisted of several activities including: installation of permanent shallow, intermediate and deep monitoring wells; well development, groundwater sampling, and aquifer testing. The objectives were as follows:

- To gather inorganic groundwater data from existing wells located in the RI Study Area and screened in the surficial aquifer through the use of low-flow pumping techniques to more accurately quantify total metals contamination. This data was gathered during Round 3 conducted in August, 1995.
- Confirm the presence or absence of fuel and solvent-related contamination in the surficial aquifer and the upper portion of the Castle Hayne Aquifer in the RI Study Area, NAOC and SAOC. To achieve these objectives seven type-two wells and two type-three wells were installed and sampled. Samples were analyzed for TCL VOCs. Sampling of these wells was conducted during Round 4 conducted during August, 1996.

- Evaluate the shallow and deep groundwater flow patterns site-wide.

Sediment Investigation

Sediment samples were collected from 10 stations along Brinson Creek to assess gross fuel-related contamination from Site 35 operation and to replace metals data rejected during RI validation. These samples were analyzed for TPH (EPA Methods 5030 and 3550), zinc and mercury.

Site Geology

In general the findings of the SGI are consistent with the findings of the RI. The upper most soils consist of sand with lesser amounts of silt and clay. Immediately below this sand are calcareous sands with varying amounts of shell and fossiliferous limestone fragments. A generally fine sand with lesser amounts of clay is present below the calcareous sands and shell/limestone fragments. This layer is generally known as the Castle Hayne confining unit and is colored a distinctive greenish-gray and has a noticeable change in moisture content, becoming dryer.

Nature and Extent of Contamination

In general, widespread organic contamination was detected in the sediments of Brinson Creek and the lower portion of the surficial aquifer. Inorganic constituents were detected in the surficial aquifer and the upper portion of the Castle Hayne. To fully assess the nature and extent of groundwater contamination, data from the SGI groundwater screening and groundwater investigations were evaluated together.

Groundwater

The results of these investigations are presented by area to best address the project specific objectives. In the NAOC on the Onslow County property (northeast side of Brinson Creek) a total of seven groundwater samples were collected and analyzed for TCL VOCs.

On the NAOC Activity property southwest side of Brinson Creek, samples were collected from 32 temporary wells and eight permanent wells during groundwater screening activities. Results identified two contaminant plumes. A solvent-related plume appears to be centered around temporary well cluster 365-TW17 and is approximately 780-feet wide. Solvent-related contamination is predominant in the lower portion of the surficial aquifer. A fuel-related plume appears to be centered around temporary well cluster 35-TW23 and is approximately 265-feet wide. Fuel-related contamination is predominant in the upper portion of the surficial aquifer.

In the RI Study Area during Round 3, samples were collected from 20 existing monitoring wells and analyzed for TAL metals. In general, four metals (iron, manganese, aluminum and antimony) were detected at levels that exceed regulatory limits. During Round 4, samples were collected from 12 existing wells located within the RI Study Area and analyzed for TCL VOCs. In general, the limits of solvent-related contamination in the lower portion of the surficial aquifer remained the same.

To assess the limits of solvent-related groundwater contamination in the SAOC, groundwater samples were collected from 27 temporary wells and six permanent wells. In general, the solvent-related contamination in the lower portion of the surficial aquifer extended to Ninth Street

A single sample was collected from a well located in the SAOC that was installed into the upper portion of the Castle Hayne Aquifer and analyzed for VOCs. No contamination was detected in this sample.

Soil Screening Investigation

No fuel or solvent-related contamination was detected in any soil sample that was collected under the SGI.

Sediment Investigation

Two samples were collected from each of the ten sampling locations along Brinson Creek and analyzed for TPH, mercury and zinc. TPH contamination was detected at nine of the ten sampling locations. The highest levels of TPH contamination were located adjacent to and downstream of Site 35.

Conclusions

Based on the data obtained under the SGI the following conclusions, presented by media, were formed:

Groundwater

- Levels of iron and arsenic detected in samples collected from wells located in the RI Study Area and screened in the surficial aquifer create an unacceptable human health risk if consumed (groundwater in this area is not used as a potable supply).
- Based on the results of the qualitative risk assessment, Baker determined that solvent-related VOCs in the groundwater would result in a human health risk if the groundwater was consumed.
- Samples collected using a low-flow sampling technique yielded results with lower concentrations of metals than those obtained in the RI, indicating that suspended solids may have influenced the inorganic levels observed in the RI data.
- Elevated levels of metal constituents in groundwater are not atypical in the Camp Lejeune groundwater. Previous studies have determined that groundwater in the Camp Lejeune area is rich in iron and manganese; samples often exceed NCWQS of 300 and 50 ug/L, respectively. The preliminary conclusion of the draft report "Evaluation of Metals in Groundwater at MCB Lejeune, North, Carolina" (Baker, 1994) generally supports the theory that concentrations of metals in groundwater are due to geologic conditions rather than site-related contamination.

- Specifically at Site 35, detections of aluminum, and manganese do not appear to emerge in a pattern that would suggest that an identifiable source exists. Elevated levels of iron were present in wells adjacent to areas where petroleum contaminated soil was identified. An available study indicates that elevated iron levels in groundwater can be associated with BTEX contamination (Becker, 1995).
- The limits of the solvent-related groundwater contamination in the lower portion of the surficial aquifer were identified to a location South of Fifth Street. In general this plume extends southward along "C" Street from Building G534 to the intersection of "C" and Sixth Street. The edge of the plume extends from this intersection across Camp Geiger to Building TC773 . At this point, the edge of the plume swings northward along the eastern tree line of Camp Geiger and continues north to Fifth Street.
- No fuel or solvent-related groundwater contamination was detected in samples collected in the NAOC on the northeast side of Brinson Creek. Therefore, fuel and solvent-related contamination apparently has not migrated off-site onto Onslow County property.

Soils

- No fuel or solvent-related contamination was detected during soil screening activities at Site 35. These results indicate that the spilled solvents and fuels have probably migrated into the saturated zone and are no longer acting as a continued source in the soil.

Sediment

- Fuel-related contamination is widespread in Brinson Creek sediments. Low levels of both gasoline and diesel fractions of the fuel-related contamination were detected in the sediments upstream of Site 35. This contamination may have been transported in part via storm runoff from U. S. Highway 17 and/or adjacent commercial property. Fuel-related contamination was detected in samples collected from all sediment sampling locations situated adjacent to and downstream of the former Fuel Farm. The highest diesel fraction was observed at sediment sampling station 35/SD06 located approximately 850 feet downstream of Site 35; the highest gasoline fraction was observed at sediment sampling station 35/SD04 located adjacent to Site 35. Therefore, previous operations most likely have contributed to fuel-related sediment contamination in Brinson Creek in areas adjacent to and downstream of the former Fuel Farm.
- Based on the analytical results and the lack of historical evidence that zinc or mercury was used at Site 35, it can be concluded that previous operations at Site 35 likely have not contributed to observed concentrations of mercury and zinc in Brinson Creek sediments.

Recommendations

No additional follow-up investigative actions are recommended.

1.0 INTRODUCTION

Marine Corps Base (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). Subsequent to this listing, the United States Environmental Protection Agency (USEPA) Region IV; the North Carolina Department of Environment, Health and Natural Resources (NC DEHNR); and the United States Department of the Navy (DoN) entered into a Federal Facilities Agreement (FFA) for MCB, Camp Lejeune. The primary purpose of the FFA is to ensure that environmental impacts associated with past and present activities at MCB, Camp Lejeune are thoroughly investigated and appropriate CERCLA response/Resource Conservation and Recovery Act (RCRA) corrective action alternatives are developed and implemented, as necessary, to protect public health, welfare, and the environment (FFA, 1989).

The Fiscal Year 1996 Site Management Plan for MCB, Camp Lejeune, the primary document referenced in the FFA, identifies 33 sites that require Remedial Investigation/Feasibility Study (RI/FS) activities. These 33 sites have been divided into 16 operable units to simplify RI/FS activities. A Remedial Investigation (RI) was conducted at Operable Unit (OU) No. 10, Site 35, Camp Geiger Area Fuel Farm in April and May of 1994. The RI Report recommended that additional field activities be conducted to fill data gaps and provide a sound basis for the development of remedial responses. These field activities were conducted under the Supplemental Groundwater Investigation (SGI) that commenced in July 1995 and concluded in October 1996.

This report describes the activities conducted under the SGI at Site 35. It has been prepared by Baker Environmental, Inc. (Baker) and submitted to the USEPA Region IV; the NC DEHNR; MCB, Camp Lejeune Environmental Management Department (EMD); the Navy Environmental Health Center (NEHC); the Agency for Toxic Substances and Disease Registry; and to the Naval Facilities Engineering Command, Atlantic Division (LANTDIV) for their review. This SGI Report contains the results of field investigations and the qualitative human health risk assessment (RA). In addition, this report provides information to support the Feasibility Study (FS) and Record of Decision (ROD) documents.

1.1 Purpose of the Supplemental Groundwater Investigation

The SGI had two primary purposes; fill the data gaps identified in the RI Report, and gather additional soil and groundwater data that would support the implementation of an in-situ air sparging pilot test. The specific objectives that supported these purposes included the following:

- Extend the SGI study area south of Fifth Street as needed to define the extent and locate the source(s) of solvent-related groundwater contamination in the surficial aquifer.
- Gather additional inorganic groundwater data from existing wells, screened in the surficial aquifer and sampled during the RI, through the use of low-flow pumping technique in order to more accurately quantify total metals contamination.
- Resample surface soils and sediment to replace data that was rejected during validation of the RI sample results.

- Collect sediment samples along Brinson Creek and analyze for TPH (EPA Methods 5030 and 3550) to determine the extent of organic contamination that was "masked" by tentatively identified compounds (tics).
- Collect groundwater and soil data from the northern side of Brinson Creek to determine if Brinson Creek is acting as a barrier to groundwater contamination that may be migrating off site.
- Collect groundwater, soil, and lithologic data from an area downgradient of the former Fuel Farm and adjacent to Brinson Creek to support the implementation of an in-situ air sparging pilot test.

1.2 Report Organization

The SGI Report is comprised of two volumes; volume one includes the text, tables, and figures, and Volume II contains the appendices. The text volume includes seven sections:

- Section 1 - Introduction
- Section 2 - Study Area Investigation
- Section 3 - Physical Characteristics of the Study Area
- Section 4 - Nature and Extent of Contamination
- Section 5 - Contaminant Fate and Transport
- Section 6 - Qualitative Human Health Risk Assessment
- Section 7 - Conclusions

1.3 Background

This section presents an overview of Site 35 and is divided into two subsections, Site Description and Site History.

1.3.1 Site Description

MCB, Camp Lejeune (also referred to as the "Activity") is located in Onslow County, North Carolina (Figure 1-1). The Activity currently covers approximately 234 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 west and northwest borders of the Activity are defined by U.S. Route 17 and State Route 24, respectively. The eastern border is defined by the Atlantic Ocean shoreline while the City of Jacksonville, North Carolina, borders the Activity to the north.

Camp Geiger is located at the extreme northwest corner of MCB, Camp Lejeune and contains a mixture of troop housing, personnel support and training facilities. The main entrance is located along U.S. Route 17, approximately 3.5 miles southeast of the City of Jacksonville, North Carolina. Camp Geiger is roughly bounded by Brinson Creek to the north and northeast, an abandoned Seaboard Railroad right of way to the east, Curtis Road to the south, and U. S. Route 17 to the west.

Site 35, Camp Geiger Area Fuel Farm refer to a former fuel storage and dispensing facility that was located just north of the intersection of Fourth and "G" Streets, prior to is demolition in the spring of 1995. The facility consisted primarily of five, 15,000-gallon aboveground storage tanks (ASTs), a pump house, a fuel loading/unloading pad, an oil/water separator, and a distribution island.

Results of previous investigations have expanded the study area beyond the confines of the former Fuel Farm. The RI study area encompassed approximately 50 adjacent acres and the SGI expanded the study area to 150 acres. The SGI study area is roughly bounded by "B" Street to the west, Second Street to the north, the five-foot contour line on Onslow County property (the northeast side of Brinson Creek) to the northeast, the Camp Geiger tree line to the east, and Eighth Street and Edwards Creek to the south (Figure 1-2). Field activities occurred in the following areas of concern:

- Northern Area of Concern (NAOC) - This area encompasses approximately 10 acres and is located in the northeast corner of the SGI study area, immediately adjacent to the former Fuel Farm. It extends approximately 1,100 feet along both sides of Brinson Creek. Approximately six acres of this area are situated on Onslow County property and the remaining four areas are located on Activity property.
- RI Study Area - This area encompasses approximately 50 acres and is roughly bounded by "C" Street to the west, Second Street to the north, Brinson Creek to the northeast, the Camp Geiger tree line to the east, and Fifth Street and Building No. TC572 to the south. The Activity portion of the NAOC is located in this area.
- Southern Area of Concern (SAOC) - This area encompasses approximately 90 acres and is roughly bounded by "B" Street to the west, Fifth Street and Building No. TC572 to the north, the tree line and the abandoned railroad right-of way to the east and Eighth Street and Edwards Creek to the south.

1.3.2 Site History

Construction of MCB, Camp Lejeune began in 1941 with the objective of developing the "Worlds Most Complete Amphibious Training Base." Construction started at Hadnot Point, where the major functions of the Activity are centered. Development at the Activity is primarily in five geographical locations under the jurisdiction of the Base Command. These areas include Camp Geiger, Montford Point, Courthouse Bay, Mainside, and the Rifle Range Area.

Construction of Camp Geiger was completed in 1945, four years after construction of MCB, Camp Lejeune was initiated. Originally, the Fuel Farm ASTs were used for the storage of No. 6 fuel oil. An underground distribution line (now abandoned) extended from the ASTs to the former Mess Hall Heating Plant, located adjacent to "D" Street, between Third and Fourth Streets. The underground line dispensed No. 6 fuel oil to a UST which fueled the Mess Hall boiler. The Mess Hall, located across "D" Street to the west, is believed to have been demolished along with its Heating Plant in the 1960s. At some unrecorded date the facility was converted for storage of other petroleum products, including unleaded gasoline, diesel fuel, and kerosene.

From the date of this conversion until the facility was decommissioned in the spring of 1995 the ASTs at Site 35 were used to dispense gasoline, diesel and kerosene to government vehicles and to supply underground storage tanks (USTs) in use at Camp Geiger and the nearby New River Marine Corps Air Station. The ASTs were supplied by commercial carrier trucks which delivered product to fill ports located on the fuel loading/unloading pad located south of the ASTs. Six, short-run (120 feet maximum), underground fuel lines were utilized to distribute the product from the unloading pad to the ASTs.

During the lifetime of the facility several releases of product occurred. Reports of a release from an underground distribution line near one of the ASTs date back to 1957-58 (ESE, 1990). Apparently, the leak occurred as the result of damage to a dispensing pump. At that time the Camp Lejeune Fire Department estimated that thousands of gallons of fuel were released although records of the incident have since been destroyed. The fuel reportedly migrated to the east and northeast toward Brinson Creek. Interceptor trenches were excavated and the captured fuel was ignited and burned.

Routinely, the ASTs at Site 35 supplied fuel to an adjacent dispensing pump that was supplied by an underground line. A leak in an underground line at the station was reportedly responsible for the loss of roughly 30 gallons per day of gasoline over an unspecified period (Law, 1992). The leaking line was subsequently sealed and replaced.

In April 1990, an undetermined amount of fuel was discovered by Camp Geiger personnel along two unnamed drainage channels north of the Fuel Farm. Apparently, the source of the fuel, believed to be diesel or jet fuel, was an unauthorized discharge from a tanker truck that was never identified. The Activity reportedly initiated an emergency clean-up which included the removal of approximately 20 cubic yards of soil.

The Fuel Farm was decommissioned and demolished during the spring of 1995. The ASTs were emptied, cleaned, dismantled, and removed along with all concrete foundations, slabs on grade, berms and associated underground piping. The Fuel Farm was demolished to make way for a six lane divided highway proposed by the North Carolina Department of Transportation (NCDOT) (Figure 1-3).

In addition to the Fuel Farm dismantling, soil remediation activities were executed between the spring of 1995 and the spring of 1996 along the highway right-of-way as per an Interim Record of Decision executed on September 15, 1994.

1.4 Summary of Previous Investigations

The purpose of this section is to summarize existing information pertaining to previous environmental studies involving Site 35. Information presented herein can be found in the Initial Assessment Study of Marine Corps Base, Camp Lejeune, North Carolina (WAR, 1983), Final Site Summary Report, MCB Camp Lejeune (ESE, 1990); Draft Field Investigation/Focused Feasibility Study, Camp Geiger Fuel Spill Site (NUS, 1990), Underground Fuel Investigation and Comprehensive Site Assessment (Law, 1992); the Addendum Report of Underground Fuel Investigation and Comprehensive Site Assessment (Law, 1993); the Interim Remedial Action Remedial Investigation/Feasibility Study for Soil (Baker, 1994a); Remedial Investigation Report (Baker, 1995a); Interim Feasibility Study for Shallow Groundwater in the Vicinity of the Former Fuel Farm (Baker, 1995b); and, the Treatability Study Work Plan, Pilot-Scale Evaluation of In-Situ Air Sparging (Baker, 1996). Sample locations associated with each of the studies conducted prior to the SGI are shown in a figure included in Appendix A.

1.4.1 Initial Assessment Study

MCB, Camp Lejeune was placed on the National Priority List (NPL) in 1983 after the Initial Assessment Study identified 76 potentially contaminated sites at the Activity (WAR, 1983). Site 35 was identified as one of 23 sites warranting further investigation. Sampling and analysis of environmental media was not conducted during the IAS.

1.4.2 Confirmation Study

ESE performed Confirmation Studies of the 23 sites requiring further investigation after the IAS, which included a study of the Fuel Farm between 1984 and 1987 (ESE, 1990). In 1984, ESE advanced three hand-auger borings (35GW-1, -2, and -3) downgradient of the site, and collected groundwater and soil samples from each location. Soils were analyzed for lead and oil and grease. Lead was detected in soil samples obtained from hand auger borings at concentrations ranging from 6 to 8 mg/kg. Oil and grease (O&G) was also detected at concentrations ranging from 40 to 2,200 mg/kg.

Shallow groundwater samples were obtained from the open boreholes and analyzed for lead, O&G, and volatile organic compounds (VOCs) including benzene, trans-1,2,-dichloroethene (trans-1,2,-DCE), trichloroethene (TCE), and methylene chloride. Lead was detected in each sample ranging from 1,063 µg/L (35GW-3) to 3,659 µg/L (35GW-1). O&G was detected in sample 35GW-2 at 46,000 µg/L. The only detected VOC was methylene chloride in sample 35GW-1 at 4 µg/L.

In 1986, ESE collected two sediment (35SE1 and 35SE2) and two surface water (35SW1 and 35SW2) samples from Brinson Creek and installed three permanent monitoring wells (35GW-4, -5, and -6 which were later renamed EMW-5, -6, and -7), two east and one west of the Fuel Farm. Table 1-1 of the RI Report (Baker, 1995A) summarizes well construction details. A copy of this table is included in Appendix A of the SGI Report. Surface water and sediment samples were analyzed for lead, O&G and ethylene dibromide. Groundwater samples were obtained in December 1986 and again in March 1987 and were analyzed for lead, O&G, and VOCs.

No target analytes were detected in either surface water sample. Both sediment samples were reported to contain lead and O&G, although no data indicating actual levels of detection were provided in ESE's report. Levels were reported to be higher in the upstream sample, prompting ESE to suggest that the discharge of contaminated groundwater to the creek is occurring at the far northern section of the Fuel Farm ASTs or that the source of O&G and lead may be upstream.

Lead was detected in only one of six samples (33 µg/L: EMW-6) obtained from the three permanent monitoring wells. O&G was detected in all six samples ranging from 200 µg/L (EMW-5: December 1986) to 12,000 µg/L (EMW-5: March 1987). Detected VOCs included benzene (range: 1.3 µg/L at EMW-7 to 30 µg/L at EMU-6), trans-1,2,-DCE (range: 3.2 µg/L at EMW-5 to 29 µg/L at EMW-7), and TCE (detected at 11 µg/L at EMW-7 on both sample dates).

ESE recommended further investigations designed to determine the horizontal and vertical extent of contamination residing within the soils and groundwater beneath the site and sediments in Brinson Creek. In addition, ESE recommended investigation of the adjacent automotive maintenance/hobby shop to determine if it is a source of VOC contamination. In conjunction with the investigations, ESE recommended a risk assessment for portions of the ESE report that pertain to Site 35.

1.4.3 Focused Feasibility Study

A Focused Feasibility Study (FFS) was conducted by NUS in 1990 in the area north of the Fuel Farm. Although the FFS was conducted, a Record of Decision was not signed as a result. The FFS included the installation of four groundwater monitoring wells numbered EMW-1, -2,-3, and -4. Table 1-1 of the RI Report (Baker, 1995A) summarizes well construction details. A copy of this table is included in Appendix A of the SGI Report. Baker was not able to obtain a copy of the NUS

report. It was, however, discussed in the Comprehensive Site Assessment Report (Law, 1992). Law indicated that the results of laboratory analysis revealed groundwater in one well and soil cuttings from two borings were contaminated with petroleum hydrocarbons although non-aqueous product was not observed. No quantifiable data was provided in the Law report.

A geophysical investigation was also conducted by NUS as part of the FFS in an attempt to identify USTs at the site of the former gas station. The results indicated the presence of a geophysical anomaly in the vicinity of the former gas station.

1.4.4 Comprehensive Site Assessment

Law conducted a Comprehensive Site Assessment (CSA) during the fall of 1991 (Law, 1992). The CSA involved the drilling of 18 soil borings to depths ranging from 15 to 44.5 feet. These soil borings were ultimately converted to nested wells (MW-8 through 25) that monitor the water table aquifer along two zones. The shallow wells were constructed to monitor the water table and generally are screened from 2.5 to 17.5 feet below ground surface (bgs). The deeper wells monitored the lower portion of the surficial aquifer and are generally screened from 17.5 to 35 feet bgs. Table 1-1 of the RI Report (Baker, 1995A) summarizes well construction details. Well MW-20 was the only well installed that is not double nested, but screened from 3 to 12.5 feet bgs. Five additional soil borings were drilled and nine soil borings were hand-augered to provide data regarding vadose zone soil contamination. Three soil borings (SB-1, SB-2, SB-3) were drilled specifically to provide subsurface stratigraphic data. Additional groundwater data was provided via 21 drive-point groundwater or "Hydropunch" samples. A "Tracer" study was also performed to investigate the integrity of the ASTs and underground distribution piping.

Soil and groundwater samples obtained under the CSA were analyzed for both organic and inorganic compounds. Groundwater analyses included purgeable hydrocarbons (EPA 601), purgeable aromatics and methyl-tertiary-butyl-ether (MTBE) (EPA 602), polynuclear aromatic hydrocarbons (PAHs) (EPA 610), and unfiltered lead (EPA 239.2). Soil analyses were limited to total petroleum hydrocarbons (TPH) (SW846 3rd Edition, 5030/3550: gasoline/diesel fractions) and lead (SW846 3rd Edition, 6010). In addition, ten soil samples were analyzed for ignitability by SW846, 3rd Edition, 1010.

The results of the CSA identified areas of impacted soil and groundwater. The nature of the contamination included both halogenated organic compounds (e.g. TCE, trans-1,2-DCE, and vinyl chloride) and nonhalogenated, fuel-related constituents (e.g., TPH, MTBE, benzene, toluene, ethylbenzene, and xylene). The contamination encountered was typically identified in both shallow (2.5 to 17.5 feet bgs) and deep (17.5 to 35 feet bgs) wells.

Law also identified several plumes of shallow groundwater contamination including two plumes comprised primarily of petroleum-based constituents (e.g., benzene, toluene, ethylbenzene, and xylenes) and two plumes comprised of halogenated organic compounds (e.g., TCE). The plumes are all located north of Fourth Street and east of E Street, except for a portion of a TCE plume that extends southwest beyond the corner of Fourth and E Streets.

In general, contaminant concentrations in soil were greatest in those samples taken at or below the water table. Law concluded that soil contamination at Site 35 was likely due to the presence of a dissolved phase groundwater plume and seasonal fluctuations of the water table.

A follow-up to the CSA was conducted by Law in 1992. Reported as an Addendum to the CSA (Law, 1993), it was designed to provide further characterization of the southern extent of the previously identified petroleum contamination. Three monitoring wells were installed including MW-26, -27, and PW-28. Monitoring well construction details are summarized in Table 1-2 of the RI Report (Baker, 1994b). A copy of this table is included in Appendix A of the SGI Report. Soil samples were obtained from each of these locations and analyzed for TPH (gasoline and diesel fractions). As part of the follow-up, a pump test was performed to estimate the hydraulic characteristics of the surficial aquifer. This test was designed to determine performance characteristics of the pumping well (PW-28) and to estimate hydraulic parameters of the aquifer. An approximate hydraulic conductivity of 100 feet/day was determined for the surficial aquifer.

1.4.5 Interim Remedial Action RI/FS for Soil

An Interim Remedial Action field investigation was initiated by Baker in December to: 1) provide additional soil data to augment the existing Site 35 database; 2) determine the presence of non-fuel related chemical contaminants; 3) provide additional information regarding the extent of soil contamination; and, 4) support an Interim Remedial Action FS.

Seven soil borings (SB-29 through SB-35) were advanced to depths of 6 to 12 feet below ground surface (bgs) for the purpose of collecting samples for chemical analysis. Samples were screened with an HNu photoionization detector (PID) to detect potential volatile organic hydrocarbons and to help select which sample would be submitted for laboratory analysis. Samples submitted to the laboratory were analyzed for USEPA Contract Laboratory Program (CLP) Target Compound List (TCL) volatiles and semivolatiles, Target Analyte List (TAL) inorganics, TPH by SW846 3rd Edition, Modified Method 8015 and oil and grease by SW846 3rd Edition Method 9071. Samples analyzed for TPH were extracted in accordance with SW 846 3rd Edition, Methods 5030 (gasoline range organics) and 3550 (diesel range organics). A composite sample was analyzed for the TCLP and RCRA Hazardous Waste Characteristics.

In addition, 13 shallow surface soil samples (BCSB-01 through BCSB-13) were collected at a depth of zero to 12 inches from topographically low areas of Brinson Creek and the drainage channel located north of the Fuel Farm. Soil samples BCSB-01 through BCSB-10 were analyzed for CLP TCL volatiles and semivolatiles, TAL inorganics, TPH by SW 846 3rd Edition, Modified Method 8015 and oil and grease by SW 846 3rd Edition, Method 9071. Soil samples BCSB-11, 12, and 13 were analyzed for TPH and oil and grease only. A composite sample was analyzed for full TCLP and RCRA characteristics.

In general, analytical data gathered during the Interim RI suggested that the petroleum hydrocarbon contamination was primarily located near the surface of the shallow groundwater. The results indicate that the highest TPH-related contamination occurs at or below the water table and groundwater fluctuations likely account for the subsurface soil contamination detected immediately above the top of the groundwater.

The Interim Remedial Action RI/FS culminated with an executed Interim Record of Decision (ROD), signed on September 15, 1994, for the remediation of contaminated soil along and adjacent to the proposed highway right-of-way at Site 35. Three areas of contaminated soil were identified. The first area was located in the vicinity of the Fuel Farm ASTs, and the two other areas were located north of the Fuel Farm. The larger of these two areas was located along "F" Street in the vicinity of monitoring well MW-25. Baker estimated that approximately 3,600 cubic yards (4,900

tons) of contaminated soil was present in these areas. Contaminated soil located in these areas was excavated and disposed at an off-site soil recycling facility beginning in 1995 as part of an Interim Remedial Action executed by OHM Corporation (OHM).

A fourth area of soil contamination, located immediately north of Building G480, was also identified in the Interim ROD. Additional data pertaining to this fourth area became available subsequent to the execution of the Interim ROD. This data indicated that contaminated soil was encountered in this area during the removal of UST in January 1994. The contaminated soil was excavated and reportedly disposed off site; however, no documentation was available regarding how or where the soil was disposed. An additional soil investigation was conducted in this area by OHM as part of the Interim Remedial Action. OHM confirmed that the contaminated soil was not returned to the excavation and that follow-up soil remediation in this area was not necessary.

1.4.6 Remedial Investigation

Site-wide, comprehensive Remedial Investigation field activities were initiated by Baker in April 1994. The purpose of these activities was to provide additional data in order to assess the impact on aquatic and benthic species in Brinson Creek, support a site-wide risk assessment, determine the full nature and extent of halogenated organic contamination in the surficial aquifer, and support an FS. Field activities included the following: a soil gas and groundwater screening investigation; a soil investigation; a groundwater investigation; a surface water/sediment investigation; and, an ecological investigation.

The soil gas survey included the collection of 67 soil gas samples and 72 groundwater screening samples. This investigation was performed to gain additional information to assess potential sources of halogenated groundwater contamination and assist in the placement of monitoring wells.

The soil investigation included the advancement of 26 soil borings based on the results of the soil gas and groundwater screening investigation. Soil samples obtained from the borings were analyzed for TCL volatiles, semivolatiles, pesticides/PCBs, TAL metals and a variety of engineering parameters.

The groundwater investigation included the installation of shallow, intermediate and deep groundwater monitoring wells. Details of these wells are included in Tables 1-1 through 1-3 of the RI Report (Baker, 1995a) provided in Appendix A. Shallow monitoring wells were installed to intercept the upper portion of the surficial aquifer. The intermediate wells were constructed to monitor the lower portion of the surficial aquifer. Deep wells were constructed to monitor the upper portion of the Castle Hayne Aquifer.

Groundwater samples were obtained from 26 newly installed well, and 29 existing wells. Groundwater samples were analyzed for TCL volatiles, semivolatiles, pesticides/PCBs, TAL metals and a variety of engineering parameters.

Surface water and sediment samples were collected from 10 stations along Brinson Creek. These stations were located upstream, downstream and adjacent to Site 35. Surface water and sediment samples were analyzed for TCL volatiles, semivolatiles, pesticides/PCBs, TAL metals and particle size distribution. The ecological investigation included biological sampling along Brinson Creek and three streams in the nearby White Oak River watershed.

There were relatively few detection of VOCs and semivolatile organic compounds (SVOCs) in the subsurface and surface soil samples. Pesticides were detected in surface soil, but were not deemed to be site related.

Extensive organic groundwater contamination was observed in both the upper and lower portions of the surficial aquifer. Fuel-related contamination appeared to be more relevant in the upper portion of the surficial aquifer, and solvent-related organics were more prevalent in the lower portion of the surficial aquifer. The extent of fuel-related contamination was adequately defined by this investigation and is limited to an area in the vicinity of the Fuel Farm and nearby USTs. However, the extent of solvent-related contamination was not adequately defined. Two plumes of solvent-related contamination were identified, a larger plume in the vicinity of Fourth Street and a smaller plume in the vicinity of Building TC474. The southern boundaries of the larger plume were not delineated and appear to extend beyond the limits of this investigation.

Elevated levels of inorganic contaminants were also detected in groundwater samples collected from the surficial aquifer and appear to be due to the sampling methods used.

Significant levels of organic and inorganic contamination were detected in the sediment samples. However, some problems were experienced with this data. Detections of organic contamination were masked by a high number of tentatively identified compounds (TICs) and some inorganic data was rejected by professional data validators. Surface water contamination was limited to a single detection of lead and zinc at a sampling location downstream of Site 35. Selected data are included in Appendix A of the SGI Report.

Based on data obtained under the RI, a series of recommendations were developed as follows:

- The remedial groundwater investigation should be extended south of Fifth Street, as needed, to define the extent of solvent-related contamination in the surficial aquifer.
- Wells constructed during the RI and sampled for inorganics should be resampled using a low-flow sampling technique.
- Surface soils and sediment along Brinson Creek should be resampled and analyzed for mercury and zinc to replace rejected dated.
- Sediment samples collected along Brinson Creek should be analyzed for TPH to provide a measure of gross organic contamination.
- An Interim Remedial Action Feasibility Study for shallow groundwater in the vicinity of the Fuel Farm and Brinson Creek should be prepared.
- Groundwater and soil samples should be collected on the northern side of Brinson Creek to determine if Brinson Creek is acting as a hydraulic barrier to shallow groundwater contamination.

1.4.7 Interim Remedial Action Feasibility Study for Shallow Groundwater in the Vicinity of the Former Fuel Farm

In the Interim Remedial Action (IRA) Feasibility Study (FS) various technologies and process options were evaluated. Ultimately, five Remedial Action Alternatives (RAAs) were developed for the remediation of contaminated groundwater in the vicinity of Site 35. These RAAs included:

- RAA 1 - No Action
- RAA 2 - No Action With Institutional Controls
- RAA 3 - Groundwater Collection And On-Site Treatment
- RAA 4 - In-Situ Air Sparging and Off-Gas Carbon Adsorption
- RAA 5 - In Well Aeration and Off-Gas Carbon Adsorption

A detailed analysis of each RAA was performed including an assessment and summary profile of each RAA against an evaluation criteria and a comparative analysis among the RAAs to assess relative performance of each with respect to the criteria. Selected sections of this report are included in Appendix B of the SGI Report.

The Interim RA FS culminated with the execution of the “ Interim Record of Decision (ROD) For Surficial Groundwater for a Portion of Operable Unit No. 10 - Camp Geiger Fuel Farm,” signed on September 5, 1995. This ROD supports the remediation of contaminated surficial groundwater in the vicinity of the former Camp Geiger Fuel Farm extending downslope to Brinson Creek and is considered interim in nature because it represents only one phase of a comprehensive investigation and remediation at Site 35. Selected sections of this report are included in Appendix B of the SGI report.

The Interim ROD detailed five Remedial Action Alternatives (RAAs) for the remediation of organic contamination of the surficial aquifer. RAA 5, In Well Aeration with Off-Gas Carbon Adsorption, was selected as the preferred remedy in the Interim ROD, contingent upon the successful execution of preliminary field pilot-scale tests. This RAA included the construction of six aeration wells to be located just north of the northern Right-Of-Way (ROW) boundary of U.S. Route 17 Bypass along the length of the plume (900 feet) and an off-gas treatment facility.

The viability of in-well aeration technology at Camp Lejeune is currently being evaluated by a field pilot at Site 69. The results of this test will help to determine the viability of in-well aeration. If the results of the pilot test demonstrate that in-well aeration cannot be performed as required, the Interim ROD provides for RAA 3, Groundwater Collection and On-Site Treatment, to be substituted as the preferred remedy. The pilot test at Site 69 has experienced substantial delays to date. In the meantime, the EPA, NC DEHNR, LANTDIV, Camp Lejeune, and Baker agreed that a field-pilot test of in-situ air sparging (IAS) would be appropriate at this site to evaluate this technology as a possible alternative to those presented in the Interim ROD. If the results of the IAS pilot test are sufficiently positive, a request may be made to prepare an explanation of significant differences (ESD) document to modify the selected alternative.

1.4.8 Pilot-Scale Evaluation Of In-Situ Air Sparging

An in-situ air sparging pilot evaluation was conducted by Baker during July and August of 1996 to assess the viability of in-situ air sparging as a possible RA technology for shallow groundwater contamination in the vicinity of Brinson Creek at Site 35. As part of this study, 14 permanent

monitoring wells, two air sparging wells, and six soil gas probes were installed in the wetland area along Brinson Creek approximately 500 feet to the northeast of the former Fuel Farm. A copy of the Treatability Study Work Plan, Pilot Scale Evaluation of In-Situ Air Sparging, is included in Appendix C of the SGI Report.

During the pilot test, air was injected into shallow and intermediate wells under two different flow rates. Helium was injected with the air as a tracer gas. Prior to the start of the test, a round of groundwater and air, samples were collected from monitoring wells and soil gas probes to establish a baseline of control data. During the first two days of the test, air was injected into the sparge wells at a rate of five standard cubic feet per minute (scfm). During the second two days of the test, air was injected at a rate 20 scfm. At regular intervals during the test static water levels and dissolved oxygen levels were measured in the monitoring wells and groundwater samples were collected. Oxygen, pressure, and helium were measured in soil gas probes and soil gas samples were collected at regular intervals during the pilot test.

Currently, a report is being prepared by Baker that will present the results of the pilot test. This report is scheduled for submission in mid-November 1996.

1.4.9 Other Investigations

Two USTs, located near the Fuel Farm, have been the subject of previous investigations conducted under the Activity's UST program. The two USTs include a No. 6 fuel oil UST situated adjacent to the former Mess Hall Heating Plant and a No. 2 fuel oil UST situated adjacent to Building G480. The former was abandoned in place years ago (date unknown) and has been the subject of previous environmental investigations performed by ATEC Associates, Inc. (ATEC) and Law; the latter was removed in January 1994. Contaminated soils adjacent to the UST were reportedly removed with the tank. However, samples were not collected to confirm the limits of contamination.

As part of the Interim Remedial Action for soil that was executed between July 1995 and April 1996 by the OHM Corporation, four soil borings were advanced in the immediate vicinity of the former No. 2 fuel oil UST. Soil samples were collected from each location immediately above the water table and analyzed for TPH (5030 and 3550). Sample results verified the remaining soils do not contain hydrocarbon contamination associated with the former UST.

ATEC conducted a site assessment in the vicinity of Building TC341 to investigate contamination associated with the UST previously used to supply fuel to the Mess Hall Heating Plant. During the investigation, ATEC installed three shallow monitoring wells and analyzed the soils and groundwater for TPH (EPA Method 8015) and TEX. (EPA Method 8020) (ATEC, 1992).

TPH in soils ranged from 110 mg/kg (MW-3) to 2,000 mg/kg (MW-2). Total TEX. in soils ranged from non-detected concentrations to 5,530 µg/kg in MW-2. TPH in groundwater was detected in MW-1 at a concentration of 5 mg/L and in MW-2 at 3 mg/L. Total TEX. was detected in the groundwater sample collected from MW-2 at a concentration of 34 µg/L. Based on these results, ATEC had recommended removal of the UST and associated piping.

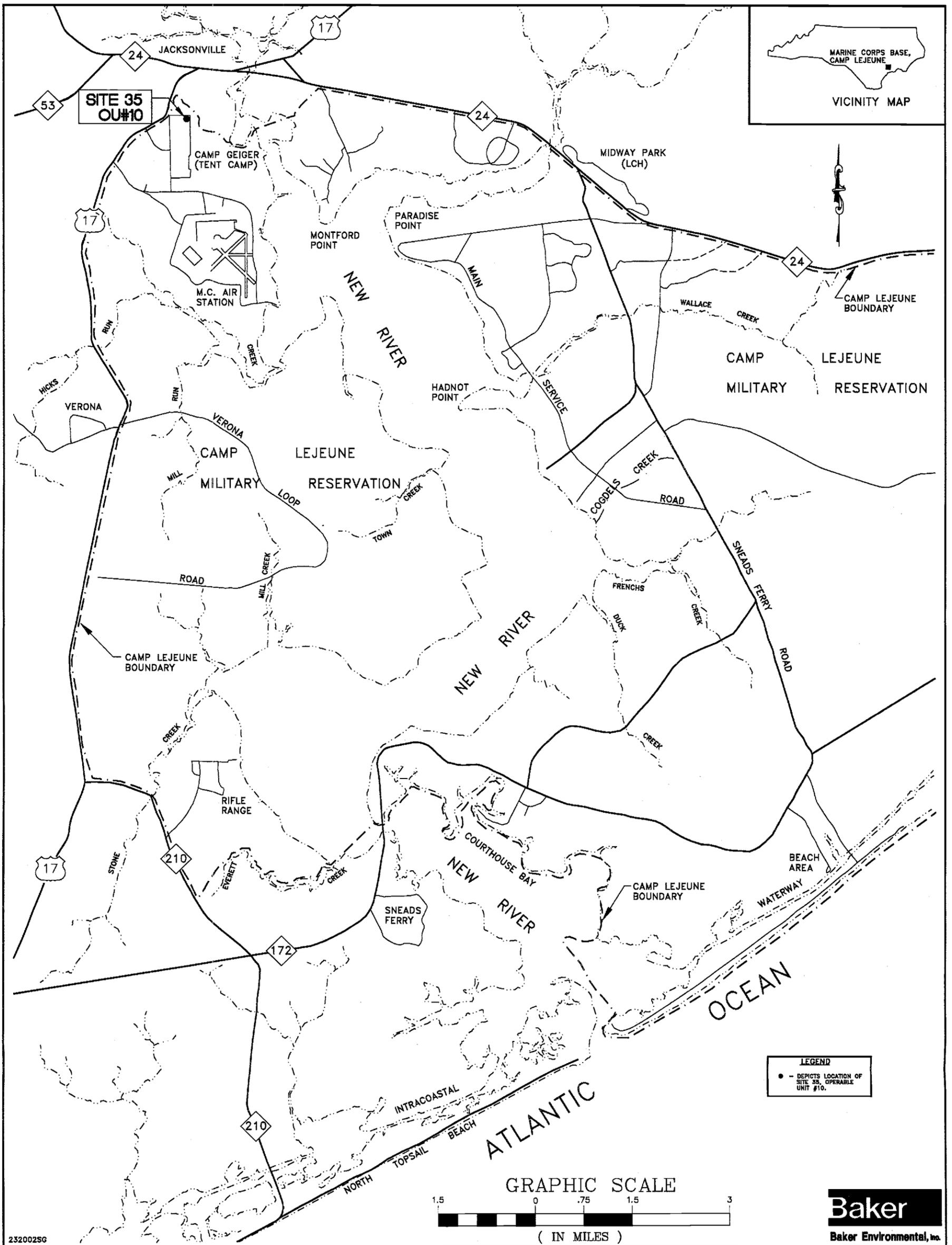
Law submitted a report to LANTDIV for a leaking underground storage tank (LUST) site assessment for Building TC341 on April 13, 1994, summarizing the activities conducted in March 1994. The assessment was conducted in order to delineate the extent of contamination identified by ATEC and

involved the installation of 12 Type II and two Type III groundwater monitoring wells and analysis of soils and groundwater. These locations are shown in a figure included in Appendix A (Figure 1-4 of the RI Report) of the SGI Report. Well construction details are provided on Table 1-3 of the RI report (Baker, 1994b). The soils were analyzed for TPH according to EPA Methods 5030/8015 (volatile fractions), 3550/8015 (semivolatile fraction), and 9071 (oil and grease), TCLP metals, ignitability, and pH. Groundwater samples were analyzed for purgeable aromatic hydrocarbons (EPA Method 602), polynuclear aromatic hydrocarbons (EPA Method 610), and the eight RCRA metals.

Results of TPH (5030/8015) in soils ranged from nondetectable concentrations to 4,100 mg/kg in MW-14 (3.5 to 5 feet). TPH (3550/8015) was detected in soil samples obtained from MW-11, MW-17, MW-14, and MW-15 at concentrations of 11 mg/kg, 11 mg/kg, 800 mg/kg, and 490 mg/kg, respectively. In addition, TCLP metals (barium, chromium, and cadmium) were detected in samples at concentrations below TCLP limits. Results for pH in soils ranged between 5.53 to 7.48 and ignitability was not detected.

RCRA metals, volatile organic compounds, and semivolatile organic compounds were detected in groundwater samples from monitoring wells MW-1 through MW-17. RCRA metals were detected in both of the samples submitted for metals analyses. VOCs were detected in four of the five samples submitted for analyses. Seventeen (17) samples were submitted for analyses of semivolatile organic compounds of which five possessed detectable concentrations. Law concluded that the majority of the soil and groundwater contamination originating from the tank system at Building TC341 had been adequately defined.

SECTION 1.0 FIGURES

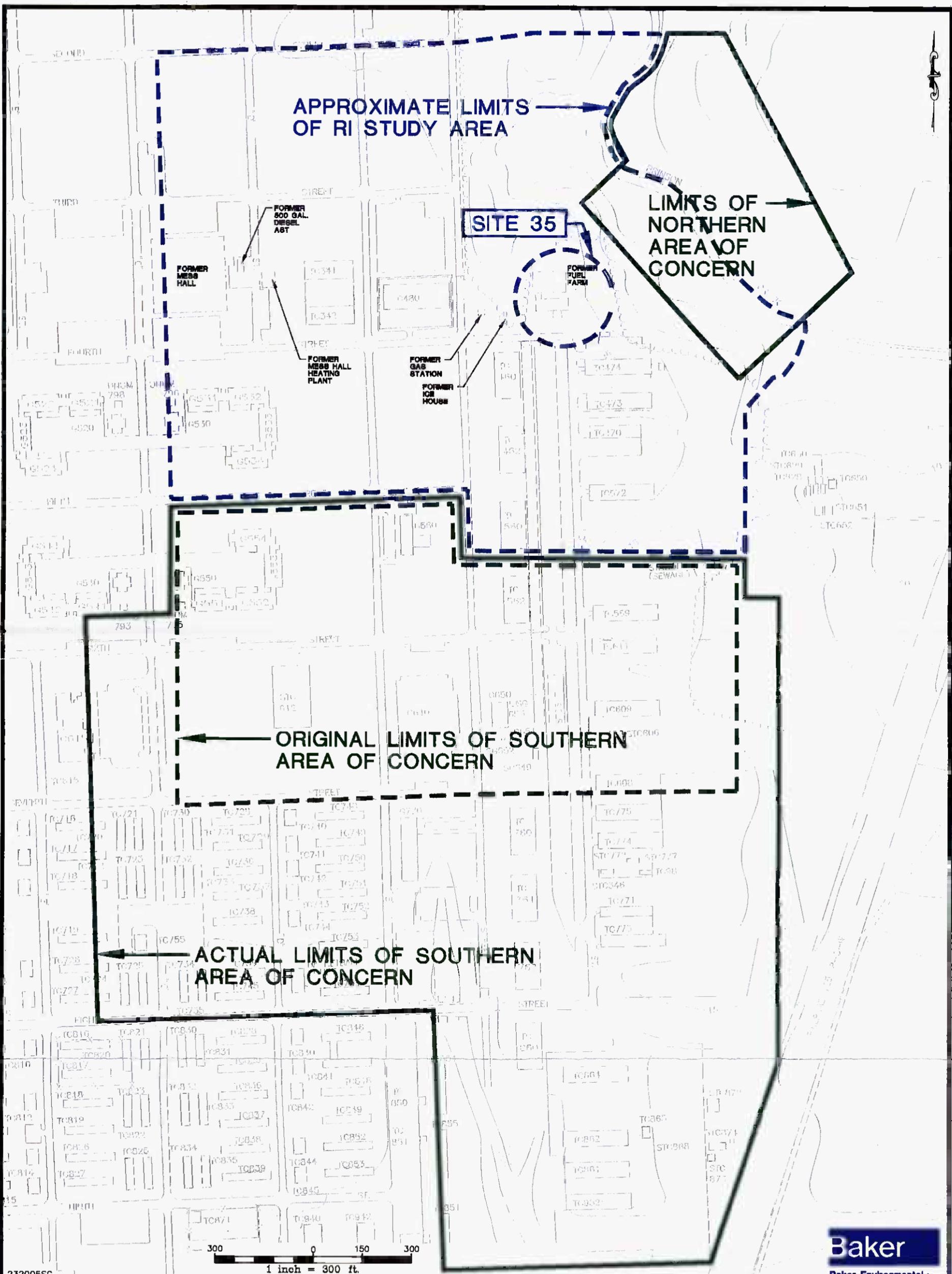


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FIGURE 1-1
 CAMP LEJEUNE AND SITE 35
 LOCATION MAP
 SITE 35, CAMP GEIGER AREA FUEL FARM, SGI
 CONTRACT TASK ORDER - 0232
 MARINE CORPS BASE, CAMP LEJEUNE
 NORTH CAROLINA

Baker
 Baker Environmental, Inc.

00157FF01Z



232005SG

LEGEND

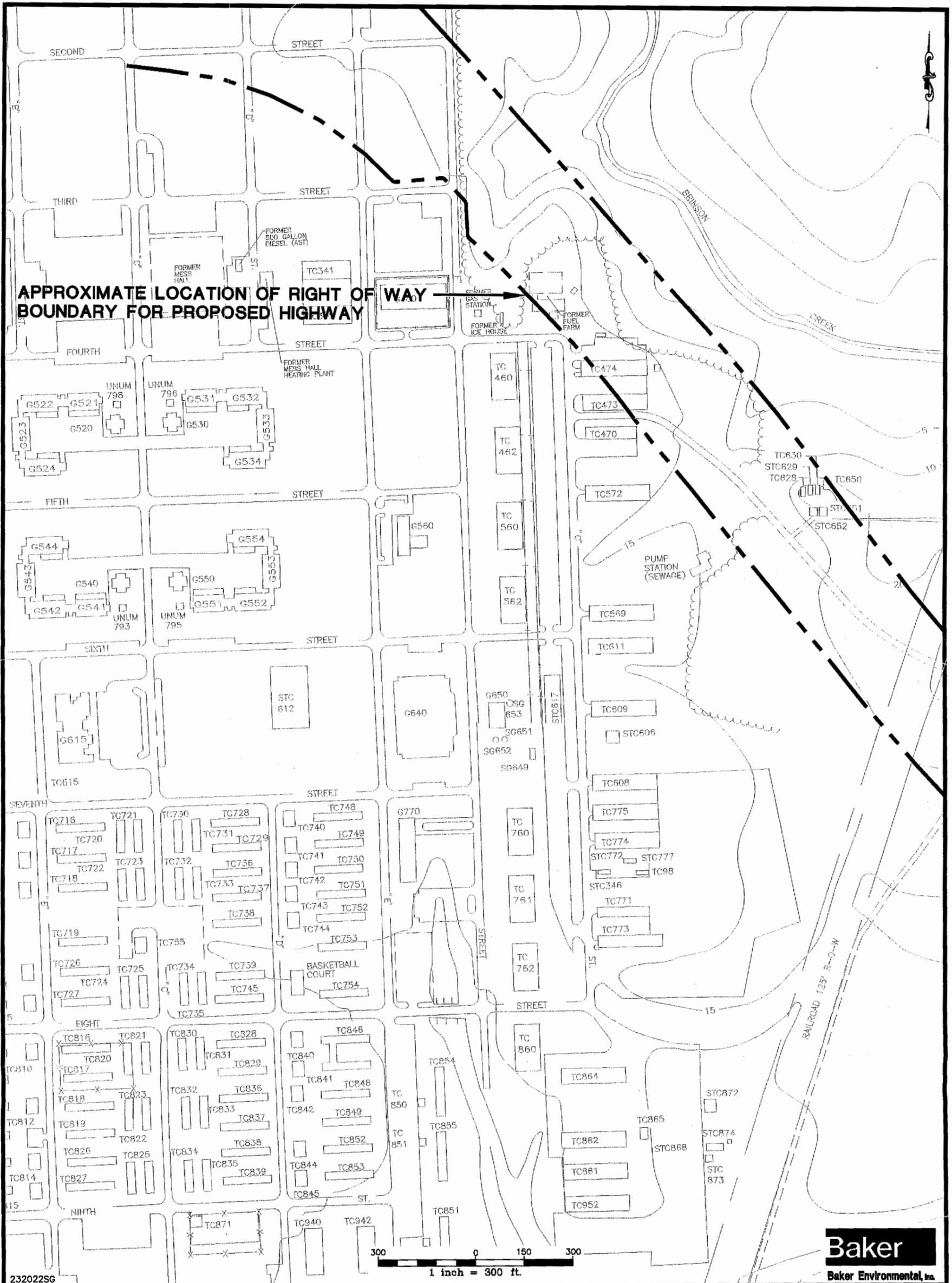
| | | | |
|-------|-----------------------------------|-----|--------------------|
| --- | - SURFACE ELEVATION CONTOUR | --- | - EDGE OF PAVEMENT |
| - - - | - FENCE | | |
| ▭ | - STRUCTURE | | |
| ~ | - TREE LINE | | |
| --- | - ABANDONED RAILROAD | | |
| --- | - UNIMPROVED ROAD/ PARKING LOT | | |

