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FINAL

INTERIM PROPOSED REMEDIAL ACTION PLAN FOR SURFICIAL GROUNDWATER OPERABLE UNIT NO. 10 SITE 35 - CAMP GEIGER AREA FUEL FARM

MARINE CORPS BASE,
CAMP LEJEUNE, NORTH CAROLINA

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LIST OF ACRONYMS AND ABBREVIATIONS

ARAR/TBC	applicable or relevant and appropriate requirement/to be considered (criteria)
AST	aboveground storage tank
Baker	Baker Environmental, Inc.
bgs	Below Ground Surface
BTEX	benze, toluene, ethylbenze, and xylene
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
COPC	contaminants of potential concern
CS	Confirmation Study
CSA	Comprehensive Site Assessment
DON	Department of the Navy
EPA	Environmental Protection Agency
ESE	Environmental Science and Engineering, Inc.
FFA	Federal Facilities Agreement
FFS	Focused Feasibility Study
FS	Feasibility Study
HI	Hazard Index
IAS	In Situ Air Sparging
IAS	Initial Assessment Study
ICR	incremental cancer risk
IRP	Installation Restoration Program
LAW	Law Engineering, Inc.
MCB	Marine Corps Base
MTBE	methyl-tertiary butyl ether
NC DEHNR	North Carolina Department of Environment, Health, and Natural Resources
NCDOT	North Carolina Department of Transportation
NCP	National Contingency Plan
NCWQS	North Carolina Water Quality Standards
NPL	National Priorities List
NUS	Halliburton NUS Environmental Corporation
O&M	operation and maintenance
OU	Operable Unit
PCB	Polychlorinated Biphenyl
PRAP	Proposed Remedial Action Plan

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

RAA	remedial action alternative
RI	Remedial Investigation
ROD	Record of Decision
SVE	Soil Vapor Extraction
T-1,2-DCE	trans-1,2-dichloroethene
TAL	Target Analyte List
TCE	trichloroethene
TCL	Target Compound List
TPH	Total Petroleum Hydrocarbons
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
VOC	Volatile Organic Compound

INTERIM PROPOSED REMEDIAL ACTION PLAN FOR SURFICIAL GROUNDWATER

Introduction

This Interim Proposed Remedial Action Plan (Interim PRAP) for Surficial Groundwater is issued to describe the Marine Corps Base (MCB) Camp Lejeune and the Department of the Navy's (DON's) preferred remedial action for petroleum hydrocarbon and solvent contamination in the surficial groundwater at Operable Unit No. 10 (Site 35 - Camp Geiger Area Fuel Farm), MCB, Camp Lejeune, North Carolina.

MCB Camp Lejeune and the DON are issuing this Interim PRAP for Surficial Groundwater as part of the public participation responsibility established under Section 117(a) of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), and the Federal Facilities Agreement (FFA) between the DON, United States Environmental Protection Agency (USEPA) Region IV, and the North Carolina Department of Environment, Health, and Natural Resources (NC DEHNR).

MCB Camp Lejeune and the DON, with the assistance of USEPA Region IV and the NC DEHNR, will select an interim remedy for surficial groundwater at Operable Unit No. 10 only after the public comment period has ended and the information submitted during this time has been reviewed and considered. The Final Interim Record of Decision (Interim ROD) for Surficial Groundwater may recommend a different remedial action than is presented in this plan, depending upon new information or public comments.

This Interim PRAP for Surficial Groundwater briefly summarizes information that can be found in greater detail in the Remedial Investigation (RI) Report (Baker, 1994), the Interim Feasibility Study (FS) Report (Baker, 1994), and other documents referenced in the RI and Interim FS Reports prepared for Operable Unit No. 10. The DON encourages the public to review these other documents in order to gain a more comprehensive understanding of the site. The administrative record file, which contains information on which the selection of the remedial action will be based, is available for public review at the Onslow County Library and at MCB Camp Lejeune, Building 67. The public is invited to review and comment on the administrative record and this Interim PRAP for Surficial Groundwater.

Operable Unit Description

Camp Lejeune is a training base for the U.S. Marine Corps, located in Onslow County, North Carolina. The Activity, as the Base is referred to, covers approximately 236 square miles and includes 14 miles of coastline. MCB Camp Lejeune is bounded to the southeast by the Atlantic Ocean, to the northeast by State Route 24, and to the west by U.S. Route 17. The town of Jacksonville, North Carolina is located north of the Base (see Figure 1).

Camp Geiger is located at the extreme northwest corner of MCB Camp Lejeune. The main entrance to Camp Geiger is off U.S. Route 17, approximately 3.5 miles southwest of the City of Jacksonville, North Carolina. Site 35, the Camp Geiger Area Fuel Farm, refers primarily to five, 15,000-gallon aboveground storage tanks (ASTs), a pump house, and a fuel unloading pad situated within Camp Geiger just north of the intersection of Fourth and "G" Streets (see Figure 2).

Site 35 is contained within Operable Unit No. 10, one of 14 operable units at MCB Camp Lejeune. An "operable unit," as defined by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), is a discrete action that comprises an incremental step toward comprehensively addressing site problems. The cleanup of a site can be divided into a number of operable units, depending on the complexity of the problems associated with the site. Operable units may address geographical portions of a site, specific site problems, or initial phases of an action. With respect to MCB Camp Lejeune, operable units were developed to combine one or more individual sites where Installation Restoration Program (IRP) activities are or will be implemented.

For this Interim PRAP for Surficial Groundwater, the study area consists of a portion of Operable Unit No. 10. More specifically, the study area consists of contaminated groundwater in the portion of the surficial aquifer that is located in the area of the Fuel Farm and downgradient towards Brinson Creek (see Figure 2).

Operable Unit Background History

Construction of Camp Geiger was completed in 1945, four years after construction of MCB Camp Lejeune was initiated. Originally, the ASTs were used for the storage of No. 6 fuel oil, but were later converted for storage of other petroleum products including unleaded gasoline, diesel fuel, and kerosene. The date of their conversion is not known. The ASTs currently in use at the site are reported to be the original tanks.

Routinely, the ASTs at Site 35 supply fuel to an adjacent dispensing pump. A leak in the underground line from the ASTs to the dispensing island 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.

The ASTs at Site 35 are currently used to dispense gasoline, diesel, and kerosene to government vehicles and to supply USTs in use at Camp Geiger and the nearby New River Marine Corps Air Station. The ASTs are supplied by commercial carrier trucks which deliver product to fill ports located on the fuel unloading pad at the southern end of the facility. Six short-run (120 feet maximum), underground fuel lines are currently utilized to distribute the product from the unloading pad to the ASTs. Product is dispensed from the ASTs via trucks and underground piping.

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 cannot be located. The fuel reportedly migrated to the east and northeast toward Brinson Creek. Interceptor trenches were excavated and the captured fuel was ignited and burned.

Another abandoned underground distribution line 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 1960's.

In April, 1990, an undetermined amount of fuel had been discovered by Camp Geiger personnel along the 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 is scheduled to be decommissioned in April 1995. Plans are currently being prepared to empty, clean, dismantle, and remove the ASTs along with all concrete foundations, slabs on grade, berms, and associated underground piping. The Fuel Farm is being removed to make way for a sixlane, divided highway proposed by the North Carolina Department of Transportation (NCDOT) (see Figure 2).

Previous Investigations

The following is a summary of the previous investigations performed at Site 35.

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 Base (Water and Air Resources, 1983). Site 35 was identified as one of 23 sites warranting further investigation. Sampling and analysis of environmental media was not conducted during the Initial Assessment Study.

Confirmation Study

ESE performed Confirmation Studies of the 22 sites requiring further investigation and investigated Site 35 between 1984 and 1987 (ESE, 1990). In 1984, ESE advanced three hand-auger borings 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 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, oil and grease, and volatile organic compounds (VOCs) including: benzene; trans-1,2-dichloroethene (T-1,2-DCE); trichloroethene (TCE); and methylene chloride. Lead was detected in each sample ranging from 3,659 µg/L to 1,063 µg/L. Oil and grease was detected in only one sample at 46,000 µg/L. The only detected VOC was methylene chloride in one sample at 4 µg/L.

In 1986, ESE collected two sediment and two surface water samples from Brinson Creek and installed three permanent monitoring wells- two east of and one west of the Fuel Farm. Surface water and sediment samples were analyzed for lead, oil and grease, and ethylene dibromide. Groundwater samples were obtained in December 1986 and again in March 1987, and were analyzed for lead, oil and grease, and VOCs.

No target analytes were detected in either surface water sample. Both sediment samples were reported to contain lead and oil and grease, 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 oil and grease and lead may be upstream.

Lead was detected in only one of six samples (33 µg/L) obtained from the three permanent monitoring wells. Oil and grease was detected in all six samples in a range from 200 µg/L to 12,000 µg/L. Detected VOCs included: benzene (range: 1.3 µg/L to 30 µg/L); trans-1,2-DCE (range: 3.2 µg/L to 29 µg/L); and TCE (detected at 11 µg/L on both sample dates).

Focused Feasibility Study

A Focused Feasibility Study (FFS) was conducted in 1990 in the area north of the Fuel Farm by NUS Corporation (NUS). The investigation included the installation of four groundwater monitoring wells. Results of laboratory analyses revealed that groundwater in one well and soil cuttings from two borings were contaminated with petroleum hydrocarbons; although nonaqueous product was not observed.

A geophysical investigation was conducted by NUS, as part of the FFS, in an attempt to identify underground storage tanks (USTs) at the site of the former gas station. The results indicated the presence of a geophysical anomaly to the north of the former gas station.

Comprehensive Site Assessment

Law Engineering, Inc. (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 that monitor the water table aquifer along two zones. The shallow zone, or water table zone, generally extends from 2.5 to 17.5 feet below ground surface (bgs). The deeper zone, monitored by the nested wells, generally ranges from 17.5 to 35 feet bgs. Five additional soil borings were drilled and nine soil borings were hand-augered to provide data regarding soil contamination in the vadose zone. 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 (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). 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 (i.e., chlorinated) organic compounds (e.g., TCE, trans-1,2-DCE, and vinyl chloride) and nonhalogenated, petroleum-based 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., BTEX) 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 petroleum contamination resulting from historical releases. Three monitoring wells were installed including MW-26, -27, and PW-28. 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 a designated pumping well and to estimate hydraulic parameters of the aquifer. An approximate hydraulic conductivity of 100 feet/day was determined for the surficial aquifer.

Interim Remedial Action RI/FS by Baker

Baker conducted an Interim Remedial Action RI in December 1993. An additional seven soil borings were located within and around groundwater contaminant plume areas identified during the CSA. In addition to the soil borings, 13 shallow soil samples were taken along Brinson Creek to determine the extent of contamination emanating from Site 35. Two of these shallow soil samples were situated upstream along Brinson Creek to provide background information on TPH and oil and grease.

