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RECORD OF DECISION
OPERABLE UNIT NO. 7
SITE 1 - FRENCH CREEK
LIQUIDS DISPOSAL AREA

MARINE CORPS BASE,
CAMP LEJEUNE, NORTH CAROLINA

CONTRACT TASK ORDER 0231

MARCH 30, 1995

Prepared For:

DEPARTMENT OF THE NAVY
ATLANTIC DIVISION
NAVAL FACILITIES
ENGINEERING COMMAND
Norfolk, Virginia

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LIST OF ACRONYMS AND ABBREVIATIONS

ARAR	Applicable or Relevant and Appropriate Requirements
Baker	Baker Environmental, Inc.
BEHP	bis (2-ethylhexyl) phthalate
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
COPC	contaminant of potential concern
DoN	Department of the Navy
EPIC	Environmental Photographic Interpretation Center
FFA	Federal Facilities Agreement
FS	Feasibility Study
GW	groundwater
HI	Hazard Index
HPIA	Hadnot Point Industrial Area
IAS	Initial Assessment Study
ICR	Incremental Cancer Risk
IRP	Installation Restoration Program
MCB	Marine Corps Base
NC DEHNR	NC Department of Environment, Health, and Natural Resources
NCP	National Contingency Plan
NPL	National Priorities List
OU	Operable Unit
PRAP	Proposed Remedial Action Plan
RA	Risk Assessment
RBC	Risk-Based Concentration
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision

SARA	Superfund Amendments and Reauthorization Act
SVOC	Semivolatile Organic Compound
TBC	to be considered
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

DECLARATION

Site Name and Location

Operable Unit No. 7
Site 1, French Creek Liquids Disposal Area
Marine Corps Base,
Camp Lejeune, North Carolina

Statement of Basis and Purpose

This decision document presents the selected remedy for Site 1, which is part of Operable Unit (OU) No. 7 at Marine Corps Base (MCB), Camp Lejeune, North Carolina. The remedy was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the administrative record for OU No. 7.

The Department of the Navy (DoN) and the Marine Corps have obtained concurrence from the State of North Carolina Department of Environment, Health and Natural Resources (NC DEHNR) and the United States Environmental Protection Agency (USEPA) Region IV on the selected remedy.

Assessment of the Site

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this Record of Decision (ROD), may present a potential threat to public health, welfare, or the environment.

Description of Selected Remedy

The selected remedy for Site 1 is a program that implements various "institutional controls." The major components of this program are:

- A long-term groundwater monitoring plan in which groundwater samples are collected semiannually and analyzed for the contaminants of potential concern (COPCs).
- Aquifer use restrictions that will prohibit the future use of the aquifer as a potable water source.
- Deed restrictions that will limit the future use of land at the site, including placement of wells.

The principal threat at Site 1 is the potential for ingestion of contaminated groundwater. The selected remedy addresses this threat because deed and aquifer use restrictions prohibit the aquifer from being used as a potable water source, and the groundwater monitoring plan will detect any deterioration in groundwater quality before exposure can occur.

Statutory Determinations

This selected remedy is protective of human health and the environment, complies with federal and state applicable or relevant and appropriate requirements (ARARs) and criteria to be considered (TBCs) directly associated with this action, and is cost-effective. The statutory preference for treatment is not satisfied because no treatment is necessary at Site 1 in order to maintain adequate protection of human health and the environment. Under this remedy, five-year reviews by the lead agency will be required.

_____ _____

Signature (Commanding General, MCB, Camp Lejeune) Date

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). 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) then entered into a Federal Facilities Agreement for MCB, Camp Lejeune in February 1991. The primary purpose of the Federal Facilities Agreement was to ensure that environmental impacts associated with past and present activities at MCB, Camp Lejeune were thoroughly investigated and appropriate CERCLA response/Resource Conservation and Recovery Act (RCRA) corrective action alternatives were developed and implemented as necessary to protect public health and the environment.

Site 1, the French Creek Liquids Disposal Area, is one of three sites that make up Operable Unit (OU) No. 7. Therefore, Site 1 has been investigated as part of a Remedial Investigation (RI) conducted for OU No. 7. Following the RI, a Feasibility Study (FS) was conducted to develop and examine remedial action alternatives (RAAs) for Site 1. A preferred alternative was identified in a Proposed Remedial Action Plan (PRAP) document and the public will be given an opportunity to comment on the RI/FS and the PRAP for Site 1. This Record of Decision (ROD) summarizes the selected remedy for the site and the remedy selection process. The final ROD will be based on the RI/FS, public comments, and any new information that may become available.

2.0 SITE LOCATION AND DESCRIPTION

Figure 1 identifies the location of OU No. 7 within MCB, Camp Lejeune. Site 1, the French Creek Liquids Disposal Area, is the most northern site located within OU No. 7. As shown, the site is located approximately one mile east of the New River and one mile southeast of the Hadnot Point Industrial Area (HPIA). It is situated on both the north and south sides of Main Service Road near the western edge of the Gun Park Area and Force Troops Complex.

A site map depicting the approximate site boundary is presented on Figure 2. This figure also depicts the approximate boundaries of suspected disposal areas at Site 1, and the northern and southern portions of the site (which include the northern and southern disposal areas, respectively).

Northern Portion of Site 1

The northern portion of Site 1 is bordered by woods and a motor-cross training area to the north, a vehicle storage area associated with Building FC-100 to the east, Main Service Road to the south, and a treeline and Building FC-115 to the west. The majority of the suspected northern disposal area is located within two fenced compounds that are associated with Buildings FC-120 and FC-134. The remaining portion of the northern former disposal area is located outside of these fenced compounds, to the west and immediately adjacent to Building FC-134.

Building FC-120 serves as a motor transport maintenance facility for the Second Landing Support Battalion. It is a two story brick structure with offices and several vehicle maintenance bays. Building FC-134, located to the north of Building FC-120, provides offices and communication equipment storage also for the Second Battalion. It is a brick structure with offices and one garage bay.

A number of covered material storage areas are located to the northwest of Building FC-120. These smaller covered structures are used for temporary storage of paint, compressed gasses, vehicle maintenance fluids, spent or contaminated materials, and batteries. In addition to these covered

storage structures, an above ground storage tank (AST) area, located adjacent to the northern side of Building FC-120, is utilized to store spent motor oil and ethylene glycol (i.e., anti-freeze). Also, a gasoline service island is located to the west of Building FC-120. The two pumps at the service island provide fuel for vehicles undergoing maintenance at Building FC-120. An underground storage tank (UST) of unknown capacity is associated with this active service island. (The location of this UST is not identified on Figure 2.)

Two equipment wash areas are also located within the northern portion of the site. The first wash area is located to the west of Building FC-120 and the second lies to the east of Building FC-134. Both equipment wash areas are concrete-lined and employ an oil and water separator collection basin. Another oil and water separator is located to the northwest of Building FC-120. Discharge from the three oil and water separators flows into a drainage ditch and sediment retention pond located to the north of Building FC-134.

Southern Portion of Site 1

As shown in Figure 2, the southern portion of Site 1 is bordered by Main Service Road to the north, Daly Road and a wooded area to the east, H. M. Smith boulevard to the south, and Gonzales Boulevard and a wooded area to the west. A portion of the suspected southern disposal area is surrounded by barbed-wire fences which contain a vehicle and equipment Administrative Deadline Lot (ADL), and a hazardous material storage area. The remaining part of the former disposal area is not fenced. Vehicle access to this southern disposal area is via a swing-arm gate located along Main Service Road.

The hazardous material storage area, which is concrete-lined and bermed, is located north of Building FC-816. This area is used for the temporary storage of vehicle maintenance fluids, spent or contaminated materials, fuel, and batteries. In addition, a number of storage lockers are located throughout the southern portion of the site. These lockers are used to store paints and other flammable materials used by maintenance and machine shop personnel.

Several small buildings are located adjacent to the southeastern edge of the suspected southern disposal area. The buildings are constructed of either formed metal, concrete block, or wood frame siding. Typically, the buildings are set on poured concrete slabs and have raised seam metal roofs. These buildings house a number of support offices, recreation facilities, machine shops, light-duty vehicle and equipment maintenance bays, and equipment storage areas. Heat is provided to the majority of these buildings by kerosene-fired stoves. Kerosene fuel is stored in ASTs located beside each building.

Two vehicle maintenance ramps are located on the southern portion of Site 1. The first ramp is located immediately to the south of Building FC-739 and the second lies to the north of Building SP-19. Both maintenance ramps are constructed of concrete and are used for the upkeep of vehicles and equipment.

Three oil and water separator collection basins are also located on the southern portion of the site. One separator is located adjacent to the Building FC-739 vehicle maintenance ramp, one separator is located southeast of Building SP-19, and one separator is located south of Building FC-816, adjacent to an equipment wash area. Discharge from the separators and wash areas flows into a stormwater sewer and then into the drainage ditch adjacent to H. M. Smith Boulevard. The drainage ditch, which starts in the southern portion of the site, flows west toward the HPIA Sewage Treatment Plant (i.e., Site 28) and empties into Cogdels Creek. Cogdels Creek eventually discharges into the New River which is located approximately one mile west of Site 1.

3.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

Site 1 had been used by several different mechanized, armored, and artillery units since the 1940s. Reportedly, liquid wastes generated from vehicle maintenance were routinely poured onto the ground surface. During motor oil changes, vehicles were driven to a disposal point and drained of used oil. In addition, acid from dead batteries was reportedly hand carried from maintenance buildings to disposal points. At times, holes were reportedly dug for waste acid disposal and then immediately backfilled. Although Site 1 continues to serve as a vehicle and equipment maintenance/staging area, past disposal practices are no longer in use.

As a result of past disposal activities, the disposal areas at Site 1 are suspected to contain petroleum, oil, and lubricants (POL) and battery acid. The total extent of both the northern and southern disposal areas is estimated to be between seven and eight acres. The quantity of POL waste disposed at the areas is estimated to be between 5,000 and 20,000 gallons; the quantity of battery acid waste is estimated to be between 1,000 and 10,000 gallons.