SOURCE: LANTDIV, OCT. 1991

FIGURE 1-2
SITE PLAN
SITE 35, CAMP GEIGER AREA FUEL FARM, SGI
CONTRACT TASK ORDER - 0232

MARINE CORPS BASE, CAMP LEJEUNE
 NORTH CAROLINA

00157FF02Y



APPROXIMATE LOCATION OF RIGHT OF WAY BOUNDARY FOR PROPOSED HIGHWAY

LEGEND

- - 10 - - SURFACE ELEVATION CONTOUR
- x - - FENCE
- ▭ - STRUCTURE
- ~~~~~ - TREE LINE
- - - - - APPROXIMATE LIMITS OF U.S. HIGHWAY 17 BYPASS

FIGURE 1-3
LOCATION OF PROPOSED HIGHWAY
RIGHT-OF-WAY
SITE 35, CAMP GEIGER AREA FUEL FARM, SGI
CONTRACT TASK ORDER - 0232
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

SOURCE: LANTDIV, OCT. 1991

Baker
 Baker Environmental, Inc.

00157FF03Z

SECTION 1.0 REFERENCES

SECTION 1.0 REFERENCES

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2.0 SGI FIELD PROGRAM

The SGI field program at Site 35 was initiated to fill data gaps identified in the RI Report (Baker, 1995) and gather data in support of an in-situ air sparging pilot test. Investigations conducted at the site were designed to provide:

- Sufficient groundwater data to define the extent and locate the source(s) of solvent-related groundwater contamination in the surficial aquifer south of Fifth Street.
- Inorganic groundwater data from existing wells screened in the surficial aquifer, using a low-flow sample collection technique to reduce sediments in groundwater samples and more accurately quantify total metals contamination.
- Metals data from surface soil and sediment samples to replace data that was rejected during validation of the RI data.
- TPH data from sediments along Brinson Creek to provide a measure of gross organic contamination.
- Groundwater and soil data from the northern side of Brinson Creek to determine if Brinson Creek is acting as a barrier to groundwater contamination that could potentially migrate off-site.
- Groundwater, soil, and lithologic data downgradient from the former Fuel Farm to support the implementation of an in-situ air sparging pilot test.

The SGI field program consisted of: a soil screening investigation; a groundwater screening investigation; a groundwater investigation that occurred in two rounds (Round 3 and 4); a sediment investigation; a site survey; and investigative derived waste (IDW) handling. SGI field activities occurred periodically between July 25, 1995 and October 9, 1996.

2.1 Soil Screening Investigation

A soil screening investigation was conducted at Site 35 in two phases. The initial phase occurred between April 8 and May 5, 1996 and was conducted in the NAOC on Activity property (southwest side of Brinson Creek) and in the SAOC (area between Fifth and Ninth Streets). The second phase occurred between July 29 and August 7, 1996 and was conducted in the NAOC on Onslow County property (northeast side of Brinson Creek). The soil screening investigation consisted of advancing soil borings, and subsurface soil sample collection for analysis and geologic identification for the purpose of meeting the following location specific objectives:

- NAOC - Onslow County property (northeast side of Brinson Creek)
 - ▶ Identify potential sources of solvent-related groundwater.
 - ▶ Provide geologic descriptions of subsurface soils.
 - ▶ Provide chemical data for use in determining potential permanent groundwater well locations

- NAOC - Activity property (southwest side of Brinson Creek)
 - ▶ Develop detailed geologic descriptions of subsurface soils to support the implementation of an in-situ air sparging pilot test.

- SAOC - Activity property (area between Fifth Street and Ninth Street)
 - ▶ Identify potential sources of solvent-related groundwater contamination.
 - ▶ Provide geologic descriptions of subsurface soils.
 - ▶ Provide chemical data for use in determining potential permanent groundwater well locations

2.1.1 Drilling Procedures

A total of 63 soil borings were advanced under the soil screening investigation with a truck mounted rig that was supplied and operated by Parratt-Wolf, Inc. of East Syracuse, New York. These borings/temporary well locations are depicted in Figure 2-1. Borings were advanced with 3.25-inch inside diameter (ID) hollow-stem augers to three depth ranges including: shallow (14 to 19.5 feet bgs); semi-shallow (23.5 to 27 feet bgs); and intermediate (32 to 47 feet bgs). The depths of individual borings drilled within the NAOC and SAOC, respectively, are summarized in Tables 2-1 and 2-2 (shallow, semi-shallow, and intermediate well borings have an A, C, or B designation, respectively). Borings were advanced in this manner to accommodate the installation of temporary monitoring wells in the upper, middle, and lower portions of the surficial aquifer. Selection of soil boring/temporary monitoring well locations was based on a review of data obtained from previous environmental investigations. A more detailed rationale for the locations of soil borings/temporary monitoring wells is provided in Section 2.2.

Shallow and semi-shallow soil borings were advanced for the purpose of temporary monitoring well installation only. These borings were not logged by the site geologist due to the close horizontal proximity of an intermediate boring. Intermediate borings were advanced to the semi-confining layer underlying the surficial aquifer for the purpose of sample collection, geologic identification and description, and temporary monitoring well installation.

The intermediate borings were continuously sampled to the water table (approximately 6 to 8 feet bgs) and every five feet thereafter to termination of the boring with a split-spoon sampling device following methods outlined in ASTM 1586-84. The sampling protocols were modified in some cases where the site geologist needed more information about a specific soil type or if the formation appeared to be unstable at a particular interval. Soils were considered unstable if problems occurred during drilling that were indicative of borehole collapse. When unstable soils were encountered, samples were not collected until the borehole was advanced beyond the problem interval. Each split-spoon soil sample was classified in the field by the site geologist. Soils were classified, recorded in a field logbook, and later transposed onto boring log records. Classification included characterization of soil type, grain size, color, moisture content, relative density (from Standard Penetration Test "blow counts"), plasticity and other pertinent information such as indications of contamination. Lithologic descriptions of site soils are provided on the Test Boring and Well Construction Records contained in Appendix D.

2.1.2 Soil Sampling

Soil samples were collected from intermediate soil borings advanced in the NAOC on Onslow County property (northeast side of Brinson Creek), the NAOC on Activity property (southwest side of Brinson Creek), and in the SAOC for the purpose of identifying potential sources of solvent-related groundwater contamination. A single vadose zone subsurface soil sample was collected from each of the intermediate soil borings and submitted for analysis. Samples were selected based on volatile organic headspace analysis or proximity to the water table. Each sample was collected via a split-spoon sampling device and placed in the appropriate laboratory supplied containers.

In the NAOC on Onslow County property (northeast side of Brinson Creek), a total of five soil borings (three intermediate and two shallow) were advanced as part of the soil screening investigation. Subsurface environmental soil samples were collected from all of the intermediate soil borings and analyzed via an on-site mobile laboratory.

In the NAOC on Activity property (southwest side of Brinson Creek), a total of 32 soil borings (10 shallow, 10 semi-shallow, and 12 intermediate) were advanced as a part of the soil screening investigation. Subsurface environmental soil samples were collected from the first ten intermediate borings (boring locations 35-TW16B through 20B and 35-TW22B through 26B) and submitted to the on-site laboratory for analysis. No contaminants were detected in these samples; therefore, a decision was made that no further soil samples would be collected from the remaining two intermediate soil borings (35-TW27B and 35-TW28B).

In the SAOC, a total of 27 soil borings (11 shallow and 16 intermediate) were advanced as part of the soil screening investigation. Subsurface soil samples were obtained from the first 11 intermediate borings (boring locations 35-TW01 through 11B) that were advanced between Sixth and Seventh Streets. No contaminants were detected in these samples, so no additional subsurface soil samples were collected from the final five intermediate soil borings advanced between Seventh and Eighth Streets (boring locations 35-TW12B through 15B and 35-TW29B).

2.1.3 Analytical Program

The analytical program for the soil screening investigation at Site 35 focused on known contaminants identified in the RI. In general, soil samples collected at the site were analyzed for cis-1,2-dichloroethene (cis-1,2-DCE), trans-1,2-dichloroethene (trans-1,2-DCE), trichloroethene (TCE), benzene, toluene, ethylbenzene, xylenes (BTEX), and methyl-tertiary-butyl-ether (MTBE) using modified EPA Methods 8010A/8020A. The analysis of soil samples was performed on-site by Microseeps, Inc. of Pittsburgh, Pennsylvania, via a mobile laboratory featuring a gas chromatograph (GC). A summary of the sample numbers, sample depths and parameters analyzed is provided in Appendix E.

2.1.4 Results

No fuel or solvent-related contaminants were detected in any subsurface soil sample collected and analyzed during the soil screening investigation.

2.2 Groundwater Screening Investigation

A groundwater screening investigation was conducted at Site 35 in two phases. The initial phase occurred between April 8 and May 5, 1996 and was conducted in the NAOC on Activity property (southwest side of Brinson Creek) and in the SAOC (between Fifth and Ninth Street). The second phase occurred between July 29 and August 7, 1996 and was conducted in the NAOC on Onslow County property (northeast side of Brinson Creek). The groundwater screening investigation conducted at Site 35 consisted of temporary well installation, groundwater sampling, and well abandonment for the purpose of meeting the following location-specific objectives:

- NAOC - Onslow County property (northeast side of Brinson Creek)
 - ▶ Determine if Brinson Creek is acting as a hydraulic barrier to fuel and solvent-related groundwater contamination migrating off-site onto Onslow County property.
 - ▶ Provide chemical data for use in determining potential permanent groundwater well locations.

- NAOC - Activity property (southwest side of Brinson Creek)
 - ▶ Provide a detailed vertical profile and determine the horizontal extent of solvent and fuel-related groundwater contamination downgradient of the former Fuel Farm at the boundary of the Brinson Creek wetland to select the precise location(s) for the in-situ air sparging pilot test.

- SAOC - Activity property (area between Fifth Street and Ninth Street)
 - ▶ Sufficiently define the horizontal extent of solvent-related groundwater contamination in the upper and lower portions of the surficial aquifer south of Fifth Street to effectively locate permanent groundwater monitoring wells.

The locations of all temporary monitoring wells are shown in Figure 2-1.

The field procedures and sampling methods employed for this study were implemented in accordance with USEPA Region IV SOPs. These procedures also include sample handling and preservation, documentation, and chain-of-custody. Specific sampling procedures are detailed in the FSAP (Baker, 1994).

2.2.1 Temporary Monitoring Well Installation

A total of 63 temporary monitoring wells were installed as part of the groundwater screening phase of the SGI at Site 35. Each temporary well was constructed with a 1-inch inside diameter (ID), Schedule 40, polyvinyl chloride (PVC) casing and No. 10 slot (0.01-inch) screen. Initially, each borehole was advanced by a 3 1/4-inch ID auger to depth (during the soil screening phase). Upon completion of the borehole, the well was fitted with a 2-inch diameter well sock and installed through the auger to depth. As the augers were removed, the borehole was allowed to collapse around the well. In all cases collapse occurred above the well screen to within a few feet of the ground surface. The installation of bentonite seals were not required because sampling occurred the same day as well installation. Once groundwater samples were obtained, the temporary wells were removed manually. The remaining open portion of the temporary well boreholes were backfilled with native material.

During drilling and well installation operations, a substantial volume of water was introduced into each borehole (between 50 and 200 gallons per borehole) to prevent heaving sands. Due to the physical limits of the temporary monitoring wells (1-inch ID), only a portion of the water added during drilling was removed. The low flow peristaltic pumps, used to purge the wells, have a maximum flow rate of between 0.25 and 0.33 gallons per minute (gpm). At these pumping rates wells that had 200 gallons of water introduced would have required 10 to 13 hours of pumping prior to sampling. Considering that this activity was a screening operation, a decision was made to follow standard purging practices prior to sampling (i.e., removal of three to five well volumes).

Temporary monitoring were installed to three depth ranges including: shallow (14 to 19.5 feet bgs); semi-shallow (23.5 to 27.5 feet bgs); and intermediate (32 to 47 feet bgs). Shallow wells were screened across the water table with a 10-foot screen. Semi-shallow and intermediate wells were screened in the middle and lower portions of the surficial aquifer, respectively, and both were constructed with five-foot screens. For identification purposes, the letters A, C, and B at the end of each well number indicate a shallow (35-TW16A), semi-shallow (35-TW16B), or intermediate (35-TW16C) well, respectively.

Temporary monitoring wells were installed in three types of configuration including: three-well clusters; two well clusters; and, single wells. The type of configuration selected depended on the sampling objectives of the AOC. A three-well cluster consisted of shallow, semi-shallow and intermediate temporary wells (i.e 35-TW16A,B,C) that were installed in the same general location, but not in the same borehole. A two well cluster consisted of a shallow and an intermediate well (i.e., 35-TW1A,B). Single wells were all constructed to an intermediate depth (i.e., 35-TW29B).

The distribution of temporary wells by AOC is described in the following sections.

NAOC - Onslow County property (northeast side of Brinson Creek)

In this area, two well clusters consisting of two wells each (35-TW30A,B and 35-TW31A,B) were installed. These clusters were located directly across Brinson Creek to monitor the plumes of fuel and solvent-related groundwater contamination located on the Activity property (southwest side of Brinson Creek) that were identified in the RI. The locations of these wells were surveyed and staked by Lanier Surveying, Inc. (Lanier) of Jacksonville, North Carolina, prior to installation.

NAOC - Activity property (southwest side of Brinson Creek)

In this area, 10, well clusters consisting of three wells each (35-TW16A,B,C through 20A,B,C and 35-TW22A,B,C through 26A,B,C) , and two single wells (35-TW27B and 35-TW28B) were installed in a line roughly parallel to Brinson Creek that extends from Second Street to Building TC474. The locations of these wells were identified by Baker personnel prior to installation.

Two intermediate single wells were installed at locations 35-TW27B and 35-TW28B based on contamination levels observed in wells 35-TW16 through 18A,B,C (see Figures 2-2, 2-3, and 2-4). Concentrations of solvent-related contamination decreased in the upper and middle portion of the surficial aquifer across wells 35-TW18A,B; 17A,B; and 16A,B. However, concentrations of solvent-related contamination in these wells increases with depth to a maximum in the lower portion of the surficial aquifer. A field decision was made based on this data to monitor only the lower portion of the surficial aquifer beyond (south of) temporary well location 35-TW16A,B,C at 100-

foot intervals in line with existing temporary wells until the horizontal extent of solvent-related contamination could be established. Two wells, 35-TW27B and 35-TW28B were installed to establish the horizontal extent of contamination in the southerly direction.

SAOC - Activity property (area between Fifth Street and Ninth Street)

In this area, 11, two-well clusters (35-TW01A,B through 11A,B) and five intermediate single wells (35-TW12B through 15B and 29B) were required to establish the approximate limits of solvent-related contamination south of Fifth Street. Prior to the commencement of drilling activities 61 potential locations were staked in a grid bounded to the north and south by Fifth and Ninth Streets, and to the east and west by the eastern tree line of Camp Geiger and "B" Street (see Figure 2-5).

Five, two well clusters (35-TW01A,B through 05A,B) were initially installed on the north side of Fifth Street between "C" Street and Building TC569, as proposed in the Work Plan Addendum. However, these well clusters did not bound the solvent-related contamination in the lower portion of the surficial aquifer. Consequently, two additional two-well clusters (35-TW06A,B and 35-TW10A,B) were installed to define the plume to the east and west.

In an attempt to identify the southern limits of the plume, four, two-well clusters (35-TW07A,B through 09A,B and 35-TW11A,B) were installed on the north side of Seventh Street between "B" Street and Building TC608 (approximately). Groundwater analytical results from this line of monitoring wells did not define the solvent-related contamination to the south. Therefore, five, single intermediate wells (35-TW12B through 15B and 35-TW29B) were installed in an area roughly bordered by Building TC771 to the north, the abandoned railroad right-of-way (ROW) to the east, Building TC952 to the south, and "E" Street to the west. Single intermediate wells were installed in this area because no solvent or fuel-related contamination was detected in the previously installed shallow temporary wells (35-TW01A through 11A). This effort was successful in identifying the edge of the solvent-related groundwater contamination plume.

2.2.2 Sampling Program

A single groundwater sample was obtained from each of the 63 temporary wells installed under the SGI. In addition, a limited number of existing permanent wells (MW16S,D through 19S,D) were sampled to supplement data obtained from the temporary wells and to provide a comparison to data previously obtained from the existing permanent monitoring wells.

Prior to sampling, the wells were purged with a low-flow peristaltic pump that maintained a flow rate of 0.25 to 0.33 gallons per minute (gpm) to reduce sediments in groundwater samples and the possibility of cross-contamination between sampling points. Samples were collected directly from the pump's discharge tubing. Subsequent to purging, a sample was collected when the following conditions were met:

- A minimum of three to five well volumes were removed.
- Three successive well volumes exhibited measurements of conductivity, pH, and temperature that varied no more than ± 10 percent.
- Samples exhibited turbidity measurements of 10 NTUs or less.

Temporary wells were purged for no more than three hours if turbidity measurements did not drop below 10 NTUs. A summary of groundwater field parameters (purging logs) is included in Table 2-3.

A total of 75 groundwater samples were collected during the groundwater screening investigation. Samples were collected from all 63 temporary wells and eight permanent wells. Four temporary wells (35-TW30A,B and 35-TW31A,B) were resampled. Preparation of groundwater screening samples incorporated procedures similar to those described for soil screening samples.

2.2.3 Analytical Program

The analytical program for the groundwater screening investigation at Site 35 focused on known contaminants identified in the RI. The majority of groundwater samples collected from the temporary monitoring wells (67 samples) were analyzed for cis-1,2-dichloroethene (cis-1,2-DCE), trans-1,2-dichloroethene (trans-1,2-DCE), trichloroethene (TCE), benzene, toluene, ethylbenzene, xylenes (BTEX), and methyl-tertiary-butyl-ether (MTBE) using modified EPA Methods 8010A/8020A. These samples were analyzed on-site by Microseeps Inc. with a mobile laboratory featuring a field GC. A summary of sample collection dates and parameters is included in Appendix F.

Due to delays in obtaining utility clearance for well installation, scheduling conflicts with the mobile lab, and resampling efforts, a total of nine groundwater screening samples were sent to a fixed-base laboratory (Quanterra Environmental Services of Knoxville, TN) and analyzed for Target Compound List (TCL) volatiles. Samples were prepared and handled according to USEPA Region IV Standard Operating Procedures (SOPs) as outlined in the FSAP (Baker, 1994). Chain-of-custody documentation (provided in Appendix G) which included information such as sample number, date and time of collection, and sampling party, accompanied the samples to the laboratories.

2.2.4 Results

Results of groundwater screening are summarized for the NAOC in Tables 2-2-4, 2-5, and 2-6, respectively, and depicted on Figures 2-2, 2-3, and 2-4, respectively. Results of groundwater screening activities in the SAOC are summarized in Table 2-6 and depicted on Figure 2-6. Groundwater contamination detected by the screening activities are summarized by AOC below:

NAOC - Onslow County property (northeast side of Brinson Creek)

No fuel or solvent-related groundwater contamination were detected in samples analyzed by the on-site or fixed-base laboratories. However, low levels of chloroform were detected (0.2 µg/L - 3.7 µg/L) from samples collected from these wells and analyzed on-site by the mobile laboratory.

NAOC -Activity property (southwest side of Brinson Creek)

Extensive fuel or solvent-related groundwater contamination was detected in the upper, mid and lower portions of the surficial aquifer. Detections of BTEX and solvent-related contamination at these intervals in the NAOC shallow aquifer are depicted in Figures 2-2, 2-3, and 2-4.

From this data the leading edge of two overlapping plumes can be identified. The northernmost plume is primarily a fuel-related contamination plume which extends approximately 300 feet from

a point north of well cluster 35-TW26A,B,C to a point near well cluster 35-TW19A,B,C, and appears to be centered near well cluster 35-TW23A,B,C. In general, contamination in the center of the plume extends down into the middle portion of the surficial aquifer (approximately 25 feet bgs). Contamination identified near the edges of the plume extends down to about 15 feet bgs.

The southernmost plume is a deeper, chlorinated solvent plume (primarily TCE and 1,2-DCE) and extends approximately 450 feet from just north of well cluster 35-TW22A,B,C to a point just south of point 35-TW27B. Samples from well clusters 35-TW16A,B,C and TW17A,B,C show the highest levels of solvent contamination. Contamination in this plume generally is absent within the upper ten feet of the aquifer, with concentrations decreasing dramatically with depth to the confining layer located 30 to 35 feet bgs.

SAOC - Activity property (between Fifth and Ninth Street)

Contamination in this area is limited to solvent-related constituents in the lower portion of the surficial aquifer. No fuel-related contaminants were encountered; however, it appears that two separate plumes of solvent-related contamination exist south of Fifth Street (each apparently from different sources). Detected solvent-related contamination and the approximate limits of the contaminant plumes are shown on Figure 2-6.

The northern plume (limits of which were established during the RI) appears to originate from an undetermined source(s) at Site 35. This plume appears to extend from Fifth Street to a point in the vicinity of Buildings TC773 and TC762. Between Fifth and Sixth Streets this plume extends from "C" Street to the eastern tree line of Camp Geiger. However, south of Sixth Street the plume begins to narrow and appears to end at Building TC773.

In the vicinity of Eighth Street, approximately 150 feet south of Building TC773, the apparent edge of another solvent-related plume was identified. Concentrations of solvent-related contamination in temporary monitoring wells installed south and southeast of Building TC773 were substantially higher than concentrations of contamination in wells installed along Seventh Street, near Building TC771, and on the north side of Eighth Street. The limits of both plumes established by the SGI are shown on Figure 2-6.

In August 1996, Baker conducted a site investigation (SI) at OU No. 16 Site 83 at Camp Geiger. The limits of this study area overlap the SGI study area in the vicinity of Building TC773. During the SI, an attempt was made to define the limits of the southern solvent-related groundwater contamination plume. The results of the SI will be included in a report scheduled for completion in November 1996.

2.3 Groundwater Investigation

The groundwater investigation performed at the site consisted of several activities including: installation of permanent shallow, intermediate and deep monitoring wells; well development; groundwater sampling; static water measurements; and aquifer testing. The objectives of this investigation were as follows:

- To gather inorganic groundwater data from existing wells screened in the surficial aquifer through the use of low-flow pumping technique to more accurately quantify total metals contamination.

- Confirm the presence or absence of fuel and solvent-related contamination in the surficial aquifer and upper portion of the Castle Hayne Aquifer.
- Evaluate the shallow and deep groundwater flow patterns in the area.

The field procedures and sampling methods employed for this study were implemented in accordance with USEPA Region IV SOPs and included sample handling and preservation, documentation and chain-of-custody procedures. Specific sampling procedures are detailed in the FSAP (Baker, 1994). The following sections describe the procedures for drilling/monitoring well installation, well development, groundwater sampling and static water level measurements.

2.3.1 Well Installation

Seven (7) Type II groundwater monitoring wells (wells without an outer casing sealing off a confining layer) were installed between April 27 and May 1, 1996 and July 31 and August 1, 1996 at locations depicted on Figure 2-7. These wells were installed in the water table aquifer to determine the horizontal and vertical extent of contamination existing within the aquifer, and evaluate the shallow groundwater flow patterns. The shallow wells were constructed in a manner that would allow the screened portion of the well to intercept the water table. The screen intervals were designed to compensate for seasonal fluctuation in the water table.

The permanent wells were constructed of two-inch nominal diameter, Schedule 40, flush-joint and threaded PVC casing with a 10-slot (0.01-inch) screen. The shallow wells were constructed with 10-foot long screens and the intermediate wells were constructed with 5-foot long screens. A medium-grained sand pack was placed in the annulus between the screen and the borehole wall extending above the screen interval (a minimum of 0.4 feet). A sodium bentonite seal (a minimum of one foot) was placed on top of the sand pack to prohibit intrusion of grout or surface run-off into the sand pack. The remaining annular space between the bentonite seal and the surface was filled with a cement/bentonite grout. The shallow and intermediate wells situated on the Activity side of the site were completed with flush mounts and wells located on Onslow County property were completed with a mounted protective casing, well pad and cement-filled ballards. Well tags, containing well construction details and the notation "Caution Not Potable Water," were affixed to the wells. Intermediate and shallow permanent well construction details are summarized in Table 2-7.

Two Type III groundwater monitoring wells (wells installed with an outer casing to seal off the confining layer) were installed in each of the deep soil borings between April 25, to April 27, 1996 and between July 30 and August 1, 1996. These wells were designed to evaluate the vertical extent of contamination and the groundwater flow patterns of the deep aquifer. The wells were constructed in a manner that would position the screen directly beneath the semi-confining layer to monitor the upper portion of the Castle Hayne Aquifer. The wells were constructed in the same manner as the intermediate wells with the exception that a steel outer casing was installed to seal off vertical migration of contamination from the water table aquifer into the Castle Hayne Aquifer via the borehole. Deep permanent well construction details are summarized in Table 2-8.

2.3.2 Well Development

Existing wells, sampled for metals and newly installed wells, were developed to remove fine-grained sediment from the screen and to establish hydraulic communication between the well and

the formation. Permanent shallow and intermediate groundwater monitoring wells were developed using a centrifugal pump and check valve or inertial pumping system (Waterra). Deep permanent wells were developed with the Waterra system. Well depths and water levels were measured and well volumes calculated. A check valve was secured to the end of a length of flexible tubing (flex hose) that was inserted into the well. The top end of the flex hose was secured to a Waterra or centrifugal pump. All flex hose was decontaminated with a damp paper towel prior to insertion into a well.

A centrifugal pump, when used to develop monitoring wells, was allowed to pump for 10 to 15 minutes to remove any stagnant water prior to being surged. After this initial pumping period, the flex hose was removed and a surge block secured to the flex hose. To flush accumulated sediment out of the sand pack the well was surged along the entire length of the screen in approximately two-foot intervals. Surging was performed on each well for approximately 20 minutes. After surging was completed, the check valve was reinserted into the well and the pump restarted. Pumping continued until pH, temperature, and conductivity readings stabilized (three successive well volume readings varying no more than 10 percent) and turbidity was less than 10 NTUs. Total pumping time did not exceed three hours if turbidity was problematic, and a minimum of three to five well volumes were removed from each well. Hoses used for development were dedicated to each well to minimize the potential of cross-contamination. Groundwater recovered during development procedures was temporarily stored in drums, then transferred into an on-site tanker or 1,000-gallon polyethylene tank. A summary of well development information is provided in Appendix H.

2.3.3 Static Water Level Measurements

Static water level measurements were collected at various times throughout the investigation. The measurements were recorded using an electronic measuring tape to the nearest 0.01 foot from the top of casing. A complete round of data was collected from a select group of existing wells and all newly installed wells on July 29, 1996. Tables 2-9, 2-10, and 2-11 summarize the measurements collected from the shallow, and intermediate monitoring wells, and deep monitoring well, respectively.

2.3.4 Groundwater Sampling

Groundwater samples were collected in two rounds: Round 3 samples were collected between August 7 and August 16, 1995 and Round 4 samples were collected between April 29, May 3, 1996 and August 4, 1996.

During Round 3 groundwater samples were collected from a total of 20 existing monitoring wells located within the limits of the RI study area (see Figure 2-8). The purpose of this sampling effort was to gather groundwater data from existing wells screened in the surficial aquifer using low-flow purging techniques to accurately quantify total metals contamination. Samples collected during this round were shipped overnight to Incheape Testing Corporation in Richardson, Texas.

During Round 4, groundwater samples were collected from 12 existing wells located within the RI study area and three newly installed wells in the NAOC (Onslow County property) and five newly installed wells in the SAOC (see Figure 2-9). The purpose of this sampling effort in the NAOC was to confirm that Brinson Creek provides a hydraulic barrier which is preventing the migration of fuel or solvent-related contamination onto Onslow County property. The purpose of the sampling effort

in the RI study area and SAOC was to confirm the presence or absence of fuel or solvent-related contamination in the surficial and Castle Hayne aquifers. Samples collected during this round were shipped overnight to Quanterra Environmental Testing Services in Knoxville, Tennessee.

Samples obtained in both rounds were collected and prepared in the same manner. Groundwater samples were collected using the low-flow sampling technique discussed in Section 2.2.2. summaries of groundwater field parameters (purging logs) for Rounds 3 and 4 are included in Tables 2-12 and 2-13, respectively. Samples were prepared and handled according to USEPA Region IV Standard Operating Procedures (SOPs) as outlined in the FSAP (Baker, 1994). Chain-of-custody documentation accompanied the samples to the laboratories and included information such as sample number, date and time of collection, and sampling party (Appendix G)

2.3.5 Groundwater Analytical Program

The analytical program focused on different contaminants based on the purpose of the sampling effort. Groundwater samples collected during Round 3 were analyzed for TAL metals and engineering parameters; total suspended solids (TSS) and total dissolved solids (TDS). The engineering parameters were intended to assist in selecting potentially applicable remedial technologies. Groundwater samples collected during Round 4 were analyzed for Target Compound List (TCL) Volatiles. A summary of the sample numbers and parameters analyzed are provided in Appendix E.

2.4 Sediment Investigation

Sediment samples were obtained along Brinson Creek to assess the extent of gross fuel-related contamination from Site 35 operations to Brinson Creek sediments and replace data rejected during the RI validation. This investigation was conducted on August 7 and 8, 1995. Samples were collected from the 10 sampling stations along Brinson Creek established during the RI. These stations include three upstream (35-SD01 through 35-SD03) and seven adjacent/downstream locations (35-SD04 through 07 and 36-SD05 through 07) between the site and the New River (Figure 2-10).

2.4.1 Sediment Sampling

At each sediment sampling station samples were collected at a depth of 0 to 6 inches and 6 to 12 inches. Because the sediment samples were collected from the near bank where the water was shallow, use of a coring device as proposed in the FSAP (Baker, 1994) was not necessary. Instead, a liner without the cover was used to collect the sediment samples. A new plastic liner tube, fitted with an eggshell catcher to prevent sample loss (if necessary), was used at each station.

The liner was pushed into the sediments to a minimum depth of 15 inches, or until refusal, whichever was encountered first. The sediments in the 0 to 6 inch interval and 6 to 12 inch interval were removed with a decontaminated extruder and placed into the appropriate sample containers. If less than 12 inches of sediments were obtained, the first 6 inches were placed in the 0 to 6 inch container, and the remaining sediment was placed in the 6- to 12-inch container.

2.4.2 Sediment Analytical Program

Sediment samples were analyzed for TPH (EPA Methods 5030 and 3550), mercury, zinc, and particle size distribution. A summary of the sample numbers and parameters analyzed are provided in Appendix E. The samples were prepared and handled in accordance with the FSAP (Baker, 1994) and USEPA Region IV SOPs.

2.5 Surveying

All SGI surveying was performed by Lanier Surveying, Inc. of Jacksonville, North Carolina. Survey data was provided for roads, major building foundations, tree lines and monitoring well locations (temporary and permanent) in the AOCs not surveyed under the previous RI or RAC Design for Site 35 Groundwater (CTO-0323). Survey points included a latitude coordinate, longitude coordinate and an elevation expressed in feet mean sea level. The vertical and horizontal accuracy was provided within 0.1 feet. In addition, all points were referenced to the North Carolina State Plain Coordinate System (NCSPCS). A sufficient number of points were established to tie new survey data with previous surveys conducted at Site 35.

2.6 Investigative Derived Waste (IDW) Handling

Field investigation activities at Site 35 resulted in the generation of various IDW including, drilling mud, soil cuttings, development water, purge water, soils from sampling activities, and decontamination fluids. General management techniques utilized for the IDW included:

- Collection and containerization of IDW material.
- Temporary storage of IDW while awaiting analytical data.
- Final disposal of aqueous and solid IDW material.

The management of the IDW was performed in accordance with guidelines developed by the USEPA Office of Emergency and Remedial Response, Hazardous Site Control Division. Appendix I provides specific details on the management and disposal of IDW generated during SGI operations.

Because this investigation was conducted at several AOCs over approximately one year, liquid and solid IDW was disposed on several occasions. Liquid IDW from Round 3 well development and groundwater sampling was containerized in an on-site tanker provided by Shamrock Environmental Inc. After receiving analytical results in October, 1995, this IDW was transported to the Hadnot Point Groundwater Treatment Plant. Solid and liquid IDW generated during April and May, 1996, was stored in a roll-off box and tanker, respectively which were located at Site 35. After receiving laboratory analytical results in May 1996, the liquid IDW was transported to the Lot 203 Groundwater Treatment Plant and the solid IDW was deposited on-site and graded. Solid and liquid IDW generated during July and August 1996 were stored in a roll-off box and two polyethylene tanks, respectively, located on Onslow County property behind the County Animal Control Facility on Georgetown Road in Jacksonville, NC. In October, 1996, after receiving the laboratory analytical results, the liquid IDW was transported to the Lot 203 Groundwater Treatment Plant for treatment and the solid IDW was transported to the Activity side of the NAOC (southwest side of Brinson Creek) where it was deposited and graded.

SECTION 2.0 TABLES

TABLE 2-1

**SUMMARY OF SHALLOW AND INTERMEDIATE TEMPORARY WELL CONSTRUCTION DETAILS
NORTHERN AREA OF CONCERN
SITE 35, CAMP GIEGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION
MARINE CORPS BASE, CAMP LEJUENE, NORTH CAROLINA
CONTRACT TASK ORDER 0232**

| Monitoring Well Number | Date Installed | Consultant Supervising Well | Ground Surface Elevation (feet, MSL) ⁽¹⁾⁽²⁾ | Boring Depth (feet, bgs) ⁽³⁾ | Well Depth (feet, bgs) | Screen Interval Depth (feet, bgs) ⁽⁴⁾ |
|------------------------|----------------|-----------------------------|--|---|------------------------|--|
| 35TW16-A | 4/16/96 | BAKER | 6.9 | 15 | 15 | 5-15 |
| 35TW16-B | 4/16/96 | BAKER | 6.9 | 36 | 36 | 30-35 |
| 35TW16-C | 4/17/96 | BAKER | 6.9 | 25 | 25 | 20-25 |
| 35TW17-A | 4/16/96 | BAKER | 4.7 | 15 | 15 | 5-15 |
| 35TW17-B | 4/16/96 | BAKER | 4.7 | 34 | 34 | 27-32 |
| 35TW17-C | 4/16/96 | BAKER | 4.7 | 23.5 | 23.5 | 18.5-23.5 |
| 35TW18-A | 4/16/96 | BAKER | 4.6 | 15 | 15 | 5-15 |
| 35TW18-B | 4/16/96 | BAKER | 4.6 | 32 | 32 | 27-32 |
| 35TW18-C | 4/16/96 | BAKER | 4.6 | 23.5 | 23.5 | 18.5-23.5 |
| 35TW19-A | 4/15/96 | BAKER | 10.9 | 15 | 15 | 5-15 |
| 35TW19-B | 4/15/96 | BAKER | 10.9 | 38 | 38 | 33-38 |
| 35TW19-C | 4/15/96 | BAKER | 10.9 | 26.5 | 26.5 | 21.5-26.5 |
| 35TW20-A | 4/15/96 | BAKER | 10.6 | 15 | 15 | 5-15 |
| 35TW20-B | 4/15/96 | BAKER | 10.6 | 38 | 38 | 23-28 |
| 35TW20-C | 4/15/96 | BAKER | 10.6 | 26.5 | 26.5 | 21.5-26.5 |
| 35TW22-A | 4/14/96 | BAKER | 9.6 | 15 | 15 | 5-15 |
| 35TW22-B | 4/14/96 | BAKER | 9.6 | 38 | 38 | 33-38 |
| 35TW22-C | 4/15/96 | BAKER | 9.6 | 26.5 | 26.5 | 21.5-26.5 |
| 35TW23-A | 4/14/96 | BAKER | 9.1 | 15 | 15 | 5-15 |
| 35TW23-B | 4/14/96 | BAKER | 9.1 | 36 | 35 | 30-35 |
| 35TW23-C | 4/14/96 | BAKER | 9.1 | 25 | 25 | 20-25 |
| 35TW24-A | 4/14/96 | BAKER | 10.7 | 15 | 15 | 5-15 |
| 35TW24-B | 4/14/96 | BAKER | 10.7 | 40 | 40 | 35-40 |
| 35TW24-C | 4/14/96 | BAKER | 10.7 | 27.5 | 27.5 | 22.5-27.5 |
| 35TW25-A | 4/13/96 | BAKER | 11.1 | 15 | 15 | 10-15 |
| 35TW25-B | 4/13/96 | BAKER | 11.1 | 40 | 40 | 35-40 |
| 35TW25-C | 4/14/96 | BAKER | 11.1 | 27.5 | 27.5 | 22.5-27.5 |
| 35TW26-A | 4/13/96 | BAKER | 10.8 | 15 | 15 | 5-15 |
| 35TW26-B | 4/13/96 | BAKER | 10.8 | 40 | 40 | 35-40 |
| 35TW26-C | 4/13/96 | BAKER | 10.8 | 27.5 | 27.5 | 22.5-27.5 |
| 35TW27-B | 4/25/96 | BAKER | 11.9 | 40 | 40 | 33-38 |
| 35TW28-B | 4/29/96 | BAKER | 11.5 | 38 | 40 | 33-38 |
| 35TW30-A | 8/3/96 | BAKER | 14.82 | 19.5 | 19.5 | 9-19 |

TABLE 2-1 (Continued)

SUMMARY OF SHALLOW AND INTERMEDIATE TEMPORARY WELL CONSTRUCTION
DETAILS
NORTHERN AREA OF CONCERN
SITE 35, CAMP GIEGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION
MARINE CORPS BASE, CAMP LEJUENE, NORTH CAROLINA
COTRACT TASK ORDER 0232

| Monitoring Well Number | Date Installed | Consultant Supervising Well | Ground Surface Elevation (feet, MSL) ⁽¹⁾⁽²⁾ | Boring Depth (feet, bgs) ⁽³⁾ | Well Depth (feet, bgs) | Screen Interval Depth (feet, bgs) ⁽⁴⁾ |
|------------------------|----------------|-----------------------------|--|---|------------------------|--|
| 35TW30-B | 8/3/96 | BAKER | 14.82 | 40 | 40 | 34.5-39.5 |
| 35TW31-A | 8/2/96 | BAKER | 9.5 | 19.5 | 19.5 | 9-19 |
| 35TW31-B | 8/2/96 | BAKER | 9.5 | 40 | 40 | 34.5-39.5 |

Notes:

- (1) MSL = Mean Sea Level
- (2) A ground surface elevation at each temporary well location was obtained by survey. However, temporary wells were removed prior to the survey.
- (3) bgs = below the ground surface
- (4) Temporary wells were installed with a well sock. A sand pack and bentonite seal were not installed.

TABLE 2-2

SUMMARY OF SHALLOW AND INTERMEDIATE TEMPORARY WELL CONSTRUCTION DETAILS
 SOUTHERN AREA OF CONCERN
 SITE 35, CAMP GIEGER AREA FUEL FARM
 SUPPLEMENTAL GROUNDWATER INVESTIGATION
 MARINE CORPS BASE, CAMP LEJUENE, NORTH CAROLINA
 CONTRACT TASK ORDER 0232

| Monitoring Well Number | Date Installed | Consultant Supervising Well | Ground Surface Elevation (feet, MSL) ⁽¹⁾⁽²⁾ | Boring Depth (feet, bgs) ⁽³⁾ | Well Depth (feet, bgs) | Screen Interval Depth (feet, bgs) ⁽⁴⁾ |
|------------------------|----------------|-----------------------------|--|---|------------------------|--|
| 35TW1-A | 4/9/96 | BAKER | 19.10 | 15 | 15 | 5-15 |
| 35TW1-B | 4/9/96 | BAKER | 19.1 | 47 | 47 | 42-47 |
| 35TW2-A | 4/9/96 | BAKER | 17.6 | 14 | 15 | 5-15 |
| 35TW2-B | 4/9/96 | BAKER | 17.6 | 47 | 47 | 42-47 |
| 35TW3-A | 4/10/96 | BAKER | 17.8 | 15 | 15 | 10-15 |
| 35TW3-B | 4/9/96 | BAKER | 17.8 | 47 | 47 | 42-47 |
| 35TW4-A | 4/10/96 | BAKER | 15.8 | 15 | 15 | 5-15 |
| 35TW4-B | 4/10/96 | BAKER | 15.8 | 42 | 42 | 37-42 |
| 35TW5-A | 4/10/96 | BAKER | 16.2 | 15 | 15 | 5-15 |
| 35TW5-B | 4/10/96 | BAKER | 16.2 | 42 | 47 | 37-42 |
| 35TW6-A | 4/11/96 | BAKER | 19.1 | 15 | 15 | 5-15 |
| 35TW6-B | 4/11/96 | BAKER | 19.1 | 47 | 47 | 42-47 |
| 35TW7-A | 4/11/96 | BAKER | 19.2 | 15 | 15 | 5-15 |
| 35TW7-B | 4/11/96 | BAKER | 19.2 | 47 | 47 | 42-45 |
| 35TW8-A | 4/11/96 | BAKER | 15.4 | 15 | 15 | 5-15 |
| 35TW8-B | 4/11/96 | BAKER | 15.4 | 42 | 42 | 35-40 |
| 35TW9-A | 4/12/96 | BAKER | 15.3 | 15 | 15 | 5-15 |
| 35TW9-B | 4/12/96 | BAKER | 15.3 | 42 | 47 | 37-42 |
| 35TW10-A | 4/12/96 | BAKER | 16.7 | 15 | 15 | 5-15 |
| 35TW10-B | 4/12/96 | BAKER | 16.7 | 47 | 47 | 42-47 |
| 35TW11-A | 4/12/96 | BAKER | 15.75 | 15 | 15 | 5-15 |
| 35TW11-B | 4/12/96 | BAKER | 15.75 | 42 | 42 | 37-42 |
| 35TW12-B | 4/26/96 | BAKER | 15.2 | 42 | 42 | 33-38 |
| 35TW13-B | 4/26/96 | BAKER | 15.2 | 42 | 42 | 33-38 |
| 35TW14-B | 4/29/96 | BAKER | 16.1 | 42 | 42 | 35-40 |
| 35TW15-B | 4/30/96 | BAKER | 15.2 | 42 | 42 | 35-40 |
| 35TW29-B | 4/30/96 | BAKER | 13.2 | 42 | 42 | 35-40 |

Notes:

- ⁽¹⁾ MSL = Mean Sea Level
- ⁽²⁾ A ground surface elevation at each temporary well location was obtained by survey. However, temporary wells were removed prior to the survey.
- ⁽³⁾ bgs = below the ground surface
- ⁽⁴⁾ Temporary wells were installed with a well sock. A sand pack and bentonite seal were not installed.

TABLE 2-3

**SUMMARY OF GROUNDWATER FIELD PARAMETERS
GROUNDWATER SCREENING ACTIVITIES
SITE 35, CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION
MCB, CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232**

| Well No. | Depth of Well (ft.) | Purge Volume (gals.) | Field Parameters | | | | |
|---------------------|---------------------|----------------------|------------------|---|------------------|-----------|------------------|
| Date of Measurement | | | Gallons Removed | Specific Conductance at 25°C (micromhos/cm) | Temperature (°C) | pH (S.U.) | Turbidity (T.U.) |
| 35-TW01A | 15.0 | 0.5 | 0.5 | 352.3 | 14.9 | 6.87 | >200.00 |
| 4/10/96 | | | 1.6 | 358.0 | 14.1 | 6.75 | 197.90 |
| | | | 3.0 | 369.0 | 13.9 | 6.45 | 22.80 |
| | | | 3.5 | 385.0 | 14.1 | 6.20 | 9.00 |
| 35-TW01B | 47.0 | 1.7 | 2.0 | 398.0 | 18.6 | 8.60 | >200.00 |
| 4/9/96 | | | 4.0 | 400.0 | 17.5 | 8.06 | 112.60 |
| | | | 6.0 | 419.0 | 18.1 | 8.07 | 32.20 |
| | | | 9.0 | 431.0 | 17.5 | 8.13 | 13.06 |
| | | | 13.0 | 431.2 | 17.9 | 8.16 | 11.32 |
| 35-TW02A | 14.0 | 0.5 | 0.5 | 225.1 | 13.4 | NA | >200.00 |
| 4/9/96 | | | 1.0 | 205.0 | 13.7 | NA | >200.00 |
| | | | 2.5 | 198.3 | 14.1 | NA | 17.10 |
| | | | 3.5 | 198.0 | 14.1 | NA | 12.20 |
| | | | 4.5 | 206.0 | 15.2 | NA | 15.00 |
| | | | 6.5 | 233.0 | 17.8 | 5.77 | 4.700 |
| 35-TW02B | 47.0 | 1.7 | 1.5 | 480.0 | 16.0 | -- | >200.00 |
| 4/9/96 | | | 3.5 | 487.0 | 16.0 | 6.85 | >200.00 |
| | | | 4.0 | 497.0 | -- | 7.40 | 114.20 |
| | | | 5.0 | 551.0 | 15.6 | 7.50 | 0.20 |
| | | | 6.5 | 550.0 | 14.9 | 8.16 | 0.40 |
| 35-TW03A | 15.0 | 0.5 | 0 | 110.0 | 16.0 | 5.77 | >200.00 |
| 4/10/96 | | | 1.5 | 100.0 | 16.6 | 5.78 | 31.00 |
| | | | 1.75 | 98.0 | 16.3 | 5.85 | 18.00 |
| | | | 2.0 | 96.0 | 16.3 | 5.76 | 11.00 |
| 35-TW03B | 47.0 | 2.0 | 3.0 | 500.0 | 13.0 | 7.20 | 111.00 |
| 4/9/96 | | | 4.0 | 550.0 | 17.0 | 7.20 | 35.00 |
| | | | 6.0 | 500.0 | 17.0 | 7.20 | 11.00 |
| | | | 7.0 | 500.0 | 17.0 | 7.20 | 8.50 |

TABLE 2-3 (Continued)

**SUMMARY OF GROUNDWATER FIELD PARAMETERS
GROUNDWATER SCREENING ACTIVITIES
SITE 35, CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION
MCB, CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232**

| Well No. | Depth of Well (ft.) | Purge Volume (gals.) | Field Parameters | | | | |
|-----------------------------|---------------------|----------------------|------------------|---|------------------|-----------|------------------|
| Date of Measurement | | | Gallons Removed | Specific Conductance at 25°C (micromhos/cm) | Temperature (°C) | pH (S.U.) | Turbidity (T.U.) |
| 35-TW04A | 15.0 | 0.5 | 1.0 | 110.0 | 16.7 | 5.19 | 139.10 |
| 4/10/96 | | | 3.0 | 99.0 | 16.0 | 4.99 | >200.00 |
| | | | 5.0 | 100.0 | 16.0 | 5.32 | 25.00 |
| | | | 7.0 | 100.0 | 15.9 | 5.15 | 25.00 |
| | | | 9.0 | 101.0 | 15.0 | 5.15 | 9.70 |
| 35-TW04B | 42.0 | 1.7 | 1.0 | 189.0 | 20.0 | 7.27 | 189.00 |
| 4/10/96 (purged 3 hours) | | | 6.0 | 600.0 | 19.2 | 6.92 | >200.00 |
| | | | 8.0 | 610.0 | 19.5 | 6.82 | >200.00 |
| | | | 10.0 | 650.0 | 19.0 | 6.98 | 135.00 |
| | | | 12.0 | 670.0 | 19.3 | 7.09 | 130.00 |
| | | | 14.0 | 620.0 | 19.9 | 7.06 | 151.00 |
| | | | 16.0 | 620.0 | 18.6 | 6.84 | 114.00 |
| 35-TW05A | 15.0 | 0.5 | 3.0 | 160.0 | 15.5 | 5.44 | 2.00 |
| 4/10/96 | | | 4.0 | 220.0 | 16.7 | 5.27 | 1.20 |
| | | | 5.0 | 225.0 | 15.9 | 4.95 | 0.70 |
| | | | 7.0 | 212.0 | 15.9 | 4.71 | 0.70 |
| 35-TW05B | 42.0 | 1.7 | 6.0 | 2,380.0 | 16.5 | 6.80 | >200.00 |
| 4/10/96 (purged 3 hours) | | | 9.0 | 2,400.0 | 16.6 | 7.02 | >200.00 |
| | | | 13.0 | 2,400.0 | 16.9 | 7.04 | >200.00 |
| | | | 15.0 | 2,500.0 | 17.6 | 6.83 | >200.00 |
| | | | 17.0 | 2,580.0 | 19.1 | 6.64 | >200.00 |
| 35-TW06A | 15.0 | 0.5 | 2.0 | 200.0 | 18.0 | 6.41 | 4.50 |
| 4/11/96 | | | 4.0 | 200.0 | 18.0 | 6.64 | 3.70 |
| | | | 4.5 | 200.0 | 18.0 | 6.29 | 2.75 |
| 35-TW06B | 47.0 | 1.7 | 28.0 | 400.0 | 21.0 | 8.12 | 81.50 |
| 4/11/96 | | | 28.5 | 400.0 | 22.0 | 8.05 | 31.10 |
| | | | 30.0 | 400.0 | 19.0 | 8.09 | 9.30 |
| | | | 32.0 | 400.0 | 19.0 | 8.33 | 9.00 |
| 35-TW07A | 15.0 | 0.5 | -- | -- | -- | -- | -- |
| 4/15/96 | | | | | | | |
| 35-TW07B | 47.0 | 1.7 | 2.0 | 500.0 | 21.0 | 8.15 | 151.50 |
| 4/15/96 | | | 3.0 | 550.0 | 25.0 | -- | -- |
| | | | 15.0 | -- | -- | -- | -- |
| | | | 20.0 | 600.0 | 18.0 | 8.11 | 26.50 |

TABLE 2-3 (Continued)

**SUMMARY OF GROUNDWATER FIELD PARAMETERS
GROUNDWATER SCREENING ACTIVITIES
SITE 35, CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION
MCB, CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232**

| Well No. | Depth of Well (ft.) | Purge Volume (gals.) | Field Parameters | | | | |
|----------------------|---------------------|----------------------|------------------|---|------------------|-----------|------------------|
| | | | Gallons Removed | Specific Conductance at 25°C (micromhos/cm) | Temperature (°C) | pH (S.U.) | Turbidity (T.U.) |
| 35-TW08A | 15.0 | 0.5 | 4.0 | 187.9 | 17.1 | 5.47 | 19.10 |
| 4/11/96 | | | 6.0 | 192.7 | 16.8 | 5.36 | 10.50 |
| | | | 7.0 | 190.1 | 17.8 | 5.36 | 7.02 |
| 35-TW08B | 42.0 | 1.7 | 12.0 | 707.0 | 19.1 | 6.93 | 7.90 |
| 4/11/96 | | | 13.5 | 696.0 | 18.1 | 6.91 | 1.88 |
| | | | 15.0 | 695.0 | 17.8 | 6.87 | 1.80 |
| 35-TW09A | 47.0 | 1.5 | 10.0 | 233.3 | 17.4 | 5.11 | 68.10 |
| 4/13/96 | | | 13.5 | 231.4 | 17.4 | 5.15 | 29.50 |
| | | | 18.0 | 231.6 | 17.7 | 5.17 | 19.80 |
| | | | 25.0 | 228.0 | 17.7 | 5.21 | 10.00 |
| 35-TW09B | 47.0 | 1.5 | 10.0 | 951.0 | 20.8 | 7.15 | 25.6 |
| 4/13/96 | | | 13.0 | 911.0 | 20.7 | 7.08 | 23.6 |
| | | | 16.0 | 914.0 | 20.7 | 7.12 | 18.2 |
| | | | 20.0 | 901.0 | 20.1 | 6.88 | 10.0 |
| 35-TW10A | 15.0 | 0.5 | 10.0 | 178.0 | 19.0 | 5.10 | 1.54 |
| 4/13/96 | | | 13.0 | 186.0 | 7.08 | 5.28 | 1.83 |
| | | | 16.0 | 914.0 | 7.12 | 4.88 | 1.06 |
| | | | 19.0 | -- | -- | -- | -- |
| 35-TW10B | 47.0 | 1.5 | 10.5 | -- | -- | -- | -- |
| 4/13/96 | | | 11.5 | 986.0 | 20.3 | 7.04 | 16.34 |
| | | | 12.0 | 957.0 | 19.2 | 6.80 | 13.80 |
| | | | 13.5 | 986.0 | 19.4 | 6.88 | 7.74 |
| 35-TW11A | 15.0 | 0.5 | 4.0 | 129.0 | -- | 4.74 | 14.00 |
| 4/12/96 | | | 7.0 | 129.0 | 16.7 | 4.74 | 1.80 |
| | | | 9.0 | 124.0 | 16.7 | 4.71 | 1.60 |
| | | | | | 121.0 | 16.7 | 4.80 |
| 35-TW11B | 42.0 | 1.7 | 29.0 | 529.0 | 18.6 | 6.89 | 22.40 |
| 4/12/96 | | | 31.0 | 536.0 | 18.8 | 7.12 | 20.50 |
| | | | 33.0 | 535.0 | 18.8 | 7.21 | 18.80 |