In addition to soil sampling, a second round of groundwater level measurements was obtained for comparison to those presented in the CSA.

The most prevalent contaminants detected in soil samples taken during the Interim Remedial Action RI were benzene, toluene, ethylbenzene, xylenes, naphthalene, and 2-methylnaphthalene. These constituents are commonly associated with fuel contamination. TPH (gasoline and diesel) and oil and grease were also observed, in addition to sporadic occurrences of lead, chromium, vanadium, and arsenic.

Analytical results, in general, confirm the Law findings that contamination in the majority of the identified soil is associated with a dissolved petroleum hydrocarbon contaminant plume in shallow groundwater. Oil and grease results observed in shallow soil samples obtained from the Brinson Creek area are likely influenced by the presence of naturally occurring organics in soils or an upgradient contamination source. This is supported by elevated background concentrations of oil and grease in surface soil samples obtained along the banks of Brinson Creek approximately 1/2-mile upstream of the site.

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 have been identified (see Figure 2). The first area is located in the vicinity of the Fuel Farm ASTs, and the two other areas are located north of the Fuel Farm. The larger of these two areas is located along "F" Street in the vicinity of monitoring well MW-25. Baker has estimated that approximately 3,600 cubic yards (4,900 tons) of contaminated soil is present in these areas. Contaminated soil located in these areas is scheduled for removal and disposal at an off-site soil recycling facility beginning July 1995.

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 a UST there in January 1994. The contaminated soil was excavated and reportedly disposed off site; however, no documentation is available regarding how or where the soil was disposed. An additional soil investigation will be conducted in this area to confirm that the contaminated soil was not returned to the excavation and that follow-up soil remediation in this area is not necessary.

Comprehensive Remedial Investigation

A comprehensive RI was conducted by Baker in 1994 to evaluate the nature and extent of the threat to public health and the environment caused by the release of hazardous substances, pollutants, or contaminants at Operable Unit No. 10, and to support an evaluation of potential remedial alternatives. Data gathering activities completed included a soil gas survey and groundwater screening investigation, a soil investigation, a groundwater investigation, a surface water and sediment investigation, and an ecological investigation.

Soil Gas Survey and Groundwater Screening Investigation

Baker monitored the collection of 67 soil gas samples and 72 groundwater screening samples from sample locations established across the Site 35 study area. This investigation focused on obtaining additional information to assess the source(s) of halogenated compounds in shallow groundwater. The majority of the sample locations were south of the Fuel Farm and south of Fourth Street, and were based on the results of previous investigations, which revealed TCE in groundwater. The purpose of this activity was to assist in the placement of soil borings/monitoring wells.

Three distinct zones of soil gas and surficial groundwater contamination were identified including: 1) an area southeast of the Fuel Farm in the vicinity of Building TC474 (i.e., the former vehicle maintenance facility); 2) an area roughly 150 feet west of the Fuel Farm in the vicinity of the former gas station; and 3) an area located about 500 feet southwest of the Fuel Farm near the intersection of Fourth and "E" Streets.

Soil Investigation

The soil investigation involved obtaining 14 surface samples at various locations across the study area. In addition, 26 soil borings were drilled at locations primarily determined by the results of the soil gas survey and groundwater screening investigation. Borings were advanced to three depths and included: 10 shallow borings (14 to 17 feet bgs); 11 intermediate borings (41 to 47 feet bgs); and five deep borings drilled to a depth equivalent to 5 to 10 feet below the semi-confining layer separating the surficial aquifer from the Castle Hayne aquifer.

Soil samples obtained from the borings were analyzed for TCL volatiles, semivolatiles, pesticides/PCBs, and TAL metals, as well as a variety of engineering parameters.

Laboratory analytical results indicate little evidence of soil contamination. The most significant contamination detected involved tetrachloroethene in subsurface soil at boring 35MW-30B located near the barracks southwest of the Fuel Farm. Pesticides were detected in subsurface soil samples only, but were deemed to not be site related. No PCBs were detected in surface or subsurface soil samples. Detected inorganics were generally similar to background surface and subsurface soil concentrations at Camp Lejeune.

Groundwater Investigation

The groundwater investigation included the installation of shallow, intermediate, and deep groundwater monitoring wells. The 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 with screens set just above what appeared to be a semi-confining layer separating the surficial aquifer from the underlying Castle Hayne aquifer. A total of 21 shallow and intermediate wells were installed under the RI. In addition, five deep groundwater wells were installed to monitor the upper portion of the Castle Hayne aquifer immediately below the suspected semi-confining layer.

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

The results of the RI confirm the results of the previous environmental investigations at this site. Groundwater contamination was observed in the surficial aquifer over a broad area. Fuel-related organic contaminants (i.e., primarily benzene, toluene, ethylbenzene, total xylenes) appear to be more prevalent in the upper portion of the surficial aquifer, although they were also detected in the lower portion. Solvent contamination (i.e., primarily halogenated hydrocarbons such as TCE and DCE) were detected in the upper portion of the surficial aquifer, but were more prevalent in the lower portion.

Fuel-related contamination appears to be limited to the area north of Fourth Street in the vicinity of obvious suspected sources such as the Fuel Farm and nearby former UST sites.

Solvent contamination in the deeper portion of the surficial aquifer has not been adequately defined to date nor have all the sources been identified. A plume appears to extend from north of Fourth Street to south of Fifth Street, beyond which the RI did not extend. The source of this plume was not determined. A second smaller plume is present in the vicinity of Buildings TC474, TC473, and TC470. The smaller plume appears to be adequately defined. The source of this plume is most likely the nearby buildings, which historically may have been used to store solvents.

Elevated levels of inorganics were also detected in samples collected from the surficial aquifer. It is questionable whether this contamination is due to past site activities because the results are similar to those obtained by Baker at other Camp Lejeune sites.

An additional groundwater investigation was recommended to define the nature and extent of shallow groundwater contamination south of Fifth Street.

Surface Water/Sediment Investigation

Surface water and sediment samples were obtained along Brinson Creek, which flows roughly north to south immediately east of the Fuel Farm. Samples were obtained from ten stations including three upstream and seven adjacent/downstream locations. Surface water and sediment samples were also collected from off-base reference stations. The reference stations included the White Oak River watershed.

The surface water and sediment samples were analyzed for TCL volatiles, semivolatiles, pesticides/PCBs, TAL metals, and particle-size distribution.

Significant levels of organic and inorganic contaminants were detected in sediment samples. The results of the VOC analysis were masked by the presence of high levels of heavy (i.e., high molecular weight) oil compounds referred to as Tentatively Identified Compounds (TICs). Lead at elevated levels was also detected in these sediment samples.

Surface water contamination was limited to a single detection of elevated levels of lead and zinc downstream of Site 35.

An additional investigation of Brinson Creek sediments was recommended. The scope of the study will involve resampling the sediments and analyzing them for total petroleum hydrocarbons (TPH) via EPA Methods 5030/8015 and 3550/8015.

Ecological Investigation

The ecological investigation included biological sampling (i.e., fish, shellfish, and benthic macroinvertebrates) along Brinson Creek and along three streams in the nearby White Oak River watershed including: Webb Creek, Hadnot Creek, and Holland Mill Creek. The work performed in the White Oak River watershed was part of an overall ecological background investigation conducted as part of the RI.

The most significant levels of contaminants were detected in fish samples. Detected contaminants included the pesticides dieldrin and 4,4'-DDD, and a single detection of mercury. None of the detected contaminants can be attributed to fuel dispensing activities historically performed at the Fuel Farm.

Interim Feasibility Study

As a result of the Remedial Investigation, an Interim Feasibility Study was initiated by Baker in October 1994, to address contaminated surficial groundwater in the vicinity of the Fuel Farm at Operable Unit No. 10. More specifically, the Interim FS addressed remediating the contaminated surficial groundwater extending downgradient from the Fuel Farm area towards Brinson Creek and containing the remainder of the contaminated plumes as they migrate in the direction of the creek. This Interim PRAP for Surficial Groundwater presents the preferred remedial action developed and evaluated during the Interim FS.

Other Investigations

Two USTs located near the Fuel Farm have been the subject of previous investigations conducted under an Activity-wide 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 the Explosive Ordnance and Disposal Armory, Office, and Supply Building. The former UST was abandoned in place years ago (date unknown) and has been the subject of previous environmental investigations performed by ATEC Associates, Inc. and Law. The latter UST was removed in January 1994. An additional soil investigation will be conducted in 1995 to confirm that no fuel contaminated soil remains at or near the former UST area at Building G480.

Summary of Site Risks

As part of the RI, a human health risk assessment and an ecological risk assessment were conducted to evaluate the current or future potential risks to human health and the environment resulting from the presence of petroleum hydrocarbon and solvent contamination in the surficial groundwater at Operable Unit No. 10.

Human Health Risk Assessment

A risk assessment was conducted for chemicals of potential concern (COPCs) detected in groundwater samples. COPCs are those chemicals detected with sufficient prevalence in an environmental medium and retained for quantitative evaluation. Baker calculated that the human health risk associated with OU No. 10 is in excess of the acceptable range. The contaminants driving the risk associated with the future potential exposure to groundwater are cis-1,2-dichloroethene, trichloroethane, benzene, antimony, arsenic, barium, beryllium, chromium, cadmium, manganese, and vanadium. The contaminant driving the risk associated with the current exposure to fish is mercury.

Exposure to groundwater was evaluated considering potential future residential receptors (children and adults), potential dermal contact, inhalation of vapors, and incidental ingestion scenarios. (Current residential receptors were not considered because the groundwater is presently not a potable water source.) The total ICR value for future residential children (2.3E-03) and adults (4.3E-03) exceeded the USEPA's upper bound risk range (1E-04). Therefore, adverse health effects to future residents from ingestion, dermal contact, and inhalation are plausible. In addition, the total HI estimated for potential future residential children (64) and adults (28) exceeded unity (1.0), suggesting that adverse systemic health effects are likely.

Exposure to fish and shell fish was evaluated considering potential ingestion by current residential adult receptors. The total ICR value (1.35 E-04) slightly exceeds the USEPA's acceptable upper bound risk range of 1E-04, and the total HI value (3.56) is greater than unity (1.0). These estimated values indicate that adverse health effects due to fish ingestion are possible, but unlikely.

Ecological Risk Assessment

Groundwater, the focus of this Interim PRAP, is not considered as a media of concern in the ecological risk assessment. However, the ecological risk assessment did indicate that the aquatic community within Brinson Creek was representative of an estuarine community and does not appear to be adversely impacted by surface water and sediment quality. Additionally, there are no significant adverse impacts to terrestrial receptors from site-related contaminants.

Scope and Role of the Interim Proposed Remedial Action

The Interim Proposed Remedial Action for surficial groundwater at Operable Unit No. 10 focuses on remediating the surficial aquifer extending downgradient from the Fuel Farm area and mitigating the further migration of contaminant plumes towards Brinson Creek. This groundwater contamination primarily consists of BTEX and halogenated organic compounds in both the upper and lower portions of the surficial aquifer. Figures 3, 4, 5, and 6 show the approximate extent of the contaminated plumes.