Previous investigations conducted at Site 1 include an Initial Assessment Study, a Confirmation Study, some additional investigations conducted by Baker Environmental, Inc. (Baker), an aerial photographic investigation, and a Remedial Investigation/Feasibility Study.

Initial Assessment Study

In 1983, an IAS was conducted by Water and Air Research, Inc. The IAS identified a number of sites at MCB, Camp Lejeune, including Site 1, as potential sources of contamination.

Confirmation Study

From 1984 through 1987, a Confirmation Study was conducted by Environmental Science and Engineering, Inc. The purpose of the study was to investigate potential contaminant source areas identified during the Initial Assessment Study. At Site 1, this Confirmation Study focused on the presence of potential contaminants in groundwater, surface water, and sediment.

Organic and metal contaminants were identified in the groundwater samples collected from the shallow aquifer. The same contaminants, however, were not observed in the deeper aquifer, and therefore suggest that vertical contaminant migration had not occurred. The organics tetrachloroethene (PCE) and trichloroethene (TCE) were identified in a number of groundwater samples collected from the shallow aquifer at levels exceeding present groundwater standards. Similarly, the metals cadmium, chromium, and lead were identified in samples obtained from the shallow aquifer at concentrations that, in certain cases, exceeded groundwater standards.

In addition, each media sampled during the Confirmation Study contained detectable concentrations of oil and grease (O&G). The presence of O&G is most likely due to the POL that is reported to have been disposed at Site 1.

Additional Investigations

Baker conducted two additional investigations at Site 1: a soil assessment (1991) and a pre-investigation groundwater sampling study (1993). The soil assessment sought to identify contaminants in groundwater, surface water, and sediment prior to initiating a proposed construction project intended for the southern portion of Site 1. The groundwater investigation was conducted to support RI scoping activities.

Analytical results from the additional soil assessment and groundwater investigation performed at Site 1 identified the presence of metals. Concentrations of detected metals such as cadmium, chromium, lead, and manganese were, in general, consistent throughout the site. Potential contaminants were also detected in groundwater and soil samples obtained from upgradient locations. The distribution and comparable nature of detected metals in environmental media at Site 1 suggested that these metals are found throughout adjoining areas.

Aerial Photographic Investigation

In 1992, an aerial photographic investigation was completed by the USEPA's Environmental Photographic Interpretation Center (EPIC). Black-and-white aerial photographs from 1944, 1949, 1952, 1956, 1960, 1964, 1984, 1988, and 1990 were made available for examination of surface conditions. These photographs were employed to locate and assess potential sources of contamination, and to delineate the extent of disposal activities within the study area. At Site 1, however, the photographs did not indicate any evidence of past disposal activities.

Remedial Investigation

In 1994, Baker conducted an RI at Site 1. Data gathering activities included soil and groundwater investigations. The following paragraphs summarize the analytical results from these investigations.

Soil

The pesticides dieldrin, 4,4'-DDE, 4,4'-DDD, 4,4'-DDT, endrin aldehyde, alpha-chlordane, and gamma-chlordane were detected in the soil at Site 1. Each of these pesticides was detected, at low concentrations, in at least two of the 124 soil samples. The pesticide 4,4'-DDT was the most prevalent, with 10 positive detections, and the highest pesticide concentration was that of 4,4'-DDE at 120 micrograms per kilogram (µg/Kg). In general, pesticide detections were concentrated in the northern portion of the study area. The positive detections were, for the most part, limited to soil samples collected from depths less than seven feet below ground surface.

The polychlorinated biphenyls (PCBs), Aroclor 1254 and Aroclor 1260, were each detected once within the subsurface sample set. Aroclor 1254 was detected in a sample from a monitoring well test boring on the southern portion of the site, and Aroclor 1260 was detected at a boring near the center of the northern disposal area.

Volatile organic compounds (VOCs) were not found in surface soils and were detected in only four subsurface soil samples scattered throughout the site. The VOC acetone was detected in one sample from the southern portion of the study area. However, the data suggested that acetone may have been an artifact of decontamination activities. Two other VOCs, TCE and toluene, were detected at very low concentrations in samples also from the northern central portion of the study area.

Semivolatile organics compounds (SVOCs) were not encountered in surface soils, but were detected in a number of subsurface soil samples. Most notable among the SVOCs detected were three polyaromatic hydrocarbon (PAH) compounds and di-n-butylphthalate. The positive detections of these compounds were located near the northern central portion of the site. However, the dispersion of di-n-butylphthalate suggested that it was the result of laboratory contamination.

Based on a comparison of base-specific background levels, positive detections of metals in soil did not appear to be the result of past disposal practices.

Groundwater

Metals were the most prevalent among contaminants detected in groundwater at Site 1 and were found distributed throughout the site. Iron and manganese, in particular, were detected at concentrations which exceeded the state drinking water standards. Barium, calcium, magnesium, potassium, and sodium were detected in each of the 18 shallow and deep groundwater samples.

Positive detections of VOCs and SVOCs in groundwater were limited to the northern portion of the study area. The VOC TCE was detected in samples obtained from three of the shallow monitoring wells. The maximum TCE concentration, 27 micrograms per liter (µg/L), was detected within the sample from monitoring well 1-GW17, located in the central northern portion of the study area. The VOCs, 1,2-dichloroethene and 1,1-dichloroethene were observed at maximum concentrations of 21 µg/L and 2 µg/L, respectively. The maximum 1,2-dichloroethene and 1,1-dichloroethene concentrations were detected in a sample obtained from well 1-GW10, located to the west of the suspected northern disposal area. Vinyl chloride was also detected at well 1-GW10. Xylenes were detected in a shallow groundwater sample from well 1-GW12, at a maximum concentration of 19 µg/L. The SVOCs phenol and diethylphthalate were detected during the first sampling round only in a sample from deep well 1-GW17DW, at concentrations of 6 µg/L and 1 µg/L, respectively.

Because these contaminants of potential concern (COPCs) were detected in soil and groundwater, a human health risk assessment (RA) and an ecological RA were conducted to evaluate the potential risks at Site 1. The results of these RAs are summarized later in this ROD.

Feasibility Study

As a result of the RI, Baker initiated an FS in 1995 to address COPCs in the groundwater at Site 1. (Based on the RAs, groundwater was determined to be the only medium of concern.) The ROD contained in this document presents the selected remedy that was developed and evaluated during the FS.

4.0 HIGHLIGHTS OF COMMUNITY PARTICIPATION

The RI/FS report and Proposed Remedial Action Plan (PRAP) for Site 1 will be released to the public on a date to be determined. These documents will be made available to the public in the administrative record file at information repositories maintained at the Onslow County Public Library and at the MCB, Camp Lejeune Library. Also, all addresses on the Site 1 mailing list will be sent a copy of the Final PRAP and Fact Sheet. The notice of availability of the PRAP and RI/FS document will be published in the "Jacksonville Daily News" on a date to be determined. A public comment period will be held from July 18, 1995 to August 18, 1995. In addition, a public meeting will be held on July 18, 1995, to respond to questions and to accept public comments on the PRAP for Site 1. The public meeting minutes will be transcribed and a copy of the transcript will be made available to the public at the aforementioned libraries. A Responsiveness Summary, included as part of this ROD, has been prepared to respond to the significant comments, criticisms and new relevant information received during the comment period. Upon signing this ROD, MCB, Camp Lejeune and the DoN will publish a notice of availability of this ROD in the local newspaper, and place this ROD in the information repository located in the Onslow County and MCB, Camp Lejeune libraries.

5.0 SCOPE AND ROLE OF THE ACTION

The selected remedy was developed to address only groundwater at Site 1. (During the RAs, groundwater was determined to be the only medium of concern.) More specifically, the alternative was developed to address the groundwater areas of concern (AOCs), or areas where COPC concentrations exceeded remediation levels (RLs), that are identified on Figure 3. As shown, these

AOCs include sporadic occurrences of manganese, and a plume of limited area containing low levels of TCE. In addition, mercury was detected at a concentration slightly exceeding its RL in one well on the southern portion of the site. The selected remedy was also developed to address the principal threat at Site 1: the potential for ingestion of contaminated groundwater.

Please note that the selected remedy presented in this ROD document was developed for Site 1, not Sites 28 and 30 which are also included in OU No. 7.

6.0 SITE CHARACTERISTICS

This section briefly describes the nature and extent of COPCs that were detected in the soil and groundwater at Site 1 during the RI. Please note that after being evaluated in the RAs, the COPCs detected in soil did not present unacceptable risks to human health or the environment.

Soil

Volatile Organic Compounds: Volatile organic compounds (VOCs) detected in the soil samples at Site 1 did not appear to be the result of widespread disposal activities. VOCs were detected in only 4 of the 124 soil samples collected at Site 1, and the positive detections were distributed throughout various locations. Two borings, both located in the central northern portion of the study area, had very low concentrations (i.e., less than 3 µg/Kg) of toluene and TCE. The extent of VOCs was limited to subsurface soil (i.e., samples obtained from greater than one foot below ground surface). The central portion of the northern disposal area also exhibited levels of VOCs in groundwater. Given their limited extent, these VOCs may be related to previous and/or ongoing maintenance activities, rather than previous disposal activities.

Semivolatile Organic Compounds: The dispersion and concentrations of semivolatile organic compounds (SVOCs) at Site 1 did not suggest widespread disposal of these compounds. Three polynuclear aromatic hydrocarbon (PAH) compounds were identified at low concentrations within a subsurface soil sample located near the central portion of the site. However, PAHs were not identified in any of the surrounding borings. Di-n-butylphthalate was detected in samples throughout the site at concentrations indicative of laboratory contamination.

Pesticides: Positive detections of pesticides were observed in both surface and subsurface soil samples. A majority of pesticide detections were observed in the central portion of the northern study area. The detected pesticide levels were low (i.e., less than 120 µg/Kg) and were most likely the result of routine pesticide application. A majority of the pesticide detections were from subsurface soil samples. Soil samples obtained from depths of one to seven feet below ground surface had the highest levels of pesticides.