| 35-TW12B | 42.0 | 2.7 | 3.0 | 528.0 | 22.7 | 7.47 | 118.30 |
| 4/26/96 | | | 6.0 | 551.0 | 23.1 | 7.75 | 142.30 |
| (purged for 3 hours) | | | 15.0 | 551.0 | 25.5 | 7.82 | 50.20 |
| | | | 16.5 | -- | -- | -- | 39.80 |

TABLE 2-3 (Continued)

**SUMMARY OF GROUNDWATER FIELD PARAMETERS
GROUNDWATER SCREENING ACTIVITIES
SITE 35, CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION
MCB, CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232**

| Well No. | Depth of Well (ft.) | Purge Volume (gals.) | Field Parameters | | | | |
|---------------------|---------------------|----------------------|------------------|---|------------------|-----------|------------------|
| Date of Measurement | | | Gallons Removed | Specific Conductance at 25°C (micromhos/cm) | Temperature (°C) | pH (S.U.) | Turbidity (T.U.) |
| 35-TW13B | 42 | 1.7 | 3.0 | 390.0 | 22.1 | 7.68 | 196.40 |
| 4/26/96 | | | 6.0 | 398.0 | 22.3 | 7.69 | 25.60 |
| | | | 9.0 | 402.0 | 18.3 | 7.58 | 3.67 |
| 35-TW14B | 42 | 3.0 | 3.0 | 573.0 | 22.7 | 6.97 | >200.00 |
| 4/29/96 | | | 6.0 | 579.0 | 22.4 | 7.05 | >200.00 |
| | | | 9.0 | 585.0 | 22.4 | 7.18 | >200.00 |
| | | | 12.0 | 584.0 | 22.3 | 7.30 | >200.00 |
| | | | 15.0 | 587.0 | 22.0 | 7.12 | 109.30 |
| | | | 18.0 | 589.0 | 22.3 | 7.14 | 95.10 |
| 35-TW15B | 42 | 2.75 | 3.0 | 730 | 21.3 | 7.60 | 190.00 |
| 4/30/96 | | | 6.0 | 698 | 21.2 | 7.58 | 6.80 |
| | | | 9.0 | 681 | 21.2 | 7.34 | 2.70 |
| 35-TW16A | 15 | 0.5 | 14.0 | 100.1 | 14.8 | 5.62 | 23.00 |
| 4/17/96 | | | 17.5 | 96.6 | 14.9 | 5.58 | 26.50 |
| | | | 21.5 | 96.2 | 15.0 | 5.62 | 23.30 |
| | | | 25.5 | 102.5 | 15.1 | 5.67 | 22.60 |
| | | | 28.5 | 105.8 | 15.2 | 5.58 | 28.00 |
| 35-TW16C | 25 | 1.0 | 6.0 | 266.5 | 17.6 | 6.25 | 46.70 |
| 4/17/96 | | | 8.0 | 266.9 | 17.1 | 6.26 | 16.33 |
| | | | 9.0 | 269.3 | 17.4 | 6.29 | 6.82 |
| 35-TW16B | 35 | 1.3 | 5.5 | 573.0 | 17.4 | 6.93 | 35.20 |
| 4/17/96 | | | 7.0 | 568.0 | 17.3 | 6.91 | 4.19 |
| | | | 8.5 | 556.0 | 17.2 | 6.93 | 8.36 |
| 35-TW17A | 15 | 0.5 | 5.0 | 138.1 | 13.7 | 5.38 | +200.00 |
| 4/17/96 | | | 9.0 | 118.1 | 14.3 | 5.63 | +200.00 |
| | | | 11.5 | 113.3 | 14.0 | 5.60 | +200.00 |
| | | | 13.5 | 113.0 | 14.3 | 5.61 | 59.10 |
| | | | 15.5 | 108.0 | 14.3 | 5.61 | 28.60 |
| | | | 17.0 | 105.2 | 14.4 | 5.58 | 12.46 |
| 35-TW17C | 23.5 | 1.0 | 7.5 | 233.8 | 16.5 | 5.88 | 43.50 |
| 4/17/96 | | | 11.5 | 233.3 | 16.4 | 5.92 | 22.00 |
| | | | 13.5 | 225.9 | 16.0 | 5.73 | 19.90 |
| | | | 15.5 | 227.3 | 16.2 | 5.64 | 11.95 |
| | | | 16.5 | 224.2 | 16.4 | 5.61 | 9.49 |

TABLE 2-3 (Continued)

**SUMMARY OF GROUNDWATER FIELD PARAMETERS
GROUNDWATER SCREENING ACTIVITIES
SITE 35, CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION
MCB, CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232**

| Well No. | Depth of Well (ft.) | Purge Volume (gals.) | Field Parameters | | | | |
|----------|---------------------|----------------------|------------------|---|------------------|-----------|------------------|
| | | | Gallons Removed | Specific Conductance at 25°C (micromhos/cm) | Temperature (°C) | pH (S.U.) | Turbidity (T.U.) |
| 35-TW17B | 32 | 1.3 | 12.5 | 520.0 | 17.2 | 6.51 | 19.23 |
| 4/17/96 | | | 15.0 | 519.0 | 17.0 | 6.70 | 7.67 |
| | | | 18.0 | 520.0 | 17.1 | 6.75 | 6.15 |
| 35-TW18A | 15 | 0.5 | 9.0 | 325.6 | 17.4 | 5.91 | 2.78 |
| 4/16/96 | | | 11.0 | 317.3 | 16.9 | 6.35 | 2.50 |
| | | | 13.0 | 319.6 | 16.6 | 6.39 | 1.30 |
| 35-TW18C | 26.5 | 1.0 | 8.0 | 591.0 | 18.3 | 6.85 | 62.60 |
| 4/16/96 | | | 12.5 | 575.0 | 18.2 | 6.98 | 10.94 |
| | | | 14.0 | 598.0 | 18.0 | 7.01 | 5.31 |
| 35-TW18B | 32.0 | 1.5 | 11.0 | 572.0 | 18.6 | 6.83 | 2.10 |
| 4/16/92 | | | 15.0 | 564.0 | 18.4 | 6.92 | 1.51 |
| | | | 17.5 | 560.0 | 18.2 | 6.97 | 1.20 |
| 35-TW19A | 15.0 | 0.5 | 6.0 | 185.6 | 16.4 | 5.69 | 20.30 |
| 4/16/96 | | | 7.5 | 180.9 | 16.4 | 5.98 | 9.80 |
| | | | 9.0 | 177.3 | 16.3 | 6.17 | 5.50 |
| 35-TW19C | 26.5 | 1.0 | 5.0 | 675.0 | 18.0 | 6.93 | 17.62 |
| 4/16/96 | | | 6.5 | 662.0 | 18.1 | 7.04 | 2.25 |
| | | | 8.0 | 648.0 | 18.0 | 7.13 | 3.02 |
| 35-TW19B | 38.0 | 1.5 | 15.5 | 529.0 | 18.4 | 6.66 | 7.54 |
| 4/16/96 | | | 18.0 | 529.0 | 18.4 | 6.98 | 9.21 |
| | | | 20.0 | 523.0 | 18.5 | 6.95 | 8.13 |
| 35-TW20A | 15.0 | 5.0 | 7.5 | 493.9 | 17.9 | 6.19 | 3.81 |
| 4/15/96 | | | 8.5 | 492.6 | 17.6 | 6.61 | 1.90 |
| | | | 9.5 | 494.2 | 17.5 | 6.61 | 1.60 |
| 35-TW20C | 26.5 | 8.0 | 10.5 | 648.0 | 19.5 | 6.94 | 2.24 |
| 4/15/96 | | | 13.0 | 635.0 | 19.4 | 6.97 | 2.42 |
| | | | 14.5 | 631.0 | 19.2 | 7.04 | 1.12 |
| 35-TW20B | 38.0 | 10.0 | 13.0 | 532.0 | 19.7 | 6.90 | 2.85 |
| 4/15/96 | | | 14.5 | 533.0 | 19.6 | 6.98 | 3.20 |
| | | | 16.0 | 524.0 | 19.4 | 7.04 | 2.45 |

TABLE 2-3 (Continued)

**SUMMARY OF GROUNDWATER FIELD PARAMETERS
GROUNDWATER SCREENING ACTIVITIES
SITE 35, CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION
MCB, CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232**

| Well No. | Depth of Well (ft.) | Purge Volume (gals.) | Field Parameters | | | | |
|---------------------|---------------------|----------------------|------------------|---|------------------|-----------|------------------|
| Date of Measurement | | | Gallons Removed | Specific Conductance at 25°C (micromhos/cm) | Temperature (°C) | pH (S.U.) | Turbidity (T.U.) |
| 35-22A | 15.0 | 0.5 | 5.0 | 527.0 | 16.5 | 5.81 | 38.20 |
| 4/15/96 | | | 6.5 | 525.0 | 16.5 | 6.30 | 36.50 |
| | | | 7.5 | 515.0 | 16.6 | 6.47 | 31.30 |
| | | | 8.5 | 515.0 | 16.7 | 6.53 | 31.90 |
| | | | 10.0 | 549.0 | 17.0 | 6.59 | 17.68 |
| | | | 11.0 | 554.0 | 17.3 | 6.51 | 9.35 |
| 35-TW22C | 26.5 | 1.0 | 8.0 | 571.0 | 19.5 | 6.75 | 9.64 |
| 4/15/96 | | | 10.5 | 563.0 | 19.5 | 6.95 | 9.74 |
| | | | 12.5 | 560.0 | 19.7 | 7.10 | 8.37 |
| 35-TW22B | 38.0 | 1.5 | 7.0 | 501.0 | 19.4 | 6.59 | 7.50 |
| 4/15/96 | | | 9.5 | 511.0 | 19.7 | 6.89 | 5.80 |
| | | | 12.0 | 509.0 | 19.7 | 6.89 | 4.36 |
| 35-TW23A | 15.0 | 0.5 | 6.0 | 646.0 | 16.4 | 6.30 | 4.24 |
| 4/15/96 | | | 7.5 | 627.0 | 16.2 | 6.63 | 3.43 |
| | | | 8.5 | 610.0 | 16.3 | 6.63 | 2.36 |
| 35-TW23C | 25.0 | 1.0 | 8.0 | 590.0 | 18.5 | 7.00 | 2.17 |
| 4/15/96 | | | 11.0 | 582.0 | 18.6 | 7.07 | 1.22 |
| | | | 13.0 | 575.0 | 18.6 | 7.13 | 1.60 |
| 35-TW23B | 35.0 | 1.5 | 9.5 | 490.6 | 19.0 | 6.88 | 14.70 |
| 4/15/96 | | | 13.0 | 494.4 | 19.0 | 7.01 | 11.46 |
| | | | 14.5 | 493.4 | 19.2 | 7.08 | 18.56 |
| | | | 16.5 | 501.0 | 19.1 | 7.25 | 7.36 |
| 35-TW24A | 15.0 | 0.5 | 7.5 | 286.5 | 18.0 | 6.04 | 6.43 |
| 4/14/96 | | | 9.0 | 280.4 | 17.5 | 6.35 | 0.94 |
| | | | 11.0 | 288.0 | 17.8 | 6.40 | 0.91 |
| 35-TW24C | 27.5 | 1.0 | 13.0 | 572.0 | 19.8 | 7.05 | 1.20 |
| 4/14/96 | | | 16.0 | 576.0 | 19.8 | 7.19 | 1.00 |
| | | | 18.0 | 569.0 | 19.6 | 7.13 | 1.18 |
| 35-TW24B | 40.0 | 1.7 | 14.0 | 393.5 | 19.7 | 6.91 | 23.0 |
| 4/14/96 | | | 18.0 | 398.0 | 20.0 | 7.18 | 16.80 |
| | | | 21.0 | 398.1 | 19.7 | 7.14 | 12.04 |
| | | | 23.0 | 413.7 | 20.3 | 7.28 | 10.50 |

TABLE 2-3 (Continued)

**SUMMARY OF GROUNDWATER FIELD PARAMETERS
GROUNDWATER SCREENING ACTIVITIES
SITE 35, CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION
MCB, CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232**

| Well No. | Depth of Well (ft.) | Purge Volume (gals.) | Field Parameters | | | | |
|---------------------|---------------------|----------------------|------------------|---|------------------|-----------|------------------|
| Date of Measurement | | | Gallons Removed | Specific Conductance at 25°C (micromhos/cm) | Temperature (°C) | pH (S.U.) | Turbidity (T.U.) |
| 35-TW25A | 15.0 | 0.5 | 7.0 | 277.0 | 16.9 | NA | 3.40 |
| 4/14/96 | | | 8.5 | 277.5 | 16.8 | NA | 3.20 |
| | | | 10.5 | 281.5 | 16.7 | NA | 3.65 |
| 35-TW25C | 27.5 | 1.0 | 11.5 | 558.0 | 19.5 | NA | 5.21 |
| 4/14/96 | | | 13.5 | 552.0 | 19.2 | NA | 4.10 |
| | | | 16.0 | 550.0 | 19.2 | NA | 3.24 |
| 35-TW25B | 40.0 | 1.5 | 5.0 | 369.3 | 19.5 | NA | 10.40 |
| 4/14/96 | | | 7.0 | 375.4 | 19.4 | NA | 7.00 |
| | | | 10.0 | 378.8 | 19.3 | NA | 6.30 |
| 35-TW26A | 15.0 | 0.5 | 8.0 | 247.7 | 17.4 | 6.52 | 3.18 |
| 4/13/96 | | | 9.0 | 244.2 | 17.5 | 6.44 | 2.60 |
| | | | 10.5 | 241.5 | 17.1 | 6.43 | 3.03 |
| 35-TW26C | 27.5 | 1.0 | 15.0 | 576.0 | 19.3 | 7.17 | 50.90 |
| 4/13/96 | | | 17.5 | 563.0 | 18.9 | 7.02 | 30.50 |
| | | | 20.0 | 558.0 | 18.7 | 6.97 | 25.01 |
| | | | 23.0 | 574.0 | 18.9 | 7.15 | 14.90 |
| | | | 26.0 | 574.0 | 19.1 | 7.13 | 8.90 |
| 35-TW26B | 40.0 | 1.5 | 2.5 | 520.0 | 17.4 | 7.32 | 143.0 |
| 4/13/96 | | | 4.0 | 490.0 | 17.5 | 7.41 | 47.0 |
| | | | 6.0 | 490.0 | 17.1 | 7.42 | 6.23 |
| 35-TW27B | 40 | 2.5 | 2.5 | 535.0 | 20.5 | 7.66 | 36.40 |
| 4/25/96 | | | 5.0 | 548.0 | 20.7 | 7.43 | 15.90 |
| | | | 7.5 | 539.0 | 20.6 | 7.69 | 4.53 |
| 35-TW28B | 40.0 | 2.2 | 2.5 | 498.0 | 21.3 | 7.11 | >200.00 |
| 4/29/96 | | | 7.5 | 549.0 | 21.9 | 7.30 | >200.00 |
| | | | 12.5 | 555.0 | 23.2 | 7.22 | 92.40 |
| | | | 17.5 | 567.0 | 23.1 | 7.11 | 14.50 |
| | | | 20.0 | 567.0 | 23.1 | 7.13 | 8.40 |
| 35-TW29B | 42.0 | 2.7 | 3.0 | 403.0 | 20.1 | 7.80 | >200.00 |
| 4/30/96 | | | 6.0 | 403.0 | 19.8 | 7.99 | >200.00 |
| | | | 9.0 | 416.0 | 18.7 | 7.97 | 7.56 |
| | | | 12.0 | 412.0 | 19.5 | 7.96 | 36.70 |
| | | | 15.0 | 411.0 | 19.3 | 7.97 | 16.40 |
| | | | 16.5 | -- | -- | -- | 10.00 |

TABLE 2-3 (Continued)

SUMMARY OF GROUNDWATER FIELD PARAMETERS
 GROUNDWATER SCREENING ACTIVITIES
 SITE 35, CAMP GEIGER AREA FUEL FARM
 SUPPLEMENTAL GROUNDWATER INVESTIGATION
 MCB, CAMP LEJEUNE, NORTH CAROLINA
 CONTRACT TASK ORDER 0232

| Well No. | Depth of Well (ft.) | Purge Volume (gals.) | Field Parameters | | | | |
|---------------------|---------------------|----------------------|------------------|---|------------------|-----------|------------------|
| Date of Measurement | | | Gallons Removed | Specific Conductance at 25°C (micromhos/cm) | Temperature (°C) | pH (S.U.) | Turbidity (T.U.) |
| 35-TW30A | 19.50 | 0.5 | 2.0 | 372.0 | 20.7 | 5.64 | 63.20 |
| 8/4/96 | | | 5.0 | 312.0 | 21.0 | 5.50 | 30.90 |
| | | | 6.0 | 319.0 | 21.5 | 5.41 | 18.30 |
| | | | 7.0 | 256.0 | 20.9 | 5.53 | 10.10 |
| 35-TW30B | 40.0 | 1.5 | 2.0 | 572.0 | 20.1 | 5.88 | >200.00 |
| 8/4/96 | | | 6.0 | 444.0 | 19.9 | 5.78 | >200.00 |
| | | | 11.0 | 392.0 | 19.4 | 5.40 | 22.40 |
| | | | 13.0 | 385.0 | 19.5 | 4.73 | 16.10 |
| | | | 15.0 | 378.0 | 19.4 | 4.42 | 12.60 |
| 35-TW31A | 19.50 | 0.5 | 0 | 505.0 | 20.5 | 4.09 | 45.50 |
| | | | 2.0 | 448.0 | 20.4 | 4.88 | 13.00 |
| | | | 3.0 | 439.3 | 20.8 | 5.14 | 7.40 |
| | | | 4.0 | 409.0 | 29.9 | 5.34 | 4.70 |
| 35-TW31B | 40.0 | 1.5 | 0 | 459.0 | 20.1 | 3.69 | >200.0 |
| | | | 1.5 | 505.0 | 19.4 | 5.20 | 49.00 |
| | | | 2.0 | 505.0 | 19.5 | 5.44 | 29.00 |
| | | | 3.0 | 500.0 | 19.5 | 5.53 | 12.60 |
| | | | 5.0 | 500.0 | 19.2 | 5.77 | 7.90 |
| 35-MW16S | 14.5 | 0.5 | 2.0 | 558.0 | 18.1 | 5.92 | 4.34 |
| 4/14/96 | | | 3.5 | 562.0 | 18.0 | 6.13 | 2.06 |
| | | | 5.0 | 560.0 | 18.2 | 6.25 | 2.04 |
| 35-MW16D | 29.0 | 2.5 | 2.5 | 493.0 | 20.1 | 6.49 | 1.90 |
| 4/14/96 | | | 5.0 | 492.0 | 20.2 | 6.58 | 0.88 |
| | | | 7.5 | 489.0 | 20.3 | 6.95 | 0.62 |
| 35-MW17S | 17.0 | 1.2 | 8.0 | 455.0 | 16.3 | 6.52 | 15.20 |
| 4/13/96 | | | 11.0 | 454.0 | 16.1 | 6.59 | 19.30 |
| | | | 13.0 | 443.0 | 16.3 | 6.61 | 22.10 |
| | | | 15.0 | 458.0 | 17.2 | 6.68 | 12.16 |
| | | | 17.0 | 446.6 | 17.9 | 6.74 | 9.35 |
| 35-MW17D | 24.5 | 2.5 | 7.5 | 449.4 | 17.7 | 6.83 | >200.00 |
| 4/13/96 | | | 9.0 | 447.9 | 17.8 | 6.98 | 31.70 |
| | | | 11.0 | 447.8 | 17.9 | 7.09 | 40.00 |
| | | | 13.0 | 442.7 | 17.8 | 7.06 | 15.88 |
| | | | 16.0 | 446.4 | 18.1 | 7.14 | 6.24 |

TABLE 2-3 (Continued)

**SUMMARY OF GROUNDWATER FIELD PARAMETERS
GROUNDWATER SCREENING ACTIVITIES
SITE 35, CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION
MCB, CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232**

| Well No. | Depth of Well (ft.) | Purge Volume (gals.) | Field Parameters | | | | |
|----------|---------------------|----------------------|------------------|---|------------------|-----------|------------------|
| | | | Gallons Removed | Specific Conductance at 25°C (micromhos/cm) | Temperature (°C) | pH (S.U.) | Turbidity (T.U.) |
| 35-MW18S | 12.5 | 1.0 | 6.5 | 380.6 | 16.8 | 6.51 | 63.60 |
| 4/13/96 | | | 8.0 | 382.2 | 16.9 | 6.66 | 44.10 |
| | | | 9.5 | 387.4 | 17.3 | 6.69 | 31.20 |
| | | | 13.0 | 390.0 | 17.5 | 6.78 | 1.87 |
| 35-MW18D | 25.0 | 3.0 | 6.5 | 500.0 | 18.7 | 6.78 | 15.50 |
| 4/13/96 | | | 8.0 | 499.0 | 18.8 | 6.96 | 10.76 |
| | | | 9.5 | 500.0 | 19.0 | 7.02 | 11.31 |
| | | | 13.0 | 496.0 | 19.0 | 6.98 | 6.70 |
| 35-MW19S | 15.0 | 2.0 | 2.5 | 227.5 | 16.7 | 6.09 | 110.10 |
| 4/14/96 | | | 5.0 | 217.1 | 16.4 | 6.25 | 29.10 |
| | | | 7.0 | 213.3 | 16.4 | 6.16 | 24.40 |
| | | | 2.0 | 209.4 | 16.0 | 6.20 | 14.40 |
| 35-MW19D | 25.0 | 4.0 | 4.0 | 490.0 | 18.8 | 6.95 | 1.34 |
| 4/14/96 | | | 8.0 | 480.0 | 18.5 | 6.91 | 0.95 |
| | | | 12.0 | 478.0 | 18.5 | 7.00 | 0.50 |

Notes:

S.U. Standard Units
°C Degrees centigrade
T.U. Turbidity Units

-- information missing from logbook
NA not available, equipment failure

TABLE 2-4
SCREENING RESULTS, UPPER PORTION OF THE SURFICIAL AQUIFER
GROUNDWATER
VOLATILE ORGANIC COMPOUNDS
SITE 35, CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 232
MCB CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232

| SAMPLE ID | 35-MW16S-04 | 35-MW17S-04 | 35-MW18S-04 | 35-MW19S-04 | 35-MW30A-04 | 35-MW60A-04 |
|----------------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| METHOD | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A |
| DATE SAMPLED | 04/14/96 | 04/13/96 | 04/13/96 | 04/14/96 | 04/08/96 | 08/04/96 |
| VOLATILES (ug/L) | | | | | | |
| VINYL CHLORIDE | NA | NA | NA | NA | NA | 50 U |
| ACETONE | NA | NA | NA | NA | NA | NA |
| 1,1-DICHLOROETHENE | NA | NA | NA | NA | NA | NA |
| 1,1-DICHLOROETHANE | NA | NA | NA | NA | NA | NA |
| trans-1,2-DICHLOROETHENE | 1 U | 1 U | 1 U | 2 | 1 U | 1 U |
| cis-1,2-DICHLOROETHENE | 1 U | 1 U | 4 | 13 | 1 U | 1 U |
| 1,2-DICHLOROETHENE (TOTAL) | NA | NA | NA | NA | NA | NA |
| CHLOROFORM | NA | NA | NA | NA | NA | 1.5 |
| TRICHLOROETHENE | 0.1 U | 0.1 U | 0.5 | 12 | 0.1 U | 0.1 U |
| BENZENE | 557 | 1 U | 99 | 1 U | 1 U | 1 U |
| TETRACHLOROETHENE | NA | NA | NA | NA | NA | NA |
| 1,1,2,2-TETRACHLOROETHANE | NA | NA | NA | NA | NA | NA |
| TOLUENE | 51 | 1 | 1 U | 1 U | NA | 1 U |
| ETHYLBENZENE | 275 | 1 U | 2 | 1 U | 1 U | 1 U |
| M&P-XYLENES | 885 | 1 U | 1 U | 1 U | 1 U | 1 U |
| O-XYLENES | 26 | 1 U | 1 U | 1 U | 1 U | 1 U |
| XYLENE (TOTAL) | NA | NA | NA | NA | NA | NA |
| METHL-TERT-BUTYL-ETHER | 16 | 5 U | 63 | 5 U | 5 U | NA |

QUALIFIER DEFINITIONS

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

NOTES

ug/kg = micrograms per kilogram.

NA = Not analyzed.

TABLE 2-4
SCREENING RESULTS, UPPER PORTION OF THE SURFICIAL AQUIFER
GROUNDWATER
VOLATILE ORGANIC COMPOUNDS
SITE 35, CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 232
MCB CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232

| SAMPLE ID | 35-TW01A-04 | 35-TW02A-04 | 35-TW03A-04 | 35-TW04A-04 | 35-TW05A-04 | 35-TW06A-04 |
|----------------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| METHOD | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A |
| DATE SAMPLED | 4/09/96 | 4/10/96 | 4/10/96 | 4/10/96 | 4/10/96 | 4/11/96 |
| VOLATILES (ug/L) | | | | | | |
| VINYL CHLORIDE | NA | NA | NA | NA | NA | NA |
| ACETONE | NA | NA | NA | NA | NA | NA |
| 1,1-DICHLOROETHENE | NA | NA | NA | NA | NA | NA |
| 1,1-DICHLOROETHANE | NA | NA | NA | NA | NA | NA |
| trans-1,2-DICHLOROETHENE | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| cis-1,2-DICHLOROETHENE | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| 1,2-DICHLOROETHENE (TOTAL) | NA | NA | NA | NA | NA | NA |
| CHLOROFORM | NA | NA | NA | NA | NA | NA |
| TRICHLOROETHENE | 0.1 U |
| BENZENE | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| TETRACHLOROETHENE | NA | NA | NA | NA | NA | NA |
| 1,1,2,2-TETRACHLOROETHANE | NA | NA | NA | NA | NA | NA |
| TOLUENE | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| ETHYLBENZENE | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| M&P-XYLENES | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| O-XYLENES | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| XYLENE (TOTAL) | NA | NA | NA | NA | NA | NA |
| METHL-TERT-BUTYL-ETHER | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |

QUALIFIER DEFINITIONS

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

NOTES

ug/kg = micrograms per kilogram.
 NA = Not analyzed.

TABLE 2-4
SCREENING RESULTS, UPPER PORTION OF THE SURFICIAL AQUIFER
GROUNDWATER
VOLATILE ORGANIC COMPOUNDS
SITE 35, CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 232
MCB CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232

| SAMPLE ID | 35-TW07A-04 | 35-TW08A-04 | 35-TW09A-04 | 35-TW10A-04 | 35-TW11A-04 | 35-TW16A-04 |
|----------------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| METHOD | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A |
| DATE SAMPLED | 4/11/96 | 4/11/96 | 4/11/96 | 4/11/96 | | 04/16/96 |
| VOLATILES (ug/L) | | | | | | |
| VINYL CHLORIDE | NA | NA | NA | NA | NA | NA |
| ACETONE | NA | NA | NA | NA | NA | NA |
| 1,1-DICHLOROETHENE | NA | NA | NA | NA | NA | NA |
| 1,1-DICHLOROETHANE | NA | NA | NA | NA | NA | NA |
| trans-1,2-DICHLOROETHENE | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| cis-1,2-DICHLOROETHENE | 1 U | 1 U | 1 U | 1 U | 1 U | 2 |
| 1,2-DICHLOROETHENE (TOTAL) | NA | NA | NA | NA | NA | NA |
| CHLOROFORM | NA | NA | NA | NA | NA | NA |
| TRICHLOROETHENE | 0.1 U | 1.1 | 0.1 U | 0.1 U | 0.1 U | 0.4 |
| BENZENE | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| TETRACHLOROETHENE | NA | NA | NA | NA | NA | NA |
| 1,1,2,2-TETRACHLOROETHANE | NA | NA | NA | NA | NA | NA |
| TOLUENE | 1 U | 1 U | 1 U | 1 | 1 | 1 U |
| ETHYLBENZENE | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| M&P-XYLENES | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| O-XYLENES | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| XYLENE (TOTAL) | NA | NA | NA | NA | NA | NA |
| METHL-TERT-BUTYL-ETHER | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |

QUALIFIER DEFINITIONS

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

NOTES

ug/kg = micrograms per kilogram.
 NA = Not analyzed.

TABLE 2-4
SCREENING RESULTS, UPPER PORTION OF THE SURFICIAL AQUIFER
GROUNDWATER
VOLATILE ORGANIC COMPOUNDS
SITE 35, CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 232
MCB CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232

| SAMPLE ID | 35-TW17A-04 | 35-TW18A-04 | 35-TW19A-04 | 35-TW20A-04 | 35-TW22A-04 | 35-TW23A-04 |
|----------------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| METHOD | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A |
| DATE SAMPLED | 04/16/96 | 04/16/96 | 04/16/96 | 04/15/96 | 04/15/96 | 04/15/96 |
| VOLATILES (ug/L) | | | | | | |
| VINYL CHLORIDE | NA | NA | NA | NA | NA | NA |
| ACETONE | NA | NA | NA | NA | NA | NA |
| 1,1-DICHLOROETHENE | NA | NA | NA | NA | NA | NA |
| 1,1-DICHLOROETHANE | NA | NA | NA | NA | NA | NA |
| trans-1,2-DICHLOROETHENE | 1 U | 4 | 1 U | 2 | 1 U | 1 U |
| cis-1,2-DICHLOROETHENE | 6 | 32 | 1 U | 4 | 16 | 9 |
| 1,2-DICHLOROETHENE (TOTAL) | NA | NA | NA | NA | NA | NA |
| CHLOROFORM | NA | NA | NA | NA | NA | NA |
| TRICHLOROETHENE | 2 | 24.6 | 0.3 | 8.8 | 4.5 | 2.2 |
| BENZENE | 1 U | 1 U | 2 | 215 | 1654 | 3296 |
| TETRACHLOROETHENE | NA | NA | NA | NA | NA | NA |
| 1,1,2,2-TETRACHLOROETHANE | NA | NA | NA | NA | NA | NA |
| TOLUENE | 1 U | 1 U | 1 U | 883 | 3636 | 7392 |
| ETHYLBENZENE | 1 U | 1 U | 1 U | 353 | 629 | 708 |
| M&P-XYLENES | 1 U | 1 U | 2 | 445 | 1293 | 1795 |
| O-XYLENES | 1 U | 1 U | 1 U | 158 | 720 | 969 |
| XYLENE (TOTAL) | NA | NA | NA | NA | NA | NA |
| METHL-TERT-BUTYL-ETHER | 5 U | 5 U | 5 U | 5 U | 5 U | 58 |

QUALIFIER DEFINITIONS

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

NOTES

ug/kg = micrograms per kilogram.

NA = Not analyzed.

TABLE 2-4
SCREENING RESULTS, UPPER PORTION OF THE SURFICIAL AQUIFER
GROUNDWATER
VOLATILE ORGANIC COMPOUNDS
SITE 35, CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 232
MCB CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232

| SAMPLE ID | 35-TW24A-04 | 35-TW25A-04 | 35-TW26A-04 | 35-TW30A-04 | 35-TW30A-04 | 35-TW31A-04 |
|----------------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| METHOD | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A | VOA1.8 | 8010A/8020A |
| DATE SAMPLED | 04/14/96 | 04/14/96 | 04/13/96 | 08/04/96 | 08/04/96 | 08/04/96 |
| VOLATILES (ug/L) | | | | | | |
| VINYL CHLORIDE | NA | NA | NA | NA | 10 U | NA |
| ACETONE | NA | NA | NA | NA | 10 U | NA |
| 1,1-DICHLOROETHENE | NA | NA | NA | NA | 10 U | NA |
| 1,1-DICHLOROETHANE | NA | NA | NA | NA | 10 U | NA |
| trans-1,2-DICHLOROETHENE | 1 U | 1 U | 1 U | 1 U | NA | 1 U |
| cis-1,2-DICHLOROETHENE | 1 U | 1 U | 1 U | 1 U | NA | 1 U |
| 1,2-DICHLOROETHENE (TOTAL) | NA | NA | NA | NA | 10 U | NA |
| CHLOROFORM | NA | NA | NA | 3.7 | 10 U | 1.5 |
| TRICHLOROETHENE | 0.2 | 0.1 U | 0.1 U | 0.1 U | 10 U | 0.1 U |
| BENZENE | 586 | 312 | 5 | 1 U | 10 U | 1 U |
| TETRACHLOROETHENE | NA | NA | NA | NA | 10 U | NA |
| 1,1,2,2-TETRACHLOROETHANE | NA | NA | NA | NA | 10 U | NA |
| TOLUENE | 3 | 2 | 1 U | 1 U | 10 U | 1 U |
| ETHYLBENZENE | 37 | 11 | 3 | 1 U | 10 U | 1 U |
| M&P-XYLENES | 7 | 1 U | 1 U | 1 U | NA | 1 U |
| O-XYLENES | 1 U | 1 U | 1 U | 1 U | NA | 1 U |
| XYLENE (TOTAL) | NA | NA | NA | NA | 10 U | NA |
| METHL-TERT-BUTYL-ETHER | 85 | 19 | 5 U | NA | 5 U | NA |

QUALIFIER DEFINITIONS

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

NOTES

ug/kg = micrograms per kilogram.

NA = Not analyzed.

TABLE 2-4
SCREENING RESULTS, UPPER PORTION OF THE SURFICIAL AQUIFER
GROUNDWATER
VOLATILE ORGANIC COMPOUNDS
SITE 35, CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 232
MCB CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232

| | |
|----------------------------|-------------|
| SAMPLE ID | 35-TW31A-04 |
| METHOD | VOA1.8 |
| DATE SAMPLED | 08/04/96 |
| VOLATILES (ug/L) | |
| VINYL CHLORIDE | 10 U |
| ACETONE | 10 U |
| 1,1-DICHLOROETHENE | 10 U |
| 1,1-DICHLOROETHANE | 10 U |
| trans-1,2-DICHLOROETHENE | NA |
| cis-1,2-DICHLOROETHENE | NA |
| 1,2-DICHLOROETHENE (TOTAL) | 10 U |
| CHLOROFORM | 10 U |
| TRICHLOROETHENE | 10 U |
| BENZENE | 10 U |
| TETRACHLOROETHENE | 10 U |
| 1,1,2,2-TETRACHLOROETHANE | 10 U |
| TOLUENE | 10 U |
| ETHYLBENZENE | 10 U |
| M&P-XYLENES | NA |
| O-XYLENES | NA |
| XYLENE (TOTAL) | 10 U |
| METHL-TERT-BUTYL-ETHER | 5 U |

QUALIFIER DEFINITIONS

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

NOTES

ug/kg = micrograms per kilogram.

NA = Not analyzed.

TABLE 2-5
SCREENING RESULTS, MIDDLE PORTION OF THE SURFICIAL AQUIFER
GROUNDWATER
VOLATILE ORGANIC COMPOUNDS
SITE 35, CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 232
MCB CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232

| SAMPLE ID | 35-TW16C-04 | 35-TW17C-04 | 35-TW18C-04 | 35-TW19C-04 | 35-TW20C-04 | 35-TW22C-04 |
|----------------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| METHOD | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A |
| DATE SAMPLED | 04/16/96 | 04/16/96 | 04/16/96 | 04/16/96 | 04/15/96 | 04/15/96 |
| VOLATILES (ug/L) | | | | | | |
| VINYL CHLORIDE | NA | NA | NA | NA | NA | NA |
| ACETONE | NA | NA | NA | NA | NA | NA |
| 1,1-DICHLOROETHENE | NA | NA | NA | NA | NA | NA |
| 1,1-DICHLOROETHANE | NA | NA | NA | NA | NA | NA |
| trans-1,2-DICHLOROETHENE | 6 | 54 | 32 | 7 | 8 | 9 |
| cis-1,2-DICHLOROETHENE | 91 | 159 | 165 | 107 | 124 | 137 |
| 1,2-DICHLOROETHENE (TOTAL) | NA | NA | NA | NA | NA | NA |
| CHLOROFORM | NA | NA | NA | NA | NA | NA |
| TRICHLOROETHENE | 17 | 153.7 | 167 | 21 | 34.4 | 37.9 |
| BENZENE | 1 U | 1 U | 1 U | 1 U | 37 | 11 |
| TETRACHLOROETHENE | NA | NA | NA | NA | NA | NA |
| 1,1,2,2-TETRACHLOROETHANE | NA | NA | NA | NA | NA | NA |
| TOLUENE | 1 U | 1 U | 1 U | 1 U | 174 | 14 |
| ETHYLBENZENE | 1 U | 1 U | 1 U | 1 U | 28 | 4 |
| M&P-XYLENES | 1 U | 1 U | 1 U | 1 U | 61 | 6 |
| O-XYLENES | 1 U | 1 U | 1 U | 1 U | 30 | 3 |
| XYLENE (TOTAL) | NA | NA | NA | NA | NA | NA |
| METHL-TERT-BUTYL-ETHER | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |

QUALIFIER DEFINITIONS

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

NOTES

ug/kg = micrograms per kilogram.

NA = Not analyzed.

TABLE 2-5
SCREENING RESULTS, MIDDLE PORTION OF THE SURFICIAL AQUIFER
GROUNDWATER
VOLATILE ORGANIC COMPOUNDS
SITE 35, CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 232
MCB CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232

| SAMPLE ID | 35-TW23C-04 | 35-TW24C-04 | 35-TW25C-04 | 35-TW26C-04 |
|----------------------------|-------------|-------------|-------------|-------------|
| METHOD | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A |
| DATE SAMPLED | 04/15/96 | 04/14/96 | 04/14/96 | 04/13/96 |
| VOLATILES (ug/L) | | | | |
| VINYL CHLORIDE | NA | NA | NA | NA |
| ACETONE | NA | NA | NA | NA |
| 1,1-DICHLOROETHENE | NA | NA | NA | NA |
| 1,1-DICHLOROETHANE | NA | NA | NA | NA |
| trans-1,2-DICHLOROETHENE | 3 | 1 U | 1 U | 1 U |
| cis-1,2-DICHLOROETHENE | 47 | 15 | 3 | 1 U |
| 1,2-DICHLOROETHENE (TOTAL) | NA | NA | NA | NA |
| CHLOROFORM | NA | NA | NA | NA |
| TRICHLOROETHENE | 10.9 | 0.8 | 0.1 U | 0.1 U |
| BENZENE | 224 | 5 | 3 | 3 |
| TETRACHLOROETHENE | NA | NA | NA | NA |
| 1,1,2,2-TETRACHLOROETHANE | NA | NA | NA | NA |
| TOLUENE | 315 | 1 U | 1 U | 1 U |
| ETHYLBENZENE | 37 | 1 U | 1 U | 1 U |
| M&P-XYLENES | 79 | 1 U | 1 U | 1 U |
| O-XYLENES | 44 | 1 U | 1 U | 1 U |
| XYLENE (TOTAL) | NA | NA | NA | NA |
| METHYL-TERT-BUTYL-ETHER | 8 | 5 U | | 5 U |

QUALIFIER DEFINITIONS

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

NOTES

ug/kg = micrograms per kilogram.
 NA = Not analyzed.

TABLE 2-6
SCREENING RESULTS, LOWER PORTION OF THE SURFICIAL AQUIFER
GROUNDWATER
VOLATILE ORGANIC COMPOUNDS
SITE 35, CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 232
MCB CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232

| SAMPLE ID | 35-MW16D-04 | 35-MW17D-04 | 35-MW18D-04 | 35-MW19D-04 | 35-TW01B-04 | 35-TW02B-04 |
|----------------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| METHOD | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A |
| DATE SAMPLED | 04/13/96 | 04/13/96 | 04/13/96 | 04/14/96 | 4/09/96 | 4/10/96 |
| VOLATILES (ug/L) | | | | | | |
| VINYL CHLORIDE | NA | NA | NA | NA | NA | NA |
| ACETONE | NA | NA | NA | NA | NA | NA |
| 1,1-DICHLOROETHENE | NA | NA | NA | NA | NA | NA |
| 1,1-DICHLOROETHANE | NA | NA | NA | NA | NA | NA |
| trans-1,2-DICHLOROETHENE | 1 U | 1 U | 1 U | 68 | 2 | 18 |
| cis-1,2-DICHLOROETHENE | 15 | 1 U | 10 | 266 | 48 | 211 |
| 1,2-DICHLOROETHENE (TOTAL) | NA | NA | NA | NA | NA | NA |
| CHLOROFORM | NA | NA | NA | NA | NA | NA |
| TRICHLOROETHENE | 0.3 | 0.1 | 0.7 | 379.2 | 1.1 | 7.6 |
| BENZENE | 8 | 1 U | 1 U | 1 U | 1 U | 1 U |
| TETRACHLOROETHENE | NA | NA | NA | NA | NA | NA |
| 1,1,2,2-TETRACHLOROETHANE | NA | NA | NA | NA | NA | NA |
| TOLUENE | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| ETHYLBENZENE | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| M&P-XYLENES | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| O-XYLENES | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| XYLENE (TOTAL) | NA | NA | NA | NA | NA | NA |
| METHL-TERT-BUTYL-ETHER | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |

QUALIFIER DEFINITIONS

J = Compound present. Reported value may not be accurate or precise.

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

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

NOTES

ug/kg = micrograms per kilogram.

NA = Not analyzed.

TABLE 2-6
SCREENING RESULTS, LOWER PORTION OF THE SURFICIAL AQUIFER
GROUNDWATER
VOLATILE ORGANIC COMPOUNDS
SITE 35, CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 232
MCB CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232

| SAMPLE ID | 35-TW03B-04 | 35-TW04B-04 | 35-TW05B-04 | 35-TW06B-04 | 35-TW07B-04 | 35-TW08B-04 |
|----------------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| METHOD | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A |
| DATE SAMPLED | 4/09/96 | 4/10/96 | 4/10/96 | 4/11/96 | 4/11/96 | 4/11/96 |
| VOLATILES (ug/L) | | | | | | |
| VINYL CHLORIDE | NA | NA | NA | NA | NA | NA |
| ACETONE | NA | NA | NA | NA | NA | NA |
| 1,1-DICHLOROETHENE | NA | NA | NA | NA | NA | NA |
| 1,1-DICHLOROETHANE | NA | NA | NA | NA | NA | NA |
| trans-1,2-DICHLOROETHENE | 5 | 2 | 1 U | 1 U | 1 U | 1 U |
| cis-1,2-DICHLOROETHENE | 125 | 46 | 13 | 1 U | 1 U | 7 |
| 1,2-DICHLOROETHENE (TOTAL) | NA | NA | NA | NA | NA | NA |
| CHLOROFORM | NA | NA | NA | NA | NA | NA |
| TRICHLOROETHENE | 13.5 | 24.6 | 1.7 | 0.1 U | 0.1 U | 1.3 |
| BENZENE | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| TETRACHLOROETHENE | NA | NA | NA | NA | NA | NA |
| 1,1,2,2-TETRACHLOROETHANE | NA | NA | NA | NA | NA | NA |
| TOLUENE | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| ETHYLBENZENE | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| M&P-XYLENES | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| O-XYLENES | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| XYLENE (TOTAL) | NA | NA | NA | NA | NA | NA |
| METHL-TERT-BUTYL-ETHER | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |

QUALIFIER DEFINITIONS

J = Compound present. Reported value may not be accurate or precise.

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

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

NOTES

ug/kg = micrograms per kilogram.

NA = Not analyzed.

TABLE 2-6
SCREENING RESULTS, LOWER PORTION OF THE SURFICIAL AQUIFER
GROUNDWATER
VOLATILE ORGANIC COMPOUNDS
SITE 35, CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 232
MCB CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232

| SAMPLE ID | 35-TW09B-04 | 35-TW10B-04 | 35-TW11B-04 | 35-TW12B-04 | 35-TW13B-04 | 35-TW14B-04 |
|----------------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| METHOD | 8010A/8020A | 8010A/8020A | 8010A/8020A | VOA1.8 | VOA1.8 | VOA1.8 |
| DATE SAMPLED | 4/11/96 | 4/11/96 | 4/11/96 | 04/26/96 | 04/26/96 | 04/29/96 |
| VOLATILES (ug/L) | | | | | | |
| VINYL CHLORIDE | NA | NA | NA | 10 U | 10 U | 10 U |
| ACETONE | NA | NA | NA | 10 U | 10 U | 10 U |
| 1,1-DICHLOROETHENE | NA | NA | NA | 10 U | 10 U | 10 U |
| 1,1-DICHLOROETHANE | NA | NA | NA | 10 U | 10 U | 10 U |
| trans-1,2-DICHLOROETHENE | 38 | 1 U | 1 U | NA | NA | NA |
| cis-1,2-DICHLOROETHENE | 1 | 11 | 6 | NA | NA | NA |
| 1,2-DICHLOROETHENE (TOTAL) | NA | NA | NA | 51 | 10 U | 14 |
| CHLOROFORM | NA | NA | NA | 10 U | 10 U | 10 U |
| TRICHLOROETHENE | 9.6 | 0.1 U | 0.5 | 93 | 10 U | 10 U |
| BENZENE | 1 U | 1 U | 1 U | 10 U | 10 U | 10 U |
| TETRACHLOROETHENE | NA | NA | NA | 10 U | 10 U | 10 U |
| 1,1,2,2-TETRACHLOROETHANE | NA | NA | NA | 10 U | 10 U | 10 U |
| TOLUENE | 1 U | 1 U | 1 U | 10 U | 10 U | 10 U |
| ETHYLBENZENE | 1 U | 1 U | 1 U | 10 U | 10 U | 10 U |
| M&P-XYLENES | 1 U | 1 U | 1 U | NA | NA | NA |
| O-XYLENES | 1 U | 1 U | 1 U | NA | NA | NA |
| XYLENE (TOTAL) | NA | NA | NA | 10 U | 10 U | 10 U |
| METHL-TERT-BUTYL-ETHER | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |

QUALIFIER DEFINITIONS

J = Compound present. Reported value may not be accurate or precise.

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

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

NOTES

ug/kg = micrograms per kilogram.

NA = Not analyzed.

TABLE 2-6
 SCREENING RESULTS, LOWER PORTION OF THE SURFICIAL AQUIFER
 GROUNDWATER
 VOLATILE ORGANIC COMPOUNDS
 SITE 35, CAMP GEIGER AREA FUEL FARM
 SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 232
 MCB CAMP LEJEUNE, NORTH CAROLINA
 CONTRACT TASK ORDER 0232

| SAMPLE ID | 35-TW15B-04 | 35-TW16B-04 | 35-TW17B-04 | 35-TW18B-04 | 35-TW19B-04 | 35-TW20B-04 |
|----------------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| METHOD | VOA1.8 | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A |
| DATE SAMPLED | 04/30/96 | 04/16/96 | 04/16/96 | 04/16/96 | 04/16/96 | 04/15/96 |
| VOLATILES (ug/L) | | | | | | |
| VINYL CHLORIDE | 10 U | NA | NA | NA | NA | NA |
| ACETONE | 10 U | NA | NA | NA | NA | NA |
| 1,1-DICHLOROETHENE | 10 U | NA | NA | NA | NA | NA |
| 1,1-DICHLOROETHANE | 10 U | NA | NA | NA | NA | NA |
| trans-1,2-DICHLOROETHENE | NA | 338 | 422 | 118 | 141 | 63 |
| cis-1,2-DICHLOROETHENE | NA | 1317 | 1417 | 410 | 611 | 318 |
| 1,2-DICHLOROETHENE (TOTAL) | 13 | NA | NA | NA | NA | NA |
| CHLOROFORM | 10 U | NA | NA | NA | NA | NA |
| TRICHLOROETHENE | 4 J | 1540.1 | 2054 | 719.5 | 834.1 | 246.3 |
| BENZENE | 10 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| TETRACHLOROETHENE | 10 U | NA | NA | NA | NA | NA |
| 1,1,2,2-TETRACHLOROETHANE | 10 U | NA | NA | NA | NA | NA |
| TOLUENE | 10 U | 1 U | 1 U | 1 U | 1 U | 2 |
| ETHYLBENZENE | 10 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| M&P-XYLENES | NA | 1 U | 1 U | 1 U | 1 U | 1 U |
| O-XYLENES | NA | 1 U | 1 U | 1 U | 1 U | 1 U |
| XYLENE (TOTAL) | 10 U | NA | NA | NA | NA | NA |
| METHL-TERT-BUTYL-ETHER | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |

QUALIFIER DEFINITIONS

J = Compound present. Reported value may not be accurate or precise.

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

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

NOTES

ug/kg = micrograms per kilogram.

NA = Not analyzed.

TABLE 2-6
SCREENING RESULTS, LOWER PORTION OF THE SURFICIAL AQUIFER
GROUNDWATER
VOLATILE ORGANIC COMPOUNDS
SITE 35, CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 232
MCB CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232

| SAMPLE ID | 35-TW22B-04 | 35-TW23B-04 | 35-TW24B-04 | 35-TW25B-04 | 35-TW26B-04 | 35-TW27B-04 |
|----------------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| METHOD | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A | VOA1.8 |
| DATE SAMPLED | 04/15/96 | 04/15/96 | 04/14/96 | 04/14/96 | 04/13/96 | 04/25/96 |
| VOLATILES (ug/L) | | | | | | |
| VINYL CHLORIDE | NA | NA | NA | NA | NA | 10 UJ |
| ACETONE | NA | NA | NA | NA | NA | 66 J |
| 1,1-DICHLOROETHENE | NA | NA | NA | NA | NA | 10 UJ |
| 1,1-DICHLOROETHANE | NA | NA | NA | NA | NA | 10 UJ |
| trans-1,2-DICHLOROETHENE | 1 U | 3 | 1 U | 1 U | 1 U | NA |
| cis-1,2-DICHLOROETHENE | 16 | 70 | 1 U | 1 U | 1 U | NA |
| 1,2-DICHLOROETHENE (TOTAL) | NA | NA | NA | NA | NA | 260 J |
| CHLOROFORM | NA | NA | NA | NA | NA | 10 U |
| TRICHLOROETHENE | 4.5 | 11.6 | 0.5 | 0.1 U | 0.1 U | 41 J |
| BENZENE | 11 | 4 | 1 U | 1 U | 1 U | 10 UJ |
| TETRACHLOROETHENE | NA | NA | NA | NA | NA | 10 UJ |
| 1,1,2,2-TETRACHLOROETHANE | NA | NA | NA | NA | NA | 10 UJ |
| TOLUENE | 14 | 6 | 1 U | 1 U | 1 U | 10 UJ |
| ETHYLBENZENE | 4 | 2 | 1 U | 1 U | 1 U | 10 U |
| M&P-XYLENES | 6 | 3 | 1 U | 1 U | 1 U | NA |
| O-XYLENES | 3 | 2 | 1 U | 1 U | 1 U | NA |
| XYLENE (TOTAL) | NA | NA | NA | NA | NA | 10 U |
| METHL-TERT-BUTYL-ETHER | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |

QUALIFIER DEFINITIONS

J = Compound present. Reported value may not be accurate or precise.

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

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

NOTES

ug/kg = micrograms per kilogram.

NA = Not analyzed.

TABLE 2-6
SCREENING RESULTS, LOWER PORTION OF THE SURFICIAL AQUIFER
GROUNDWATER
VOLATILE ORGANIC COMPOUNDS
SITE 35, CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 232
MCB CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232

| SAMPLE ID | 35-TW28B-04 | 35-TW29B-04 | 35-TW30B-04 | 35-TW30B-04 | 35-TW31B-04 | 35-TW31B-04 |
|----------------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| METHOD | VOA1.8 | VOA1.8 | 8010A/8020A | VOA1.8 | 8010A/8020A | VOA1.8 |
| DATE SAMPLED | 04/29/96 | 04/30/96 | 08/04/96 | 08/04/96 | 8/04/96 | 08/04/96 |
| VOLATILES (ug/L) | | | | | | |
| VINYL CHLORIDE | 10 U | 10 U | NA | 10 U | NA | 10 U |
| ACETONE | 10 U | 10 U | NA | 10 U | NA | 10 U |
| 1,1-DICHLOROETHENE | 4 J | 10 U | NA | 10 U | NA | 10 U |
| 1,1-DICHLOROETHANE | 3 J | 10 U | NA | 10 U | NA | 10 U |
| trans-1,2-DICHLOROETHENE | NA | NA | 1 U | NA | 1 U | NA |
| cis-1,2-DICHLOROETHENE | NA | NA | 1 U | NA | 1 U | NA |
| 1,2-DICHLOROETHENE (TOTAL) | 2 J | 28 | NA | 10 U | NA | 10 U |
| CHLOROFORM | 10 U | 10 U | 1 | 10 U | 0.3 | 10 U |
| TRICHLOROETHENE | 10 U | 220 | 0.1 U | 10 U | 0.1 U | 10 U |
| BENZENE | 10 U | 10 U | 1 U | 10 U | 1 U | 10 U |
| TETRACHLOROETHENE | 10 U | 2 J | NA | 10 U | NA | 10 U |
| 1,1,2,2-TETRACHLOROETHANE | 10 U | 23 | NA | 10 U | NA | 10 U |
| TOLUENE | 10 U | 10 U | 1 U | 10 U | 1 U | 10 U |
| ETHYLBENZENE | 10 U | 10 U | 1 U | 10 U | 1 U | 10 U |
| M&P-XYLENES | NA | NA | 1 U | NA | 1 U | NA |
| O-XYLENES | NA | NA | 1 U | NA | 1 U | NA |
| XYLENE (TOTAL) | 10 U | 10 U | NA | 10 U | NA | 10 U |
| METHL-TERT-BUTYL-ETHER | 5 U | 5 U | NA | 5 U | NA | 5 U |

QUALIFIER DEFINITIONS

J = Compound present. Reported value may not be accurate or precise.

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

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

NOTES

ug/kg = micrograms per kilogram.

NA = Not analyzed.

TABLE 2-7

**SUMMARY OF PERMANENT SHALLOW AND INTERMEDIATE WELL CONSTRUCTION DETAILS
 SITE 35, CAMP GEIGER AREA FUEL FARM
 SUPPLEMENTAL GROUNDWATER INVESTIGATION
 MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA
 CONTRACT TASK ORDER 0232**

| Well No. | Date Installed | Consultant Supervising Well Installation | Top of PVC Casing Elevation (feet, above MSL) ⁽¹⁾ | Ground Surface Elevation (feet, above MSL) | Stick-Up ⁽²⁾ (feet, above ground surface) | Boring Depth (feet, bgs) ⁽³⁾ | Well Depth (feet, bgs) | Screen Interval Depth (feet, bgs) ⁽⁴⁾ | Depth to Sand Pack (feet, bgs) | Depth to Bentonite (feet, bgs) |
|----------|----------------|--|--|--|--|---|------------------------|--|--------------------------------|--------------------------------|
| 35-MW39B | 4-28-96 | Baker | 18.83 | 19.10 | -0.27 | 47.0 | 47.0 | 40.0-45.0 | 38.0 | 35.6 |
| 35-MW40B | 4-27-96 | Baker | 17.59 | 17.80 | -0.21 | 17.0 | 47.0 | 40.0-45.0 | 38.0 | 35.6 |
| 35-MW41B | 4-28-96 | Baker | 16.43 | 16.70 | -0.27 | 47.0 | 47.0 | 40.0-45.0 | 37.9 | 35.1 |
| 35-MW42B | 5-1-96 | Baker | 15.12 | 15.20 | -0.08 | 17.0 | 42.0 | 35.0-45.0 | 33.0 | 24.0 |
| 35-MW43B | 5-1-96 | Baker | 15.01 | 15.30 | -0.29 | 43.0 | 42.0 | 35.0-45.0 | 33.0 | 27.0 |
| 35-MW60A | 8-1-96 | Baker | 10.08 | 7.6 | 2.48 | 14.0 | 20.0 | 9.0-19.0 | 7.0 | 5.0 |
| 35-MW60B | 8-1-96 | Baker | 9.59 | 7.1 | 2.49 | 47.0 | 36.0 | 30.0-35.0 | 28.0 | 26.0 |

- Notes: ⁽¹⁾ MSL = mean sea level
⁽²⁾ Wells 35-MW39B through 43B are flush mounted
⁽³⁾ bgs = below ground surface
⁽⁴⁾ Screen interval is measured from top to bottom slot of screen
 "A" designation is shallow; "B" designation is intermediate.

TABLE 2-8

SUMMARY OF PERMANENT DEEP WELL CONSTRUCTION DETAILS
 SITE 35, CAMP GEIGER AREA FUEL FARM
 SUPPLEMENTAL GROUNDWATER INVESTIGATION
 MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA
 CONTRACT TASK ORDER 0232

| Well No. | Date Installed | Consultant Supervising Well Installation | Top of PVC Casing Elevation (feet, above MSL) | Ground Surface Elevation (feet, above MSL) | Stick-Up (feet, above ground surface) ⁽²⁾ | Boring Depth (feet, bgs) ⁽³⁾ | Well Depth (feet, bgs) | Steel Outer Casing Depth (feet, bgs) | Screen Interval Depth (feet, bgs) ⁽⁴⁾ | Depth to Sand Pack (feet, bgs) | Depth to Bentonite (feet, bgs) |
|----------|----------------|--|---|--|--|---|------------------------|--------------------------------------|--|--------------------------------|--------------------------------|
| 35GWD-6 | 4-25-96 | Baker | 17.57 | 17.80 | -.23 | 69.0 | 69.0 | 46.0 | 63.0-68.0 | 60.0 | 58.0 |
| 35GWD-7 | 7-30-96 | Baker | 9.41 | 7.30 | 2.11 | 52.0 | 61.5 | 35.0 | 46.0-51.0 | 44.0 | 37.0 |

- Note: (1) MSL = mean sea level
 (2) Well 35GWD-6 is flush mounted
 (3) bgs = below ground surface
 (4) Screen interval is measured from top to bottom slot of screen

TABLE 2-9

SUMMARY OF WATER LEVEL MEASUREMENTS FROM SHALLOW WELLS
 SITE 35, CAMP GEIGER AREA FUEL FARM
 SUPPLEMENTAL GROUNDWATER INVESTIGATION
 MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA
 CONTRACT TASK ORDER 0232

| Well No. | Top of Casing Elevation (feet, above MSL) ⁽¹⁾ | Depth to Groundwater (feet, below top of casing) (5-1-96) | Depth to Groundwater (feet, below top of casing) (7-13-96) | Depth to Groundwater (feet, below top of casing) (7-29-96) | Groundwater Elevation (feet, above MSL) (5-1-96) | Groundwater Elevation (feet, above MSL) (7-13-96) | Groundwater Elevation (feet, above MSL) (7-29-96) |
|----------|--|---|--|--|--|---|---|
| EMW-1 | 19.21 | -- | 9.5 | 7.96 | -- | 9.71 | 11.25 |
| EMW-3 | 7.13 | 2.68 | 3.54 | 1.64 | 4.45 | 3.59 | 5.49 |
| EMW-5 | 18.05 | 9.02 | 9.14 | 8.62 | 9.03 | 8.91 | 9.43 |
| EMW-6 | 18.52 | 13.40 | 13.54 | 12.50 | 5.12 | 4.98 | 6.02 |
| EMW-7 | 16.00 | 10.52 | 10.60 | 8.50 | 5.48 | 5.40 | 7.50 |
| MW-4S | 20.52 | -- | 7.72 | 5.17 | -- | 12.80 | 15.35 |
| MW-9S | 18.92 | -- | 8.82 | 7.40 | -- | 10.10 | 11.52 |
| MW-10S | 18.99 | 8.28 | 8.45 | 7.19 | 10.71 | 10.54 | 11.80 |
| MW-12S | 19.91 | -- | 12.76 | 11.68 | -- | 7.15 | 8.23 |
| MW-13S | 16.92 | -- | 11.70 | 10.33 | -- | 5.22 | 5.59 |
| MW-14S | 17.78 | 10.96 | 11.22 | 10.11 | 6.82 | 6.56 | 7.67 |
| MW-16S | 20.10 | 14.38 | 14.54 | 13.41 | 5.72 | 5.56 | 6.69 |
| MW-17S | 16.83 | 12.30 | 12.42 | 11.33 | 4.53 | 4.41 | 5.50 |
| MW-19S | 8.61 | 4.38 | 4.10 | 3.46 | 4.23 | 4.51 | 5.51 |
| MW-23S | 8.74 | 6.36 | 5.24 | -- | 2.38 | 3.50 | -- |
| MW-29A | 20.62 | 8.84 | 9.42 | 7.75 | 11.78 | 11.20 | 12.87 |
| MW-30A | 18.38 | 7.10 | 7.06 | 5.16 | 11.28 | 11.32 | 13.22 |
| 35MW-31A | 18.32 | 10.46 | 10.95 | 9.92 | 7.86 | 7.37 | 8.40 |
| 35MW-32A | 18.23 | 8.72 | 7.38 | -- | 9.51 | 10.85 | -- |
| 35MW-33A | 16.68 | -- | 9.78 | 8.76 | -- | 6.90 | 7.92 |
| 35MW-34A | 16.77 | 8.59 | 5.98 | 4.75 | 8.18 | 10.79 | 12.02 |
| 35MW-35A | 15.45 | 8.81 | 8.16 | 7.25 | 7.27 | 7.29 | 8.20 |

TABLE 2-9 (Continued)

**SUMMARY OF WATER LEVEL MEASUREMENTS FROM SHALLOW WELLS
 SITE 35, CAMP GEIGER AREA FUEL FARM
 SUPPLEMENTAL GROUNDWATER INVESTIGATION
 MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA
 CONTRACT TASK ORDER 0232**

| Well No. | Top of Casing Elevation (feet, above MSL) ⁽¹⁾ | Depth to Groundwater (feet, below top of casing) (5-1-96) | Depth to Groundwater (feet, below top of casing) (7-13-96) | Depth to Groundwater (feet, below top of casing) (7-29-96) | Groundwater Elevation (feet, above MSL) (5-1-96) | Groundwater Elevation (feet, above MSL) (7-13-96) | Groundwater Elevation (feet, above MSL) (7-29-96) |
|----------|--|---|--|--|--|---|---|
| 35MW-36A | 13.30 | -- | 9.32 | 8.78 | -- | 3.98 | 4.52 |
| 35MW-37A | 20.30 | 7.70 | 7.60 | 6.05 | 12.60 | 12.70 | 14.25 |
| 35MW-38A | 19.74 | 7.64 | 8.36 | 6.50 | 12.10 | 11.38 | 13.24 |

Note: ⁽¹⁾ MSL = mean sea level

TABLE 2-10

**SUMMARY OF WATER LEVEL MEASUREMENTS FROM INTERMEDIATE WELLS
SITE 35, CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232**

| Well No. | Top of Casing Elevation (feet, above MSL) ⁽¹⁾ | Depth to Groundwater (feet, below top of casing) (5-1-96) | Depth to Groundwater (feet, below top of casing) (7-13-96) | Depth to Groundwater (feet, below top of casing) (7-29-96) | Groundwater Elevation (feet, above MSL) (5-1-96) | Groundwater Elevation (feet, above MSL) (7-13-96) | Groundwater Elevation (feet, above MSL) (7-29-94) |
|----------|--|---|--|--|---|--|--|
| MW-9D | 18.88 | -- | 8.84 | 7.34 | -- | 10.04 | 11.54 |
| MW-10D | 19.01 | 8.34 | 8.55 | 7.02 | 10.67 | 10.46 | 11.99 |
| MW-12D | 19.94 | -- | 12.84 | 11.75 | -- | 7.10 | 8.19 |
| MW-13D | 17.02 | -- | 11.74 | 10.45 | -- | 5.28 | 6.57 |
| MW-14D | 17.73 | 10.90 | 11.15 | 10.08 | 6.83 | 6.58 | 7.65 |
| MW-16D | 20.06 | 14.34 | 15.50 | 13.47 | 5.72 | 4.56 | 6.59 |
| MW-17D | 16.77 | 12.18 | 12.24 | 11.20 | 4.59 | 4.53 | 5.57 |
| MW-18D | 13.85 | 9.18 | 9.14 | 8.18 | 4.67 | 4.71 | 5.67 |
| MW-19D | 8.57 | 4.14 | 3.98 | 3.28 | 4.43 | 4.59 | 5.29 |
| MW-23D | 8.74 | 4.98 | 4.70 | -- | 3.76 | 4.04 | -- |
| 35MW-26B | 15.05 | 7.70 | 7.82 | 6.81 | 7.35 | 7.23 | 8.24 |
| 35MW-29B | 20.28 | 8.50 | 8.88 | 7.15 | 11.78 | 11.40 | 13.13 |
| 35MW-30B | 18.38 | 7.24 | 7.55 | 5.50 | 11.14 | 10.83 | 12.88 |
| 35MW-31B | 18.46 | 10.82 | 11.14 | 10.09 | 7.64 | 7.32 | 8.37 |
| 35MW-32B | 18.75 | 9.66 | 9.70 | -- | 9.09 | 9.05 | -- |
| 35MW-33B | 16.62 | -- | 9.70 | 8.71 | -- | 6.92 | 7.91 |
| 35MW-34B | 16.76 | 7.22 | 8.82 | 7.56 | 9.54 | 7.94 | 9.20 |
| 35MW-35B | 15.67 | 8.42 | 8.74 | 7.62 | 7.25 | 6.93 | 8.05 |
| 35MW-36B | 13.22 | -- | 9.42 | 9.02 | -- | 3.80 | 4.20 |
| 35MW-37B | 20.33 | 8.00 | 8.30 | 6.45 | 12.33 | 12.03 | 13.88 |
| 35MW-38B | 20.00 | 8.08 | 8.48 | 6.65 | 11.92 | 11.52 | 13.35 |
| 35MW-39B | 18.83 | 7.38 | 7.80 | 5.74 | 11.45 | 11.03 | 13.09 |
| 35MW-40B | 17.59 | 6.94 | 6.90 | 5.17 | 10.65 | 10.69 | 12.42 |

TABLE 2-10 (Continued)

**SUMMARY OF WATER LEVEL MEASUREMENTS FROM INTERMEDIATE WELLS
SITE 35, CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232**

| Well No. | Top of Casing Elevation (feet, above MSL) ⁽¹⁾ | Depth to Groundwater (feet, below top of casing) (5-1-96) | Depth to Groundwater (feet, below top of casing) (7-13-96) | Depth to Groundwater (feet, below top of casing) (7-29-96) | Groundwater Elevation (feet, above MSL) (5-1-96) | Groundwater Elevation (feet, above MSL) (7-13-96) | Groundwater Elevation (feet, above MSL) (7-29-94) |
|----------|--|---|--|--|---|--|--|
| 35MW-41B | 16.43 | -- | 8.12 | 6.57 | -- | 8.31 | 9.86 |
| 35MW-42B | 15.12 | 5.80 | -- | 4.60 | 9.32 | -- | 10.52 |
| 35MW-43B | 15.01 | -- | 4.78 | 3.31 | -- | 10.23 | 11.70 |

Note: ⁽¹⁾ MSL = mean sea level

TABLE 2-11

SUMMARY OF WATER LEVEL MEASUREMENTS FROM DEEP WELLS
 SITE 35, CAMP GEIGER AREA FUEL FARM
 SUPPLEMENTAL GROUNDWATER INVESTIGATION
 MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA
 CONTRACT TASK ORDER 0232

| Well No. | Top of Casing Elevation (feet, above MSL) ⁽¹⁾ | Depth to Groundwater (feet, below top of casing) (5-1-96) | Depth to Groundwater (feet, below top of casing) (7-13-96) | Depth to Groundwater (feet, below top of casing) (7-29-96) | Groundwater Elevation (feet, above MSL) (5-1-96) | Groundwater Elevation (feet, above MSL) (7-13-96) | Groundwater Elevation (feet, above MSL) (7-29-96) |
|----------|--|---|--|--|---|--|--|
| 35GWD-1 | 19.95 | -- | 8.82 | 6.18 | -- | 11.13 | 13.77 |
| 35GWD-2 | 20.10 | -- | 14.20 | 16.19 | -- | 5.90 | 3.91 |
| 35GWD-3 | 19.03 | 8.12 | 9.42 | 7.91 | 10.91 | 9.61 | 11.12 |
| 35GWD-5 | 10.09 | 5.68 | 5.40 | 4.70 | 4.41 | 4.69 | 5.39 |
| 35GWD-6 | 17.57 | -- | 7.18 | 5.46 | -- | 10.39 | 12.11 |

Notes:

⁽¹⁾ MSL = mean sea level

Monitoring well 35GWD-4 was abandoned.

TABLE 2-12

**SUMMARY OF GROUNDWATER FIELD PARAMETERS
ROUND THREE
SITE 35, CAMP GEIGER FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION
MCB, CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232**

| Well No. | Depth of Well (ft.) | Purge Volume (gals.) | Field Parameters | | | | |
|----------|---------------------|----------------------|------------------|---|------------------|-----------|------------------|
| | | | Gallons Removed | Specific Conductance at 25°C (micromhos/cm) | Temperature (°C) | pH (S.U.) | Turbidity (T.U.) |
| 35-MW14S | 16.18 | .75 | .75 | 715 | 22.9 | 6.67 | 10.2 |
| 8/10/95 | | | 1.5 | 687 | 22.6 | 6.68 | 5.13 |
| | | | 2.30 | 678 | 22.9 | 6.71 | 1.99 |
| 35-EMW3 | 13.78 | 7.20 | 7.20 | 443.1 | 23.2 | 6.81 | 3.42 |
| 8/10/95 | | | 14.4 | 443.3 | 23.5 | 6.67 | 1.75 |
| | | | 21.6 | 444.2 | 23.4 | 6.88 | 1.07 |
| 35-MW19D | 27.16 | 3.6 | 3.6 | 492 | 20.2 | 6.92 | 25.7 |
| 8/11/95 | | | 7.3 | 503 | 20.0 | 6.90 | 5.93 |
| | | | 11.1 | 502 | 19.9 | 6.98 | 2.75 |
| 35-GWD5 | 56.4 | 8.1 | 8.1 | 393.3 | 21.1 | 7.3 | 3.34 |
| 8/11/95 | | | 16.2 | 384.6 | 20.2 | 7.29 | .88 |
| | | | 28 | 393.6 | 21.5 | 7.27 | .26 |
| 35-MW29B | 47.0 | 6.2 | 6.2 | 422.9 | 21.3 | 6.99 | 8.25 |
| 8/12/95 | | | 12.4 | 433.2 | 21.7 | 7.08 | 3.42 |
| | | | 18.6 | 439.0 | 21.7 | 7.09 | 1.90 |
| 35-MW33A | 14.0 | .22 | .5 | 124.3 | 24.3 | 4.55 | 40.3 |
| 8/12/95 | | | 1.0 | 122.9 | 24.4 | 4.53 | 33.1 |
| | | | 2.1 | 125.5 | 24.5 | 4.54 | 5.62 |
| | | | 3.0 | 125.6 | 24.5 | 4.54 | .08 |
| 35-EMW7 | 27.51 | 2.62 | 1.0 | 552 | 23.1 | 7.91 | 4.55 |
| 8/10/95 | | | 3.5 | 536 | 21.4 | 7.95 | NA |
| | | | 5.0 | 539 | 28.1 | 7.95 | 4.32 |
| | | | 6.5 | 529 | 21.5 | 7.87 | 4.35 |
| | | | 10.25 | 520 | 21.0 | 7.71 | 1.25 |
| 35-MW19D | 27.16 | 3.6 | 3.6 | 482 | 20.2 | 6.92 | 25.7 |
| 8/11/95 | | | 7.3 | 503 | 20.0 | 6.90 | 5.93 |
| | | | 11.1 | 502 | 19.9 | 6.98 | 2.75 |

TABLE 2-12 (Continued)

**SUMMARY OF GROUNDWATER FIELD PARAMETERS
ROUND THREE
SITE 35, CAMP GEIGER FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION
MCB, CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232**

| Well No. | Depth of Well (ft.) | Purge Volume (gals.) | Field Parameters | | | | |
|----------|---------------------|----------------------|------------------|---|------------------|-----------|------------------|
| | | | Gallons Removed | Specific Conductance at 25°C (micromhos/cm) | Temperature (°C) | pH (S.U.) | Turbidity (T.U.) |
| 35-MW10S | 17.14 | 1.4 | 1.4 | 351.7 | 24.4 | 7.34 | 1.00 |
| 8/9/95 | | | 2.8 | 339.9 | 24.0 | 7.31 | .05 |
| | | | 4.2 | 374.9 | 23.7 | 7.25 | 3.73 |
| | | | 7.0 | 372.1 | 27.3 | 7.26 | 6.89 |
| 35-MW10D | 31.84 | 3.7 | 3.7 | 557 | 22 | 7.03 | 12.30 |
| 8/9/95 | | | 7.5 | 566 | 22.3 | 7.00 | 1.56 |
| | | | 11.2 | 570 | 22.5 | 7.03 | .85 |
| 35-MW16D | 33.48 | 2.9 | 2.9 | 457.5 | 21.8 | 6.95 | 9.5 |
| 8/9/95 | | | 5.5 | 459.9 | 21.7 | 7.05 | .49 |
| | | | 9.0 | 462 | 21.4 | NA | .10 |
| 35-MW16S | 15.30 | .33 | .5 | 683 | 22.5 | 6.70 | 1.12 |
| 8/10/95 | | | 1.3 | 668 | 22.3 | 6.70 | .96 |
| | | | 2.0 | 668 | 22.2 | 6.75 | 1.15 |
| 35-MW14D | 30.60 | 3.1 | 3.1 | 541 | 21.6 | 7.03 | 11.61 |
| 8/10/95 | | | 6.2 | 551 | 21.4 | 6.96 | 3.20 |
| | | | 9.3 | 547 | 21.3 | 6.96 | .93 |
| 35-MW19S | 15.66 | 1.75 | 2.0 | 565.2 | 21.2 | 7.46 | 9.56 |
| 8/11/95 | | | 3.5 | 255.8 | 21.1 | 7.69 | 13.57 |
| | | | 6.0 | 257.5 | 21.2 | 7.43 | 14.55 |
| | | | 8.5 | 248.4 | 20.9 | 7.35 | 8.93 |
| 35-MW29A | 16.00 | 1.12 | 1 | 238.5 | 23.5 | 4.46 | 20.10 |
| 8/12/95 | | | 2.5 | 240 | -- | 2.63 | 14.01 |
| | | | 4 | 209 | 23.5 | 6.37 | 1.02 |
| | | | 5 | 209 | 23.5 | 6.41 | 1.04 |
| | | | 6.25 | 207 | 23.5 | 6.41 | 1.02 |

TABLE 2-12 (Continued)

**SUMMARY OF GROUNDWATER FIELD PARAMETERS
ROUND THREE
SITE 35, CAMP GEIGER FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION
MCB, CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232**

| Well No. | Depth of Well (ft.) | Purge Volume (gals.) | Field Parameters | | | | |
|---------------------|---------------------|----------------------|------------------|---|------------------|-----------|------------------|
| Date of Measurement | | | Gallons Removed | Specific Conductance at 25°C (micromhos/cm) | Temperature (°C) | pH (S.U.) | Turbidity (T.U.) |
| 35-M233B | 44.00 | 5.11 | 1.0 | 524 | 25.0 | 8.48 | 1.25 |
| 8/12/95 | | | 3.5 | 523 | 25.0 | 7.16 | 2.20 |
| | | | 5.0 | NA | NA | NA | NA |
| | | | 7.5 | 525 | 25.1 | 7.20 | 1.68 |
| | | | 8.5 | 509 | 27.7 | 7.20 | 1.44 |
| | | | 9.0 | NA | NA | NA | NA |
| | | | 9.5 | 508 | 22.4 | 7.21 | 1.19 |
| | | | 10.0 | NA | NA | NA | NA |
| | | | 10.5 | 509 | 22.3 | 7.17 | .89 |
| | | | 14 | 509 | 22.9 | 7.20 | 1.17 |
| | | | 17 | 504 | 22.7 | 7.30 | 1.00 |
| 35-MW09S | 14.01 | .84 | 2.5 | 638 | 25.6 | 7.31 | 19.09 |
| 8/12/95 | | | 3.0 | 630 | 30.6 | 7.50 | 9.99 |
| | | | 4.1 | 634 | 26.9 | 7.39 | 4.10 |
| | | | 5.25 | 637 | 25.9 | 7.39 | 4.36 |
| 35-MW09D | 31.61 | 3.71 | 3.1 | 507 | 24.6 | 7.35 | 20.4 |
| | | | 4.25 | 505 | 23.3 | 7.25 | 27.1 |
| | | | 5.0 | 506 | 23.2 | 7.32 | 14.75 |