The proposed remedial action is considered to be interim in nature because it provides for additional protection to human health and the environment, but is not necessarily intended to represent the final solution for Operable Unit No. 10. The Interim Proposed Remedial Action does not consider groundwater contamination across the entire operable unit because, based on the results of the RI, it has not been completely defined to date. Since the entire area of shallow contamination cannot be addressed, the Interim Proposed Remedial Action focuses on remediating and containing shallow groundwater contamination along the downgradient extreme of the plumes; that is, in the area roughly between the proposed highway and Brinson Creek (see Figure 2). A remediation system installed in this area would be able to address the groundwater contamination from Site 35 prior to its discharge into Brinson Creek. Additional remediation west and south of the proposed highway (i.e., further upgradient) may be necessary, but will be part of an overall site-wide groundwater remediation action to be considered under a future comprehensive FS.

The scope and goals for the remediation of petroleum and solvent contaminated groundwater were driven by the North Carolina Water Quality Standards (NCWQS). In the Interim Feasibility Study that addressed contaminated surficial groundwater at Site 35, risk based cleanup goals were finalized. These were then compared to Federal Maximum Contaminant Levels (MCLs) and NCWQS, and the most conservative value for each contaminant selected as the remediation goal. In each case, for this evaluation, the most conservative criteria was the NCWQS. The remediation goals for the organic contaminants of concern are listed below:

• Benzene	1 μg/L
• Trichloroethene	2.8 μg/L
• cis-1,2-dichloroethene	70 μg/L
• trans-1,2-dichloroethene	70 μg/L
• Ethyl benzene	29 μg/L
• Methyl Tertiary Butyl Ether	200 μg/L
• Xylenes	530 μg/L

<u>**Summary of Alternatives**</u>

Various technologies and process options were screened and evaluated under the Interim FS. Ultimately, the following five Remedial Action Alternatives (RAAs) were developed:

- 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 brief description of each alternative, as well as the estimated cost and timeframe to implement the alternative, are as follows:

- **RAA 1 - No Action**
  Capital Cost: $0
  Annual Operation and Maintenance (O&M): $0
  Total Net Present Worth (30 Years): $0
  Months to Implement: 0

Under RAA 1, no remedial actions will be performed to reduce the toxicity, mobility, or volume of the contaminated surficial groundwater at Operable Unit No. 10. This method assumes that passive remediation will occur via natural attenuation processes and that the contaminant levels will be reduced over an indefinite period of time. However, the achievable reductions versus time is difficult if not impossible to predict.

The No Action RAA is required by the NCP to provide a baseline for comparison with other alternatives. Since contaminants will remain at the site under this alternative, USEPA is required by the NCP [40 CFR 300.515(e)(ii)] to review the effects of this alternative no less often than every five years.

- **RAA 2 - No Action with Institutional Controls**
  Capital Cost: $6,200
  Annual Operation and Maintenance (O&M) Costs: $19,100
  Total Net Present Worth (30 years): $299,800
  Months to Implement: 1

Under RAA 2, no remedial actions will be performed to reduce the toxicity, mobility, or volume of the contaminated surficial groundwater at Operable Unit No. 10. This RAA assumes that the Base Master Plan will be modified to include restrictions on the use of the surficial aquifer in the vicinity of the Fuel Farm. This will reduce the risk to human health and the environment posed by this media by eliminating one exposure pathway; however, without additional remediation the contaminated surficial groundwater will remain a future source of contamination for Brinson Creek.

In addition to aquifer-use restrictions, long-term groundwater monitoring is to be included under this RAA to provide data regarding the impact of natural attenuation and the progress of contaminant migration. Long-term groundwater monitoring includes the semi-annual collection and analysis (TCL VOCs) of groundwater samples from 11 monitoring wells, the development of a semi-annual monitoring report, and the replacement of one monitoring well every five years.

Since contaminants will remain at the site under this alternative, the USEPA is required by the NCP [40 CFR 300.515(e)(iii)] to review the effects of this alternative no less often than every five years.

- **RAA 3 - Groundwater Collection and On-Site Treatment**
  Capital Cost: $2,122,700
  Annual Operation and Maintenance (O&M) Costs: $57,100
  Total Net Present Worth (30 years): $3,000,500
  Months to Implement: 3

  RAA 3 is a source collection and treatment alternative, the source being the contaminated surficial groundwater in the vicinity of the Fuel Farm at Operable Unit No. 10. Under this alternative, a vertical interceptor trench will be installed at the downgradient edge of the contaminated plume in the area between the proposed highway and Brinson Creek. The interceptor trench will extend from the ground surface to the semi-confining layer at the base of the surficial aquifer. The purpose of the interceptor trench is to collect contaminated surficial groundwater for transfer to an on-site treatment facility prior to it being discharged to Brinson Creek.

  The type of interceptor trench proposed under RAA 3 is termed a "biopolymer slurry drainage trench." This type of trench can be installed without dewatering or structural bracing. Through the use of a natural, biodegradable slurry, the walls of a trench excavation can be supported and the trench can be installed without personnel entering an excavation. Compared to other trenching methods, this technique is safer and more cost-effective in areas with a high groundwater and unstable soil, because there are no costs of dewatering and water disposal or shoring.

  A biopolymer slurry drainage trench is constructed in much the same manner as a typical slurry cut-off wall. However, unlike a bentonite-clay slurry, a biodegradable biopolymer slurry supports the walls of the trench while excavated materials are removed and drainage structures are installed. The biopolymer slurry then naturally biodegrades after the trench is backfilled. In the end, a permeable wall is left intact.

  The interceptor trench will be designed to collect groundwater at a rate roughly equal to the rate of groundwater flow (5 to 10 gpm) across the upgradient face of the trench (31,900 square feet). Flow across the downgradient face of the trench will be restricted by an impermeable geomembrane barrier. Drawdown of the groundwater surface will be minimized so as to mitigate the potential of excessive ground settlement beneath the highway. The collected groundwater will be conveyed to an on-site treatment system located just east of the proposed highway right-of-way, near the southern end of the trench, where it appears that adequate space and firm ground is available.

The collected groundwater will be treated sufficiently to allow for its discharge to Brinson Creek at a point downstream of Operable Unit No. 10. It is anticipated that the groundwater treatment system will include: filtration for the removal of suspended solids; precipitation for the removal of inorganics; sludge collection and disposal; volatilization (air stripping) for the removal of VOCs; and secondary treatment of VOC emissions from the air stripper and of the treated groundwater (i.e., via carbon adsorption).

RAA 3 assumes that the Base Master Plan will be modified to include restrictions on the use of the surficial aquifer in the vicinity of the Fuel Farm. This will reduce the risk to human health and the environment posed by this media by eliminating one exposure pathway.

In addition to aquifer-use restrictions, long-term groundwater monitoring is to be included under this RAA to provide data regarding the impact of natural attenuation and the progress of contaminant migration. Long-term groundwater monitoring includes the semi-annual collection and analysis (TCL VOCs) of groundwater samples from 11 monitoring wells, the development of a semi-annual monitoring report, and the replacement of one monitoring well every five years.

Since contaminants will remain at the site under this alternative, the USEPA is required by the NCP [40 CFR 300.515(e)(iii)] to review the effects of this alternative no less often than every five years.

- **RAA 4 - In Situ Air Sparging And Off-Gas Carbon Adsorption**
  Capital Cost: $1,068,400
  Annual Operation and Maintenance (O&M) Costs: $90,100
  Total Net Present Worth (30 years): $2,459,600
  Months to Implement: 3

In situ air sparging (IAS) is a technique in which air is injected into water saturated zones for the purpose of removing organic contaminants, primarily via volatilization and, secondarily, via aerobic biodegradation. IAS systems introduce contaminant-free air into an impacted aquifer near the base of the zone of contamination, forcing contaminants to transfer from the groundwater into sparged air bubbles. The air bubbles are then transported into soil pore spaces in the unsaturated zone where they are typically collected via soil vapor extraction (SVE) and conveyed to an on-site off-gas treatment system.

An IAS system typically is comprised of the following components: 1) air injection wells; 2) an air compressor; 3) air extraction wells; 4) a vacuum pump; 5) associated piping and valving for air conveyance; and, 6) an off-gas treatment system (e.g., activated carbon, combustion, or oxidation). Under RAA 4, a line of air sparging wells will be installed between the proposed highway and Brinson Creek in order to treat the contaminated plume near its downgradient extreme. Based on empirical data from similar sites, the radius of influence of an air sparging well ranges from five to almost 200 feet, but is typically on the order of 25 feet (EPA, 1992). The proposed off-gas treatment system, consisting primarily of activated carbon units, will be located just east of the proposed highway right-of-way, near the southern end of the air sparging wells, where it appears that adequate space and firm foundation material is available.

Air sparging systems are most effective in sandy soils, but can be adversely impacted by high levels of inorganic compounds in the groundwater, which oxidized and precipitate when contacted by the sparged air. These organics can form a heavy scale on well screens and clog the well space of the sand pack surrounding the well screen, resulting in a reduction in permeability. A field pilot test is recommended to determine the loss of efficiency over time as a result of inorganics precipitation and oxidation, the radius of influence of the wells under various heads of injection air pressure, and the rate of off-gas organic contaminant removal via carbon adsorption and carbon breakthrough.

RAA 4 assumes that the Base Master Plan will be modified to include restrictions on the use of the surficial aquifer in the vicinity of the Fuel Farm. This will reduce the risk to human health and the environment posed by this media by eliminating one exposure pathway.

In addition to aquifer-use restrictions, long-term groundwater monitoring is to be included under this RAA to provide data regarding the impact of natural attenuation and the progress of contaminant migration. Long-term groundwater monitoring includes the semi-annual collection and analysis (TCL VOCs) of groundwater samples from 11 monitoring wells, the development of a semi-annual monitoring report, and the replacement of one monitoring well every five years.

Since contaminants will remain at the site under this alternative, the USEPA is required by the NCP [40 CFR 300.515(e)(iii)] to review the effects of this alternative no less often than every five years.

- **RAA 5 - In Well Aeration and Off-Gas Carbon Adsorption**
  Capital Cost: $1,248,300
  Annual Operation and Maintenance (O&M): $82,300
  Total Net Present Worth (30 years): $2,519,700
  Months of Implementation: 3

In well aeration is a relatively new technology that utilizes circulating air flow within a groundwater well that, in effect, turns the well into an air stripper. In well aeration differs from air sparging in that volatilization occurs outside the well, via air sparging, and within the well, via air stripping. Similar to air sparging, this technique removes organic contaminants from groundwater, primarily via volatilization, and secondarily via aerobic biodegradation. Under RAA 5, a line of in well aeration wells will be installed between the proposed highway and Brinson Creek in order to treat the contaminated plume and contain the remaining plumes near their downgradient extremes. The radius of influence of an in well aeration well is reportedly much greater than a typical air sparging well system. At Site 35, the radius of influence has been calculated by the technology's developers to be over 100 feet. This radius of influence is based upon site-specific geological and hydrogeological parameters. Volatilized organic contaminants collected by the in well aeration system, unlike air sparging, will be conveyed to independent carbon adsorption units placed adjacent to each well system.

