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Action Memorandum
for
Time Critical Removal Action
Site 89, Operable Unit 16

Marine Corps Base
Camp Lejeune, North Carolina

Prepared For

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TABLE OF CONTENTS

Page

LIST OF ACRONYMS iv

I. PURPOSE 1

II. SITE CONDITIONS AND BACKGROUND 2
- A. Site Description 2
  - 1. Camp Lejuene Description 2
  - 2. Site Description 3
  - 3. Release or Threatened Release into the Environment of a Hazardous Substance, Pollutant, or Contaminant 4
  - 4. National Priority List Status 5
  - 5. Maps, Pictures, and Other Graphic Representations 5
- B. Other Actions 6
  - 1. Previous Investigations 6
  - 2. Current Actions to Reduce Potential Exposure 6
  - 3. Future Actions 7
- C. State and Local Authorities' Roles 8
- D. Quantities and Types of Substances Present 8

III. THREATS TO PUBLIC HEALTH OR WELFARE OR THE ENVIRONMENT, AND STATUTORY AND REGULATORY AUTHORITIES 16

IV. ENDANGERMENT DETERMINATION 19

V. PROPOSED ACTIONS AND ESTIMATED COSTS 20
- A. Proposed Actions 20
  - 1. Proposed Action Description 20
  - 2. Contribution to Remedial Performance 22
  - 3. Description of Alternative Technologies 24
  - 4. Applicable or Relevant and Appropriate Requirements 25
  - 5. Project Schedule 27
- B. Estimated Costs 28

VI. EXPECTED CHANGE IN THE SITUATION SHOULD ACTION BE DELAYED OR NOT TAKEN 28

VII. OUTSTANDING POLICY ISSUES 28

VIII. ENFORCEMENT 28

IX. RECOMMENDATION 29

X. REFERENCES 30

ATTACHMENT A **Tables and Figures**

Table 1	Site 89 Remedial Design,VOCs in Vadose Zone Soil - Maximum Detections and Target Cleanup/Treatment Standards
Figure 1	Site Location Map
Figure 2	Site Map
Figure 3	Sample Location Map
Figure 4a	Composite VOCs in Vadose Zone Soils (1 – 3 feet bgs)
Figure 4b	Composite VOCs in Vadose Zone Soils (3 – 5 feet bgs)
Figure 5a	Individual VOCs in Vadose Zone Soils (1 – 3 feet bgs)
Figure 5b	Individual VOCs in Vadose Zone Soils (3 – 5 feet bgs)
Figure 6	Volatile Organic Compounds in Vadose Zone Soils
Figure 7	Volatile Organic Compounds in Groundwater
Figure 8	On-Site LTTD TCRA - Site Layout

ATTACHMENT B **Response to Comments**

ATTACHMENT C **Health Advisories and Risk Screening**

ATTACHMENT D **Cost Estimates**

LIST OF ACRONYMS

ARARs	Applicable or relevant and appropriate requirements
AWQC	Ambient Water Quality Criteria
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
DLA	Defense Logistics Agency
DoN	Department of the Navy
DRMO	Defense Reutilization and Marketing Office
EE/CA	Engineering Evaluation/Cost Analysis
EMD	Environmental Management Department
FFA	Federal Facilities Agreement
HDPE	high-density polyethylene
IR	Installation Restoration
LANTDIV	Atlantic Division, Navy Facilities Engineering Command
LTM	Long Term Monitoring
LTTD	Low Temperature Thermal Desorption
MCB	Marine Corps Base
MCL	maximum contaminant level
NC DENR	North Carolina Department of Environment and Natural Resources
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
PCA	tetrachloroethane
PCE	tetrachloroethene
ppm	parts per million
PRG	preliminary remediation goal
RAB	Restoration Advisory Board
RAC	Remedial Action Contractor
RBC	risk-based concentration
RI	Remedial Investigation
SARA	Superfund Amendments and Reauthorization Act
TCE	trichloroethene
TCRA	Time Critical Removal Action
USEPA	United States Environmental Protection Agency
UST	underground storage tank
VC	vinyl chloride
VOCs	volatile organic compounds

ACTION MEMORANDUM
TIME CRITICAL REMOVAL ACTION
SITE 89 - DRMO AREA
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

I. PURPOSE

This Action Memorandum documents approval of the time-critical removal action (TCRA) described herein for Site 89, the Defense Reutilization and Marketing Office (DRMO) area of Camp Geiger, which is located near the intersection of "G" and Eighth Streets, on Marine Corps Base, Camp Lejeune.

This Action Memorandum, which serves as the decision document for the TCRA, has been completed in accordance with the program requirements defined by: the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA); the Superfund Amendments and Reauthorization Act of 1986 (SARA); the National Oil and Hazardous Substances Pollution Contingency Plan (NCP); and, the U.S. Environmental Protection Agency's (USEPA) Superfund Removal Procedures - Action Memorandum Guidance dated December 1990 (USEPA, 1990). This Action Memorandum follows the guidelines published in the Navy/Marine Corps IR Manual, dated February 1992.

The Department of the Navy (DoN) has broad authority under CERCLA Section 104 and Executive Order 12580 to carry out removal actions when a release or threatened release is on, or the sole source is from, a military installation. The Installation Restoration (IR) Program was initiated to identify, assess, characterize, and clean up or control contamination from past hazardous waste disposal operations and hazardous material spills at military installations.

The primary focus of this TCRA for Site 89 is the removal of VOC-contaminated soil and treatment of the soil by low temperature thermal desorption (LTTD). In conjunction with the soil removal, an aeration system will be installed in Edwards Creek just downstream of Site 89 to remove volatile organic contaminants (VOCs) from surface water. In addition, the DRMO fence will be extended to enclose the portions of Edwards Creek adjacent to Site 89 that have been most impacted by contaminant migration from the site.

As Site 89 is used for industrial purposes, a primary goal of this TCRA is to reduce the potential exposure of current users of the site (i.e., DRMO workers) by removing soils with contaminant concentrations greater than industrial risk-based cleanup levels. The possible exposure of current industrial workers to contaminants has been temporarily addressed by placing a tarp and a high-density polyethylene (HDPE) liner over the unpaved area in the DRMO. Because of the tarp and HDPE liner, which prevents dermal, ingestion, and inhalation exposures, there is no current risk of potential exposure to contaminated soil. The TCRA will provide a permanent means to eliminate exposure of future workers to soil contaminants. This TCRA will also reduce the potential exposure threat to off-site receptors (recreational users of Edwards Creek) by restricting access to impacted portions of the creek and by installation of an aeration system in Edwards Creek to remove volatile contaminants from surface water. In addition, by removing a significant source area, this TCRA will also eliminate the potential for cross-media contamination (contaminant migration from soil to groundwater, surface water, and sediment).

Residual soil and groundwater contamination remaining following implementation of this TCRA will be addressed by additional remedial actions to be implemented following the TCRA. An Engineering Evaluation/Cost Analysis (EECA) will be conducted during TCRA implementation to evaluate potential technologies and remedial alternatives that may be implemented to address residual contamination.

II. SITE CONDITIONS AND BACKGROUND

A. Site Description

1. Camp Lejeune Description

MCB, Camp Lejeune (shown on Figure 1) is located on the coastal plain of North Carolina in Onslow County. The facility encompasses approximately 236 square miles and is bisected by the New River. The New River flows southeasterly and forms a large estuary before entering the Atlantic Ocean. The southeastern border of MCB, Camp Lejeune is the Atlantic Ocean shoreline. The western and northeastern boundaries of the facility are U.S. Route 17 and State Route 24, respectively. The City of Jacksonville, North Carolina borders MCB, Camp Lejeune to the north.

2. Site Description

Site 89, located near the intersection of "G" and Eighth Streets, is the larger of two sites within Operable Unit 16 of MCB, Camp Lejuene. It encompasses a significant portion of Camp Geiger and includes all of the DRMO and additional area to the south and east. The DRMO is operated by the Defense Logistics Agency (DLA), with the primary function of managing scrap and surplus metal. Other materials, such as rubber tires and fuel bladders (mobile storage tanks), have also been managed at the site.

Site 89 is currently used as a storage yard for the DRMO. The fenced storage area (shown on Figure 2) is a staging area for electronic equipment, vehicles, and used appliances. Asphalt roads and gravel parking areas cover most of the western portion of Site 89. The eastern portion of Site 89 is heavily wooded, as is the area immediately south of the DRMO. Edwards Creek, the nearest surface water body, is located along the western and southern portions of the site. The land surface of Site 89 gently slopes in the direction of Edwards Creek, which begins as a series of drainage ditches within Camp Geiger. The creek begins near Eighth Street and flows south for a short distance before turning east, where it tends to widen as it flows through the wooded area of Site 89. The eastern portion of the creek flows through a low-lying swampy area. A housing development lies to the southeast of Site 89 (south of Edwards Creek). The wooded area to the east of the DRMO is designated as Hunting Area 1A.

Historical records for the area indicate that the Base Motor Pool operated on the site until approximately 1988. The Base Motor Pool was then relocated to its current location, an asphalt paved area immediately north of the DRMO facility. The Base Motor Pool reportedly used solvents for parts cleaning during this time, including acetone, trichloroethene (TCE), and 2-butanone.

Originally, the focus of investigations at the site was a small area within the DRMO that formerly contained an underground storage tank (UST) identified as STC-868, which was a 550-gallon steel tank located between Building STC-867 (a soil storage facility) and an elevated wash rack. The tank was installed in 1983 and was used to store waste oil. This UST reportedly was removed in 1993.

The initial UST investigation at Site 89 detected chlorinated solvents in the groundwater. As chlorinated solvents are not normally associated with a petroleum UST site, their discovery in groundwater led to the inclusion of Site 89 into MCB, Camp Lejeune's IR Program. Subsequent studies have identified organic contaminants in surface water, sediment, and soil. As a result, Site 89 has expanded to include more than the former UST area. The area currently includes the entire DRMO and additional areas outside the DRMO fence, including the wooded areas to the south and the east, as shown on Figure 2.

3. Release or Threatened Release into the Environment of a Hazardous Substance, Pollutant, or Contaminant

High levels of chlorinated solvents have been detected in the soil and groundwater at the DRMO during recent site investigations. The soil contaminants provide a continuing source of contamination for release to groundwater, which subsequently discharges to Edwards Creek, resulting in surface water and sediment contamination.

There appear to be two distinct source areas of chlorinated solvent releases to soil and groundwater. One source area is located in the vicinity of monitoring well MW02 (located near the covered wash area). The specific location of this source area has not been identified to date. A second, and more significant source area, which is the focus of this TCRA, is located in the southern, unpaved area of the DRMO.

Table 1 presents the maximum contaminant concentrations detected in vadose zone soil at Site 89 and a comparison of this data to risk-based criteria, groundwater protection screening criteria, and regulatory standards. USEPA Region III Residential and Industrial Risk-Based Concentrations (RBCs) and USEPA Region IX Residential and Industrial Preliminary Remediation Goals (PRGs) are contaminant concentrations protective of human health according to the USEPA. Contaminants that have been detected in Site 89 soil in exceedance of EPA Region IX Industrial PRGs include 1,1,2,2-tetrachloroethane (PCA), tetrachloroethene (PCE), trichloroethene (TCE), and vinyl chloride (VC). For Site 89, the North Carolina Department of the Environment and Natural Resources (NC DENR) has approved a site-specific target cleanup goal of 1000 ppb (1 ppm) for 1,1,2,2-PCA. Figures 4, 5, and 6 present the distribution of these VOCs in vadose zone soil based on investigations and studies conducted to date.

The highest 1,1,2,2-PCA concentrations have been found in the southern portion of the DRMO. The highest 1,1,2,2-PCA found in vadose zone soil center on borings SB05 and SB69 (apparent source area), while the highest groundwater concentrations of 1,1,2,2-PCA center around temporary well TW102. Prior to the installation of temporary wells at Site 89, the highest groundwater concentrations of 1,1,2,2-PCA had been observed at monitoring well MW02, in the northern portion of the DRMO. The source of 1,1,2,2-PCA in MW02 is unknown at this time.

For TCE and PCE, the highest vadose zone soil concentrations also are found in the vicinity of SB05 and SB69. High concentrations of TCE and PCE in soil were also found SB33. The highest concentrations of VC were detected in SB04.

A layer of very fine sand with lesser amounts of silt and clay was observed at a depth of approximately 14 feet below ground surface (bgs) in the vicinity of SB69. Concentrations of 1,1,2,2-PCA were observed to decrease by one to two orders-of-magnitude in soil samples collected from this layer. This relatively fine-grained layer may act as a partial barrier to the downward migration of spilled product. This layer is likely an important factor in the fate and transport of 1,1,2,2-PCA and other VOCs in soil and groundwater.

4. National Priority List Status

MCB, Camp Lejeune was placed on the CERCLA National Priorities List (NPL) on October 4, 1989. Subsequent to this listing, the USEPA, Region IV; the North Carolina Department of Environment and Natural Resources (NC DENR); and the United States DoN entered into a Federal Facilities Agreement (FFA) for MCB, Camp Lejeune. The Fiscal Year 2000 Site Management Plan for MCB, Camp Lejeune (the primary document referenced in the FFA), identified Site 89 as an area requiring additional investigation of potential "hot spots".

5. Maps, Pictures, and Other Graphic Representations

Attachment A contains figures that depict the site location and the overall scope of the proposed removal action. These figures are referenced throughout the text.

B. Other Actions

1. Previous Investigations

Site investigations that have been completed to date at Site 89 include:

- Phase I and II Remedial Investigation (RI) - August 1996 and May 1997
- MCB, Camp Lejeune Long-Term Monitoring Program - April 1999
- Immediate Response Field Effort - June/July 1999
- Immediate Response Field Effort – October 1999
- Delineation of Soil Contamination Field Effort – December 1999
- Additional Delineation of Soil and Groundwater Field Effort – March 2000
- Pre-Construction Soil Delineation Field Effort – April 2000

The findings from these investigations are summarized in Section II D of this report.