From the 1940s to the early 1980s, much of the surface area at Site 1 was without asphalt or concrete. Typically, open storage lots require constant maintenance and addition of surface material to offset erosion and compaction. The continued maintenance and addition of asphalt, concrete, and gravel may help to explain the presence of pesticides within subsurface soil samples. The frequency and overall concentration of pesticides in soil, however, does not represent pesticide disposal activities.

Polychlorinated Biphenyls: Two positive detections of polychlorinated biphenyls (PCBs) were observed in separate subsurface soil samples. The Aroclor 1254, was identified at an estimated concentration of 18 µg/Kg in a subsurface soil sample from the southern portion of the site. The Aroclor 1260, was detected at a concentration of 1,300 µg/Kg in a subsurface sample from the central northern portion of the site. At one time it was not uncommon to use oil, possibly containing PCBs, as a dust suppressor and to apply pesticides. The localized detection of both pesticides and

PCBs at one soil boring location suggests that an isolated event may have resulted in positive detections of these compounds. In either case, soil borings located immediately adjacent to the two borings with PCBs did not exhibit PCB contamination. Therefore, the results of soil analyses were not determined to be characteristic of PCB disposal activities.

Metals: None of the 124 samples submitted for analysis had metals concentrations greater than one order of magnitude above base-specific background levels. As a result, the range of metals concentrations in soil at Site 1 were not indicative of metal disposal operations and therefore the extent of metals contamination in soils at Site 1 was not addressed.

Groundwater

Volatile Organic Compounds: Positive detections of VOCs were limited to shallow groundwater samples obtained from wells located on the northern portion of the study area. The lack of positive VOC detections in samples obtained from the deep aquifer suggest that these contaminants have not migrated from the surficial aquifer. The highest concentration of a single VOC, TCE at 27 microgram per liter (µg/L), was detected in well 1-GW17. Monitoring well 1-GW17 lies within the central portion of the northern suspected disposal area. TCE was also detected in two other shallow wells, 1-GW10 and 1-GW11. These two wells, however, are located off site beyond the northwestern perimeter of the suspected disposal area. The lack of positive VOC detections in wells 1-GW02, 1-GW03, and 1-GW15, which are hydraulically downgradient of 1-GW17, suggested that the extent of VOC contamination in groundwater was limited to the observed locations. Moreover, the limited extent of VOC contamination (i.e., in both soil and groundwater) suggested that the source may have resulted from spillage of small quantities rather than from long-term disposal or buried containers.

Bordering the suspected disposal area to the north is a vehicle training area. Operation and maintenance of mechanized vehicles throughout the training area may have resulted in unintentional spillage of these compounds. The concentrations of TCE and 1,2-dichloroethene may be related to off-site sources of contamination observed in this area, and not related to previous or ongoing activities at Site 1.

Semivolatile Organic Compounds: Samples from the 16 shallow and two deep groundwater monitoring wells, and the one supply well within Site 1 were submitted for analysis of SVOCs. The SVOCs phenol and diethylphthalate were detected in one deep groundwater sample, 1-GW17DW (located within the central portion of the northern study area), obtained during the first sampling round. Estimated concentrations of phenol and diethylphthalate were 6 µg/L and 1 µg/L, respectively. Soil analytical results from this location did not indicate the presence of SVOCs. Similar low concentrations of phenols were detected in shallow groundwater samples obtained during the Confirmation Study. However, the entire area is actively used for vehicle maintenance and storage, which may account for the presence of contamination at this low level.

Pesticides/PCBs: Pesticide and PCB contaminants were not detected in any of the four shallow and one deep groundwater samples submitted for analysis of pesticides and PCBs. As a result, the extent of pesticide and PCB contamination in groundwater will not be addressed.

Metals: Metals were detected in each of the 19 groundwater samples submitted for analysis. Iron and manganese were the only metals detected at levels in excess of either federal or state standards. Positive detections of both iron and manganese were distributed throughout the site, indicative of natural site conditions rather than disposal activities. In addition, concentrations of metals in groundwater at Site 1 did not appear to represent a particular trend or pattern of dispersal.

The distribution of metals does not appear to be related to groundwater flow direction. The decrease of metals concentrations between the first and second sampling rounds was most likely the result of modified sample acquisition procedures. Elevated metals observations have been recorded at other MCB, Camp Lejeune sites and are likely the consequence of loose surficial soils. During the resampling, a low flow purge method was utilized to minimize the presence of suspended solids or colloids in samples that are associated with the surficial soils. The resulting data set yielded a more accurate assessment of existing conditions. Current studies at the base support the opinion that total metals concentrations in groundwater are due more to geologic conditions (i.e., naturally occurring concentrations and unconsolidated soils) and sample acquisition methods than to actual metals concentrations in the surficial aquifer.

7.0 SUMMARY OF SITE RISKS

As part of the RI, a human health RA and an ecological RA were conducted to evaluate the potential risks to human health and the environment resulting from the presence of contaminants at Site 1.

Human Health Risk Assessment

The human health RA investigated the potential for COPCs to affect human health and/or the environment, both now and in the future, assuming that no further remedial actions are implemented at the site. Hypothetical scenarios, in which hypothetical receptors were assumed to be exposed to the site COPCs, were used to evaluate the actual and potential risks that exist at the site. Thus, both current and future scenarios were developed.

For Site 1, on-site military personnel were assumed to be the potential receptors under the current scenario. Under the future scenario, future residents (both children and adults) and future construction workers were assumed to be the potential receptors. Exposure to soil via ingestion, dermal contact, and inhalation was analyzed for military personnel; exposure to soil via ingestion and dermal contact was analyzed for future construction workers; and exposure to soil and groundwater via ingestion, dermal contact, and inhalation were analyzed for future residents. Exposure frequencies and durations were assumed to be 350 days/year over 4 years for military personnel, 350 days/year over 6 and 30 years for future residents, and 90 days/year over 1 year for construction workers.

Table 1 identifies the COPCs that were evaluated during the human health RA. Numeric values that quantify the total risks associated with the site COPCs (both carcinogenic and noncarcinogenic risks) were generated. For carcinogenic risks, these values are known as incremental cancer risk (ICR) values. For noncarcinogenic risk, these values are known as hazard index (HI) values. ICR and HI values were generated for each potential receptor and its respective exposure pathways.

Table 2 presents the ICR and HI values calculated for Site 1. USEPA considers ICR values between 1.0E-04 and 1.0E-06 to be generally acceptable and protective of human health and the environment. In other words, an ICR less than 1.0E-04 indicates that adverse carcinogenic health affects due to COPC exposure are unlikely. USEPA also considers HI values less than 1.0 to be generally acceptable and protective of human health and the environment. In other words, adverse noncarcinogenic health effects due to COPC exposure are unlikely. As shown on Table 2, ingestion of groundwater by future residents was the only scenario in which ICR and HI values exceeded the acceptable limits.

Thus, the RA indicated that there were no unacceptable potential risks (neither carcinogenic nor noncarcinogenic) associated with exposure to the surface soil and subsurface soil COPCs. However, there were some potential future risks associated with ingestion of the groundwater COPCs, in particular, arsenic and manganese.

Although arsenic and manganese in the groundwater created some potential risk if ingested by future residents, it is important to keep in perspective the way in which this risk was determined. The approach taken in the human health RA is highly conservative. At Site 1, it was the future residential scenario that created risk. However, this scenario is unlikely to occur in the foreseeable future because Site 1 is actively being used as a vehicle maintenance and equipment storage area. In addition, ingestion of groundwater by future residents is unlikely to occur because the groundwater at Site 1 is not used as a potable water source. There are two water supply wells located within a one-mile radius of the site, but the wells are no longer in service.

In addition, upon comparison of arsenic and manganese levels in the groundwater to state and federal regulatory standards, only manganese exceeded its standard. Thus, although both arsenic and manganese contributed to the site risks, arsenic did not exceed regulatory standards. This indicates the highly conservative nature of the human health RA.

Another fact to consider is that the levels of arsenic and manganese used to calculate groundwater exposure risks were primarily calculated from off-site wells. Also, these levels either did not exceed regulatory standards or exceeded the standards infrequently. Consequently, it is reasonable to assume that the risks associated with arsenic and manganese are over-estimations of the risk that actually exists.

Ecological Risk Assessment

The purpose of the ecological RA was to determine if COPCs were adversely impacting the ecological integrity of aquatic and terrestrial communities on or adjacent to the site. The ecological RA also evaluated the potential effects of COPCs on sensitive environments including wetlands, protected species, and fish nursery areas. The following paragraphs describe the state of aquatic and terrestrial communities as determined in the ecological RA.

At Site 1, there were no aquatic communities identified that would be exposed to site related COPCs. As a result, the assessment concluded that there are no ecological risks associated with aquatic communities.

The only site related COPCs that could potentially affect terrestrial communities were metals. In particular, the presence of cadmium and chromium in surface soil indicated a slight potential for affecting terrestrial invertebrates and plants at the site. However, because the concentrations of these metals only slightly exceeded the literature values used to determine risk, cadmium and chromium were not expected to present a significant ecological risk. Based on the terrestrial food chain model, there appeared to be a slight risk for deer, rabbit, fox, and quail receptors. However, this risk was expected to be insignificant because of the low levels by which terrestrial reference values were exceeded.

8.0 DESCRIPTION OF ALTERNATIVES

The following five groundwater remedial action alternatives (RAAs) were developed during the FS for Site 1:

- Groundwater RAA 1 - No Action
- Groundwater RAA 2 - Institutional Controls
- Groundwater RAA 3 - Extraction and On-Site Treatment
- Groundwater RAA 4 - In-Well Aeration and Off-Gas Carbon Adsorption
- Groundwater RAA 5 - Extraction and Off-Site Treatment

A summary of each groundwater RAA is presented below.