In well aeration systems, like IAS systems, are most effective in sandy soils, but can be adversely impacted by high levels of inorganic compounds in the groundwater which oxidize and precipitate when contacted by air. These inorganics can form a heavy scale on well screens and clog the well space of the sand pack surrounding the well screen, resulting in a reduction in permeability. A field pilot test is recommended ensure the viability of this technology at Site 35 and to determine the loss of efficiency over time as a result of inorganics precipitation and oxidation, the radius of influence of the wells under various heads of injection air pressure, and the rate of off-gas organic contaminant removal via carbon adsorption and carbon breakthrough.

RAA 5 assumes that the Base Master Plan will be modified to include restrictions on the use of the surficial aquifer in the vicinity of the Fuel Farm. This will reduce the risk to human health and the environment posed by this media by eliminating one exposure pathway.

In addition to aquifer-use restrictions, long-term groundwater monitoring is to be included under this RAA to provide data regarding the impact of natural attenuation and the progress of contaminant migration. Long-term groundwater monitoring includes the semi-annual collection and analysis (TCL VOCs) of groundwater samples from 11 monitoring wells, the development of a semi-annual monitoring report, and the replacement of one monitoring well every five years.

Since contaminants will remain at the site under this alternative, the USEPA is required by the NCP [40 CFR 300.515(e)(iii)] to review the effects of this alternative no less often than every five years.

Evaluation of Alternatives and the Preferred Alternative

The Interim Preferred Remedial Action alternative is RAA 5 (In Well Aeration and Off-Gas Carbon Adsorption). The following paragraphs describe the process by which RAA 5 was selected over RAAs 1, 2, 3, and 4. This process involved a comparison/contrast evaluation of the five RAAs based on seven criteria: overall protectiveness, compliance with ARARs, long-term effectiveness/ performance, reduction of toxicity, mobility, or volume through treatment, short-term effectiveness, implementability, and cost. Two other criteria, USEPA/State acceptance and community acceptance, will be considered after a preferred remedial action is selected. (Table 1 presents a complete summary of the alternatives evaluation; Table 2 provides a glossary of the evaluation criteria).

RAA 1 (No Action) and RAA 2 (No Action With Institutional Controls) are no action alternatives; RAA 3 (Groundwater Collection and On-Site Treatment), RAA 4 (In Situ Air Sparging and Off-Gas Carbon Adsorption), and RAA 5 (In Well Aeration and Off-Gas Carbon Adsorption) are source control alternatives. Since source control alternatives are more effective at complying with ARARs, achieving remediation goals, contributing to the overall protection of human health and the environment, and achieving a permanent reduction in toxicity, mobility, and volume of waste; RAAs 3, 4, and 5 are preferred over the no action alternatives.

Of the three source control alternatives, RAA 3 is the most difficult to implement because it involves constructing a large permeable trench (approximately 2 feet wide, by 30 feet deep, by 1,080 feet long) in the soft ground of a wetlands area. RAA 4 and RAA 5, on the other hand, have similar implementability ratings because the major construction activity, in both cases, involves the drilling and installation of multiple vertical wells. Since well installation at OU No. 10 has been executed successfully in the past, RAAs 4 and 5 should be relatively easy to implement compared to RAA 3.

Despite its more difficult implementability, RAA 3 would likely be the easiest alternative to operate and maintain because it involves fewer mechanical components than RAAs 4 and 5. Additionally, under RAAs 4 and 5, high metals in the groundwater could precipitate and oxidize easily, because these RAAs involve in situ aeration. The process could clog the well screens, which would require frequent maintenance or even well replacement.

Both RAA 3 and RAA 5 performed well under the short-term and long-term effectiveness/ performance evaluation. RAA 4, however, did not perform well. When the groundwater surface is within several feet of the ground surface, like it is at OU No. 10, vapor extraction (a main component of RAA 4) is difficult to control and there is a risk of releasing toxic vapors to the atmosphere. Thus, RAA 4 could pose a risk to the community that RAAs 3 and 5 do not.

Under the final criterion, cost effectiveness, RAA 4 resulted in the lowest net present worth, $2,459,600. RAA 5 resulted in the next lowest cost, $2,519,700, which is very close to the cost of RAA 4. RAA 3, however, requires $3,000,500, which is roughly $500,000 more than either RAA 4 or RAA 5. Therefore, RAA 4 is the most cost effective alternative, although RAA 5 is a very close second.

In conclusion, neither RAA 1 nor RAA 2 was selected to be the preferred alternative because of the potential environmental impacts associated with no action alternatives. RAA 3 was not selected because of its higher cost and difficult implementability. Despite its similarities to RAA 5, RAA 4 was not selected because of the possible release of toxic vapors associated with vapor extraction at Operable Unit No. 10. Thus, RAA 5, which appears to be almost the most cost effective alternative, was selected as the Interim Preferred Remedial Action. Figure 7 presents a plan view of RAA 5.

The viability of in well aeration technology at Camp Lejeune needs to be determined by means of a field pilot test. Additionally, the field pilot test will provide important design support data. If it is determined, based on the results of the field pilot test, that in well aeration can not perform as required, RAA 3 (groundwater collection and on-site treatment) will be selected as the Interim Preferred Remedial Action.

COMMUNITY PARTICIPATION

A critical part of the selection of a remedial action alternative is community involvement. The following information is provided to the community in order to obtain input on the selection of an Interim Remedial Action Alternative for surficial groundwater at Operation Unit No. 10, Site 35.

Public Comment Period

The public comment period will begin on May 10, 1995, and end on June 10, 1995, for the Interim Proposed Remedial Action Plan for surficial groundwater at Operable Unit No. 10, Site 35. Written comments should be sent to the following address:

Commander
Atlantic Division Naval Facilities Engineering Command
1510 Gilbert Street (Bldg. N-26)
Norfolk, Virginia 23511-2699
Attention: Ms. Katherine Landman, Code 1823

Information Repositories

A collection of information, including the administrative record, is available at the following locations:

MCB Camp Lejeune
Building 67, Room 238
Marine Corps Base
Camp Lejeune, NC 28542

M-F: 7:00 a.m.-4:00 p.m.
Closed Saturday and Sunday

Onslow County Library
58 Doris Avenue East
Jacksonville, NC 28540
(910) 455-7350

Hours: M-Th: 9:00 a.m. - 9:00 p.m.
F-Sa: 9:00 a.m. - 6:00 p.m.
Closed Sunday

IF YOU HAVE ANY QUESTIONS ABOUT OPERABLE UNIT NO 10, PLEASE CONTACT ONE OF THE FOLLOWING:

Commanding General
AC/S EMD (IRD)
Marine Corps Base
PSC Box 20004
Camp Lejeune, North Carolina 28452-0004
Attention: Mr. Neal Paul
(910) 451-5068

Commander
Atlantic Division
Naval Facilities Engineering Command
1510 Gilbert Street (Bldg. N-26)
Norfolk, Virginia 23511-2699
Attention: Ms. Katherine Landman, Code 1823
(804) 322-4818

Remedial Project Manager
U.S. EPA, Region IV
345 Courland Street, NE
Atlanta, Georgia 30365
Attention: Ms. Gena Townsend
(404) 347-3016

NC Department of Environment, Health, and Natural Resources
Division of Solid Waste Management
Superfund Section
P.O. Box 27687
Raleigh, North Carolina 27611-7687
Attention: Mr. Patrick Watters
(919) 733-2801

Community Information Line
Public Affairs Office
Marine Corps Base, Camp Lejeune, North Carolina
(910) 451-5782

MAILING LIST

If you are not on the mailing list and would like to receive future publications pertaining to Operable Unit No. 10, please fill out, detach, and mail this form to:

Commanding General
AC/S EMD (IRD)
Marine Corps Base
PSC Box 20004
Camp Lejeune, North Carolina 28542-0004
(910) 451-5068

Attn: Mr. Tom Morris

Name ____

Address ____

Affiliation ____

Phone (   ) ________________________

TABLES

TABLE 1

SUMMARY OF ALTERNATIVES EVALUATION
OPERABLE UNIT NO. 10 (SITE 35)
INTERIM PROPOSED REMEIDAL ACTION PLAN, CTO-0232
MCB CAMP LEJEUNE, NORTH CAROLINA

Evaluation Criteria	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
OVERALL PROTECTIVENESS					
• Human Health	Potential risks associated with groundwater exposure will remain. Some reduction in contaminant levels may result from natural attenuation.	Aquifer-use restrictions mitigate risks from direct groundwater exposure.	Active collection and treatment will reduce contaminant levels in groundwater within capture zone of interceptor trench (estimated at 100 feet upgradient maximum). Aquifer-use restrictions will also mitigate risks from direct groundwater exposure.	Active in situ volatilization and biodegradation will reduce contaminant levels in groundwater within radius of influence of wells (estimated at 25 feet). Aquifer-use restrictions will also mitigate risks from direct groundwater exposure.	Active in-well volatilization and in situ biodegradation will reduce contaminant levels in groundwater within radius of influence of wells (estimated at 45 to 60 feet). Aquifer-use restrictions will also mitigate risks from direct groundwater exposure.
• Environment	Contaminated groundwater will continue to be a source of future contamination to Brinson Creek.	Contaminated groundwater will continue to be a source of future contamination to Brinson Creek.	Interceptor trench serves as a barrier to contaminated groundwater discharge to Brinson Creek.	Air sparging wells and SVE wells serve as a barrier to contaminated groundwater discharge to Brinson Creek.	Aeration wells serve as a barrier to contaminated groundwater discharge to Brinson Creek.
COMPLIANCE WITH ARARs					
• Chemical-Specific	No active effort made to reduce groundwater contaminant levels to below federal or state ARARs.	No active effort made to reduce groundwater contaminant levels to below federal or state ARARs.	Reductions in groundwater contaminant levels to below federal or state ARARs can be expected within capture zone of interceptor trench. Reductions upgradient will be less substantial if at all.	Reductions in groundwater contaminant levels to below federal or state ARARs can be expected within radius of influence of wells. Reductions upgradient will be less substantial if at all.	Reductions in groundwater contaminant levels to below federal or state ARARs can be expected within radius of influence of wells. Reductions upgradient will be less substantial if at all.
• Location-Specific	Not Applicable.	Not Applicable.	Wetlands and alligators (endangered species) are concerns because of proposed location of interceptor trench. It is assumed that necessary approvals can be obtained.	Wetlands and alligators (endangered species) are concerns because of proposed location of interceptor trench. It is assumed that necessary approvals can be obtained.	Wetlands and alligators (endangered species) are concerns because of proposed location of interceptor trench. It is assumed that necessary approvals can be obtained.
• Action-Specific	Not Applicable.	Not Applicable.	Can be designed to meet these ARARs.	Can be designed to meet these ARARs.	Can be designed to meet these ARARs.
LONG-TERM EFFECTIVENESS AND PERFORMANCE					
• Magnitude of Residual Risk	Any long-term effect on contamination will be the result of natural attenuation processes only.	Any long-term effect on contamination will be the result of natural attenuation processes only. Aquifer-use restrictions will provide a permanent means for protection against direct exposure to the contaminated surficial groundwater.	Provides an effective means of intercepting contaminated groundwater and blocking its discharge to Brinson Creek for as long as it remains in operation. Aquifer-use restrictions will provide a permanent means for protection against direct exposure to the contaminated surficial groundwater.	Provides an effective means of intercepting and treating contaminated groundwater prior to its discharge to Brinson Creek for as long as it remains in operation. Toxic vapors escaping to the air due to poor vapor extraction may increase risk to community. Aquifer-use restrictions will provide a permanent means for protection against direct exposure to the contaminated surficial groundwater.	Provides an effective means of intercepting and treating contaminated groundwater prior to its discharge to Brinson Creek for as long as it remains in operation. Aquifer-use restrictions will provide a permanent means for protection against direct exposure to the contaminated surficial groundwater.