| | | | 6.0 | 518 | 26.7 | 7.34 | 6.78 |
| | | | 7.5 | 510 | 24.0 | 7.47 | 3.0 |
| | | | 11.6 | 507 | 23.7 | 7.31 | 0.98 |
| 35-MW22S | 18.31 | .70 | 0.6 | 610 | 27.0 | 6.48 | 5.4 |
| 8/13/95 | | | 2.25 | 648 | 27.7 | 6.57 | 13.1 |
| | | | 3.33 | 663 | 26.6 | 6.59 | 3.4 |
| 35-MW22D | 36.94 | 3.7 | 0.75 | 624 | 25.7 | 6.99 | 61 |
| 8/13/95 | | | 2.66 | 574 | 25.4 | 7.13 | 36.4 |
| | | | 7.5 | 537 | 25.0 | 7.21 | 4.6 |
| | | | 12.0 | 530 | 25.4 | 7.29 | 1.24 |

TABLE 2-12 (Continued)

**SUMMARY OF GROUNDWATER FIELD PARAMETERS
 ROUND THREE
 SITE 35, CAMP GEIGER FUEL FARM
 SUPPLEMENTAL GROUNDWATER INVESTIGATION
 MCB, CAMP LEJEUNE, NORTH CAROLINA
 CONTRACT TASK ORDER 0232**

| Well No. | Depth of Well (ft.) | Purge Volume (gals.) | Field Parameters | | | | |
|---------------------|---------------------|----------------------|------------------|---|------------------|-----------|------------------|
| Date of Measurement | | | Gallons Removed | Specific Conductance at 25°C (micromhos/cm) | Temperature (°C) | pH (S.U.) | Turbidity (T.U.) |
| EMW-5 | 26.08 | 9.41 | 3 | 405.2 | 26.5 | 6.06 | 2.78 |
| 8/11/95 | | | 5.7 | 381.9 | 26.2 | 6.03 | 1.99 |
| | | | 9.0 | 370.2 | 26.2 | 6.05 | 1.45 |

Notes:

- S.U. Standard units
- °C Degrees centigrade
- T.U. Turbidity units
- Equipment failure

TABLE 2-13

**SUMMARY OF GROUNDWATER FIELD PARAMETERS
ROUND FOUR
SITE 35, CAMP GEIGER FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION
MCB, CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232**

| Well No. | Depth of Well (ft.) | Purge Volume (gals.) | Field Parameters | | | | |
|---------------------|---------------------|----------------------|------------------|---|------------------|-----------|------------------|
| Date of Measurement | | | Gallons Removed | Specific Conductance at 25°C (micromhos/cm) | Temperature (°C) | pH (S.U.) | Turbidity (T.U.) |
| 35-MW35A | 14.0 | .97 | 0.5 | 133.4 | -- | 5.34 | 6.89 |
| 4/27/96 | | | 1.25 | 125.2 | 16.6 | 5.28 | 7.07 |
| | | | 2.0 | 122.1 | 16.6 | 5.44 | 5.45 |
| | | | 3.25 | 119.6 | 16.8 | 5.72 | 4.54 |
| 35-MW09D | 31.5 | 3.75 | 1.5 | 417.5 | 18.0 | 8.0 | 132 |
| 4/27/96 | | | 4.0 | 453.4 | 20.2 | 7.43 | 4.9 |
| | | | 8.0 | 436.3 | 19.3 | 7.07 | 0.8 |
| | | | 12.0 | 434.7 | 19.7 | 7.31 | 0.6 |
| 35-MW30B | 27.4 | 2.3 | 0 | 422.7 | 20.2 | 8.0 | 9.81 |
| 4/27/96 | | | 8 | 441.7 | 20.1 | 7.52 | 1.79 |
| | | | 14 | 454.2 | 20.1 | 7.41 | 0.68 |
| | | | 17 | 445.7 | 20.1 | 7.41 | 0.63 |
| EMW-3 | 42.0 | 5.7 | 2.5 | 615 | 18.6 | 7.14 | 44.4 |
| 4/26/96 | | | 5.0 | 615 | 19.3 | 7.24 | 10.3 |
| | | | 7.5 | 609 | 19.8 | 7.21 | 3.0 |
| 35-MW14D | 31.0 | 3.2 | 3.5 | 564 | 17.3 | 7.21 | 2.73 |
| 4/26/96 | | | 7.0 | 559 | 17.6 | 7.40 | 1.55 |
| | | | 10.5 | 558 | 17.8 | 7.34 | 1.49 |
| 35-MW36A | 14.9 | 0.9 | 1.0 | 314 | 16.4 | 6.6 | 24.9 |
| 4/27/96 | | | 2.0 | 311 | 16.6 | 6.65 | 13.96 |
| | | | 3.0 | 310 | 16.9 | 6.56 | 5.07 |
| 35-MW36B | 41.0 | 5.1 | 5 | 565 | 18.8 | 7.27 | 4.66 |
| 4/27/96 | | | 10 | 572 | 18.6 | 7.31 | 2.85 |
| | | | 15 | 578 | 18.8 | 7.24 | 2.49 |
| 35-MW19S | 15.0 | 1.7 | 2.0 | 259 | 16.5 | 6.83 | 9.12 |
| 4/27/96 | | | 4.0 | 249 | 16.4 | 6.92 | 4.47 |
| | | | 6.0 | 246 | 16.5 | 7.02 | 2.87 |
| 35-MW19B | 25.0 | 3.4 | 3.5 | 537 | 18.4 | 7.19 | 0.96 |
| 4/27/96 | | | 7.0 | 536 | 18.4 | 7.28 | 1.21 |
| | | | 10.5 | 537 | 18.6 | 7.31 | 0.89 |

TABLE 2-13 (Continued)

SUMMARY OF GROUNDWATER FIELD PARAMETERS
 ROUND FOUR
 SITE 35, CAMP GEIGER FUEL FARM
 SUPPLEMENTAL GROUNDWATER INVESTIGATION
 MCB, CAMP LEJEUNE, NORTH CAROLINA
 CONTRACT TAKS ORDER 0232

| Well No. | Depth of Well (ft.) | Purge Volume (gals.) | Field Parameters | | | | |
|---------------------|---------------------|----------------------|------------------|---|------------------|-----------|------------------|
| Date of Measurement | | | Gallons Removed | Specific Conductance at 25°C (micromhos/cm) | Temperature (°C) | pH (S.U.) | Turbidity (T.U.) |
| 35-MW10D | 30.0 | 3.5 | 3.5 | 607 | 19.7 | 7.24 | 4.11 |
| 4/27/96 | | | 7.0 | 608 | 19.0 | 7.25 | 2.33 |
| | | | 10.5 | 603 | 19.3 | 7.47 | 2.93 |
| 35-MW32A | 16.0 | 1.2 | 1.5 | 125 | 17.2 | 5.60 | 164.4 |
| 4/27/96 | | | 3.0 | 124 | 18.0 | 5.12 | 51.0 |
| | | | 4.5 | 121 | 18.1 | 5.11 | 4.71 |
| 35-MW37B | 45.0 | 6.8 | 7.0 | 482 | 18.8 | 7.10 | 1.25 |
| 4/28/96 | | | 14.0 | 487 | 19.2 | 7.24 | 0.93 |
| | | | 21.0 | 490 | 19.3 | 7.21 | 0.91 |
| 35-GWD6 | 67.0 | 9.8 | 10 | 472 | 22.1 | 9.78 | 68 |
| 4/30/96 | | | 20 | 481 | 21.7 | 8.74 | 12.4 |
| | | | 30 | 487 | 21.5 | 8.52 | 9.3 |
| 35-MW40B | 43.9 | 6.0 | 6.0 | 588 | 21.6 | 7.78 | 7.62 |
| 5/1/96 | | | 12.0 | 589 | 20.9 | 7.81 | 4.90 |
| | | | 18.0 | 578 | 20.5 | 7.81 | 4.30 |
| 35-MW42B | 39.3 | 5.5 | 5.5 | 543 | 22.0 | 6.73 | 11.4 |
| 5/1/96 | | | 11.0 | 558 | 22.3 | 6.77 | 9.5 |
| | | | 16.5 | 558 | 22.6 | 6.84 | 7.9 |
| 35-MW39B | 44.4 | 6.2 | 5 | 420 | 19 | 6.80 | 2.56 |
| 5/2/96 | | | 10 | 395 | 20 | 6.68 | 1.39 |
| | | | 16 | 400 | 20 | 6.70 | 1.38 |
| | | | 18 | 400 | 20 | 6.67 | 1.90 |
| 35-MW41B | 44.1 | 6.0 | 5 | 950 | 21 | 6.22 | 7.2 |
| 5/2/96 | | | 10 | 900 | 20 | 6.40 | 5.06 |
| | | | 15 | 900 | 20 | 6.33 | 2.73 |
| | | | 16 | 900 | 20 | 6.41 | 1.83 |
| | | | 17 | 900 | 20 | 6.41 | 1.80 |
| | | | 18 | 900 | 20 | 6.39 | 1.25 |
| 35-MW43B | 38.8 | 5.7 | 5 | 600 | 20 | 7.24 | 15.9 |
| 5/3/96 | | | 10 | 700 | 20 | 7.28 | 13.2 |

TABLE 2-13 (Continued)

**SUMMARY OF GROUNDWATER FIELD PARAMETERS
ROUND FOUR
SITE 35, CAMP GEIGER FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION
MCB, CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TAKS ORDER 0232**

| Well No. | Depth of Well (ft.) | Purge Volume (gals.) | Field Parameters | | | | |
|---------------------|---------------------|----------------------|------------------|---|------------------|-----------|------------------|
| Date of Measurement | | | Gallons Removed | Specific Conductance at 25°C (micromhos/cm) | Temperature (°C) | pH (S.U.) | Turbidity (T.U.) |
| | | | 15 | 700 | 21 | 7.24 | 8.9 |
| | | | 16 | 700 | 21 | 7.26 | 8.8 |
| | | | 17 | 700 | 21 | 7.25 | 9.0 |

TABLE 2-13 (Continued)

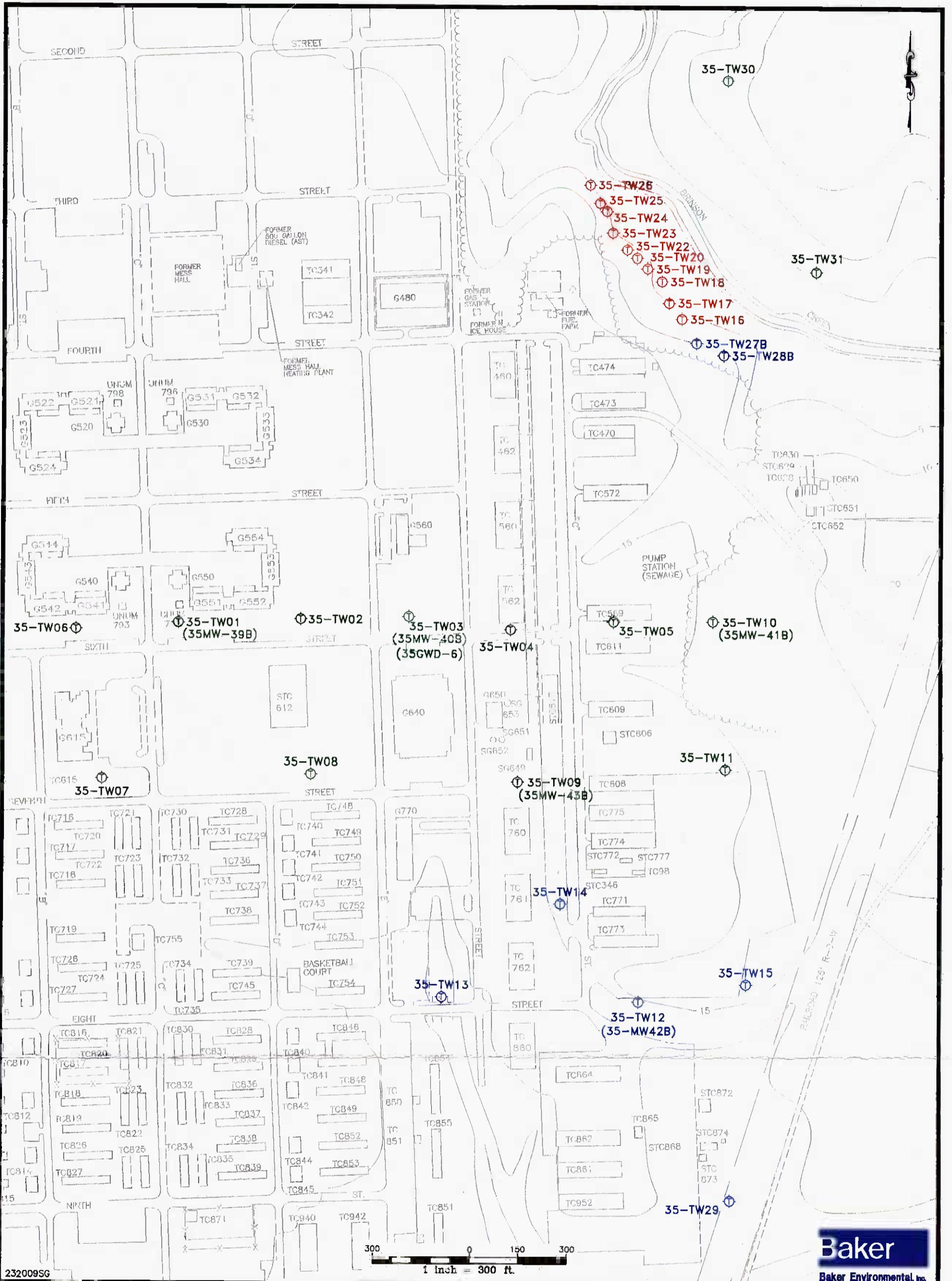
**SUMMARY OF GROUNDWATER FIELD PARAMETERS
ROUND FOUR
SITE 35, CAMP GEIGER FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION
MCB, CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TAKS ORDER 0232**

| Well No. | Depth of Well (ft.) | Purge Volume (gals.) | Field Parameters | | | | |
|----------|---------------------|----------------------|------------------|---|------------------|-----------|------------------|
| | | | Gallons Removed | Specific Conductance at 25°C (micromhos/cm) | Temperature (°C) | pH (S.U.) | Turbidity (T.U.) |
| 35-GWD7 | 51.5 | 7.6 | 7.6 | 392 | 20.9 | 6.34 | 29.6 |
| 8/14/96 | | | 15.2 | 380 | 20.4 | 5.39 | 25.5 |
| | | | 22.8 | 379 | 20.3 | 5.84 | 9.3 |
| 35-MW60A | 21.94 | 2.7 | 3 | 74.3 | 23.1 | 4.71 | 16 |
| 8/4/96 | | | 7 | 86.9 | 21.3 | 5.43 | 4.46 |
| | | | 11 | 87.1 | 21.5 | 5.37 | 1.99 |
| | | | 19 | 87.1 | 20.8 | 5.37 | 0.6 |
| 35-MW60B | 37.41 | 5.4 | 0 | 466 | 23.6 | 5.78 | 13.92 |
| 8/4/96 | | | 5 | 459 | 20.9 | 5.90 | 11.56 |
| | | | 10.5 | 445 | 20.2 | 4.88 | 4.20 |
| | | | 15.5 | 440 | 20.6 | 5.65 | 4.90 |
| | | | 21 | 455 | 20.1 | 5.69 | 3.33 |
| | | | 26 | 467 | 20.2 | 5.62 | 1.69 |

Notes:

- S.U. Standard units
- °C Degrees centigrade
- T.U. Turbidity units
- Equipment failure

SECTION 2.0 FIGURES



LEGEND

- 35-TW16 - TEMPORARY THREE-WELL CLUSTER INSTALLED AS A PART OF THE BAKER SGI (1996). THE WELLS ARE SCREENED IN THE UPPER, LOWER, AND MID PORTION OF THE SURFICIAL AQUIFER.
- 35-TW06 - TEMPORARY TWO-WELL CLUSTER INSTALLED AS A PART OF THE BAKER SGI (1996). THE WELLS ARE SCREENED IN THE UPPER AND LOWER PORTION OF THE SURFICIAL AQUIFER.
- 35-TW27 - SINGLE TEMPORARY WELL INSTALLED AS A PART OF THE BAKER SGI (1996). THIS WELL IS SCREENED IN THE LOWER PORTION OF THE SURFICIAL AQUIFER.

SOURCE: LANTDIV, OCT. 1991

FIGURE 2-1
LOCATIONS OF TEMPORARY MONITORING WELLS
INSTALLED DURING THE SCREENING PHASE
SITE 35, CAMP GEIGER AREA FUEL FARM, SGI
CONTRACT TASK ORDER - 0232
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

00157FERIV

FEDERAL MAXIMUM CONTAMINATION LEVELS AND NORTH CAROLINA WATER QUALITY STANDARDS CLASS GA STANDARDS

| ORGANIC CONTAMINANTS | MCL (ug/L) | N.C. REGULATION (ug/L) |
|------------------------------|------------|------------------------|
| VOLATILES | | |
| TRICHLOROETHENE | 5 | 2/8 |
| CIS-1,2-DICHLOROETHENE | 70 | 70 |
| TRANS-1,2-DICHLOROETHENE | 100 | 70 |
| 1,2-DICHLOROETHENE (TOTAL)** | 70 | 70 |
| BENZENE | 5 | 1 |
| ETHYLBENZENE | 700 | 29 |
| TOLUENE | 1000 | 1000 |
| XYLENES (TOTAL) | 10,000 | 530 |
| MTBE | * | 200 |

* - NO STANDARD AVAILABLE.

** - ONLY RESULTS FOR TOTAL 1,2-DICHLOROETHENE WERE AVAILABLE. SO, THE CONSERVATIVE REGULATORY VALUES FOR THE CIS AND TRANS SPECIES WERE ASSUMED.

NOTES:

CONTAMINANT CONCENTRATIONS ARE EXPRESSED IN MICROGRAMS PER LITER (ug/L).

CONTAMINANTS THAT EXCEED N.C. REGULATIONS ARE COLORED GREEN.

CONTAMINANTS THAT EXCEED MCLs ARE COLORED BLUE.

CONTAMINANTS THAT EXCEED BOTH N.C. REGULATIONS AND MCLs ARE COLORED RED.

| SAMPLE ID | 35-TW25A |
|--------------|----------|
| BENZENE | 312 |
| TOLUENE | 2 |
| ETHYLBENZENE | 11 |
| MTBE | 19 |

35-TW30A

| SAMPLE ID | 35-TW30A |
|-----------|----------|
| ND | ND |

| SAMPLE ID | 35-MW18S |
|------------------------|----------|
| BENZENE | 99 |
| ETHYLBENZENE | 2 |
| CIS-1,2-DICHLOROETHENE | 4 |
| TRICHLOROETHENE | 0.5 |
| MTBE | 63 |

| SAMPLE ID | 35-TW23A |
|------------------------|----------|
| BENZENE | 3296 |
| TOLUENE | 7392 |
| ETHYLBENZENE | 708 |
| XYLENES | 2764 |
| CIS-1,2-DICHLOROETHENE | 9 |
| TRICHLOROETHENE | 2.2 |
| MTBE | 58 |

| SAMPLE ID | 35-TW22A |
|------------------------|----------|
| BENZENE | 1654 |
| TOLUENE | 3636 |
| ETHYLBENZENE | 629 |
| XYLENES | 2013 |
| CIS-1,2-DICHLOROETHENE | 16 |
| TRICHLOROETHENE | 4.5 |

| SAMPLE ID | 35-TW31A |
|-----------|----------|
| ND | ND |

| SAMPLE ID | 35-TW20A |
|--------------------------|----------|
| BENZENE | 215 |
| TOLUENE | 883 |
| ETHYLBENZENE | 353 |
| XYLENES | 603 |
| TRANS-1,2-DICHLOROETHENE | 2 |
| CIS-1,2-DICHLOROETHENE | 42 |
| TRICHLOROETHENE | 8.8 |

| SAMPLE ID | 35-MW17S |
|-----------|----------|
| ND | ND |

| SAMPLE ID | 35-TW26A |
|--------------|----------|
| BENZENE | 5 |
| ETHYLBENZENE | 3 |

| SAMPLE ID | 35-TW24A |
|-----------------|----------|
| BENZENE | 586 |
| TOLUENE | 3 |
| ETHYLBENZENE | 37 |
| XYLENES | 7 |
| TRICHLOROETHENE | 0.2 |
| MTBE | 85 |

| SAMPLE ID | 35-MW16S |
|--------------|----------|
| BENZENE | 557 |
| TOLUENE | 51 |
| ETHYLBENZENE | 275 |
| XYLENES | 911 |
| MTBE | 16 |

| SAMPLE ID | 35-TW24A |
|-----------|----------|
| ND | ND |

35-TW22A

35-TW20A

35-TW19A

| SAMPLE ID | 35-TW19A |
|-----------------|----------|
| BENZENE | 2 |
| XYLENES | 2 |
| TRICHLOROETHENE | 0.3 |

MW-19S

35-TW18A

| SAMPLE ID | 35-MW19S |
|--------------------------|----------|
| TRANS-1,2-DICHLOROETHENE | 2 |
| CIS-1,2-DICHLOROETHENE | 13 |
| TRICHLOROETHENE | 12 |

35-TW17A

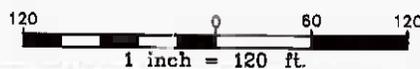
35-TW16A

| SAMPLE ID | 35-TW18A |
|--------------------------|----------|
| TRANS-1,2-DICHLOROETHENE | 4 |
| CIS-1,2-DICHLOROETHENE | 32 |
| TRICHLOROETHENE | 24.6 |

| SAMPLE ID | 35-TW17A |
|------------------------|----------|
| CIS-1,2-DICHLOROETHENE | 6 |
| TRICHLOROETHENE | 2 |

| SAMPLE ID | 35-TW16A |
|------------------------|----------|
| CIS-1,2-DICHLOROETHENE | 2 |
| TRICHLOROETHENE | 0.4 |

NOTES:
 * CONTAMINANT CONCENTRATIONS ARE EXPRESSED IN MICROGRAMS PER LITER (ug/L).
 * A = WELLS WITH A 10' SCREEN LENGTH BISECTING THE WATER TABLE.



LEGEND

- EMW-7 MONITORING WELL INSTALLED UNDER CS (1986) BY ESE.
- MW-1 MONITORING WELL INSTALLED UNDER CSA (1991) BY LAW.
- 35-QWD-5 MONITORING WELL INSTALLED UNDER BAKER RI (1994).
- 35-TW23A TEMPORARY WELL INSTALLED UNDER BAKER SGI (1996).

FIGURE 2-2
 SCREENING RESULTS, NOAC FUEL AND SOLVENT - RELATED CONTAMINATION IN THE UPPER PORTION OF THE SURFICIAL AQUIFER SITE 35, CAMP GEIGER AREA FUEL FARM, SGI CONTRACT TASK ORDER - 0232

MARINE CORPS BASE, CAMP LEJEUNE
 NORTH CAROLINA

FEDERAL MAXIMUM CONTAMINATION LEVELS AND NORTH CAROLINA WATER QUALITY STANDARDS CLASS GA STANDARDS

| ORGANIC CONTAMINANTS | MCL (ug/L) | N.C. REGULATION (ug/L) |
|------------------------------|------------|------------------------|
| VOLATILES | | |
| TRICHLOROETHENE | 5 | 2.8 |
| CIS-1,2-DICHLOROETHENE | 70 | 70 |
| TRANS-1,2-DICHLOROETHENE | 100 | 70 |
| 1,2-DICHLOROETHENE (TOTAL)** | 70 | 70 |
| BENZENE | 5 | 1 |
| ETHYLBENZENE | 700 | 29 |
| TOLUENE | 1000 | 1000 |
| XYLENES (TOTAL) | 10,000 | 530 |
| MTBE | * | 200 |

* - NO STANDARD AVAILABLE.

** - ONLY RESULTS FOR TOTAL 1,2-DICHLOROETHENE WERE AVAILABLE. SO, THE CONSERVATIVE REGULATORY VALUES FOR THE CIS AND TRANS SPECIES WERE ASSUMED.

NOTES:

CONTAMINANT CONCENTRATIONS ARE EXPRESSED IN MICROGRAMS PER LITER (ug/L).

CONTAMINANTS THAT EXCEED N.C. REGULATIONS ARE COLORED GREEN.

CONTAMINANTS THAT EXCEED MCLs ARE COLORED BLUE.

CONTAMINANTS THAT EXCEED BOTH N.C. REGULATIONS AND MCLs ARE COLORED RED.

| | |
|------------------------|----------|
| SAMPLE ID | 35-TW25C |
| BENZENE | 3 |
| CIS-1,2-DICHLOROETHENE | 3 |

| | |
|--------------------------|----------|
| SAMPLE ID | 35-TW23C |
| BENZENE | 224 |
| TOLUENE | 315 |
| ETHYLBENZENE | 37 |
| XYLENES | 123 |
| TRANS-1,2-DICHLOROETHENE | 3 |
| CIS-1,2-DICHLOROETHENE | 47 |
| TRICHLOROETHENE | 10.9 |
| MTBE | 8 |

| | |
|--------------------------|----------|
| SAMPLE ID | 35-TW22C |
| BENZENE | 33 |
| TOLUENE | 58 |
| ETHYLBENZENE | 12 |
| XYLENES | 37 |
| TRANS-1,2-DICHLOROETHENE | 9 |
| CIS-1,2-DICHLOROETHENE | 137 |
| TRICHLOROETHENE | 37.9 |

| | |
|--------------------------|----------|
| SAMPLE ID | 35-TW20C |
| BENZENE | 37 |
| TOLUENE | 174 |
| ETHYLBENZENE | 28 |
| XYLENES | 91 |
| TRANS-1,2-DICHLOROETHENE | 8 |
| CIS-1,2-DICHLOROETHENE | 124 |
| TRICHLOROETHENE | 34.4 |

| | |
|-----------|----------|
| SAMPLE ID | 35-TW26C |
| BENZENE | 3 |

| | |
|------------------------|----------|
| SAMPLE ID | 35-TW24C |
| BENZENE | 5 |
| CIS-1,2-DICHLOROETHENE | 15 |
| TRICHLOROETHENE | 0.8 |

| | |
|--------------------------|----------|
| SAMPLE ID | 35-TW19C |
| TRANS-1,2-DICHLOROETHENE | 7 |
| CIS-1,2-DICHLOROETHENE | 107 |
| TRICHLOROETHENE | 21 |

| | |
|--------------------------|----------|
| SAMPLE ID | 35-TW18C |
| TRANS-1,2-DICHLOROETHENE | 32 |
| CIS-1,2-DICHLOROETHENE | 165 |
| TRICHLOROETHENE | 167 |

| | |
|--------------------------|----------|
| SAMPLE ID | 35-TW17C |
| TRANS-1,2-DICHLOROETHENE | 54 |
| CIS-1,2-DICHLOROETHENE | 159 |
| TRICHLOROETHENE | 153.7 |

| | |
|--------------------------|----------|
| SAMPLE ID | 35-TW16C |
| TRANS-1,2-DICHLOROETHENE | 6 |
| CIS-1,2-DICHLOROETHENE | 91 |
| TRICHLOROETHENE | 17 |

FORMER GAS STATION
FORMER ICE HOUSE

FORMER FUEL FARM

TC 460

TC474

TC473

TC470

TC 462

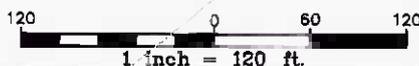
TC572

C630

S10629

TC628

NOTES:
CONTAMINANT CONCENTRATIONS ARE EXPRESSED IN MICROGRAMS PER LITER (ug/L).
C = WELLS WITH A 5' SCREEN LENGTH PLACED MIDWAY BETWEEN THE WATER TABLE AND THE CONFINING UNIT.



Baker

Baker Environmental, Inc.

LEGEND

- EMW-7 MONITORING WELL INSTALLED UNDER CS (1986) BY ESE.
- MW-1 MONITORING WELL INSTALLED UNDER CSA (1991) BY LAW.
- 35GWD-5 MONITORING WELL INSTALLED UNDER BAKER RI (1994).
- 35-TW23C TEMPORARY WELL INSTALLED UNDER BAKER SGI (1996).

FIGURE 2-3
SCREENING RESULTS, NOAC FUEL AND SOLVENT - RELATED CONTAMINATION IN THE MIDDLE PORTION OF THE SURFICIAL AQUIFER SITE 35, CAMP GEIGER AREA FUEL FARM, SGI CONTRACT TASK ORDER - 0232

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

FEDERAL MAXIMUM CONTAMINATION LEVELS AND NORTH CAROLINA WATER QUALITY STANDARDS CLASS GA STANDARDS

| ORGANIC CONTAMINANTS | MCL (ug/L) | N.C. REGULATION (ug/L) |
|------------------------------|------------|------------------------|
| VOLATILES | | |
| TRICHLOROETHENE | 5 | 2.8 |
| 1,1-DICHLOROETHANE | * | 700 |
| 1,1-DICHLOROETHENE | 7 | 7 |
| CIS-1,2-DICHLOROETHENE | 70 | 70 |
| TRANS-1,2-DICHLOROETHENE | 100 | 70 |
| 1,2-DICHLOROETHENE (TOTAL)** | 70 | 70 |
| ACETONE | * | 700 |
| BENZENE | 5 | 1 |
| ETHYLBENZENE | 700 | 29 |
| TOLUENE | 1000 | 1000 |
| XYLENES (TOTAL) | 10.000 | 5.30 |

* - NO STANDARD AVAILABLE.

** - ONLY RESULTS FOR TOTAL 1,2-DICHLOROETHENE WERE AVAILABLE. SO, THE CONSERVATIVE REGULATORY VALUES FOR THE CIS AND TRANS SPECIES WERE ASSUMED.

NOTES:

* CONTAMINANT CONCENTRATIONS ARE EXPRESSED IN MICROGRAMS PER LITER (ug/L).

* CONTAMINANTS THAT EXCEED N.C. REGULATIONS ARE COLORED GREEN.

* CONTAMINANTS THAT EXCEED MCLs ARE COLORED BLUE.

* CONTAMINANTS THAT EXCEED BOTH N.C. REGULATIONS AND MCLs ARE COLORED RED.

| SAMPLE ID | 35-MW16D |
|------------------------|----------|
| BENZENE | 8 |
| CIS-1,2-DICHLOROETHENE | 15 |
| TRICHLOROETHENE | 0.3 |

| SAMPLE ID | 35-MW17D |
|-----------|----------|
| ND | |

35-TW26B

35-TW25B

35-TW24B

MW-18D

35-TW23B

35-TW22B

35-TW20B

35-TW19B

MW-19D

35-TW18B

35-TW17B

35-TW16B

35-TW27B

35-TW28B

| SAMPLE ID | 35-TW28B |
|----------------------------|----------|
| 1,1-DICHLOROETHENE | 4 J |
| 1,1-DICHLOROETHANE | 3 J |
| 1,2-DICHLOROETHENE (TOTAL) | 2 J |

| SAMPLE ID | 35-TW27B |
|----------------------------|----------|
| 1,2-DICHLOROETHENE (TOTAL) | 260 J |
| TRICHLOROETHENE | 41 J |
| ACETONE | 66 J |

| SAMPLE ID | 35-TW16B |
|--------------------------|----------|
| TRANS-1,2-DICHLOROETHENE | 338 |
| CIS-1,2-DICHLOROETHENE | 1317 |
| TRICHLOROETHENE | 1540.4 |

| SAMPLE ID | 35-TW26B |
|-----------|----------|
| ND | |

| SAMPLE ID | 35-TW25B |
|-----------|----------|
| ND | |

| SAMPLE ID | 35-TW24B |
|------------------------|----------|
| CIS-1,2-DICHLOROETHENE | 17 |
| TRICHLOROETHENE | 0.5 |

35-TW30B

| SAMPLE ID | 35-MW18D |
|------------------------|----------|
| CIS-1,2-DICHLOROETHENE | 10 |
| TRICHLOROETHENE | 0.7 |

| SAMPLE ID | 35-TW30B |
|-----------|----------|
| ND | |

| SAMPLE ID | 35-TW23B |
|--------------------------|----------|
| BENZENE | 4 |
| TOLUENE | 6 |
| ETHYLBENZENE | 2 |
| XYLENES | 5 |
| TRANS-1,2-DICHLOROETHENE | 3 |
| CIS-1,2-DICHLOROETHENE | 70 |
| TRICHLOROETHENE | 11.6 |

| SAMPLE ID | 35-TW22B |
|--------------------------|----------|
| BENZENE | 11 |
| TOLUENE | 14 |
| ETHYLBENZENE | 4 |
| XYLENES | 9 |
| TRANS-1,2-DICHLOROETHENE | 5 |
| CIS-1,2-DICHLOROETHENE | 77 |
| TRICHLOROETHENE | 10.5 |

| SAMPLE ID | 35-TW31B |
|-----------|----------|
| ND | |

| SAMPLE ID | 35-TW20B |
|--------------------------|----------|
| TOLUENE | 2 |
| TRANS-1,2-DICHLOROETHENE | 63 |
| CIS-1,2-DICHLOROETHENE | 318 |
| TRICHLOROETHENE | 246.3 |

| SAMPLE ID | 35-TW19B |
|--------------------------|----------|
| TRANS-1,2-DICHLOROETHENE | 141 |
| CIS-1,2-DICHLOROETHENE | 611 |
| TRICHLOROETHENE | 834.1 |

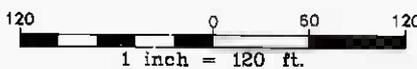
| SAMPLE ID | 35-MW19D |
|--------------------------|----------|
| TRANS-1,2-DICHLOROETHENE | 68 |
| CIS-1,2-DICHLOROETHENE | 266 |
| TRICHLOROETHENE | 379.2 |

| SAMPLE ID | 35-TW18B |
|--------------------------|----------|
| TRANS-1,2-DICHLOROETHENE | 118 |
| CIS-1,2-DICHLOROETHENE | 410 |
| TRICHLOROETHENE | 719.5 |

| SAMPLE ID | 35-TW17B |
|--------------------------|----------|
| TRANS-1,2-DICHLOROETHENE | 422 |
| CIS-1,2-DICHLOROETHENE | 1417 |
| TRICHLOROETHENE | 2054.2 |

NOTES:

- * CONTAMINANT CONCENTRATIONS ARE EXPRESSED IN MICROGRAMS PER LITER (ug/L).
- * B/D = WELLS WITH A 5' SCREEN LENGTH LOCATED ON TOP OF THE CONFINING UNIT.



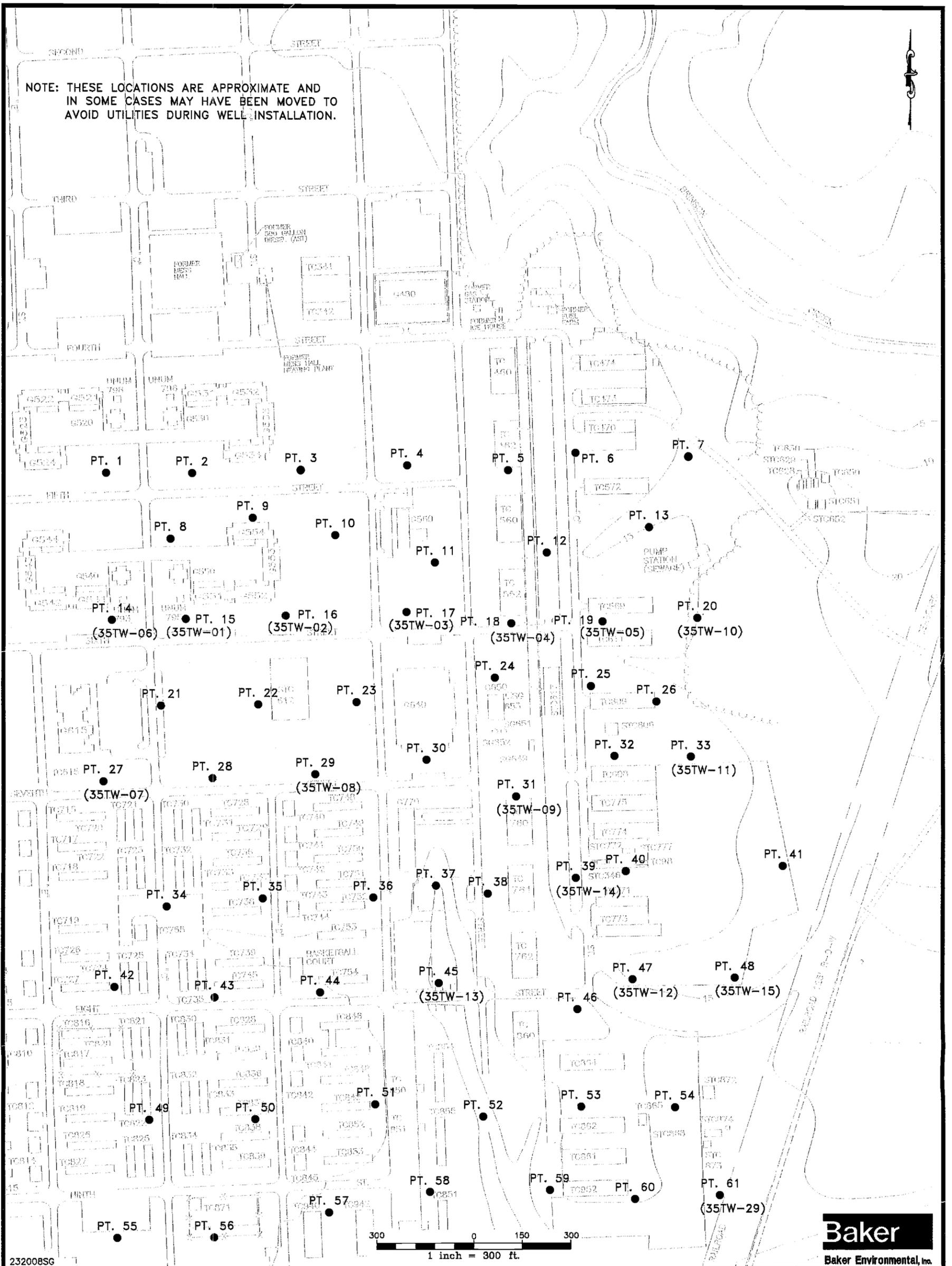
LEGEND

- EMW-7 MONITORING WELL INSTALLED UNDER CS (1986) BY ESE.
- MW-1 MONITORING WELL INSTALLED UNDER CSA (1991) BY LAW.
- 35GWD-5 MONITORING WELL INSTALLED UNDER BAKER RI (1994).
- 35-TW23B TEMPORARY WELL INSTALLED UNDER BAKER SGI (1996).

FIGURE 2-4
SCREENING RESULTS, NOAC FUEL AND SOLVENT - RELATED CONTAMINATION IN THE LOWER PORTION OF THE SURFICIAL AQUIFER SITE 35, CAMP GEIGER AREA FUEL FARM, SGI CONTRACT TASK ORDER - 0232

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

NOTE: THESE LOCATIONS ARE APPROXIMATE AND IN SOME CASES MAY HAVE BEEN MOVED TO AVOID UTILITIES DURING WELL INSTALLATION.



232008SG

LEGEND

PT. 1
● - POTENTIAL LOCATION FOR TEMPORARY WELL.

(35TW-06) - LOCATION THAT WAS ULTIMATELY SELECTED FOR A TEMPORARY WELL.

SOURCE: LANTDIV, OCT. 1991

FIGURE 2-5
POTENTIAL LOCATIONS FOR TEMPORARY MONITORING WELLS
SITE 35, CAMP GEIGER AREA FUEL FARM, SGI CONTRACT TASK ORDER - 0232
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

00157FF04Z

FEDERAL MAXIMUM CONTAMINATION LEVELS AND NORTH CAROLINA WATER QUALITY STANDARDS CLASS GA STANDARDS

| ORGANIC CONTAMINANTS | MCL (ug/L) | N.C. REGULATION (ug/L) |
|------------------------------|------------|------------------------|
| VOLATILES | | |
| TRICHLOROETHENE | 5 | 2.8 |
| 1,1-DICHLOROETHANE | * | 700 |
| 1,1-DICHLOROETHENE | 7 | 7 |
| CIS-1,2-DICHLOROETHENE | 70 | 70 |
| TRANS-1,2-DICHLOROETHENE | 100 | 70 |
| 1,2-DICHLOROETHENE (TOTAL)** | 70 | 70 |
| TETRACHLOROETHENE | 5 | 0.7 |
| 1,1,2,2-TETRACHLOROETHANE | * | * |

* - NO STANDARD AVAILABLE

** - ONLY RESULTS FOR TOTAL 1,2-DICHLOROETHENE WERE AVAILABLE. SO, THE CONSERVATIVE REGULATORY VALUES FOR THE CIS AND TRANS SPECIES WERE ASSUMED.

NOTES:

CONTAMINANT CONCENTRATIONS ARE EXPRESSED IN MICROGRAMS PER LITER (ug/L).

CONTAMINANTS THAT EXCEED N.C. REGULATIONS ARE COLORED GREEN.

CONTAMINANTS THAT EXCEED MCLs ARE COLORED BLUE.

CONTAMINANTS THAT EXCEED BOTH N.C. REGULATIONS AND MCLs ARE COLORED RED.

SAMPLE ID 35-TW01B

| | |
|--------------------------|-----|
| TRANS-1,2-DICHLOROETHENE | 2 |
| CIS-1,2-DICHLOROETHENE | 48 |
| TRICHLOROETHENE | 1.1 |

SAMPLE ID 35-TW06B

| | |
|----|--|
| ND | |
|----|--|

SAMPLE ID 35-TW08B

| | |
|------------------------|-----|
| CIS-1,2-DICHLOROETHENE | 7 |
| TRICHLOROETHENE | 1.3 |

SAMPLE ID 35-TW07B

| | |
|----|--|
| ND | |
|----|--|

NOTES:
 • CONTAMINANT CONCENTRATIONS ARE EXPRESSED IN MICROGRAMS PER LITER (ug/L).
 • B = WELLS, WITH A 5' SCREEN LENGTH LOCATED ON TOP OF THE CONFINING UNIT.

SAMPLE ID 35-TW02B

| | |
|--------------------------|-----|
| TRANS-1,2-DICHLOROETHENE | 18 |
| CIS-1,2-DICHLOROETHENE | 211 |
| TRICHLOROETHENE | 7.6 |

SAMPLE ID 35-TW03B

| | |
|--------------------------|------|
| TRANS-1,2-DICHLOROETHENE | 5 |
| CIS-1,2-DICHLOROETHENE | 125 |
| TRICHLOROETHENE | 13.5 |

SAMPLE ID 35-TW04B

| | |
|--------------------------|------|
| TRANS-1,2-DICHLOROETHENE | 2 |
| CIS-1,2-DICHLOROETHENE | 46 |
| TRICHLOROETHENE | 24.6 |

SAMPLE ID 35-TW05B

| | |
|------------------------|-----|
| CIS-1,2-DICHLOROETHENE | 13 |
| TRICHLOROETHENE | 1.7 |

SAMPLE ID 35-TW10B

| | |
|------------------------|----|
| CIS-1,2-DICHLOROETHENE | 11 |
|------------------------|----|

SAMPLE ID 35-TW11B

| | |
|------------------------|-----|
| CIS-1,2-DICHLOROETHENE | 6 |
| TRICHLOROETHENE | 0.5 |

SAMPLE ID 35-TW15B

| | |
|------------------------|----|
| DICHLOROETHENE (TOTAL) | 13 |
| TRICHLOROETHENE | 4 |

SAMPLE ID 35-TW09B

| | |
|--------------------------|-----|
| TRANS-1,2-DICHLOROETHENE | 1 |
| CIS-1,2-DICHLOROETHENE | 38 |
| TRICHLOROETHENE | 9.8 |

SAMPLE ID 35-TW14B

| | |
|------------------------|----|
| DICHLOROETHENE (TOTAL) | 14 |
|------------------------|----|

SAMPLE ID 35-TW13B

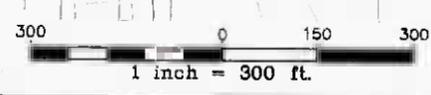
| | |
|----|--|
| ND | |
|----|--|

SAMPLE ID 35-TW12B

| | |
|------------------------|----|
| DICHLOROETHENE (TOTAL) | 51 |
| TRICHLOROETHENE | 93 |

SAMPLE ID 35-TW29B

| | |
|---------------------------|-----|
| DICHLOROETHENE (TOTAL) | 28 |
| TRICHLOROETHENE | 220 |
| TETRACHLOROETHENE | 2 |
| 1,1,2,2-TETRACHLOROETHANE | 23 |



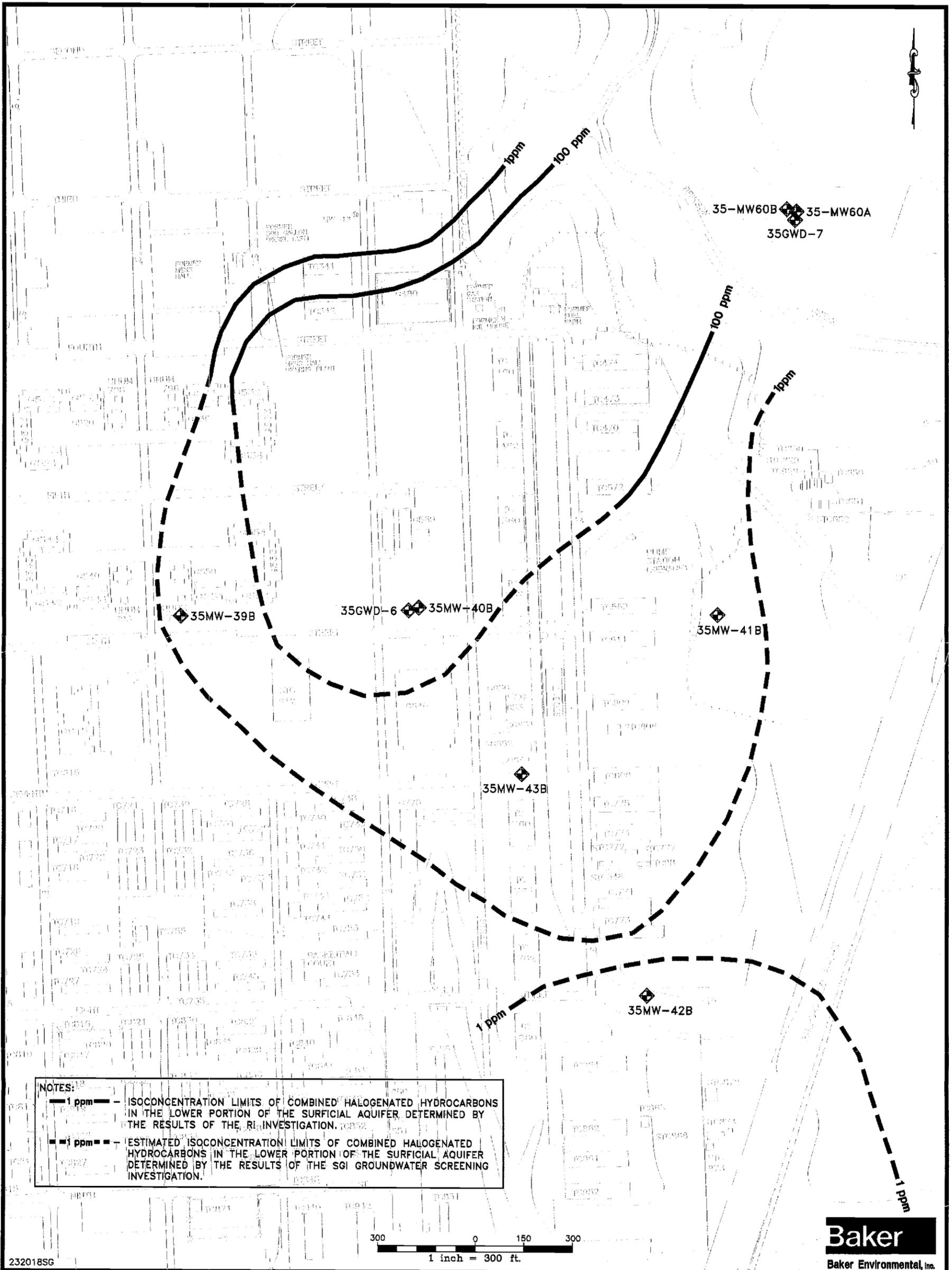
LEGEND
 35-TW01B - TEMPORARY WELL INSTALLED UNDER BAKER SGI (1996).
 — 1 ppm — ISOCONCENTRATION LIMITS OF COMBINED HALOGENATED HYDROCARBONS IN THE LOWER PORTION OF THE SURFICIAL AQUIFER DETERMINED BY THE RESULTS OF THE RI.
 - - 1 ppm - - ESTIMATED ISOCONCENTRATION LIMITS OF COMBINED HALOGENATED HYDROCARBONS IN THE LOWER PORTION OF THE SURFICIAL AQUIFER DETERMINED BY THE RESULTS OF THE SGI GROUNDWATER SCREENING INVESTIGATION.

FIGURE 2-6
 SCREENING RESULTS, SOAC FUEL AND SOLVENT - RELATED CONTAMINATION IN THE LOWER PORTION OF THE SURFICIAL AQUIFER SITE 35, CAMP GEIGER AREA FUEL FARM, SGI CONTRACT TASK ORDER - 0232

MARINE CORPS BASE, CAMP LEJEUNE
 NORTH CAROLINA

SOURCE: LANTDIV, OCT. 1991

00157FF054



NOTES:

— 100 ppm — ISOCONCENTRATION LIMITS OF COMBINED HALOGENATED HYDROCARBONS IN THE LOWER PORTION OF THE SURFICIAL AQUIFER DETERMINED BY THE RESULTS OF THE RI INVESTIGATION.

- - - 1 ppm - - - ESTIMATED ISOCONCENTRATION LIMITS OF COMBINED HALOGENATED HYDROCARBONS IN THE LOWER PORTION OF THE SURFICIAL AQUIFER DETERMINED BY THE RESULTS OF THE SGI GROUNDWATER SCREENING INVESTIGATION.

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LEGEND

35-MW39B
◆ - MONITORING WELL INSTALLED UNDER BAKER SGI (1996).

35GWD-6
◆ - MONITORING WELL SCREENED IN THE UPPER PORTION OF THE CASTLE HAYNE BY BAKER DURING RI (1996).

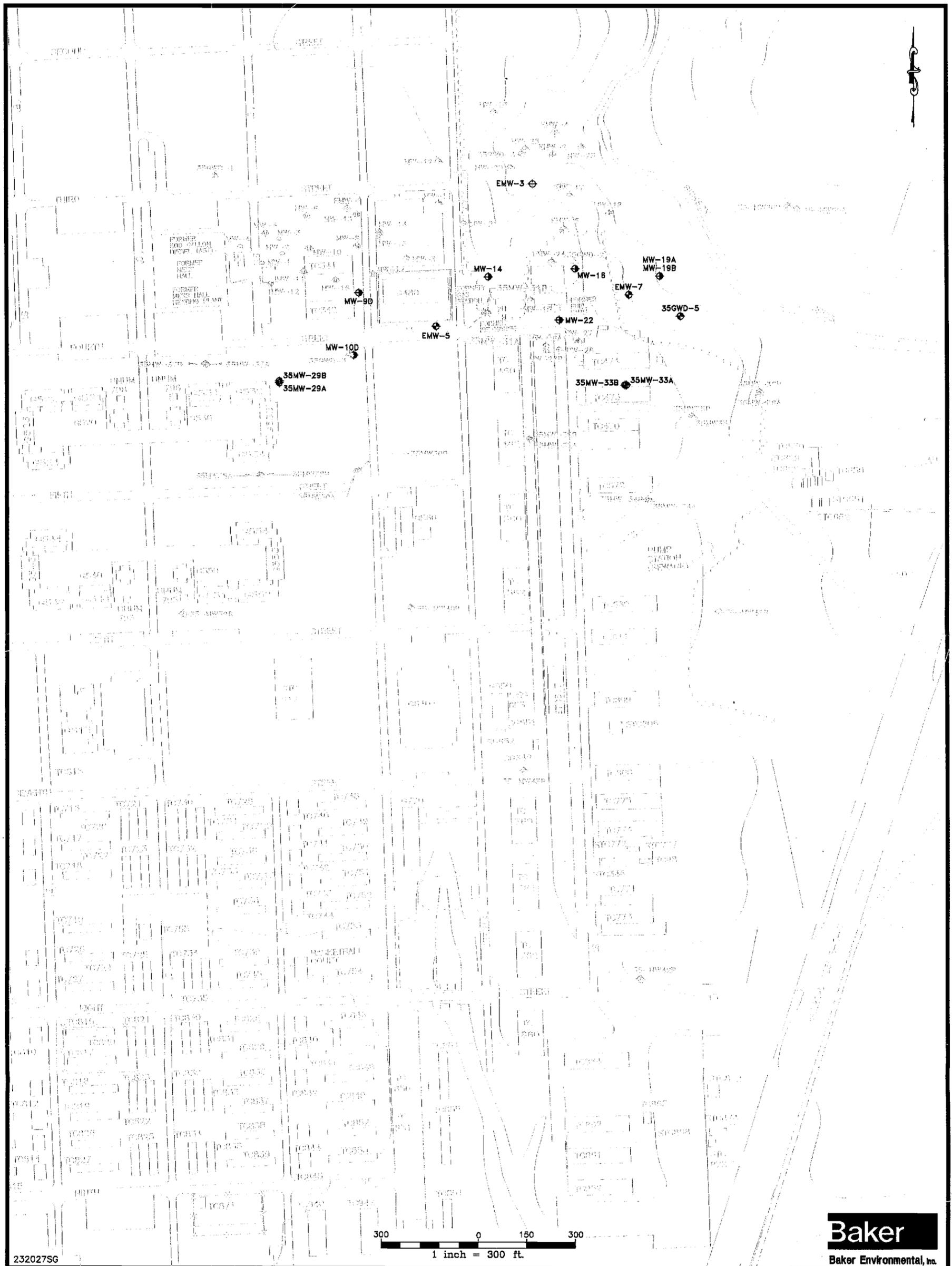
A - WELLS SCREENED IN THE UPPER PORTION OF THE SURFICIAL AQUIFER.

B - WELLS SCREENED IN THE LOWER PORTION OF THE SURFICIAL AQUIFER.

SOURCE: LANTDIV, OCT. 1991

FIGURE 2-7
LOCATIONS OF PERMANENT SGI MONITORING WELLS
SITE 35, CAMP GEIGER AREA FUEL FARM, SGI CONTRACT TASK ORDER - 0232
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

00157FFB22



232027SG

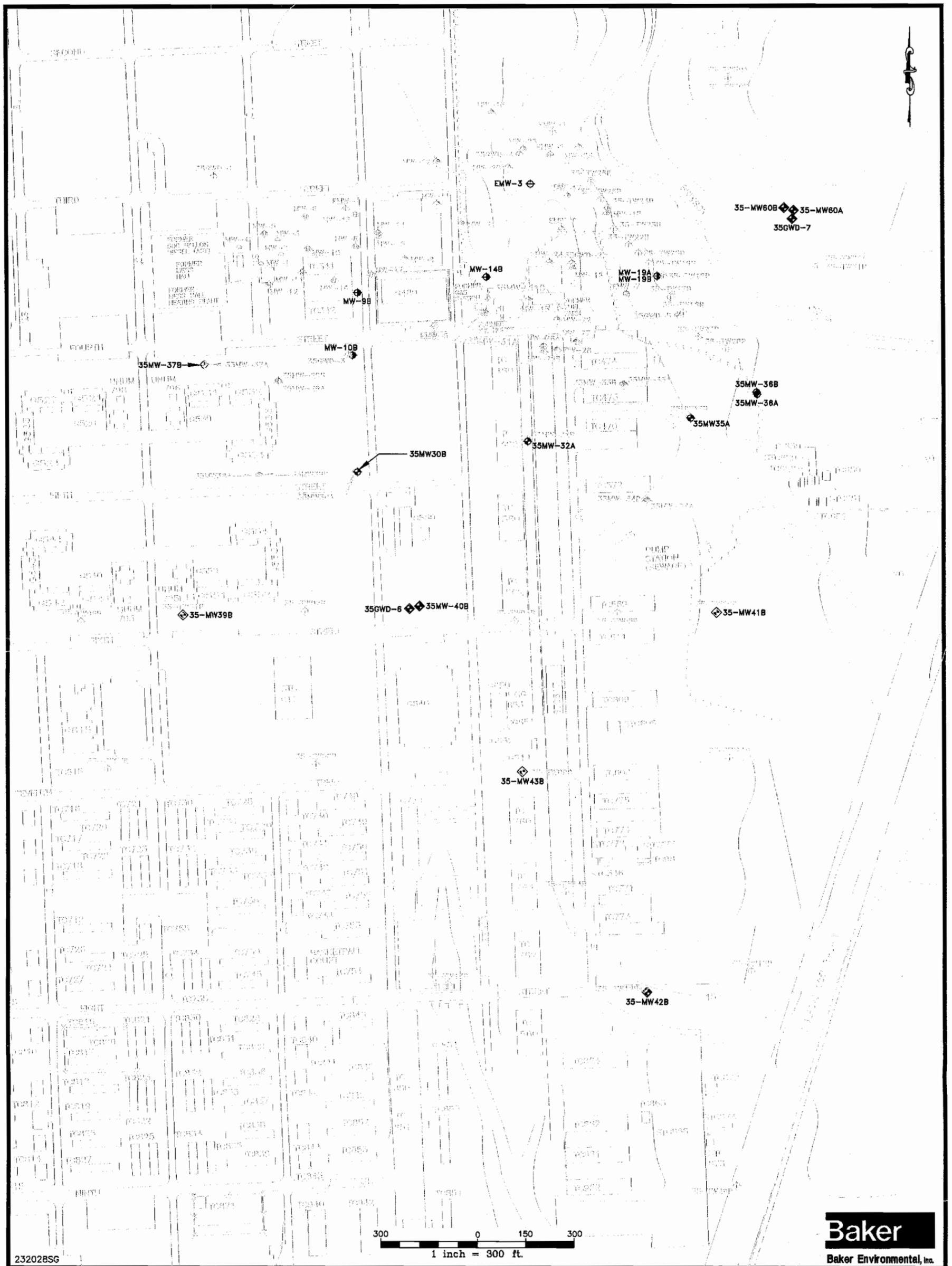
Baker
Baker Environmental, Inc.

LEGEND

| | |
|----------|--|
| EMW-7 | MONITORING WELL INSTALLED UNDER CS (1986) BY ESE. |
| EMW-1 | MONITORING WELL INSTALLED BY NUS (1980). |
| MW-1 | MONITORING WELL INSTALLED UNDER CSA (1991) BY LAW. |
| MW-5 | MONITORING WELLS INSTALLED UNDER WST SITE ASSESSMENT (1994). |
| 35MW-38B | MONITORING WELLS INSTALLED UNDER BAKER RI (1994). |
| 35GWD-1 | MONITORING WELL INSTALLED UNDER BAKER RI INVESTIGATION (1994). |

SOURCE: LANTDIV, OCT. 1991

FIGURE 2-8
SGI GROUNDWATER SAMPLING LOCATIONS,
ROUND 3, METALS
SITE 35, CAMP GEIGER AREA FUEL FARM, SGI
CONTRACT TASK ORDER - 0232
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

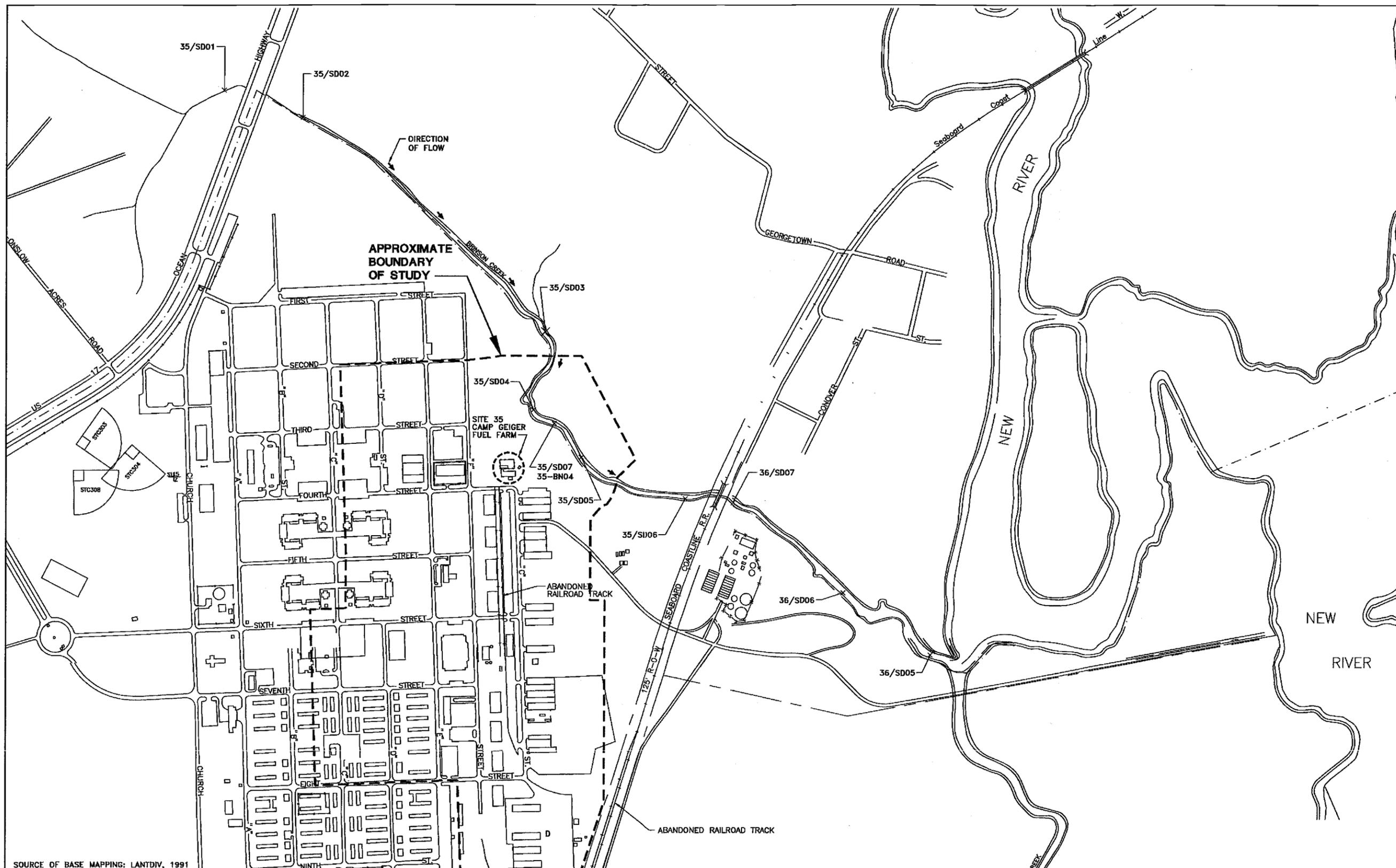


LEGEND

- EMW-7 MONITORING WELL INSTALLED UNDER CS (1986) BY ESE.
- EMW-1 MONITORING WELL INSTALLED BY NUS (1990).
- MW-1 MONITORING WELL INSTALLED UNDER CSA (1991) BY LAW.
- MW-8 MONITORING WELLS INSTALLED UNDER WST SITE ASSESSMENT (1994).
- 35MW-36B MONITORING WELLS INSTALLED UNDER BAKER RI (1994).
- 35GWD-1 MONITORING WELL INSTALLED UNDER BAKER RI INVESTIGATION (1994).

SOURCE: LANTDIV, OCT. 1991

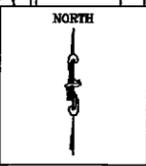
FIGURE 2-9
SGI GROUNDWATER SAMPLING LOCATIONS,
ROUND 4, VOLATILES
SITE 35, CAMP GEIGER AREA FUEL FARM, SGI
CONTRACT TASK ORDER - 0232
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



SOURCE OF BASE MAPPING: LANTDIV, 1991

LEGEND
 36/SD01 - LOCATION OF SEDIMENT COLLECTION POINT
 x

DATE OCT. 1994
 SCALE N.T.S.
 DRAWN W.J.H.
 REVIEWED J.S.C.
 S.O.# 62470-232-0000-07000
 CADD# 232023SG



**SITE 35, CAMP GEIGER AREA FUEL FARM, SGI
 MARINE CORPS BASE, CAMP LEJEUNE
 NORTH CAROLINA**
**BAKER ENVIRONMENTAL, Inc.
 Coraopolis, Pennsylvania**



**SGI SEDIMENT SAMPLING LOCATIONS
 CONTRACT TASK ORDER - 0232**
 SCALE 1" = 300'
 DATE OCT. 1994

SHEET NO.
2-10

SECTION 2.0 REFERENCES

SECTION 2.0 REFERENCES

Baker. 1994. Remedial Investigation/Feasibility Study Sampling and Analysis Plan for Operable Unit No. 10. Marine Corps Base, Camp Lejeune, North Carolina.

3.0 PHYSICAL CHARACTERISTICS OF THE STUDY AREA

This section presents a discussion of the physical characteristics of Site 35, Camp Geiger Area Fuel Farm including: surface features, climatology, hydrology, geology (regional and site), soils, hydrogeology (regional and site), land usage, regional ecology, and a water supply well inventory of the area. This information was obtained from available literature pertaining to MCB, Camp Lejeune and from the SGI field activities.

3.1 Surface Features

The generally flat topography of MCB Camp Lejeune is typical of the North Carolina Coastal Plain. Elevations on the Activity vary from sea level to 72 feet above mean sea level (msl); however, the elevation of most of Camp Lejeune is between 20 and 40 feet msl.

Drainage at Camp Lejeune is generally toward the New River, except in areas near the coast which drain through the Intracoastal Waterway. In developed areas, natural drainage has been altered by asphalt cover, storm sewers, and drainage ditches. Approximately 70 percent of Camp Lejeune is in broad, flat interstream areas. Drainage is poor in these areas and the soils are often wet (WAR, 1983).

The U.S. Army Corps of Engineers has mapped the limits of the 100-year floodplain at Camp Lejeune at 7.0 feet above msl in the upper reaches of the New River (WAR, 1983); this increases downstream to 11 feet above msl near the coastal area (WAR, 1983). Site 35 does not lie within the 100-year floodplain of the New River.

The surface of the study area is primarily covered with vegetation, however, a significant portion is covered by roads, buildings, and parking areas. Northeastern and eastern portions of the site are bordered by Brinson Creek, wetlands, and woodlands.

The topography of Site 35 is relatively flat. An average elevation between 11 and 18 feet msl was recorded during a recent survey of the site. Changes in elevation are gradual giving the site a flat appearance. The elevation drops adjacent to Brinson Creek defining the creek's flood plain. Surface runoff across the study area is primarily toward Brinson Creek via man-made drainage ditches, storm drains and catch basins and natural drainage patterns. Impervious surfaces, such as roadways, paved parking lots, and buildings, modify surface runoff and infiltration across the study area.

3.2 Climatology

MCB Camp Lejeune is located within the Coastal Plain physiographic province of North Carolina. Coastal Plain elevations range from 200 feet above msl at the western boundary to generally 30 feet or less in areas of tidal influence to the east. The tidal portion of the Coastal Plain, where MCB Camp Lejeune is situated, is generally flat and swampy.

Although coastal North Carolina lacks distinct wet and dry seasons, there is some seasonal variation in average precipitation. July tends to receive the most precipitation and rainfall amounts during summer are generally the greatest. Daily showers during the summer are not uncommon, nor are periods of one or two weeks without rain. Convective showers and thunderstorms contribute to the variability of precipitation during the summer months. October tends to receive the least amount of precipitation, on average. Throughout the winter and spring months precipitation occurs

primarily in the form of migratory low pressure storms. MCB Camp Lejeune's average yearly rainfall is approximately 52 inches. Table 3-1 presents a climatic summary of data collected during 27 years (January 1955 to December 1982) of observations at Marine Corps Air Station (MCAS) New River.

Coastal Plain temperatures are moderated by the proximity of the Atlantic Ocean. The ocean effectively reduces the average daily fluctuation of temperature. Lying 50 miles offshore at its nearest point, the Gulf Stream tends to have little direct effect on coastal temperatures. The southern reaches of the cold Labrador Current offsets any warming effect the Gulf Stream might otherwise provide.

MCB Camp Lejeune experiences hot and humid summers; however, ocean breezes frequently produce a cooling effect. The winter months tend to be mild, with occasional brief cold spells. Average daily temperatures range from 38° F to 58° F in January and 72° F to 86° F in July. The average relative humidity, between 75 and 85 percent, does not vary greatly from season to season.

Observations of sky conditions indicate yearly averages of approximately 112 days clear, 105 partly cloudy, and 148 cloudy. Measurable amounts of rainfall occur 120 days per year, on the average. Prevailing winds are generally from the south-southwest 10 months of the year, and from the north-northwest during September and October. The average wind speed for MCAS New River is 6.9473 miles per hour.

3.3 Surface Water Hydrology

The majority of MCB Camp Lejeune is situated near sea level (i.e., estuarine conditions which are tidally influenced). The New River, the dominant surface water feature which receives drainage from Brinson Creek, flows in a southerly direction and empties into the Atlantic Ocean through the New River Inlet.

A single surface water (Brinson Creek) body is located in the northern corner of the study area. Several surface drainage pathways lead to Brinson Creek which flows southeast to the New River. Brinson Creek is designated by the North Carolina Fisheries Rules as Class I inland fishing waters.

The New River is designated as Class SC, High Quality Water (HQW) (NC DEHNR, 1993, and NCMFC, 1992). Classic SC waters are saltwaters protected for secondary recreation, fishing, aquatic life including propagation and survival, and wildlife. HQW are waters that are rated as excellent based on one or more of the following factors: biological and physical/chemical characteristics through division monitoring or special studies; native and special trout waters (and their tributaries) designated by the Wildlife Resources Commission; primary nursery areas designated by the Marine Fisheries Commission; other functional nursery areas designated by the Wildlife Resources Commission; critical habitat designated by the Wildlife Resources Commission or the Department of Agriculture; all water supply watersheds which are classified as WS-I or WS-II or those for which a formal petition for reclassification as WS-I or WS-II have been received from the appropriate local government and accepted by the Division of Environmental Management; and, all Class SA waters (NC DEHNR, 1993). This section of the New River is classified as a primary fish nursery area, but it is not a water supply.

3.4 Geology

3.4.1 Regional Geology

MCB Camp Lejeune is located in the Atlantic Coastal Plain physiographic province. The sediments of the Atlantic Coastal Plain consist of interbedded sands, clays, calcareous clays, shell beds, sandstone, and limestone. These sediments are layered in interfingering beds and lenses that gently dip and thicken to the southeast (ESE, 1990). Regionally, they comprise 10 aquifers and nine confining units which overlie igneous and metamorphic basement rock of pre-Cretaceous age. The combined thickness of the sediments is approximately 1,500 feet. These sediments were deposited in marine or near-marine environments and range in age from early Cretaceous to Quaternary time. Table 3-2 presents a generalized geologic and hydrogeologic units in coastal North Carolina (Harned et al., 1989).

United States Geological Survey (USGS) studies at MCB Camp Lejeune indicate that the area is underlain by sand and limestone aquifers separated by semi-confining units (i.e., in some portions of the base) of silt and clay. These aquifers include the water table (surficial), Castle Hayne, Beaufort, Peedee, Black Creek, and upper and lower Cape Fear. The surficial aquifer ranges in thickness from 0 to 73 feet and averages 25 feet according to U.S.G.S (Cardinell, et al, 1993). The estimated lateral hydraulic conductivity for the surficial aquifer is 50 feet per day (ft/d) and is based on a general composition of fine sand mixed with some silt and clay (Cardinell, et al, 1993). Less permeable clay and silt beds function as confining units or semi-confining units which separate the aquifers and impede the flow of groundwater between aquifers. The vertical hydraulic conductivity of the Castle Hayne semi-confining unit was estimated to range from 0.0014 to 0.41 ft/d and is comparable to those determined for silt (Cardinell et al, 1993). A generalized hydrogeologic cross-section of this area is presented in Figures 3-1 and 3-2 and illustrates the relationship between the aquifers in this area (Cardinell et al., 1993).

3.4.2 Site Geology

The findings of the SGI are generally consistent with those of the RI; the same general stratigraphic sequence that was originally described for Site 35 was observed throughout the northern portion of Camp Geiger. For the SGI report, hydrogeologic unit names have been assigned to the various soils to place the study area within the context of the regional stratigraphy illustrated by the cross sections shown on Figure 3-2.

As described in the RI Report, the upper-most soils are sand with lesser amounts of silt and clay. Lenses of silts and clays are present throughout the sand. Immediately below this sand are calcareous sands with varying amounts of shell and fossiliferous limestone fragments, interbedded with shell and fossiliferous limestone fragment layers. Collectively, these soils comprise what is called the undifferentiated formation as shown on Table 3-2, as well as the surficial aquifer. The amount of shell and fossil material observed in the calcareous layer during the SGI differs from that of the RI. The RI reported that this layer contained 0 to 35 percent shell fragments. Observations from the SGI indicate that the shell content is often greater than 50 percent, and in some instances approaches 90 percent. This difference may be attributable to facies changes.

A generally fine sand with lesser amounts of silt and clay is present immediately below the calcareous sands and shell/limestone fragment layer. This unit has been interpreted as the Belgrade Formation, or Castle Hayne Confining Unit, which was not fully described in the RI due to limited

information. This unit was observed throughout the study area, typically at an elevation of approximately 20 to 30 feet below msl. The soils of this unit have a distinct green, or greenish-gray color, and contain less water than the overlying soils. This unit was observed to be seven to 12 feet thick at two locations (35GWD-6, and 35GWD-7), which is consistent with RI findings.

As described in the RI Report, a fine to medium sand with lesser amounts of shell fragments, silt, and clay is present immediately below the Castle Hayne Confining Unit. This unit has been interpreted as the River Bend Formation, or the upper portion of the Castle Hayne Aquifer. The top of this unit is approximately 35 to 40 feet below msl. The two deep monitoring wells installed for the SGI encountered a similar material at similar elevations.

Geologic cross-sections were constructed from existing cross-sections in the RI Report using additional geologic data gathered during the SGI to illustrate the subsurface stratigraphy beneath the SGI study area. As shown on Figure 3-3, several areas were traversed to provide a cross-sectional view of the study area. Three cross-sections were constructed: A-A' crosses west to east along the northern portion of the study area; B-B' crosses north to south; C-C' crosses west to east along the central portion of the study area; and D-D' crosses west to east in the south central portion of the study area.

Cross-section A-A' (originally presented in the RI Report) depicts subsurface soils to an elevation of -51.3 feet msl from the western boundary of the study area to the eastern boundary. As illustrated on Figure 3-4, the soil underlying this portion of the area consist of fine to medium sands, clayey silts, and silty sands.

In general, in the western portion of the study area, a fine sand with trace to some silt is underlain by another fine sand that is partially cemented with calcium carbonate and contains 10 to 20 percent shell fragments to a depth of approximately -25 msl. Underlying the partially cemented sand is a very dense to dense, greenish gray, fine sand containing some silt, trace to some shell fragments. This semi-confining unit separates the Quaternary sediments from the Castle Hayne Aquifer and appears to be approximately eight to 12 feet thick, generally thickening toward the east. The Castle Hayne Formation is present beneath this unit. Borings were advanced only 10 to 15 feet into this formation during the RI, therefore providing limited knowledge of specific details regarding the condition of the Castle Hayne beneath the study area. The upper portion of the Castle Hayne was described as a partially cemented, gray, fine sand with some shell fragment and limestone fragments encountered periodically.

In the eastern portion of the study area this entire sequence of subsurface soil types appears to be overlain by silty clay or a clayey silt. The unit is not uniform and varies from approximately four to 20 feet thick.

Cross-section B-B' was originally presented in the RI Report, but has been modified to reflect the larger dimensions of the SGI study area. This cross-section (Figures 3-5 and 3-5A) begins on the NAOC on Onslow County property (northeast side of Brinson Creek), and extends through the middle of the study area to the southern limits of the study area. This section shows the same sequence of units as section A-A'. The sand and calcareous sand/shells and limestone of the undifferentiated formation (surficial aquifer) overlay the green sand and silt of the Castle Hayne Confining Unit. A substantial silty clay layer is present within the surficial aquifer in the vicinity of 35-TW04B and 35-MW43B. Groundwater typically occurs within 10 feet of the surface.

Cross-section C-C' (originally presented in the RI Report) illustrates the soils beneath the southern portion of the site to an elevation of -51.3 (Figure 3-6). In general, the soils consisted of the same types observed in the other cross-sections previously discussed. The only difference in this cross-section, when compared with the others, is the increase in interbedded soils in the eastern portion of the area.

Cross-section D-D' is a newly constructed cross-section (Figure 3-7) which depicts the area located south of cross-section C-C', and was created to reflect the larger dimension of the study area. Again, this cross-section shows the same sequence of units as in the other sections, demonstrating the consistent sequence of soil types.

The upper sand unit of the undifferentiated formation (surficial aquifer) is present throughout the study area. Lenses of silts and clays are generally limited in extent and found throughout the study area. These fine-grained soils are predominant along the western portion of cross-section A-A' (near Brinson Creek), and in the middle of cross-section B-B' (between Sixth and Seventh Streets). The lower calcareous sand/shell and limestone unit of the undifferentiated formation is also present throughout the study area. The top of this unit is typically 10 feet below msl, with one exception; cross-sections A-A' and B-B' show that the top of this unit dips to nearly 20 feet below msl in the vicinity of Brinson Creek. This may be a result of historic stream erosion of the calcareous sand/shell and limestone unit, following a depositional period. The sands and silts of the Castle Hayne Confining Unit are also present throughout the study area.

Overall, the soils encountered during investigations within the study area are fairly consistent throughout. Within the study area, a laterally continuous confining unit was present between -26.0 and -28.1 feet msl. The location of the confining unit separating the surficial aquifer from the Castle Hayne Aquifer was encountered approximately 40 feet bgs. This is consistent with the range reported by the USGS, but exceeds the reported average of 25 feet (Cardinell, et al, 1993). It should be noted that results of the RI and SGI indicate that a semi-confining unit separates the surficial aquifer from the Castle Hayne Aquifer (consistent with the Harned, et al, report of 1989). This unit will be referred to as "semi-confining" in this report.

3.5 Surface Soils

Information regarding site soil conditions was obtained from the Soil Survey publication prepared by the U.S. Department of Agriculture - Soil Conservation Service (SCS) for Marine Corps Base Camp Lejeune, North Carolina (SCS, 1984). Due to past grading and surface activities at the site, the soils described in the SCS publication may differ from current site conditions.

According to the SCS Soil Survey the site is underlain by a single distinct soil unit, the Baymeade-Urban (BaB) Land Complex. Baymeade-Urban soils exhibit zero to six percent slopes and only about 30 percent of their surface area has been altered through urbanization. Infiltration is rapid and surface water runoff slow in the remaining undisturbed areas. The seasonal high water table ranges from four to five feet bgs for Baymeade-Urban soils.

3.6 Hydrogeology

The following sections discuss the regional and site-specific hydrogeologic conditions. The information presented on the regional hydrogeology has been obtained from literature (Harned, et

al., 1989); site-specific hydrogeologic information is presented from data collected during the field investigation.

3.6.1 Regional Hydrogeology

The surficial water table aquifer lies in a series of undifferentiated sediments, primarily sand and clay, which commonly extend to depths of 50 to 100 feet. This aquifer is not used as a water supply at MCB Camp Lejeune because of its low-yielding production rates. A semi-confining unit underlies the surficial aquifer within the eastern portion of MCB Camp Lejeune (Harned, et al., 1989).

The principal water supply aquifer for the Activity consists of a series of sand and limestone beds at a depth of between 50 and 300 feet bgs. This series of sediments generally is known as the Castle Hayne Aquifer, is about 150 to 350 feet thick in the area, and is the most productive aquifer in North Carolina. Estimated transmissivity (T) and hydraulic conductivity (K) values for the Castle Hayne Aquifer range from 4,300 to 24,500 ft²/day (32,200 to 183,300 gallons/foot/day) and 14 to 82 feet/day, respectively (Harned et al., 1989).

Onslow County and MCB Camp Lejeune lie in an area where the Castle Hayne Aquifer contains freshwater, although the proximity of saltwater in deeper layers just below the aquifer and in the New River estuary is of concern in managing water withdrawals from the aquifer. Overpumping of the deeper parts of the aquifer could cause intrusion of saltwater. The aquifer contains water having less than 250 milligrams per liter (mg/l) chloride throughout the area of the Activity (Harned et al., 1989).

The aquifers that lie below the Castle Hayne consist of thick sequences of sand and clay. Although some of these aquifers are used for water supply elsewhere in the Coastal Plain, they contain saltwater in the MCB Camp Lejeune area and are not used (Harned et al., 1989).

Rainfall in the MCB Camp Lejeune area enters the ground in recharge areas, infiltrates the soil, and moves downward until it reaches the water table, which is the top of the saturated zone. In the saturated zone, groundwater flows in the direction of lower hydraulic head, moving through the system to discharge areas like the New River and its tributaries or the ocean (Harned et al., 1989).

Water levels in wells tapping the surficial aquifer vary seasonally. The surficial aquifer receives more recharge in the winter than in the summer when much of the water evaporates or is transpired by plants before it can reach the water table. Therefore, the water table generally is highest in the winter months and lowest in summer or early fall (Harned et al., 1989).

In semi-confined aquifers, water is sometimes under excess head and the level to which it rises in a tightly cased well is called the potentiometric surface. The hydraulic head in the semi-confined Castle Hayne Aquifer, shows a different pattern of variation over time. Some seasonal variation also is common in the potentiometric surface of the Castle Hayne Aquifer, but the changes tend to be slower and over a smaller range than for water table wells (Harned et al., 1989).

3.6.2 Site Hydrogeology

The following sections describe the site hydrogeologic conditions for the surficial (water table aquifer) and the deep (Castle Hayne Aquifer) water-bearing zones at Site 35. Hydrogeologic

characteristics in the vicinity of the site were evaluated by reviewing groundwater data gathered during the RI and SGI. The findings of the SGI are generally consistent with those presented in the RI Report. Some seasonal and temporal variations are evident when comparing SGI to RI data. Such variations include differences in static water levels and hydraulic conductivity.

Groundwater was encountered at varying depths during the drilling program. This variation is primarily attributed to topographical changes. In general, the groundwater was encountered between 5.5 and 8.5 feet bgs. The water table nears the ground surface in the area of Brinson Creek, where the topographic elevation decreases.

Three rounds of static water level measurements were collected from monitoring wells at Site 35 on May 1, July 13, and July 29, 1996. A summary of this data is provided on Tables 2-9, 2-10, and 2-11. Two groundwater flow maps were developed from the July 29 static water level data obtained from the shallow, intermediate, and deep wells, as shown in Figures 3-8 and 3-9.

The direction of surficial aquifer groundwater flow in the vicinity of Site 35 is to the northeast, toward Brinson Creek (Figure 3-8). The pathway is consistent with the RI findings. Groundwater elevations were slightly higher in July 1996 when compared to September, 1994 and is likely attributable to seasonal and yearly rainfall variation. The groundwater flow gradient in July 1996 was approximately 0.007 feet/foot. Groundwater in the surficial aquifer appears to discharge to Brinson Creek based on the groundwater flow direction, the relative elevations of the creek, the ground surface elevations, and the groundwater potentiometric surface (Figure 3-8).

Groundwater flow direction in the upper portion of the Castle Hayne Aquifer in the vicinity of Site 35 is to the northeast (Figure 3-9), at a gradient of 0.008 feet/foot (consistent with RI findings). According to the USGS Hydrogeologic Study for Camp Lejeune (Cardinell, et al., 1993), deep groundwater flows and discharges to the New River, located approximately 3/4 miles east and northeast of Site 35.

Table 3-3 provides a summary of horizontal hydraulic conductivity measurements of six slug tests conducted at Site 35. Five of the slug tests were conducted in wells screened in the lower portion of the surficial aquifer. The remaining slug test was conducted in a well screened in the upper portion of the Castle Hayne Aquifer. Each slug test consisted of a falling head and rising head test. The hydraulic conductivity was estimated using the Bouwer-Rice solution via AQTESOLV™ software. Copies of the AQTESOLV solution printouts are provided in Appendix J.

Some of the data appears unrepresentative of the aquifer for reasons discussed in Appendix J. The valid slug test data for the surficial aquifer are fairly consistent. The rising head test data range from 57.5 ft/day at 35-MW41B to 83.8 ft/day at 35-MW40B, with an average of 71 ft/day. Additionally, the averages of the falling head and rising head tests are similar; 89.5 feet/day and 71.0 feet/day, respectively. The average transmissivity value for the falling head test is approximately 3,581 ft²/day, and 2,840 ft²/day for the rising head test.