2. Current Actions to Reduce Potential Exposures

In addition to implementation of the TCRA, LANTDIV and the Base Environmental Management Department (EMD) have taken or are currently taking other actions to minimize the possibility of potential exposures to contaminants released at the site. Each of these actions mitigates the potential for on-site industrial workers and recreational users of the area (hunters, family housing residents, and recreational users of Edwards Creek) to be exposed to the contaminated media associated with Site 89. The actions taken to reduce potential exposures include:

- Installed an aeration system in Edwards Creek immediately downstream of Site 89 to remove VOCs from surface water
- Constructed a chain-link fence to isolate impacted portions of Edwards Creek
- Prohibited hunting in Hunting Area 1A
- Blocked off road access to Edwards Creek
- Installed additional groundwater monitoring wells to determine if contaminants are migrating off-site

- Placed an HDPE liner and tarp over the unpaved areas of contaminated soil to prevent possible exposure to site workers
- Roped off and posted warning signs around the unpaved contaminated soil area in the DRMO to reduce potential exposure of industrial workers at the site
- Moved all DRMO equipment and operations from the southern portion of the DRMO impacted area
- Relocated (in-progress) DRMO operations to another site at Camp Lejeune

LANTDIV and the Base EMD also have issued notifications to the public and to appropriate regulatory agencies to make potentially affected parties aware of the situation at Site 89 and to ensure that all appropriate actions are implemented at Site 89. Notifications have included:

- Notified the public of potential risks to children posed by contaminated surface water in Edwards Creek by handing out flyers to residents in the nearby housing development, and through the media (local and Base newspapers).
- Notified the Base Facilities Department.
- Notified the Industrial Health Department to start testing/monitoring DRMO workers.
- Notified the Division of Marine Fisheries.
- Notified the State Toxicologist to determine if a fish advisory is warranted.
- Notified the Restoration Advisory Board (RAB).

3. Future Actions

Other than implementation of the TCRA, future actions proposed for Site 89 include the evaluation (via an EE/CA) and implementation of remedial action to address residual soil and groundwater contamination at Site 89. In addition, Site 89 will continue to be monitored under the Camp Lejuene LTM Program.

C. State and Local Authorities' Roles

The USEPA and NC DENR have been involved in planning and reviewing site investigation reports, TCRA design documents, and this Action Memorandum. Comments on this Action Memorandum have been received from the USEPA, NC DENR, and Marine Corps Base, Camp Lejeune. These comments, and responses to the comments, are provided as Attachment B. Involvement by all parties in the planning process will continue throughout the TCRA implementation period through meetings and correspondence. Response to public notice is anticipated throughout the Site 89 TCRA implementation period.

D. Quantities and Types of Substances Present

Several investigations have been completed to date at Site 89 and have confirmed the presence of VOCs in soil, groundwater, surface water, and sediment. Based on these investigations, it is apparent that the DRMO Area of Site 89 exhibits the highest concentrations of VOCs in the affected media. A summary description of the results from previous site investigations of Site 89 follows.

Figure 3 illustrates the sample locations utilized during the various investigations. Maps summarizing VOCs in soil (vadose zone) and groundwater from previous site investigations are provided in Figures 6 and 7, respectively.

Phase I and II RI - August 1996 and May 1997

The RI was conducted in two phases; Phase I in August 1996 and Phase II in May 1997. Soil, groundwater, surface water, and sediment samples were collected and analyzed for VOCs, semi-volatile organic compounds (SVOCs), metals, and pesticides/polychlorinated biphenyls (PCBs). Findings of the Phase I and II investigations are summarized below.

The VOCs detected in soil samples included 1,1,2,2-PCA, 1, 2-DCE, 2-butanone, acetone, benzene, carbon disulfide, PCE, toluene, and TCE. None of the VOCs exceeded the Region III RBCs for soil; however, several detections of TCE exceeded the screening criteria for transfer of soil contaminants to groundwater (SSLs). The majority of detections were present in samples collected from monitoring well clusters IR89-MW01 and IR89-MW03 located within the DRMO area.

The groundwater investigation portion of the RI at Site 89 included the collection of samples from the surficial (also referred to as the shallow aquifer) and the upper portion of the Castle Hayne aquifer (referred to as the deep aquifer). Six VOCs were detected in the groundwater samples collected from monitoring wells at Site 89, including 1,1,2,2-PCA, cis-1, 2-DCE, trans-1, 2-DCE, PCE, TCE, and VC. The majority of the detections were from shallow monitoring wells within the DRMO near the existing wash racks.

A total of ten surface water samples were collected during the RI from Edwards Creek. Volatile organic compounds detected in the surface water samples included 1,1,2,2-PCA, methylene chloride, chloroform, cis-1, 2-DCE, trans-1, 2-DCE, PCE, TCE, and VC. The sample locations with the highest detections were IR89-SW02 and IR89-SW04. These stations are located south and hydraulically downgradient of the DRMO area. Four of the compounds, including 1,1,2,2-PCA, PCE, TCE, and VC, were detected at concentrations exceeding Federal Ambient Water Quality Criteria (AWQCs) standards.

Ten sediment samples were collected from five locations in Edwards Creek during the Phase II RI. The samples were collected with a sediment corer at depths of zero to six inches and six to twelve inches below the creek bed. The majority of the detections occurred in the zero to six-inch sample depth. Nine VOCs were detected in the samples, including: 1,1,2,2-PCA, 1, 1, 2-TCA, 1,1-DCE, 1,2-DCE (total), cis-1, 2-DCE, trans-1, 2-DCE, toluene, TCE, and VC. There are no sediment screening levels applicable in USEPA Region IV.

Monitoring Program - April 1999:

Groundwater samples at Site 89 are collected on a semi-annual basis as part of the base-wide long-term groundwater monitoring (LTM) program at Camp Lejeune. The monitoring program at Site 89 is intended to detect changes in groundwater contaminant concentrations and monitor contaminant migration. In addition, the program provides data used in evaluating natural attenuation processes.

The first round of sampling for Site 89 under the monitoring program was performed in April 1999. Nine groundwater and four surface water samples were obtained during the first round of LTM at Site 89 in April 1999. Each of the samples was analyzed for VOCs.

Of the nine groundwater samples collected at Site 89, five were from within or near the DRMO area (IR89-MW02, IR89-MW03, IR89-MW03IW, IR89-MW04, and IR89-MW04IW). Ten VOCs were detected from these monitoring wells, including VC, acetone, methylene chloride, 2-butanone, TCE, cis-1, 2-DCE, trans-1,2-DCE, PCE, 1,1,2,2-PCA, and 1, 1, 2-TCA. The compounds methylene chloride and 2-butanone were detected, but were considered laboratory artifacts and not site contaminants. Nearly all of the detected contaminants exceeded Federal Maximum Contaminant Levels (MCLs) and/or North Carolina Water Quality Standards (NCWQS) for groundwater. A detection of 1, 1, 2, 2-PCA at 30,000 ug/L was identified during the April 1999 monitoring effort in the sample obtained from monitoring well IR89-MW02. If the ingestion pathway were evaluated under a drinking water scenario, the detected concentration of PCA would pose cancer risks above the USEPA acceptable risk range of 1.0×10^{-6} to 1.0×10^{-4}; however, the surficial aquifer is not used as a drinking water source.

Eight VOCs were detected in the four surface water samples collected from Edwards Creek as part of the April 1999 monitoring program. These include VC, acetone, methylene chloride, TCE, cis-1, 2-DCE, trans-1, 2-DCE, 1,1,2,2-PCA, and 1, 1, 2-TCA. Of these contaminants for which there are Federal or State water quality standards, all detections except for one exceeded Federal Ambient Water Quality Standards. The detections for 1, 1, 2, 2-PCA in samples IR89-SW04 and IR89-SW11 also exceeded the applicable North Carolina Water Quality Standards (NCWQS) for surface water.

Immediate Response Field Effort - June/July 1999:

The detection of 1,1,2,2-PCA at 30,000 ug/L in the groundwater sample from shallow monitoring well IR89-MW02 (April 1999 data) initiated discussions regarding the significance of the detection, the potential impact to Edwards Creek, and the potential for a continuing source of VOCs to be present at the site. As a result of these discussions, an immediate response investigation was completed in June/July 1999 to further define the nature and extent of contamination at Site 89. Activities included the installation of permanent monitoring wells and associated groundwater sampling, the collection of soil samples, and the collection of surface water samples. The investigation also including the following activities:

- A groundwater sample was obtained from existing monitoring well IR89-MW02 to verify 1,1,2,2-PCA concentrations within the shallow aquifer.

- Monitoring well IR89-MW08 was installed approximately 200 feet southeast of existing monitoring well IR89-MW02 to assess whether 1,1,2,2-PCA had migrated in the shallow aquifer toward the existing drainage ditch which discharges to Edwards Creek.

- A monitoring well cluster, including one shallow and one intermediate well, was installed directly adjacent to Edwards Creek. The cluster was positioned immediately upstream of the railroad crossing (White Street Extension) to determine if 1,1,2,2-PCA had migrated to Edwards Creek in the shallow or intermediate aquifer.

- Soil samples were collected during the installation of the shallow monitoring wells. The samples were obtained at depths of 1 to 3 feet bgs and at 3 to 5 ft bgs.

- Surface water samples were obtained from three locations in Edwards Creek: one sample each from upstream and downstream of the railroad crossing (White Street Extension) and one sample approximately 250 feet downstream of the crossing.

During the installation of monitoring wells IR89-MW08 and IR89-MW09, soil samples were collected from the 1-3 foot and 3-5 foot depths. Contaminants that were detected included acetone, trans-1,2-DCE, cis-1, 2-DCE, TCE, 1,1,2-TCE, PCE, 1,1,2,2-PCA, and xylenes (total). The 1-3 foot soil sample collected from IR89-MW09 had the highest concentration of 1,1,2,2-PCA at 29,000 ug/kg. The concentration of 1,1,2,2-PCA in the 3-5 foot sample was 27,000 ug/kg. This sample also contained the highest concentration of TCE at 2,000 ug/kg. The concentrations for each contaminant were compared to the USEPA Region III risk-based concentrations (RBCs) for residential and industrial scenarios, and for the transfer of contaminants from soil to groundwater. Concentrations of 1,1,2-TCA, PCE, and 1,1,2,2-PCA and vinyl chloride exceeded either industrial and/or residential RBCs. All of the detected concentrations of 1,1,2-TCA, PCE, 1,1,2,2-PCA, and TCE were found to exceed the screening level for transfer from soil to groundwater.

Groundwater samples were collected at Site 89 from monitoring wells IR89-MW02, IR89-MW09, and IR89-MW09IW, and VOCs were detected in each of the samples. Nine VOCs were detected, including VC, acetone, cis-1, 2-DCE, trans-1, 2-DCE, 1,1,2-TCA, 1,1,2,2-PCA, TCE, benzene, and PCE. Although many of the compounds were detected at low concentrations, TCE concentrations exceeded the Federal MCL and the NCWQS at every well. The highest concentration of TCE

(59,000 ug/L) was from IR89-MW09. This monitoring well is located at the extreme southern point of the site adjacent to Edwards Creek. In addition, 1,1,2,2-PCA was detected at 89-MW02 at concentrations of 46,000 ug/L and 47,000 ug/L for the sample and duplicate sample, respectively. Overall, one or more detections of the following contaminants exceeded NCWQS, interim NCWQS (NCAC 2L), and/or Federal MCLs: VC, cis-1,2-DCE, trans-1,2-DCE, 1,1,2-TCA, 1,1,2,2-PCA, TCE and PCE.

Three surface water samples were collected from Edwards Creek as part of the immediate response field effort. VOCs were again detected, which is consistent with previous sampling efforts in the creek. Eleven VOCs were detected, including VC, acetone, 1, 1-DCE, cis-1, 2-DCE, trans-1, 2-DCE, 1, 1, 2, 2-PCA, TCE, 1, 1, 2-TCA, benzene, toluene, and chlorobenzene. Of the contaminants that have a State or Federal standards, all exceeded Federal AWQS except for the detections of toluene and chlorobenzene. Detections of 1, 1, 2, 2-PCA and TCE also exceeded the NCWQS.

Immediate Response Field Effort – October 1999:

An additional investigation was conducted in October 1999 to further delineate potential source soils, further characterize groundwater, and characterize surface water and sediment. The following provides a brief summary of investigation results for each media.

Soil

Soil samples were collected from 40 borings located inside and outside the DRMO. Samples were collected at various depths from the surface to the water table. Soil samples collected from the sample depth (e.g.; 1 to 3 feet or 3 to 5 feet) were selected for laboratory analysis based on PID readings and visual observations. The soil in each interval with the highest PID reading and/or any visual indications of contamination was selected for sampling.

Sixteen VOCs were detected in surface and subsurface soils. The summary of maximum detections of VOCs is presented in Table 1 along with USEPA Region III RBCs. Detections of 1,1,2,2-PCA, PCE, TCE, and VC exceeded the applicable residential and/or industrial RBCs. All the October 1999 maximum detections in soils were greater than the June/July detections. Figures 6 and 7 shows the analytical results of the June/July and October 1999 field efforts for surface and subsurface soil.

The maximum 1,1,2,2-PCA concentration was 18,000,000 μg/kg in SB05. The maximum concentrations of PCE, TCE, and vinyl chloride were 31,000 μg/kg, 210,000 μg/kg, and 5,900 μg/kg, respectively.

Groundwater

Six new monitoring wells were installed during the October investigation. Four of the wells were installed screening the uppermost portion of the surficial aquifer. Wells 89-MW10, 89-MW11, 89-MW12, and 89-MW13 extend 15 feet bgs, with a 10-foot screen length. The wells were constructed using 2-inch diameter, schedule 40 polyvinyl chloride (PVC) riser and screen (0.01-inch slots).

Two intermediate wells ("IW" wells) were installed, screening the upper portion of the Castle Hayne aquifer immediately above the semi-confining unit. Well 89-MW11IW was nested with 89-MW-11 and extends to 39 feet bgs (screening interval of 34 to 39 feet bgs). Well 89-MW-02IW was nested with 89-MW02 and extends to 40 feet bgs (screening interval of 35 to 40 feet bgs).