TABLE 1 (Continued)

SUMMARY OF ALTERNATIVES EVALUATION
OPERABLE UNIT NO. 10 (SITE 35)
INTERIM PROPOSED REMEDIAL ACTION PLAN, CTO-0232
MCB CAMP LEJEUNE, NORTH CAROLINA

Evaluation Criteria	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
• Adequacy and Reliability of Controls	Not Applicable.	Aquifer-use restrictions are reliable if enforced. Enforcement is likely as Camp Geiger is a controlled military installation	Interceptor trench involves basic technology and should be adequate and reliable for an indefinite period.	Air sparging has a long track record of commercial use and should be able to be controlled adequately and reliably for an indefinite period. High levels of metals in groundwater could short circuit the system prompting frequent maintenance. Well replacement over several years may result.	In well aeration is a relatively new technology without a substantial commercial track record. High levels of metals could short circuit the system prompting frequent maintenance. Well replacement over several years may result.
• Estimated Period of Operation	30 Years	30 Years	30 years unless additional active treatment actions are implemented upgradient.	30 years unless additional active treatment actions are implemented upgradient.	30 years unless additional active treatment actions are implemented upgradient.
• Need for 5-Year Review	Review required because no active treatment is included	Review required because no active treatment is included.	Review required because area impacted by treatment will be limited.	Review required because area impacted by treatment will be limited.	Review required because area impacted by treatment will be limited.
REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT					
• Treatment Process Used	No active treatment process applied.	No active treatment process applied.	On-site groundwater treatment includes filtration, metals precipitation, air stripping, air and water carbon adsorption.	In situ volatilization and biodegradation. Off-gas carbon adsorption.	In situ volatilization and biodegradation. Off-gas carbon adsorption.
• Reduction of Toxicity, Mobility or Volume	No reduction except by natural attenuation.	No reduction except by natural attenuation.	Reduction of organic and inorganic contaminants expected within capture zone of trench.	Reduction of organic contaminants expected within radius of influence of wells.	Reduction of organic contaminants expected within radius of influence of wells.
• Residuals Remaining After Treatment	No active treatment process applied.	No active treatment process applied.	Residuals include metals sludge and spent carbon which would have to be disposed of properly.	Residuals requiring disposal include spent carbon and a small volume of condensed contaminated vapor (water).	Residuals requiring disposal include spent carbon and a small volume of condensed contaminated vapor (water).
• Statutory Preference for Treatment	Not satisfied.	Not satisfied.	Satisfied except that area impacted by treatment is limited and does not include entire plume of contaminated surficial groundwater.	Satisfied except that area impacted by treatment is limited and does not include entire plume of contaminated surficial groundwater.	Satisfied except that area impacted by treatment is limited and does not include entire plume of contaminated surficial groundwater.
SHORT-TERM EFFECTIVENESS					
• Community Protection	Risks to community not increased by remedy implementation.	Risks to community not increased by remedy implementation.	Minimal, if any, risks during collection and treatment.	Possible migration of toxic vapors through ground surface because vapor extraction is difficult to control when groundwater surface is within several feet of ground surface.	Minimal, if any, risks during operation and treatment.
• Worker Protection	None.	Protection required during well installation and sampling.	Trench installation procedure limits worker exposure by design.	Minimal potential for worker exposure.	Minimal potential for worker exposure.

TABLE 1 (Continued)

SUMMARY OF ALTERNATIVES EVALUATION
OPERABLE UNIT NO. 10 (SITE 35)
INTERIM PROPOSED REMEDIAL ACTION PLAN, CTO-0232
MCB CAMP LEJEUNE, NORTH CAROLINA

Evaluation Criteria	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
• Environmental Impacts	Continued impacts from unchanged existing conditions.	Continued impacts from unchanged existing conditions.	Wetlands disturbance during installation could be significant. Trench will serve as a barrier for contaminated groundwater discharge to Brinson Creek.	Minimal wetlands disturbance. System will serve as a barrier for contaminated groundwater discharge to Brinson Creek.	Minimal wetlands disturbance. System will serve as a barrier for contaminated groundwater discharge to Brinson Creek.
• Installation Period	Not Applicable.	Less than 30 days required to install additional groundwater monitoring wells.	60 to 90 days estimated to install trench and treatment system.	60 to 90 days estimated to install sparging and SVE wells and treatment system.	60 to 90 days estimated to install aeration wells and treatment system.
IMPLEMENTABILITY					
• Ability to Construct and Operate	No construction or operation activities.	Involves standard well installation and sampling only.	Soft ground in wetlands areas may hamper construction and result in delays. Once installed, operating is straight-forward using commercially proven technology. Approximately 2,000 to 3,000 cubic yards of potentially contaminated soil excavated from the trench will require disposal. Lack of access may be a significant cost factor.	Construction of activities involve primarily well installation which has been previously executed successfully in this area. Disposal of drill cuttings required. Thin vadose zone may hamper effective vapor extraction which could result in the release of toxic vapors to atmosphere. High metals in groundwater could clog well screens which would require frequent maintenance or well replacement.	Construction of activities involve primarily well installation which has been previously executed successfully in this area. Disposal of drill cuttings required. High metals in groundwater could clog well screens which would require frequent maintenance or well replacement.
• Ability to Monitor Effectiveness	No monitoring.	Proposed monitoring will provide an indication of effects of natural attenuation and progress of contaminants migration.	Proposed monitoring will give notice of failure so that system can be adjusted before a significant contaminant release occurs.	Proposed monitoring will give notice of failure so that system can be adjusted before a significant contaminant release occurs.	Proposed monitoring will give notice of failure so that system can be adjusted before a significant contaminant release occurs.
• Availability of Services and Equipment	None required.	Well installation and sampling services available from multiple vendors.	Biopolymer trench technology available from a limited number of vendors.	Air sparging technology is available from multiple vendors.	In well aeration is a patented priority technology currently available from only one vendor.
• Requirements for Agency Coordination	None required.	Must submit semi-annual reports to document long term monitoring.	None required, provided the intent of wetlands and air and water discharge permits are met. Must submit semi-annual reports to document long term monitoring.	None required, provided the intent of wetlands and air and water discharge permits are met. Must submit semi-annual reports to document long term monitoring.	None required, provided the intent of wetlands and air and water discharge permits are met. Must submit semi-annual reports to document long term monitoring.
COSTS					
• Net Present Worth (30 years)	$0	$299,800	$3,000,500	$2,459,600	$2,519,700

TABLE 2
GLOSSARY OF EVALUATION CRITERIA

- **Overall Protection of Human Health and Environmental** - addresses whether or not an alternative provides adequate protection and describes how risks posed through each pathway are eliminated, reduce, or controlled through treatment engineering or institutional controls

- **Compliance with ARARs/TBCs** - addresses whether or not an alternative will meet all of the applicable or relevant and appropriate requirements (ARARs), other criteria to be considered (TBCs), or other federal and state environmental statutes and/or provide grounds for invoking a waiver.

- **Long-term Effectiveness and Permanence** - refers to the magnitude of residual risk and the ability of an alternative to maintain reliable protection of human health and the environment over time once cleanup goals have been met.

- **Reduction of Toxicity, Mobility, or Volume through Treatment** - is the anticipated performance of the treatment options that may be employed in an alternative.

- **Short-term Effectiveness** - refers to the speed with which the alternative achieves protection, as well as the remedy's potential to create adverse impacts on human health and the environment that may result during the construction and implementation period.

- **Implementability** - is the technical and administrative feasibility of an alternative, including the availability of materials and services needed to implement the chosen solution.

- **Cost** - includes capital and operation and maintenance costs. For comparative purposes, presents present worth values.

- **USEPA/State Acceptance** - indicates whether, based on review of the RI and FS reports and the PRAP the USEPA and state concur with, oppose, or have no comments on the preferred alternative.

- **Community Acceptance** - will be assessed in the Record of Decision (ROD) following a review of the public comments received on the RI and FS reports on the PRAP.