The slug tests conducted during the SGI were performed in wells located roughly 1/4 mile south of the original study area. The hydraulic conductivity data collected for the SGI are an order of magnitude higher than the RI data. These higher hydraulic conductivity values may be attributable to the relatively larger grain sizes observed in the SGI soil borings (discussed in Section 3.4.2).

The average surficial aquifer hydraulic conductivity values calculated for this study are on the same order of magnitude as the value in Cardinell, et al., 1993. The average hydraulic conductivity of the rising and falling head slug tests conducted during the SGI is 80.3 feet/day; this is slightly higher, but comparable to the Cardinell value of 50 feet/day. The Cardinell value was estimated based on grain size; a general composition of fine sand, mixed with some silty clay.

The measured hydraulic conductivity and transmissivity in the Castle Hayne Aquifer at Site 35 are 7.3 ft/day and 1,460 ft²/day, respectively, and are similar to the RI data, as well as the Cardinell data. The RI presented a hydraulic conductivity value of 6.03 ft/day. Cardinell reported hydraulic conductivity and transmissivity values from several studies. Hydraulic conductivity values ranged from 14 to 91 ft/day, and transmissivity values ranged from 820 ft²/day to 26,000 ft²/day. Note that this comparison involves one data point from Site 35. Aquifer heterogeneities observed at other sites (and likely at Site 35) would produce an average value different than a single value.

3.7 Land Use and Demography

Present military population of MCB Camp Lejeune is approximately 40,000 active duty personnel. The military dependent community is in excess of 32,000. About 36,000 of these personnel and dependents reside in base housing units. The remaining personnel and dependents live off base and have had dramatic effects on the surrounding area. An additional 4,412 civilian employees perform facilities management and support functions. The population of Onslow County has grown from 17,739 in 1940, prior to formation of the base, to its present population of 121,350.

Site 35, the Camp Geiger Area Fuel Farm, was formerly used to dispense gasoline, diesel, and kerosene to government vehicles and to supply USTs in use at Camp Geiger and the New River Marine Corps Air Station. The fuel farm was demolished in 1995 to make way for a proposed highway. Barracks are located within 1,000 feet of the site and many warehouses and storage facilities are located adjacent to and within the boundaries of the study area. A COMMARFORLANT Nuclear Biological Chemical Defense School Training Range is located adjacent to the southeast boundary of the site.

3.8 Identification of Water Supply Wells

Water supply wells located within a one-mile radius of Site 35 are illustrated on Figure 3-10. Supply well information was obtained from "USGS Water Resources Investigation Report 89-4096" (Harned, et al., 1989). As shown on Table 3-4, nine active wells were identified within one mile of the site. Complete historic information was not available for many of the wells; however, the following was noted:

- Four wells were installed in 1941 and 1942;
- One was estimated to have been installed in the 1950s;
- Three wells were installed in 1975;
- An installation date was not available for one well;
- Total depth of the wells range from 70 to 250 feet bgs.

Figures 3-8 and 3-9 indicate that local groundwater flow (shallow and deep) is towards Brinson Creek. Figure 3-10 indicates that none of the supply wells that surround Site 35 are downgradient of the contaminant plume. The closest supply well is located 1,000 feet to the west. Given the location and distance of these wells in relation to Site 35 and local geological/hydrogeological conditions, it is unlikely that contaminants present at Site 35 would migrate to these supply wells and impact the quality of the drinking water.

SECTION 3.0 TABLES

TABLE 3-1

**CLIMATIC DATA SUMMARY FOR MCAS NEW RIVER
SITE 35, CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION
MCB CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232**

| | Temperature (Celsius) | | | Relative Humidity (Percent) | Temperature (Fahrenheit) | | | Mean Number of Days With | | | | |
|-----------|--------------------------|---------|---------|-----------------------------------|-----------------------------|---------|---------|--------------------------|--------|-------------|-------|-------|
| | Maximum | Minimum | Average | | Maximum | Minimum | Average | Precipitation | | Temperature | | |
| | | | | | | | | >=0.01" | >=0.5" | >=90F | >=75F | <=32F |
| January | 7.5 | 1.4 | 4.2 | 76 | 54 | 34 | 44 | 11 | 2 | 0 | 1 | 14 |
| February | 7.0 | 1.5 | 3.8 | 74 | 57 | 36 | 46 | 9 | 3 | 0 | 1 | 11 |
| March | 8.0 | 0.8 | 3.5 | 78 | 64 | 42 | 53 | 10 | 2 | 0 | 5 | 7 |
| April | 6.5 | 0.5 | 3.0 | 79 | 73 | 51 | 62 | 8 | 2 | -- | 14 | -- |
| May | 8.4 | 1.7 | 4.3 | 86 | 80 | 60 | 70 | 10 | 3 | 2 | 25 | 0 |
| June | 11.8 | 2.4 | 5.8 | 85 | 85 | 67 | 76 | 11 | 4 | 6 | 19 | 0 |
| July | 14.3 | 4.5 | 8.0 | 85 | 88 | 72 | 80 | 14 | 5 | 12 | 31 | 0 |
| August | 12.6 | 1.7 | 6.1 | 87 | 87 | 71 | 80 | 12 | 4 | 11 | 31 | 0 |
| September | 12.2 | 1.4 | 4.7 | 87 | 83 | 66 | 75 | 9 | 3 | 3 | 27 | 0 |
| October | 6.5 | 0.7 | 2.8 | 82 | 74 | 54 | 64 | 7 | 2 | -- | 16 | -- |
| November | 5.7 | 0.6 | 2.6 | 80 | 66 | 44 | 55 | 7 | 1 | 0 | 6 | 4 |
| December | 6.1 | 0.4 | 4.0 | 77 | 58 | 37 | 48 | 9 | 2 | 0 | 2 | 11 |
| Annual | 14.3 | 0.4 | 52.8 | 81 | 72 | 53 | 63 | 117 | 33 | 34 | 188 | 47 |

Notes: -- Less than 0.5 days
" - inches

Source: Naval Oceanography Command Detachment, Asheville, North Carolina. Measurements obtained from January 1955 to December 1982.

TABLE 3-2

**GEOLOGIC AND HYDROGEOLOGIC UNITS IN THE
COASTAL PLAIN OF NORTH CAROLINA
SITE 35, CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION
MCB CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232**

| GEOLOGIC UNITS | | | HYDROGEOLOGIC UNITS |
|---------------------------------|---------------------------------|---|--|
| System | Series | Formation | Aquifer and Confining Unit |
| Quaternary | Holocene/Pleistocene | Undifferentiated | Surficial Aquifer |
| Tertiary | Pliocene | Yorktown Formation ⁽¹⁾ | Yorktown Confining Unit |
| | | | Yorktown Aquifer |
| | Miocene | Eastover Formation ⁽¹⁾ | Pungo River Confining Unit |
| | | Pungo River Formation ⁽¹⁾ | |
| | | Belgrade Formation ⁽²⁾ | Castle Hayne Confining Unit |
| | Oligocene | River Bend Formation | Castle Hayne Aquifer |
| | Eocene | Castle Hayne Formation | Beaufort Confining Unit ⁽³⁾ |
| | Palocene | Beaufort Formation | Beaufort Aquifer |
| | | | |
| Cretaceous | Upper Cretaceous | Peedee Formation | Peedee Confining Unit |
| | | | Peedee Aquifer |
| | | Black Creek and Middendorf Formations | Black Creek Confining Unit |
| | | | Black Creek Aquifer |
| | Cape Fear Formation | Upper Cape Fear Confining Unit | |
| | | Upper Cape Fear Aquifer | |
| | | Lower Cape Fear Confining Unit | |
| | | Lower Cape Fear Aquifer | |
| Lower Cretaceous ⁽¹⁾ | Unnamed Deposits ⁽¹⁾ | Lower Cretaceous Confining Unit | |
| | | Lower Cretaceous Aquifer ⁽¹⁾ | |
| Pre-Cretaceous Basement Rocks | | -- | -- |

Notes: (1) Geologic and hydrologic units probably not present beneath Camp Lejeune.

(2) Constitutes part of the surficial aquifer and Castle Hayne confining unit in the study area.

(3) Estimated to be confined to deposits of Paleocene age in the study area.

Source: USGS, 1989.

TABLE 3-3

**SUMMARY OF HYDRAULIC CONDUCTIVITY DATA
SITE 35, CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION
MCB CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232**

| Well ID | Hydraulic Conductivity | | Transmissivity | | General Description |
|-----------------------------|------------------------|-------------|----------------|-------------|---|
| | Falling Head | Rising Head | Falling Head | Rising Head | |
| Surficial Aquifer | | | | | |
| 35-MW39B | 75.6 | 71.7 | 3,024.0 | 2,868.0 | Fine sand, little silt and clay |
| 35-MW40B | 122.7 | 83.8 | 4,908.0 | 3,352.0 | Sand, some silt, trace clay, limestone fragments |
| 35-MW41B | 70.3 | 57.5 | 2,812.0 | 2,300.0 | Sand and gravel, little silt, trace clay |
| 35-MW42B | 89.4 | 153.6 | 3,576.0 | 6,144.0 | Shell fragments, little silt |
| 35-MW43B | 256.1 | 184.2 | 10,244.0 | 7,368.0 | Fine to medium sand, little silt, trace shell fragments and clay |
| Maximum | 256.1 | 184.2 | 10,244.0 | 7,368.0 | |
| Minimum | 70.3 | 57.5 | 2,812.0 | 2,300.0 | |
| Average ⁽¹⁾ | 89.5 | 71.0 | 3,581.3 | 2,840.0 | |
| Castle Hayne Aquifer | | | | | |
| 35-GWD06 | 7.0 | 7.6 | 1,400.0 | 1,520.0 | Fine sand, some shell fragments |

Notes:

⁽¹⁾ The average excludes the data for wells 35-MW42B and 35-MW43B (See Appendix L).

The rising head conductivity value for well 35-GWD06 is an average of two values.

The thickness of the surficial aquifer is estimated to be 40 feet.

The thickness of the Castle Hayne Aquifer is estimated to be 200 feet.

TABLE 3-4

**SUMMARY OF WATER SUPPLY WELLS WITHIN A ONE-MILE RADIUS
SITE 35, CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION
MCB CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232**

| Well No. | USGS Identification Number | Date Drilled | Drilling Company | Total Depth (feet) | Screen Depth (feet) | Approximate Distance and Direction from Edge of the Plume (feet) |
|-----------------------|----------------------------|--------------|-------------------------------|--------------------|--|--|
| MCAS-203 | 3443230772653.1 | -- | -- | 173 | -- | 3100/Southeast |
| MCAS-106 | 3443260772701.1 | 1954 (est.) | -- | -- | -- | 2600/Southeast |
| TC-1251 | 3443290772710.1 | 1975 | Carolina Well and Pump Co. | 240 | 120-140 160-170 | 4290/South-Southwest |
| TC-1253 | 3443370772729.1 | 1975 | Carolina Well and Pump Co. | 250 | 120-135 155-170 | 1600/Southwest |
| TC-1254 | 3443290772710.1 | -- | Caolina Well and Pump Co. | 195 | 118-122 145-160 175-185 | 2600/Southwest |
| TC-700 ⁽¹⁾ | 3443560772727.1 | 1941 | -- | 76 | 27.5-76 | 1000/West-Southwest |
| TC-600 | 3444050772728.1 | 1941 | Layne Atlantic Co. | 70 | 48-70 | 1000/West |
| TC-502 ⁽¹⁾ | 3444070772728.1 | 1941 | Virginia Machine and Well Co. | 182 | 110-184 | 1000/West-Northwest |
| TC-604 | 3444000772811.1 | 1942 | Layne Atlantic Co. | 113 | 45-50 60-65 82-87 97-102 108-113 | 3100/West |

Notes:

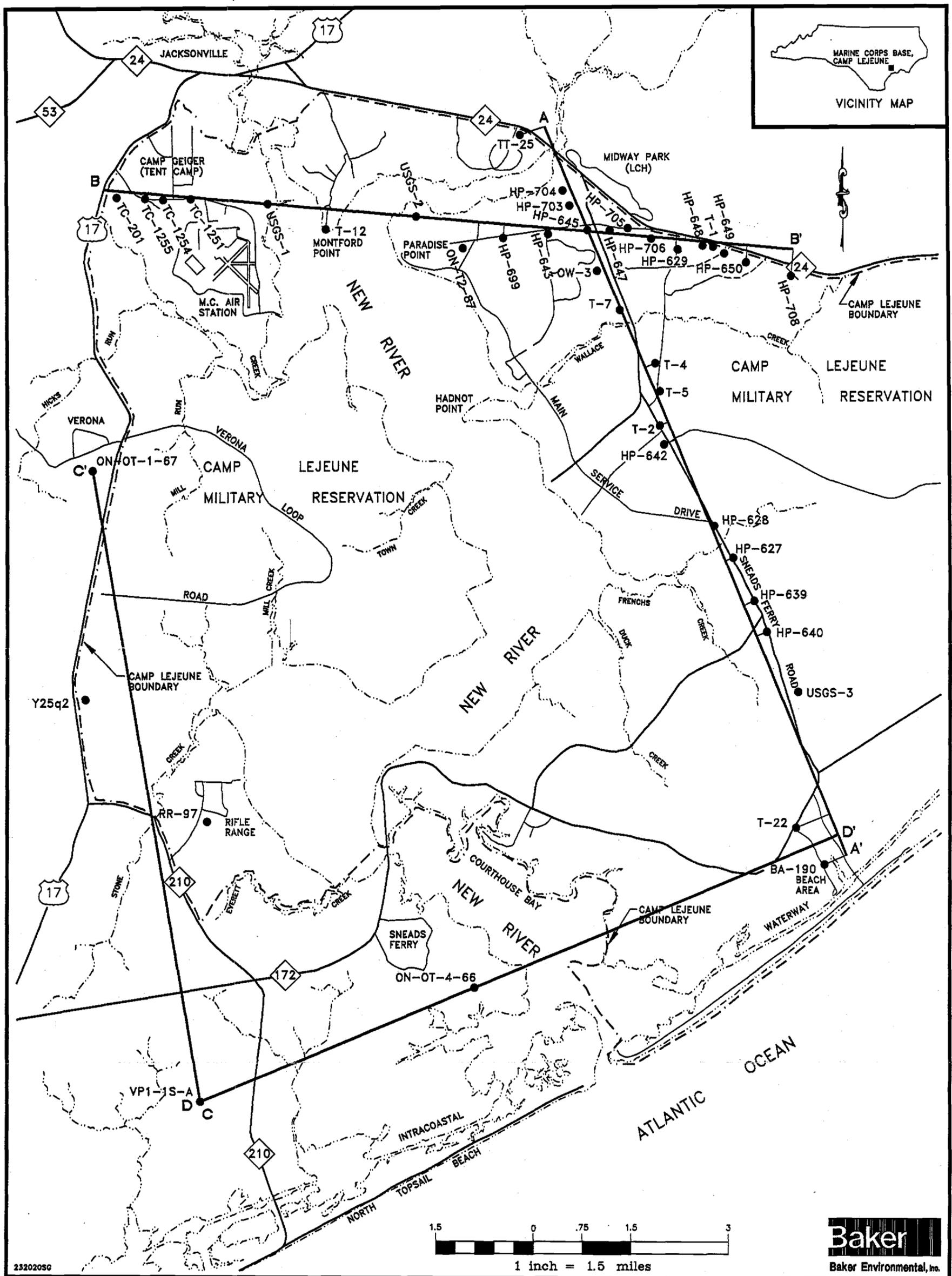
⁽¹⁾ Wells are listed as open hole wells according to the U. S. Geological Survey, Water Resources Investigations Report 89-4096.

- No data was available.

est. - estimated

Source: According to U. S. Geological Survey, Water Resources Investigations Report 89-4096.

SECTION 3.0 FIGURES



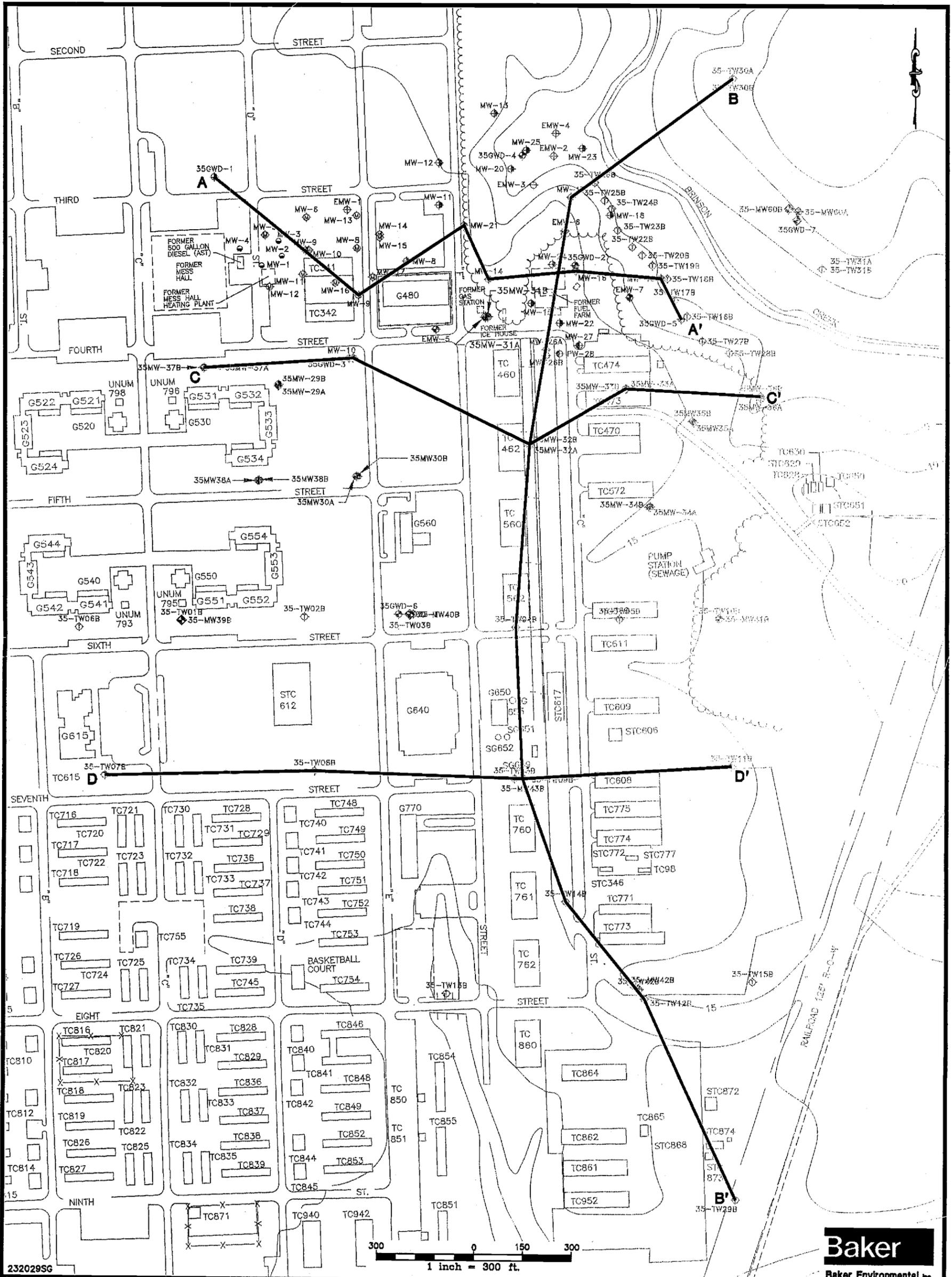
SOURCE: U.S. GEOLOGICAL SURVEY,
 WATER-RESOURCES INVESTIGATIONS
 REPORT, 93-4049, FIGURE 9

FIGURE 3-1
 LOCATION OF HYDROGEOLOGIC CROSS-SECTIONS
 SITE 35, CAMP GEIGER AREA FUEL FARM, SGI
 CONTRACT TASK ORDER - 0232

MARINE CORPS BASE, CAMP LEJEUNE
 NORTH CAROLINA

Baker
 Baker Environmental, Inc.

00157FFB32



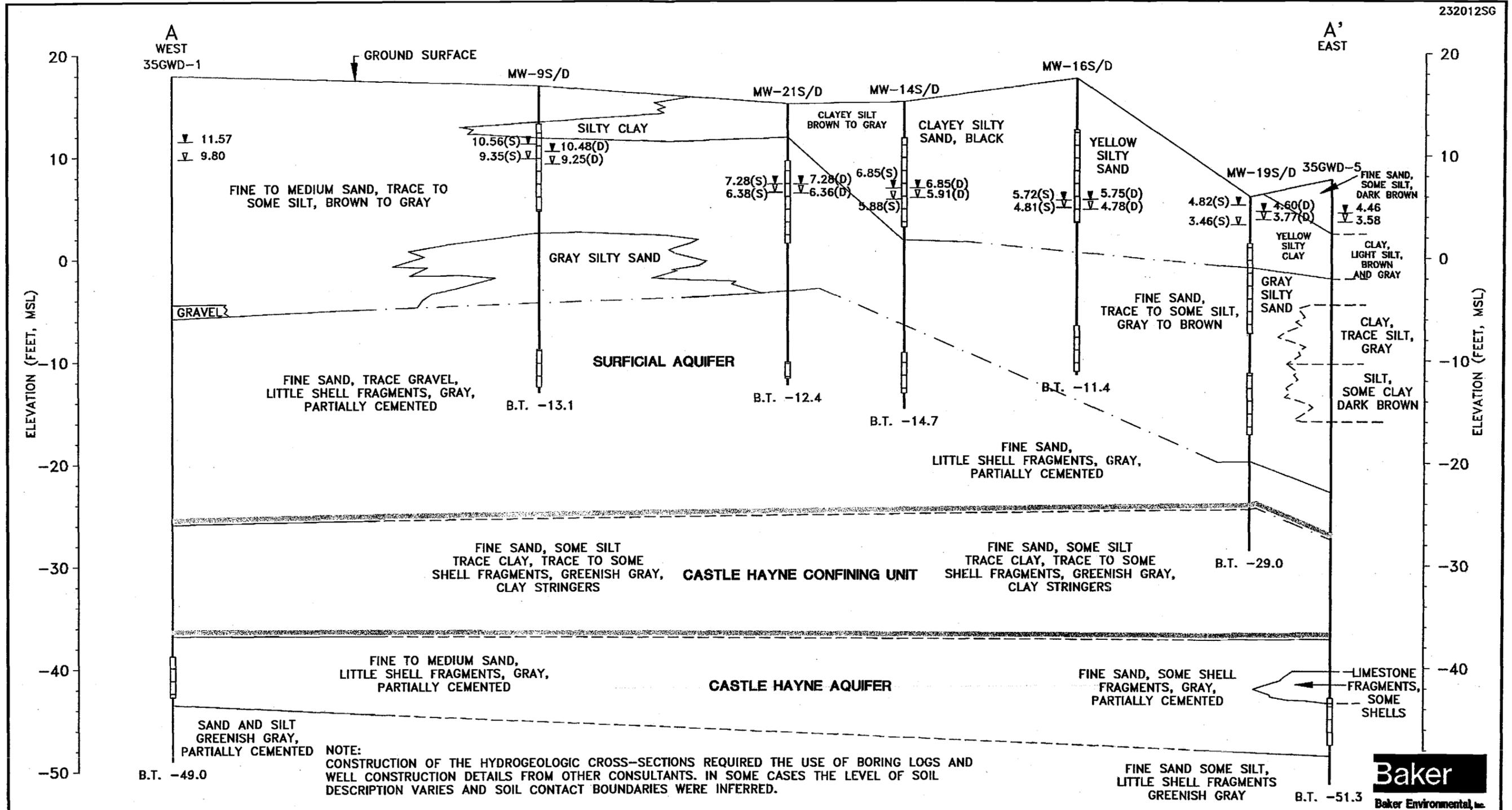
Baker
Baker Environmental, Inc.

LEGEND

A ——— A' - CROSS SECTION

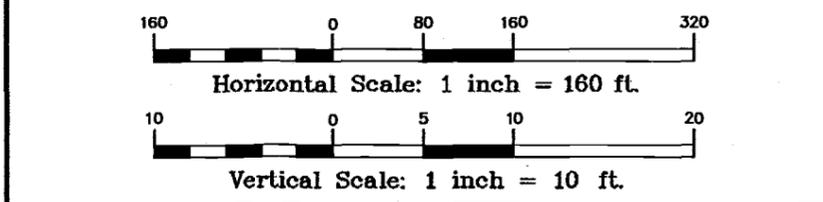
FIGURE 3-3
CROSS SECTION LOCATION MAP
SITE 35, CAMP GEIGER AREA FUEL FARM, SGI
CONTRACT TASK ORDER - 0232

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



LEGEND

| | |
|-------------|--|
| ▽ 10.48 | GROUNDWATER ELEVATION COLLECTED ON 9-9-94 (MSL) |
| ▽ 9.25 | GROUNDWATER ELEVATION COLLECTED ON 7-20-94 (MSL) |
| B.T. -49.0' | BORING TERMINATED, ELEVATION MSL |
| ▭ | WELL SCREEN INTERVAL |
| - · - · - | INFERRED SOIL CONTACT |
| — · — · — | ESTIMATED SOIL CONTACT |
| - - - - - | PROJECTED SOIL CONTACT |
| ===== | HYDROGEOLOGIC UNIT BOUNDARY |



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.

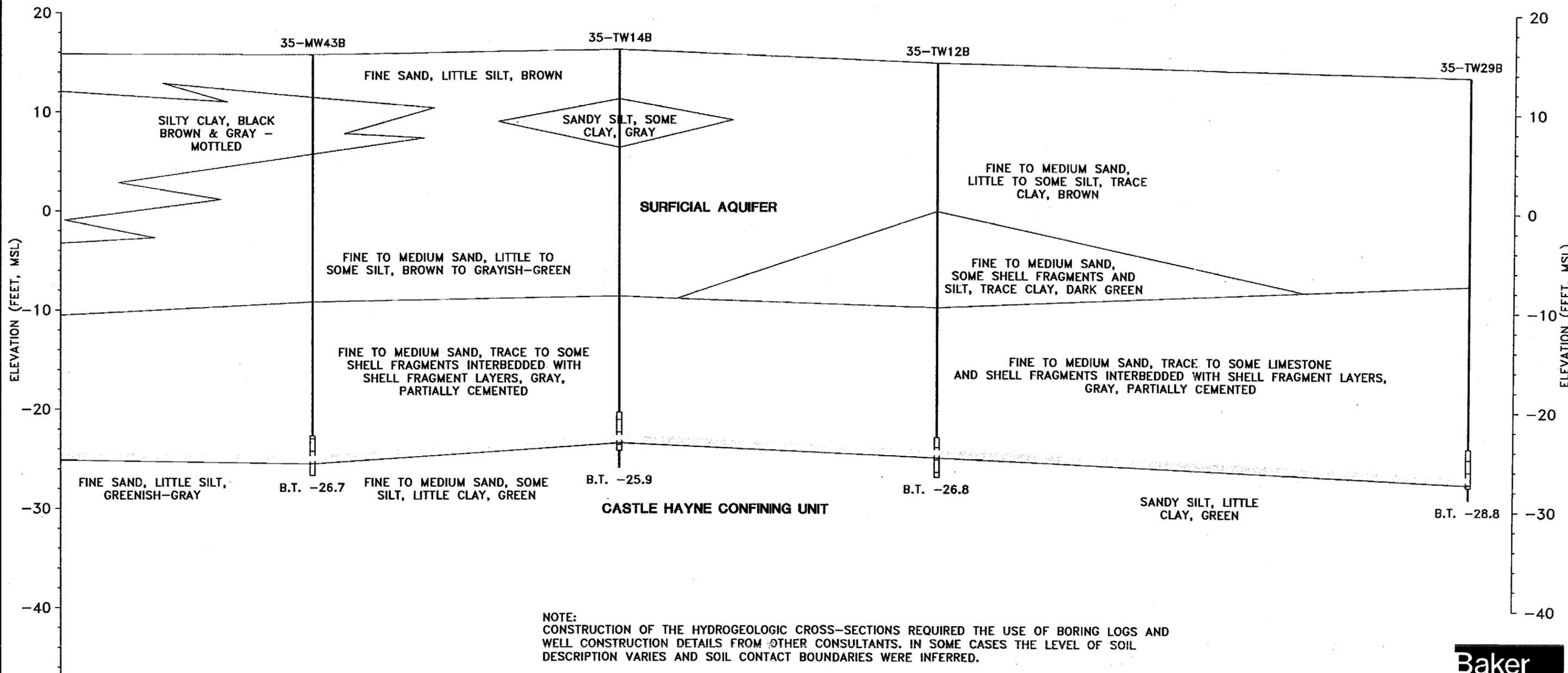
FIGURE 3-4
HYDROGEOLOGIC CROSS-SECTION A-A'
SITE 35, CAMP GEIGER AREA FUEL FARM, SGI
CONTRACT TASK ORDER - 0232

MARINE CORPS BASE, CAMP LEJEUNE
 NORTH CAROLINA



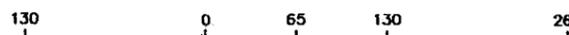
MATCHES WITH
FIGURE 3-5

B'
SOUTH

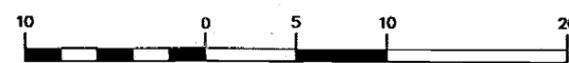


LEGEND

- ▼ 5.22 GROUNDWATER ELEVATION COLLECTED ON 9-9-94 (MSL)
- ▼ 4.30 GROUNDWATER ELEVATION COLLECTED ON 7-20-94 (MSL)
- B.T. -42.1' BORING TERMINATED, ELEVATION MSL
- ▭ WELL SCREEN INTERVAL
- - - INFERRED SOIL CONTACT
- ESTIMATED SOIL CONTACT
- - - - PROJECTED SOIL CONTACT
- — — — HYDROGEOLOGIC UNIT BOUNDARY



Horizontal Scale: 1 inch = 130 ft.

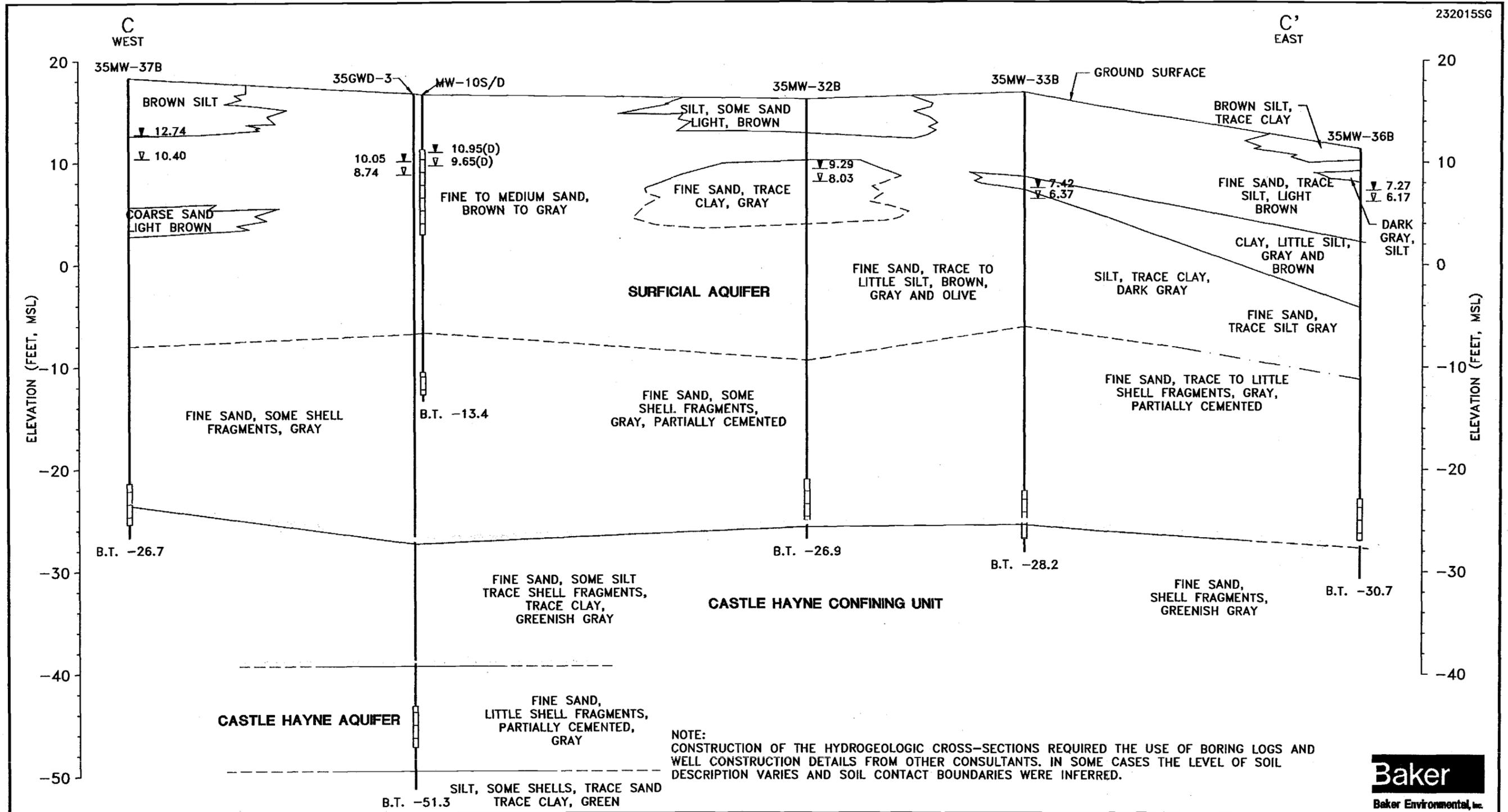


Vertical Scale: 1 inch = 10 ft.

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

FIGURE 3-5A
HYDROGEOLOGIC CROSS-SECTION B-B'
SITE 35, CAMP GEIGER AREA FUEL FARM, SGI
CONTRACT TASK ORDER - 0232

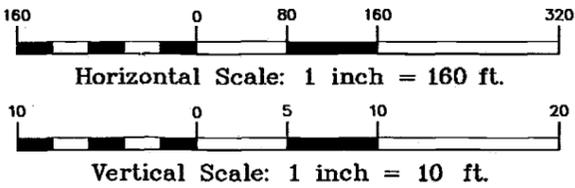
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



NOTE: CONSTRUCTION OF THE HYDROGEOLOGIC CROSS-SECTIONS REQUIRED THE USE OF BORING LOGS AND WELL CONSTRUCTION DETAILS FROM OTHER CONSULTANTS. IN SOME CASES THE LEVEL OF SOIL DESCRIPTION VARIES AND SOIL CONTACT BOUNDARIES WERE INFERRED.



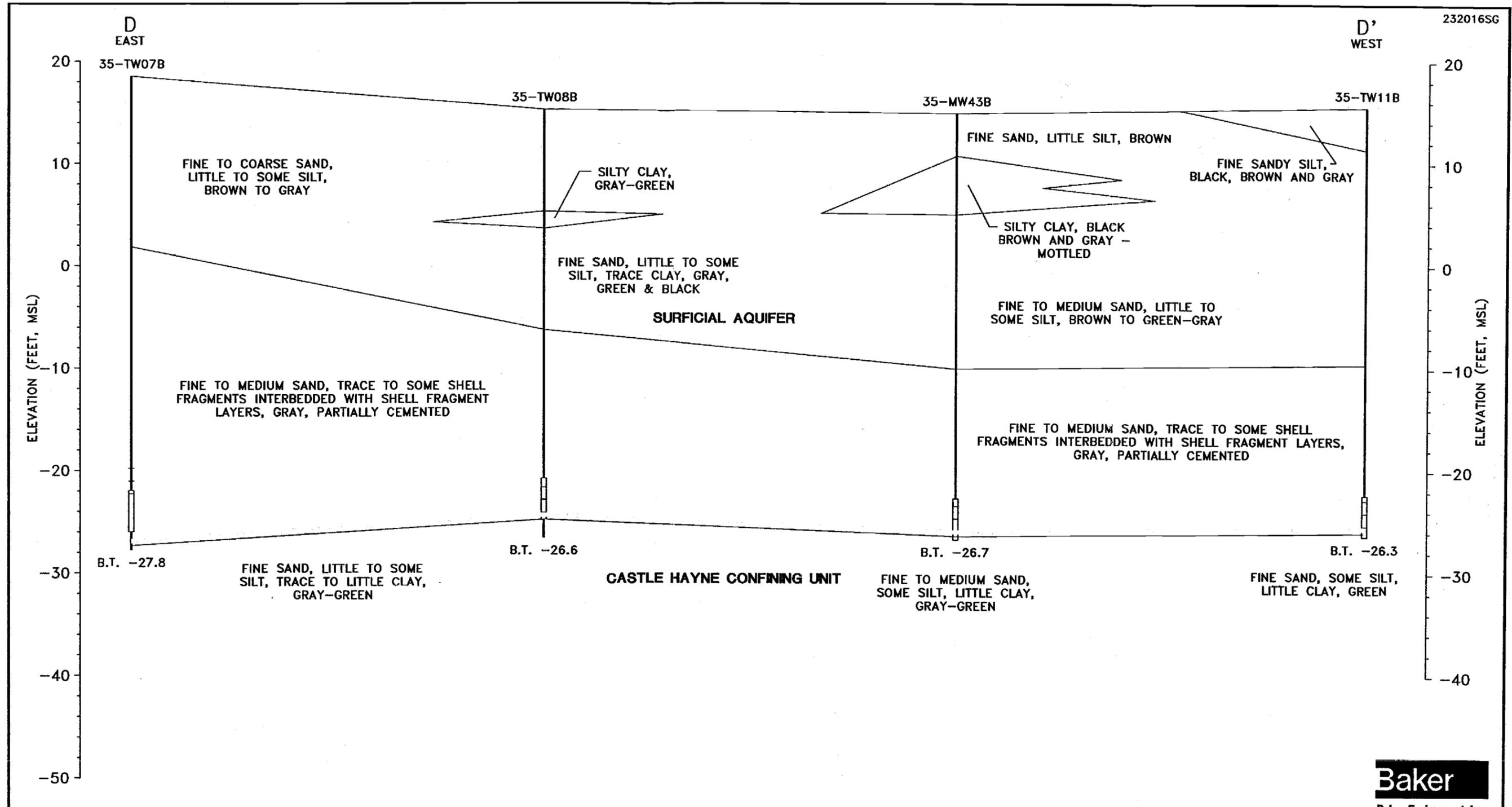
- LEGEND**
- ▽ 12.74 GROUNDWATER ELEVATION COLLECTED ON 9-9-94 (MSL)
 - ▽ 10.40 GROUNDWATER ELEVATION COLLECTED ON 7-20-94 (MSL)
 - B.T. -26.7' BORING TERMINATED, ELEVATION MSL
 - WELL SCREEN INTERVAL
 - - - INFERRED SOIL CONTACT
 - - - ESTIMATED SOIL CONTACT
 - - - PROJECTED SOIL CONTACT
 - - - - - HYDROGEOLOGIC UNIT BOUNDARY



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.

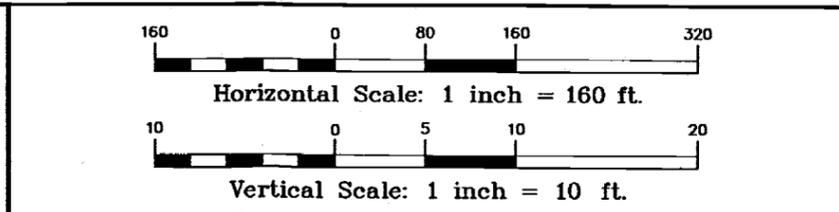
FIGURE 3-6
HYDROGEOLOGIC CROSS-SECTION C-C'
SITE 35, CAMP GEIGER AREA FUEL FARM, SGI
CONTRACT TASK ORDER - 0232

MARINE CORPS BASE, CAMP LEJEUNE
 NORTH CAROLINA



LEGEND

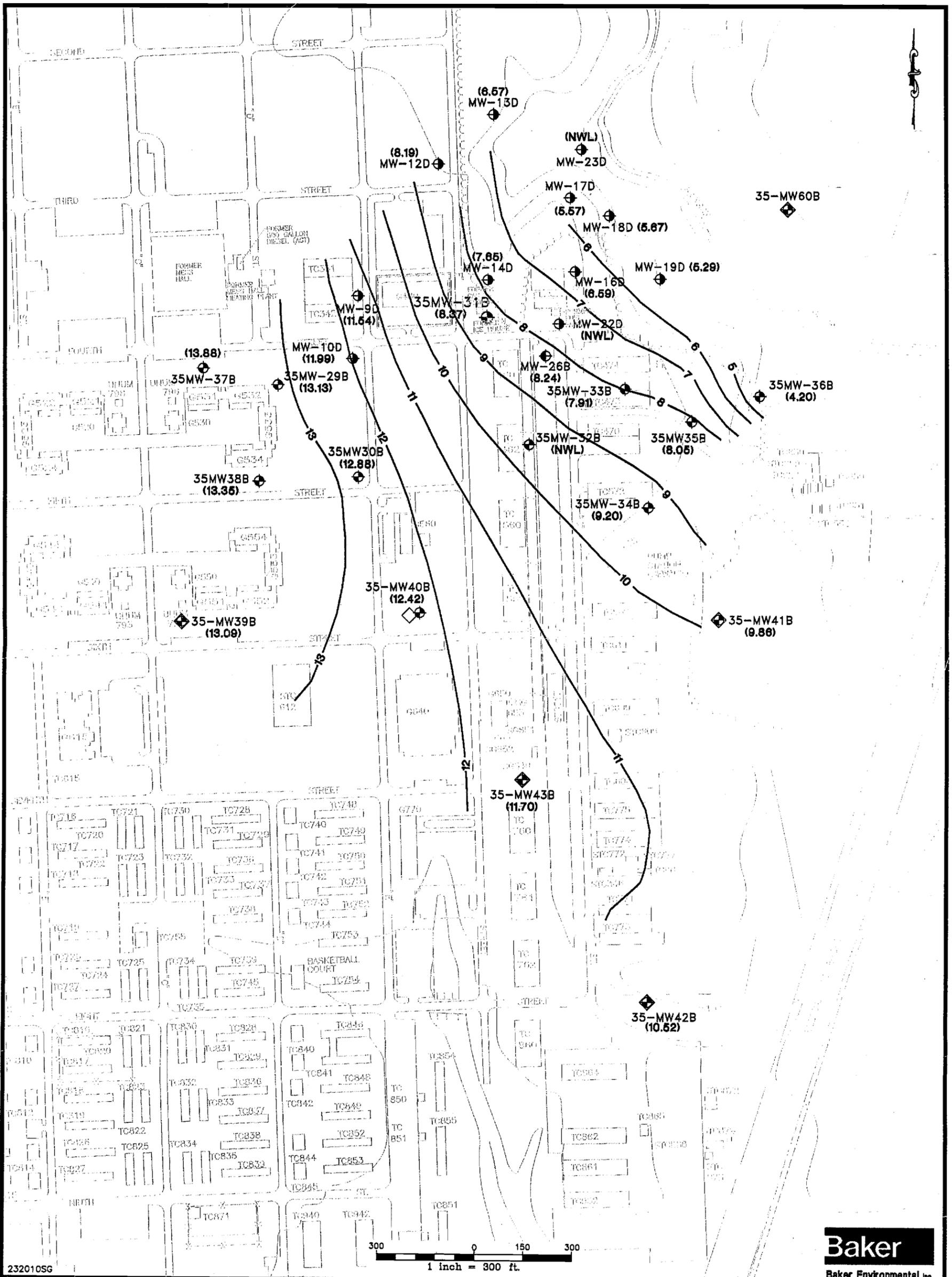
| | |
|-------------|----------------------------------|
| B.T. -26.7' | BORING TERMINATED, ELEVATION MSL |
| | WELL SCREEN INTERVAL |
| | INFERRED SOIL CONTACT |
| | ESTIMATED SOIL CONTACT |
| | PROJECTED SOIL CONTACT |
| | HYDROGEOLOGIC UNIT BOUNDARY |



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 3-7
HYDROGEOLOGIC CROSS-SECTION D-D'
SITE 35, CAMP GEIGER AREA FUEL FARM, SGI
CONTRACT TASK ORDER - 0232

MARINE CORPS BASE, CAMP LEJEUNE
 NORTH CAROLINA

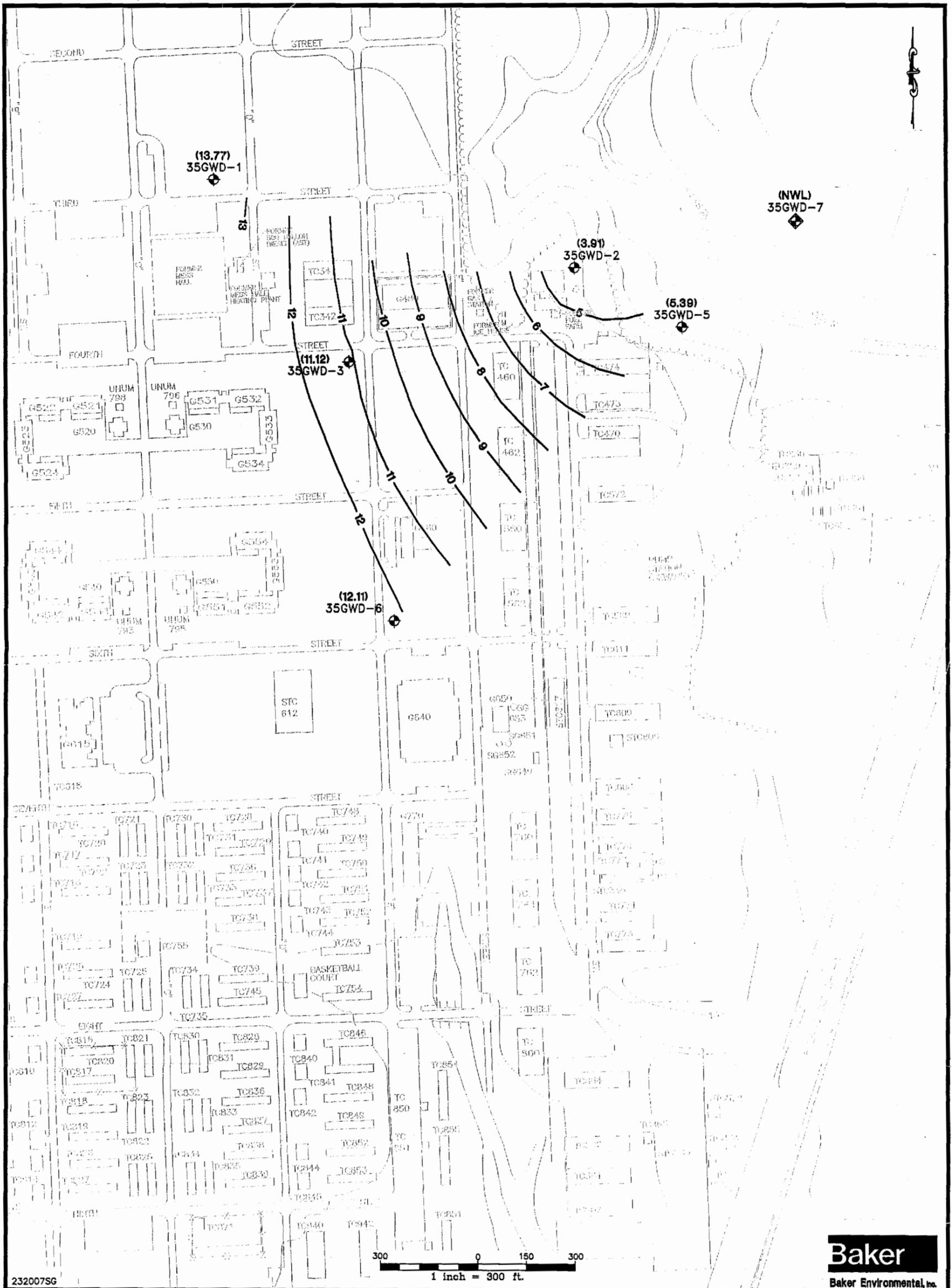


35MW-38B - MONITORING WELL WITH STATIC WATER ELEVATION (FT ABOVE MSL).
 (13.35)
 (NWL) - NO WATER LEVEL MEASUREMENT OBTAINED.
 — 10 — - GROUNDWATER EQUAL POTENTIAL CONTOUR.

SOURCE: LANTDIV, OCT. 1991

FIGURE 3-8
 GROUNDWATER ELEVATION CONTOURS FOR THE SURFICIAL AQUIFER (JULY 29, 1996)
 SITE 35, CAMP GEIGER FUEL FARM SGI
 CONTRACT TASK ORDER - 0232
 MARINE CORPS BASE, CAMP LEJEUNE
 NORTH CAROLINA





Baker
Baker Environmental, Inc.

LEGEND

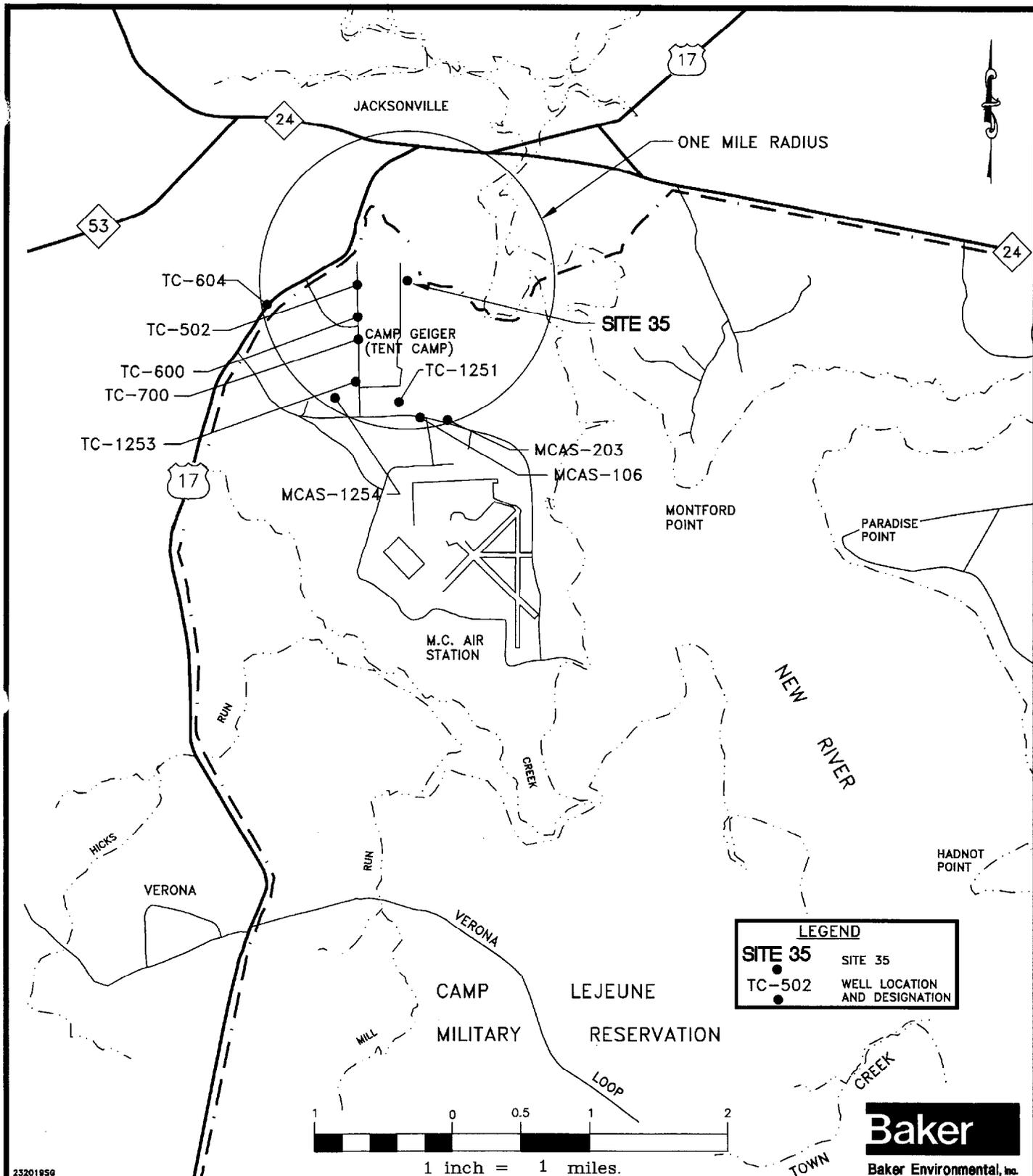
35GWD-1 - MONITORING WELL WITH STATIC WATER ELEVATION (FT ABOVE MSL).
 (13.77)

(NWL) - NO WATER LEVEL MEASUREMENT OBTAINED.

— 10 — - GROUNDWATER EQUAL POTENTIAL CONTOUR.

SOURCE: LANTDIV, OCT. 1991

FIGURE 3-9
GROUNDWATER CONTOUR MAP DEPICTING FLOW
IN THE UPPER PORTION OF THE
CASTLE HAYNE AQUIFER
(JULY 29, 1996)
SITE 35, CAMP GEIGER FUEL FARM SGI
CONTRACT TASK ORDER - 0232
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



23201956

SOURCE: U.S.G.S. WATER-RESOURCES INVESTIGATIONS REPORT 89-4096

FIGURE 3-10
SUPPLY WELL LOCATION MAP
SITE 35, CAMP GEIGER AREA FUEL FARM, SGI
CONTRACT TASK ORDER - 0232

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

SECTION 3.0 REFERENCES

SECTION 3.0 REFERENCES

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4.0 NATURE AND EXTENT OF CONTAMINATION

This section presents a discussion of the nature and extent of contamination at Site 35 based on the results of the SGI. The results are presented by media type (i.e., groundwater, soil, and sediment) and study area (i.e. NAOC, SAOC, and RI Study Area). The limits of each study area are depicted on Figure 1-2. Non-site related constituents are identified and segregated from site-related contamination, to provide an accurate evaluation of site-related contamination.

4.1 Data Quality/Management Tracking

Usability of the data generated during the SGI was determined by a third party data validator, Heartland Environmental Services, Inc. (Heartland) of St. Charles, Missouri. However, results of engineering parameters, TCLP, RCRA Hazardous Waste Characteristics, and soil and groundwater screening by the on-site laboratory were not submitted for validation. Procedures stipulated by the National Functional Guidelines for Organic Analysis (USEPA, 1991) and the National Functional Guidelines for Inorganic Analysis (USEPA, 1988) were utilized during the validation process. Validation of the analytical data serves to reduce the inherent uncertainties associated with its usability. Data qualified as "J" were retained as estimated. Estimated analytical results within a data set are common and considered to be usable by the USEPA (USEPA, 1989). Data may be qualified as estimated for several reasons including: an exceedance of holding times; high or low surrogate recovery; or intra-sample variability. In addition, values may be assigned an estimated "J" qualifier if the reported value is below the Contract Required Detection Limit (CRDL) or the Contract Required Quantitation Limit (CRQL).

Additional qualifiers were employed during the validation of data. The "NJ" qualifier denotes that a compound was tentatively identified, but the reported value may not be accurate or precise. Compounds that were not detected and had inaccurate or imprecise quantitation limits were assigned the "UJ" qualifier. No SGI data were rejected.

The management and tracking of data, from time of field collection to receipt of validation report, is of primary importance to the overall quality of laboratory analytical results. Field samples and their corresponding analyses were recorded on chain-of-custody forms, provided in Appendix G. Chain-of-custody forms were compared with the amended RI/FS Work Plan (Baker, 1993) and FSAP (Baker, 1993) to verify that the appropriate laboratory analyses had been requested. Amendments to these documents are presented in Appendix K. Upon receipt of laboratory analytical results, a further comparison was performed to verify that each sample received by the laboratory was analyzed for the correct parameters. Finally, the validation report was compared to the requested laboratory analyses.

The management and tracking of data was used to determine the following items:

- Identify and correct chain-of-custody discrepancies prior to laboratory analysis
- Verify the receipt of all samples by the laboratory
- Confirm that requested sample analyses and validation were performed
- Ensure the delivery of a complete data set

4.2 Non-Site Related Analytical Results

A limited number of organic compounds and inorganic constituents detected in environmental media at Site 35 may be attributable to non-site related conditions or activities. Two primary non-site

related sources include laboratory contaminants and naturally-occurring inorganic compounds. In addition, non-site related operational activities and conditions may contribute to "on-site" contamination. A discussion of non-site related analytical results for Site 35 is provided in the subsections which follow.

4.2.1 Laboratory Contaminants

Field blank and trip blank samples provide a measure of contamination that has been introduced into a sample set during the collection, transportation, preparation, or analysis of samples. To remove non-site related constituents from further consideration, the concentrations of chemicals detected in blanks were compared to concentrations of the same chemicals detected in environmental samples. All QA/QC results are included in Appendix H.

Typically, common laboratory contaminants (i.e., acetone, 2-butanone, chloroform, methylene chloride, toluene, and phthalate esters) are retained for use in interpreting site conditions only when observed concentrations in any environmental sample exceed ten times the maximum concentration detected in any blank. If the concentration of a common laboratory contaminant is less than ten times the maximum blank concentration, its presence among the data is attributed to laboratory contamination in that particular sample (USEPA, 1989) and excluded from further evaluation. For example, a single groundwater sample (35-TW27B) submitted for TCL VOCs exhibited acetone, at a level of 66 µg/L. Because no acetone was detected in any field or trip blanks the result cannot be excluded outright from further evaluation. Considering there is no history of acetone use at Site 35, and that acetone is a common laboratory contaminant, this detection is considered suspect.

Typically, blanks containing organic constituents that are not considered common laboratory contaminants (i.e., all other TCL compounds) are retained in the site analytical database only when observed concentrations exceed five times the maximum concentration detected in any QA/QC blank (USEPA, 1989). For example, a single detection of TCE was exhibited in trip blank sample 35-TB07-04 at a level of 3 µg/L. TCE detected in samples (35-MW42B-04 and 35-MW43B) that were shipped with trip blank 35-TB07-04, was present in concentrations greater than five times the level detected in the trip blank (15 µg/L). As such, no detections of TCE in samples 35-MW42B-04 and 35-MW43B-04 can be excluded.

However, the third-party validator, (Heartland) reexamined the data package and recommended that the trip blank result be considered an artifact. This recommendation is based on the fact that the trip blank was analyzed after a blank spike which contained TCE.

4.2.2 Naturally-Occurring Inorganic Constituents

To differentiate between inorganic contamination due to site operations and naturally-occurring inorganic constituents in site media, the results of the sample analyses were compared to known information regarding background conditions at Camp Lejeune. The following data sets were used for each media:

- Groundwater: Camp Lejeune Background Groundwater Samples
- Sediment: Camp Lejeune Background Sediment Samples

The following subsections address the various comparison criteria used to evaluate groundwater and sediment analytical results from samples collected at Site 35.

4.2.2.1 Sediment

Base-specific inorganic background concentrations have been compiled from a number of locations throughout Camp Lejeune to supplement the evaluation of detected inorganic constituents in sediment. Inorganic constituents detected in Brinson Creek sediments are compared to base-specific background concentrations in subsequent sections. Typical inorganic background concentration values for sediments at Camp Lejeune are presented in Appendix H. Base-specific background values are based on analytical results of samples collected upgradient of areas or IRP sites known or suspected to have been impacted by operations or disposal activities. Inorganic constituents detected below these levels are assumed to be naturally-occurring.

4.2.2.2 Groundwater

Chemical-specific Applicable, Relevant, and Appropriate Requirements (ARARs) are available for evaluation of inorganics in groundwater. A subsequent section, addresses the analytical results from Round 3 of the SGI. Only those inorganic parameters with concentrations exceeding applicable state or federal regulations are discussed. Inorganic analyses were not performed on samples collected during Round 4.

During Round 3 sampling activities, groundwater samples were analyzed for total TAL metals (unfiltered). Aluminum, iron, and manganese were the constituents which were most frequently detected above regulatory limits. However, aluminum, iron and manganese are considered naturally-occurring inorganic constituents in groundwater and not attributable to previous site operations for the following reasons:

- There is no historical record of any use or disposal of aluminum, iron or manganese at Site 35.
- Elevated concentrations of these three metals in unfiltered groundwater samples collected throughout Camp Lejeune are not considered atypical based on experience gained during other IR studies.
- Groundwater in the Camp Lejeune area is naturally rich in iron and manganese. Iron and manganese concentrations, for both total and filtered samples, obtained during investigations conducted at Camp Lejeune often exceed the North Carolina Water Quality Standards (NCWQS) of 300 and 50 µg/L, respectively. Elevated levels of iron and manganese, at concentrations above the NCWQS, were reported in samples collected from a number of base potable water supply wells which are installed in the deep Castle Hayne Aquifer (Greenhorne and O'Mara, 1992).
- Existing evidence suggests that in areas of TEX. plumes, where biodegradation is occurring, dissolved iron concentrations in groundwater increase (Becker, 1995). It is believed that ferric compounds present in soil can act as an electron receptor and are reduced (Borden, et al., 1995).

4.2.3 Other Non-Site Related Contamination

Groundwater and sediment sample results indicates that non-site related contamination had been introduced to the site. The following sections discuss this finding by media and explore the impact to Site 35.

4.2.3.1 Sediment

Samples collected from two of the three upstream sediment sampling stations in Brinson Creek exhibited detections of gasoline (0.164 to 0.759 µg/L) and diesel (54.9 to 104 µg/L) contamination. The source of this contamination is believed to be from U.S. Highway 17 and adjacent commercial property. Bar ditches located on the east and west side of U.S. Highway 17 collect storm runoff from the highway and adjacent commercial property and discharge it to Brinson Creek.

4.2.3.1 Groundwater

Groundwater samples were collected from six monitoring wells located in the NAOC on Onslow County property (northeast side of Brinson Creek) during Round 4 and analyzed via an on-site mobile laboratory for selected volatile organic compounds. These samples exhibited concentrations of chloroform ranging from 0.2 to 1.9 µg/L. Another round of samples were collected from these wells and sent to a fixed-based laboratory. Since chloroform was not detected in any of these samples or associated blanks, chloroform is not believed to be attributable with Site 35 activities.

4.3 Analytical Results and Extent of Contamination

The following sections discuss analytical results and extent of contamination as determined by the groundwater screening investigation, groundwater investigation, subsurface soil investigation and sediment investigation. To fully assess the nature and extent of groundwater contamination, results from temporary well sampling performed during the groundwater screening investigation and results from new and existing permanent well sampling conducted during the SGI groundwater investigation were evaluated together.

4.3.1 Groundwater Screening and Groundwater Investigation

This section presents the analytical results and a discussion pertaining to the extent of groundwater contamination from the SGI groundwater screening investigation, and sampling Rounds 3 and 4 of the SGI groundwater investigation. The results of these investigations are presented by area of concern to better address the project objectives for each area of concern. A summary of positive detections from Round 3 of the groundwater investigation are included in Table 4-1. These results are depicted on Figures 4-1 and 4-2. A summary of positive detections from the groundwater screening investigation are included in Tables 2-4, 2-5 and 2-6. These results are depicted on Figures 2-2, 2-3, 2-4 and 2-6. A summary of positive detections from Round 4 of the groundwater investigation are included in Table 4-2. These results are depicted on Figures 4-3 and 4-4.

4.3.1.1 Northern Area Of Concern - Onslow County Property (northeast side of Brinson Creek)

In this area of concern a total of seven groundwater samples were collected and analyzed to determine if fuel and solvent-related compounds had migrated off-site onto Onslow County property. The limits of this study area are depicted in Figure 1-2. Groundwater analytical results

obtained from this area are presented on Figures 2-2, 2-4, 4-1 and 4-2. Three of the seven samples were collected from wells screened in the upper portion of the surficial aquifer; two from temporary wells (35-TW30A and 35-TW31A) and one from a permanent well (35-MW60A). Three of the seven samples were collected from wells screened in the lower portion of the surficial aquifer; two from temporary wells (35-TW30B and 35-TW31B) and one from a permanent well (35-MW60B). A single sample was collected from a well screened in the Castle Hayne Aquifer (35-GW07). Samples collected from the surficial aquifer were analyzed in the field by an on-site mobile lab for a limited number of fuel and solvent-related volatile organic compounds. Because low levels of chloroform were detected by the on-site laboratory, all the wells screened in the surficial aquifer were resampled and analyzed at a fixed-based laboratory for TCL VOCs. VOCs were not detected in any of the samples analyzed at the fixed-base laboratory.

4.3.1.2 Northern Area Of Concern - Activity Property (southwest side of Brinson Creek)

Samples were collected from 32 temporary wells and eight permanent wells for the purpose of establishing the horizontal and vertical limits of fuel and solvent-related contamination in an area adjacent to the southwest edge of Brinson Creek, roughly between Third Street and permanent monitoring well cluster 35MW-36. Groundwater analytical results from this area are presented in Figures 2-2, 2-3, and 2-4. Ten temporary wells (35-TW26A through 35-TW22A and 35-TW20A through 35-TW16A) and four permanent wells (MW-16S through MW-19S) were screened in the upper portion of the surficial aquifer. Ten temporary wells (35-TW26C through 35-TW22C and 35-TW20C through 35-TW16C) were screened in the mid portion of the surficial aquifer. No permanent wells were screened in the middle portion of the surficial aquifer. Twelve of the temporary wells (35-TW26B through 35-TW22B, 35-TW20B through 35-TW16B, 35-TW27B, and 35-TW28B) and four permanent wells (MW-16D through MW-19D) were screened in the lower portion of the surficial aquifer. Thirty eight of the forty samples collected from these wells were analyzed for TCE, cis-1,2-DCE, trans-1,2-DCE, TEX, and methyl-tertiary-butyl-ether (MTBE) by the on-site mobile laboratory. Two of the forty samples were analyzed by a fixed-base laboratory for TCL VOCs. As expected, the solvent-related contamination was predominant in the lower portion of the surficial aquifer, and fuel-related contamination was predominant in the upper portion of the surficial aquifer.

The extent of the solvent-related contamination plume is approximately 780-feet wide and defined by temporary well cluster 35-TW25 to the north and permanent well cluster 35MW-36 to the south. The plume appears to be centered in the vicinity of temporary well cluster 35-TW17. In the upper portion of the surficial aquifer the maximum total solvent-related contaminant is 60.6 µg/L (35-TW18A). However, concentrations increase dramatically with depth. At the confining unit the maximum total solvent-related contaminant concentration is 3,893.2 µg/L (35-TW17B).

The fuel-related contamination plume overlaps the solvent-related plume. In the upper portion of the surficial aquifer the fuel-related plume is approximately 450-feet wide and is defined by temporary well clusters 35-TW26 to the north and 35-TW17 to the south. Near the confining unit the width of the plume narrows to approximately 265 wide feet and is delineated by monitoring well cluster 35-MW18 and temporary well cluster 35-TW19. The plume appears to be centered in the vicinity of temporary well cluster 35-TW23. In the upper portion of the surficial aquifer the maximum total fuel-related contaminant concentration is 14,218 µg/L (35-TW23A). However, concentrations dramatically decrease with depth to the confining unit where the maximum total fuel-related contaminant concentration is 38 µg/L (35-TW22B).

4.3.1.3 RI Study Area

The objectives of the groundwater investigation within the limits of the RI Study Area (Figure 1-1) were to: 1) more accurately assess metals contamination in the surficial aquifer; and, 2) confirm the presence or absence of solvent-related contamination in the surficial aquifer. To assess metals contamination, groundwater samples were collected from 20 existing permanent monitoring wells during Round 3 SGI sampling activities which occurred in July and August, 1995. Eleven of these wells (EMW-3, EMW-7, EMW-5, MW-9S, MW-10S, MW-14S, MW-16S, MW-19S, MW-22S, 35MW-29A and 35MW-33A) were screened in the upper portion of the surficial aquifer and eight wells (MW-9D, MW-10D, MW-14D, MW-16D, MW-19D, MW-22D, 35MW-29B, and 35MW-33B) were screened in the lower portion of the surficial aquifer. In addition, one well, 35GWD-5, was screened in the upper portion of the Castle Hayne Aquifer. All of the groundwater samples were analyzed for total TAL metals.

To confirm the presence or absence of solvent-related contamination in the surficial aquifer groundwater samples were collected from 12 existing permanent monitoring wells during Round 4 SGI sampling activities, which occurred during April and May, 1996. Five of the wells (EMW-3, MW-19S, 35MW-32A, 35MW-35A, 35MW-36A) were screened in the upper portion of the surficial aquifer and seven wells (MW-9D, MW-10D, MW-14D, MW-19D, 35MW-30B, 35MW-36B, and 35MW-37B) were screened in the lower portion of the surficial aquifer. No samples were collected from wells screened in the upper portion of the Castle Hayne Aquifer during Round 4. Samples were analyzed for TCL VOCs by the fixed-base laboratory.

Upper Portion of the Surficial Aquifer

The results of the SGI groundwater investigation within the upper portion of the surficial aquifer within the RI Study Area are discussed in the following sections. For clarity, fuel and solvent-related contaminants are discussed separately from inorganic contaminants.

Fuel and Solvent-Related Contamination

Contamination in the upper portion of the surficial aquifer within the confines of the RI Study Area (Figure 1-2) was limited, but included both fuel and solvent-related contaminants. Contaminant concentrations are depicted in Figure 4-1. Of the five samples collected, three (35-EMW03-04, 35-MW19S-04 and 35-MW35A-04) exhibited fuel and solvent-related contamination including: 1,2-DCE (total); TCE; and, 1,1,2,2-tetrachloroethane. Only TCE was detected at concentrations in excess of NCWQS and MCL levels (5.0 and 2.8 µg/L, respectively) in two (35-MW19S-04 and 35-MW35A-04) of the five samples.

Benzene was the only fuel-related contaminant detected. Only one sample (35-EMW03-04) exhibited benzene at a level of 3 µg/L which exceeds the NCWQS of 1 µg/L but is below the MCL of 5 µg/L.

Analytical results of the SGI Round 4 groundwater sampling effort conducted in the RI Study Area generally indicate that detected concentrations of solvent-related contaminants are lower than solvent-related contamination encountered during the RI. The magnitude of this decrease can be demonstrated by the following example. During the RI, samples collected from monitoring wells EMW-3, MW-19S, 35-MW32A, 35-MW35A, and 35-MW36A exhibited total concentrations of solvent-related contaminants of 120.3 µg/L, 58.8 µg/L, 184.3 µg/L, 185.9 µg/L, and 4.6 µg/L,

respectively. Results from the same wells during the SGI had the following levels of total solvent-related contamination; 3 µg/L, 28 µg/L, non-detect, 47 µg/L, and non detect, respectively.

Levels of fuel-related contaminants encountered in the SGI appear to be similar to those concentrations of the RI with the exception of MW-19S. Total fuel-related contamination detected in a sample collected during the RI from MW-19S was 91 µg/L, but no fuel-related contamination was detected in a sample collected during the SGI. However, wells that exhibited the highest level of fuel-related contamination in the RI were not sample during the SGI.

Inorganic Contamination

During the SGI Round 3 sampling efforts, groundwater samples were collected from 11 permanent monitoring wells screened in the upper portion of the surficial aquifer within the RI Study Area and analyzed for TAL metals. All positive detections of these metals are presented in Figure 4-3. In general, metals were detected in all 11 samples (35-EMW03-02, 35-EMW07-02, 35-EMW05-02, 35-MW09S-02, 35-MW10S-02, 35-MW14S-02, 35-MW16S-02, 35-MW19S-02, 35-MW22S-02, 35-MW33A-02 and 35-MW29A-02) screened in the upper portion of the surficial aquifer. However, six of the 23 TAL metals (beryllium, cadmium, chromium, copper, mercury, and nickel) were not detected in any samples submitted for analysis. Six TAL metals (antimony, lead, selenium silver, thallium, and vanadium) were present in three or fewer of the 11 samples. Eleven TAL metals (aluminum, arsenic, barium, calcium, cobalt, iron, magnesium, manganese, potassium, sodium, and zinc) were found in six or more of the samples submitted for analysis.

Four TAL metals (iron, manganese, aluminum, and antimony) were present in concentrations which exceed the NCWQS and/or MCLs. Iron concentrations exceeded the NCWQS and Secondary MCL of 300 µg/L in six (35-EMW03-02, 35-EMW05-02, 35-MW14S-02, 35-MW16S-02, 35-MW22S-02, and 35-MW29-02) of the 11 samples submitted and ranged from (3,350 to 40,400 µg/L). Manganese concentrations exceeded the NCWQS and Secondary MCL of 50 µg/L in four (35-EMW05-02, 35-MW16S-02, 35-MW19S-02, and 35-MW22S-02) of the 11 samples submitted and ranged from (51.7 to 141 µg/L). Aluminum exceeded MCLs in eight (35-EMW03-02, 35-EMW05-02, 35-MW09S-02, 35-MW10S-02, 35-MW19S-02, 35-MW22S-02, 35-MW29A-02 and 35-MW33A-02) of the 11 samples submitted. Concentrations of aluminum that exceeded MCLs ranged from 93.2 to 520 µg/L. Antimony was present at 20 µg/L in 34-MW22S-02 which exceeded the MCL of 6 µg/L.

In general, no clear limits of metals contamination emerge which would point to a specific contaminant source. However, a pattern emerges with the iron detections. Five (35-EMW05, 35-EMW03, 35-MW14S, 35-MW16S and 35-MW22S) of the six samples with iron levels that exceed NCWQS and MCLs are located adjacent to areas where petroleum-contaminated soil remediation occurred. These samples were collected as soil remediation was occurring. The presence of iron in the soil was identified in the RI and red streaking in the soil was generally observed during drilling operations in the NAOC. An available study indicates iron concentrations in groundwater have been shown to increase at the leading edge of a TEX. plume where biodegradation is occurring (Becker, 1995). It is possible that similar chemical activity is occurring near the former Fuel Farm and contributing to the elevated iron levels.

In addition, groundwater in the Camp Lejeune area is naturally rich in iron and manganese. Iron and manganese concentrations, both for total and filtered samples, in groundwater at Camp Lejeune often exceed the North Carolina Water Quality Standards (NCWQS) of 300 and 50 µg/L,

respectively. Elevated levels of iron and manganese, at concentrations above the NCWQS, were reported in samples collected from a number of base potable water supply wells which are installed at depths greater than 162 feet below ground surface (Greenhorne and O'Mara, 1992).

A draft Report entitled "Evaluation of Metals in Groundwater at MCB, Lejeune, North Carolina (Appendix I) addresses the pervasiveness of metals in groundwater at Camp Lejeune and identifies a number of potential causes. Preliminary conclusions of the study support the opinion that concentrations of metals in groundwater are due to geologic conditions rather than site-related contamination.

Lower Portion of the Surficial Aquifer and Upper Portion of the Castle Hayne Aquifer

The results of the SGI groundwater investigation within the lower portion of the surficial aquifer and upper portion of the Castle Hayne of the RI Study area are presented herein. For clarity, fuel and solvent-related contaminants are discussed separately from inorganic contaminants.

Fuel and Solvent-related Contamination

During Round 3 sampling effort, seven groundwater samples (35-MW37B-04, 35-MW10D-04, 35-30B-04, 35-MW09B-04, 35MW14D-04, 35-MW19D-04, and 35-MW36B-04) were collected from seven wells screened in the lower portion of the surficial aquifer and located within the limits of the RI Study Area. These results were analyzed for TCL VOCs and the results are presented on Figure 4-2. In the lower portion of the surficial aquifer, contamination consisted of primarily solvent-related compounds, 1,2-DCE (total) and TCE. Solvent-related contamination was detected in five of the seven samples (35-MW37B-04, 35-MW30B-04, 35-MW10D-04, 35-MW14D-04, 35-MW19D-04) collected.

TCE, 1,2-DCE and vinyl chloride were detected at levels in excess of the NCWQS and MCLs. TCE exceeded the NCWQS and MCL of 2.8 and 5.0 µg/L, respectively, in four (35-MW30B-04, 35-MW10D-04, 35-MW14D-04, and 35-MW19D-04) of the seven samples submitted. Concentrations that exceeded regulatory limits ranged from 71 to 740 µg/L. 1,2-DCE exceeded the NCWQS and MCL of 70 µg/L in four (35-MW10D-04, 35-MW14D-04, 35-MW19D-04, and 35-MW30B-04,) of the seven samples submitted. The concentrations that exceeded regulatory limits ranged from 160 to 1,200 µg/L. Vinyl chloride exceeded the NCWQS and MCL of 0.015 and 2 µg/L, respectively, in one (35-MW10D-02) of seven samples submitted. The concentration of vinyl chloride in this sample was 13 µg/L.

A comparison of SGI results to results previously obtained under the RI generally indicate the limits of the solvent-related groundwater contamination plume are similar to the limits defined under the RI. The limits of the plume based on SGI data are depicted on Figure 4-2. Figure 6 from the Interim ROD (Baker, 1995), which is provided in Appendix N, presents the limits of the plume based on the RI data. Contaminant levels have generally remained at levels comparable to those detected in the RI.

A limited number of samples exhibited low levels of fuel-related contamination. Fuel-related contaminants were detected in four (35-MW30B-04, 35-MW10D-04, 35-MW37B-04, and 35-MW14D-04) of the seven samples submitted for analysis. Benzene exceeded the NCWQS of 1.0 µg/L, in two of the seven samples (35-MW30B-04 and 35-MW14D-04) obtained from the RI Study Area. However, the levels of benzene in both samples were below the MCL of 5 µg/L.

Inorganics

During the SGI Round 3 sampling efforts conducted during July and August, 1995, a total of eight samples (35-MW10D-02, 35-MW29B-02, 35-MW09D-02, 35-MW14D-02, 35-MW16D-02, 35-MW19D-02, 35-MW33D-02, and 35-MW22D-02) were collected from intermediate permanent monitoring wells screened in the lower portion of the surficial aquifer and located within the limits of the previous RI Study Area. One sample was collected from a deep permanent monitoring well (35GWD-5) which was screened in the upper portion of the Castle Hayne aquifer within the limits of the previous RI Study Area. These samples were analyzed for TAL metals. All positive metal detections are presented on Figure 4-4. In general, metals were detected in all eight of the intermediate monitoring wells and the deep well. However, ten of the 23 TAL metals (antimony, arsenic, beryllium, cadmium, chromium, copper, mercury, nickel, silver, and vanadium) were not detected in any samples submitted for analysis. Two of these metals (cobalt and thallium) were detected in two of the eight samples submitted. Eleven TAL metals (aluminum, barium, calcium, iron, lead, magnesium, manganese, potassium, sodium, and zinc) were detected in three or more of the samples submitted for analysis.

A total of three TAL metals (iron, manganese, and lead) were detected at levels in excess of NCWQS and/or MCLs in intermediate wells. Iron exceeded the NCWQS and Secondary MCL of 300 µg/L in seven (35-MW10D-02, 35-MW09D-02, 35-MW14D-02, 35-MW16D-02, 35-MW22-02, 35-MW29B-02, and 35-MW33D-02) of the eight samples submitted. Iron was the only metal to exceed the NCWQS or MCL in the sample obtained from the Castle Hayne. Concentrations that exceeded regulatory limits ranged from (648 to 2,580 µg/L). Manganese exceeded the NCWQS and Secondary MCLs of 50 µg/L in one (35-MW16D-02) of the eight samples submitted. The concentration of manganese in this sample was 275 µg/L. Lead exceeded the NCWQS and the Federal Action Level of 15 µg/L in one (35-MW14D-02) of the eight samples submitted. The concentration of lead in this sample was 15.4 µg/L.

No pattern of metals contamination emerges that would suggest that this contamination is associated with previous site operations. In addition, the previous discussion dealing with the pervasiveness of metals at Camp Lejeune is applicable.

4.3.1.4 Southern Area Of Concern - Activity Property (between Fifth and Ninth Streets)

The objective of field activities with respect to groundwater in the SAOC was to assess the extent of solvent-related contamination south of Fifth Street. During SGI groundwater screening activities and the Round 3 sampling effort, groundwater samples were collected from 27 temporary monitoring wells and six permanent monitoring wells. These samples were analyzed for TCL VOCs. Sixteen (35-TW01B through 35-TW15B and 35-TW29B) of the temporary wells and the five (35-MW39B, 35-MW40B, 35-MW41B, 35-MW42B, and 35-MW43B) permanent monitoring wells were screened in the lower portion of the surficial aquifer. Eleven temporary wells (35-TB01A through 35-TB11A) were screened in the upper portion of the surficial aquifer. One permanent monitoring well (35GWD-6) was screened in the upper portion of the Castle Hayne aquifer. The results of the groundwater screening investigation are shown on Figure 2-6. The results of samples collected from permanent wells in this area as part of the groundwater investigation are shown in Figure 4-2.

Upper Portion of the Surficial Aquifer

The object of the investigation in the SAOC was to determine the extent of solvent-related contamination south of Fifth Street and confirm the absence of fuel-related contamination in the upper portion of the surficial aquifer. To achieve this, groundwater samples were collected from 11 (35-TW01A through 35-TW11A) temporary monitoring wells located between Fifth and Sixth Streets. These samples were analyzed for TCE, cis-1,2-DCE, and trans-1,2-DCE by an on-site mobile laboratory.

All of these monitoring wells were screened in the upper portion of the surficial aquifer.

No fuel or solvent-related contamination was exhibited in any of the eleven samples obtained. From these results, it is concluded that the probability of encountering contamination in the upper portion of the surficial aquifer south of Sixth Street that was related to Site 35 is remote. Therefore, a decision was made to only install intermediate wells between Sixth and Ninth Streets.

Lower Portion of the Surficial Aquifer

During the SGI groundwater screening investigation and Round 4 sampling effort in the SAOC, groundwater samples were collected from 16 temporary and five permanent monitoring wells screened in the lower portion of the surficial aquifer in the SAOC. Samples collected from 11 temporary wells (35-TW01B through 35-TW11B) were analyzed for 1,2-cis-DCE, 1,2-trans-DCE, and TCE by an on-site mobile lab, while the remaining ten (35-TW12B through 35-TW15B, 35-TW29B, and 35-MW39B through 35-MW43B) samples collected were analyzed for TCL VOCs by a fixed-base laboratory. The results of the TCL VOCs are reported as total 1,2-DCE rather than cis-1,2-DCE and trans-1,2-DCE.

In the lower portion of the surficial aquifer contamination consisted primarily of solvent-related compounds, such as 1,2-DCE, and TCE. Two other solvent-related compounds, tetrachloroethane and 1,1,2,2-tetrachloroethane, were detected in a single sample. Of the 21 samples submitted, solvent-related contamination was detected in 18 samples. The results from temporary wells are depicted in Figure 2-6 and the results from permanent wells are depicted in Figure 4-2. One sample exhibited low levels of benzene.

TCE, 1,2-cis-DCE, 1,2-trans-DCE, total 1,2-DCE, and tetrachloroethane were detected at levels in excess of the NCWQS and MCLs. TCE exceeded the NCWQS and MCL of 5.0 and 2.58 µg/L, respectively, in nine (35-TW02B, 35-TW03B, 35-TW04B, 35-TW09B, 35-TW12B, 35-TW29B, 35-TW15B, 35-MW40B-04, and 35-MW42B-04) of the 21 samples submitted. Concentrations in wells that exceeded regulatory limits ranged from 4 to 220 µg/L. The contaminant 1,2-DCE (all reported forms) exceeded the NCWQS and MCL of 70 µg/L in only three (35-MW40B-04, 35-TW02B, and 35-TW03B) of the 21 samples submitted. The concentration in the wells that exceeded regulatory limits ranged from 125 to 211 µg/L. Tetrachloroethane was detected in one of the samples (35-TW29B) at a concentration of 2 µg/L, which exceeds the NCWQS 0.7 µg/L, but not the MCL of 5 µg/L.

Based on the results of the SGI, the extent of the solvent-related plume in the SAOC has been defined. The plume extends southward along "C" Street from Building G534 to the intersection of "C" and Sixth Street. The edge of the plume extends from this intersection across Camp Geiger to

Building TC773 . At this point, the edge of the plume swings northward along the eastern tree line of Camp Geiger to Fifth Street.

Castle Hayne Aquifer

During Round 4 of the SGI, a sample was collected from deep well SSGWD-6 to determine if fuel and solvent-related contamination had migrated into the upper portion of the Castle Hayne aquifer. This sample was analyzed for TCL VOCs. No contaminants were detected in this sample. The semi-confining layer between the shallow and Castle Hayne aquifers appears to prevent VOC migration.

4.3.2 Soil Screening Investigation

This section discusses the results of the soil screening investigation that was conducted during April and May 1996. Soil screening activities were conducted in three areas of concern including, the NAOC on Onslow County property (northeast side of Brinson Creek), the NAOC on Activity property (southwest side of Brinson Creek), and the SAOC between Fifth and Ninth Streets. The objective of the soil screening investigation at three locations was to identify potential sources of fuel- and solvent-related groundwater contamination, and to characterize subsurface soil lithology. A total of 24 soil borings (35-TW01B through 35-TW11B, 35-TW16 through 35-TW20B, 35-TW22 through 35-TW26B, 35-TW30B, 35-TW31B and 35-MW60B) were advanced during the SGI for this expressed purpose. Environmental soil samples collected from these 24 borings were analyzed by an on-site mobile laboratory for TCE, cis-1,2-DCE, and trans-1,2-DCE, and TEX.. No contamination was detected in any of these samples. The source for fuel and solvent-related groundwater contamination was not encountered.

4.3.2 Sediment Investigation

To assess the gross extent of fuel-related contamination (and replace metals data rejected during RI validation), sediment samples were collected from 10 sampling stations located along Brinson Creek. These stations extended a distance of approximately 7,200 feet from sampling station 35-SD01, located from just north of U.S. Highway 17, to sampling station 36-SD05, located at the confluence of Brinson Creek, Edwards Creek and the New River (see Figure 2-10). These stations include: three upstream stations (35-SD01 through 35-SD03); three stations located approximately adjacent to Site 35 (35-SD04, 35-SD07, and 35-SD05); and four downstream locations (35-SD06, 36-SD07, 36-SD06, and 36-SD05). At each sediment sampling station samples were collected at two intervals, 0 to 6 inches and 6 inches to 12 inches. Sediment samples were analyzed for TPH (EPA methods 5030 and 3550), mercury and zinc.