- **Groundwater RAA 1 - No Action**

  Capital Cost: $0
  Annual Operation and Maintenance (O&M) Costs: $0
  Net Present Worth (NPW): $0
  Years to Implement: None

  Under the no action RAA, no additional remedial actions will be performed to reduce the toxicity, mobility, or volume of contaminants identified in the groundwater. The no action alternative is required by the NCP to provide a baseline for comparison with other remedial action alternatives that provide a greater level of response.

  Since contaminants will remain at the site under this RAA, the NCP requires the lead agency to review the effects of this alternative no less often than once every five years.

- **Groundwater RAA 2 - Institutional Controls**

  Capital Cost: $0
  Annual O&M Costs: $50,000
  NPW: $690,000
  Years to Implement: 30

  Under Groundwater RAA 2, no remedial actions will be performed to reduce the toxicity, mobility, or volume of groundwater contaminants at Site 1. Instead, the following institutional controls will be implemented: continued groundwater monitoring, aquifer-use restrictions, and deed restrictions. The aquifer use restrictions will prohibit the groundwater from being used as a potable water source, and the deed restrictions will limit the future use of land at Site 1, including placement of wells. In addition, a "general housekeeping" program for managing waste handling and disposal practices would be recommended at Site 1.

  Because the groundwater AOCs will not receive direct remediation under RAA 2, the NCP requires the lead agency to review the effects of this alternative no less often than once every five years.

- **Groundwater RAA 3 - Extraction and On-Site Treatment**

  Capital Cost: $700,000
  Annual O&M Costs: $80,000
  NPW: $1,900,000
  Years to Implement: 30

  Groundwater RAA 3 is a source collection and treatment alternative. Under RAA 3, three shallow extraction wells (less than 30 feet deep), will be installed to pump groundwater from the surficial aquifer to the ground surface. The radii of influence of these wells will intercept the areas of concern in the northern portion of the site and provide a hydraulic barrier if the TCE plume migrates in the direction of groundwater flow. While collecting the TCE plume, the extraction wells will also collect any dissolved manganese that exists near the plume. The mercury detected on the southern portion of the site will be addressed by a monitoring plan described later.

After being extracted, the groundwater will receive treatment at an on-site treatment plant. Groundwater treatment will include precipitation, flocculation, sedimentation, and filtration for metals (i.e., manganese) removal, and air stripping for VOC (i.e., TCE) removal. The treated groundwater will be discharged off site to Cogdels Creek.

In addition to extraction, treatment, and discharge, RAA 3 incorporates a groundwater monitoring plan to measure the effects of the remedial action alternative. Wells included under this plan will be monitored semiannually for TCE, manganese, and mercury. Also, deed restrictions and aquifer-use restrictions will be implemented under this RAA, and a general housekeeping program will be recommended for the site.

Until the RLs are met for the COPCs, the NCP requires the lead agency to review the effects of this alternative no less often than once every five years.

- **Groundwater RAA 4 - In-Well Aeration and Off-Gas Carbon Adsorption**

Capital Cost: $640,000
Annual O&M Costs: $60,000
NPW: $1,630,000
Years to Implement: 30

RAA 4 is another source collection and treatment alternative. Under RAA 4, four in-well aeration wells will be installed lengthwise along the TCE plume. The wells' combined radii of influence will progress along the TCE plume as it travels in the direction of groundwater flow. VOCs collected by the in-well aeration system will undergo carbon adsorption treatment and subsequent discharge to the atmosphere. Manganese and mercury detected at the site will be addressed by the continued groundwater monitoring plan described later.

In-well aeration is a new technology that utilizes circulating air flow within a groundwater well that, in effect, turns the well into an air stripper. Similar to air sparging, this technique removes organic contaminants from groundwater primarily via volatilization and secondarily via aerobic biodegradation. In-well aeration systems are most effective in sandy soils, but can be adversely impacted by high levels of metals in the groundwater. When metals come in contact with air, they oxidize and precipitate. Consequently, they can from a heavy scale on well screens and clog the well space of the sand pack surrounding the well screen resulting in decreased permeability. A field pilot test is recommended to determine the loss of efficiency over time as a result of metals precipitation and oxidation, the radii 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.

In addition to the in-well aeration system, RAA 4 incorporates a groundwater monitoring plan to measure the effects of this remedial action alternative. Wells included under this plan will be monitored semiannually for TCE, manganese, and mercury. Also, deed restrictions and aquifer-use restrictions will be implemented under this RAA, and a general housekeeping program will be recommended for the site.

Until the RLs are met, the NCP requires the lead agency to review the effects of this alternative no less often than once every five years.

- **Groundwater RAA 5 - Extraction and Off-Site Treatment**

  Capital Cost: $810,000
  Annual O&M Costs: $50,000
  NPW: $1,500,000
  Years to Implement: 30

  Groundwater RAA 5 is the third source collection and treatment alternative considered for Site 1. Under RAA 5, three shallow extraction wells (less than 30 feet deep), will be installed to pump groundwater from the surficial aquifer to the ground surface. The radius of influence of these wells will intercept the areas of concern in the northern portion of the site and provide a hydraulic barrier if the TCE plume migrates in the direction of groundwater flow. While collecting the TCE plume, the extraction wells will also collect any dissolved manganese that exists near the plume. The mercury detected on the southern portion of the site will be addressed by a monitoring plan described later.

  Once groundwater is extracted, it will be transported to the HPIA Treatment System, an existing treatment system that is located within Site 78. The groundwater will be transported to the system by tanker trucks. At the HPIA Treatment System, the groundwater will receive VOC and metals treatment via air stripping, carbon adsorption, and metals removal.

  In addition to extraction and off-site treatment, RAA 3 will incorporate a groundwater monitoring plan to measure the effects of the remedial action alternative. Wells included under this plan will be monitored semiannually for TCE, manganese, and mercury. Also, deed restrictions and aquifer-use restrictions will be implemented under this RAA, and a general housekeeping program will be recommended for the site.

  Until the RLs are met, the NCP requires the lead agency to review the effects of this alternative no less often than once every five years.

9.0 SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

During the FS, a detailed analysis in which the groundwater RAAs were evaluated against seven evaluation criteria, was conducted. These evaluation criteria are: overall protection of human health and the environment; compliance with applicable or relevant and appropriate requirements (ARARs); long-term effectiveness and permanence; reduction of toxicity, mobility and volume; short-term effectiveness; implementability; and cost. Table 3 summarizes the results of this evaluation and Table 4 provides definitions of the evaluation criteria. In addition, the RAAs were comparatively analyzed to identify their relative advantages and disadvantages with respect to the nine evaluation criteria. The results of this comparative analysis are described below.

Overall Protection of Human Health and the Environment

Groundwater RAA 1, the no action alternative, will not reduce potential risks to human health and the environment. On the other hand, RAAs 2, 3, 4, and 5 will reduce potential risks because they all involve institutional controls which prevent future exposure to the groundwater. In addition, RAAs 3, 4, and 5 involve direct treatment systems (groundwater extraction/on-site treatment, in-well aeration, or groundwater extraction/off-site treatment) which provide additional protection to human health and the environment. However, the additional protection that RAAs 3, 4, and 5 provide may not be necessary considering the minimal risks associated with the groundwater COPCs.

The magnitude of residual risk is considered to be minimal. The groundwater COPCs, TCE, manganese, and mercury, do not pose substantial risks to human health or the environment for the following reasons:

- The TCE plume was delineated based on low concentrations, concentrations: 8 µg/L at well 1-GW01 and 18 µg/L at well 1-GW17, that only slightly exceeded the RL. These low groundwater concentrations, in addition to non-detectable levels in the soil, indicate that there is no significant source of TCE at the site. Instead, the TCE is most likely the result of random, isolated spills from current site operations or from off-site activities related to the motor cross training area.

- Based on an analytical model for solute transport in groundwater, TCE from Site 1 does not currently impact the nearest receptor, potable water supply well HP-638.

- Over time, TCE concentrations will decrease via naturally occurring in situ processes such as dilution, volatilization, adsorption, and chemical reactions with subsurface materials.

- Based on past studies, manganese concentrations in groundwater at MCB, Camp Lejeune often exceed the state and federal standard of 50 µg/L. Elevated manganese levels, at concentrations above the standards were reported in samples collected from a number of base potable water supply wells during a 1992 study of the base. Manganese concentrations at several Site 1 wells exceeded the state water standards, but fell within the range of concentrations for samples collected elsewhere at MCB, Camp Lejeune.

- Mercury exceeded its RL at only one well by 0.1 µg/L, which is a relatively minor exceedance. Consequently, it is likely that mercury exceeded its RL because of suspended solids in the total metals sample, and the COPC is not site-related.

- There is no record of any historical use, either industrial or disposal, of manganese or mercury at Site 1.

- The depth to the water table (approximately 8 feet) makes it unlikely that any ecological receptors will come in contact with the groundwater.

Considering the minimal risks associated with the groundwater COPCs, institutional controls (RAA 2) will be adequate for protecting human health and the environment. Groundwater extraction and treatment (RAAs 3 and 5) and in-well aeration (RAA 4) will be unnecessary to provide adequate protection. No action, however, provides no protection. Therefore RAA 1 may be inferior to the other four alternatives, and RAAs 3, 4, and 5 may overcompensate for the minor risks that exist at the site.

Compliance with ARARs

Under all five RAAs, the groundwater COPCs that are not naturally occurring metals (i.e., TCE) are expected to eventually meet their federal and state chemical-specific ARARs. Under RAAs 1 and 2, COPCs will meet their ARARs via passive remediation (or natural attenuation). Under RAAs 3, 4, and 5, COPCs will meet their ARARs via active remediation (extraction/treatment or in-well aeration). Because manganese is a naturally occurring metal at MCB, Camp Lejeune, it will probably never meet its ARARs at Site 1. Similarly, TCE is thought to be the result of on-going site activities, not past disposal activities at the site. Thus, active remediation systems may not permanently restore TCE levels to their chemical-specific ARAR.

RAAs 3, 4, and 5 can be designed to meet all of the location- and action-specific ARARs that apply to them. No location- or action-specific ARARs apply to RAAs 1 and 2.