Groundwater samples were collected from 16 monitoring wells. Nine VOCs were detected in groundwater. These include 1,1,2,2-PCA, 2-butanone, acetone, chloromethane, cis/trans-1,2-DCE, TCE, VC, PCE, and 1,1-DCE. The maximum 1,1,2,2-PCA concentration was 26,000 μg/L detected in 89-GW02. The maximum VC concentration was 740 μg/L detected in 89-GW13.

Surface Water

Surface water samples were collected from eleven locations. Five VOCs were detected in surface water including 1,1,2,2-PCA, TCE, VC, cis/trans-1,2-DCE, and acetone. The maximum concentrations of 1,1,2,2-PCA and VC were 2,500 μg/L and 100 μg/L, respectively. Both of these maximum detections were at sample location 89-DSW14.

Sediments

Sediment samples were collected from ten locations. Five VOCs were detected in sediment including 1,1,2,2-PCA, 2-butanone, acetone, TCE, and cis/trans-1,2-DCE. The maximum 1,1,2,2-PCA concentration was 4,000 mg/kg detected at sample location 89-DSD14.

Delineation of Soil Contamination - December 1999:

This effort was designed to further delineate the extent of soil contamination and identify additional contamination hot spots. Samples were collected from 29 borings located inside and outside the DRMO. Soil samples were collected at various depths (0.5 to 1.0 feet; 1 to 3 feet; and 3 to 5 feet) from the ground surface to the water table. Groundwater was observed to be generally shallower in December than in October, at approximately 3 feet bgs versus 5 bgs feet in December. Thus, fewer 3-5 foot intervals were collected in December than in October.

For this sampling event, a mobile laboratory was used to analyze soil samples for selected VOCs. Ten percent of the samples collected for the mobile laboratory were split and sent to a fixed-base laboratory for confirmation purposes. Additional samples were collected and analyzed by the fixed-base laboratory and were analyzed for semi-volatile organic compounds (SVOCs), metals, and polychlorinated biphenyls (PCBs). Other soil samples were analyzed for total organic carbon (TOC). Lastly, selected soil samples were analyzed for Synthetic Precipitation Leaching Procedure (SPLP) VOCs.

Nine VOCs were detected in the mobile laboratory samples including TCE, 1,2-DCE, vinyl chloride, 1,1,2,2-PCA, TCE, benzene, toluene, and xylenes. Three VOCs were detected in the samples that were sent to the fixed-base laboratory. These were 1,1,2,2-PCA, 1,1,2-TCA, and TCE. No SVOCs were detected. TAL list inorganics were detected, but at relatively low levels. Only arsenic was detected above the residential RBC. TOC concentrations ranged from non-detected (<500 mg/kg) to 5,000 mg/kg.

The mobile laboratory was successful in determining the horizontal limits of contamination. The fixed-based laboratory generally confirmed non-detects and trace concentrations of contaminants. The mobile laboratory was not very successful, however, in identifying additional 1,1,2,2-PCA hot spots. The mobile laboratory generally detected tetrachloroethene (PCE) and TCE where the fixed base laboratory detected 1,1,2,2-PCA.

Additional Delineation of Soil and Groundwater Contamination - March 2000:

Soil samples were collected from six borings placed in and around the proposed TCRA excavation area. Samples were collected at one-foot intervals from the surface to a depth of 10 feet below ground surface. Soil samples collected from the sample depth interval were selected for laboratory analysis based on PID readings and visual observations. The soil in each interval with the highest PID reading, and/or any visual indications of contamination was selected for sampling.

Similar VOCs were detected in subsurface soils in March 2000 as these found in the October and December investigations. The maximum 1,1,2,2-PCA concentration was 87,000,000 ug/kg in SB69 (located at SB05). The maximum concentrations of PCE, TCE, and vinyl chloride were 150,000 ug/kg, 3,000,000 ug/kg, and 280 ug/kg, respectively.

A total of four permanent monitoring wells (two shallow and two intermediate) were installed south of Edwards Creek and Site 89. Three shallow temporary monitoring wells were installed inside the DRMO within and in the vicinity of the proposed excavation area. The maximum detected 1,1,2,2-PCA concentration was 1,800,000 ug/L located at 89-TW102. The maximum concentrations of TCE and VC were 360,000 ug/L and 1,200 ug/L, respectively (both at 89-TW-103). PCE was not detected in groundwater. No VOCs were detected in the wells located on the southern side of Edwards Creek.

Pre-Construction Soil Delineation– April 2000:

On April 6, 2000 additional subsurface soil samples were collected between 10 and 17-feet below ground surface (bgs) at the approximate location of boring SB69. The purpose of this sampling effort was to provide the Remedial Action Contractor (RAC) with additional information to plan a maximum excavation depth. Soil samples collected from the sample depth interval were selected for laboratory analysis based on PID readings and visual observations. The soil in each interval with the highest PID reading, and/or soil exhibiting visual indications of contamination were selected for sampling.

Similar VOCs were detected in subsurface soils in April as in the October, December, and March investigations. The maximum 1,1,2,2-PCA concentration was 1,800,000 µg/kg. The maximum concentration of TCE was 360,000 µg/kg. PCE and VC were not detected.

III. THREATS TO PUBLIC HEALTH OR WELFARE OR THE ENVIRONMENT, AND STATUTORY AND REGULATORY AUTHORITIES

Section 300.415 of the NCP lists the factors to be considered in determining the appropriateness of a time-critical removal action. Paragraphs (b)(2) - (i), (ii), (iv), and (v) of Section 300.415, listed below, apply to the conditions at Site 89:

300.415(b)(2)(i)	"Actual or potential exposure to nearby human populations, animals, or food chain from hazardous substances or pollutants or contaminants."
300.415(b)(2)(ii)	"Actual or potential contamination of drinking water supplies or sensitive ecosystems."
300.415(b)(2)(iv)	"High levels of hazardous substances or pollutants or contaminants in soils largely at or near the surface that may migrate."
300.415(b)(2)(v)	"Weather conditions that may cause hazardous substances or pollutants or contaminants to migrate or be released."

This section details the potential threats to public health and welfare primarily as they relate to criteria in sections 300.415(b)(2)(i) and (iv) of the NCP, specifically high levels of hazardous substances in soils that may migrate and human populations that may potentially be exposed to the contaminants.

The criteria used to evaluate Site 89 against these factors include field and laboratory data collected over the course of the investigations at the Site. These data were compiled to form a conceptual model of the site, providing a "snap shot" of site conditions. The site conditions were modeled to estimate risks to human health and the environment associated with site conditions.

Elevated concentrations of chlorinated solvents (specifically, 1,1,2,2-PCA, TCE, and VC) were detected in soils. As shown in Table 1, the contaminant concentrations in soil exceeded applicable standards or criteria. Section II of this Action Memorandum describes the nature and extent of contamination. It is known that these contaminants have migrated to Edwards Creek, which is located southwest of the site. Therefore, exposure to a child trespasser via accidental ingestion and dermal

contact of surface water and sediment while playing in and around the creek was evaluated. It is also reasonable to expect that exposure could occur to a current industrial worker and/or future construction worker during excavation activities via accidental ingestion, dermal contact, and/or inhalation of fugitive dusts.

In order to evaluate the potential human health effects associated with contamination at Site 89, a risk screening approach was employed. Risk screening is common at many CERCLA sites where limited data are available and quick decisions concerning potential remediation are required. The risk screening process is not intended to be a substitute for the comprehensive, baseline risk assessment process, but is intended to provide a screening tool to direct risk management decisions. Using this screening technique, estimates of potential risk associated with point exposures to contaminants can be quickly and accurately calculated for decision-making purposes.

Risk screening was conducted by developing site-specific "acceptable concentrations" in environmental media similar to USEPA Region III RBCs. These acceptable concentrations are the maximum concentrations in a particular medium at which either no carcinogenic risks or noncarcinogenic adverse health effects would occur. Acceptable concentrations were developed for the contaminants 1,1,2,2-PCA, TCE, and VC for soil and 1,1,2,2-PCA and TCE for surface water/sediment. The soil concentrations considered ingestion, dermal contact, and/or inhalation exposure pathways for the current industrial worker and future construction worker receptors. The surface water/sediment concentrations considered ingestion and dermal contact exposure pathways for the child trespasser receptors. Site-specific exposure factors used in the development of acceptable concentrations were obtained from the Site 89 Final RI Report (Baker, 1998). For carcinogens, the lower end of USEPA's generally acceptable risk range (1×10^{-6}) was used to derive acceptable concentrations. A hazard index of 1.0 was used to develop acceptable concentration values for noncarcinogens.

Risk screening was accomplished by dividing the concentration of a given contaminant in an environmental medium by its associated acceptable concentration. To present a worst case scenario, only the locations of the maximum detected concentrations of 1,1,2,2-PCA, TCE, and vinyl chloride in subsurface soil were evaluated. Surface water/sediment sampling stations along Edwards Creek near the site and at points downstream were evaluated. For example, at location 89-SB33 (three to five feet bgs), the detected concentration of 1,1,2,2-PCA in soil was 2,000 mg/kg and the associated

acceptable concentration was calculated as 16 mg/kg (as a carcinogen), the corresponding risk value at the exposure point would be:

$$\frac{2{,}000 \text{ mg/kg}}{16 \text{ mg/kg}} = 125$$

Because the acceptable concentration value was calculated for a target risk of 1×10^{-6}, the corresponding incremental lifetime cancer risk is 1.25×10^{-4}.

For the evaluation of noncarcinogenic health effects, the acceptable concentration for 1,1,2,2-PCA (as a noncarcinogen) was calculated as 11,099 mg/kg. As previously mentioned, the detected concentration of 1,1,2,2-PCA at location SB33 (three to five feet bgs) was 2000 mg/kg. The corresponding risk value at the exposure point would be:

$$\frac{2{,}000 \text{ mg/kg}}{11{,}099 \text{ mg/kg}} = 0.35$$

The target hazard index value used in deriving the acceptable concentration was 1.0. Therefore, the noncarcinogenic hazard screening value of 0.35 calculated for SB33 (three to five feet bgs) did not exceed the target index of 1.0.

Risk screening values were calculated for the current industrial worker and future construction worker for Site 89 soil boring locations in the most contaminated area of the site (SB04, SB05, and SB33). The carcinogenic risk screening values that were calculated for these locations, primarily subsurface, exceeded the target risk of 1×10^{-6}. The noncarcinogenic hazard screening value that was calculated for SB05 (three to five feet bgs) exceeded the target index of 1.0.

Risk screening values were calculated for the child trespasser scenario for surface water/sediment sampling stations along Edwards Creek near the site and at points downstream. The carcinogenic risk screening values that were calculated for these locations, primarily near the site, exceeded the target risk of 1×10^{-6}. It is important to note that these risk screening calculations predict potential risks to particular receptors *in the event of no remedial/response action.* Detailed risk calculations can be found in Attachment C.

At this time, Site 89 does not appear to be adversely affecting off-site populations of humans or animals. Contaminated soil has not been detected off-site. The impacted soil area is located within the secure confines of a DRMO lot with limited access by visitors. Areas of known soil contamination are also located beneath asphalt pavement and secured tarpaulins. Construction or other activities that may disturb the soil or groundwater have been halted and are not permitted at the site. Contaminants have only been detected in surface water and sediment in Edwards Creek only in the vicinity of the site and have not migrated downstream. A fence has been erected in the near term to isolate affected portions of Edwards Creek from trespassers. Hunting and fishing have been prohibited within the affected area. None of the contaminants are believed to be migrating off of the Base property.

The known extent of groundwater contamination is not within an aquifer used for drinking water supply and no known irrigation wells exist within the area of groundwater contamination. The deep aquifer does not appear to be impacted by the site contaminants. Also, the deep wells used for potable water at MCB, Camp Lejeune are not located in the immediate vicinity of Site 89.

Based on the preliminary risk screening summarized above, a time critical removal action is required to address potential human health risk and minimize migration of contaminants from site soils. Removal of the soils as well as subsequent clean up of residual soil contamination and groundwater assures that the site will not adversely impact the environment or Base personnel.

IV. ENDANGERMENT DETERMINATION

Based upon the concentrations, the frequency of detection, and the risk characterization results, the surface soil warrants further actions to mitigate or abate potential adverse impacts to human health and the environment. Actual and potential future releases of hazardous substances from this site, if not addressed by implementing the proposed remedial actions discussed in this Action Memorandum, may endanger public health, welfare, and the environment.

V. PROPOSED ACTIONS AND ESTIMATED COSTS

A. Proposed Actions

1. Proposed Action Description

Several concurrent actions are planned as part of the Site 89 TCRA. These include:

1. Removal of VOC-contaminated soil from the source area and treatment of the soil by Low Temperature Thermal Desorption (LTTD)
2. Implementation of an aeration system in Edwards Creek just downstream of Site 89 to remove VOCs from surface water
3. Extension of the fence to enclose the portions of Edwards Creek adjacent to Site 89 that have been most impacted by contaminant migration from the site (completed June 2000)

The primary component of the proposed Site 89 TCRA is the removal of the VOC-contaminated soil source area and treatment by LTTD. This action consists of: removal of soil contaminated with VOCs at concentrations greater than the target cleanup levels; on-site treatment of the soil by LTTD to proposed treatment standards; and replacement of the treated soils back into the excavation on site. LTTD was selected as the most appropriate remedial technology for this site because it is a proven technology and is a presumptive remedy for VOC-contaminated soils (USEPA, 1993).

Contaminated soils within the DRMO area are a source of groundwater contamination at Site 89. The groundwater, in turn, is a source of surface water and sediment contamination in Edwards Creek. PCE, TCE, 1,1,2,2-PCA and VC have been identified as the main soil contaminants of concern (COCs) at the site because they exceed risk-based screening criteria or trigger potential risk. Table 1 presents a comparison of VOCs detected in Site 89 vadose zone soils to various standards and risk-based criteria including North Carolina Soil Screening Levels (SSLs), Federal Land Disposal Restrictions (LDRs), EPA Region III Residential and Industrial Risk-Based Concentrations (RBCs), and EPA Region IX Residential and Industrial Preliminary Remediation Goals (PRGs).