4.3.2.1 Fuel- Related Contamination

Fuel-related contamination was detected at nine out of the 10 sediment sampling stations. Only samples collected at station 35-SD01, located upstream of U.S. Highway 17, exhibited no detections of either gasoline or diesel contamination. As depicted in Figure 4-5 fuel-related contamination is relatively low in the upstream stations (35-SD02 and 35-SD03). At these locations gasoline fractions are less than 1 mg/kg and diesel fractions range between 54.9 and 104 mg/kg. It should be noted that bar ditches on the east and west side of U.S. Highway 17 that collect storm runoff from the highway and adjacent commercial property discharge to Brinson Creek near sampling station 35-SD02.

Fuel-related contamination that was generally greater than levels observed at upstream locations was detected in six sediment sampling stations (35-SD04, 35-SD07, 35-SD05, 35-SD06, 36-SD07, and 36-SD06). These stations ranged between 3,520 to 5,960 feet downstream of sampling station 35-SD01. At these six stations the heavier diesel contamination was detected at higher levels than the lighter gasoline fraction. Gasoline levels ranged from .0999 to 29.7 mg/kg, and diesel levels ranged from 92.2 to 7,420 mg/kg.

At the southernmost sampling station (36-SD05), levels of gasoline and diesel contamination appear to drop to levels comparable to those observed at the upstream sampling stations.

Figures 4-6 and 4-7 graphically depict levels of gasoline and diesel contamination at the sediment sampling stations along Brinson Creek. Exact levels of fuel-related contamination detected in each sample are summarized in Table 4-3.

4.3.2.2 Inorganic Contamination

As shown in Figure 4-9, zinc was detected at all 10 sampling stations and in 19 of the 20 samples collected. Mercury was detected at two of the 10 sampling stations and in 3 of the 20 samples collected. All zinc detections were below National Oceanic and Atmosphere Administration (NOAA) ER-L sediment screening values. Two of the three samples exhibited mercury levels of 0.16 mg/Kg which slightly exceeds the NOAA ER-L screening value of 0.16. The absence of zinc levels above NOAA ER-L screening values, the magnitude of the mercury exceedences, and the location of these exceedences (approximately 2,250 feet downstream from Site 35) indicate that past activities at Site 35 are not believed to have not contributed to metals contamination in Brinson Creek sediments.

SECTION 4.0 TABLES

**TABLE 4-1
 POSITIVE DETECTION SUMMARY
 ROUND 3, GROUNDWATER
 INORGANICS
 SITE 35, CAMP GEIGER AREA FUEL FARM
 SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 0232
 MCB, CAMP LEJEUNE, NORTH CAROLINA
 CONTRACT TASK ORDER 0232**

| LOCATION | 35-EMW03-02 | 35-EMW05-02 | 35-EMW07-02 | 35-GW05-02m | 35-MW09D-02 | 35-MW09S-02 |
|----------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| LAB ID | D95-7537-1 | D95-7597-6 | D95-7537-2 | D95-7537-8 | D95-7597-2 | D95-7597-7 |
| DATE SAMPLED | 08/10/95 | 08/11/95 | 08/10/95 | 08/11/95 | 08/12/95 | 08/12/95 |
| METALS (ug/L) | | | | | | |
| Aluminum | 96.5 | 93.2 J | 20 U | 25.9 | 26.2 J | 198 J |
| Antimony | 20 U |
| Arsenic | 2 U | 8.7 J | 2 U | 2 U | 1.4 U | 3.2 J |
| Barium | 20 U | 21.7 J | 20 U | 20 U | 20.9 J | 57.7 J |
| Calcium | 89900 | 45100 | 105000 | 56900 | 104000 | 98600 |
| Cobalt | 9 J | 3.8 J | 2.8 J | 2 U | 2 U | 2 U |
| Iron | 3350 | 20200 | 106 | 337 | 1650 | 162 |
| Lead | 1 UJ | 12.1 J | 1 UJ | 1 U | 1 UJ | 1 UJ |
| Magnesium | 2240 J | 3610 J | 3480 J | 2280 | 2260 J | 4110 J |
| Manganese | 22.9 | 51.7 | 26.2 | 22.1 | 19.7 | 38.6 |
| Potassium | 734 J | 1160 J | 2150 J | 4400 | 844 J | 3350 J |
| Selenium | 2.5 UJ | 2.5 UJ | 2.5 U | 2.5 U | 2.5 UJ | 3.4 J |
| Silver | 2 U | 2 U | 2 U | 2 U | 2 U | 2 U |
| Sodium | 8120 | 9090 | 7940 | 31900 | 8740 | 29000 |
| Thallium | 0.7 U | 9.9 U | 0.7 U | 1 | 9.9 U | 9.9 U |
| Vanadium | 2 U | 2 U | 2 U | 2 U | 2 U | 5.5 J |
| Zinc | 10.5 J | 5 U | 10.6 J | 6.7 | 10.9 U | 18.5 U |

QUALIFIER DEFINITIONS

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

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

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

NOTES

mg/kg = milligrams per kilogram

**TABLE 4-1
 POSITIVE DETECTION SUMMARY
 ROUND 3, GROUNDWATER
 INORGANICS
 SITE 35, CAMP GEIGER AREA FUEL FARM
 SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 0232
 MCB, CAMP LEJEUNE, NORTH CAROLINA
 CONTRACT TASK ORDER 0232**

| LOCATION | 35-MW10D-02 | 35-MW10S-02 | 35-MW14D-02 | 35-MW14S-02 | 35-MW16D-02 | 35-MW16S-02 |
|----------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| LAB ID | 95-7537-15 | 95-7537-14 | 95-7537-17 | 95-7537-16 | 95-7537-13 | 95-7537-11 |
| DATE SAMPLED | 08/09/95 | 08/09/95 | 08/10/95 | 08/10/95 | 08/09/95 | 08/10/95 |
| METALS (ug/L) | | | | | | |
| Aluminum | 20 U | 303 | 28.6 J | 20 U | 20 U | 20 U |
| Antimony | 20 U |
| Arsenic | 2 U | 3.5 J | 2 U | 4.2 J | 2 U | 10.3 |
| Barium | 20 U | 20 U | 33.7 J | 27.1 J | 20 U | 32.2 J |
| Calcium | 122000 | 75000 | 119000 | 142000 | 96900 | 124000 |
| Cobalt | 2 U | 2 U | 2 U | 2.9 J | 6.1 J | 16 J |
| Iron | 1490 | 152 | 1070 | 4490 | 2580 | 40400 |
| Lead | 1 | 1 U | 15.4 | 1 U | 1 U | 8.9 |
| Magnesium | 2420 | 1800 J | 2450 J | 4520 J | 3440 J | 4580 J |
| Manganese | 19 | 7.5 J | 23.4 | 44.6 | 275 | 141 |
| Potassium | 811 | 860 J | 1270 J | 1460 J | 970 J | 793 J |
| Selenium | 2.5 U | 2.5 U | 2.5 U | 2.5 UJ | 2.5 U | 2.5 UJ |
| Silver | 2 U | 2 U | 2 U | 2 U | 2 U | 10.9 |
| Sodium | 8390 | 9970 | 9560 | 10400 | 8380 | 4350 J |
| Thallium | 0.7 U | 0.7 U | 0.7 U | 0.7 UJ | 0.7 UJ | 0.9 J |
| Vanadium | 2 U | 9.1 J | 2 U | 2 U | 2 U | 2 U |
| Zinc | 13.8 | 6.5 J | 29.5 | 22.5 | 12.9 J | 11.5 J |

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

NOTES

mg/kg = milligrams per kilogram

**TABLE 4-1
 POSITIVE DETECTION SUMMARY
 ROUND 3, GROUNDWATER
 INORGANICS
 SITE 35, CAMP GEIGER AREA FUEL FARM
 SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 0232
 MCB, CAMP LEJEUNE, NORTH CAROLINA
 CONTRACT TASK ORDER 0232**

| LOCATION | 35-MW19D-02 | 35-MW19S-02 | 35-MW22D-02 | 35-MW22S-02 | 35-MW29A-02 | 35-MW29B-02 |
|----------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| LAB ID | D95-7537-5 | D95-7537-6 | D95-7597-8 | D95-7597-9 | D95-7597-4 | D95-7597-5 |
| DATE SAMPLED | 08/11/95 | 08/11/95 | 08/13/95 | 08/13/95 | 08/12/95 | 08/12/95 |
| METALS (ug/L) | | | | | | |
| Aluminum | 47.8 J | 282 | 22.6 J | 123 U | 357 | 20 U |
| Antimony | 20 U | 20 U | 20 U | 20 J | 20 U | 20 U |
| Arsenic | 2 U | 2 U | 1.4 U | 7.1 J | 13.3 | 1.4 U |
| Barium | 20 U | 20 U | 24.7 J | 32.5 U | 81.7 J | 20 U |
| Calcium | 109000 | 35600 | 104000 | 133000 | 7460 | 93500 |
| Cobalt | 2.2 J | 4.4 J | 2 U | 5.6 J | 3.3 J | 2 U |
| Iron | 113 | 266 | 1110 | 15700 | 9360 | 933 |
| Lead | 1 UJ | 1 U | 2.5 J | 1 UJ | 1 UJ | 1.4 J |
| Magnesium | 4990 J | 1880 J | 3020 J | 3230 J | 1550 J | 1890 J |
| Manganese | 36.7 | 102 | 41.2 | 63.5 | 29.2 | 17.1 |
| Potassium | 3360 J | 2650 J | 1120 J | 2320 J | 2170 J | 1110 J |
| Selenium | 2.5 U | 2.5 U | 2.5 UJ | 2.5 UJ | 2.5 UJ | 2.5 UJ |
| Silver | 2 U | 2 U | 2 U | 2 U | 2 U | 2 U |
| Sodium | 10500 | 11300 | 7050 | 5080 | 14600 | 6460 |
| Thallium | 0.7 J | 0.7 U | 9.9 U | 9.9 U | 9.9 U | 9.9 U |
| Vanadium | 2 U | 2 U | 2 U | 2 U | 2 U | 2 U |
| Zinc | 10.4 J | 9.9 J | 5.9 U | 5 U | 17.4 U | 11.6 U |

QUALIFIER DEFINITIONS

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

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

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

NOTES

mg/kg = milligrams per kilogram

**TABLE 4-1
 POSITIVE DETECTION SUMMARY
 ROUND 3, GROUNDWATER
 INORGANICS
 SITE 35, CAMP GEIGER AREA FUEL FARM
 SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 0232
 MCB, CAMP LEJEUNE, NORTH CAROLINA
 CONTRACT TASK ORDER 0232**

| LOCATION | 35-MW33A-02 | 35-MW33D-02 |
|----------------------|-------------|-------------|
| LAB ID | D95-7597-1 | D95-7597-3 |
| DATE SAMPLED | 08/12/95 | 08/12/95 |
| METALS (ug/L) | | |
| Aluminum | 520 | 20 U |
| Antimony | 20 U | 20 U |
| Arsenic | 1.4 U | 1.4 U |
| Barium | 98.4 J | 20 U |
| Calcium | 6380 | 102000 |
| Cobalt | 2 U | 2 U |
| Iron | 58.4 J | 648 |
| Lead | 6 J | 1.5 J |
| Magnesium | 3620 J | 2170 J |
| Manganese | 8.8 J | 20.1 |
| Potassium | 1840 J | 929 J |
| Selenium | 2.6 J | 2.5 UJ |
| Silver | 2 U | 2 U |
| Sodium | 5370 | 7340 |
| Thallium | 9.9 U | 9.9 U |
| Vanadium | 2 U | 2 U |
| Zinc | 7.6 U | 24.3 U |

QUALIFIER DEFINITIONS

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

NOTES

mg/kg = milligrams per kilogram

**TABLE 4-2
 POSITIVE DETECTION SUMMARY
 ROUND 4, GROUNDWATER
 VOLATILE ORGANIC COMPOUNDS
 SITE 35, CAMP GEIGER AREA FUEL FARM
 SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 232
 MCB CAMP LEJEUNE, NORTH CAROLINA
 CONTRACT TASK ORDER 0232**

| SAMPLE ID | 35-EMW03-04 | 35-MW09D-04 | 35-MW10D-04 | 35-MW14D-04 | 35-MW16S-04 | 35-MW16D-04 |
|----------------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| METHOD | VOA1.8 | VOA1.8 | VOA1.8 | VOA1.8 | 8010A/8020A | 8010A/8020A |
| DATE SAMPLED | 04/26/96 | 04/27/96 | 04/27/96 | 04/27/96 | 04/14/96 | 04/13/96 |
| VOLATILES (ug/L) | | | | | | |
| VINYL CHLORIDE | 10 U | 10 U | 13 | 10 U | NA | NA |
| ACETONE | 10 U | 10 U | 10 U | 10 U | NA | NA |
| 1,1-DICHLOROETHENE | 10 U | 10 U | 6 J | 10 U | NA | NA |
| 1,1-DICHLOROETHANE | 10 U | 10 U | 10 U | 10 U | NA | NA |
| trans-1,2-DICHLOROETHENE | NA | NA | NA | NA | 1 U | 1 U |
| cis-1,2-DICHLOROETHENE | NA | NA | NA | NA | 1 U | 15 |
| 1,2-DICHLOROETHENE (TOTAL) | 3 J | 10 U | 1200 | 160 | NA | NA |
| CHLOROFORM | 10 U | 10 U | 10 U | 10 U | NA | NA |
| TRICHLOROETHENE | 10 U | 10 U | 740 | 71 | 0.1 U | 0.3 |
| BENZENE | 3 J | 10 U | 10 U | 3 J | 557 | 8 |
| TETRACHLOROETHENE | 10 U | 10 U | 10 U | 10 U | NA | NA |
| 1,1,2,2-TETRACHLOROETHANE | 10 U | 10 U | 10 U | 10 U | NA | NA |
| TOLUENE | 10 U | 10 U | 2 J | 10 U | 51 | 1 U |
| ETHYLBENZENE | 10 U | 10 U | 10 U | 10 U | 275 | 1 U |
| M&P-XYLENES | NA | NA | NA | NA | 885 | 1 U |
| O-XYLENES | NA | NA | NA | NA | 26 | 1 U |
| XYLENE (TOTAL) | 10 U | 10 U | 10 U | 10 U | NA | NA |
| METHL-TERT-BUTYL-ETHER | 5 U | 5 U | 5 U | 5 U | 16 | 5 U |

**TABLE 4-2
 POSITIVE DETECTION SUMMARY
 ROUND 4, GROUNDWATER
 VOLATILE ORGANIC COMPOUNDS
 SITE 35, CAMP GEIGER AREA FUEL FARM
 SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 232
 MCB CAMP LEJEUNE, NORTH CAROLINA
 CONTRACT TASK ORDER 0232**

| SAMPLE ID | 35-MW17S-04 | 35-MW17D-04 | 35-MW18S-04 | 35-MW18D-04 | 35-MW19S-04 | 35-MW19S-04 |
|----------------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| METHOD | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A | VOA1.8 |
| DATE SAMPLED | 04/13/96 | 04/13/96 | 04/13/96 | 04/13/96 | 04/14/96 | 04/27/96 |
| VOLATILES (ug/L) | | | | | | |
| VINYL CHLORIDE | NA | NA | NA | NA | NA | 10 U |
| ACETONE | NA | NA | NA | NA | NA | 10 U |
| 1,1-DICHLOROETHENE | NA | NA | NA | NA | NA | 10 U |
| 1,1-DICHLOROETHANE | NA | NA | NA | NA | NA | 10 U |
| trans-1,2-DICHLOROETHENE | 1 U | 1 U | 1 U | 1 U | 2 | NA |
| cis-1,2-DICHLOROETHENE | 1 U | 1 U | 4 | 10 | 13 | NA |
| 1,2-DICHLOROETHENE (TOTAL) | NA | NA | NA | NA | NA | 16 |
| CHLOROFORM | NA | NA | NA | NA | NA | 10 U |
| TRICHLOROETHENE | 0.1 U | 0.1 | 0.5 | 0.7 | 12 | 12 |
| BENZENE | 1 U | 1 U | 99 | 1 U | 1 U | 10 U |
| TETRACHLOROETHENE | NA | NA | NA | NA | NA | 10 U |
| 1,1,2,2-TETRACHLOROETHANE | NA | NA | NA | NA | NA | 10 U |
| TOLUENE | 1 | 1 U | 1 U | 1 U | 1 U | 10 U |
| ETHYLBENZENE | 1 U | 1 U | 2 | 1 U | 1 U | 10 U |
| M&P-XYLENES | 1 U | 1 U | 1 U | 1 U | 1 U | NA |
| O-XYLENES | 1 U | 1 U | 1 U | 1 U | 1 U | NA |
| XYLENE (TOTAL) | NA | NA | NA | NA | NA | 10 U |
| METHL-TERT-BUTYL-ETHER | 5 U | 5 U | 63 | 5 U | 5 U | 5 U |

**TABLE 4-2
 POSITIVE DETECTION SUMMARY
 ROUND 4, GROUNDWATER
 VOLATILE ORGANIC COMPOUNDS
 SITE 35, CAMP GEIGER AREA FUEL FARM
 SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 232
 MCB CAMP LEJEUNE, NORTH CAROLINA
 CONTRACT TASK ORDER 0232**

| SAMPLE ID | 35-MW19D-04 | 35-MW19D-04 | 35-MW30A-04 | 35-MW30B-04 | 35-MW32A-04 | 35-MW35A-04 |
|----------------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| METHOD | 8010A/8020A | VOA1.8 | 8010A/8020A | VOA1.8 | VOA1.8 | VOA1.8 |
| DATE SAMPLED | 04/14/96 | 04/27/96 | 04/08/96 | 04/27/96 | 04/27/96 | 04/27/96 |
| VOLATILES (ug/L) | | | | | | |
| VINYL CHLORIDE | NA | 10 U | NA | 10 U | 10 U | 10 U |
| ACETONE | NA | 10 U | NA | 10 U | 10 U | 10 U |
| 1,1-DICHLOROETHENE | NA | 10 U | NA | 10 U | 10 U | 10 U |
| 1,1-DICHLOROETHANE | NA | 10 U | NA | 10 U | 10 U | 10 U |
| trans-1,2-DICHLOROETHENE | 68 | NA | 1 U | NA | NA | NA |
| cis-1,2-DICHLOROETHENE | 266 | NA | 1 U | NA | NA | NA |
| 1,2-DICHLOROETHENE (TOTAL) | NA | 360 | NA | 620 | 10 U | 5 J |
| CHLOROFORM | NA | 10 U | NA | 10 U | 10 U | 10 U |
| TRICHLOROETHENE | 379.2 | 320 | 0.1 U | 270 | 10 U | 25 |
| BENZENE | 1 U | 10 U | 1 U | 2 J | 10 U | 10 U |
| TETRACHLOROETHENE | NA | 10 U | NA | 10 U | 10 U | 10 U |
| 1,1,2,2-TETRACHLOROETHANE | NA | 10 U | NA | 10 U | 10 U | 17 J |
| TOLUENE | 1 U | 10 U | NA | 10 U | 10 U | 10 U |
| ETHYLBENZENE | 1 U | 10 U | 1 U | 10 U | 10 U | 10 U |
| M&P-XYLENES | 1 U | NA | 1 U | NA | NA | NA |
| O-XYLENES | 1 U | NA | 1 U | NA | NA | NA |
| XYLENE (TOTAL) | NA | 10 U | NA | 10 U | 10 U | 10 U |
| METHL-TERT-BUTYL-ETHER | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |

**TABLE 4-2
 POSITIVE DETECTION SUMMARY
 ROUND 4, GROUNDWATER
 VOLATILE ORGANIC COMPOUNDS
 SITE 35, CAMP GEIGER AREA FUEL FARM
 SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 232
 MCB CAMP LEJEUNE, NORTH CAROLINA
 CONTRACT TASK ORDER 0232**

| SAMPLE ID | 35-MW36A-04 | 35-MW36B-04 | 35-MW37B-04 | 35-MW39B-04 | 35-MW40B-04 | 35-MW41B-04 |
|----------------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| METHOD | VOA1.8 | VOA1.8 | VOA1.8 | VOA1.8 | VOA1.8 | VOA1.8 |
| DATE SAMPLED | 04/27/96 | 04/27/96 | 04/28/96 | 05/02/96 | 05/01/96 | 05/01/96 |
| VOLATILES (ug/L) | | | | | | |
| VINYL CHLORIDE | 10 U |
| ACETONE | 10 U |
| 1,1-DICHLOROETHENE | 10 U | 4 J | 10 U | 10 U | 10 U | 10 U |
| 1,1-DICHLOROETHANE | 10 U | 4 J | 10 U | 10 U | 10 U | 10 U |
| trans-1,2-DICHLOROETHENE | NA | NA | NA | NA | NA | NA |
| cis-1,2-DICHLOROETHENE | NA | NA | NA | NA | NA | NA |
| 1,2-DICHLOROETHENE (TOTAL) | 10 U | 10 U | 10 U | 12 | 180 | 10 |
| CHLOROFORM | 10 U |
| TRICHLOROETHENE | 10 U | 10 U | 10 U | 10 U | 16 | 10 U |
| BENZENE | 10 U | 10 U | 10 U | 4 J | 10 U | 10 U |
| TETRACHLOROETHENE | 10 U |
| 1,1,2,2-TETRACHLOROETHANE | 10 U |
| TOLUENE | 10 U | 10 U | 4 J | 10 U | 10 U | 10 U |
| ETHYLBENZENE | 10 U |
| M&P-XYLENES | NA | NA | NA | NA | NA | NA |
| O-XYLENES | NA | NA | NA | NA | NA | NA |
| XYLENE (TOTAL) | 10 U |
| METHL-TERT-BUTYL-ETHER | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |

TABLE 4-2
POSITIVE DETECTION SUMMARY
ROUND 4, GROUNDWATER
VOLATILE ORGANIC COMPOUNDS
SITE 35, CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 232
MCB CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232

| SAMPLE ID | 35-MW42B-04 | 35-MW43B-04 | 35-MW60A-04 | 35-MW60A-04 | 35-MW60B-04 | 35-MW60B-04 |
|----------------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| METHOD | VOA1.8 | VOA1.8 | 8010A/8020A | VOA1.8 | 8010A/8020A | VOA1.8 |
| DATE SAMPLED | 05/03/96 | 05/03/96 | 08/04/96 | 08/04/96 | 08/04/96 | 08/04/96 |
| VOLATILES (ug/L) | | | | | | |
| VINYL CHLORIDE | 10 U | 10 U | 50 U | 10 U | 50 U | 10 U |
| ACETONE | 10 UJ | 10 U | NA | 10 U | NA | 10 U |
| 1,1-DICHLOROETHENE | 10 U | 10 U | NA | 10 U | NA | 10 U |
| 1,1-DICHLOROETHANE | 10 U | 10 U | NA | 10 U | NA | 10 U |
| trans-1,2-DICHLOROETHENE | NA | NA | 1 U | NA | 1 U | NA |
| cis-1,2-DICHLOROETHENE | NA | NA | 1 U | NA | 1 U | NA |
| 1,2-DICHLOROETHENE (TOTAL) | 48 | 30 | NA | 10 U | NA | 10 U |
| CHLOROFORM | 10 U | 10 U | 1.5 | 10 U | 0.2 | 10 U |
| TRICHLOROETHENE | 83 | 12 U | 0.1 U | 10 U | 0.1 U | 10 U |
| BENZENE | 10 U | 10 U | 1 U | 10 U | 1 U | 10 U |
| TETRACHLOROETHENE | 10 U | 10 U | NA | 10 U | NA | 10 U |
| 1,1,2,2-TETRACHLOROETHANE | 10 U | 10 U | NA | 10 U | NA | 10 U |
| TOLUENE | 10 U | 10 U | 1 U | 10 U | 1 U | 10 U |
| ETHYLBENZENE | 10 U | 10 U | 1 U | 10 U | 1 U | 10 U |
| M&P-XYLENES | NA | NA | 1 U | NA | 1 U | NA |
| O-XYLENES | NA | NA | 1 U | NA | 1 U | NA |
| XYLENE (TOTAL) | 10 U | 10 U | NA | 10 U | NA | 10 U |
| METHL-TERT-BUTYL-ETHER | 5 U | 5 U | NA | 5 U | NA | 5 U |

TABLE 4-2
POSITIVE DETECTION SUMMARY
ROUND 4, GROUNDWATER
VOLATILE ORGANIC COMPOUNDS
SITE 35, CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 232
MCB CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232

| SAMPLE ID | 35-TW01A-04 | 35-TW01B-04 | 35-TW02A-04 | 35-TW02B-04 | 35-TW03A-04 | 35-TW03B-04 |
|----------------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| METHOD | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A |
| DATE SAMPLED | 4/09/96 | 4/09/96 | 4/10/96 | 4/10/96 | 4/10/96 | 4/09/96 |
| VOLATILES (ug/L) | | | | | | |
| VINYL CHLORIDE | NA | NA | NA | NA | NA | NA |
| ACETONE | NA | NA | NA | NA | NA | NA |
| 1,1-DICHLOROETHENE | NA | NA | NA | NA | NA | NA |
| 1,1-DICHLOROETHANE | NA | NA | NA | NA | NA | NA |
| trans-1,2-DICHLOROETHENE | 1 U | 2 | 1 U | 18 | 1 U | 5 |
| cis-1,2-DICHLOROETHENE | 1 U | 48 | 1 U | 211 | 1 U | 125 |
| 1,2-DICHLOROETHENE (TOTAL) | NA | NA | NA | NA | NA | NA |
| CHLOROFORM | NA | NA | NA | NA | NA | NA |
| TRICHLOROETHENE | 0.1 U | 1.1 | 0.1 U | 7.6 | 0.1 U | 13.5 |
| BENZENE | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| TETRACHLOROETHENE | NA | NA | NA | NA | NA | NA |
| 1,1,2,2-TETRACHLOROETHANE | NA | NA | NA | NA | NA | NA |
| TOLUENE | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| ETHYLBENZENE | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| M&P-XYLENES | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| O-XYLENES | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| XYLENE (TOTAL) | NA | NA | NA | NA | NA | NA |
| METHL-TERT-BUTYL-ETHER | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |

TABLE 4-2
POSITIVE DETECTION SUMMARY
ROUND 4, GROUNDWATER
VOLATILE ORGANIC COMPOUNDS
SITE 35, CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 232
MCB CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232

| SAMPLE ID | 35-TW04A-04 | 35-TW04B-04 | 35-TW05A-04 | 35-TW05B-04 | 35-TW06A-04 | 35-TW06B-04 |
|----------------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| METHOD | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A |
| DATE SAMPLED | 4/10/96 | 4/10/96 | 4/10/96 | 4/10/96 | 4/11/96 | 4/11/96 |
| VOLATILES (ug/L) | | | | | | |
| VINYL CHLORIDE | NA | NA | NA | NA | NA | NA |
| ACETONE | NA | NA | NA | NA | NA | NA |
| 1,1-DICHLOROETHENE | NA | NA | NA | NA | NA | NA |
| 1,1-DICHLOROETHANE | NA | NA | NA | NA | NA | NA |
| trans-1,2-DICHLOROETHENE | 1 U | 2 | 1 U | 1 U | 1 U | 1 U |
| cis-1,2-DICHLOROETHENE | 1 U | 46 | 1 U | 13 | 1 U | 1 U |
| 1,2-DICHLOROETHENE (TOTAL) | NA | NA | NA | NA | NA | NA |
| CHLOROFORM | NA | NA | NA | NA | NA | NA |
| TRICHLOROETHENE | 0.1 U | 24.6 | 0.1 U | 1.7 | 0.1 U | 0.1 U |
| BENZENE | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| TETRACHLOROETHENE | NA | NA | NA | NA | NA | NA |
| 1,1,2,2-TETRACHLOROETHANE | NA | NA | NA | NA | NA | NA |
| TOLUENE | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| ETHYLBENZENE | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| M&P-XYLENES | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| O-XYLENES | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| XYLENE (TOTAL) | NA | NA | NA | NA | NA | NA |
| METHL-TERT-BUTYL-ETHER | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |

TABLE 4-2
POSITIVE DETECTION SUMMARY
ROUND 4, GROUNDWATER
VOLATILE ORGANIC COMPOUNDS
SITE 35, CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 232
MCB CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232

| SAMPLE ID | 35-TW07A-04 | 35-TW07B-04 | 35-TW08A-04 | 35-TW08B-04 | 35-TW09A-04 | 35-TW09B-04 |
|----------------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| METHOD | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A |
| DATE SAMPLED | 4/11/96 | 4/11/96 | 4/11/96 | 4/11/96 | 4/11/96 | 4/11/96 |
| VOLATILES (ug/L) | | | | | | |
| VINYL CHLORIDE | NA | NA | NA | NA | NA | NA |
| ACETONE | NA | NA | NA | NA | NA | NA |
| 1,1-DICHLOROETHENE | NA | NA | NA | NA | NA | NA |
| 1,1-DICHLOROETHANE | NA | NA | NA | NA | NA | NA |
| trans-1,2-DICHLOROETHENE | 1 U | 1 U | 1 U | 1 U | 1 U | 38 |
| cis-1,2-DICHLOROETHENE | 1 U | 1 U | 1 U | 7 | 1 U | 1 |
| 1,2-DICHLOROETHENE (TOTAL) | NA | NA | NA | NA | NA | NA |
| CHLOROFORM | NA | NA | NA | NA | NA | NA |
| TRICHLOROETHENE | 0.1 U | 0.1 U | 1.1 | 1.3 | 0.1 U | 9.6 |
| BENZENE | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| TETRACHLOROETHENE | NA | NA | NA | NA | NA | NA |
| 1,1,2,2-TETRACHLOROETHANE | NA | NA | NA | NA | NA | NA |
| TOLUENE | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| ETHYLBENZENE | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| M&P-XYLENES | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| O-XYLENES | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| XYLENE (TOTAL) | NA | NA | NA | NA | NA | NA |
| METHL-TERT-BUTYL-ETHER | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |

TABLE 4-2
POSITIVE DETECTION SUMMARY
ROUND 4, GROUNDWATER
VOLATILE ORGANIC COMPOUNDS
SITE 35, CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 232
MCB CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232

| SAMPLE ID | 35-TW10A-04 | 35-TW10B-04 | 35-TW11A-04 | 35-TW11B-04 | 35-TW12B-04 | 35-TW13B-04 |
|----------------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| METHOD | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A | VOA1.8 | VOA1.8 |
| DATE SAMPLED | 4/11/96 | 4/11/96 | 4/11/96 | 4/11/96 | 04/26/96 | 04/26/96 |
| VOLATILES (ug/L) | | | | | | |
| VINYL CHLORIDE | NA | NA | NA | NA | 10 U | 10 U |
| ACETONE | NA | NA | NA | NA | 10 U | 10 U |
| 1,1-DICHLOROETHENE | NA | NA | NA | NA | 10 U | 10 U |
| 1,1-DICHLOROETHANE | NA | NA | NA | NA | 10 U | 10 U |
| trans-1,2-DICHLOROETHENE | 1 U | 1 U | 1 U | 1 U | NA | NA |
| cis-1,2-DICHLOROETHENE | 1 U | 11 | 1 U | 6 | NA | NA |
| 1,2-DICHLOROETHENE (TOTAL) | NA | NA | NA | NA | 51 | 10 U |
| CHLOROFORM | NA | NA | NA | NA | 10 U | 10 U |
| TRICHLOROETHENE | 0.1 U | 0.1 U | 0.1 U | 0.5 | 93 | 10 U |
| BENZENE | 1 U | 1 U | 1 U | 1 U | 10 U | 10 U |
| TETRACHLOROETHENE | NA | NA | NA | NA | 10 U | 10 U |
| 1,1,2,2-TETRACHLOROETHANE | NA | NA | NA | NA | 10 U | 10 U |
| TOLUENE | 1 | 1 U | 1 U | 1 U | 10 U | 10 U |
| ETHYLBENZENE | 1 U | 1 U | 1 U | 1 U | 10 U | 10 U |
| M&P-XYLENES | 1 U | 1 U | 1 U | 1 U | NA | NA |
| O-XYLENES | 1 U | 1 U | 1 U | 1 U | NA | NA |
| XYLENE (TOTAL) | NA | NA | NA | NA | 10 U | 10 U |
| METHL-TERT-BUTYL-ETHER | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |

**TABLE 4-2
 POSITIVE DETECTION SUMMARY
 ROUND 4, GROUNDWATER
 VOLATILE ORGANIC COMPOUNDS
 SITE 35, CAMP GEIGER AREA FUEL FARM
 SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 232
 MCB CAMP LEJEUNE, NORTH CAROLINA
 CONTRACT TASK ORDER 0232**

| SAMPLE ID | 35-TW14B-04 | 35-TW15B-04 | 35-TW16A-04 | 35-TW16B-04 | 35-TW16C-04 | 35-TW17A-04 |
|----------------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| METHOD | VOA1.8 | VOA1.8 | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A |
| DATE SAMPLED | 04/29/96 | 04/30/96 | 04/16/96 | 04/16/96 | 04/16/96 | 04/16/96 |
| VOLATILES (ug/L) | | | | | | |
| VINYL CHLORIDE | 10 U | 10 U | NA | NA | NA | NA |
| ACETONE | 10 U | 10 U | NA | NA | NA | NA |
| 1,1-DICHLOROETHENE | 10 U | 10 U | NA | NA | NA | NA |
| 1,1-DICHLOROETHANE | 10 U | 10 U | NA | NA | NA | NA |
| trans-1,2-DICHLOROETHENE | NA | NA | 1 U | 338 | 6 | 1 U |
| cis-1,2-DICHLOROETHENE | NA | NA | 2 | 1317 | 91 | 6 |
| 1,2-DICHLOROETHENE (TOTAL) | 14 | 13 | NA | NA | NA | NA |
| CHLOROFORM | 10 U | 10 U | NA | NA | NA | NA |
| TRICHLOROETHENE | 10 U | 4 J | 0.4 | 1540.1 | 17 | 2 |
| BENZENE | 10 U | 10 U | 1 U | 1 U | 1 U | 1 U |
| TETRACHLOROETHENE | 10 U | 10 U | NA | NA | NA | NA |
| 1,1,2,2-TETRACHLOROETHANE | 10 U | 10 U | NA | NA | NA | NA |
| TOLUENE | 10 U | 10 U | 1 U | 1 U | 1 U | 1 U |
| ETHYLBENZENE | 10 U | 10 U | 1 U | 1 U | 1 U | 1 U |
| M&P-XYLENES | NA | NA | 1 U | 1 U | 1 U | 1 U |
| O-XYLENES | NA | NA | 1 U | 1 U | 1 U | 1 U |
| XYLENE (TOTAL) | 10 U | 10 U | NA | NA | NA | NA |
| METHL-TERT-BUTYL-ETHER | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |

**TABLE 4-2
 POSITIVE DETECTION SUMMARY
 ROUND 4, GROUNDWATER
 VOLATILE ORGANIC COMPOUNDS
 SITE 35, CAMP GEIGER AREA FUEL FARM
 SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 232
 MCB CAMP LEJEUNE, NORTH CAROLINA
 CONTRACT TASK ORDER 0232**

| SAMPLE ID | 35-TW17B-04 | 35-TW17C-04 | 35-TW18A-04 | 35-TW18B-04 | 35-TW18C-04 | 35-TW19A-04 |
|----------------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| METHOD | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A |
| DATE SAMPLED | 04/16/96 | 04/16/96 | 04/16/96 | 04/16/96 | 04/16/96 | 04/16/96 |
| VOLATILES (ug/L) | | | | | | |
| VINYL CHLORIDE | NA | NA | NA | NA | NA | NA |
| ACETONE | NA | NA | NA | NA | NA | NA |
| 1,1-DICHLOROETHENE | NA | NA | NA | NA | NA | NA |
| 1,1-DICHLOROETHANE | NA | NA | NA | NA | NA | NA |
| trans-1,2-DICHLOROETHENE | 422 | 54 | 4 | 118 | 32 | 1 U |
| cis-1,2-DICHLOROETHENE | 1417 | 159 | 32 | 410 | 165 | 1 U |
| 1,2-DICHLOROETHENE (TOTAL) | NA | NA | NA | NA | NA | NA |
| CHLOROFORM | NA | NA | NA | NA | NA | NA |
| TRICHLOROETHENE | 2054 | 153.7 | 24.6 | 719.5 | 167 | 0.3 |
| BENZENE | 1 U | 1 U | 1 U | 1 U | 1 U | 2 |
| TETRACHLOROETHENE | NA | NA | NA | NA | NA | NA |
| 1,1,2,2-TETRACHLOROETHANE | NA | NA | NA | NA | NA | NA |
| TOLUENE | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| ETHYLBENZENE | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| M&P-XYLENES | 1 U | 1 U | 1 U | 1 U | 1 U | 2 |
| O-XYLENES | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| XYLENE (TOTAL) | NA | NA | NA | NA | NA | NA |
| METHL-TERT-BUTYL-ETHER | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |

**TABLE 4-2
 POSITIVE DETECTION SUMMARY
 ROUND 4, GROUNDWATER
 VOLATILE ORGANIC COMPOUNDS
 SITE 35, CAMP GEIGER AREA FUEL FARM
 SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 232
 MCB CAMP LEJEUNE, NORTH CAROLINA
 CONTRACT TASK ORDER 0232**

| SAMPLE ID | 35-TW19B-04 | 35-TW19C-04 | 35-TW20A-04 | 35-TW20B-04 | 35-TW20C-04 | 35-TW22A-04 |
|----------------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| METHOD | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A |
| DATE SAMPLED | 04/16/96 | 04/16/96 | 04/15/96 | 04/15/96 | 04/15/96 | 04/15/96 |
| VOLATILES (ug/L) | | | | | | |
| VINYL CHLORIDE | NA | NA | NA | NA | NA | NA |
| ACETONE | NA | NA | NA | NA | NA | NA |
| 1,1-DICHLOROETHENE | NA | NA | NA | NA | NA | NA |
| 1,1-DICHLOROETHANE | NA | NA | NA | NA | NA | NA |
| trans-1,2-DICHLOROETHENE | 141 | 7 | 2 | 63 | 8 | 1 U |
| cis-1,2-DICHLOROETHENE | 611 | 107 | 4 | 318 | 124 | 16 |
| 1,2-DICHLOROETHENE (TOTAL) | NA | NA | NA | NA | NA | NA |
| CHLOROFORM | NA | NA | NA | NA | NA | NA |
| TRICHLOROETHENE | 834.1 | 21 | 8.8 | 246.3 | 34.4 | 4.5 |
| BENZENE | 1 U | 1 U | 215 | 1 U | 37 | 1654 |
| TETRACHLOROETHENE | NA | NA | NA | NA | NA | NA |
| 1,1,2,2-TETRACHLOROETHANE | NA | NA | NA | NA | NA | NA |
| TOLUENE | 1 U | 1 U | 883 | 2 | 174 | 3636 |
| ETHYLBENZENE | 1 U | 1 U | 353 | 1 U | 28 | 629 |
| M&P-XYLENES | 1 U | 1 U | 445 | 1 U | 61 | 1293 |
| O-XYLENES | 1 U | 1 U | 158 | 1 U | 30 | 720 |
| XYLENE (TOTAL) | NA | NA | NA | NA | NA | NA |
| METHL-TERT-BUTYL-ETHER | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |

**TABLE 4-2
 POSITIVE DETECTION SUMMARY
 ROUND 4, GROUNDWATER
 VOLATILE ORGANIC COMPOUNDS
 SITE 35, CAMP GEIGER AREA FUEL FARM
 SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 232
 MCB CAMP LEJEUNE, NORTH CAROLINA
 CONTRACT TASK ORDER 0232**

| SAMPLE ID | 35-TW22B-04 | 35-TW22C-04 | 35-TW23A-04 | 35-TW23B-04 | 35-TW23C-04 | 35-TW24A-04 |
|----------------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| METHOD | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A |
| DATE SAMPLED | 04/15/96 | 04/15/96 | 04/15/96 | 04/15/96 | 04/15/96 | 04/14/96 |
| VOLATILES (ug/L) | | | | | | |
| VINYL CHLORIDE | NA | NA | NA | NA | NA | NA |
| ACETONE | NA | NA | NA | NA | NA | NA |
| 1,1-DICHLOROETHENE | NA | NA | NA | NA | NA | NA |
| 1,1-DICHLOROETHANE | NA | NA | NA | NA | NA | NA |
| trans-1,2-DICHLOROETHENE | 1 U | 9 | 1 U | 3 | 3 | 1 U |
| cis-1,2-DICHLOROETHENE | 16 | 137 | 9 | 70 | 47 | 1 U |
| 1,2-DICHLOROETHENE (TOTAL) | NA | NA | NA | NA | NA | NA |
| CHLOROFORM | NA | NA | NA | NA | NA | NA |
| TRICHLOROETHENE | 4.5 | 37.9 | 2.2 | 11.6 | 10.9 | 0.2 |
| BENZENE | 11 | 11 | 3296 | 4 | 224 | 586 |
| TETRACHLOROETHENE | NA | NA | NA | NA | NA | NA |
| 1,1,2,2-TETRACHLOROETHANE | NA | NA | NA | NA | NA | NA |
| TOLUENE | 14 | 14 | 7392 | 6 | 315 | 3 |
| ETHYLBENZENE | 4 | 4 | 708 | 2 | 37 | 37 |
| M&P-XYLENES | 6 | 6 | 1795 | 3 | 79 | 7 |
| O-XYLENES | 3 | 3 | 969 | 2 | 44 | 1 U |
| XYLENE (TOTAL) | NA | NA | NA | NA | NA | NA |
| METHL-TERT-BUTYL-ETHER | 5 U | 5 U | 58 | 5 U | 8 | 85 |

**TABLE 4-2
 POSITIVE DETECTION SUMMARY
 ROUND 4, GROUNDWATER
 VOLATILE ORGANIC COMPOUNDS
 SITE 35, CAMP GEIGER AREA FUEL FARM
 SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 232
 MCB CAMP LEJEUNE, NORTH CAROLINA
 CONTRACT TASK ORDER 0232**

| SAMPLE ID | 35-TW24B-04 | 35-TW24C-04 | 35-TW25A-04 | 35-TW25B-04 | 35-TW25C-04 | 35-TW26A-04 |
|----------------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| METHOD | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A | 8010A/8020A |
| DATE SAMPLED | 04/14/96 | 04/14/96 | 04/14/96 | 04/14/96 | 04/14/96 | 04/13/96 |
| VOLATILES (ug/L) | | | | | | |
| VINYL CHLORIDE | NA | NA | NA | NA | NA | NA |
| ACETONE | NA | NA | NA | NA | NA | NA |
| 1,1-DICHLOROETHENE | NA | NA | NA | NA | NA | NA |
| 1,1-DICHLOROETHANE | NA | NA | NA | NA | NA | NA |
| trans-1,2-DICHLOROETHENE | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| cis-1,2-DICHLOROETHENE | 1 U | 15 | 1 U | 1 U | 3 | 1 U |
| 1,2-DICHLOROETHENE (TOTAL) | NA | NA | NA | NA | NA | NA |
| CHLOROFORM | NA | NA | NA | NA | NA | NA |
| TRICHLOROETHENE | 0.5 | 0.8 | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| BENZENE | 1 U | 5 | 312 | 1 U | 3 | 5 |
| TETRACHLOROETHENE | NA | NA | NA | NA | NA | NA |
| 1,1,2,2-TETRACHLOROETHANE | NA | NA | NA | NA | NA | NA |
| TOLUENE | 1 U | 1 U | 2 | 1 U | 1 U | 1 U |
| ETHYLBENZENE | 1 U | 1 U | 11 | 1 U | 1 U | 3 |
| M&P-XYLENES | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| O-XYLENES | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| XYLENE (TOTAL) | NA | NA | NA | NA | NA | NA |
| METHL-TERT-BUTYL-ETHER | 5 U | 5 U | 19 | 5 U | | 5 U |

**TABLE 4-2
 POSITIVE DETECTION SUMMARY
 ROUND 4, GROUNDWATER
 VOLATILE ORGANIC COMPOUNDS
 SITE 35, CAMP GEIGER AREA FUEL FARM
 SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 232
 MCB CAMP LEJEUNE, NORTH CAROLINA
 CONTRACT TASK ORDER 0232**

| SAMPLE ID | 35-TW26B-04 | 35-TW26C-04 | 35-TW27B-04 | 35-TW28B-04 | 35-TW29B-04 | 35-TW30A-04 |
|----------------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| METHOD | 8010A/8020A | 8010A/8020A | VOA1.8 | VOA1.8 | VOA1.8 | 8010A/8020A |
| DATE SAMPLED | 04/13/96 | 04/13/96 | 04/25/96 | 04/29/96 | 04/30/96 | 08/04/96 |
| VOLATILES (ug/L) | | | | | | |
| VINYL CHLORIDE | NA | NA | 10 UJ | 10 U | 10 U | NA |
| ACETONE | NA | NA | 66 J | 10 U | 10 U | NA |
| 1,1-DICHLOROETHENE | NA | NA | 10 UJ | 4 J | 10 U | NA |
| 1,1-DICHLOROETHANE | NA | NA | 10 UJ | 3 J | 10 U | NA |
| trans-1,2-DICHLOROETHENE | 1 U | 1 U | NA | NA | NA | 1 U |
| cis-1,2-DICHLOROETHENE | 1 U | 1 U | NA | NA | NA | 1 U |
| 1,2-DICHLOROETHENE (TOTAL) | NA | NA | 260 J | 2 J | 28 | NA |
| CHLOROFORM | NA | NA | 10 U | 10 U | 10 U | 3.7 |
| TRICHLOROETHENE | 0.1 U | 0.1 U | 41 J | 10 U | 220 | 0.1 U |
| BENZENE | 1 U | 3 | 10 UJ | 10 U | 10 U | 1 U |
| TETRACHLOROETHENE | NA | NA | 10 UJ | 10 U | 2 J | NA |
| 1,1,2,2-TETRACHLOROETHANE | NA | NA | 10 UJ | 10 U | 23 | NA |
| TOLUENE | 1 U | 1 U | 10 UJ | 10 U | 10 U | 1 U |
| ETHYLBENZENE | 1 U | 1 U | 10 U | 10 U | 10 U | 1 U |
| M&P-XYLENES | 1 U | 1 U | NA | NA | NA | 1 U |
| O-XYLENES | 1 U | 1 U | NA | NA | NA | 1 U |
| XYLENE (TOTAL) | NA | NA | 10 U | 10 U | 10 U | NA |
| METHL-TERT-BUTYL-ETHER | 5 U | 5 U | 5 U | 5 U | 5 U | NA |

**TABLE 4-2
 POSITIVE DETECTION SUMMARY
 ROUND 4, GROUNDWATER
 VOLATILE ORGANIC COMPOUNDS
 SITE 36, CAMP GEIGER AREA FUEL FARM
 SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 232
 MCB CAMP LEJEUNE, NORTH CAROLINA
 CONTRACT TASK ORDER 0232**

| SAMPLE ID | 35-TW30A-04 | 35-TW30B-04 | 35-TW30B-04 | 35-TW31A-04 | 35-TW31A-04 | 35-TW31B-04 |
|----------------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| METHOD | VOA1.8 | 8010A/8020A | VOA1.8 | 8010A/8020A | VOA1.8 | 8010A/8020A |
| DATE SAMPLED | 08/04/96 | 08/04/96 | 08/04/96 | 08/04/96 | 08/04/96 | 8/04/96 |
| VOLATILES (ug/L) | | | | | | |
| VINYL CHLORIDE | 10 U | NA | 10 U | NA | 10 U | NA |
| ACETONE | 10 U | NA | 10 U | NA | 10 U | NA |
| 1,1-DICHLOROETHENE | 10 U | NA | 10 U | NA | 10 U | NA |
| 1,1-DICHLOROETHANE | 10 U | NA | 10 U | NA | 10 U | NA |
| trans-1,2-DICHLOROETHENE | NA | 1 U | NA | 1 U | NA | 1 U |
| cis-1,2-DICHLOROETHENE | NA | 1 U | NA | 1 U | NA | 1 U |
| 1,2-DICHLOROETHENE (TOTAL) | 10 U | NA | 10 U | NA | 10 U | NA |
| CHLOROFORM | 10 U | 1 | 10 U | 1.5 | 10 U | 0.3 |
| TRICHLOROETHENE | 10 U | 0.1 U | 10 U | 0.1 U | 10 U | 0.1 U |
| BENZENE | 10 U | 1 U | 10 U | 1 U | 10 U | 1 U |
| TETRACHLOROETHENE | 10 U | NA | 10 U | NA | 10 U | NA |
| 1,1,2,2-TETRACHLOROETHANE | 10 U | NA | 10 U | NA | 10 U | NA |
| TOLUENE | 10 U | 1 U | 10 U | 1 U | 10 U | 1 U |
| ETHYLBENZENE | 10 U | 1 U | 10 U | 1 U | 10 U | 1 U |
| M&P-XYLENES | NA | 1 U | NA | 1 U | NA | 1 U |
| O-XYLENES | NA | 1 U | NA | 1 U | NA | 1 U |
| XYLENE (TOTAL) | 10 U | NA | 10 U | NA | 10 U | NA |
| METHL-TERT-BUTYL-ETHER | 5 U | NA | 5 U | NA | 5 U | NA |

TABLE 4-2
POSITIVE DETECTION SUMMARY
ROUND 4, GROUNDWATER
VOLATILE ORGANIC COMPOUNDS
SITE 35, CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 232
MCB CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232

| SAMPLE ID | 35-TW31B-04 | 35-GWD06-04 | 35-GWD07-04 |
|----------------------------|-------------|-------------|-------------|
| METHOD | VOA1.8 | VOA1.8 | VOA1.8 |
| DATE SAMPLED | 08/04/96 | 4/30/96 | 4/30/96 |
| VOLATILES (ug/L) | | | |
| VINYL CHLORIDE | 10 U | 10 U | 10 U |
| ACETONE | 10 U | 10 U | 10 U |
| 1,1-DICHLOROETHENE | 10 U | 10 U | 10 U |
| 1,1-DICHLOROETHANE | 10 U | 10 U | 10 U |
| trans-1,2-DICHLOROETHENE | NA | NA | NA |
| cis-1,2-DICHLOROETHENE | NA | NA | NA |
| 1,2-DICHLOROETHENE (TOTAL) | 10 U | 10 U | 10 U |
| CHLOROFORM | 10 U | 10 U | 10 U |
| TRICHLOROETHENE | 10 U | 10 U | 10 U |
| BENZENE | 10 U | 10 U | 10 U |
| TETRACHLOROETHENE | 10 U | 10 U | 10 U |
| 1,1,2,2-TETRACHLOROETHANE | 10 U | 10 U | 10 U |
| TOLUENE | 10 U | 10 U | 10 U |
| ETHYLBENZENE | 10 U | 10 U | 10 U |
| M&P-XYLENES | NA | NA | NA |
| O-XYLENES | NA | NA | NA |
| XYLENE (TOTAL) | 10 U | 10 U | 10 U |
| METHL-TERT-BUTYL-ETHER | 5 U | 5 U | NA |

**TABLE 4-3
 POSITIVE DETECTION SUMMARY
 SEDIMENTS
 TOTAL PETROLEUM HYDROCARBONS
 SITE 35 CAMP GEIGER AREA FUEL FARM
 MCB CAMP LEJEUNE, NORTH CAROLINA
 CONTRACT TASK ORDER 0232**

| Location | 35-SD01-06-02 | 35-SD01-612-02 | 35-SD02-06-02 | 35-SD02-612-02 | 35-SD03-06-02 |
|---|---------------|----------------|---------------|----------------|---------------|
| Lab id. | D95-7350-1 | D95-7350-2 | D95-7350-3 | D95-7350-4 | 95-7354-10 |
| Date Sampled | 08/08/95 | 08/08/95 | 08/08/95 | 08/08/95 | 08/07/95 |
| Total Petroleum Hydrocarbon 5030/8015M ug/kg | | | | | |
| Gasoline | 69 U | 61 U | 62 U | 164 | 759 |
| Total Petroleum Hydrocarbon 3550/8015M mg/kg | | | | | |
| Diesel | 69 U | 36.7 U | 37.4 U | 104 | 54.9 |

**TABLE 4-3
 POSITIVE DETECTION SUMMARY
 SEDIMENTS
 TOTAL PETROLEUM HYDROCARBONS
 SITE 35 CAMP GEIGER AREA FUEL FARM
 MCB CAMP LEJEUNE, NORTH CAROLINA
 CONTRACT TASK ORDER 0232**

| Location | 35-SD03-612-02 | 35-SD04-06-02 | 35-SD04-612-02 | 35-SD05-06-02 | 35-SD05-612-02 |
|---|----------------|---------------|----------------|---------------|----------------|
| Lab id. | 95-7354-11 | D95-7354-8 | D95-7354-9 | D95-7354-6 | D95-7354-7 |
| Date Sampled | 08/07/95 | 08/07/95 | 08/07/95 | 08/07/95 | 08/07/95 |
| Total Petroleum Hydrocarbon 5030/8015M ug/kg | | | | | |
| Gasoline | 70 U | 2390 | 29700 | 5600 | 3650 |
| Total Petroleum Hydrocarbon 3550/8015M mg/kg | | | | | |
| Diesel | 84.5 | 735 | 459 | 550 | 1100 |

**TABLE 4-3
 POSITIVE DETECTION SUMMARY
 SEDIMENTS
 TOTAL PETROLEUM HYDROCARBONS
 SITE 35 CAMP GEIGER AREA FUEL FARM
 MCB CAMP LEJEUNE, NORTH CAROLINA
 CONTRACT TASK ORDER 0232**

| Location | 35-SD06-06-02 | 35-SD06-612-02 | 35-SD07-06-02 | 35-SD07-06D-02 | 35-SD07-612-02 |
|---|---------------|----------------|---------------|----------------|----------------|
| Lab id. | D95-7354-4 | D95-7354-5 | D95-7354-1 | D95-7354-2 | D95-7354-3 |
| Date Sampled | 08/07/95 | 08/07/95 | 08/08/95 | 08/08/95 | 08/07/95 |
| Total Petroleum Hydrocarbon 5030/8015M ug/kg | | | | | |
| Gasoline | 14200 | 1070 J | 188 J | 364 | 1420 |
| Total Petroleum Hydrocarbon 3550/8015M mg/kg | | | | | |
| Diesel | 7420 | 234 | 239 | 180 U | 292 |

**TABLE 4-3
 POSITIVE DETECTION SUMMARY
 SEDIMENTS
 TOTAL PETROLEUM HYDROCARBONS
 SITE 35 CAMP GEIGER AREA FUEL FARM
 MCB CAMP LEJEUNE, NORTH CAROLINA
 CONTRACT TASK ORDER 0232**

| Location | 36-SD05-06-02 | 36-SD05-612-02 | 36-SD06-06-02 | 36-SD06-612-02 | 36-SD07-06-02 |
|---|---------------|----------------|---------------|----------------|---------------|
| Lab id. | 95-7350-10 | 95-7350-11 | D95-7350-8 | D95-7350-9 | D95-7350-5 |
| Date Sampled | 08/07/95 | 08/08/95 | 08/07/95 | 08/07/95 | 08/07/95 |
| Total Petroleum Hydrocarbon 5030/8015M ug/kg | | | | | |
| Gasoline | 102 | 143 | 99 | 892 | 2280 |
| Total Petroleum Hydrocarbon 3550/8015M mg/kg | | | | | |
| Diesel | 41.8 U | 64.5 | 92.2 | 444 | 708 |

**TABLE 4-3
 POSITIVE DETECTION SUMMARY
 SEDIMENTS
 TOTAL PETROLEUM HYDROCARBONS
 SITE 35 CAMP GEIGER AREA FUEL FARM
 MCB CAMP LEJEUNE, NORTH CAROLINA
 CONTRACT TASK ORDER 0232**

| Location | 36-SD07-06D-02 | 36-SD07-612-02 |
|---|----------------|----------------|
| Lab id. | D95-7350-6 | D95-7350-7 |
| Date Sampled | 08/07/95 | 08/07/95 |
| Total Petroleum Hydrocarbon 5030/8015M ug/kg | | |
| Gasoline | 2240 | 115 U |
| Total Petroleum Hydrocarbon 3550/8015M mg/kg | | |
| Diesel | 1140 | 68.8 U |

**TABLE 4-4
 POSITIVE DETECTION SUMMARY
 SEDIMENTS
 INORGANICS
 SITE 35, CAMP GEIGER AREA FUEL FARM
 SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 0232
 MCB, CAMP LEJEUNE, NORTH CAROLINA
 CONTRACT TASK ORDER 0232**

| LOCATION | 35-SD01-06-02 | 35-SD01-612-02 | 35-SD02-06-02 | 35-SD02-612-02 | 35-SD03-06-02 | 35-SD03-612-02 |
|-----------------------|---------------|----------------|---------------|----------------|---------------|----------------|
| LAB ID | D95-7350-1 | D95-7350-2 | D95-7350-3 | D95-7350-4 | 95-7354-10 | 95-7354-11 |
| DATE SAMPLED | 08/08/95 | 08/08/95 | 08/08/95 | 08/08/95 | 08/07/95 | 08/07/95 |
| METALS (mg/kg) | | | | | | |
| Mercury | 0.13 U | 0.12 U | 0.12 U | 0.26 U | 0.15 U | 0.13 U |
| Zinc | 12.6 | 4.1 | 27.1 | 62.1 | 26.6 | 11.4 |

QUALIFIERS

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

NOTES

mg/kg = milligrams per kilogram

**TABLE 4-4
 POSITIVE DETECTION SUMMARY
 SEDIMENTS
 INORGANICS
 SITE 35, CAMP GEIGER AREA FUEL FARM
 SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 0232
 MCB, CAMP LEJEUNE, NORTH CAROLINA
 CONTRACT TASK ORDER 0232**

| LOCATION | 35-SD04-06-02 | 35-SD04-612-02 | 35-SD05-06-02 | 35-SD05-612-02 | 35-SD06-06-02 | 35-SD06-612-02 |
|-----------------------|---------------|----------------|---------------|----------------|---------------|----------------|
| LAB ID | D95-7354-8 | D95-7354-9 | D95-7354-6 | D95-7354-7 | D95-7354-4 | D95-7354-5 |
| DATE SAMPLED | 08/07/95 | 08/07/95 | 08/07/95 | 08/07/95 | 08/07/95 | 08/07/95 |
| METALS (mg/kg) | | | | | | |
| Mercury | 0.14 U | 0.14 U | 0.25 U | 0.23 U | 0.28 U | 0.36 |
| Zinc | 34.2 | 42.2 | 106 | 104 | 92.9 | 9.9 |

QUALIFIERS

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

NOTES

mg/kg = milligrams per kilogram

**TABLE 4-4
 POSITIVE DETECTION SUMMARY
 SEDIMENTS
 INORGANICS
 SITE 35, CAMP GEIGER AREA FUEL FARM
 SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 0232
 MCB, CAMP LEJEUNE, NORTH CAROLINA
 CONTRACT TASK ORDER 0232**

| LOCATION | 35-SD07-06-02 | 35-SD07-612-02 | 36-SD05-06-02 | 36-SD05-612-02 | 36-SD06-06-02 | 36-SD06-612-02 |
|-----------------------|---------------|----------------|---------------|----------------|---------------|----------------|
| LAB ID | D95-7354-1 | D95-7354-3 | 95-7350-10 | 95-7350-11 | D95-7350-8 | D95-7350-9 |
| DATE SAMPLED | 08/08/95 | 08/07/95 | 08/07/95 | 08/08/95 | 08/07/95 | 08/07/95 |
| METALS (mg/kg) | | | | | | |
| Mercury | 0.19 U | 0.13 U | 0.13 U | 0.13 U | 0.16 | 0.16 |
| Zinc | 72.6 | 45.6 | 28.4 | 18.2 | 22.6 | 10.1 |

QUALIFIERS

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

NOTES

mg/kg = milligrams per kilogram

**TABLE 4-4
 POSITIVE DETECTION SUMMARY
 SEDIMENTS
 INORGANICS
 SITE 35, CAMP GEIGER AREA FUEL FARM
 SUPPLEMENTAL GROUNDWATER INVESTIGATION - CTO 0232
 MCB, CAMP LEJEUNE, NORTH CAROLINA
 CONTRACT TASK ORDER 0232**

| LOCATION | 36-SD07-06-02 | 36-SD07-612-02 |
|-----------------------|---------------|----------------|
| LAB ID | D95-7350-5 | D95-7350-7 |
| DATE SAMPLED | 08/07/95 | 08/07/95 |
| METALS (mg/kg) | | |
| Mercury | 0.34 U | 0.31 U |
| Zinc | 65.8 | 2.2 U |

QUALIFIERS

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

NOTES

mg/kg = milligrams per kilogram

SECTION 4.0 FIGURES

FEDERAL MAXIMUM CONTAMINATION LEVELS AND NORTH CAROLINA WATER QUALITY STANDARDS CLASS GA STANDARDS

| ORGANIC CONTAMINANTS | MCL (ug/L) | N.C. REGULATION (ug/L) |
|------------------------------|------------|------------------------|
| VOLATILES | | |
| TRICHLOROETHENE | 5 | 2.8 |
| 1,2-DICHLOROETHENE (TOTAL)** | 70 | 70 |
| 1,1,2,2-TETRACHLOROETHANE | * | * |
| BENZENE | 5 | 1 |

* - ND STANDARD AVAILABLE.

** - ONLY RESULTS FOR TOTAL 1,2-DICHLOROETHENE WERE AVAILABLE. SO, THE CONSERVATIVE REGULATORY VALUES FOR THE CIS AND TRANS SPECIES WERE ASSUMED.

NOTES:

CONTAMINANT CONCENTRATIONS ARE EXPRESSED IN MICROGRAMS PER LITER (ug/L).

CONTAMINANTS THAT EXCEED N.C. REGULATIONS ARE COLORED GREEN.

CONTAMINANTS THAT EXCEED MCLs ARE COLORED BLUE.

CONTAMINANTS THAT EXCEED BOTH N.C. REGULATIONS AND MCLs ARE COLORED RED.

| | |
|----------------------------|-------------|
| SAMPLE ID | 35-EMW03-04 |
| VOLATILES | |
| 1,2-DICHLOROETHENE (TOTAL) | 3 J |
| BENZENE | 3 J |

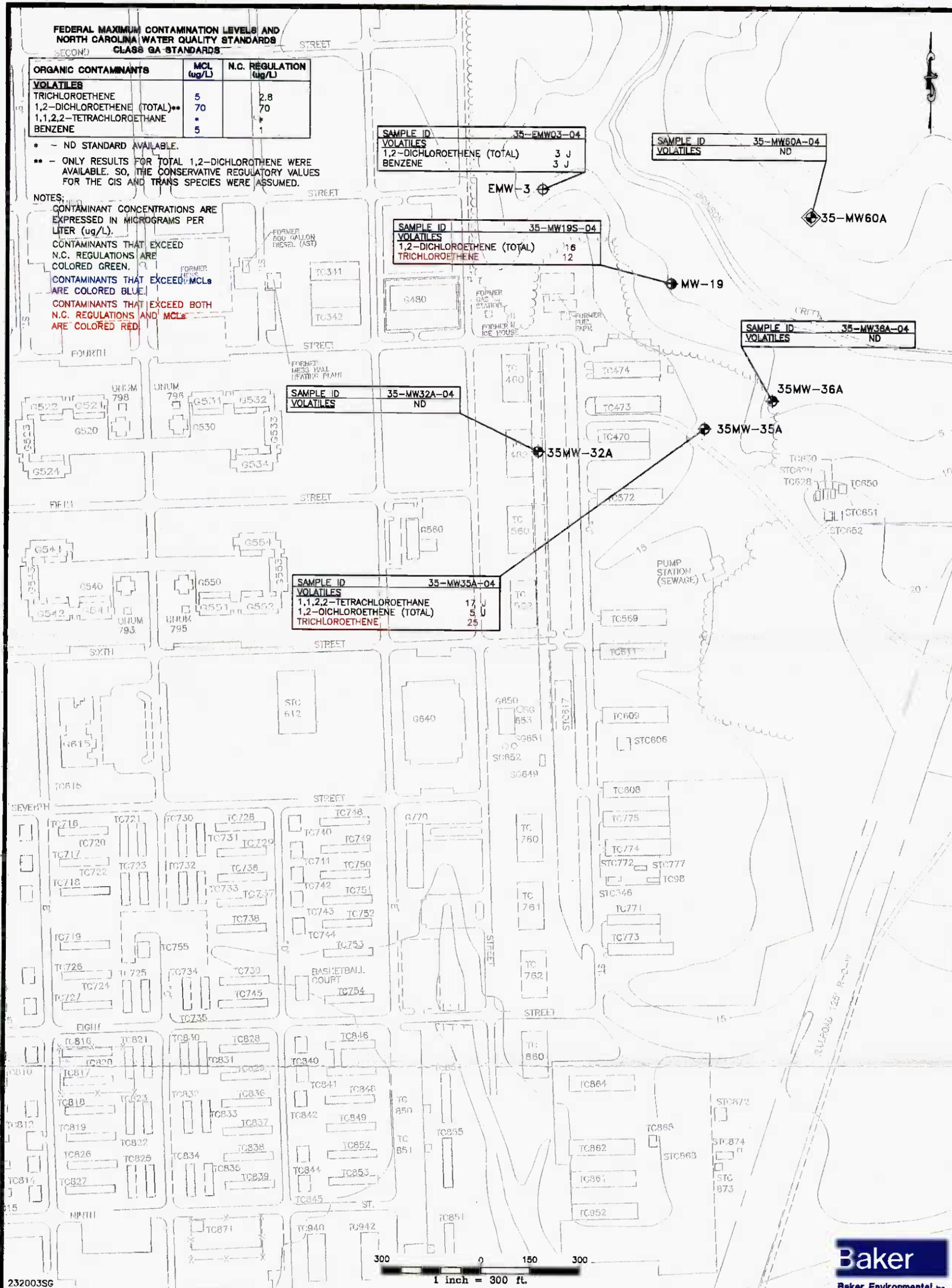
| | |
|-----------|-------------|
| SAMPLE ID | 35-MW60A-04 |
| VOLATILES | ND |

| | |
|----------------------------|-------------|
| SAMPLE ID | 35-MW19S-04 |
| VOLATILES | |
| 1,2-DICHLOROETHENE (TOTAL) | 16 |
| TRICHLOROETHENE | 12 |

| | |
|-----------|-------------|
| SAMPLE ID | 35-MW36A-04 |
| VOLATILES | ND |

| | |
|-----------|-------------|
| SAMPLE ID | 35-MW32A-04 |
| VOLATILES | ND |

| | |
|----------------------------|-------------|
| SAMPLE ID | 35-MW35A-04 |
| VOLATILES | |
| 1,1,2,2-TETRACHLOROETHANE | 17 J |
| 1,2-DICHLOROETHENE (TOTAL) | 5 U |
| TRICHLOROETHENE | 25 |



232003SG

| | |
|----------|--|
| EMW-3 | — MONITORING WELL INSTALLED BY NUS (1990). |
| MW-19 | — MONITORING WELL INSTALLED UNDER CSA BY LAW (1991). |
| 35-MW36A | — MONITORING WELL INSTALLED UNDER BAKER RI (1994). |
| 35-TW11A | — TEMPORARY WELL INSTALLED UNDER BAKER (1996). |
| 35-MW60A | — MONITORING WELL INSTALLED UNDER BAKER SGI (1996). |

SOURCE: LANTDIV, OCT. 1991

FIGURE 4-1
 DETECTED ORGANICS IN THE UPPER PORTION OF THE SURFICIAL AQUIFER
 SITE 35, CAMP GEIGER AREA FUEL FARM, SGI CONTRACT TASK ORDER - 0232
 MARINE CORPS BASE, CAMP LEJEUNE
 NORTH CAROLINA



00157 FEB 44

FEDERAL MAXIMUM CONTAMINATION LEVELS AND NORTH CAROLINA WATER QUALITY STANDARDS CLASS GA STANDARDS

| ORGANIC CONTAMINANTS | MCL (ug/L) | N.C. REGULATION (ug/L) |
|------------------------------|------------|------------------------|
| VOLATILES | | |
| TRICHLOROETHENE | 5 | 2.8 |
| 1,1-DICHLOROETHANE | * | 700 |
| 1,1-DICHLOROETHENE | 7 | 7 |
| 1,2-DICHLOROETHENE (TOTAL)** | 70 | 70 |
| BENZENE | 5 | 1 |
| TOLUENE | 1000 | 1000 |
| VINYL CHLORIDE | 2 | .015 |

* - NO STANDARD AVAILABLE.

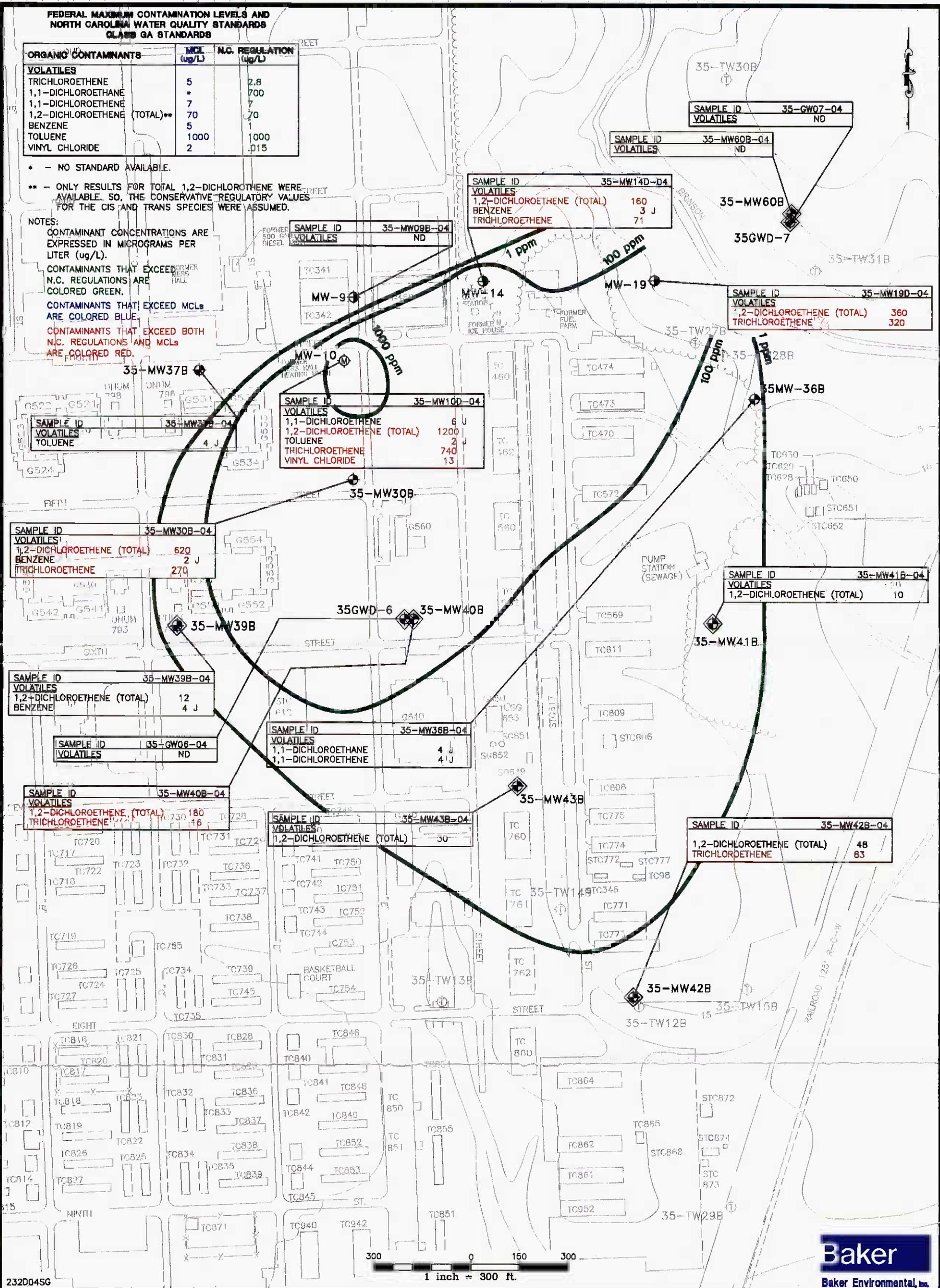
** - ONLY RESULTS FOR TOTAL 1,2-DICHLOROETHENE WERE AVAILABLE. SO, THE CONSERVATIVE REGULATORY VALUES FOR THE CIS AND TRANS SPECIES WERE ASSUMED.

NOTES:
CONTAMINANT CONCENTRATIONS ARE EXPRESSED IN MICROGRAMS PER LITER (ug/L).

CONTAMINANTS THAT EXCEED N.C. REGULATIONS ARE COLORED GREEN.

CONTAMINANTS THAT EXCEED MCLs ARE COLORED BLUE.

CONTAMINANTS THAT EXCEED BOTH N.C. REGULATIONS AND MCLs ARE COLORED RED.



232D04SG

LEGEND

- MW-1 - MONITORING WELL INSTALLED UNDER CSA (1991) BY LAW.
- MW-10 - MONITORING WELL INSTALLED UNDER UST SITE ASSESSMENT (1994).
- 35MW-36B - MONITORING WELL INSTALLED UNDER BAKER RI (1994).
- 35-MW39B - MONITORING WELL INSTALLED UNDER BAKER SGI (1996).
- LIMITS OF SOLVENT-RELATED CONTAMINATION FROM SGI RESULTS

SOURCE: LANTDIV, OCT. 1991

FIGURE 4-2
DETECTED FUEL AND SOLVENT - RELATED CONTAMINATION IN THE LOWER PORTION OF THE SURFICIAL AQUIFER AND THE UPPER PORTION OF THE CASTLE HAYNE AQUIFER SITE 35, CAMP GEIGER AREA FUEL FARM, SGI CONTRACT TASK ORDER - 0232 MARINE CORPS BASE, CAMP LEJEUNE NORTH CAROLINA



FEDERAL MAXIMUM CONTAMINATION LEVELS AND NORTH CAROLINA WATER QUALITY STANDARDS CLASS GA STANDARDS

| INORGANIC CONTAMINANTS | MCL (ug/L) | N.C. REGULATION (ug/L) |
|------------------------|------------|------------------------|
| ALUMINUM** | 50 | * |
| ANTIMONY | 6 | * |
| ARSENIC | 50 | 50 |
| BARIUM | 2000 | 2000 |
| CALCIUM | * | * |
| COBALT | * | * |
| IRON** | 300 | 300 |
| LEAD*** | 15 | 15 |
| MAGNESIUM | * | * |
| MANGANESE** | 50 | 50 |
| POTASSIUM | * | * |
| SELENIUM | 50 | 50 |
| SILVER** | 100 | 18 |
| SODIUM | * | * |
| THALLIUM | 2 | * |
| VANADIUM | * | * |
| ZINC | 5000 | 2100 |

* - NO STANDARD AVAILABLE
 ** - DENOTES THE SECONDARY MCL
 *** - DENOTES THE FEDERAL ACTION LEVEL

NOTES:
 CONTAMINANT CONCENTRATIONS ARE EXPRESSED IN MICROGRAMS PER LITER (ug/L).
 CONTAMINANTS THAT EXCEED N.C. REGULATIONS ARE COLORED GREEN.
 CONTAMINANTS THAT EXCEED MCLs ARE COLORED BLUE.
 CONTAMINANTS THAT EXCEED BOTH N.C. REGULATIONS AND MCLs ARE COLORED RED.

Sample ID 35-EMW05-02

| | |
|-----------|---------|
| Aluminum | 93.2 J |
| Arsenic | 8.7 J |
| Barium | 21.7 J |
| Calcium | 45100 J |
| Cobalt | 3.8 J |
| Iron | 20200 J |
| Lead | 12.1 J |
| Magnesium | 3610 J |
| Manganese | 51.7 J |
| Potassium | 1160 J |
| Sodium | 9090 J |

Sample ID 35-EMW03-02

| | |
|-----------|---------|
| Aluminum | 96.5 J |
| Calcium | 89900 J |
| Cobalt | 9 J |
| Iron | 3350 J |
| Magnesium | 2240 J |
| Manganese | 22.9 J |
| Potassium | 734 J |
| Sodium | 8120 J |
| Zinc | 10.5 J |

Sample ID 35-MW14S-02

| | |
|-----------|----------|
| Arsenic | 4.2 J |
| Barium | 27.1 J |
| Calcium | 142000 J |
| Cobalt | 2.9 J |
| Iron | 4490 J |
| Magnesium | 4520 J |
| Manganese | 44.6 J |
| Potassium | 1460 J |
| Sodium | 10400 J |
| Zinc | 22.5 J |

Sample ID 35-MW16S-02

| | |
|-----------|----------|
| Arsenic | 10.3 J |
| Barium | 32.2 J |
| Calcium | 124000 J |
| Cobalt | 16 J |
| Iron | 40400 J |
| Lead | 8.9 J |
| Magnesium | 4580 J |
| Manganese | 141 J |
| Potassium | 793 J |
| Silver | 10.9 J |
| Sodium | 4350 J |
| Thallium | 0.9 J |
| Zinc | 11.5 J |

Sample ID 35-MW19S-02

| | |
|-----------|---------|
| Aluminum | 282 J |
| Calcium | 35600 J |
| Cobalt | 4.4 J |
| Iron | 266 J |
| Magnesium | 1880 J |
| Manganese | 102 J |
| Potassium | 2650 J |
| Sodium | 11300 J |
| Zinc | 9.9 J |

Sample ID 35-EMW07-02

| | |
|-----------|----------|
| Aluminum | 105000 J |
| Cobalt | 2.8 J |
| Iron | 108 J |
| Magnesium | 3480 J |
| Manganese | 26.2 J |
| Potassium | 2150 J |
| Sodium | 7940 J |
| Zinc | 10.6 J |

Sample ID 35-MW33A-02

| | |
|-----------|--------|
| Aluminum | 520 J |
| Barium | 98.4 J |
| Calcium | 6380 J |
| Iron | 58.4 J |
| Lead | 6 J |
| Magnesium | 3620 J |
| Manganese | 8.8 J |
| Potassium | 1840 J |
| Selenium | 2.6 J |
| Sodium | 5370 J |

Sample ID 35-MW22S-02

| | |
|-----------|----------|
| Antimony | 20 J |
| Arsenic | 7.1 J |
| Calcium | 133000 J |
| Cobalt | 5.6 J |
| Iron | 15700 J |
| Magnesium | 3230 J |
| Manganese | 63.5 J |
| Potassium | 2320 J |
| Sodium | 5080 J |

Sample ID 35-MW09S-02

| | |
|-----------|---------|
| Aluminum | 198 J |
| Arsenic | 3.2 J |
| Barium | 57.7 J |
| Calcium | 98600 J |
| Iron | 162 J |
| Magnesium | 4110 J |
| Manganese | 38.6 J |
| Potassium | 3350 J |
| Selenium | 3.4 J |
| Sodium | 29000 J |
| Vanadium | 5.5 J |

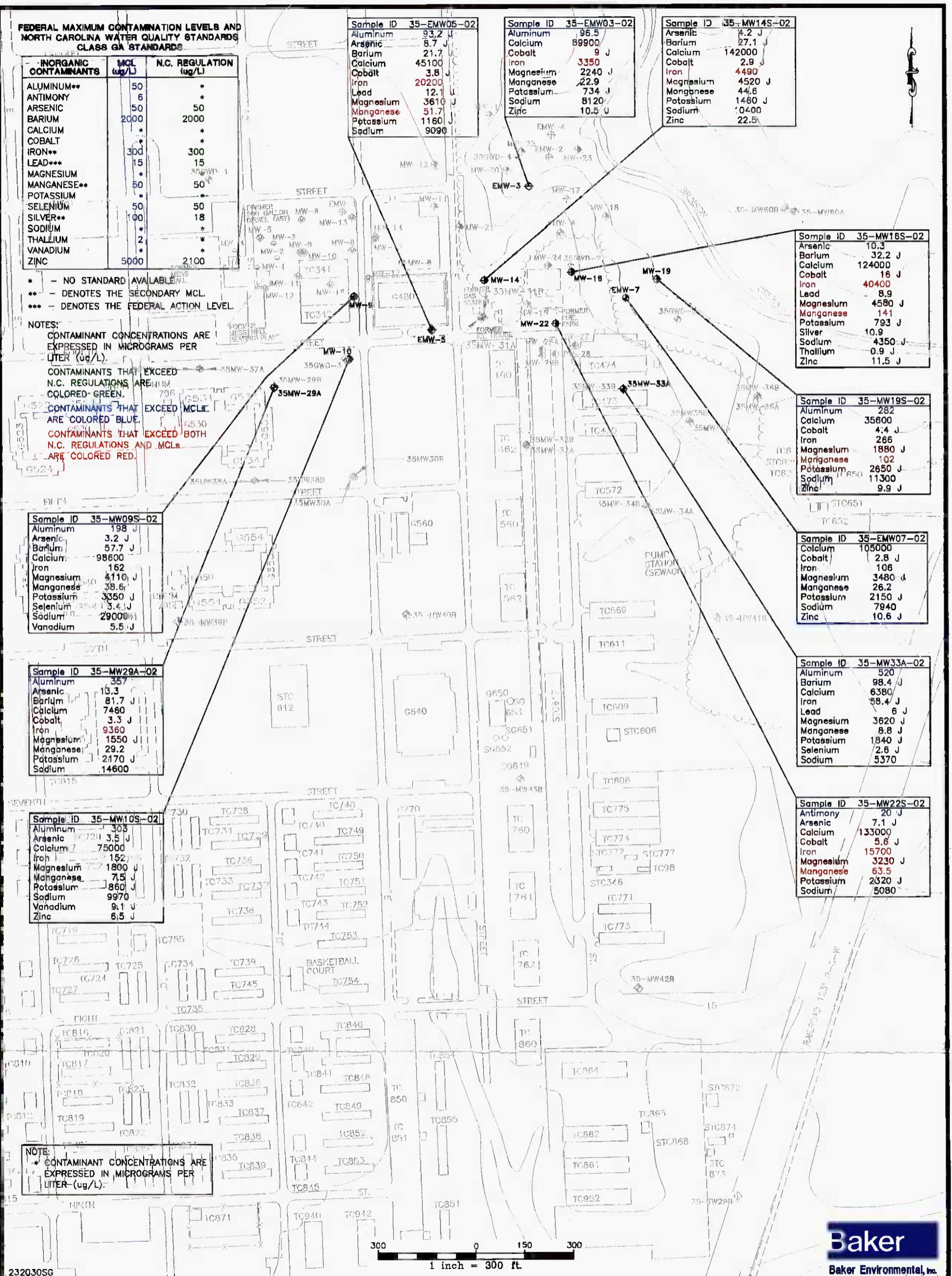
Sample ID 35-MW29A-02

| | |
|-----------|---------|
| Aluminum | 357 J |
| Arsenic | 13.3 J |
| Barium | 81.7 J |
| Calcium | 7460 J |
| Cobalt | 3.3 J |
| Iron | 9360 J |
| Magnesium | 1550 J |
| Manganese | 29.2 J |
| Potassium | 2170 J |
| Sodium | 14600 J |

Sample ID 35-MW10S-02

| | |
|-----------|---------|
| Aluminum | 303 J |
| Arsenic | 3.5 J |
| Calcium | 75000 J |
| Iron | 152 J |
| Magnesium | 1800 J |
| Manganese | 7.5 J |
| Potassium | 860 J |
| Sodium | 9970 J |
| Vanadium | 9.1 J |
| Zinc | 6.5 J |

NOTE:
 CONTAMINANT CONCENTRATIONS ARE EXPRESSED IN MICROGRAMS PER LITER (ug/L).



LEGEND

- EMW-7 MONITORING WELL INSTALLED UNDER CS (1986) BY ESE.
- EMW-1 MONITORING WELL INSTALLED BY MUS (1990).
- MW-1 MONITORING WELL INSTALLED UNDER CSA (1991) BY LAW.
- MW-5 MONITORING WELLS INSTALLED UNDER WST SITE ASSESSMENT (1994).
- 35MW-389 MONITORING WELLS INSTALLED UNDER BAKER RI (1994).
- 35GWD-1 MONITORING WELL INSTALLED UNDER BAKER RI INVESTIGATION (1994).

FIGURE 4-3
 DETECTED INORGANICS IN THE UPPER PORTION OF THE SURFICIAL AQUIFER
 SITE 35, CAMP GEIGER FUEL FARM SGI
 CONTRACT TASK ORDER - 0232
 MARINE CORPS BASE, CAMP LEJEUNE
 NORTH CAROLINA



FEDERAL MAXIMUM CONTAMINATION LEVELS AND NORTH CAROLINA WATER QUALITY STANDARDS CLASS GA STANDARDS

| INORGANIC CONTAMINANTS | MCL (ug/L) | N.C. REGULATION (ug/L) |
|------------------------|------------|------------------------|
| ALUMINUM** | 50 | * |
| BARIUM | 2000 | 2000 |
| CALCIUM | * | * |
| COBALT | * | * |
| IRON** | 300 | 300 |
| LEAD*** | 15 | 15 |
| MAGNESIUM | * | * |
| MANGANESE** | 50 | 50 |
| POTASSIUM | * | * |
| SODIUM | * | * |
| THALLIUM | 2 | * |
| ZINC | 5000 | 2100 |

* - NO STANDARD AVAILABLE.
 ** - DENOTES THE SECONDARY MCL.
 *** - DENOTES THE FEDERAL ACTION LEVEL.

NOTES:
 CONTAMINANT CONCENTRATIONS ARE EXPRESSED IN MICROGRAMS PER LITER (ug/L).
 CONTAMINANTS THAT EXCEED N.C. REGULATIONS ARE COLORED GREEN.
 CONTAMINANTS THAT EXCEED MCLs ARE COLORED BLUE.
 CONTAMINANTS THAT EXCEED BOTH N.C. REGULATIONS AND MCLs ARE COLORED RED.

Sample ID 35-MW14D-02

| | |
|-----------|--------|
| Aluminum | 28.6 J |
| Barium | 33.7 J |
| Calcium | 119000 |
| Iron | 1070 |
| Lead | 15.4 |
| Magnesium | 2450 J |
| Manganese | 23.4 |
| Potassium | 1270 J |