Long-Term Effectiveness and Permanence

RAA 1 will create the most residual risk; the other RAAs create less residual risk. In the long run, RAAs 2, 3, 4, and 5 are likely to create equal amounts of residual risk because they all allow the groundwater COPCs to remain on site. Although RAAs 3, 4, and 5 involve active remediation, when the remediation systems are shut down, manganese and TCE levels may once again rise. (This is because manganese is naturally occurring at the base and TCE may be introduced through on-going site activities.) Regardless, the magnitude of any residual risk will be minimal for the seven reasons stated earlier in this section.

RAAs 2, 3, 4, and 5 involve continued groundwater monitoring, aquifer-use restrictions, and deed restrictions, which are all adequate and reliable controls; RAA 1 involves no controls. As a result, RAAs 2, 3, 4, and 5 can mitigate human health exposure through the use of institutional controls, but RAA 1 cannot. Also, the effectiveness of RAAs 2, 3, 4, and 5 can be determined, but the effectiveness of RAA 1 cannot.

All five RAAs will initially require 5-year reviews to ensure that adequate protection of human health and the environment is maintained. Under RAAs 1 and 2, this review will be required for a longer period of time.

Reduction of Toxicity, Mobility, or Volume Through Treatment

RAAs 1 and 2 do not involve treatment processes so these alternatives will only reduce toxicity, mobility, or volume of the COPCs via passive remediation. RAAs 3, 4, and 5, however, involve extraction/treatment so they will reduce the toxicity, mobility, and volume of COPCs via active remediation. (RAAs 3, 4, and 5 satisfy the statutory preference for treatment.) Although the extraction/treatment system will reduce toxicity, naturally occurring manganese levels and additional solvent spills may occur after the treatment system is shut down.

Under all five RAAs, TCE and manganese levels exceeding ARARs may remain after remediation (active or passive) processes have occurred. Under RAAs 3, 4, and 5, active treatment processes will create additional residuals like metals sludge, spent carbon, and contaminated condensed vapor. These additional residuals will require proper disposal.

Short-Term Effectiveness

While the treatment systems are in operation, RAAs 3, 4, and 5 will reduce TCE and manganese levels. However, RAAs 3, 4, and 5 will also create the most risk during implementation. Risks to the community and workers will be increased during extraction well, aeration well, piping, and/or treatment plant installation and operation.

For costing purposes, a time frame of 30 years has been assumed for all RAAs to achieve the RIs. The timeframe should be shorter for RAAs 3, 4, and 5.

Implementability

RAA 1 is the most implementable alternative. RAAs 2, 3, and 5 use conventional, well-demonstrated, and commercially available technologies so these RAAs are proven to be implementable and reliable. RAA 4 (in-well aeration), however, involves an emerging technology that does not have an extensive commercial track record. A field pilot test is necessary to determine

this alternative's implementability. RAA 2 is a more implementable alternative since only institutional controls are necessary.

Despite its high level of implementability, RAA 1 does not include adequate monitoring to determine its effectiveness. As a result, failure to detect increases in COPC levels could result in potential exposure to the groundwater. RAAs 2, 3, 4, and 5 include monitoring plans so there will be notice of contaminant increases before significant exposure can occur.

Cost

In terms of NPW, the no action alternative (RAA 1) would be the least expensive RAA to implement, followed by RAA 2, RAA 5, RAA 4, and then RAA 3. The estimated NPW values in increasing order are $0 (RAA 1), $690,000 (RAA 2), $1,500,000 (RAA 5), $1,630,000 (RAA 4), and $1,900,000 (RAA 3).

10.0 SELECTED REMEDY

This section of the ROD focuses on the remedy that was selected for Site 1. A description of the selected remedy will be presented along with the estimated costs to implement the remedy. In addition, the remediation levels to be attained at the conclusion of the remedy will be discussed.

Remedy Description

The selected remedy for Site 1 is Groundwater RAA 2 - Institutional Controls. The major components of this RAA are:

- A long-term groundwater monitoring plan that is depicted in Figure 4. As shown, certain wells will be sampled semiannually and the samples will be selectively analyzed for the groundwater COPCs.
- Aquifer use restrictions that will prohibit the future use of the aquifer as a potable water source.
- Deed restrictions that will limit the future use of land at the site, including placement of wells.
- Natural attenuation processes, such as dilution, volatilization, adsorption, and chemical reactions with subsurface materials, may reduce COPC levels, particularly TCE, to below RLs.

Each component of this selected remedy will mitigate the principal threat at Site 1: the potential for ingestion of contaminated groundwater.

Estimated Costs

The estimated costs for the selected remedy are:

Capital Cost: $0
Annual O&M Cost: $50,000
Net Present Worth: $690,000

The net present worth is based on the assumption that groundwater monitoring will occur for 30 years. It is important to note that the cost estimate was calculated for the FS evaluation and is not

intended to be as accurate as a construction cost estimate. An FS cost estimate should have an accuracy of +50 to -30 percent.

Remediation Levels

Although an operation period of 30 years was used for cost estimations, the selected remedy will actually be operated until the RLs developed in the FS are met. The RLs for the groundwater COPCs are: 2.8 µg/L for TCE, 50 µg/L for manganese, and 1.1 µg/L for mercury. These RLs are all North Carolina state water quality standards.

Since the selected remedy does not involve active remediation, the RLs will only be achieved via passive remediation, or natural attenuation processes. (In the case of manganese, however, the RL will probably never be achieved.) The monitoring plan will indicate when RLs have been achieved.

11.0 STATUTORY DETERMINATIONS

A selected remedy should satisfy the statutory requirements of CERCLA Section 121 which include: (1) be protective of human health and the environment; (2) comply with ARARs; (3) be cost-effective; (4) utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and (5) satisfy the preference for treatment that reduces toxicity, mobility, or volume as principal element, or provide and explanation as to why this preference is not satisfied. The evaluation of how RAA 2 satisfies these requirements for Site 1 is presented below.

Protection of Human Health and the Environment

RAA 2 provides protection to human health and the environment by mitigating the potential risk associated with ingestion of contaminated groundwater.

Compliance with Applicable or Relevant and Appropriate Requirements

RAA 2 will comply with ARARs identified in the FS.

Cost-Effectiveness

The selected remedy, RAA 2, has been evaluated to be the most cost-effective alternative considered for Site 1 (excluding the no action alternative).

Utilization of Permanent Solutions and Alternative Treatment Technologies

RAA 2 does not utilize permanent solutions or alternative treatment technologies. However, RAA 2 is still capable of providing adequate protection to human health and the environment.

Preference for Treatment as a Principal Element

RAA 2 does not satisfy the preference for treatment as a principal element. Although it does not meet this preference, the RAA 2 still provides adequate protection to human health and the environment.

12.0 RESPONSIVENESS SUMMARY

Overview

To be completed after the public meeting.

Background on Community Involvement

A record review of the MCB, Camp Lejeune files indicates that the community involvement centers mainly on a social nature, including the community outreach programs and base/community clubs. The file search did not locate written Installation Restoration Program concerns of the community. A review of historic newspaper articles indicated that the community is interested in the local drinking and groundwater quality, as well as that of the New River, but that there are no expressed interests or concerns specific to the environmental sites (including Site 1). Two local environmental groups, the Stump Sound Environmental Advocates and the Southeastern Watermen's Association, have posed questions to the base and local officials in the past regarding other environmental issues. These groups were sought as interview participants prior to the development of the Camp Lejeune, IRP, Community Relations Plan. Neither group was available for the interviews.

Community relations activities to date are summarized below:

- Conducted additional community relations interviews, February through March 1990. A total of 41 interviews were conducted with a wide range of persons including base personnel, residents, local officials, and off-base residents.
- Prepared a Community Relations Plan, September 1990.
- Conducted additional community relations interviews, August 1993. Nineteen persons were interviewed, representing local business, civic groups, on- and off-base residents, military and civilian interests.
- Prepared a revised Final Community Relations Plan, February 1994.
- Established two information repositories.
- Established the Administrative Record for all of the sites at the base.
- Released PRAP for public review in repositories,_____ .
- Released public notice announcing public comment and document availability of the PRAP, _____.
- Held Restoration Advisory Board meeting, _____, to review PRAP and solicit comments.
- Held public meeting on _____, to solicit comments and provide information. Approximately ____ people attended. The public meeting transcript is available in the repositories.

Summary of Comments Received During the Public Comment Period and Agency Responses

To be completed after the public meeting.

TABLES

TABLE 1

SUMMARY OF COPCs EVALUATED DURING THE RA
SITE 1, FRENCH CREEK LIQUIDS DISPOSAL AREA
MCB CAMP LEJEUNE, NORTH CAROLINA

Environmental Medium	COPC
Surface Soil	Aluminum Antimony Arsenic Barium Cadmium Chromium Copper Lead Manganese Vanadium Zinc 4,4-DDE 4,4'-DDT alpha-chlordane gamma-chlordane
Subsurface Soil	Aluminum Arsenic Barium Cadmium Chromium Cobalt Copper Lead Manganese Nickel Vanadium BEHP
Shallow and Deep Groundwater	Arsenic Barium Manganese Mercury 1,2-dichloroethene (total) Trichloroethene