A number of issues were considered and evaluated in order to establish reasonable and achievable remediation goals and treatment standards for Site 89. These included: the goals of the TCRA in the context of the long-term site remediation plan; the overall environmental concerns at Site 89; regulatory issues (ARARs); land use considerations; and, the limitations of the LTTD technology. Ultimately, the NCDENR established a site-specific remediation goal for Site 89 of 1000 ppb (1 ppm) for 1,1,2,2-PCA.

The estimated limits of excavation and approximate locations of staging and treatment areas are presented on Figure 8. The estimated volume of contaminated vadose zone soil that contains VOCs at concentrations higher than the remediation goal is approximately 10,000 cubic yards (15,000 tons) of soil. The contaminated soil will be excavated and staged prior to treatment in the on-site LTTD unit. It is assumed that the excavation will be approximately five to seven feet below ground surface, depending on site conditions and groundwater elevation. Confirmation sampling within the excavation will be performed to ensure that vadose zone soils that exceed the remediation goal have been removed.

The groundwater elevation varies seasonally, but generally ranges between three and five feet below ground surface. It is anticipated that excavation will stop when the groundwater table is encountered. However, if required to facilitate removal of impacted soil, groundwater may be pumped from the excavation area. Options for management of contaminated water include: on-site pretreatment and discharge to the base sanitary sewer; on-site pretreatment and haul to the on-base (Lot 203) treatment system; or, haul directly to the Lot 203 treatment system. On-site pretreatment of contaminated water may include settling (to remove settleable solids), air stripping (to remove VOCs), and, possibly carbon adsorption (polishing).

Ideally, the soil should be dewatered to approximately 20% moisture content or less in order to be efficiently treated in the LTTD unit. If it is necessary to dewater the soil prior to treatment, the excavated soil will be placed on an impervious surface for gravity dewatering. The soil then will be loaded into the on-site LTTD unit to be treated to established treatment standards. Following confirmation sampling of treated soil to ensure that established treatment standards are met, the treated soil will be backfilled into the on-site excavation. If treated soil does not meet treatment standards, the soil will be re-processed through the LTTD unit until treatment standards are met. As a contingency plan, if soil cannot be treated to treatment standards using LTTD, it may be disposed in the Base landfill (Land Disposal Restrictions must be met for landfill disposal).

An additional component of the TCRA will be the installation of an aeration system within the ponded area of Edwards Creek just downstream of Site 89. The aeration system will consist of "floating cage" aerators that will produce an 8-foot high fountain to strip the VOCs from surface water. A debris screen will be installed upstream of the aeration pond. Fencing will be installed around the pond to discourage trespassers. In addition, the fence along the southern edge of the DRMO area has been extended across Edwards Creek to enclose the most contaminated zone of the creek. The proposed location of the aeration pond and the fence extension are presented on Figure 8.

ARARs and substantive requirements of applicable permits will be implemented prior to the start of this time critical removal action. A budgetary cost estimate for the time critical removal action is presented in Attachment D.

2. Contribution to Remedial Performance

This TCRA includes the removal of VOC-contaminated soils with contaminant concentrations exceeding the established clean-up goal of 1 ppm for 1,1,2,2-PCA. The removal action will be protective of human health for future industrial users of the site by eliminating the direct-contact risk presented by the soils. This removal action will also eliminate a significant source of groundwater, surface water, and sediment contamination, thereby reducing the possibility of future significant contaminant releases from the site.

Other components of the TCRA that are being implemented concurrently with the soil removal action are also protective of human health. These actions include installation of an aeration system in Edwards Creek just downstream of Site 89 to remove VOCs from surface water and extension of the fence to enclose the portions of Edwards Creek adjacent to Site 89 that have been most impacted by contaminant migration from the site.

Long-Term Clean-Up Plan

It is recognized that additional remedial actions ultimately will be required at Site 89 to address residual soil and groundwater contamination that will remain following implementation of this TCRA. This TCRA will not address contamination that is within the saturated zone at the source area at significant depths. Although a primary source of groundwater contamination will be removed through

this TCRA, the shallow aquifer has already been impacted and is contributing to surface water and sediment contamination in Edwards Creek. Therefore, the contaminated groundwater must also be remediated to mitigate the continued release of contaminants to the creek.

An Engineering Evaluation and Cost Analysis (EE/CA) is planned this year to evaluate possible remedial options to address these remaining concerns. However, this TCRA will address immediate concerns and will be a significant step in the direction of protection of public health and the environment.

Immediate Threats To Be Addressed

The immediate threat to public health that is being addressed by this time critical removal action is elimination of the potential direct-contact risk to site industrial workers. The threat of exposure to surface water in Edwards Creek also will be immediately addressed by the installation of an aeration system to reduce VOC contaminant concentrations in the creek. In addition, the installation of fencing to restrict access to the portion of Edwards Creek that is most impacted by releases from Site 89 immediately addresses the threat of exposure to surface water and sediment in Edwards Creek. The immediate threat to the environment that is being addressed by this time critical removal action is elimination of the potential cross-media contamination (contaminant migration from soil to groundwater, surface water, and sediment).

Extent of Remediation Accomplished With the Time Critical Removal Action:

This TCRA will significantly reduce direct contact exposures by removal of the contaminated surface and near-surface soils. Residual contamination in soils will be at concentrations less than Region IX Industrial PRGs, which are protective of the most likely users of the site, industrial workers. Further, the proposed aeration system in Edwards Creek will reduce the potential threat to human health (trespassing child) in portions of Edwards Creek downstream of Site 89. This removal action also includes fencing to restrict access to the portion of Edwards Creek that is most highly contaminated, which will prevent exposure to contaminated surface water and sediment.

Consistency with Long-Term Remedy:

As previously discussed, it is recognized that additional remedial actions ultimately will be required at Site 89 to address residual soil and groundwater contamination that will remain following implementation of this TCRA. Nonetheless, implementation of this TCRA is consistent with future long-term remedies for the soil, groundwater, and surface water or sediment contamination at the site. The implementation of this removal action will reduce the cost of the long-term cleanup plan by removing a significant source area and will minimize the potential for contaminants in soil to migrate to groundwater, surface water and sediment.

3. Description of Alternative Technologies

Two alternatives to on-site treatment of soils by LTTD (off-site incineration and off-site treatment and disposal) were considered for this TCRA. These two alternative technologies are described below.

Off-Site Incineration:

Incineration is a presumptive remedy for VOC contaminated soils (USEPA, 1993) and was considered as a possible alternative to on-site LTTD. Incineration is a proven technology and is an effective means of destroying organic contaminants. For this alternative, soils with contaminant concentrations greater than the proposed soil clean-up goals would be excavated and transported to a permitted, off-site incineration facility. Soils would be incinerated and the smaller quantity of ash disposed in a landfill (disposal is included in the cost of incineration). The site would then be restored to its original condition.

This alternative would require less time to complete than on-site LTTD because excavated soil would be taken off site and no soil treatment would be performed at the site. This alternative would be timely and would be as protective of human health and the environment at the site as the LTTD alternative. However, incineration would be the most costly alternative to implement. A budgetary cost estimate for the off-site incineration alternative is provided in Attachment D.

Off-Site Treatment and Disposal:

For this alternative, soils with contaminant concentrations greater than the proposed clean-up goals would be excavated, dewatered, and transported to an approved off-site Subtitle C landfill facility. Transportation could be accomplished via truck or rail. Contaminated soil must meet land ban restriction (LDR) concentrations prior to land disposal. Therefore, the soil would be treated at the disposal facility in order to meet the LDRs and then would be disposed of in the Subtitle C landfill. Off-site landfill disposal with pretreatment is an easily-implemented technology and is an effective means of managing contaminated soil from the site. This alternative would be as protective of human health and the environment as the other alternatives.

The off-site disposal alternative would require less time to complete that on-site LTTD because excavated soil would be taken off site and no soil treatment would be performed at the site. This alternative would be timely and would be as protective of human health and the environment at the site as the LTTD alternative. However, off-site disposal alternative is more costly to implement than on-site LTTD treatment. A budgetary cost estimate for the off-site incineration alternative is provided in Attachment D.

4. Applicable or Relevant and Appropriate Requirements

The 1990 NCP requires that removal actions attain applicable or relevant and appropriate federal and state requirements (ARARs) with limited exception, to the extent practicable. Four factors are applied to determine whether the attainment of ARARs is practicable in a particular removal situation: (1) the exigencies of the situation; (2) the scope of the removal action to be taken; (3) the effect of ARAR attainment on the statutory limits for removal action duration and cost; and (4) the criteria listed under SARA Section 121(d) providing conditions under which ARARs may be waived. The criteria listed under SARA Section 121(d)(4) for which ARARs may be waived include the following:

- Interim remedy waiver
- Greater risk to health and the environment
- Technical impracticability
- Inconsistent application of State requirements

The removal action set forth in this memorandum will comply with all applicable, relevant, and appropriate environmental and health requirements, to the extent practicable considering the exigencies of the situation.

ARARs are divided into three categories: chemical-specific, location-specific, and action-specific. Chemical-specific ARARs are particular to individual contaminants. Location-specific ARARs depend upon the location of the contamination and potential restrictions on activities conducted in these areas (i.e., wetlands, floodplains, etc.). Action-specific ARARs govern the remedial action and are usually technology- or Base-specific directions or limitations that control actions taken at CERCLA sites. In addition to ARARs, USEPA may, as appropriate, identify other Federal or State advisories, criteria, or guidance to be considered for specific releases.

The following ARARs may be applicable to the removal action at Site 89 and will be considered:

- Chemical-specific ARARs:
  - Resource Conservation and Recovery Act
  - Federal Ambient Water Quality Criteria
  - National Ambient Air Quality Standards
  - North Carolina Air Pollution Regulations
  - Land Disposal Restrictions Universal Treatment Standards
  - USEPA Region III Risk-Based Concentrations
  - USEPA Region IX Preliminary Remediation Goals
  - North Carolina Soil Screening Levels for Groundwater Protection
  - North Carolina Groundwater Standards
  - North Carolina Water Quality Standards
  - North Carolina Surface Water Effluent Limitations
  - North Carolina Hazardous Waste Rules

- Location-specific ARARs:
  - Fish and Wildlife Coordination Act
  - Federal Endangered Species Act
  - Coastal Zone Management Act

- Executive Order 11990 on Protection of Wetlands
- Clean Water Act, Section 404 (Wetlands)
- North Carolina Hazardous Waste Management Rules
- North Carolina Solid Waste Management Rules

- Action-specific ARARs:
  - Occupational Safety and Health Administration
  - Department of Transportation Rules for Hazardous Materials Transport
  - North Carolina Sedimentation Pollution Control Act of 1973
  - North Carolina Groundwater Corrective Action
  - North Carolina Well Construction Standards
  - North Carolina Injection Well Construction Standards
  - North Carolina Water Quality Discharge Requirements
  - North Carolina Sediment Control Rules

5. Project Schedule

Completion of the removal action is anticipated within 9 months of the approved and signed Action Memorandum. The construction efforts associated with the removal action for Site 89 will begin following the completion and acceptance of this Action Memorandum. The anticipated schedule will follow the general outline below:

- Creek Aeration Design – April 2000
- Creek Aeration Construction – May/June 2000
- Fence Extension Construction – May/June 2000
- LTTD Draft Remedial Design – March 22, 2000 (completed)
- LTTD Final Remedial Design – May/June 2000
- LTTD Remediation Work Plan – May/June 2000
- LTTD Mobilization – May 2000 (completed)
- LTTD Implementation – 6-8 months (estimated to be completed by November 2000)
- LTTD Demobilization - 1 month (estimated to be completed by December 2000)

B. Estimated Costs

The estimated capital costs for the proposed action and other alternatives are listed below. Cost estimate spreadsheets for each alternative are presented in Attachment D. There are no operation and maintenance costs associated with any of these alternatives.

- On-Site LTTD Treatment - $2,075,000
- Off-Site Incineration - $10,138,000
- Off-Site Treatment and Landfill Disposal - $3,190,000

VI. EXPECTED CHANGE IN THE SITUATION SHOULD ACTION BE DELAYED OR NOT TAKEN

If no action is taken or the action is significantly delayed, the potential direct exposure threat will continue to be temporarily abated by site controls (fencing and access restrictions) and the temporary cover that are in place at the site. However, no action will be taken to permanently abate the potential direct exposure threat. In addition, the threat of cross-media contamination (contaminant migration from soil to groundwater, sediment, and surface water) also will remain.

VII. OUTSTANDING POLICY ISSUES

As noted, herein, both Federal (USEPA) and State (NC DENR) agencies are currently involved in environmental planning for Site 89 at MCB, Camp Lejeune. The general public is also involved via the RAB, the announcement of available site related information, and the published request for public comment. All of the agency and public comments received in relation to this Action Memorandum will be taken into consideration prior to the start of remedial action at Site 89.

VIII. ENFORCEMENT

The DoN can and will perform the approved response action for Site 89 promptly and properly.

IX. RECOMMENDATION

This decision document presents the selected removal action for Site 89 - DRMO Area. This removal action was developed in accordance with CERCLA as amended, and is consistent with the NCP. Because conditions at Site 89 - DRMO Area warrant time critical removal actions, this Action Memorandum is submitted for approval. Response actions should commence as soon as practical due to the potential threat to human health and the environment.

Approval by:

_____ _____

Commanding General, Marine Corp Base, Camp Lejuene Date

X. REFERENCES

Baker Environmental, Inc., 1996. Phase I Remedial Investigation for Site 89. November 1996

Baker Environmental, Inc., 1998. Remedial Investigation for Sites 89 and 93. June 1998

Baker Environmental, Inc., 1999. Long-Term Monitoring Report for O.U. 16. April 1999

Baker Environmental, Inc., 1999. Focused Site Investigation Letter Report. November 3, 1999

Baker Environmental, Inc., 2000. Focused Site Investigation Letter Report. February 1, 2000

Long, E.W., D.D. MacDonald, S.L. Smith, and F.D. Calder 1995. Incidence of Adverse Biological Effects within Ranges of Chemical Concentrations in Marine and Estuarine Sediments. Environmental Management Vol. 19, No. 1, pp. 81-97.