| Sodium | 9560 |
| Zinc | 29.5 |

Sample ID 35-MW18D-02

| | |
|-----------|--------|
| Calcium | 96900 |
| Cobalt | 6.1 J |
| Iron | 2580 |
| Magnesium | 3440 J |
| Manganese | 275 |
| Potassium | 970 J |
| Sodium | 8380 |
| Zinc | 12.9 J |

Sample ID 35-MW19D-02

| | |
|-----------|--------|
| Aluminum | 47.8 J |
| Calcium | 109000 |
| Cobalt | 2.2 J |
| Iron | 113 |
| Magnesium | 4990 J |
| Manganese | 36.7 |
| Potassium | 3360 J |
| Sodium | 10500 |
| Thallium | 0.7 J |
| Zinc | 10.4 J |

Sample ID 35-GW05-02m

| | |
|-----------|-------|
| Aluminum | 25.9 |
| Calcium | 56900 |
| Iron | 337 |
| Magnesium | 2280 |
| Manganese | 22.1 |
| Potassium | 4400 |
| Sodium | 31900 |
| Thallium | 1 |
| Zinc | 6.7 |

Sample ID 35-MW09D-02

| | |
|-----------|--------|
| Aluminum | 26.2 J |
| Barium | 20.9 J |
| Calcium | 104000 |
| Iron | 1650 |
| Magnesium | 2260 J |
| Manganese | 19.7 |
| Potassium | 844 J |
| Sodium | 8740 |

Sample ID 35-MW29B-02

| | |
|-----------|--------|
| Calcium | 93500 |
| Iron | 933 |
| Lead | 114 J |
| Magnesium | 1890 J |
| Manganese | 17.1 |
| Potassium | 1110 J |
| Sodium | 8460 |

Sample ID 35-MW10D-02

| | |
|-----------|--------|
| Calcium | 122000 |
| Iron | 1490 |
| Lead | 1 |
| Magnesium | 2420 |
| Manganese | 19 |
| Potassium | 811 |
| Sodium | 8390 |
| Zinc | 13.8 |

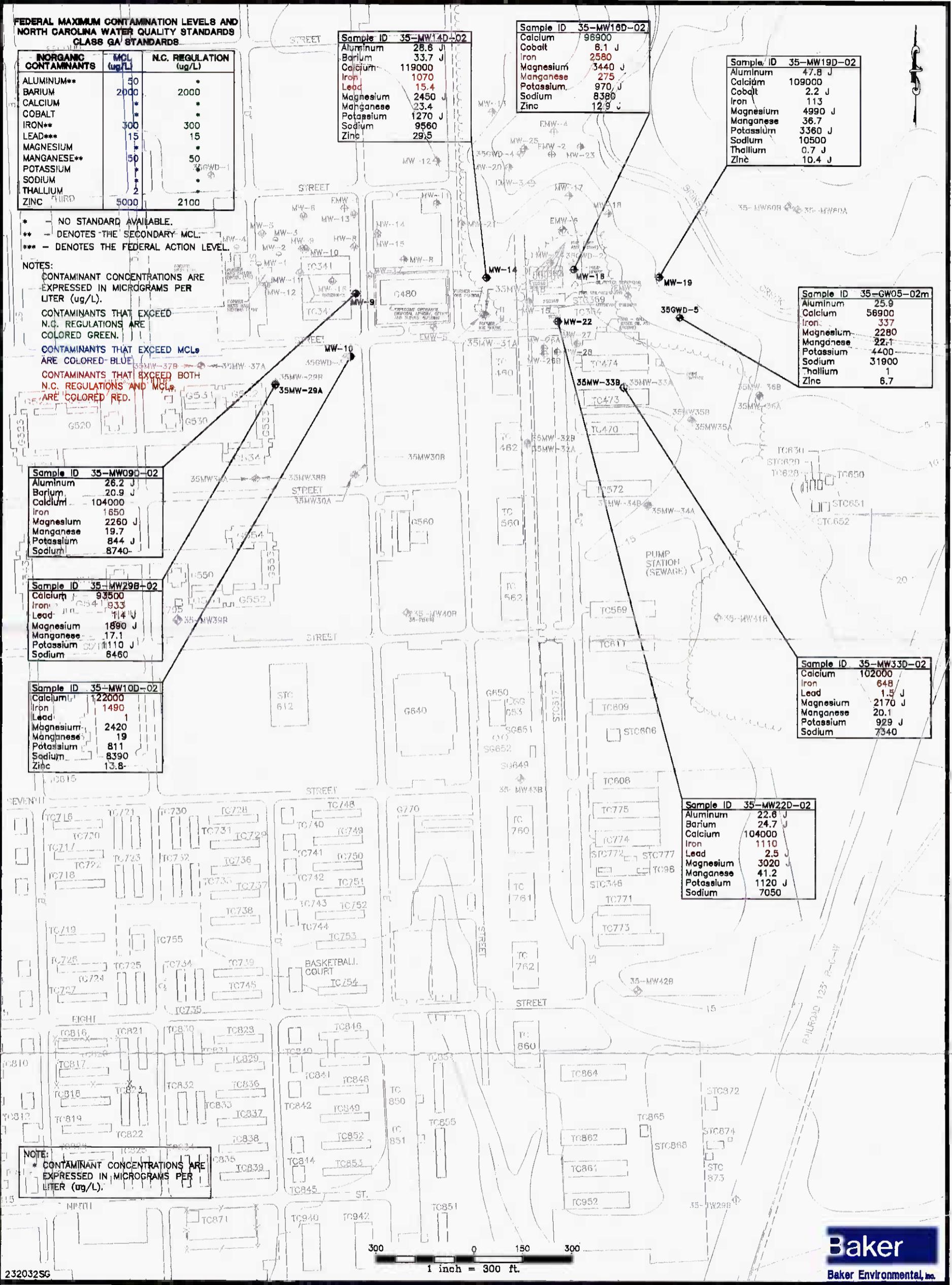
Sample ID 35-MW33D-02

| | |
|-----------|--------|
| Calcium | 102000 |
| Iron | 648 |
| Lead | 1.5 J |
| Magnesium | 2170 J |
| Manganese | 20.1 |
| Potassium | 929 J |
| Sodium | 7340 |

Sample ID 35-MW22D-02

| | |
|-----------|--------|
| Aluminum | 22.6 J |
| Barium | 24.7 J |
| Calcium | 104000 |
| Iron | 1110 |
| Lead | 2.5 J |
| Magnesium | 3020 J |
| Manganese | 41.2 |
| Potassium | 1120 J |
| Sodium | 7050 |

NOTE:
 CONTAMINANT CONCENTRATIONS ARE EXPRESSED IN MICROGRAMS PER LITER (ug/L).

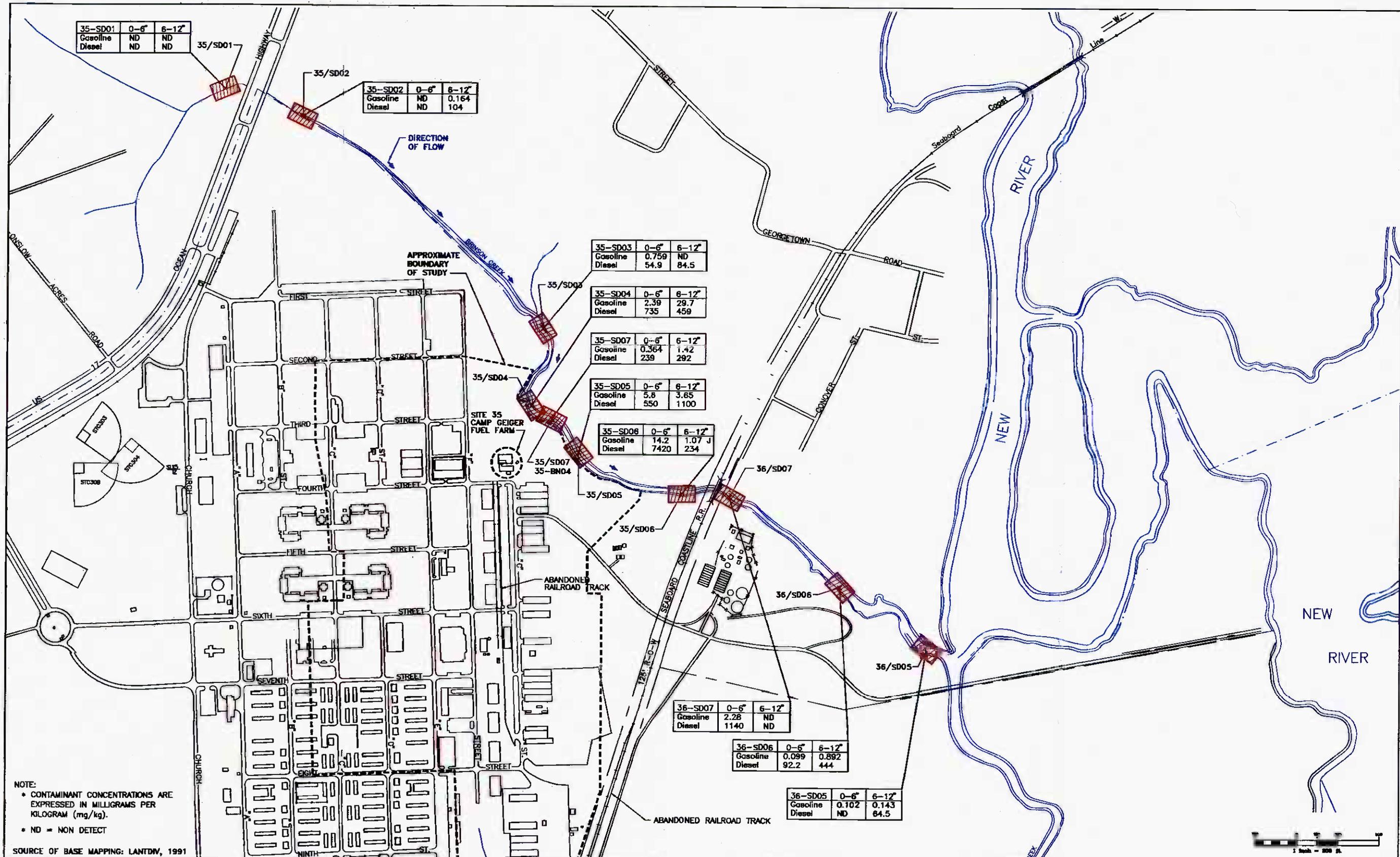


LEGEND

- EMW-7 MONITORING WELL INSTALLED UNDER CS (1986) BY ESE.
- EMW-1 MONITORING WELL INSTALLED BY NUS (1990).
- MW-1 MONITORING WELL INSTALLED UNDER CSA (1991) BY LAW.
- MW-5 MONITORING WELLS INSTALLED UNDER WST SITE ASSESSMENT (1994).
- 35MW-389 MONITORING WELLS INSTALLED UNDER BAKER RI (1994).
- 35GWD-1 MONITORING WELL INSTALLED UNDER BAKER RI INVESTIGATION (1994).

FIGURE 4-4
 DETECTED INORGANICS IN THE LOWER PORTION OF THE SURFICIAL AQUIFER AND THE CASTLE HAYNE AQUIFER
 SITE 35, CAMP GEIGER FUEL FARM SGI
 CONTRACT TASK ORDER - 0232
 MARINE CORPS BASE, CAMP LEJEUNE
 NORTH CAROLINA





| | | |
|----------|------|-------|
| 35-SD01 | 0-6" | 6-12" |
| Gasoline | ND | ND |
| Diesel | ND | ND |

| | | |
|----------|------|-------|
| 35-SD02 | 0-6" | 6-12" |
| Gasoline | ND | 0.164 |
| Diesel | ND | 104 |

| | | |
|----------|-------|-------|
| 35-SD03 | 0-6" | 6-12" |
| Gasoline | 0.759 | ND |
| Diesel | 54.9 | 84.5 |

| | | |
|----------|------|-------|
| 35-SD04 | 0-6" | 6-12" |
| Gasoline | 2.39 | 29.7 |
| Diesel | 735 | 459 |

| | | |
|----------|-------|-------|
| 35-SD07 | 0-6" | 6-12" |
| Gasoline | 0.364 | 1.42 |
| Diesel | 239 | 292 |

| | | |
|----------|------|-------|
| 35-SD05 | 0-6" | 6-12" |
| Gasoline | 5.8 | 3.65 |
| Diesel | 550 | 1100 |

| | | |
|----------|------|--------|
| 35-SD08 | 0-6" | 6-12" |
| Gasoline | 14.2 | 1.07 J |
| Diesel | 7420 | 234 |

| | | |
|----------|------|-------|
| 36-SD07 | 0-6" | 6-12" |
| Gasoline | 2.28 | ND |
| Diesel | 1140 | ND |

| | | |
|----------|-------|-------|
| 36-SD06 | 0-6" | 6-12" |
| Gasoline | 0.099 | 0.692 |
| Diesel | 92.2 | 444 |

| | | |
|----------|-------|-------|
| 36-SD05 | 0-6" | 6-12" |
| Gasoline | 0.102 | 0.143 |
| Diesel | ND | 84.5 |

NOTE:
 * CONTAMINANT CONCENTRATIONS ARE EXPRESSED IN MILLIGRAMS PER KILOGRAM (mg/kg).
 * ND = NON DETECT
 SOURCE OF BASE MAPPING: LANTDIV, 1991

36/SD01 X - LOCATION OF SEDIMENT COLLECTION POINT
 [Red Hatched Box] - SAMPLE ZONE

DATE: OCT. 1994
 SCALE: 1" = 500'
 DRAWN: W.J.H.
 REVIEWED: J.S.C.
 S.O.#: 62470-232-0060-67000
 CADD#: 25203380

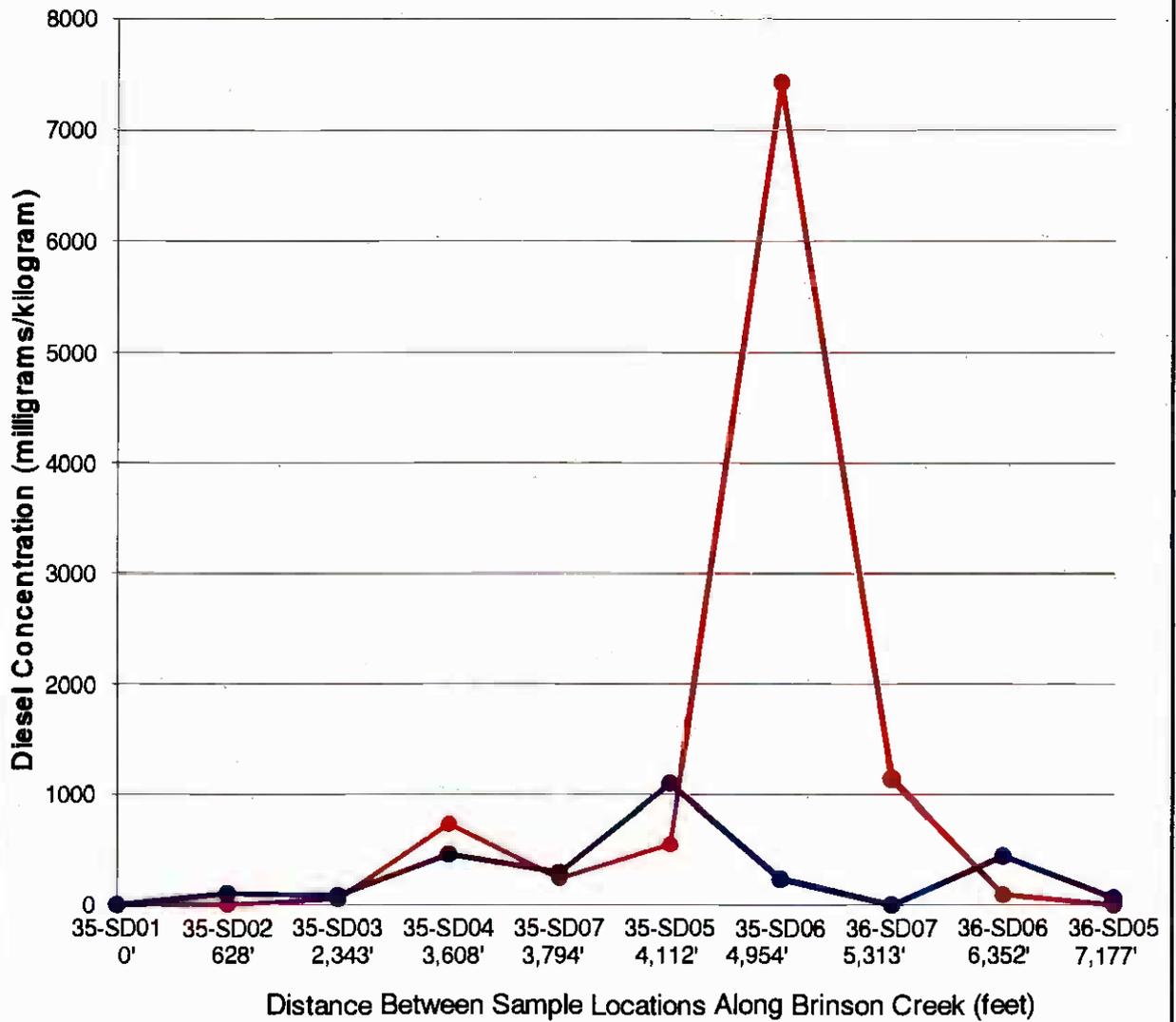


SITE 35, CAMP GEIGER AREA FUEL FARM, SGI MARINE CORPS BASE, CAMP LEJUNE NORTH CAROLINA
 BAKER ENVIRONMENTAL, Inc.
 Coraopolis, Pennsylvania



DETECTED TOTAL PETROLEUM HYDROCARBONS (TPH) IN BRINSON CREEK SEDIMENTS
 CONTRACT TASK ORDER - 0232
 SCALE: 1" = 500'
 DATE: OCT. 1994

SHEET NO.
 4-5

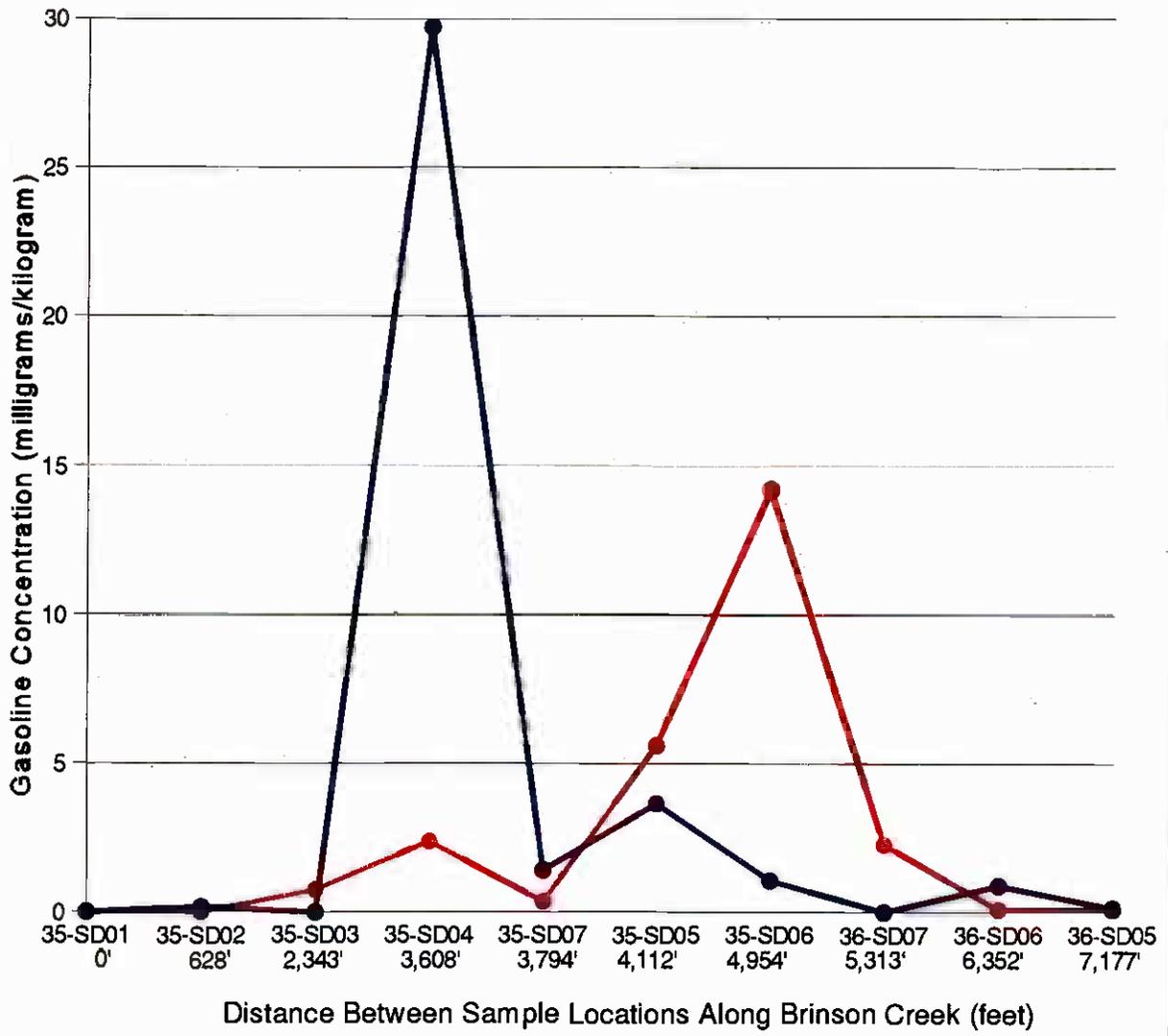


LEGEND

- Diesel Detected in Sediment 0 - 6" (mg/kg)
- Diesel Detected in Sediment 6 - 12" (mg/kg)

FIGURE 4-6

**GRAPH OF THE DIESEL CONCENTRATIONS DETECTED IN THE SEDIMENTS ALONG BRINSON CREEK
 SITE 35, CAMP GEIGER AREA FUEL FARM, SGI
 CONTRACT TASK ORDER 0232
 MARINE CORPS BASE, CAMP LEJUENE,**

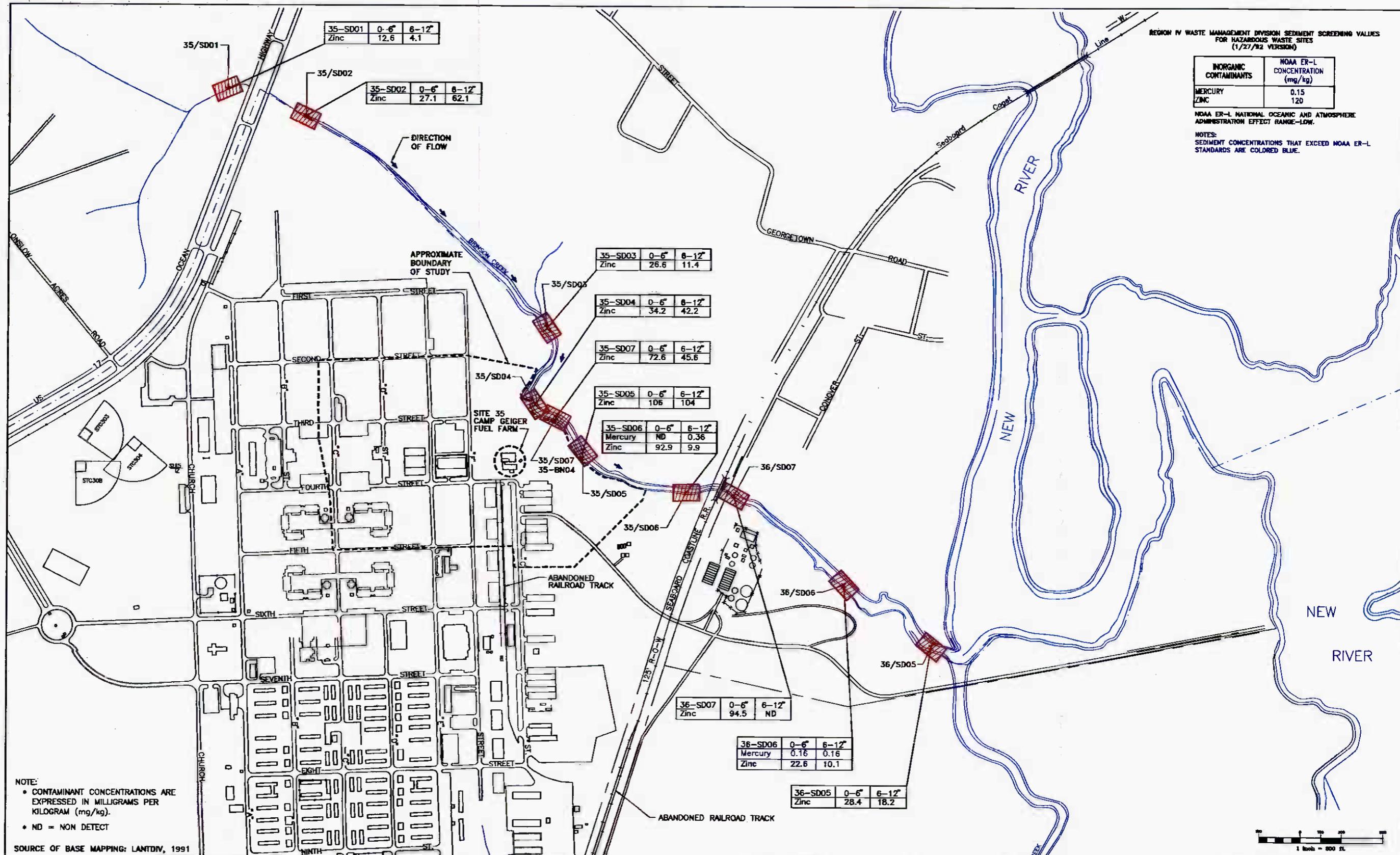


LEGEND

- Diesel Detected in Sediment 0 - 6" (mg/kg)
- Diesel Detected in Sediment 6 - 12" (mg/kg)

FIGURE 4-7

**GRAPH OF THE GASOLINE CONCENTRATIONS DETECTED IN THE SEDIMENTS ALONG BRINSON CREEK
SITE 35, CAMP GEIGER AREA FUEL FARM, SGI
CONTRACT TASK ORDER 0232
MARINE CORPS BASE, CAMP LEJUENE,
NORTH CAROLINA**



REGION IV WASTE MANAGEMENT DIVISION SEDIMENT SCREENING VALUES FOR HAZARDOUS WASTE SITES (1/27/82 VERSION)

| INORGANIC CONTAMINANTS | NOAA ER-L CONCENTRATION (mg/kg) |
|------------------------|---------------------------------|
| MERCURY | 0.15 |
| ZINC | 120 |

NOAA ER-L NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION EFFECT RANGE-LOW.

NOTES:
SEDIMENT CONCENTRATIONS THAT EXCEED NOAA ER-L STANDARDS ARE COLORED BLUE.

NOTE:
• CONTAMINANT CONCENTRATIONS ARE EXPRESSED IN MILLIGRAMS PER KILOGRAM (mg/kg).
• ND = NON DETECT

SOURCE OF BASE MAPPING: LAMTDIV, 1991

LEGEND
 36/SD01 X - LOCATION OF SEDIMENT COLLECTION POINT
 [Red Hatched Box] - SAMPLE ZONE

DATE: OCT. 1994
 SCALE: 1" = 300'
 DRAWN: W.J.H.
 REVIEWED: J.S.C.
 S.O.#: 82470-252-0000-07000
 CADD#: 23203490



SITE 35, CAMP GEIGER AREA FUEL FARM, SGI MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA
BAKER ENVIRONMENTAL, Inc.
 Coraopolis, Pennsylvania



DETECTED INORGANICS IN BRINSON CREEK SEDIMENTS
 CONTRACT TASK ORDER - 0232
 SCALE: 1" = 300'
 DATE: OCT. 1994

SHEET NO.
4-8

SECTION 4.0 REFERENCES

SECTION 4.0 REFERENCES

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5.0 CONTAMINANT FATE AND TRANSPORT

The potential for a contaminant to migrate and persist in an environmental medium is critical when evaluating the potential for a chemical to elicit an adverse human health or ecological effect. The environmental mobility of a chemical is influenced by its physical and chemical properties, the physical characteristics of the site, and the site chemistry. This section presents a discussion of the various physical and chemical properties of contaminants detected at OU No. 10, Site 35 during the SGI that impact the fate and transport of the contaminants in the environment. The basis for this discussion of contaminant fate and transport is discussed in Section 4.0, Nature and Extent of Contamination.

5.1 Chemical and Physical Properties Impacting Fate and Transport

Table 5-1 presents the physical and chemical properties associated with a representative group of organic contaminants detected at the site which determine inherent environmental mobility and fate. These properties include:

- Vapor pressure
- Water solubility
- Octanol/water partition coefficient
- Organic carbon adsorption coefficient (sediment partition)
- Specific gravity
- Henry's Law constant
- Mobility index

A discussion of the environmental significance of each of these properties follows.

Vapor pressure provides an indication of the rate at which a chemical may volatilize. It is of primary significance at environmental interfaces such as surface soil/air and surface water/air. Volatilization is not as important when evaluating groundwater and subsurface soils. Contaminants with higher vapor pressures, such as volatile organic compounds will enter the atmosphere at a quicker rate than the contaminants with low vapor pressures.

The rate at which a contaminant is leached from soil by infiltrating precipitation is proportional to its water solubility. More soluble contaminants are usually more readily leached than less soluble contaminants.

The octanol/water partition coefficient (K_{ow}) is a measure of the equilibrium partitioning of contaminants between octanol and water. A linear relationship between octanol/water partition coefficient and the uptake of chemicals by fatty tissues of animal and human receptors (the bioconcentration factor - BCF) has been established (Lyman et al., 1982). The coefficient is also useful in characterizing the sorption of compounds by organic soils where experimental values are not available.

The organic carbon adsorption coefficient (K_{oc}) indicates the tendency of a chemical to adhere to soil particles organic carbon. Contaminants with high soil/sediment adsorption coefficients generally have low water solubilities and vice versa.

Specific gravity is the ratio of the weight of a given volume of pure chemical at a specified temperature to the weight of the same volume of water at a given temperature. Its primary use is to determine whether a contaminant will have a tendency to float or sink (as an immiscible liquid) in water if it exceeds its corresponding water solubility.

Vapor pressure and water solubility are of use in determining volatilization rates from surface water bodies and from groundwater. These two parameters can be used to estimate an equilibrium concentration of a contaminant in the water phase and in the air directly above the water. This can be expressed as Henry's Law Constant.

A quantitative assessment of mobility has been developed that uses water solubility (S), vapor pressure (VP), and organic carbon partition coefficient (K_{oc}) (Laskowski, 1983). This value is referred to as the Mobility Index (MI). It is defined as:

$$MI = \log((S*VP)/K_{oc})$$

A scale to evaluate MI is presented by Ford and Gurba (1984):

| <u>Relative MI</u> | <u>Mobility Description</u> |
|--------------------|-----------------------------|
| > 5 | extremely mobile |
| 0 to 5 | very mobile |
| -5 to 0 | slightly mobile |
| -10 to -5 | immobile |
| < -10 | very immobile |

5.2 Contaminant Transport Pathways

Based on the evaluation of existing conditions at Site 35 during the SGI, the following potential contaminant transport pathways have been identified.

- Leaching of sediment contaminants to surface water.
- Migration of groundwater contaminants off site.
- Groundwater infiltration from the shallow aquifer to the deep aquifer.
- Groundwater discharge to surface water.

Contaminants released to the environment could also undergo the following during transportation:

- Physical transformations: volatilization, precipitation
- Chemical transformations: photolysis, hydrolysis, oxidation, reduction
- Biological transformation: biodegradation
- Accumulation in one or more media

The following paragraphs describe the potential transport pathways listed above.

5.2.1 Leaching of Sediment Contaminants to Surface Water

When in contact with surface water, contaminants attached to sediment particles can disassociate from the sediment particle into surface water. This is primarily influenced by the physical and

chemical properties of the contaminant, (i.e., water solubility, K_{oc}) and the physical and chemical properties of the sediment particle (i.e., grain size, f_{oc}).

Surface water sample analytical results indicate that there has not been significant leaching of sediment contaminants into surface water (Section 4.0), based on the infrequent occurrence and level of contamination.

5.2.2 Migration of Groundwater Contaminants

Contaminants leaching from soils to underlying groundwater can migrate as dissolved constituents in groundwater in the direction of groundwater flow. Three general processes govern the migration of dissolved contaminants caused by the flow of water: (1) advection, movement caused by flow of groundwater; (2) dispersion, movement caused by irregular mixing of waters during advection; and (3) retardation, principally chemical mechanisms which occur during advection. Subsurface transport of the immiscible contaminants is governed by a set of factors different from those of dissolved contaminants. The potential movement of immiscible organic liquids (non-aqueous phase liquids) will not be discussed in this section.

Advection is the process which most strongly influences the migration of dissolved organic solutes. Groundwater, under water table aquifer conditions (i.e., unconfined aquifer), generally flows from regions of the subsurface where the water table is under a higher head to regions (i.e., recharge areas) of where the water table is under a lower head (i.e., discharge areas). Hydraulic gradient is the term used to describe the magnitude of this force (i.e., the slope of the water table). In general, the gradient usually follows the topography for shallow, uniform sandy aquifers which are commonly found in coastal regions. In general, groundwater flow velocities, in sandy aquifers, under natural gradient conditions are probably between 10 meters/year to 100 meters/year (Lyman, et al., 1982).

The average seepage velocity of groundwater flow at Site 35 for both the shallow and deep water-bearing zones can be estimated using a variation of Darcy's Equation:

$$V_x = \frac{Ki}{N_e} \quad (\text{Fetter, 1988})$$

Where:

| | | |
|-------|---|---------------------------------|
| V_x | = | average seepage velocity |
| K | = | hydraulic conductivity (cm/sec) |
| i | = | hydraulic gradient |
| N_e | = | effective porosity |

Thus, when monitoring wells or potable supply wells in sand aquifers are located hundreds of meters downgradient of a contaminant source, the average travel time for the groundwater to flow from the source to the well point is typically on the order of years. In the zone of influence created by a high capacity production well or well field, however, the artificially increased gradient could substantially increase the local velocity, and the average travel times for groundwater flow are increased.

Dispersion results from two basic processes, molecular diffusion and mechanical mixing. The kinetic activity of dissolved solutes result in diffusion of solutes from a zone of high concentration to a lower concentration. Dispersion and spreading during transport result in the dilution of

contaminants (maximum concentration of contaminant decreases with distance from the plume). For simple hydrogeological systems, the spreading is reported to be proportional to the flow rate. Furthermore, dispersion in the direction of flow is often observed to be markedly greater than dispersion in the directions transverse (perpendicular) to the flow. In the absence of detailed studies to determine dispersive characteristics at Site 35, longitudinal and transverse dispersivities are estimated based on similar hydrogeological systems (Mackay, et al., 1985).

Some dissolved contaminants may interact with the aquifer solids encountered along the flow path through adsorption, partitioning, ion exchange, and other processes. The interactions result in the contaminant distribution between aqueous phase and aquifer solids, diminution of concentrations in the aqueous phase, and retardation of the movement of the contaminant relative to groundwater flow. The higher the fraction of the contaminant sorbed, the more retarded its transport. Certain halogenated organic solvents sorption is affected by hydrophobicity (antipathy for dissolving in water) and the fraction of solid organic matter in the aquifer solids (organic carbon content). If the aquifer below Site 35 is homogeneous, sorption of hydrophobic organic solute should be constant in space and time. If the sorptive interaction is at equilibrium and completely reversible, the solute should move at a constant average velocity equal to the groundwaters average velocity divided by the retardation factor.

Organic contaminants can be transformed into other organic compounds by a complex set of chemical and biological mechanisms. The principal classes of chemical reactions that can affect organic contaminants in water are hydrolysis and oxidation. However, it is believed that most chemical reactions occurring in the groundwater zone are likely to be slow compared with transformations mediated by microorganisms. Certain organic groundwater contaminants can be biologically transformed by microorganisms attached to solid surfaces within the aquifer. Factors which affect the rates of biotransformation of organic compounds include: water temperature and pH, the number of species of microorganisms present, the concentration of substrate, and presence of microbial toxicants and nutrients, and the availability of electron acceptors. Transformation of a toxic organic solute is no assurance that it has been converted to harmless or even less harmful products. Biotransformation of common groundwater contaminants, such as TCE, TCA, and PCE, can result in the formation of such intermediates as vinyl chloride (Mackay, et al., 1985).

The interaction of non-ionic organic compounds with solid phases can also be used to predict the fate of the highly nonpolar organic contaminants (i.e., 4,4'-DDT, PCBs). Sorptive binding is proportional to the organic content of the sorbent. Sorption of non-ionic organic pesticides can be attributed to an active fraction of the soil organic matter (Lyman et al., 1982). The uptake of neutral organics by soils results from their partitioning to the solutes aqueous solubility and to its liquid-liquid (e.g., octanol-water) partition coefficient. Currently, information is available on the interrelation of soil organic properties to the binding of pesticides, herbicides, and high molecular weight pollutants such as PCBs. However, data is lacking for the non-ionic components of solvents and fuels, which may potentially be responsible for groundwater contamination at Site 35. Organic matrices in natural systems that have varying origins, degrees of humification, and degrees of association with inorganic matrices exhibit dissimilarities in their ability to sorb non-ionic organic contaminants.

The soils and sediments formed or deposited on the land surface can act as a reservoir for inorganic contaminants. Soils contain surface-active mineral and humic constituents involved in reactions that affect metal retention. The surfaces of fine-grained soil particles are very active chemically; surface sites are negatively or positively charged or they are electronically neutral. Oppositely charged

metallic counterions from solutions in soils (i.e., groundwater) are attracted to these charged surfaces. The relative proportions of ions attracted to these various sites depends on the degree of acidity or alkalinity of the soil, on its mineralogical composition, and on its content of organic matter. The extent of adsorption depends on either the respective charges on the adsorbing surface and the metallic cation. In addition to these adsorption reactions, precipitation of new mineral phases also may occur if the chemical composition of the soil solution becomes supersaturated with respect to the insoluble precipitates. Of the probable precipitates, the most important of these phases are hydroxides, carbonates, and sulfides. The precipitation of hydroxide minerals is important for metals such as iron and aluminum, the precipitation of carbonate minerals is significant for calcium and barium, and the precipitation of sulfide minerals dominates the soil chemistry of zinc, cadmium, and mercury. A number of precipitates may form if metals are added to soils, the concentration of metal in solution, will be controlled, at equilibrium, by the solid phase that results in the lowest value of the activity of the metallic ion in solution (Evans, 1989).

5.2.3 Groundwater Discharge to Surface Water

Groundwater discharge to Brinson Creek is very likely at Site 35. Groundwater can transport contamination to Brinson Creek but is dependent on the solubility of the contamination. Like groundwater flow, three general processes govern the flow of the water: advection, dispersion and retardation. These three processes are described in detail in Section 5.2.5.

5.2.4 Groundwater Infiltration from the Shallow to the Deep Aquifer

Vertical movement of groundwater from one aquifer system to another, through a semi-confining unit is dependent on a number of factors including: intrinsic permeability of all involved units; density of the fluid (i.e., water and/or contaminant); viscosity of the fluid; hydraulic head; unit thickness; effective porosity; and bulk density of the soil comprising the semi-confining unit. At Site 35, the vertical hydraulic gradient (h) was calculated using the four deep wells (completed below the confining unit) and adjacent intermediate wells (terminated at the confining unit). A potential for downward movement through the semi-confining unit exist in the vicinity of 35GWD-05/MW-19D and 35GWD-3/MW-10D. The portions of the site represented by 35GWD-04/MW-25D and 35GWD-02/MW-16D indicate that a potential for upward movement through the semi-confining unit exists.

VOC contaminants concentrations above NCWQS or Federal MCLs were not detected in the deep wells indicating that contamination has not migrated from the shallow to the deep aquifer.

5.3 Fate and Transport Summary

The following paragraphs summarize the contaminant group fate and transport data for contaminants detected in media collected at Site 35.

5.3.1 Volatile Organic Compounds

VOCs (i.e., 1,2-dichloroethene, and TCE) tend to be mobile in environmental media as indicated by their presence in groundwater and their corresponding MI values. Their environmental mobility is a function of high water solubilities, high vapor pressures, low K_{ow} and K_{oc} values, and high mobility indices.

Without a continuing source, VOCs do not generally tend to persist in environmental media because photolysis, oxidation, and biodegradation figure significantly in their removal.

5.3.2 Inorganics

Inorganics can be found as solid complexes at ambient temperature and pressure in soils at the site. Inorganic ions exist in pure solutions as hydrated ions. Groundwater, as opposed to a pure solution, is a highly complex chemical system which is heavily influenced by the mineralogy of the substrate. Factors affecting the transport of inorganics in saturated soils are interactive and far more complex and numerous than those affecting the transport of organic contaminants.

The most complicated pathway for inorganic contaminants is migration in subsurface soils and groundwaters, where oxidation reduction potential (Eh) and pH play critical roles. Table 5-2 presents an assessment of relative inorganic environmental mobilities as a function of Eh and pH. Soils at MCB Camp Lejeune are relatively neutral, therefore, inorganics in the subsurface soil should be relatively immobile.

Transport of inorganic species in groundwater is mainly a function of the inorganic's solubility in solution under the chemical conditions of the soil-solution matrix. The inorganic must be dissolved (i.e., in solution) for leaching and transport by advection with the groundwater to occur. Generally, dynamic and reversible processes control solubility and transport of the dissolved metal ions. Such processes include precipitation/dissolution, adsorption/desorption, and ion exchange.

Inorganics could be sorbed onto colloidal materials, theoretically increasing their inherent mobility in saturated porous media. It is important to note, however, that colloids themselves are not mobile in most soil/water systems.

Inorganics such as arsenic and chromium depend upon speciation to influence their mobility. Speciation varies with the chemistry of the environmental medium and temporal factors. These variables make the site-specific mobility of an inorganic constituent difficult to assess.

SECTION 5.0 TABLES

TABLE 5-1

**ORGANIC PHYSICAL AND CHEMICAL PROPERTIES
SITE 35, CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION
MCB CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232**

| Chemical | Vapor Pressure (mm Hg) | Water Solubility (mg/l) | Octanol/Water Coefficient (log K_{ow}) | Sediment Partition (log K_{oc}) | Specific Gravity (g/cm ³) | Henry's Law Constant (atm-m ³ /mole) | Mobility Index | Comments |
|---------------------------|------------------------|-------------------------|---|------------------------------------|---------------------------------------|---|----------------|-------------|
| Volatiles: | | | | | | | | |
| Benzene | 76 | 1780 | 2.13 | 1.92 | 0.879 | 5.55E-03 | 3.2 | Very mobile |
| cis-1,2-Dichloroethene | 208 | 3,500 | .70 | 1.69 | -- | 7.95E-03 | -- | -- |
| trans-1,2-Dichloroethen | 324 | 6,300 | .48 | 1.77 | 1.26 | 6.56E-03 | 2.9 | |
| 1,1-Dichloroethene | 500 | 400 | 1.48 | 2.26 | 1.218 | 1.90E-01 | 3.0 | Very mobile |
| Ethylbenzene | 7 | 152 | 3.15 | 2.93 | 0.867 | 6.44E-03 | 0.1 | Very mobile |
| Tetrachloroethene | 14 | 150 | 2.6 | 2.6 | 1.626 | 2.87E-03 | 0.75 | Very mobile |
| Toluene | 22 | 515 | 2.69 | 2.54 | 0.867 | 5.90E-03 | 1.5 | Very mobile |
| 1,1,2-Trichloroethane | 19 | 4500 | 2.17 | 1.75 | 1.44 | 7.42E-04 | 3.2 | Very mobile |
| 1,1,2,2-Tetrachloroethane | 5 | 2900 | 2.39 | 2.07 | 1.60 | 3.83E-04 | 2.2 | Very mobile |
| Trichloroethene | 60 | 1100 | 2.29 | 2.09 | 1.46 | 1.17E-03 | 2.7 | Very mobile |
| Xylenes (total) | 6 | 180 | 3.02 | 2.84 | 0.87 | 4.64E-03 | 0.19 | Very mobile |

- Sources:
1. Verscheuren, K. 1983. Handbook of Environmental Data on Organic Chemicals. Van Nostrand Reinhold Co., New York.
 2. Lyman, et al. 1982. Handbook of Chemical Property Estimation Methods. Environmental Behavior of Organic Compounds.
 3. USEPA. 1982. Aquatic Fate Process Data for Organic Priority Pollutants. Final Report.

TABLE 5-2

RELATIVE MOBILITIES OF INORGANICS AS A FUNCTION OF ENVIRONMENTAL CONDITIONS (Eh, pH)
 SITE 35, CAMP GEIGER AREA FUEL FARM
 SUPPLEMENTAL GROUNDWATER INVESTIGATION
 MCB CAMP LEJEUNE, NORTH CAROLINA
 CONTRACT TASK ORDER 0232

| Relative Mobility | Environmental Conditions | | | |
|-------------------|---------------------------|---------------------------|---------------------------|---|
| | Oxidizing | Acidic | Neutral/ Alkaline | Reducing |
| Very high | | | Se | |
| High | Se, Zn | Se, Zn, Cu, Ni, Hg, Ag | | |
| Medium | Cu, Ni, Hg, Ag, As, Cd | As, Cd | As, Cd | |
| Low | Pb, Ba, Se | Pb, Ba, Be | Pb, Ba, Be | |
| Very Low | Fe, Cr | Cr | Cr, Zn, Cu, Ni, Hg, Ag | Cr, Se, Zn, Cu, Ni, Hg, Pb, Ba, Be, Ag |

Notes:

| | | | | | |
|----|---|----------|----|---|-----------|
| Se | = | Selenium | Cd | = | Cadmium |
| Zn | = | Zinc | Ba | = | Barium |
| Cu | = | Copper | Pb | = | Lead |
| Ni | = | Nickel | Fe | = | Iron |
| Hg | = | Mercury | Cr | = | Chromium |
| Ag | = | Silver | Be | = | Beryllium |
| As | = | Arsenic | Zn | = | Zinc |

Source: Swartzbaugh, et al., "Remediating Sites Contaminated with Heavy Metals." Hazardous Materials Control, November/December 1992.

SECTION 5.0 REFERENCES

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6.0 BASELINE HUMAN HEALTH RISK ASSESSMENT

The following subsections present a human health risk assessment conducted on recent groundwater data collected for the Supplemental Groundwater Investigation (SGI) for Operable Unit No. 10, Site 35. The assessment was performed in accordance with "Risk Assessment Guidance for Superfund, Human Health Evaluation Manual: Part A" and USEPA Region IV Supplemental Guidance (USEPA, 1989a, USEPA, 1992c). The purpose of this risk assessment is to assess whether the constituents of concern in the groundwater at the site pose a current or potential future risk to human health (based on the most recent data) in the absence of remedial action.

Following recommendations given in the initial RI, additional data were collected. Supplemental data included 20 groundwater samples collected in August 1995 for inorganic analysis using the low-flow sampling technique. A quantitative and qualitative risk assessment was conducted using the inorganic data to determine if the noncarcinogenic risks found in the original risk assessment were reduced by applying this sampling technique for the collection of groundwater samples. Due to the reduction in suspended particulates using the low-flow sampling technique, the analytical findings are believed to better represent the nature of the groundwater and therefore, are more reliable in assessing the risk. Thirty groundwater samples were collected in April 1996 (referred to as Round 4) and analyzed for volatile organic compounds (VOCs). The additional VOC data was collected to delineate the VOC contamination across the site. Because the additional VOC data was collected to define the limits of the plume, this data was not used for human health risk assessment purposes. However, VOC data are discussed qualitatively in this section.

6.1 Introduction

This supplemental risk assessment investigates the potential for groundwater contaminants of potential concern (COPCs) to affect human health and/or the environment, both now and in the future, under a "no further remedial action scenario." The BRA process evaluates the data generated during the sampling and analytical phase of the SGI to supplement the results of the initial risk assessment conducted as part of the RI (Baker, 1994). Contaminant intakes by hypothetical receptors are determined and combined with the toxicological properties of the contaminants to estimate (inferentially) the potential public health impacts posed by constituents detected in Site 35 groundwater. The Round 4 VOC contaminants are discussed qualitatively, while the low-flow purge inorganic data will be evaluated quantitatively, as well as qualitatively, and combined with the organic risk results from the data collected for the initial RI (referred to as Round 2 and 3). The development of exposure scenarios is consistent with the methodology for baseline risk assessment, as specified by USEPA.

The components of the BRA include:

- Identification of contaminants of potential concern
- The exposure assessment
- The toxicity assessment
- Risk characterization
- Uncertainty analysis
- Conclusions of the BRA and potential site risk

The text of this BRA is divided into seven sections, including the introduction. Included in the introduction is a summary of the results of the risk assessment from the initial RI. Section 6.2

establishes the criteria for the selection of COPCs. The groundwater COPCs were chosen (qualitatively for Round 4 VOCs and quantitatively, as well as qualitatively, for low-flow purge inorganics) from an overall list of contaminants detected at the site. Section 6.3 discusses the site characteristics, identifies potential human exposure pathways, and describes potential future exposure scenarios, and calculates potential exposure by estimating daily intakes. In addition, advisory criteria for the evaluation of human health is discussed. Section 6.4 discusses toxicological information for the COPCs. Section 6.5 discusses the risk characterization. Section 6.6 discusses the sources of uncertainty in the BRA. Section 6.7 provides the conclusion for the potential human health impacts in the form of total site risks from groundwater. Referenced tables and figures are presented after the text portion of this section.

Conclusions of Initial BRA for Site 35

Under the initial BRA prepared for the RI, surface soil, subsurface soil, groundwater, surface water, sediment, and biota were evaluated as media of concern. Potential receptors included current recreational adult and child, current military personnel, future construction worker, and future adult and child residents. The following conclusions were made.

The total site ICR for the current recreational child (4.4×10^{-7}), current recreational adult (1.9×10^{-5}), and current military personnel (3.1×10^{-6}) were within the USEPA's upper bound risk range (1×10^{-6} to 1×10^{-4}); therefore, adverse effects were considered unlikely. The total site HI for the current recreational child (0.01) and current military personnel (0.09) did not exceed unity. Therefore, adverse effects were considered unlikely. The total site HI for the current recreational adult (1.8) was slightly above unity. The total site risk for the current residential adult was due to potential exposure from fish fillet ingestion which is driven by the presence of mercury. However, the exposure parameters used to calculate risk from fish ingestion are very conservative; mercury was not found to be causing a risk in any other media at Site 35; and the fish collected at Site 35 were considered migratory and move along Brinson Creek, therefore this risk may not be related to contamination at the site. Consequently, the risk from ingestion of fish is believed to be unrelated to the site.

The total site ICR and HI for the future construction worker (1.2×10^{-7} and 0.02, respectively) were below the USEPA's risk range; therefore, risk to this receptor was considered unlikely. The total site ICR for future adult residents (4.3×10^{-3}) and future child residents (2.1×10^{-3}) exceeded the USEPA's upper bound risk range (1×10^{-6} to 1×10^{-4}). The total site risk for both receptors was driven by future potential exposure to arsenic and beryllium in the groundwater. The total site HI for the future adult resident (44) and the future child resident (104) exceeded unity. The total site risk was driven by future potential exposure to groundwater. The HI values were driven by the presence of cis-1,2-dichloroethene, trichloroethene, benzene, antimony, arsenic, barium, chromium, cadmium, manganese, and vanadium.

6.2 Contaminants of Potential Concern

COPCs are site-related contaminants used to quantitatively estimate human exposures and associated potential health effects and qualitatively assess contaminant levels. This risk assessment qualitatively and quantitatively evaluates groundwater only. The discussion of findings presented in Section 4.0, Nature and Extent of Contamination, was used as the basis for this section.

6.2.1 Criteria for Selecting Contaminants of Potential Concern

Quantifying risk for all positively identified contaminants may distract from the dominant risk driving contaminants at the site. Therefore, the data set was reduced to a list of COPCs. COPCs are site-related contaminants used to quantitatively estimate human exposures and associated potential health effects. In order to assess qualitative risks, all contaminants must be retained unless contaminant levels can be attributed to sources other than the site (i.e., blank contamination).

The criteria used in selecting the COPCs from the constituents detected during the field sampling and analytical phase of the supplemental groundwater investigation were:

- Historical information
- Prevalence
- Mobility
- Persistence
- Toxicity
- Comparison to USEPA Region III Risk-Based Contaminant of Concern (COC) Screening Values
- Examination of federal and state criteria and standards
- Comparison to investigation associated field and laboratory blank data
- Comparison to anthropogenic levels

The criteria chosen to establish the COPCs are based on the guidance in the USEPA's Risk Assessment Guidance for Superfund (USEPA, 1989a). A comparison to contaminant-specific criteria was also considered in the selection of COPCs. A brief description of the selection criteria used in choosing final COPCs is presented below. A contaminant did not need to fit into all of these categories in order to be retained as a COPC.

6.2.1.1 Historical Information

Using historical information to associate contaminants with site activities, when combined with the following selection procedures, helps determine contaminant retention or elimination. A description of Site 35, including the site history and summary of past activities, is given in Section 1.0.

6.2.1.2 Prevalence

The frequency of positive detections in sample sets and the level at which a contaminant is detected in a given medium are factors that determine a chemical's prevalence. The occurrence of a chemical must be evaluated with respect to the number of samples taken to determine the frequency criterion which warrants the inclusion of a chemical as a COPC. Contaminants that are infrequently detected, may be artifacts in the data due to sampling or analytical practices. A contaminant may not be retained for quantitative evaluation in the BRA if: 1) it is detected infrequently in an environmental medium (i.e., equal to or less than 5 percent when at least 20 samples of a medium are available); 2) it is absent or detected at low concentrations in other media; or, 3) site history does not provide evidence the contaminant to be present. Physiochemical properties (i.e., fate and transport) and toxicological properties for each infrequently detected constituent were evaluated.

6.2.1.3 Mobility

The physical and chemical properties of a contaminant are responsible for its transport in the environment. These properties, in conjunction with site conditions, determine whether a contaminant will tend to volatilize into the air from surface soils or surface waters, or be transported via advection or diffusion through soils, groundwaters, and surface waters. Physical and chemical properties also describe a contaminant's tendency to adsorb onto soil/sediment particles. Environmental mobility can correspond to either an increased or decreased potential to affect human health and/or the environment.

6.2.1.4 Persistence

The persistence of a contaminant in the environment depends on factors such as the microbial content of soil and water, organic carbon content, the concentration of the contaminant, climate, and the ability of the microbes to degrade the contaminant under site conditions. In addition, chemical degradation (i.e., hydrolysis), photochemical degradation and certain fate processes such as sorption may contribute to the elimination or retention of a particular compound in a given medium.

6.2.1.5 Toxicity

The potential toxicity of a contaminant is an important consideration when selecting COPCs for further evaluation in the human health assessment. For example the weight-of-evidence (WOE) classification should be considered in conjunction with concentrations detected at the site. Some effects considered in the selection of COPCs include carcinogenicity, mutagenicity, teratogenicity, systemic effects, and reproductive toxicity. Bioaccumulation and bioconcentration properties may affect the severity of the toxic response in an organism and/or subsequent receptors and are evaluated if relevant data exist.

Despite their inherent toxicity, certain inorganic contaminants are essential nutrients. Essential nutrients need not be considered for further consideration in the quantitative risk assessment if they are present in relatively low concentration (i.e., below two times the average base-specific background levels or slightly elevated above naturally occurring levels), or if the contaminant is toxic at doses much higher than those which could be assimilated through exposures at the sites.

6.2.1.6 USEPA Region III COC Screening Values

COC screening values are derived using conservative USEPA promulgated default values and the most recent toxicological criteria available. COC screening values for potentially carcinogenic and noncarcinogenic chemicals are individually derived based on a target incremental lifetime cancer risk (ICR) of 1×10^{-6} and a target hazard quotient of 0.1, respectively. For potential carcinogens, the toxicity criteria applicable to the derivation of COC screening values are oral and inhalation cancer slope factors; for noncarcinogens, they are chronic oral and inhalation reference doses. These toxicity criteria are subject to change as more updated information and results from the most recent toxicological/epidemiological studies become available. Therefore, the use of toxicity criteria in the derivation of COC screening values requires that the screening concentrations be updated periodically to reflect changes in the toxicity criteria.

The COC screening values can be updated by incorporating information from another set of tables containing risk-based concentrations (RBCs) that are issued by USEPA Region III on a semi-annual

basis. The RBCs are derived using the same equations and USEPA promulgated default exposure assumptions that were used by Region III to derive the COC screening values. In addition, the RBCs for potentially carcinogenic chemicals are based on a target ICR of 1×10^{-6} . The only difference in the derivation methodologies for the COC screening values and the RBCs is that the RBCs for noncarcinogens are based on a target hazard quotient of 1.0 rather than 0.1. The COC screening values for noncarcinogens are to be derived based on a target hazard quotient of 0.1, to account for cumulative risk from multiple chemicals in a medium. Re-derivation of the noncarcinogenic RBCs based on a target hazard quotient of 0.1, while using the most recent toxicological criteria available, results in a set of values that can be used as COC screening values. In other words, an updated set of COC screening values can be attained twice a year by using the carcinogenic RBCs issued semi-annually by USEPA Region III and dividing the accompanying noncarcinogenic RBCs by a factor of 10. It should be noted that the most recent update was published in June of 1996.

6.2.1.7 State and Federal Criteria and Standards

Contaminant concentrations in aqueous media can be compared to contaminant-specific state and federal criteria. This risk assessment utilizes North Carolina Water Quality Standards (NCWQS) for groundwater. The only enforceable federal regulatory standards for water are Federal Maximum Contaminant Levels (MCLs).

Regulatory guidelines are used, when necessary, to infer potential health risks and environmental impacts. Health Advisories (HA) are relevant regulatory guidelines. An explanation of the federal and state criteria and standards used for qualitative evaluation of contaminants is presented below.

North Carolina Water Quality Standards (Groundwater) - NCWQSs are the maximum allowable concentrations resulting from any discharge of contaminants to the land or waters of the state, which may be tolerated without creating a threat to human health or which otherwise render the groundwater unsuitable for its intended purpose.

Maximum Contaminant Levels - MCLs are enforceable standards for public water supplies promulgated under the Safe Drinking Water Act and are designed for the protection of human health. MCLs are based on laboratory or epidemiological studies and apply to drinking water supplies consumed by a minimum of 25 persons. They are designed for prevention of human health effects associated with a lifetime exposure (70-year lifetime) of an average adult (70 kg) consuming two liters of water per day. MCLs also consider the technical feasibility of removing the contaminant from the public water supply.

Health Advisories - HAs are guidelines developed by the USEPA Office of Drinking Water for nonregulated constituents in drinking water. These guidelines are designed to consider both acute and chronic toxic effects in children (assumed body weight 10 kg) who consume 1 liter of water per day or in adults (assumed body weight 70 kg) who consume 2 liters of water per day. HAs are generally available for acute (1 day), and subchronic (10 days), and chronic (longer-term) exposure scenarios. These guidelines are designed to consider only threshold effects and, as such, are not used to set acceptable levels of potential human carcinogens (USEPA, 1994a).

6.2.1.8 Contaminant Concentrations in Blanks

The association with contaminants detected in field related blanks (i.e., trip blanks, equipment rinsates and/or field blanks) or laboratory method blanks with the same contaminants detected in

analytical samples may eliminate non-site-related contaminants from the list of COPCs. Blank data should be compared with results from samples with which the blanks are associated. However, due to the difficulty in determining this association between certain blanks and data, the maximum contaminant concentrations reported in the blanks will be compared to the entire sample data set to evaluate COPCs. In accordance with the National Functional Guidelines for Organics common lab contaminants (i.e., acetone, 2-butanone, methylene chloride, toluene, and phthalate esters) should be considered attributable to site activities only if the concentrations in the sample exceed ten times the maximum amount detected in any blank. If a contaminant is not a common lab contaminant, then concentrations that are less than five times the concentration found in any blank are believed to be non-site-related. The elimination of a sample result will directly correlate to a reduction in the prevalence of contaminant in a media. Consequently, a contaminant that may have been included on the basis of prevalence would be eliminated as a COPC if elimination due to blank concentration reduces the prevalence of a contaminant to less than five percent.

Blanks containing organic constituents that were not considered common laboratory contaminants (i.e., all other TCL compounds) were considered as positive results only when observed concentrations exceeded five times the maximum concentration detected in any blank (USEPA, 1989a). All TCL compounds at less than five times the maximum level of contamination noted in any blank were considered to be not detected in that sample. The maximum concentrations of the detected blank contaminants were as follows:

- Benzene 18 µg/L
- Trichloroethene 3J µg/L

Although these were the compounds detected in the blanks associated with Site 35 Round 4 groundwater samples, it should be noted that it was the professional opinion of the independent third-party validator that these positive detections were laboratory artifacts and should not be used to qualify environmental data (refer to Section 4.0 for further information).

6.2.1.9 Anthropogenic Levels

Ubiquitous anthropogenic background concentrations result from non-site related sources such as combustion of fossil fuels (i.e., automobiles), plant synthesis, natural fires and factories. A good example of ubiquitous, anthropogenic chemicals in environmental are the PAHs. In general, anthropogenic chemicals were not eliminated as COPCs without considering other selection criteria. It is difficult to determine that such chemicals are present at the site due to operations not related to the site or the surrounding area. Omitting anthropogenic background chemicals from the risk assessment could result in the loss of important information for those potentially exposed.

6.2.2 Selection of Contaminants of Potential Concern

Round 4 VOCs

Under the SGI, 30 groundwater samples were analyzed for VOCs and evaluated qualitatively in this risk assessment. Table 6-1 presents the VOCs detected in the groundwater. The positive detections of benzene and trichloroethene in the environmental samples were not considered to be blank related based on the professional opinion of the third-party validator. All detected VOCs were retained as qualitative groundwater COPCs for the SGI.

Low-Flow Purge Inorganics

Twenty groundwater samples were collected using a low-flow purge sampling method and analyzed for inorganics. The analytical findings are evaluated quantitatively in this risk assessment. Table 6-2 presents the inorganics detected in the groundwater. Calcium, magnesium, potassium, and sodium were not retained as COPCs because they are considered essential nutrients and are not expected to cause adverse effects at the detected concentrations. Aluminum, barium, cobalt, selenium, silver, vanadium, and zinc were detected at concentrations less than their respective tap water COC screening values; and therefore, were not retained as COPCs. Antimony was detected infrequently (1 out of 20, 5 percent); and therefore, was not retained as a groundwater COPC. Lead was detected at a maximum concentration of 15.4 µg/L, which exceeded the lead action level of 15 µg/L for groundwater. However, the average lead concentration was 6.1 µg/L, which is considered below the level of health concern. Consequently, lead was not retained as a COPC. Arsenic, iron, manganese, and thallium were detected frequently at maximum concentrations that exceeded their respective tap water COC screening values. Therefore, these inorganics were retained as COPCs to quantitatively assess groundwater for the SGI.

6.3 Exposure Assessment

This section addresses potential human exposure pathways for groundwater at Site 35. Groundwater is the only media evaluated in this BRA. The exposure scenarios presented in the following sections are used to estimate individual risks. A reasonable maximum exposure (RME) scenario was utilized in this assessment, which is consistent with USEPA Region IV recommendations regarding human health risk assessment.

6.3.1 Exposure Pathways

Currently, the shallow groundwater in the area of the sites is not used as a potable supply for residents or base personnel. However, under a future scenario (albeit unlikely due to poor transmissivity and insufficient flow) the major potential exposure pathways, retained for evaluation, include the use of on-site groundwater are ingestion and dermal contact.

6.3.2 Quantification of Exposure

The concentrations used in the estimation of chronic daily intakes (CDIs) must be representative of the type of exposure being considered.

Exposure to groundwater can occur discretely or at a number of sampling locations. These media are transitory in that concentrations change frequently over time. Averaging transitory data obtained from multiple locations is difficult and requires many more data points at discrete locations than exist within OU No. 10. As a result, the best way to represent groundwater contaminants from an exposure standpoint is to use a representative exposure concentration. The human health assessment for future groundwater use considered groundwater data collected from all of the monitoring wells within Site 35.

Since all the data sets originate from a skewed underlying distribution and since log normal distribution best fits the majority of environmental data sets, the lognormal distribution was used to represent groundwater to determine representative exposure concentrations. This ensures conservatism in the estimation of chronic daily intake associated with potential exposures. Ninety-

five percent upper confidence levels (95 percent UCL) derived for lognormal data sets produce concentrations in excess of the 95 percent interval derived assuming normality. For the sake of conservatism, the 95 percent UCL for the lognormal distribution was used for each contaminant in a given data set for quantifying potential exposure. For exposure areas with limited amounts of data or extreme variability in measured data, the 95 percent UCL can be greater than the maximum measured concentration, therefore, in cases where the 95 percent UCL for a contaminant exceeds the maximum detected value in a given data set, the maximum result was used in the estimate of exposure of the 95 percent UCL. However, the true mean may still be higher than this maximum value (i.e., the 95 percent UCL indicates a higher mean is possible), especially if the most contaminated portion of the site has not been sampled.