COPC = Contaminant of Potential Concern

TABLE 2

SUMMARY OF POTENTIAL RISKS
SITE 1, FRENCH CREEK LIQUIDS DISPOSAL AREA
MCB, CAMP LEJEUNE, NORTH CAROLINA

Exposure Pathway	Future Child		Future Adult		Current Military		Future Construction Worker	
	NC Risk	Carc Risk	NC Risk	Carc Risk	NC Risk	Carc Risk	NC Risk	Carc Risk
Soil Ingestion	1.0E-01	2.3E-06	1.1E-02	1.2E-06	3.3E-02	1.5E-07	1.3E-02	5.1E-08
Soil Dermal Contact	5.8E-03	1.4E-07	3.1E-03	3.7E-07	9.5E-03	4.4E-08	5.9E-04	2.3E-09
Soil Inhalation	9.1E-05	2.4E-10	3.9E-05	5.2E-10	4.7E-05	7.2E-11	NA	NA
total	1.1E-01	2.5E-06	1.4E-02	1.6E-06	4.3E-02	1.9E-07	1.4E-02	5.4E-08
Groundwater Ingestion	17	8.2E-05	7.5	1.7E-04	NA	NA	NA	NA
Groundwater Dermal Contact	2.2E-01	1.0E-06	1.1E-01	2.5E-06	NA	NA	NA	NA
Groundwater Inhalation	NA	1.8E-07	NA	9.9E-08	NA	NA	NA	NA
total	17.2	8.3E-05	7.6	1.7E-04	NA	NA	NA	NA
Total	**17.3**	**8.5E-05**	**7.6**	**1.7E-04**	**4.3E-02**	**1.9E-07**	**1.4E-02**	**5.4E-08**

Notes: NC = Noncarcinogenic risk (shaded areas indicate HI > 1.0)
Carc = Carcinogenic Risk (shaded areas indicate ICR > 1E-04)
NA = Not Applicable

TABLE 3

SUMMARY OF THE RAA EVALUATION
SITE 1, FRENCH CREEK LIQUIDS DISPOSAL AREA
MCB, CAMP LEJEUNE, NORTH CAROLINA

Evaluation Criteria	RAA 1 No Action	RAA 2 Institutional Controls	RAA 3 Extraction and On-Site Treatment	RAA 4 In-Well Aeration and Off-Gas Carbon Adsorption	RAA 5 Extraction and Off-Site Treatment
OVERALL PROTECTIVENESS • Human Health	No reduction in potential human health risks, except through natural attenuation of groundwater COPCs.	Institutional controls and natural attenuation will reduce potential human health risks.	Institutional controls, natural attenuation, and the extraction/ treatment system will reduce potential human health risks.	Institutional controls, natural attenuation, and in situ treatment will reduce potential human health risks.	Institutional controls, natural attenuation, and extraction/treatment will reduce potential human health risks.
• Environmental Protection	No reduction in potential risks to ecological receptors, except through natural attenuation of groundwater COPCs.	Institutional controls and natural attenuation will reduce potential risks to ecological receptors.	Institutional controls, natural attenuation, and the extraction/ treatment system will reduce potential risks to ecological receptors.	Institutional controls, natural attenuation, and in situ treatment will reduce potential risks to ecological receptors.	Institutional controls, natural attenuation, and extraction/treatment will reduce potential risks to ecological receptors.
COMPLIANCE WITH ARARS • Chemical-Specific ARARs	No active effort made to reduce COPC levels to below federal or state ARARs. However, TCE may naturally attenuate to meet it ARARs, and metals consistently exceed federal and/or state ARARs in groundwater throughout MCB, Camp Lejeune.	No active effort made to reduce COPC levels to below federal or state ARARs. However, TCE may naturally attenuate to meet its ARARs, and metals consistently exceed federal and/or state ARARs in groundwater throughout MCB, Camp Lejeune.	TCE and manganese within the wells' zone of influence are expected to meet chemical-specific ARARs while the system is in operation.	TCE is expected to meet chemical-specific ARARs while the system is in operation.	TCE and manganese within the wells' zone of influence are expected to meet chemical-specific ARARs.
• Location-Specific ARARs	Not applicable.	Not applicable.	Can be designed to meet location-specific ARARs.	Can be designed to meet location-specific ARARs.	Can be designed to meet location-specific ARARs.
• Action-Specific ARARs	Not applicable.	Not applicable.	Can be designed to meet action-specific ARARs.	Can be designed to meet action-specific ARARs.	Can be designed to meet action-specific ARARs.

TABLE 3 (Continued)

SUMMARY OF THE RAA EVALUATION
SITE 1, FRENCH CREEK LIQUIDS DISPOSAL AREA
MCB, CAMP LEJEUNE, NORTH CAROLINA

Evaluation Criteria	RAA 1 No Action	RAA 2 Institutional Controls	RAA 3 Extraction and On-Site Treatment	RAA 4 In-Well Aeration and Off-Gas Carbon Adsorption	RAA 5 Extraction and Off-Site Treatment
LONG-TERM EFFECTIVENESS AND PERMANENCE • Magnitude of Residual Risk	The residual risk from untreated COPCs will be minimal; natural, attenuation will mitigate any residual risk that may exist.	The residual risk from untreated COPCs will be minimal; institutional controls and natural attenuation will mitigate any residual risk that may exist.	The residual risk from untreated COPCs will be minimal; institutional controls and natural attenuation will mitigate any residual risk that may exist; the extraction/treatment system will not mitigate residual risk in the long run.	The residual risk from untreated COPCs will be minimal; institutional controls and natural attenuation will mitigate any residual risk that may exist; in situ treatment will not mitigate residual risk in the long run.	The residual risk from untreated COPCs will be minimal; institutional controls and natural attenuation will mitigate any residual risk that may exist; extraction/treatment will not mitigate residual risk in the long run.
• Adequacy and Reliability of Controls	The USEPA 5-year review alone may not be adequate for determining the alternative's effectiveness.	The proposed monitoring plan is adequate and reliable for determining effectiveness; aquifer use and deed restrictions are adequate and reliable for preventing human health exposure.	The proposed monitoring plan is adequate and reliable for determining effectiveness; aquifer use and deed restrictions are adequate and reliable for preventing human health exposure.	The proposed monitoring plan is adequate and reliable for determining effectiveness; aquifer use and deed restrictions are adequate and reliable for preventing human health exposure.	The proposed monitoring plan is adequate and reliable for determining effectiveness; aquifer use and deed restrictions are adequate and reliable for preventing human health exposure.
• Need for 5-year Review	Review will be required to ensure adequate protection of human health and the environment.	Review will be required to ensure adequate protection of human health and the environment.	Until remediation levels are met, review will be required to ensure adequate protection of human health and the environment.	Until remediation levels are met, review will be required to ensure adequate protection of human health and the environment.	Until remediation levels are met, review will be required to ensure adequate protection of human health and the environment.
REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT • Treatment Process Used	No active treatment process applied.	No active treatment process applied.	The treatment process includes air stripping for VOC removal and neutralization, precipitation, flocculation, sedimentation, and filtration for metals removal.	The treatment process includes off-gas carbon adsorption for VOC removal; also, in situ volatilization and biodegradation of VOCs is employed.	The treatment processes, include air stripping and carbon adsorption for VOC removal; also, flocculation and sedimentation for metals removal.

TABLE 3 (Continued)

SUMMARY OF THE RAA EVALUATION
SITE 1, FRENCH CREEK LIQUIDS DISPOSAL AREA
MCB, CAMP LEJEUNE, NORTH CAROLINA

Evaluation Criteria	RAA 1 No Action	RAA 2 Institutional Controls	RAA 3 Extraction and On-Site Treatment	RAA 4 In-Well Aeration and Off-Gas Carbon Adsorption	RAA 5 Extraction and Off-Site Treatment
• Amount Destroyed or Treated	No COPC reduction except by natural attenuation.	No COPC reduction except by natural attenuation.	VOCs and metals within the wells' zone of influence will be treated.	VOCs within the wells' zone of influence will be treated.	VOCs and metals within the wells' zone of influence will be treated.
• Reduction of Toxicity, Mobility, or Volume	No COPC reduction except by natural attenuation.	No COPC reduction except by natural attenuation.	Reduction in toxicity, mobility, and volume of VOCs and metals within the wells' zone of influence.	Reduction in toxicity, mobility, and volume of VOCs.	Reduction in toxicity, mobility, and volume of VOCs and metals within the wells' zone of influence.
• Residuals Remaining After Treatment	No active treatment process applied.	No active treatment process applied.	TCE and manganese levels that exceed remediation levels may still exist after treatment; residuals also include metals sludge which will require proper disposal.	TCE and manganese levels that exceed remediation levels may still exist after treatment; residuals also include metals sludge, spent carbon, and a small volume of condensed contaminated vapor (water) which will require proper disposal	TCE and manganese levels that exceed remediation levels may still exist after treatment.
• Statutory Preference for Treatment	Not satisfied.	Not satisfied.	Satisfied.	Satisfied.	Satisfied.
SHORT-TERM EFFECTIVENESS • Community Protection	Potential risks to the community will not be increased.	Potential risks to the community will not be increased.	Potential risks to the community will be increased during installation and operation.	Potential risks to the community will be increased during installation and operation.	Potential risks to the community will be increased during installation and operation.
• Worker Protection	No risks to workers.	No significant risks to workers.	Potential risks to workers will be increased; worker protection is required.	Potential risks to workers will be increased; worker protection is required.	Potential risks to workers will be increased; worker protection is required.
• Environmental Impact	No additional environmental impacts; current impacts will continue.	No additional environmental impacts; current impacts will continue.	No additional environmental impacts if aquifer drawdown does not affect surrounding water bodies.	No additional environmental impacts if aquifer drawdown does not affect surrounding water bodies.	No additional environmental impacts if aquifer drawdown does not affect surrounding water bodies.
• Time Until Action is Complete	Estimated 30 years.	Estimated 30 years.	Thirty years used to estimate NPW costs. Time for completion of remediation is unknown.	Thirty years used to estimate NPW costs. Time for completion of remediation is unknown.	Three years used to estimate trucking costs; thirty years used to estimate monitoring costs.