USEPA, 1990. Superfund Removal Procedures, Action Memorandum Guidance. EPA/540/P-90/004. December 1990.

USEPA, 1993. Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA. EPA/540-R-93-057. August 1993.

USEPA, 1993. Presumptive Remedies: Site Characterization and Technology Selection for CERCLA Sites With Volatile Organic Compounds in Soils. EPA/540-F-93-048. September 1993.

USEPA, 1999. Region III Risk-Based Concentrations, October 7, 1999

USEPA, 1999. Region IX Preliminary Remediation Goals, March 2000

ATTACHMENT A
TABLES AND FIGURES

Table 1
Site 89 Remedial Design
VOCs in Vadose Zone Soil
Maximum Detections and Possible Target Cleanup/Treatment Standards

	North Carolin SSLs (for gw protection)	Land Disposal Restrictions (LDRs)	EPA Region IX PRGs Residential	EPA Region IX PRGs Industrial	EPA Region III RBCs Residential	EPA Region III RBCs Industrial	Maximum Detection		Detection Frequency	Location of Max Detect
VOLATILES (ug/kg)										
1,1,2,2-Tetrachloroethane	0.953	6,000	380	900	3,200	29,000	**18,000,000**		59/111	IR89-SB05-02
1,1,2-Trichloroethane	3.34	6,000	840	1,900	11,000	100,000	890	J	13/110	IR89-TW102-34
1,1-Dichloroethene	44.5	6,000	54	6,700	1,100	9,500	12		3/110	IR89-SB16-02
1,2-Dichloroethane	1.84	6,000	350	760	7,000	63,000	5	J	1/110	IR89-SB11-02
2-Butanone (MEK)	692	36,000	7,300,000	28,000,000	47,000,000	1,200,000,000	15		11/110	IR89 SB07-02
4-Methyl-2-pentanone-MIBK	2280	33,000	790,000	2,900,000	6,300,000	160,000,000	6	J	2/110	IR89-SB11-02
Acetone	2810	160,000	1,600,000	6,200,000	7,800,000	200,000,000	**170,000**		35/112	IR89-SB69-12
Benzene	5.62	10,000	670	1,500	22,000	200,000	1,000		3/113	IR89-SB10-01
cis-1,2-Dichloroethylene	350	NA	43,000	150,000	780,000	20,000,000	25,000		36/114	IR89-SB04-01
trans-1,2-Dichloroethylene	380	30,000	63,000	210,000	160,000	41,000,000	**40,000**		36/114	IR89-SB04-01
Ethylbenzene	241	10,000	1,500,000	6,000,000	7,800,000	200,000,000	1,200		9/113	IR89-TW103-23
Tetrachloroethene	7.42	6,000	5,700	19,000	12,000	110,000	**150,000**	J	20/110	IR89-SB69-12
Toluene	7270	10,000	590,000	2,000,000	16,000,000	410,000,000	4,100		11/114	IR89-SB10-01
Trichloroethene	18.3	6,000	2,800	6,100	58,000	520,000	**420,000**		64/111	IR89-SB69-12
Vinyl chloride	0.0952	6,000	22	49	340	3,000	5,900	J	22/112	IR89-SB04-01
Xylenes, Total	4960	30,000	1,400,000	4,500,000	160,000,000	4,100,000,000	6,800		12/114	IR89-SB10-02

Total 1,2-Dichloroethylene analyzed for all samples, but speciated in samples where concentrations exceeded the LDR.
All units are ug/kg or parts per billion (ppb).
NA - Not available
18,000,000 Exceeds Region IX Industrial PRG (Target Cleanup Level)
18,000,000 Exceeds LDR

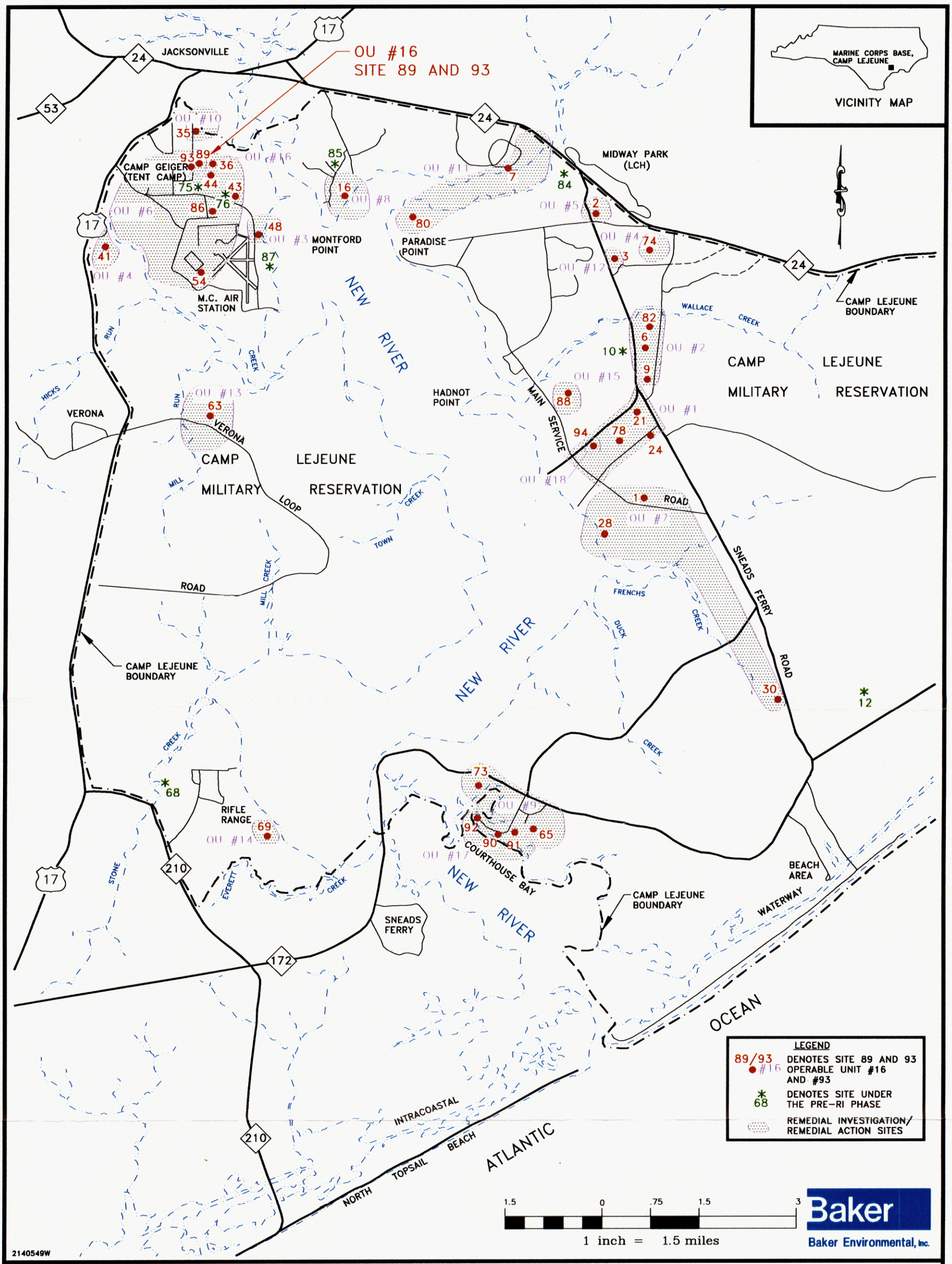
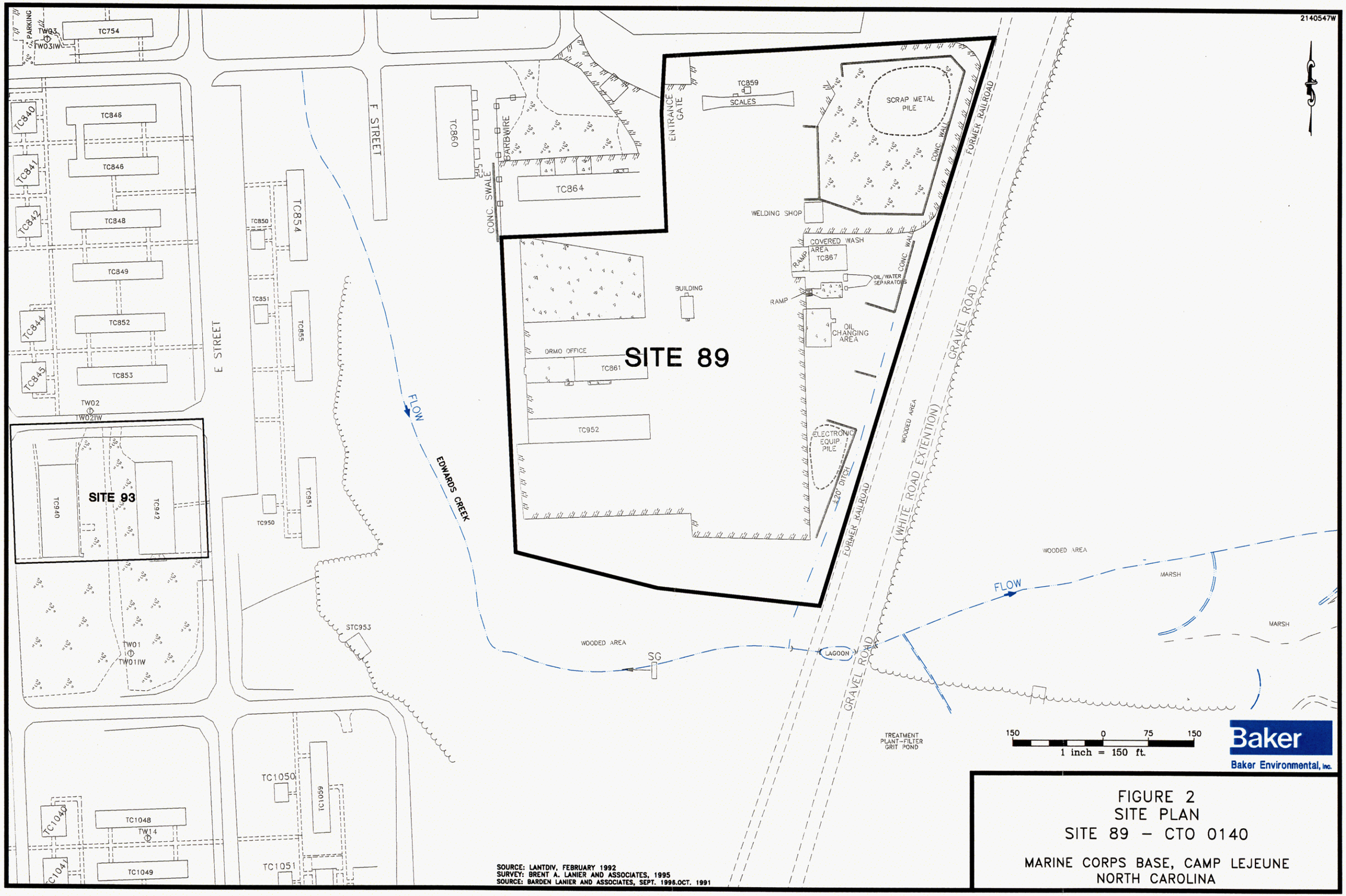


FIGURE 1
LOCATION OF SITE 89 AT
MARINE CORPS BASE CAMP LEJEUNE
CTO – 0140

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

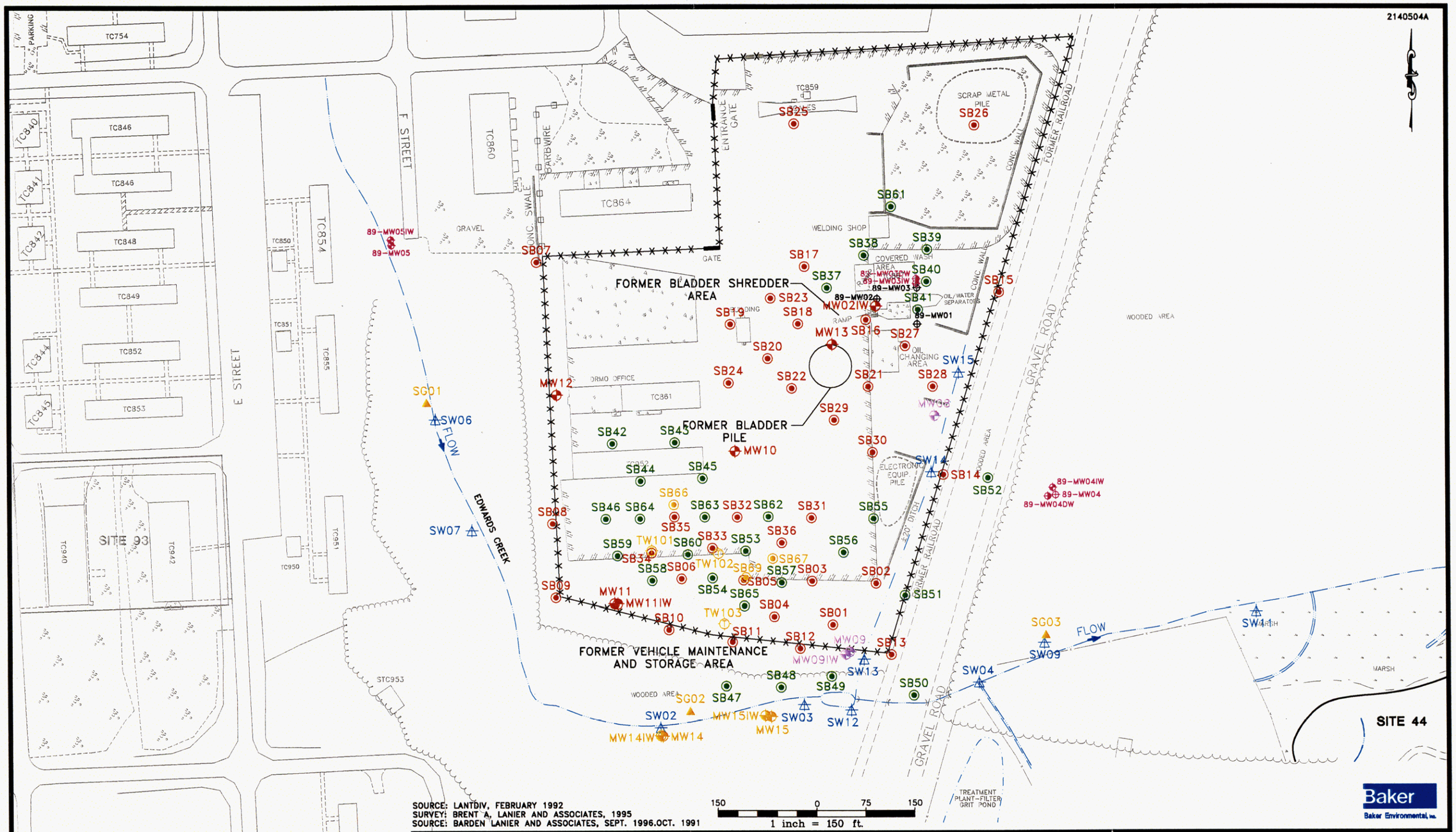
02373DB01Y



SOURCE: LANTDIV, FEBRUARY 1992
SURVEY: BRENT A. LANIER AND ASSOCIATES, 1995
SOURCE: BARDEN LANIER AND ASSOCIATES, SEPT. 1996.OCT. 1991