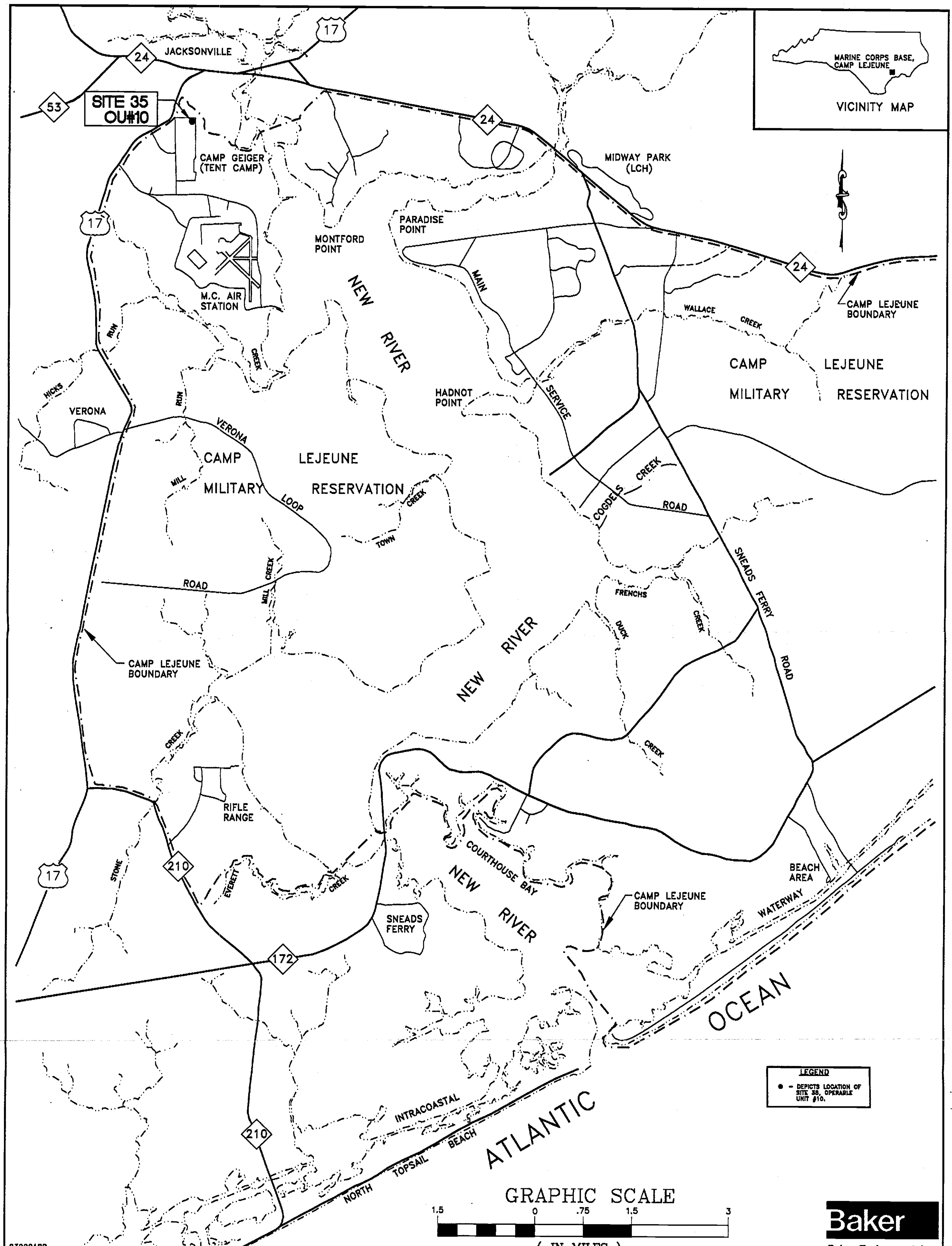
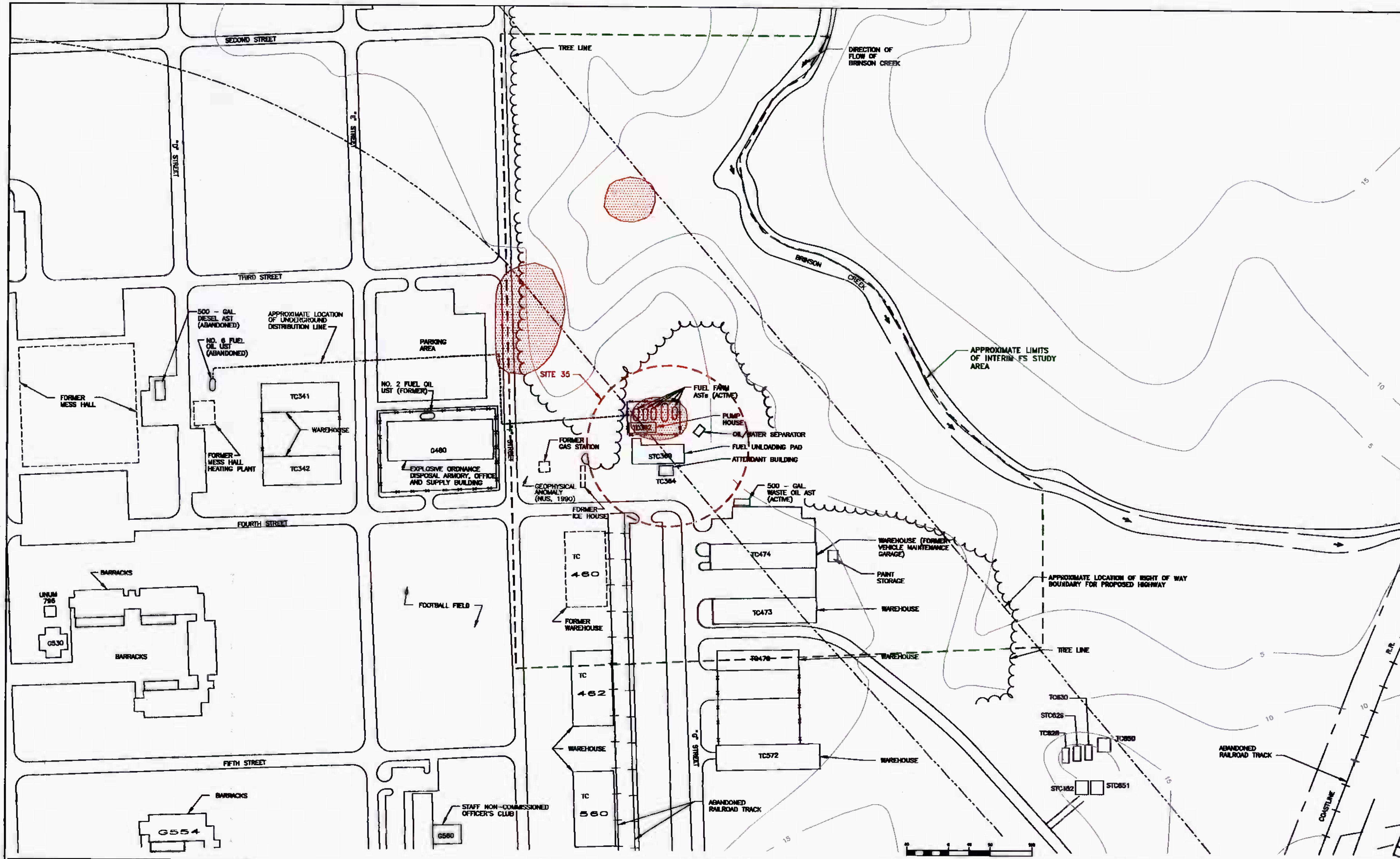


FIGURE 1
CAMP LEJEUNE AND SITE 35
LOCATION MAP

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

01537DD012



LEGEND	
—x—x—	FENCE LINE
—10—	CONTOUR LINES DEPICTING SURFICIAL RELIEF
-------	APPROXIMATE LOCATION OF THE UNDERGROUND DISTRIBUTION LINE
— — —	APPROXIMATE LOCATION OF RIGHT OF WAY BOUNDARY FOR PROPOSED HIGHWAY
(hatched area)	APPROXIMATE LIMITS OF TPH CONTAMINATION ABOVE THE REMEDIATION GOALS

DATE	DEC. 1994
SCALE	SEE BAR SCALE
DRAWN	REL
REVIEWED	JSC
B.O.#	62470-232-0000-07000
CADD#	232202PR

NORTH

INTERIM ROD FOR SURFICAL GROUNDWATER, CTO-0232
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

BAKER ENVIRONMENTAL, Inc.
Coraopolis, Pennsylvania

Baker
Baker Environmental, Inc.

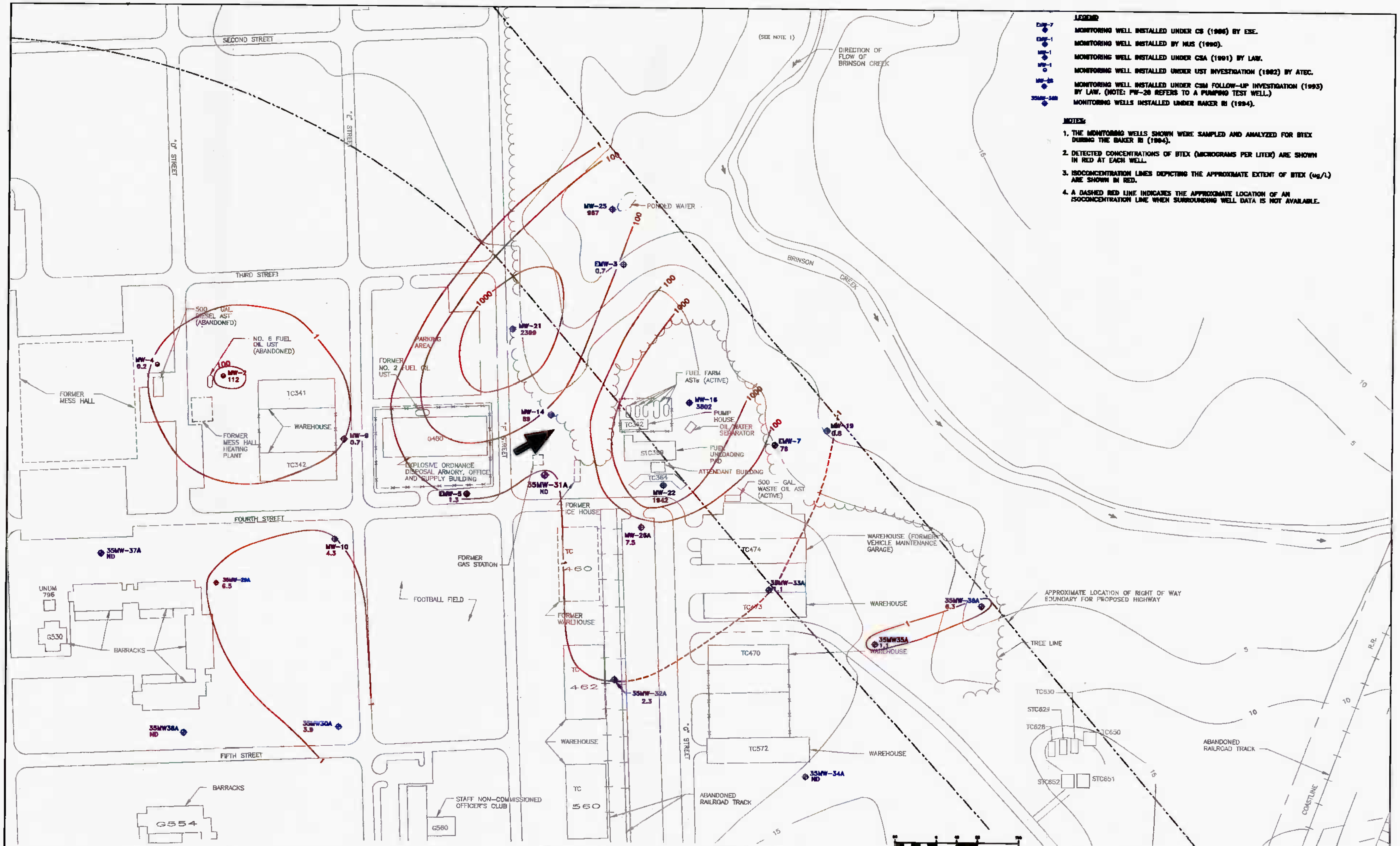
SITE PLAN
SITE 35 – CAMP GEIGER AREA FUEL FARM
CONTRACT TASK ORDER – 0232

SCALE 1" = 80'