TABLE 3 (Continued)

SUMMARY OF THE RAA EVALUATION
SITE 1, FRENCH CREEK LIQUIDS DISPOSAL AREA
MCB, CAMP LEJEUNE, NORTH CAROLINA

Evaluation Criteria	RAA 1 No Action	RAA 2 Institutional Controls	RAA 3 Extraction and On-Site Treatment	RAA 4 In-Well Aeration and Off-Gas Carbon Adsorption	RAA 5 Extraction and Off-Site Treatment
IMPLEMENTABILITY • Ability to Construct and Operate	No construction or operation activities.	No construction or operation activities; institutional controls have been easily implemented in the past.	The infrastructure within a developed area like Site 1 poses some minor construction problems; groundwater must be lifted above ground surface for treatment; metals precipitation could clog well screens.	The technology has been commercially applied, but it is still relatively new; the infrastructure within a developed area like Site 1 poses some minor construction problems; groundwater does not need to be lifted above ground surface for treatment; metals precipitation could clog well screens.	The infrastructure within a developed area like Site 1 poses some minor construction problems; groundwater does not need to be lifted above ground surface for treatment; metals precipitation could clog well screens.
• Ability to Monitor Effectiveness	No proposed monitoring plan; failure to detect contamination could result in potential ingestion of groundwater.	Proposed monitoring plan will detect contaminants before significant exposure can occur.	Proposed monitoring plan will detect contaminants before significant exposure can occur; O&M checks will provide notice of a system failure.	Proposed monitoring plan will detect contaminants before significant exposure can occur; O&M checks will provide notice of a system failure.	Proposed monitoring plan will detect contaminants before significant exposure can occur; O&M checks will provide notice of a system failure.
• Availability of Services and Capacities; Equipment	No services or equipment required.	No special services or equipment required.	Services and equipment are readily available.	The patented technology is exclusively licensed to a single vendor.	Services and equipment are readily available.
• Requirements for Agency Coordination	None required.	Must submit semiannual reports to document sampling.	Air and water discharge permits may be required.	Air and water discharge permits may be required.	Air and water discharge permits may be required.
COST	$0	$690,000	$1,900,000	$1,630,000	$1,500,000

TABLE 4
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** - addressed whether or no tan 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 statues 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 environmental 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 material sand services needed to implement the chosen solution.
- **Cost** - includes capital and operation and maintenance costs. For comparative purposes, presents present worth values.

FIGURES

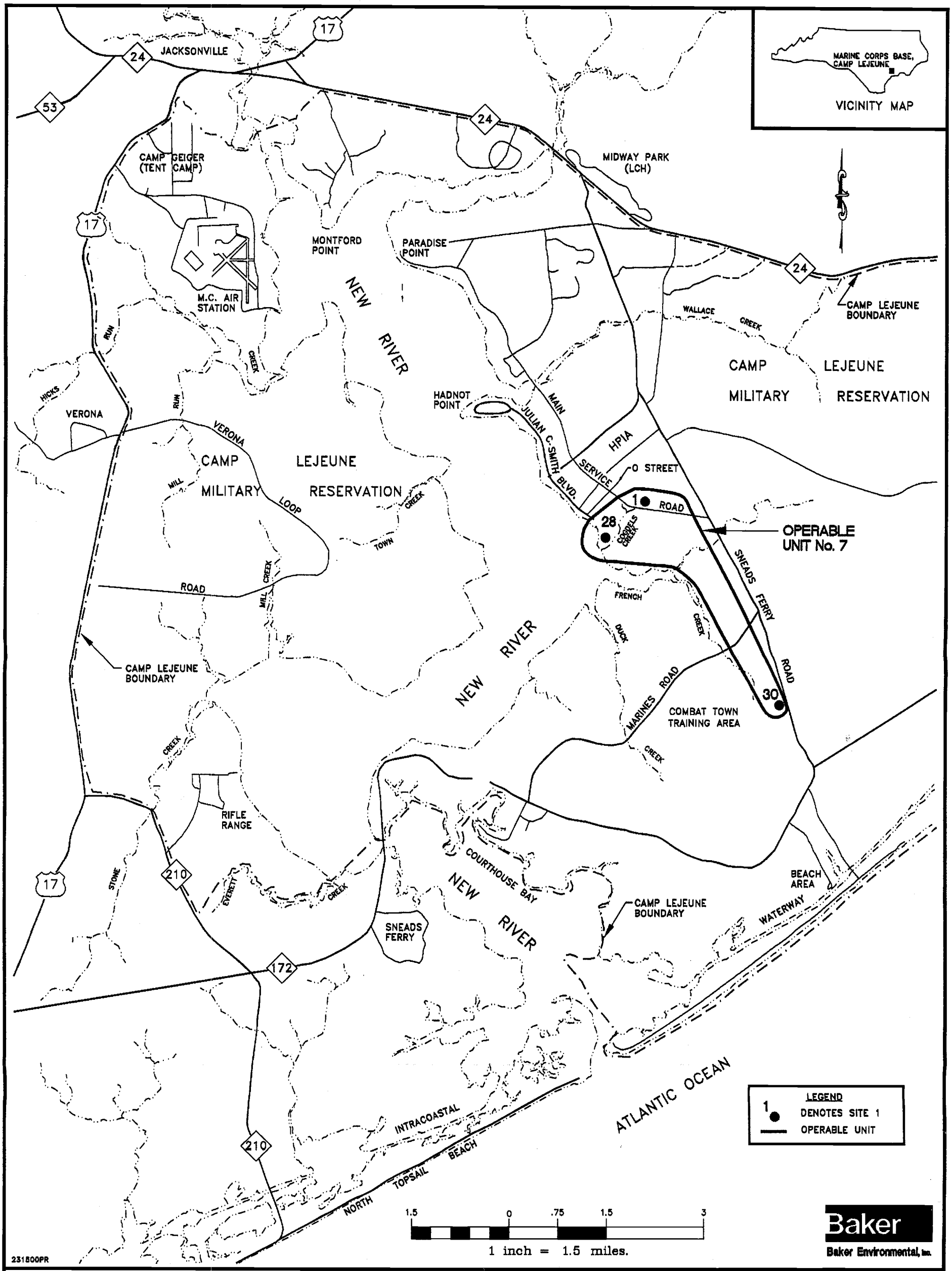
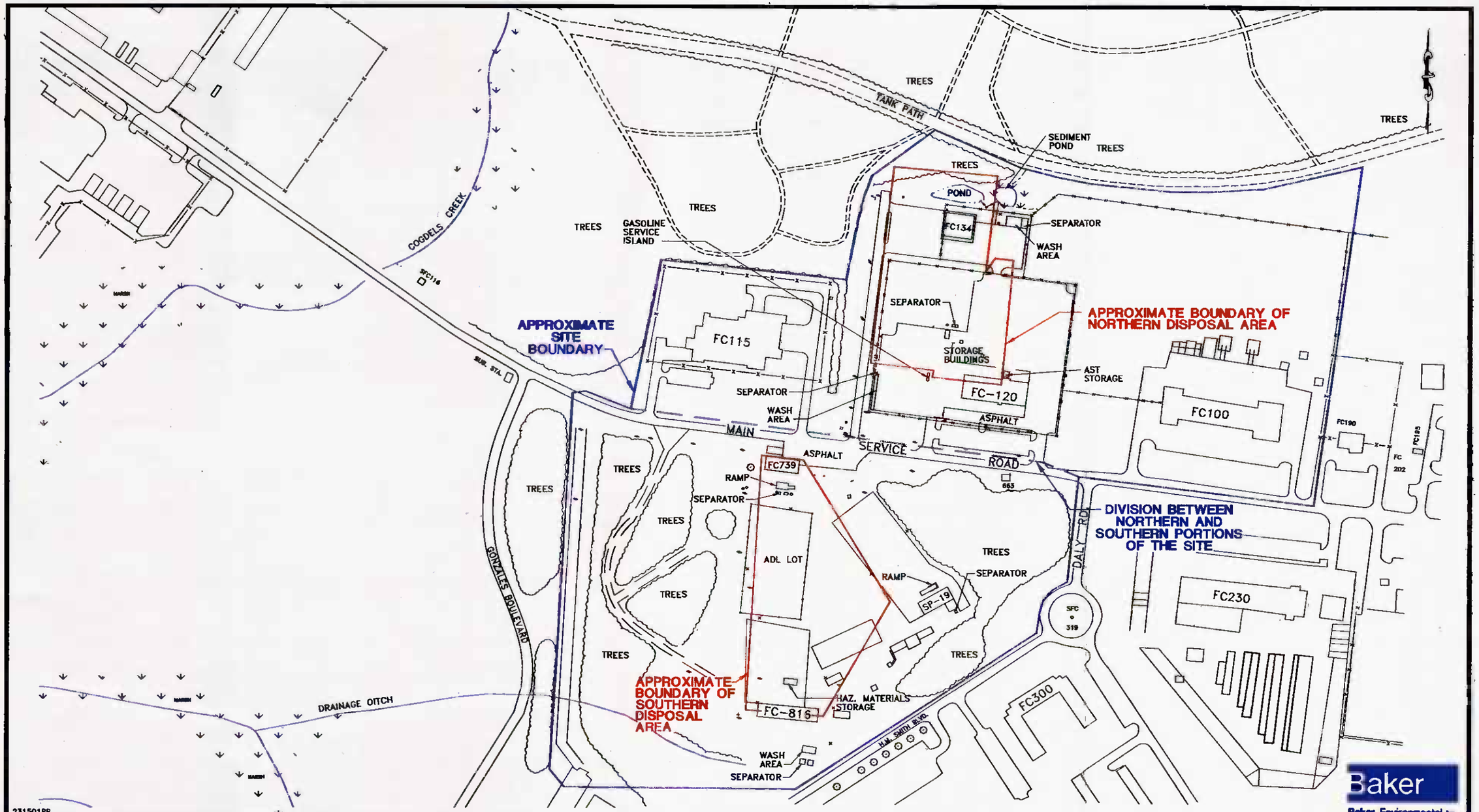