FIGURE 2
SITE PLAN
SITE 89 – CTO 0140

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

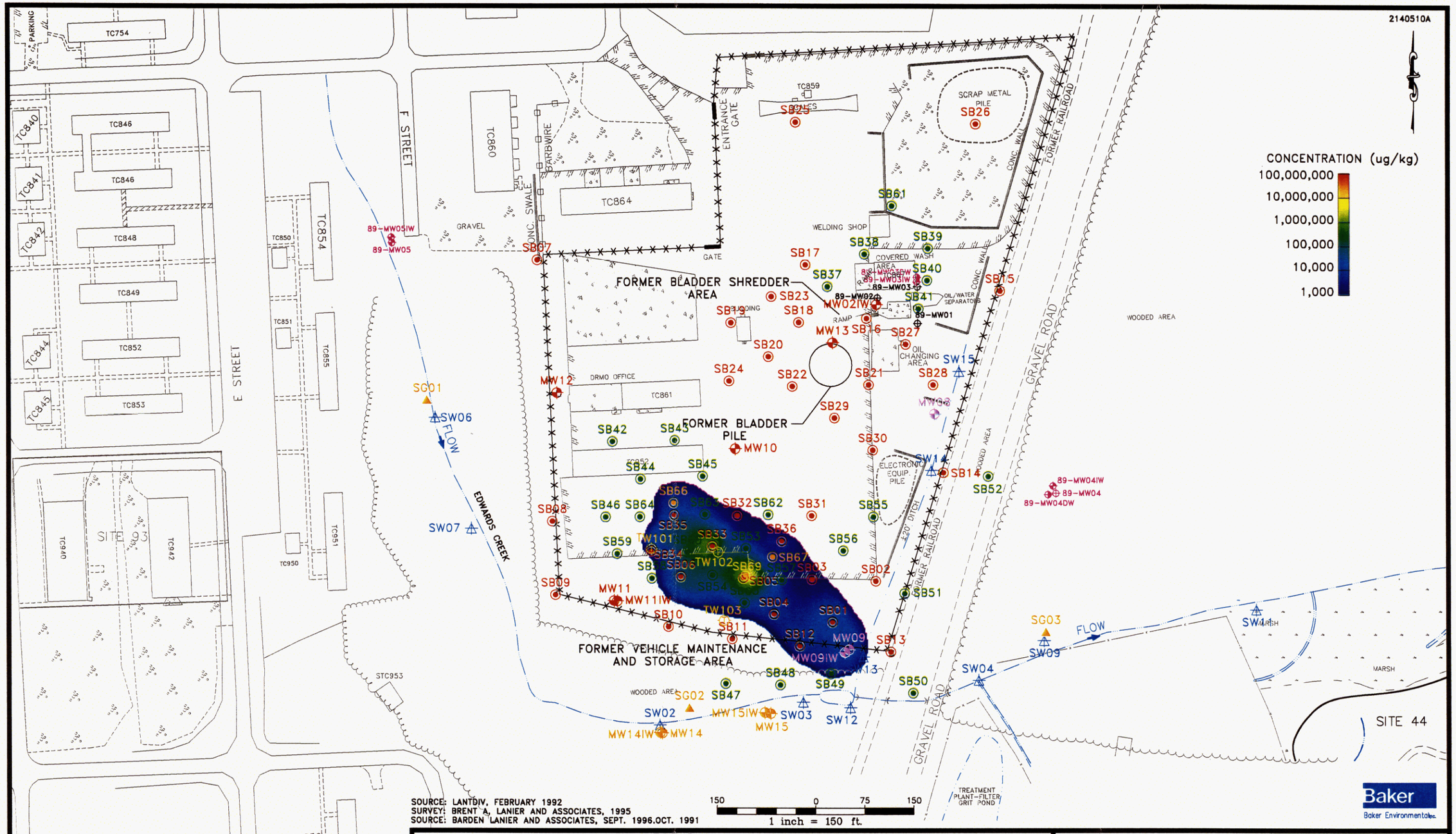


LEGEND

- DRMO FENCE LINE
- GROUNDWATER MONITORING WELL (OCT. 1999)
- GROUNDWATER MONITORING WELL (UST INVESTIGATION)
- GROUNDWATER MONITORING WELL (JUN./JUL. 1999)
- GROUNDWATER MONITORING WELL (APR. 1997)
- SOIL BORING LOCATION (OCT. 1999)
- SOIL BORING LOCATION (DEC. 1999)
- SURFACE WATER/SEDIMENT LOCATION (OCT. 1999)
- MONITORING WELL LOCATION (MARCH 2000)
- SOIL BORING LOCATION (MARCH 2000)
- STAFF GAUGE LOCATION (MARCH 2000)
- TEMPORARY WELL LOCATION (MARCH 2000)

FIGURE 3
SAMPLE LOCATION MAP
SITE 89
CTO-0140

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

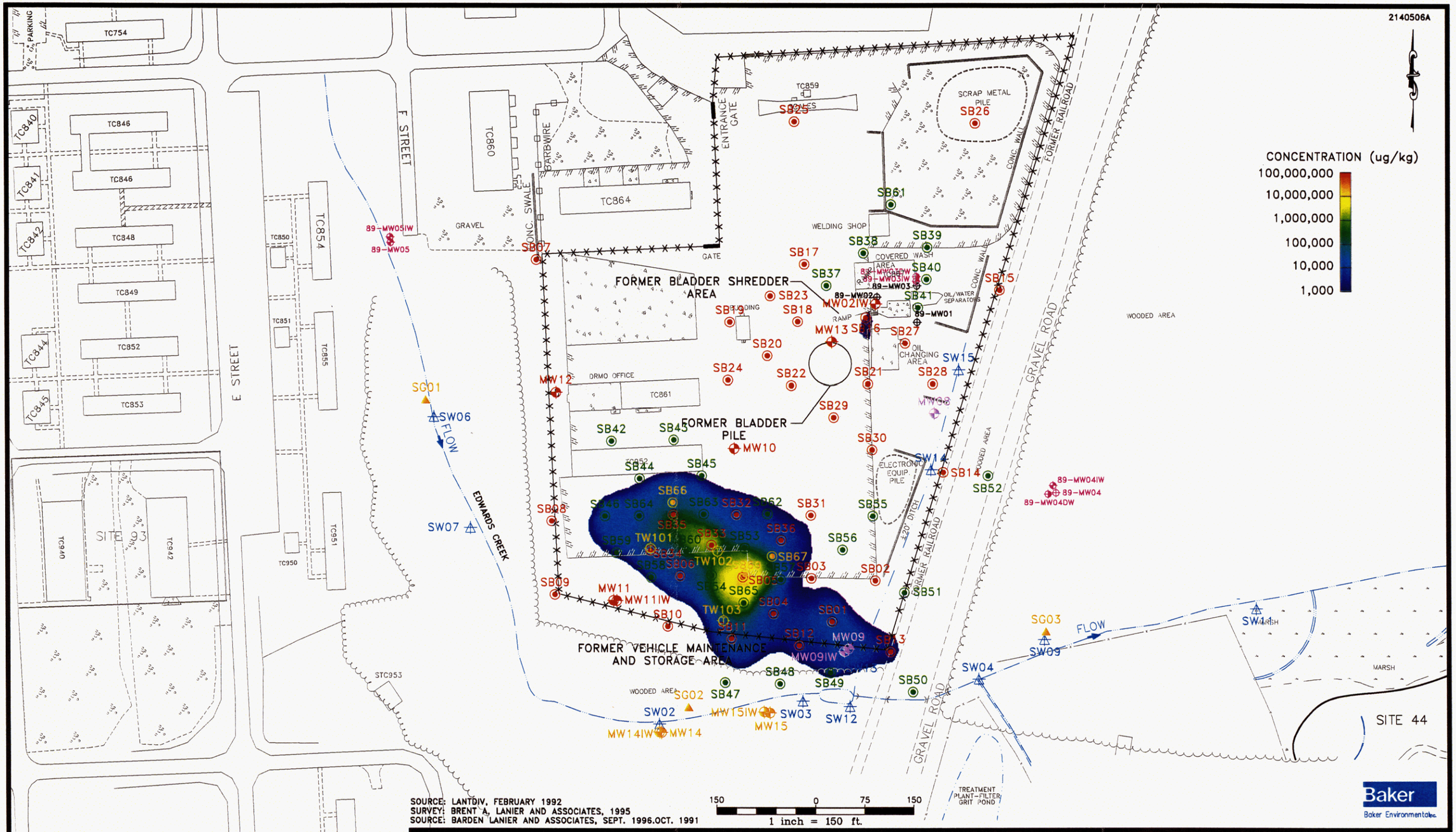


LEGEND

- DRMO FENCE LINE
- GROUNDWATER MONITORING WELL (OCT. 1999)
- GROUNDWATER MONITORING WELL (UST INVESTIGATION)
- GROUNDWATER MONITORING WELL (JUN./JUL. 1999)
- GROUNDWATER MONITORING WELL (APR. 1997)
- SOIL BORING LOCATION (OCT. 1999)
- SOIL BORING LOCATION (DEC. 1999)
- SURFACE WATER/SEDIMENT LOCATION (OCT. 1999)
- MONITORING WELL LOCATION (MARCH 2000)
- SOIL BORING LOCATION (MARCH 2000)
- STAFF GAUGE LOCATION (MARCH 2000)
- TEMPORARY WELL LOCATION (MARCH 2000)

FIGURE 4a
COMPOSITE VOCs
VADOSE ZONE SOILS (1-3' BGS)
SITE 89 - CTO-0140

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



LEGEND

- DRMO FENCE LINE
- GROUNDWATER MONITORING WELL (OCT. 1999)
- GROUNDWATER MONITORING WELL (UST INVESTIGATION)
- GROUNDWATER MONITORING WELL (JUN./JUL. 1999)
- GROUNDWATER MONITORING WELL (APR. 1997)
- SOIL BORING LOCATION (OCT. 1999)
- SOIL BORING LOCATION (DEC. 1999)
- SURFACE WATER/SEDIMENT LOCATION (OCT. 1999)
- MONITORING WELL LOCATION (MARCH 2000)
- SOIL BORING LOCATION (MARCH 2000)
- STAFF GAUGE LOCATION (MARCH 2000)
- TEMPORARY WELL LOCATION (MARCH 2000)

FIGURE 4b
COMPOSITE VOCs
VADOSE ZONE SOILS (3-5' BGS)
SITE 89 - CTO-0140

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

2140509A

TETRACHLOROETHENE (19,000 ug/kg)

TRICHLOROETHENE (6100 ug/kg)

1,1,2,2,-TETRACHLOROETHANE (1000 ug/kg)

1,1,2,2,-TETRACHLOROETHANE (1000 ug/kg)

VINYL CHLORIDE (49 ug/kg)

SOURCE: LANTDIV, FEBRUARY 1992
SURVEY: BRENT A, LANIER AND ASSOCIATES, 1995
SOURCE: BARDEN LANIER AND ASSOCIATES, SEPT. 1996.OCT. 1991