DATE DEC. 1994

FIGURE No. 2

01547DDB1Y



LEGEND	
FENCE LINE	
CONTOUR LINES DEPICTING SURFICIAL RELIEF	
ISOCONCENTRATION LIMITS OF COMBINED BTEX	
APPROXIMATE LOCATION OF RIGHT OF WAY BOUNDARY FOR PROPOSED HIGHWAY	
APPROXIMATE GROUNDWATER FLOW DIRECTION	

DATE	NOVEMBER 1994
SCALE	SEE BAR SCALE
DRAWN	REL
REVIEWED	JBC
S.O.#	62470-232-0000-07000
CADD#	232203PR

NORTH

INTERIM ROD FOR SURFICIAL GROUNDWATER, CTO-0232
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

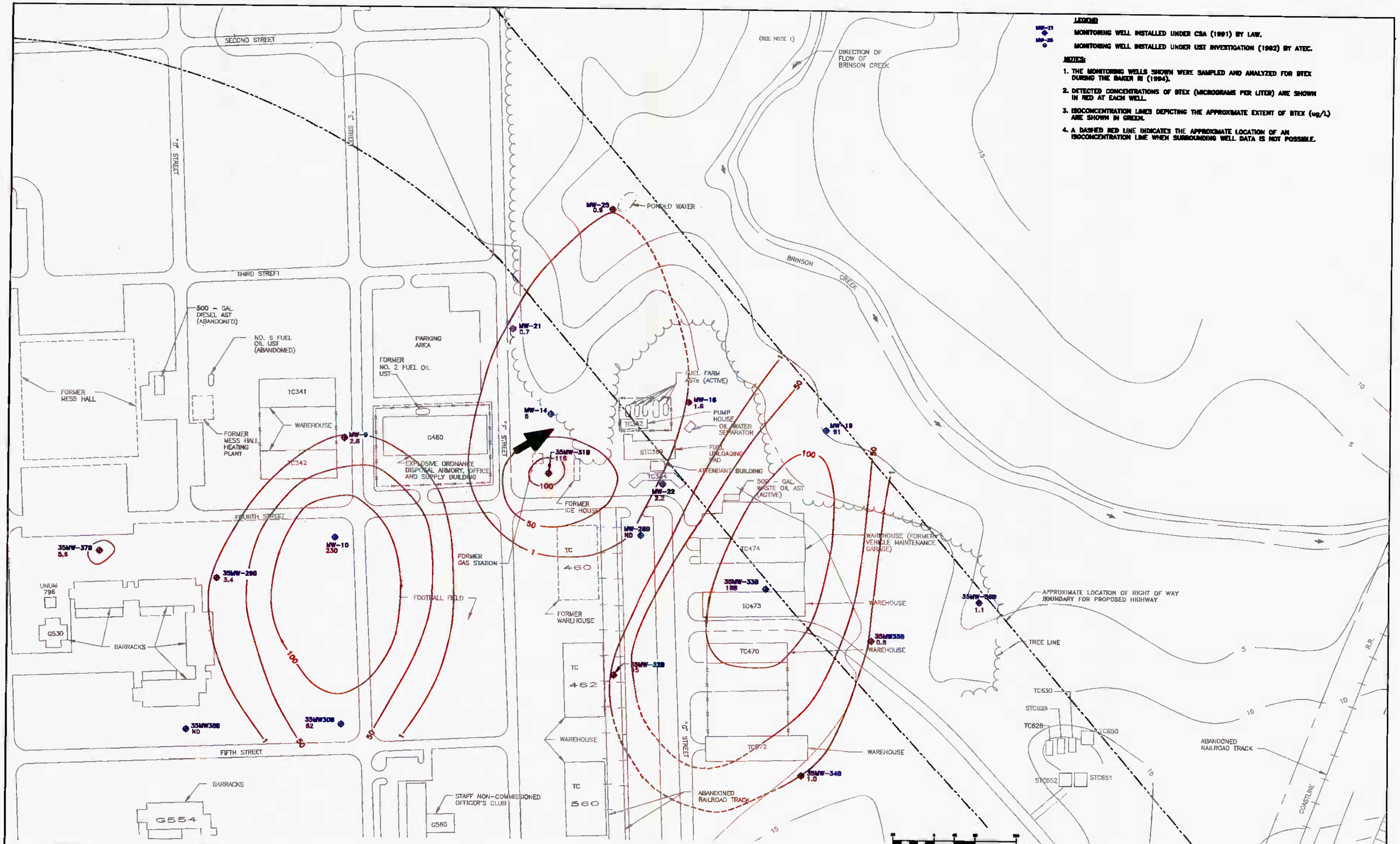
BAKER ENVIRONMENTAL, Inc.
Coraopolis, Pennsylvania

Baker
Baker Environmental, Inc.

LIMITS OF COMBINED BTEX IN THE UPPER PORTION OF THE SURFICIAL AQUIFER SITE 35 - CAMP GEIGER AREA FUEL FARM

SCALE 1" = 80'
DATE NOVEMBER 1994

FIGURE No. 3



LEGEND	
-x-x-	FENCE LINE
—15—	CONTOUR LINES DEPICTING SURFICIAL RELIEF
—50—	ISOCONCENTRATION LIMITS OF COMBINED BTEX
- - -	APPROXIMATE LOCATION OF RIGHT OF WAY BOUNDARY FOR PROPOSED HIGHWAY
➡	APPROXIMATE GROUNDWATER FLOW DIRECTION

DATE	DEC. 1994
SCALE	SEE BAR SCALE
DRAWN	REL
REVIEWED	JBC
S.O.#	62470-232-0000-07000
CADD#	232204PR

NORTH

INTERIM ROD FOR SURFICIAL GROUNDWATER, CTO-0232
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

BAKER ENVIRONMENTAL, Inc.
Coraopolis, Pennsylvania

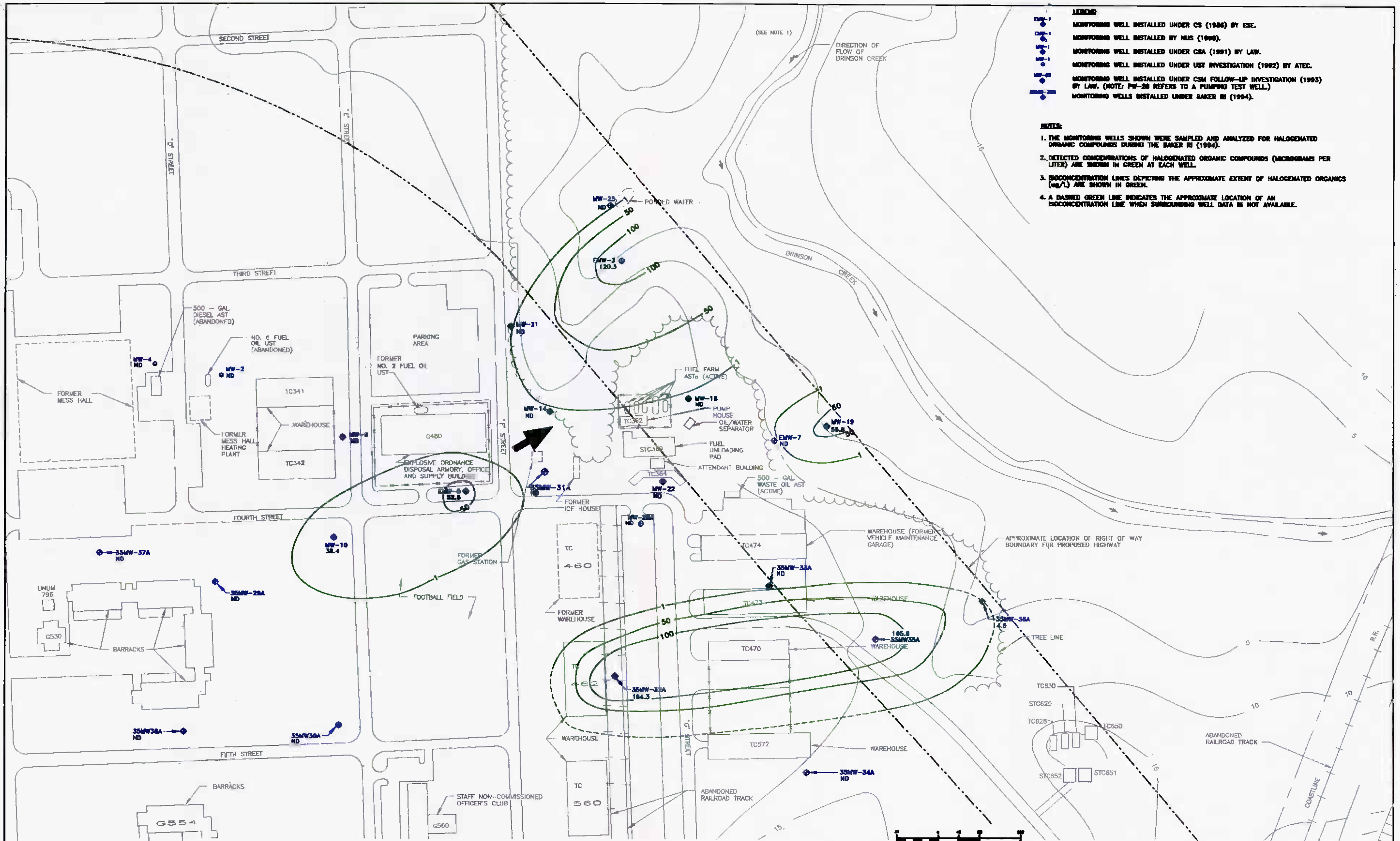
Baker
Baker Environmental, Inc.