Data and frequency summaries and statistical summaries are presented in Appendices O and P, respectively.

6.3.3 Calculation of Chronic Daily Intakes

To numerically estimate the risks for future human receptors at Site 35, a CDI must be estimated for each COPC in every retained exposure pathway.

Appendix Q contains the specific CDI equations for each exposure scenario of interest. These equations were adopted from USEPA's Risk Assessment Guidance for Superfund, Volume I (USEPA, 1989a).

The following paragraphs present the general equations and input parameters used in the calculation of CDIs for each potential exposure pathway. The potential exposure pathways chosen for quantitative evaluation of inorganic COPCs are ingestion and dermal contact. Since the VOCs are not evaluated quantitatively, inhalation of volatile organics was not chosen as an exposure pathway. Input parameters were taken from USEPA's default exposure factors guidelines where available and applicable. All inputs not defined by USEPA were derived from USEPA documents concerning exposure or best professional judgment. All exposure assessments incorporate the representative contaminant concentrations in the estimation of intakes. Therefore, only one exposure scenario was developed for each exposure route/receptor combination.

Carcinogenic risks are calculated as an incremental lifetime risk; and therefore, incorporate terms to represent the exposure duration (years) over the course of a lifetime (70 years or 25,550 days).

Noncarcinogenic risks, on the other hand, are estimated using the concept of an average annual exposure. The intake incorporates terms describing the exposure time and/or frequency that represent the number of hours per day and the number of days per year that exposure occurs. In general, noncarcinogenic risks for many exposure routes (e.g., groundwater ingestion) are greater for children than adults because of the differences in body weights and similar exposure frequencies. Future residential exposure scenarios consider 1 to 6 year old children weighing 15 kg, and adults weighing 70 kg on average.

6.3.3.1 Ingestion of Groundwater

Shallow groundwater is not currently being used as a potable supply at Site 35. Development of the shallow aquifer for potable use is unlikely because of the general water quality in the shallow zone

and poor flow rates. However, there remains the possibility that upon closure of this facility, residential housing could be constructed and shallow groundwater used for potable purposes in the future. Deep groundwater from Site 35 is currently used for potable purposes. However, supply wells which have been determined to be contaminated have been permanently abandoned. In addition, current operating wells are periodically monitored for control purposes.

The CDI of contaminants associated with the future potential consumption of groundwater are estimated using the following general equation:

$$CDI = \frac{C \times IR \times EF \times ED}{BW \times AT}$$

Where:

| | | |
|----|---|---|
| C | = | Contaminant concentration in groundwater (mg/L) |
| IR | = | Ingestion rate (L/day) |
| EF | = | Exposure frequency (days/year) |
| ED | = | Exposure duration (years) |
| BW | = | Body weight (kg) |
| AT | = | Averaging time (days) |

The following paragraphs discuss the exposure assumptions used in the estimation of potential COPCs with the potential ingestion of groundwater.

Future On-Site Residents

Exposure to COPCs via ingestion of groundwater is retained as a potential future exposure pathway for both children and adults.

An IR of 1.0 L/day is used for the amount of water consumed by a 1 to 6 year old child weighing 15 kg. This ingestion rate provides a health conservative exposure estimate (for systemic, noncarcinogenic toxicants) designed to protect young children who could potentially be more affected than adolescents, or adults. This value assumes that children obtain all the tap water they drink from the same source for 350 days/year [which represents the exposure frequency (EF)]. An averaging time (AT) of 2,190 days (6 years x 365 days/year) is used for noncarcinogenic compound exposure.

The ingestion rate (IR) for adults is 2 liters/day (USEPA, 1989a). The ED used for the estimation of adult CDIs is 30 years (USEPA, 1991), which represents the national upper-bound (90th percentile) time at one residence. The averaging time for noncarcinogens is 10,950 days. An averaging time (AT) of 25,550 days (70 years x 365 days/year) is used to evaluate exposure for both children and adults to potential carcinogenic compounds. Table 6-3 presents a summary of the input parameters for the ingestion of groundwater scenarios.

6.3.3.2 Dermal Contact with Groundwater

Shallow groundwater is not currently being used as a potable supply at Site 35. However, there remains the possibility that upon closure of this facility residential housing could be constructed and groundwater used for residential purposes in the future.

The CDI associated with the dermal contact with groundwater is estimated using the following general equation:

$$CDI = \frac{C \times SA \times PC \times ET \times EF \times ED \times CF}{BW \times AT}$$

Where:

| | | |
|----|---|---|
| C | = | Contaminant concentration in groundwater (mg/L) |
| SA | = | Surface area available for contact (cm ²) |
| PC | = | Dermal permeability constant (cm/hr) |
| ET | = | Exposure time (hour/day) |
| EF | = | Exposure frequency (days/year) |
| ED | = | Exposure duration (years) |
| CF | = | Conversion factor (1 L/1000 cm ³) |
| BW | = | Body weight (kg) |
| AT | = | Averaging time (days) |

The following paragraphs discuss the exposure assumptions used in the estimation of potential COPCs with potential dermal contact with groundwater.

Future On-Site Residents

Children and adults could contact COPCs through dermal contact with groundwater while bathing or showering.

It was assumed that bathing would take place 350 days/year using site groundwater as the sole source. The whole body skin surface area (SA) available for dermal absorption is estimated to be 10,000 cm² for children and 23,000 cm² for adults (USEPA, 1992a). The permeability constant (PC) reflects the movement of a chemical across the skin and into the blood stream. The permeability of a chemical is an important property in evaluating actual absorbed dose, yet many compounds do not have literature PC values. For contaminants in which a PC value has not been established, the permeability constant for water (1.55E-03 cm/hr), is used (USEPA, 1992a). This value may in fact be a realistic estimate of the adsorption rate of a chemical when COPC concentrations are in the part-per-billion range.

An exposure time (ET) of 0.25 hour/day (USEPA, 1992a) is used to conservatively estimate the duration of bathing or showering. The exposure duration, body weight, and averaging time are the same as those used for the ingestion of groundwater scenario. Table 6-3 presents the exposure factors used to estimate CDIs associated with the future dermal contact with COPCs in groundwater.

6.4 Toxicity Assessment

Section 6.3 identified potential exposure pathways and potentially affected populations for this BRA. This section will review the available toxicological information for the potential COPCs.

6.4.1 Toxicological Evaluation

The purpose of this section is to define the toxicological values used to evaluate the potential exposure to the potential COPCs identified in Section 6.2. A toxicological evaluation characterizes the inherent toxicity of a compound and consists of the review of scientific data to determine the nature and extent of the potential human health and environmental effects associated with potential exposure to various contaminants.

Human data from occupational exposures are often insufficient for determining quantitative indices of toxicity because of uncertainties in exposure estimates, and inherent difficulties in determining causal relationships established by epidemiological studies. For this reason, animal bioassays are conducted under controlled conditions and their results are extrapolated to humans. There are several stages to this extrapolation. First, to account for species differences, conversion factors are used to extrapolate from test animals to humans. Second, the relatively high doses administered to test animals must be extrapolated to the lower doses more typical of human exposures. For potential noncarcinogens, safety factors and modifying factors are applied to animal results when developing acceptable human doses. For potential carcinogens, mathematical models are used to extrapolate effects at high doses to effects at lower doses. Epidemiological data can be used for inferential purposes to establish the credibility of the experimentally derived indices.

The available toxicological information indicates that many of the potential COPCs have both potential carcinogenic and noncarcinogenic health effects in humans and/or experimental animals. Although the potential COPCs may potentially cause adverse health and environmental impacts, dose-response relationships and the potential for exposure must be evaluated before the risk to receptors can be determined. Dose-response relationships correlate the magnitude of the dose with the probability of toxic effects, as discussed in the following section.

6.4.2 Dose-Response Evaluation

An important component of the risk assessment is the relationship between the dose of a compound (amount to which an individual or population is potentially exposed) and the potential for adverse health effects resulting from the exposure to that dose. Dose-response relationships provide a means by which potential public health impacts may be evaluated. The published information on doses and responses is used in conjunction with information on the nature and magnitude of exposure to develop an estimate of risk.

Standard carcinogenic slope factors (CSFs) and/or reference doses (RfDs) have been developed for many of the COPCs. This section provides a brief description of these parameters.

6.4.2.1 Carcinogenic Slope Factor

CSFs are used to estimate an upper-bound lifetime probability of an individual developing cancer as a result of exposure to a particular level of a potential carcinogen (USEPA, 1989a). This factor is generally reported in units of $(\text{mg}/\text{kg}/\text{day})^{-1}$ and is derived through an assumed low-dosage linear multistage model and an extrapolation from high to low dose-responses determined from animal studies. The value used in reporting the slope factor is the upper 95th percent confidence limit.

These slope factors are also accompanied by USEPA WOE classifications which designate the strength of the evidence that the COPC is a potential human carcinogen.

In assessing the carcinogenic potential of a chemical, the Human Health Assessment Group (HHAG) of USEPA classifies the chemical into one of the following groups, according to the weight of evidence from epidemiologic and animal studies:

- Group A - Human Carcinogen (sufficient evidence of carcinogenicity in humans)
- Group B - Probable Human Carcinogen (B1 - limited evidence of carcinogenicity in humans; B2 - sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans)
- Group C - Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data)
- Group D - Not Classifiable as to Human Carcinogenicity (inadequate or no evidence)
- Group E - Evidence of Noncarcinogenicity for Humans (no evidence of carcinogenicity in adequate studies)

6.4.2.2 Reference Dose

The RfD is developed for chronic and/or subchronic human exposure to chemicals and is based solely on the noncarcinogenic effects of chemical substances. It is defined as an estimate of a daily exposure level for the human population, including sensitive populations, that is likely to be without an appreciable risk of adverse effects during a lifetime. The RfD is usually expressed as dose (mg) per unit body weight (kg) per unit time (day). It is generally derived by dividing a no-observed-(adverse)-effect-level (NOAEL or NOEL) or a lowest observed-adverse-effect-level (LOAEL) for the critical toxic effect by an appropriate "uncertainty factor (UF)". Effect levels are determined from laboratory or epidemiological studies. The UF is based on the availability of toxicity data.

UFs usually consist of multiples of 10, where each factor represents a specific area of uncertainty naturally present in the extrapolation process. These UFs are presented below and were taken from the "Risk Assessment Guidance Document for Superfund, Volume I, Human Health Evaluation Manual (Part A) (USEPA, 1989a):

- A UF of 10 is to account for variation in the general population and is intended to protect sensitive populations (e.g., elderly, children).
- A UF of 10 is used when extrapolating from animals to humans. This factor is intended to account for the interspecies variability between humans and other mammals.
- A UF of 10 is used when a NOAEL derived from a subchronic instead of a chronic study is used as the basis for a chronic RfD.
- A UF of 10 is used when a LOAEL is used instead of a NOAEL. This factor is intended to account for the uncertainty associated with extrapolating from LOAELs to NOAELs.

In addition to UFs, a modifying factor (MF) is applied to each reference dose and is defined as:

- A MF ranging from >0 to 10 is included to reflect a qualitative professional assessment of additional uncertainties in the critical study and in the entire data base for the chemical not explicitly addressed by the preceding uncertainty factors. The default for the MF is 1.

Thus, the RfD incorporates the uncertainty of the evidence for chronic human health effects. Even if applicable human data exist, the RfD still maintains a margin of safety so that chronic human health effects are not underestimated.

Toxicity factors and the USEPA WOE classifications are presented in Table 6-4. The hierarchy (USEPA, 1989a) for choosing these values was as follows:

- Integrated Risk Information System (IRIS)
- Health Effects Assessment Summary Table (HEAST)

The IRIS data base is updated monthly and contains both verified CSFs and RfDs. The USEPA has formed the Carcinogen Risk Assessment Verification Endeavor (CRAVE) Workgroup to review and validate toxicity values used in developing CSFs. Once the slope factors have been verified via extensive peer review, they appear in the IRIS data base. Like the CSF Workgroup, the USEPA has formed a RfD Workgroup to review existing data used to derive RfDs. Once the reference doses has been verified, they also appear in IRIS.

HEAST on the other hand, provides both interim (unverified) and verified CSFs and RfDs. This document is published quarterly and incorporates any applicable changes to its data base.

6.5 Risk Characterization

This section presents and discusses the estimated incremental lifetime cancer risks (ICRs) and hazard indices (HIs) for identified potential receptor groups which could be exposed to COPCs via the exposure pathways presented in Section 6.3.

These quantitative risk calculations for potentially carcinogenic compounds estimate ICRs levels for an individual in a specified population. This unit risk refers to the cancer risk that is found to be over and above the background cancer risk in unexposed individuals. For example, an ICR of 1×10^{-6} indicates that, for a lifetime exposure, one additional case of cancer may occur per one million exposed individuals.

The ICR to individuals was estimated from the following relationship:

$$ICR = \sum_{i=1}^n CDI_i \times CSF_i$$

where CDI_i is the chronic daily intake (mg/kg/day) for compound i and CSF_i is the cancer slope $[(\text{mg}/\text{kg}/\text{day})^{-1}]$ for contaminant i . The CSF is defined in most instances as an upper 95th percentile confidence limit of the probability of a carcinogenic response based on experimental animal data, and the CDI is defined as the exposure expressed as a mass of a substance contracted per unit body weight per unit time, averaged over a period of time (i.e., six years to a lifetime). The above

equation was derived assuming that cancer is a non-threshold process and that the potential excess risk level is proportional to the cumulative intake over a lifetime.

In contrast to the above approach for potentially carcinogenic effects, quantitative risk calculations for noncarcinogenic compounds assume that a threshold toxicological effect exists. Therefore, the potential for noncarcinogenic effects are calculated by comparing CDIs with threshold levels (reference doses).

Noncarcinogenic effects were estimated by calculating the hazard index (HI) which is defined as:

$$\begin{aligned} \text{HI} &= \text{HQ}_1 + \text{HQ}_2 + \dots \text{HQ}_n \\ &= \sum_{i=1}^n \text{HQ}_i \end{aligned}$$

where $\text{HQ}_i = \text{CDI}_i / \text{RfD}_i$

HQ_i is the hazard quotient for contaminant i , CDI_i is the chronic daily intake (mg/kg/day) of contaminant i , and RfD_i is the reference dose (mg/kg/day) of the contaminant i over a prolonged period of exposure.

6.5.1 Human Health Risks

The following paragraphs present the results of the human health evaluation for the supplemental groundwater data collected for the SGI at Site 35. The VOC results are discussed qualitatively since the sampling strategy was planned for delineation of the VOC plume, rather than for human health risk assessment purposes. The low-flow purge inorganic data (August, 1995) was evaluated quantitatively and incorporated into the original risk assessment calculations for comparative purposes.

For the low-flow purge inorganic data, ICRs and HIs were calculated (Appendix Q). These values were then added to the ICR and HI values calculated for the organics from Rounds 2 and 3 (RI data) of sampling, replacing the original inorganic ICR and HI calculations. These estimated ICRs are compared to the target risk range of 1×10^{-6} to 1×10^{-4} . A value of 1.0 is used for examination of these HIs. The HI is calculated by comparing estimated CDIs with threshold levels below which, noncarcinogenic health effects are not expected to occur. Any HI equal to or exceeding 1.0 suggested that noncarcinogenic health effects are possible. If the HI was less than 1.0, then systemic human health effects are considered unlikely.

Round 4 VOCs

The detected concentrations in the Round 4 VOC data were compared qualitatively to MCLs, NCWQS values, and Region III tap water COC screening values. All detected VOCs were retained as qualitative COPCs for further consideration. In general, there were a smaller number of volatiles detected in the Round 4 VOC data. The detected concentrations of Round 4 VOCs were also generally lower than the detected VOC concentrations in Rounds 2 and 3 (RI data). Vinyl chloride, 1,2-dichloroethene (total), and trichloroethene exceeded their respective MCLs and NWQS values. Furthermore, benzene and tetrachloroethene exceeded their respective NWQS values. Vinyl chloride, 1,1-dichloroethene, 1,2-dichloroethene (total), trichloroethene, benzene, and 1,1,2,2-tetrachloroethane exceeded their respective tap water COC screening values. The positive detections

of benzene and trichloroethene were not considered to be blank-related based on the professional opinion of the third-party validator. These results are shown in Table 6-1.

Low-Flow Purge Inorganics

The ICR and HI values estimated for potential future residential receptors (children and adults) from ingestion and dermal contact of inorganics in groundwater, collected using low-flow purge sampling, are presented on Table 6-5. The total ICR value (calculated for most recent inorganic data only) for future residential children (5.2×10^{-5}) was within the USEPA's upper bound risk range (1×10^{-6} to 1×10^{-4}). The total ICR value for adults (1.1×10^{-4}) slightly exceeded the USEPA's upper bound risk range. This was due to the presence of arsenic. The total HIs (calculated for most recent inorganic data only) estimated for potential future residential children (11) and adults (4.7) exceeded unity (1.0). These elevated HIs were driven by the presence of iron (79%) and arsenic (12%).

The ICR and HI values calculated for the most recent inorganic data were then added to those of the organic data from the initial RI. The risk calculations for the RI groundwater data are presented in Appendix Q. The re-calculated total site groundwater ICR values for future residential children (1.4×10^{-4}) and adults (3.1×10^{-4}) exceeded the USEPA's acceptable risk range. These elevated ICR values were driven by organics, specifically trichloroethene, detected in Rounds 2 and 3. In the initial RI, total site carcinogenic risks were 4.3×10^{-3} for future adult residents and 2.1×10^{-3} for future child residents. The recalculated total site groundwater HI values for future residential children (48) and adults (21) exceeded unity. These elevated HI values were also driven by organics, specifically benzene and trichloroethene, detected in Rounds 2 and 3. The total site HI values calculated for the initial RI were 104 for the future child resident and 44 for the future adult resident. These results are shown in Table 6-6.

6.6 Sources of Uncertainty

Uncertainties may be encountered throughout the process of performing a BRA. This section discusses the sources of uncertainty involved with the following:

- Sample acquisition
- Analytical data
- Exposure assessment
- Toxicity assessment
- Iron
- Compounds not quantitatively evaluated

Table 6-7 provides a summary of the sources of uncertainty associated with this BRA and the effects on total site risk.

6.6.1 Sample Acquisition

During the sampling event, a low-flow well purging and sampling technique was employed. While purging the groundwater from each of the monitoring wells, a flow rate of less than 0.25 gallons per minute was maintained. Samples collected for metals analyses were obtained directly from the pump discharge. This sampling technique removes much of the sedimentation in the groundwater before sampling. Such a sample more closely represents the true groundwater contamination. Groundwater samples collected without using the low-flow purging technique may show

contamination that is actually related to the sedimentation in the groundwater. This type of result may overestimate the risk to receptors from exposure to groundwater.

6.6.2 Analytical Data

The development of a BRA depends on the reliability of and uncertainties with the analytical data available to the risk assessor. Analytical data are limited by the precision and accuracy of the analytical method of analysis. For example, Contract Laboratory Program (CLP) methods have, in general, a precision of approximately plus or minus 50 percent depending on the sample media and the presence of interfering compounds. A value of 100 µg/kg could be as high as 150 µg/kg or as low as 50 µg/kg. In addition, the statistical methods used to compile and analyze the data (mean concentration, standard deviation, and detection frequencies) are subject to the uncertainty in the ability to acquire data.

Data validation serves to reduce some of the inherent uncertainty associated with the analytical data by establishing the usability of the data to the risk assessor who may or may not choose to include the data point in the estimation of risk. Data qualified as "J" (estimated) were retained for the estimation of risk at Site 35. Data can be qualified as estimated for many reasons including a slight exceedance of holding times, high or low surrogate recovery, or intrasample variability. Organic data qualified "B" (detected in blank) or "R" (unreliable) were not used in the estimation of risk due to the unusable nature of the data. Due to the comprehensive sampling and analytical program at Site 35, the loss of some data points qualified "B" or "R" did not significantly increase the uncertainty in the estimation of risk.

6.6.3 Exposure Assessment

In performing exposure assessments, uncertainties can arise from two main sources. First, the chemical concentration to which a receptor may be exposed must be estimated for every medium of interest. Second, uncertainties can arise in the estimation of contaminant intakes resulting from contact by a receptor with a particular medium.

Estimating the contaminant concentration in a given medium to which a human receptor could potentially be exposed can be as simple as deriving the 95th percent upper confidence limit of the mean for a data set. More complex methods of deriving the contaminant concentration is necessary when exposure to COPCs in a given medium occurs subsequent to release from another medium, or analytical data are not available to characterize the release. In this case, modeling is usually employed to estimate the potential human exposure.

Groundwater samples were analyzed for total (unfiltered) and dissolved (filtered) inorganic contaminants using the low-flow purge method. These samples were obtained from wells which were constructed using USEPA Region IV monitoring well design specifications. Groundwater obtained from monitoring wells cannot be considered representative of potable groundwater or groundwater which is obtained from a domestic well "at the tap". The use of total inorganic analytical results overestimates the potential human health risks associated with potable use scenarios. However, for the sake of conservatism, total organic results were used to estimate the potential intake associated with groundwater use.

Currently, the shallow groundwater is not used as a potable source. Potential current receptors (i.e., military personnel, military dependents, and civilian base personnel) are exposed to

groundwater drawn from the deep zone via ingestion, dermal contact, and inhalation. Therefore, assessing current risks to contaminants detected in the shallow aquifer for current receptors is unnecessary and if estimated may present an unlikely risk. Therefore, groundwater exposures to current receptors was not estimated for this investigation.

To estimate an intake, certain assumptions must be made about exposure events, exposure durations, and the corresponding assimilation of contaminants by the receptor. Exposure factors, have been generated by the scientific community and have undergone review by the USEPA. Regardless of the validity of these exposure factors, they have been derived from a range of values generated by studies conducted by a limited number of individuals. In all instances, values used in the risk assessment, scientific judgments, and conservative assumptions agree with those of the USEPA. Conservative assumptions designed not to underestimate daily intakes were employed throughout the BRA and should error conservatively, thus adequately protecting human health and allowing the establishment of reasonable clean-up goals.

6.6.4 Toxicity Assessment

In making quantitative estimates of the toxicity of varying doses of a compound to human receptors, uncertainties arise from two sources. First, data on human exposure and the subsequent effects are usually insufficient, if they are available at all. Human exposure data usually lack adequate concentration estimations and suffer from inherent temporal variability. Therefore, animal studies are often used and therefore new uncertainties arise from the process of extrapolating animal results to humans. Second, to obtain observable effects with a manageable number of experimental animals, high doses of a compound are used over a relatively short time period. In this situation, a high dose means that experimental animal exposures are much greater than human environmental exposures. Therefore, when applying the results of the animal experiment to the human condition, the effects at the high doses must be extrapolated to approximate effects at lower doses.

In extrapolating effects from animals to humans and high doses to low doses, scientific judgment and conservative assumptions are employed. In selecting animal studies for use in dose response calculations, the following factors are considered:

- Studies are preferred where the animal closely mimics human pharmacokinetics.
- Studies are preferred where dose intake most closely mimics the intake route and duration for humans.
- Studies are preferred which demonstrate the most sensitive response to the compound in question.

For compounds believed to cause threshold effects (i.e., noncarcinogens), safety factors are employed in the extrapolation of effects from animals to humans, and from high to low doses. The use of conservative assumptions results in quantitative indices of toxicity that are not expected to underestimate potential toxic effects, but may overestimate these effects by an order of magnitude or more.

6.6.5 Iron

Recently, the element iron was given a RBC value and toxicity values with which to evaluate potential human health risks. However, iron is still considered an essential nutrient. Also, the studies that prompted the addition of a RBC value for iron are provisional only and have not

undergone formal review by the USEPA. For these reasons, the selection of iron as a COPC for evaluation in human health risk assessments is associated with some uncertainty. In this manner, a conservative approach is taken and potential toxic effects are not expected to be underestimated.

6.6.6 Compounds Not Quantitatively Evaluated

The Round 4 groundwater VOC data was not evaluated quantitatively, but was discussed qualitatively. The qualitative assessment of the VOC data was done because the data points were chosen in order to delineate the VOC plume. Such data points used quantitatively in the risk assessment could bias the calculations since the points were chosen based on their prior detected concentrations. The initial RI organic data risk calculations represent potential adverse health effects due to organic constituents detected in Site 35 groundwater. The qualitative assessment was conducted to support the results of the previous BRA and assist in the selection of the remedial alternative.

6.7 Conclusions of the BRA for the Supplemental Groundwater Investigation

As shown in the conclusions of the previous risk assessment, the elevated risk levels were associated with the future receptors and more specifically, future potential exposure to groundwater at Site 35. The carcinogenic risk drivers include arsenic and beryllium. The noncarcinogenic risk drivers include cis-1,2-dichloroethene, trichloroethene, benzene, antimony, arsenic, barium, chromium, cadmium, manganese, and vanadium. The initial RI recommended further groundwater sampling to assess the extent of the VOC plume. Also, it was recommended to resample groundwater using low-flow purge technique to remove high concentrations of metals due to sedimentation. The purpose of this risk assessment is to evaluate the potential risks from exposure to groundwater based on the most recent data.

The Round 4 VOC data were examined qualitatively in this supplemental BRA. All detected VOCs were chosen as qualitative COPCs. The detected concentrations of these compounds were generally lower than those detected in the first round. In addition, fewer VOCs were detected in this second round of data. The additional data suggests that the potential for adverse health effects to occur would not increase.

Carcinogenic and noncarcinogenic risks were calculated for the low-flow purge inorganic data. These values were added to the organic risk calculations from the initial BRA, replacing the inorganic data from the initial RI. The total groundwater ICR for future child residents (1.4×10^{-4}) and adult residents (3.1×10^{-4}) slightly exceeded the USEPA's upper bound risk range (1×10^{-6} to 1×10^{-4}). These elevated total ICR values are driven by the ingestion of trichloroethene and benzene (approximately 60 percent combined) in the groundwater. Arsenic contributed approximately 35 percent to the total ICR. It should be noted that arsenic is a naturally occurring element. In addition, there is no historical record of any use or disposal of arsenic at Site 35. When compared to the results of the previous risk assessment, the carcinogenic risk from groundwater is one order of magnitude less. Beryllium, the main driver of the previous carcinogenic risk calculations, was not detected in the supplemental investigation. As a result, the VOCs are now the main contributors to the ICR value. These results are shown in Table 6-6.

The total groundwater HI values for the future child resident (48) and the future adult resident (21) exceeded unity. The ingestion pathway contributed over 90 percent to these elevated HI values. The total HI values for future adults and children are driven by benzene (approximately 37 percent) and trichloroethene (approximately 20 percent) from the RI organic data. The detected concentrations of VOCs from the initial investigation also drive the noncarcinogenic risk.

SECTION 6.0 TABLES

TABLE 6-1

**GROUNDWATER DATA SUMMARY
VOLATILE ORGANIC COMPOUNDS
SITE 35 - CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION
MCB, CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232**

| Compound | Groundwater Criteria | | | | | Frequency/Range | | Comparison to Criteria | | | | |
|-------------------------------|--------------------------------|------------------------------|---|---|----------------|---|----------------------------------|-------------------------------------|-----------------------------------|-----------------------------------|--|----------------|
| | NCWQS ⁽¹⁾ (µg/L) | MCL ⁽²⁾ (µg/L) | Region III Tapwater COC Value ⁽³⁾ (µg/L) | Federal Health Advisories ⁽⁴⁾ (µg/L) | | No. of Positive Detects/ No. of Samples | Concentration Range (µg/L) | No. of Detects Above NCWQS | No. of Detects Above MCL | No. of Detects Above COC | No. of Detects Above Health Advisories | |
| | | | | 10 kg Child | 70 kg Adult | | | | | | 10 kg Child | 70 kg Adult |
| Volatiles: | | | | | | | | | | | | |
| Vinyl Chloride | 0.015 | 2 | 0.019 | 10 | 50 | 1/30 | 13 | 1 | 1 | 1 | 1 | 0 |
| Acetone | 700 | NE | 370 | NE | NE | 1/30 | 66J | 0 | NA | 0 | NA | NA |
| 1,1-Dichloroethene | 7 | 7 | 0.044 | 1,000 | 4,000 | 3/30 | 4J - 6J | 0 | 0 | 3 | 0 | 0 |
| 1,1-Dichloroethane | 700 | NE | 81 | NE | NE | 2/30 | 3J - 4J | 0 | NA | 0 | NA | NA |
| 1,2-Dichloroethene (Total) | NE | 70 | 5.5 | 3,000 | 11,000 | 18/30 | 2J - 1,200 | NA | 6 | 15 | 0 | 0 |
| Trichloroethene | 2.8 | 5 | 1.6 | NE | NE | 12/30 | 4J - 740 | 12 | 11 | 12 | NA | NA |
| Benzene | 1 | 5 | 0.36 | NE | NE | 4/30 | 2J - 4J | 4 | 0 | 4 | NA | NA |
| Tetrachloroethene | 0.7 | 5 | 1.1 | 1,000 | 5,000 | 1/30 | 2J | 1 | 0 | 1 | 0 | 0 |
| 1,1,2,2- Tetrachloroethane | NE | NE | 0.052 | NE | NE | 2/30 | 17J - 23 | NA | NA | 2 | NA | NA |
| Toluene | 1,000 | 1,000 | 75 | 2,000 | 7,000 | 2/30 | 2J - 4J | 0 | 0 | 0 | 0 | 0 |

Notes:

- ⁽¹⁾ NCWQS = North Carolina Water Quality Standards for Groundwater
- ⁽²⁾ MCL = Safe Drinking Water Act Maximum Contaminant Level
- ⁽³⁾ USEPA Region III Contaminants of Concern (COC) Screening Criteria Table (1993, 1996)
- ⁽⁴⁾ Longer Term Health Advisories for a 10 kg Child and 70 kg Adult
- NE - No Criteria Established
- NA - Not Applicable
- J - Estimated Value

TABLE 6-2

**GROUNDWATER DATA AND COPC SELECTION SUMMARY
INORGANICS
SITE 35 - CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION
MCB, CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232**

| Analyte | Groundwater Criteria | | | | | Frequency/Range | | Comparison to Criteria | | | | |
|------------|--------------------------------|------------------------------|---|---|----------------|---|----------------------------------|-------------------------------------|-----------------------------------|-----------------------------------|--|----------------|
| | NCWQS ⁽¹⁾ (µg/L) | MCL ⁽²⁾ (µg/L) | Region III Tapwater COC Value ⁽³⁾ (µg/L) | Federal Health Advisories ⁽⁴⁾ (µg/L) | | No. of Positive Detects/ No. of Samples | Concentration Range (µg/L) | No. of Detects Above NCWQS | No. of Detects Above MCL | No. of Detects Above COC | No. of Detects Above Health Advisories | |
| | | | | 10 kg Child | 70 kg Adult | | | | | | 10 kg Child | 70 kg Adult |
| Aluminum | NE | 50/200 ⁽⁵⁾ | 3,700 | NE | NE | 12/20 | 22.6J-520 | NA | 7/4 | 0 | NA | NA |
| Antimony | NE | 6 | 1.5 | 10 | 15 | 1/20 | 20J | NA | 1 | 1 | 1 | 1 |
| Arsenic | 50 | 50 | 0.045 | NE | NE | 7/20 | 3.2J-13.3 | 0 | 0 | 7 | NA | NA |
| Barium | 2,000 | 2,000 | 260 | NE | NE | 9/20 | 20.9J-98.4J | 0 | 0 | 0 | NA | NA |
| Calcium+ | NE | NE | NE | NE | NE | 20/20 | 6,380-142,000 | NA | NA | NA | NA | NA |
| Cobalt | NE | NE | 220 | NE | NE | 10/20 | 2.2J-16J | NA | NA | 0 | NA | NA |
| Iron | 300 | 300 ⁽⁵⁾ | 1,100 | NE | NE | 20/20 | 58.4J-40,400 | 14 | 14 | 10 | NA | NA |
| Lead | 15 | 15 ⁽⁶⁾ | NE | NE | NE | 8/20 | 1-15.4 | 1 | 1 | NA | NA | NA |
| Magnesium+ | NE | NE | NE | NE | NE | 20/20 | 1,550J-4,990J | NA | NA | NA | NA | NA |
| Manganese | 50 | 50 ⁽⁵⁾ | 180 | NE | NE | 20/20 | 7.5J-275 | 5 | 5 | 1 | NA | NA |
| Potassium+ | NE | NE | NE | NE | NE | 20/20 | 728J-4,400 | NA | NA | NA | NA | NA |
| Selenium | 50 | 50 | 18 | NE | NE | 2/20 | 2.6J-3.4J | 0 | 0 | 0 | NA | NA |
| Silver | 18 | NE | 18 | 200 | 200 | 1/20 | 10.9 | 0 | NA | 0 | 0 | 0 |
| Sodium+ | NE | NE | NE | NE | NE | 20/20 | 4,350J-31,900 | NA | NA | NA | NA | NA |

TABLE 6-2 (Continued)

**GROUNDWATER DATA AND COPC SELECTION SUMMARY
INORGANICS
SITE 35 - CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION, CTO-0232
MCB, CAMP LEJEUNE, NORTH CAROLINA**

| Analyte | Groundwater Criteria | | | | | Frequency/Range | | Comparison to Criteria | | | | |
|----------|--------------------------------|------------------------------|---|---|----------------|---|----------------------------------|-------------------------------------|-----------------------------------|-----------------------------------|--|----------------|
| | NCWQS ⁽¹⁾ (µg/L) | MCL ⁽²⁾ (µg/L) | Region III Tapwater COC Value ⁽³⁾ (µg/L) | Federal Health Advisories ⁽⁴⁾ (µg/L) | | No. of Positive Detects/ No. of Samples | Concentration Range (µg/L) | No. of Detects Above NCWQS | No. of Detects Above MCL | No. of Detects Above COC | No. of Detects Above Health Advisories | |
| | | | | 10 kg Child | 70 kg Adult | | | | | | 10 kg Child | 70 kg Adult |
| Thallium | NE | 2 | 0.29 | 7 | 20 | 3/20 | 0.7J-1 | NA | 0 | 3 | 0 | 0 |
| Vanadium | NE | NE | 26 | NE | NE | 2/20 | 5.5J-9.1J | NA | NA | 0 | NA | NA |
| Zinc | 2,100 | 5,000 ⁽⁵⁾ | 1,100 | 3,000 | 10,000 | 11/20 | 6.5J-29.5 | 0 | 0 | 0 | 0 | 0 |

Notes:

Shaded areas indicate parameter selected as COPC.

- ⁽¹⁾ NCWQS = North Carolina Water Quality Standards for Groundwater
- ⁽²⁾ MCL = Safe Drinking Water Act Maximum Contaminant Level
- ⁽³⁾ USEPA Region III Contaminants of Concern (COC) Screening Criteria Table (1993, 1996)
- ⁽⁴⁾ Longer Term Health Advisories for a 10 kg Child and 70 kg Adult
- ⁽⁵⁾ SMCL = Secondary Maximum Contaminant Level
- ⁽⁶⁾ Action Level for drinking water.

+ - Essential Nutrient

NE - No Criteria Established

NA - Not Applicable

J - Estimated Value

TABLE 6-3

**EXPOSURE INPUT PARAMETERS
FUTURE RESIDENTIAL CHILDREN AND ADULTS
SUPPLEMENTAL GROUNDWATER INVESTIGATION
MCB, CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232**

| Input Parameter | Units | Future Receptor | | Comments/References |
|--|-----------------|-------------------------|-------------------|---------------------|
| | | Child (1 to 6 years) | Adult | |
| Exposure Duration, ED | years | 6 | 30 | USEPA, 1991a |
| Exposure Frequency, EF | days/year | 350 | 350 | USEPA, 1991a |
| Ingestion Rate, IR | L/day | 1 | 2 | USEPA, 1991a |
| Surface Area, SA | cm ² | 10,000 | 23,000 | USEPA, 1992a |
| Body Weight, BW | kg | 15 | 70 | USEPA, 1989b |
| Permeability Constant, PC | cm/hr | Chemical-Specific | Chemical-Specific | USEPA, 1992a |
| Averaging Time, AT noncarcinogens, AT _{nc} | day | 2,190 | 10,950 | USEPA, 1989b |
| carcinogens, AT _c | day | 25,550 | 25,550 | USEPA, 1989b |

TABLE 6-4

**TOXICITY FACTORS
SITE 35 - CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION
MCB, CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232**

| | RfD | Dermally Adjusted RfD* | RfC | CSF | Dermally Adjusted CSF* | CSFI | Oral Absorption Factors ⁽¹⁾ | WOE | Reference |
|--------------------|---------|------------------------|---------|-----|------------------------|---------|--|-----|------------|
| Inorganics: | | | | | | | | | |
| Arsenic | 3.0E-04 | 6.0E-05 | ND | 1.5 | 7.5 | 1.5E+01 | 20% | A | IRIS, 1995 |
| Lead | ND | ND | ND | ND | ND | ND | 20% | ND | |
| Manganese | 2.3E-02 | 4.6E-03 | 1.4E-05 | ND | ND | ND | 20% | D | IRIS, 1995 |
| Thallium | 8.0E-05 | 1.6E-05 | ND | ND | ND | ND | 20% | ND | IRIS, 1995 |

Notes:

- RfD = Oral Reference Dose (mg/kg - day)
- RfC = Inhalation Reference Concentration (mg/cu m)
- CSF = Oral Cancer Slope Factor (mg/kg-day)⁻¹
- CSFI = Inhalation Cancer Slope Factor (mg/kg-day)⁻¹
- WOE = Weight of Evidence
- IRIS = Integrated Risk Information System
- ND = Not Determined
- A = Human Carcinogen
- D = Not Classifiable as to Human Carcinogenicity

* Only oral toxicity values were dermally adjusted; inhalation toxicity values were not adjusted.
 Dermally-adjusted RfD = oral RfD*oral absorption factor
 Dermally-adjusted CSF = oral CSF/oral absorption factor

⁽¹⁾ Region IV recommended values (i.e., 80% for VOCs, 50% for SVOCs/Pesticides, and 20% for Inorganics).

TABLE 6-4

**TOXICITY FACTORS
SITE 35 - CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION
MCB, CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232**

| | RfD | Dermally Adjusted RfD* | RfC | CSF | Dermally Adjusted CSF* | CSFI | Oral Absorption Factors ⁽¹⁾ | WOE | Reference |
|--------------------|---------|------------------------|---------|-----|------------------------|---------|--|-----|------------|
| Inorganics: | | | | | | | | | |
| Arsenic | 3.0E-04 | 6.0E-05 | ND | 1.5 | 7.5 | 1.5E+01 | 20% | A | IRIS, 1995 |
| Lead | ND | ND | ND | ND | ND | ND | 20% | ND | |
| Manganese | 2.3E-02 | 4.6E-03 | 1.4E-05 | ND | ND | ND | 20% | D | IRIS, 1995 |
| Thallium | 8.0E-05 | 1.6E-05 | ND | ND | ND | ND | 20% | ND | IRIS, 1995 |

Notes:

- RfD = Oral Reference Dose (mg/kg - day)
- RfC = Inhalation Reference Concentration (mg/cu m)
- CSF = Oral Cancer Slope Factor (mg/kg-day)⁻¹
- CSFI = Inhalation Cancer Slope Factor (mg/kg-day)⁻¹
- WOE = Weight of Evidence
- IRIS = Integrated Risk Information System
- ND = Not Determined
- A = Human Carcinogen
- D = Not Classifiable as to Human Carcinogenicity

- * Only oral toxicity values were dermally adjusted; inhalation toxicity values were not adjusted.
Dermally-adjusted RfD = oral RfD*oral absorption factor
Dermally-adjusted CSF = oral CSF/oral absorption factor

- ⁽¹⁾ Region IV recommended values (i.e., 80% for VOCs, 50% for SVOCs/Pesticides, and 20% for Inorganics).

TABLE 6-5

INCREMENTAL LIFETIME CANCER RISK (ICR) AND HAZARD INDEX (HI)
 ASSOCIATED WITH INORGANICS IN GROUNDWATER (LOW-FLOW PURGE SAMPLING)
 FUTURE ADULT AND CHILD RESIDENTS
 SITE 35, CAMP GEIGER AREA FUEL FARM
 SUPPLEMENTAL GROUNDWATER INVESTIGATION
 MCB, CAMP LEJEUNE, NORTH CAROLINA
 CONTRACT TASK ORDER 0232

| Pathway | Receptors | | | |
|----------------|--------------------------------|-------------|--------------------------------|-------------|
| | Adults | | Children (1-6 yrs.) | |
| | ICR | HI | ICR | HI |
| Ingestion | 1.1 x 10 ⁻⁴ (99) | 4.7 (99) | 5.1 x 10 ⁻⁵ (99) | 11 (99) |
| Dermal Contact | 1.6 x 10 ⁻⁶ (1) | 0.07 (1) | 6.4 x 10 ⁻⁷ (1) | 0.14 (1) |
| TOTAL | 1.1 x 10 ⁻⁴ | 4.7 | 5.2 x 10 ⁻⁵ | 11 |

Notes:

() - Percent contribution of exposure pathway to total groundwater risk

TABLE 6-6

**TOTAL SITE GROUNDWATER RISK
SITE 35 - CAMP GEIGER AREA FUEL FARM
REMEDIAL INVESTIGATION
MCB, CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232**

| Receptors | Rounds 2 and 3 Organics Groundwater | | Low-Flow Purge Sampling Inorganics Groundwater | | Total Groundwater Risk | |
|-----------------------|---|------------|---|-------------|------------------------------|----|
| | ICR | HI | ICR | HI | ICR | HI |
| Future Child Resident | 9.1x10 ⁻⁵ (65) | 37 (77) | 5.2x10 ⁻⁵ (35) | 11 (23) | 1.4x10 ⁻⁴ | 48 |
| Future Adult Resident | 2.0x10 ⁻⁴ (65) | 16 (77) | 1.1x10 ⁻⁴ (35) | 4.7 (23) | 3.1x10 ⁻⁴ | 21 |

Notes:

- ICR = Incremental Lifetime Cancer Risk
- HI = Hazard Index
- () = Percent contribution to total risk

TABLE 6-7

**SUMMARY OF UNCERTAINTIES IN THE RESULTS
HUMAN HEALTH RISK ASSESSMENT
SITE 35, CAMP GEIGER AREA FUEL FARM
SUPPLEMENTAL GROUNDWATER INVESTIGATION,
MCB, CAMP LEJEUNE, NORTH CAROLINA
CONTRACT TASK ORDER 0232**

| | Potential Magnitude for Over-Estimation of Risks | Potential Magnitude for Under-Estimation of Risks | Potential Magnitude for Over or Under-Estimation of Risks |
|--|--|---|---|
| <u>Environmental Sampling and Analysis</u> | | | |
| Sufficient samples may not have been taken to characterize the media being evaluated. | | | Low |
| Systematic or random errors in the chemical analysis may yield erroneous data. | | | Low |
| <u>Selection of COPCs</u> | | | |
| The use of USEPA Region III COPC screening concentrations in selecting COPCs in groundwater. | | | Low |
| <u>Exposure Assessment</u> | | | |
| The standard assumptions regarding body weight, exposure period, life expectancy, population characteristics, and lifestyle may not be representative of the actual exposure situations. | | | Moderate |
| The use of the 95th percentile upper confidence level data of the lognormal distribution in the estimation of the RME. | | | Low |
| Assessing future residential property use when the likelihood of residential development is low. | High | | |
| The amount of media intake is assumed to be constant and representative of any actual exposure. | | | Low |
| <u>Toxicological Assessment</u> | | | |
| Toxicological indices derived from high dose animal studies, extrapolated to low dose human exposure. | Moderate | | |
| <u>Risk Characterization</u> | | | |
| Assumption of additivity in the quantitation of cancer risks without consideration of synergism, antagonism, promotion and initiation. | | | Moderate |
| Assumption of additivity in the estimation of systemic health effects without consideration of synergism, antagonism, etc. | | | Moderate |
| Additivity of risks by individual exposure pathways (dermal and ingestion). | Low | | Low |
| Compounds not quantitatively evaluated. | | Low | |

Notes:

Low = Assumptions categorized as "low" may effect risk estimates by less than one order of magnitude.
 Moderate = Assumptions categorized as "moderate" may effect estimates of risk by between one and two orders of magnitude.

High = Assumptions categorized as "high" may effect estimates of risk by more than two orders of magnitude.

Source: Risk Assessment Guidance for Superfund, Volume 1, Part A: Human Health Evaluation Manual. USEPA, 1989a.

SECTION 6.0 REFERENCES

SECTION 6.0 REFERENCES

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7.0 CONCLUSIONS AND RECOMMENDATIONS

This section presents conclusions based on information presented in sections 1.0 through 6.0. The information gathered during the SGI filled the data gaps identified in the RI and as such, no recommendations for follow-up action are needed.

7.1 Conclusions

Based on the data obtained under the SGI the following conclusions, presented by media, were formed:

7.1.1 Groundwater

- Levels of iron and arsenic detected in samples collected from wells located in the RI Study Area and screened in the surficial aquifer create an unacceptable human health risk if consumed (groundwater in this area is not used as a potable supply).
- Based on the results of the qualitative risk assessment, Baker determined that solvent-related VOCs in the groundwater would result in a human health risk if the groundwater was consumed.
- Samples collected using a low-flow sampling technique yielded results with lower metals than those obtained in the RI, indicating that suspended solids may have influenced the inorganic levels observed in the RI data.
- Elevated levels of metal constituents in groundwater are not atypical in the Camp Lejeune groundwater. Previous studies have determined that groundwater in the Camp Lejeune area is rich in iron and manganese; samples often exceed NCWQS of 300 and 50 ug/L, respectively. The preliminary conclusion of the draft report "Evaluation of Metals in Groundwater at MCB Lejeune, North, Carolina" (Baker, 1994) generally supports the theory that concentrations of metals in groundwater are due to geologic conditions rather than site-related contamination.
- Specifically at Site 35, detections of aluminum, and manganese do not appear to emerge in a pattern that would suggest that an identifiable source exists. Elevated levels of iron were present in wells adjacent to areas where petroleum contaminated soil was identified. An available study indicates that elevated iron levels in groundwater can be associated with BTEX contamination (Becker, 1995).
- The limits of the solvent-related groundwater contamination in the lower portion of the surficial aquifer were identified to a location South of Fifth Street. In general this plume extends southward along "C" Street from Building G534 to the intersection of "C" and Sixth Street. The edge of the plume extends from this intersection across Camp Geiger to Building TC773 . At this point, the edge of the plume swings northward along the eastern tree line of Camp Geiger and continues north to Fifth Street.
- No fuel or solvent-related groundwater contamination was detected in samples collected in the NAOC on the northeast side of Brinson Creek. Therefore, fuel and

solvent-related contamination apparently has not migrated off-site onto Onslow County property.

7.1.2 Soils

- No fuel or solvent-related contamination was detected during soil screening activities at Site 35. These results that the spilled solvents and fuels have probably migrated inot the saturateed zone and are no longer acting as a continued source in the soil.

7.1.3 Sediment

- Fuel-related contamination is widespread in Brinson Creek sediments. Low levels of both gasoline and diesel fractions of the fuel-related contamination were detected in the sediments upstream of Site 35. This contamination may have been transported in part via storm runoff from U. S. Highway 17 and/or adjacent commercial property. Fuel-related contamination was detected in samples collected from all sediment sampling locations situated adjacent to and downstream of the former Fuel Farm. The highest diesel fraction was observed at sediment sampling station 35/SD06 located approximately 850 feet downstream of Site 35; the highest gasoline fraction was observed at sediment sampling station 35/SD04 located adjacent to Site 35. Therefore, previous operations most likely have contributed to fuel-related sediment contamination in Brinson Creek in areas adjacent to and downstream of the former Fuel Farm.
- Based on the analytical results and the lack of historical evidence that zinc or mercury was used at Site 35, it can be concluded that previous operations at Site 35 likely have not contributed to mercury and zinc contamination in Brinson Creek sediments.

7.2 Recommendations

No additional follow-up investigative actions are recommended.

SECTION 7.0 REFERENCES

SECTION 7.0 REFERENCES

Baker. 1994. Evaluation of Metals in Groundwater at Camp Lejeune. Marine Corps Base, Camp Lejeune, North Carolina.

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