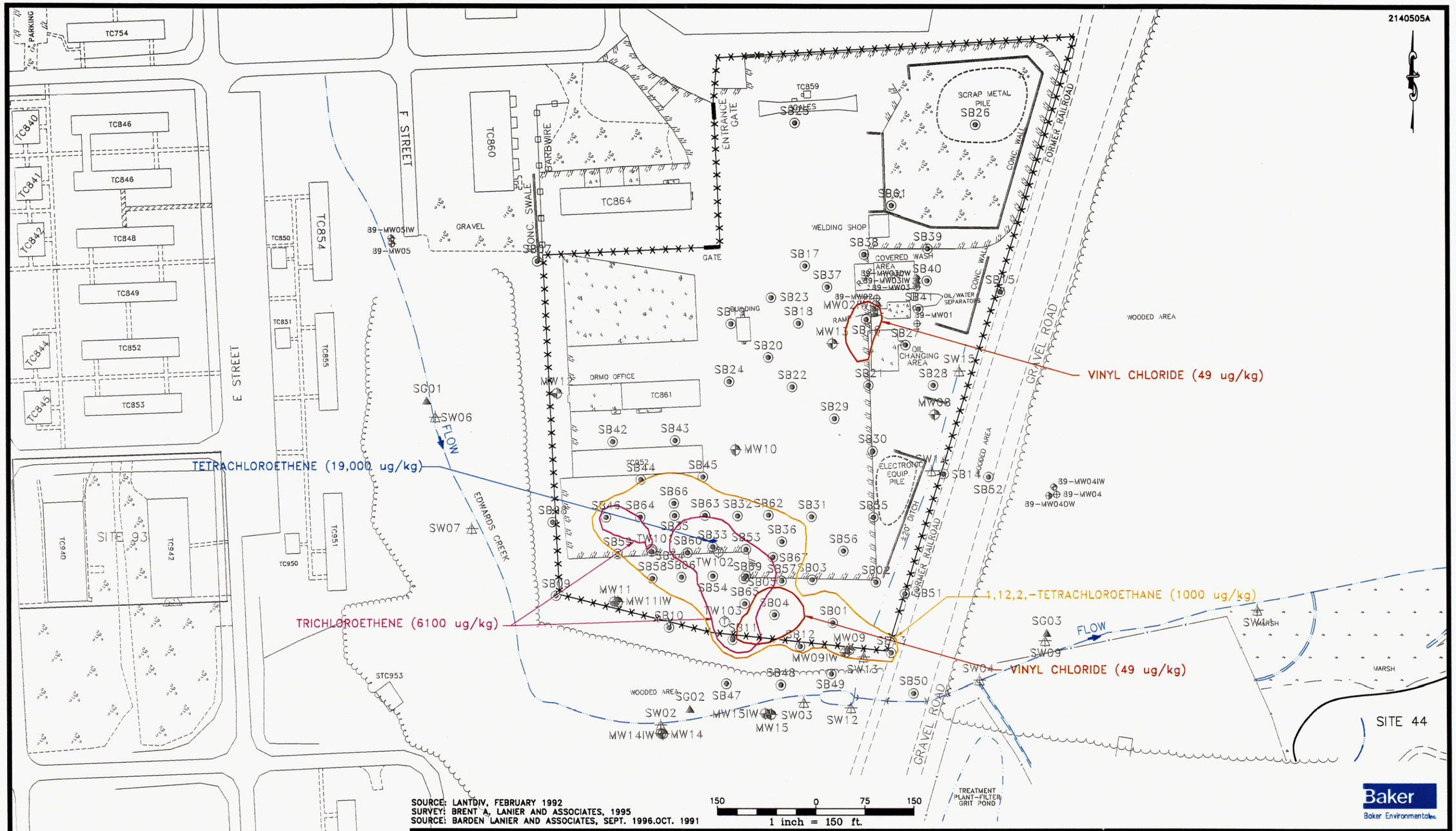
150 0 75 150
1 inch = 150 ft.

Baker
Baker Environmental Inc.

LEGEND

- DRMO FENCE LINE
- GROUNDWATER MONITORING WELL (OCT. 1999)
- GROUNDWATER MONITORING WELL (UST INVESTIGATION)
- GROUNDWATER MONITORING WELL (JUN/JUL. 1999)
- GROUNDWATER MONITORING WELL (APR. 1997)
- SOIL BORING LOCATION (OCT. 1999)
- SOIL BORING LOCATION (DEC. 1999)
- SURFACE WATER/SEDIMENT LOCATION (OCT. 1999)
- MONITORING WELL LOCATION (MARCH 2000)
- SOIL BORING LOCATION (MARCH 2000)
- STAFF GAUGE LOCATION (MARCH 2000)
- TEMPORARY WELL LOCATION (MARCH 2000)

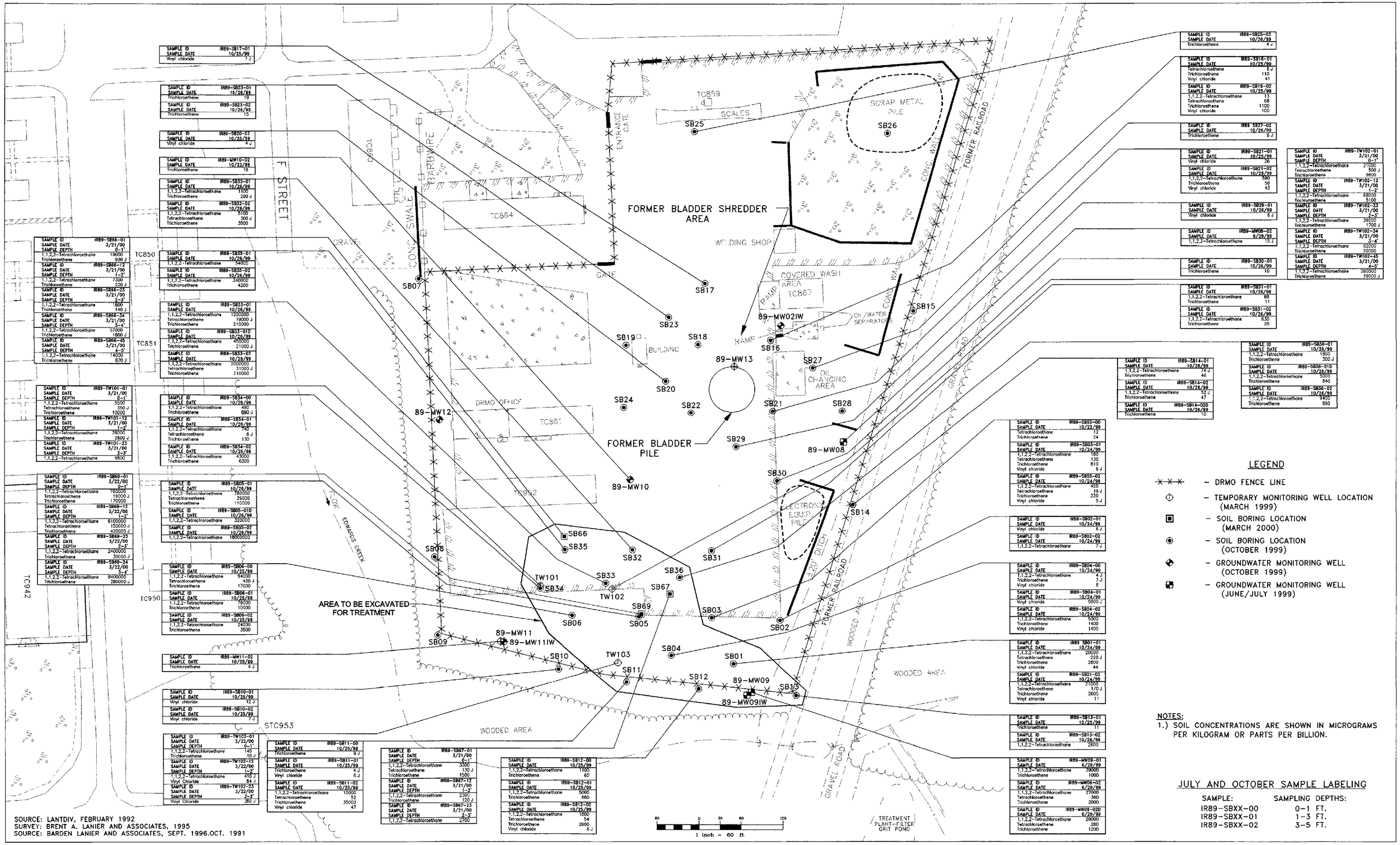
FIGURE 5a
INDIVIDUAL VOCs IN VADOSE ZONE SOILS (1-3' BGS)
SITE 89
CTO-0140
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



LEGEND

- DRMO FENCE LINE
- GROUNDWATER MONITORING WELL (OCT. 1999)
- GROUNDWATER MONITORING WELL (UST INVESTIGATION)
- GROUNDWATER MONITORING WELL (JUN/JUL. 1999)
- GROUNDWATER MONITORING WELL (APR. 1997)
- SOIL BORING LOCATION (OCT. 1999)
- SOIL BORING LOCATION (DEC. 1999)
- SURFACE WATER/SEDIMENT LOCATION (OCT. 1999)
- MONITORING WELL LOCATION (MARCH 2000)
- SOIL BORING LOCATION (MARCH 2000)
- STAFF GAUGE LOCATION (MARCH 2000)
- TEMPORARY WELL LOCATION (MARCH 2000)

FIGURE 5b
INDIVIDUAL VOCs IN VADOSE ZONE SOILS (3-5' BGS)
SITE 89
CTO-0140
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



SAMPLE ID	IR89-SB17-01
SAMPLE DATE	10/25/99
Vinyl chloride	7 J

SAMPLE ID	IR89-SB23-01
SAMPLE DATE	10/26/99
Trichloroethene	19

SAMPLE ID	IR89-SB23-02
SAMPLE DATE	10/26/99
Trichloroethene	15

SAMPLE ID	IR89-SB20-02
SAMPLE DATE	10/25/99
Vinyl chloride	4 J

SAMPLE ID	IR89-MW10-02
SAMPLE DATE	10/22/99
Trichloroethene	19

SAMPLE ID	IR89-SB32-01
SAMPLE DATE	10/26/99
1,1,2,2-Tetrachloroethane	1100
Trichloroethene	290 J

SAMPLE ID	IR89-SB32-02
SAMPLE DATE	10/26/99
1,1,2,2-Tetrachloroethane	5100
Tetrachloroethene	300 J
Trichloroethene	3500

SAMPLE ID	IR89-SB66-01
SAMPLE DATE	3/21/00
SAMPLE DEPTH	0-1'
1,1,2,2-Tetrachloroethane	19000
Trichloroethene	930 J

SAMPLE ID	IR89-SB66-12
SAMPLE DATE	3/21/00
SAMPLE DEPTH	1-2'
1,1,2,2-Tetrachloroethane	7300
Trichloroethene	220 J

SAMPLE ID	IR89-SB66-23
SAMPLE DATE	3/21/00
SAMPLE DEPTH	2-3'
1,1,2,2-Tetrachloroethane	1800
Trichloroethene	140 J

SAMPLE ID	IR89-SB66-34
SAMPLE DATE	3/21/00
SAMPLE DEPTH	3-4'
1,1,2,2-Tetrachloroethane	57000
Trichloroethene	1800 J

SAMPLE ID	IR89-SB66-45
SAMPLE DATE	3/21/00
SAMPLE DEPTH	4-5'
1,1,2,2-Tetrachloroethane	14000
Trichloroethene	870 J

SAMPLE ID	IR89-SB35-01
SAMPLE DATE	10/26/99
1,1,2,2-Tetrachloroethane	54000

SAMPLE ID	IR89-SB35-02
SAMPLE DATE	10/26/99
1,1,2,2-Tetrachloroethane	340000
Trichloroethene	4200

SAMPLE ID	IR89-SB33-01
SAMPLE DATE	10/28/99
1,1,2,2-Tetrachloroethane	1200000
Tetrachloroethene	19000 J
Trichloroethene	210000

SAMPLE ID	IR89-SB33-01D
SAMPLE DATE	10/26/99
1,1,2,2-Tetrachloroethane	440000
Trichloroethene	21000 J

SAMPLE ID	IR89-SB33-02
SAMPLE DATE	10/28/99
1,1,2,2-Tetrachloroethane	2000000
Tetrachloroethene	31000 J
Trichloroethene	210000

SAMPLE ID	IR89-TW101-01
SAMPLE DATE	3/21/00
SAMPLE DEPTH	0-1'
1,1,2,2-Tetrachloroethane	5500
Tetrachloroethene	330 J
Trichloroethene	10000

SAMPLE ID	IR89-TW101-12
SAMPLE DATE	3/21/00
SAMPLE DEPTH	1-2'
1,1,2,2-Tetrachloroethane	38000
Trichloroethene	2600 J

SAMPLE ID	IR89-TW101-23
SAMPLE DATE	3/21/00
SAMPLE DEPTH	2-3'
1,1,2,2-Tetrachloroethane	9800

SAMPLE ID	IR89-SB34-00
SAMPLE DATE	10/26/99
1,1,2,2-Tetrachloroethane	490
Trichloroethene	690 J

SAMPLE ID	IR89-SB34-01
SAMPLE DATE	10/26/99
1,1,2,2-Tetrachloroethane	740
Tetrachloroethene	6 J
Trichloroethene	130

SAMPLE ID	IR89-SB34-02
SAMPLE DATE	10/26/99
1,1,2,2-Tetrachloroethane	43000
Trichloroethene	6300

SAMPLE ID	IR89-SB69-01
SAMPLE DATE	3/22/00
SAMPLE DEPTH	0-1'
1,1,2,2-Tetrachloroethane	760000
Tetrachloroethene	19000 J
Trichloroethene	170000

SAMPLE ID	IR89-SB69-12
SAMPLE DATE	3/22/00
SAMPLE DEPTH	1-2'
1,1,2,2-Tetrachloroethane	6100000
Tetrachloroethene	150000 J
Trichloroethene	420000 J

SAMPLE ID	IR89-SB69-23
SAMPLE DATE	3/22/00
SAMPLE DEPTH	2-3'
1,1,2,2-Tetrachloroethane	2400000
Trichloroethene	30000 J

SAMPLE ID	IR89-SB69-34
SAMPLE DATE	3/22/00
SAMPLE DEPTH	3-4'
1,1,2,2-Tetrachloroethane	8400000
Trichloroethene	280000 J

SAMPLE ID	IR89-SB05-01
SAMPLE DATE	10/26/99
1,1,2,2-Tetrachloroethane	780000
Tetrachloroethene	29000
Trichloroethene	110000

SAMPLE ID	IR89-SB05-01D
SAMPLE DATE	10/26/99
1,1,2,2-Tetrachloroethane	920000

SAMPLE ID	IR89-SB05-02
SAMPLE DATE	10/25/99
1,1,2,2-Tetrachloroethane	18000000

SAMPLE ID	IR89-SB06-00
SAMPLE DATE	10/25/99
1,1,2,2-Tetrachloroethane	94000
Tetrachloroethene	420 J
Trichloroethene	17000

SAMPLE ID	IR89-SB06-01
SAMPLE DATE	10/25/99
1,1,2,2-Tetrachloroethane	78000
Trichloroethene	10000

SAMPLE ID	IR89-SB06-02
SAMPLE DATE	10/25/99
1,1,2,2-Tetrachloroethane	24000
Trichloroethene	3500

SAMPLE ID	IR89-MW11-02
SAMPLE DATE	10/25/99
Trichloroethene	4 J

SAMPLE ID	IR89-SB10-01
SAMPLE DATE	10/25/99
Vinyl chloride	12 J

SAMPLE ID	IR89-SB10-02
SAMPLE DATE	10/25/99
Vinyl chloride	7 J

SAMPLE ID	IR89-TW103-01
SAMPLE DATE	3/22/00
SAMPLE DEPTH	0-1'
1,1,2,2-Tetrachloroethane	140
Trichloroethene	10 J