FIGURE 1
OPERABLE UNIT No. 7 – SITES 1, 28, AND 30
MARINE CORPS BASE, CAMP LEJEUNE

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

00240II01Z



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LEGEND

- VEGETATION
- FENCE
- CREEK/DRAINAGE
- MARSH
- UNIMPROVED ROAD

SOURCE: LANTDIV, FEBRUARY 1992 AND W.K. DICKSON & ASSOC., JUNE 1994

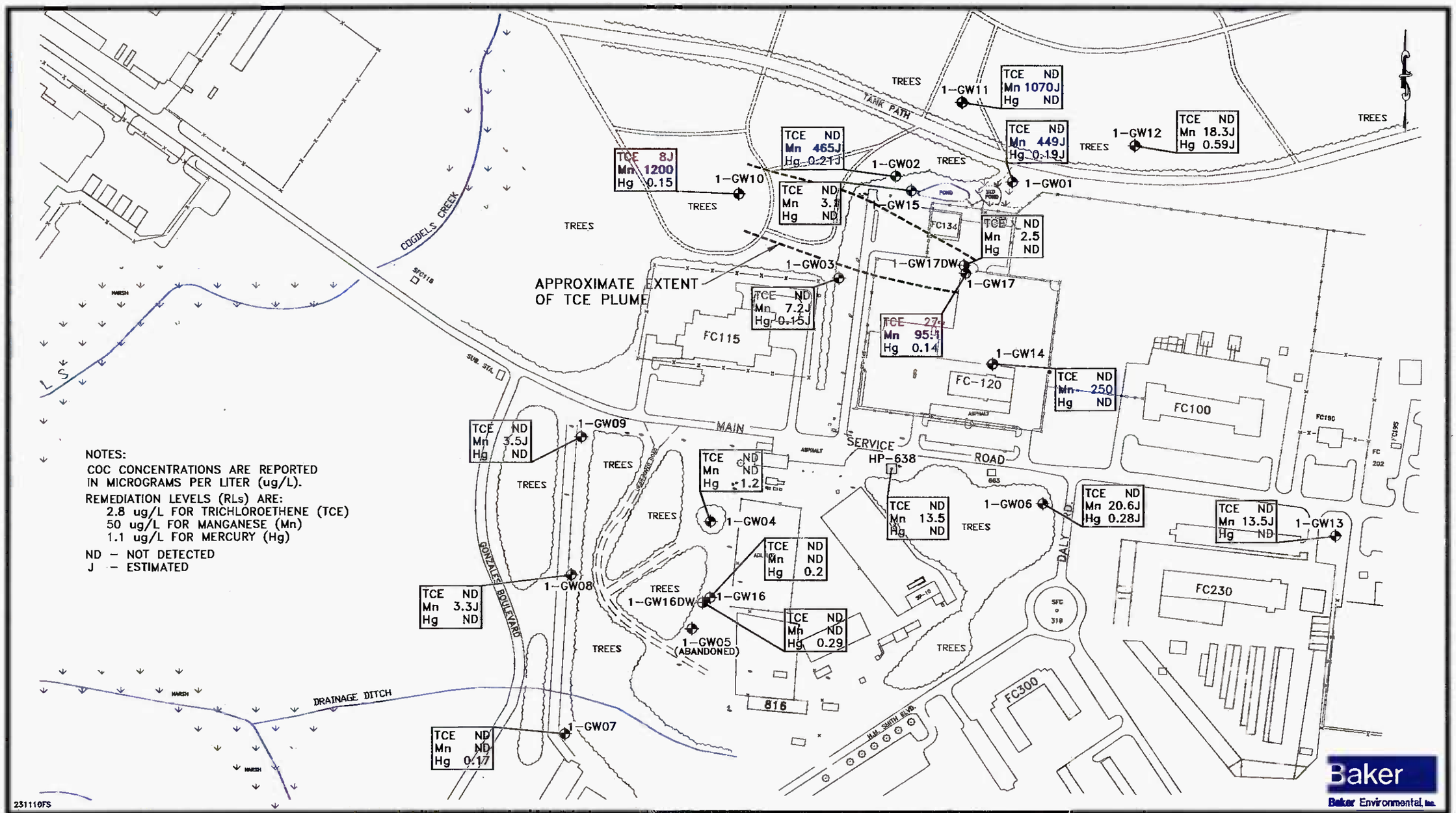
300 0 150 300 600

1 inch = 300 ft.

FIGURE 2
SITE MAP
SITE 1 – FRENCH CREEK LIQUIDS DISPOSAL AREA

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

00240IIB1Y



NOTES:
COC CONCENTRATIONS ARE REPORTED IN MICROGRAMS PER LITER (ug/L).
REMEDIATION LEVELS (RLs) ARE:
2.8 ug/L FOR TRICHLOROETHENE (TCE)
50 ug/L FOR MANGANESE (Mn)
1.1 ug/L FOR MERCURY (Hg)
ND – NOT DETECTED
J – ESTIMATED

231110FS

LEGEND

1-GW07 SHALLOW MONITORING WELL
1-GW16DW DEEP MONITORING WELL
HP-638 EXISTING WATER SUPPLY WELL

TCE 8J CONCENTRATION EXCEEDING THE TCE RL
Mn 1200 CONCENTRATION EXCEEDING THE MANGANESE RL
Hg 0.15 CONCENTRATION EXCEEDING THE MERCURY RL

SOURCE: LANTDIV, FEBRUARY 1992 AND W.K. DICKSON & ASSOC., JUNE 1994

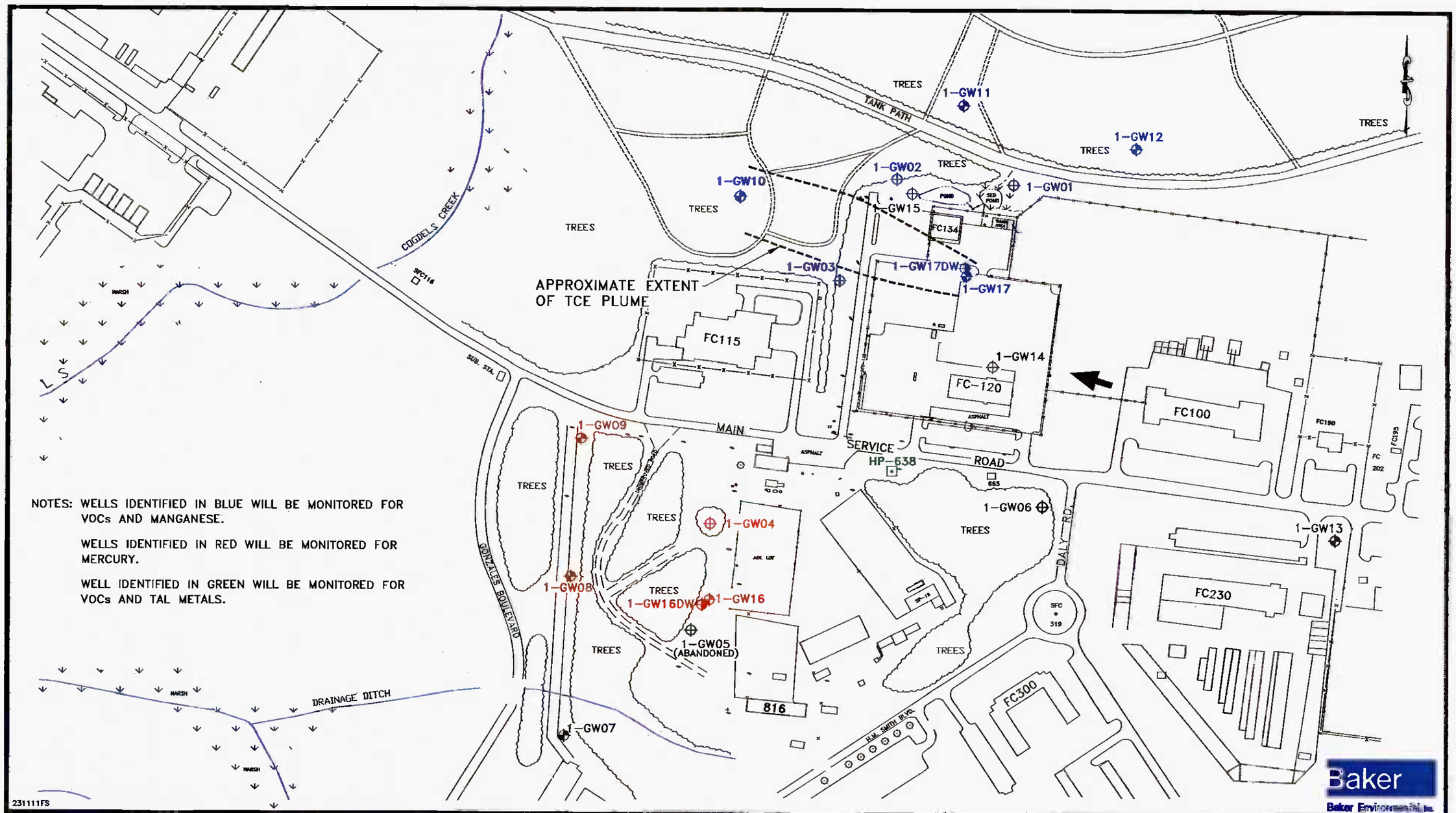
300 0 150 300 600

1 inch = 300 ft.

FIGURE 3
GROUNDWATER AREAS OF CONCERN
SITE 1 – FRENCH CREEK LIQUIDS DISPOSAL AREA

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

Baker
Baker Environmental, Inc.



NOTES: WELLS IDENTIFIED IN BLUE WILL BE MONITORED FOR VOCs AND MANGANESE.

WELLS IDENTIFIED IN RED WILL BE MONITORED FOR MERCURY.

WELL IDENTIFIED IN GREEN WILL BE MONITORED FOR VOCs AND TAL METALS.

231111FS

LEGEND

- 1-GW07 — SHALLOW MONITORING WELL
- 1-GW16DW — DEEP MONITORING WELL
- HP-638 — WATER SUPPLY WELL THAT IS NOT IN SERVICE
- APPROXIMATE GROUNDWATER FLOW DIRECTION

SOURCE: LANTDIV, FEBRUARY 1992 AND W.K. DICKSON & ASSOC., JUNE 1994

300 0 150 300 600

1 inch = 300 ft.

FIGURE 4
PREFERRED ALTERNATIVE – GROUNDWATER
RAA 2: INSTITUTIONAL CONTROLS
SITE 1 – FRENCH CREEK LIQUIDS DISPOSAL AREA

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

Baker
Baker Environmental Inc.