LIMITS OF COMBINED BTEX IN THE LOWER PORTION OF THE SURFICIAL AQUIFER SITE 35 - CAMP GEIGER AREA FUEL FARM

SCALE 1" = 80'

DATE DEC. 1994

FIGURE No. 4



LEGEND

- FENCE LINE
- CONTOUR LINES DEPICTING SURFICIAL RELIEF
- ISOCONCENTRATION LIMITS OF COMBINED HALOGENATED ORGANICS.
- APPROXIMATE LOCATION OF RIGHT OF WAY BOUNDARY FOR PROPOSED HIGHWAY
- APPROXIMATE GROUNDWATER FLOW DIRECTION

DATE	DEC. 1994
SCALE	SEE BAR SCALE
DRAWN	REL
REVIEWED	JSC
S.O.#	62470-232-0000-07000
CADD#	232605PR

NORTH

INTERIM ROD FOR SURFICIAL GROUNDWATER, CTO-0232
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

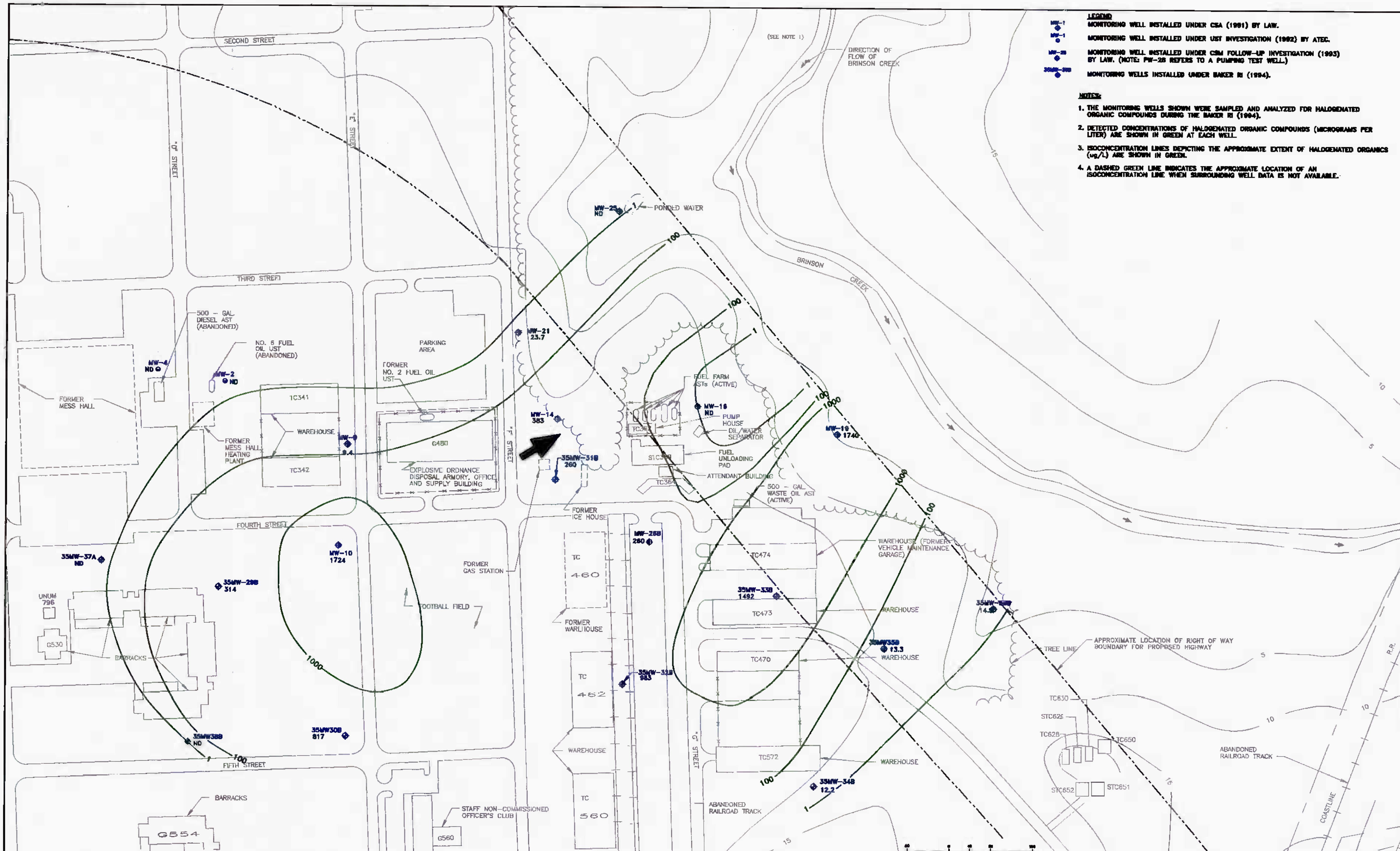
BAKER ENVIRONMENTAL, Inc.
Coraopolis, Pennsylvania

Baker
Baker Environmental, Inc.

LIMITS OF COMBINED HALOGENATED ORGANIC COMPOUNDS IN THE UPPER PORTION OF THE SURFICIAL AQUIFER
SITE 35 – CAMP GEIGER AREA FUEL FARM

SCALE 1" = 80'
DATE DEC. 1994

FIGURE No.
5



LEGEND	
FENCE LINE	
CONTOUR LINES DEPICTING SURFICIAL RELIEF	
ISOCONCENTRATION LIMITS OF COMBINED HALOGENATED ORGANICS.	
APPROXIMATE LOCATION OF RIGHT OF WAY BOUNDARY FOR PROPOSED HIGHWAY	
APPROXIMATE GROUNDWATER FLOW DIRECTION	

DATE	DEC. 1994
SCALE	SEE BAR SCALE
DRAWN	REL
REVIEWED	JSC
S.O.#	62470-232-0000-07000
CADD#	232296PR

NORTH

INTERIM ROD FOR SURFICIAL GROUNDWATER, CTO-0232
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

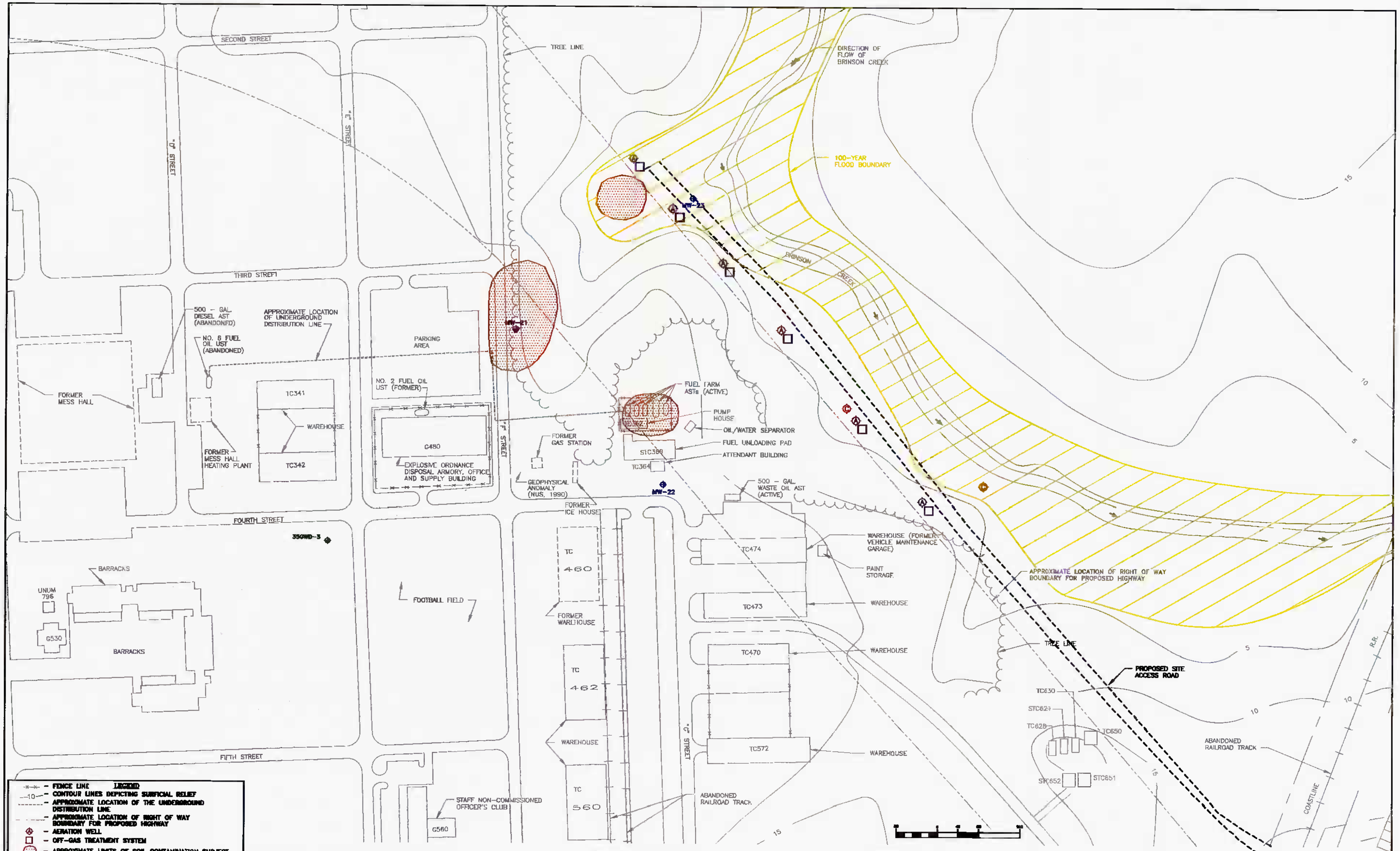
BAKER ENVIRONMENTAL, Inc.
Coraopolis, Pennsylvania

Baker
Baker Environmental, Inc.

LIMITS OF COMBINED HALOGENATED ORGANIC COMPOUNDS IN THE LOWER PORTION OF THE SURFICIAL AQUIFER
SITE 35 – CAMP GEIGER AREA FUEL FARM

SCALE 1" = 80'
DATE DEC. 1994

FIGURE No. 6



LEGEND

- FENCE LINE
- CONTOUR LINES DEPICTING SURFICIAL RELIEF
- APPROXIMATE LOCATION OF THE UNDERGROUND DISTRIBUTION LINE
- APPROXIMATE LOCATION OF RIGHT OF WAY BOUNDARY FOR PROPOSED HIGHWAY
- AERATION WELL
- OFF-GAS TREATMENT SYSTEM
- APPROXIMATE LIMITS OF SOIL CONTAMINATION SUBJECT TO REMEDIATION UNDER INTERIM ROD CTO-0160 DATED AUGUST 31, 1994.
- 100 YEAR FLOOD BOUNDARY (ref. FIRM FLOOD INSURANCE RATE MAP, ONSLOW COUNTY, NORTH CAROLINA; FEMA COMMUNITY PANEL NUMBER 3 70340 0305C.
- PROPOSED LOCATION OF SITE ACCESS ROAD

PROPOSED LONG TERM MONITORING WELLS:

- MW-23 – EXISTING WELL CLUSTER IN THE SURFICIAL AQUIFER
- 35GWD-3 – EXISTING WELL IN THE DEEP AQUIFER
- PROPOSED WELL CLUSTER IN THE SURFICAL AQUIFER

DATE	MARCH 1995
SCALE	
DRAWN	REL
REVIEWED	JSC
E.O.#	02470-232-0000-07000
CADD#	232207PR

INTERIM ROD FOR GROUNDWATER REMEDIATION, CTO-0232
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

BAKER ENVIRONMENTAL, Inc.
Coraopolis, Pennsylvania

Baker
Baker Environmental, Inc.

RAA 5: IN WELL AERATION AND OFF-GAS CARBON ADSORPTION – PLAN VIEW
SITE 35 – CAMP GEIGER AREA FUEL FARM

SCALE

DATE MARCH 1995

FIGURE No. 7