SAMPLE ID	IR89-TW102-12
SAMPLE DATE	3/22/00
SAMPLE DEPTH	1-2'
1,1,2,2-Tetrachloroethane	410 J
Vinyl Chloride	84 J

SAMPLE ID	IR89-TW102-23
SAMPLE DATE	3/22/00
SAMPLE DEPTH	2-3'
Vinyl Chloride	260 J

SAMPLE ID	IR89-SB11-00
SAMPLE DATE	10/25/99
Trichloroethene	9 J

SAMPLE ID	IR89-SB11-01
SAMPLE DATE	10/25/99
Tetrachloroethene	4 J
Vinyl chloride	6 J

SAMPLE ID	IR89-SB11-02
SAMPLE DATE	10/25/99
1,1,2,2-Tetrachloroethane	10000
Tetrachloroethene	52
Trichloroethene	35000
Vinyl chloride	47

SAMPLE ID	IR89-SB47-01
SAMPLE DATE	3/21/00
SAMPLE DEPTH	0-1'
1,1,2,2-Tetrachloroethane	3300
Tetrachloroethene	130 J
Trichloroethene	1500

SAMPLE ID	IR89-SB47-12
SAMPLE DATE	3/21/00
SAMPLE DEPTH	1-2'
1,1,2,2-Tetrachloroethane	2300
Trichloroethene	120 J

SAMPLE ID	IR89-SB47-23
SAMPLE DATE	3/21/00
SAMPLE DEPTH	2-3'
1,1,2,2-Tetrachloroethane	2700

SAMPLE ID	IR89-SB12-00
SAMPLE DATE	10/25/99
1,1,2,2-Tetrachloroethane	1100
Trichloroethene	60

SAMPLE ID	IR89-SB12-01
SAMPLE DATE	10/25/99
1,1,2,2-Tetrachloroethane	5000
Trichloroethene	660

SAMPLE ID	IR89-SB12-02
SAMPLE DATE	10/25/99
1,1,2,2-Tetrachloroethane	1800
Tetrachloroethene	54
Trichloroethene	2600
Vinyl chloride	6 J

SAMPLE ID	IR89-SB25-02
SAMPLE DATE	10/26/99
Trichloroethene	4 J

SAMPLE ID	IR89-SB16-01
SAMPLE DATE	10/25/99
Tetrachloroethene	6 J
Trichloroethene	110
Vinyl chloride	41

SAMPLE ID	IR89-SB16-02
SAMPLE DATE	10/25/99
1,1,2,2-Tetrachloroethane	13
Tetrachloroethene	68
Trichloroethene	1100
Vinyl chloride	100

SAMPLE ID	IR89-SB27-02
SAMPLE DATE	10/26/99
Trichloroethene	6 J

SAMPLE ID	IR89-SB21-01
SAMPLE DATE	10/25/99
Vinyl chloride	26

SAMPLE ID	IR89-SB21-02
SAMPLE DATE	10/25/99
1,1,2,2-Tetrachloroethane	590
Trichloroethene	56
Vinyl chloride	43

SAMPLE ID	IR89-SB29-01
SAMPLE DATE	10/26/99
Vinyl chloride	6 J

SAMPLE ID	IR89-MW08-02
SAMPLE DATE	6/29/99
1,1,2,2-Tetrachloroethane	15 J

SAMPLE ID	IR89-SB30-01
SAMPLE DATE	10/26/99
Trichloroethene	10

SAMPLE ID	IR89-SB31-01
SAMPLE DATE	10/26/99
1,1,2,2-Tetrachloroethane	88
Trichloroethene	11

SAMPLE ID	IR89-SB31-02
SAMPLE DATE	10/26/99
1,1,2,2-Tetrachloroethane	630
Trichloroethene	28

SAMPLE ID	IR89-SB14-01
SAMPLE DATE	10/26/99
1,1,2,2-Tetrachloroethane	74 J
Trichloroethene	46

SAMPLE ID	IR89-SB14-02
SAMPLE DATE	10/26/99
1,1,2,2-Tetrachloroethane	52 J
Trichloroethene	47

SAMPLE ID	IR89-SB14-02D
SAMPLE DATE	10/26/99
Trichloroethene	10

SAMPLE ID	IR89-SB36-01
SAMPLE DATE	10/26/99
1,1,2,2-Tetrachloroethane	1900
Trichloroethene	300 J

SAMPLE ID	IR89-SB36-01D
SAMPLE DATE	10/26/99
1,1,2,2-Tetrachloroethane	5000
Trichloroethene	640

SAMPLE ID	IR89-SB36-02
SAMPLE DATE	10/26/99
1,1,2,2-Tetrachloroethane	9400
Trichloroethene	850

SAMPLE ID	IR89-SB03-00
SAMPLE DATE	10/22/99
Tetrachloroethene	12
Trichloroethene	24

SAMPLE ID	IR89-SB03-01
SAMPLE DATE	10/24/99
1,1,2,2-Tetrachloroethane	160
Tetrachloroethene	130
Trichloroethene	810
Vinyl chloride	6 J

SAMPLE ID	IR89-SB03-02
SAMPLE DATE	10/24/99
1,1,2,2-Tetrachloroethane	420
Tetrachloroethene	19 J
Trichloroethene	230
Vinyl chloride	5 J

SAMPLE ID	IR89-SB02-01
SAMPLE DATE	10/24/99
Vinyl chloride	8 J

SAMPLE ID	IR89-SB02-02
SAMPLE DATE	10/24/99
1,1,2,2-Tetrachloroethane	7 J

SAMPLE ID	IR89-SB04-00
SAMPLE DATE	10/24/99
1,1,2,2-Tetrachloroethane	4 J
Trichloroethene	7 J
Vinyl chloride	8

SAMPLE ID	IR89-SB04-01
SAMPLE DATE	10/24/99
Vinyl chloride	5600 J

SAMPLE ID	IR89-SB04-02
SAMPLE DATE	10/24/99
1,1,2,2-Tetrachloroethane	5300
Trichloroethene	1400
Vinyl chloride	1400

SAMPLE ID	IR89-SB01-01
SAMPLE DATE	10/24/99
1,1,2,2-Tetrachloroethane	20000
Tetrachloroethene	220 J
Trichloroethene	2600
Vinyl chloride	44

SAMPLE ID	IR89-SB01-02
SAMPLE DATE	10/24/99
1,1,2,2-Tetrachloroethane	21000
Tetrachloroethene	170 J
Trichloroethene	2600
Vinyl chloride	11

SAMPLE ID	IR89-SB13-01
SAMPLE DATE	10/25/99
Trichloroethene	11

SAMPLE ID	IR89-SB13-02
SAMPLE DATE	10/25/99
1,1,2,2-Tetrachloroethane	2600

SAMPLE ID	IR89-MW09-01
SAMPLE DATE	6/29/99
1,1,2,2-Tetrachloroethane	29000
Trichloroethene	1000

SAMPLE ID	IR89-MW09-02
SAMPLE DATE	6/29/99
1,1,2,2-Tetrachloroethane	27000
Tetrachloroethene	360
Trichloroethene	2000

SAMPLE ID	IR89-MW09-02D
SAMPLE DATE	6/29/99
1,1,2,2-Tetrachloroethane	28000
Tetrachloroethene	280
Trichloroethene	1200

SAMPLE ID	IR89-TW102-01
SAMPLE DATE	3/21/00
SAMPLE DEPTH	0-1'
1,1,2,2-Tetrachloroethane	21000
Tetrachloroethene	500 J
Trichloroethene	9800

SAMPLE ID	IR89-TW102-12
SAMPLE DATE	3/21/00
SAMPLE DEPTH	1-2'
1,1,2,2-Tetrachloroethane	68000
Trichloroethene	5100

SAMPLE ID	IR89-TW102-23
SAMPLE DATE	3/21/00
SAMPLE DEPTH	2-3'
1,1,2,2-Tetrachloroethane	35000
Trichloroethene	1700 J

SAMPLE ID	IR89-TW102-34
SAMPLE DATE	3/21/00
SAMPLE DEPTH	3-4'
1,1,2,2-Tetrachloroethane	92000
Trichloroethene	20000

SAMPLE ID	IR89-TW102-45
SAMPLE DATE	3/21/00
SAMPLE DEPTH	4-5'
1,1,2,2-Tetrachloroethane	260000
Trichloroethene	19000 J

LEGEND

- DRMO FENCE LINE
- TEMPORARY MONITORING WELL LOCATION (MARCH 1999)
- SOIL BORING LOCATION (MARCH 2000)
- SOIL BORING LOCATION (OCTOBER 1999)
- GROUNDWATER MONITORING WELL (OCTOBER 1999)
- GROUNDWATER MONITORING WELL (JUNE/JULY 1999)

NOTES:

1.) SOIL CONCENTRATIONS ARE SHOWN IN MICROGRAMS PER KILOGRAM OR PARTS PER BILLION.

JULY AND OCTOBER SAMPLE LABELING

SAMPLE:	SAMPLING DEPTHS:
IR89-SBXX-00	0-1 FT.
IR89-SBXX-01	1-3 FT.
IR89-SBXX-02	3-5 FT.

SOURCE: LANTDIV, FEBRUARY 1992
SURVEY: BRENT A. LANIER AND ASSOCIATES, 1995
SOURCE: BARDEN LANIER AND ASSOCIATES, SEPT. 1996.OCT. 1991

REVISIONS

DATE	APRIL 2000
SCALE	1" = 60'
DRAWN	JWP
REVIEWED	TLO
S.O.#	26007-140
CADD#	2140503A

NORTH

CTO - 0140
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

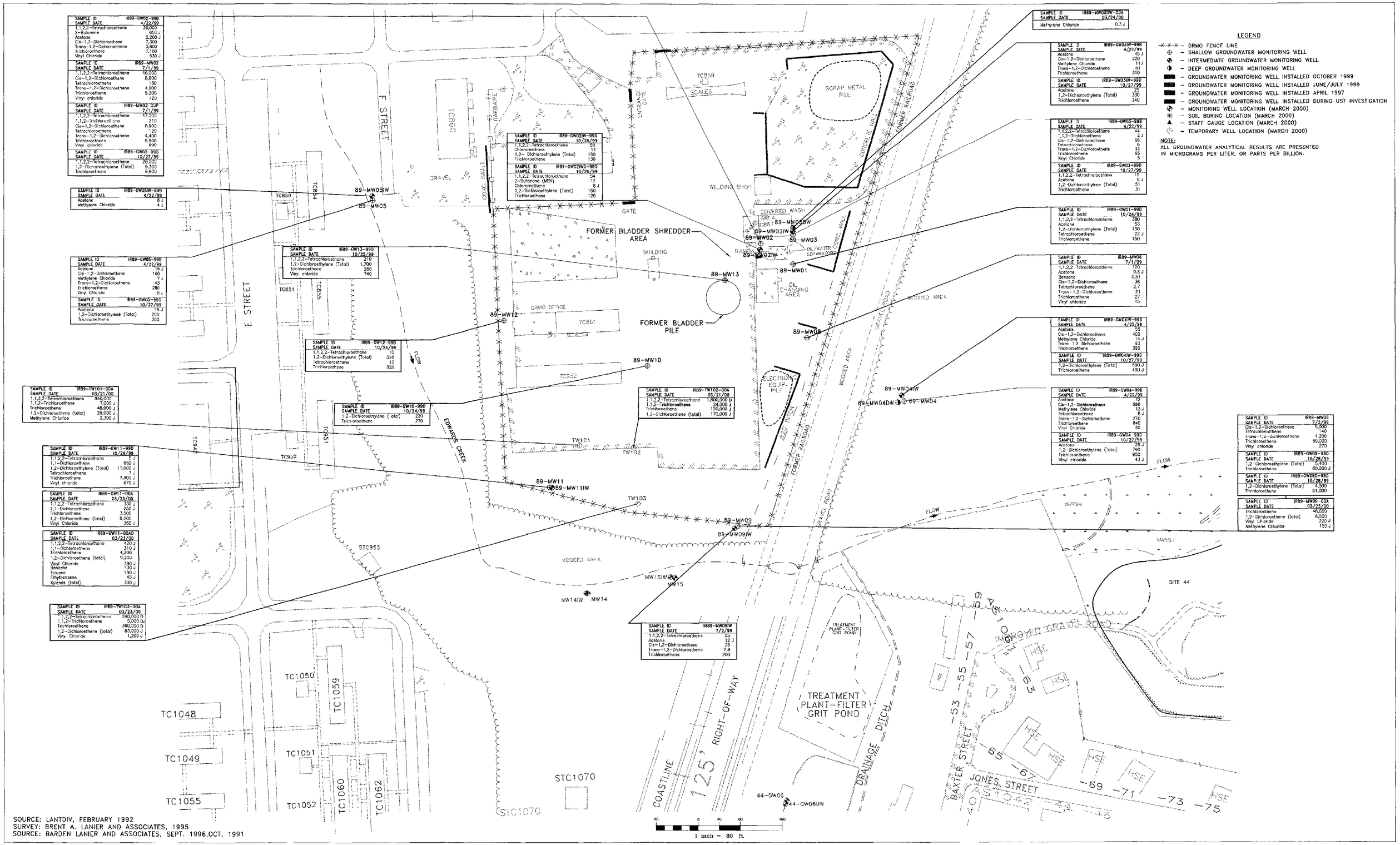
BAKER ENVIRONMENTAL, Inc.
Coraopolis, Pennsylvania

Baker
Baker Environmental, Inc.

VOLATILE ORGANIC COMPOUNDS IN VADOSE ZONE SOIL
SITE 89

SCALE 1" = 60'
DATE APRIL 2000

FIGURE
6



REVISIONS			
DATE	APRIL 2000	NORTH	
SCALE	1" = 80'		
DRAWN	WJH		
REVIEWED	MKD		
S.O.#	26007-140		
CADD#	2140502A		

CTO - 0140
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

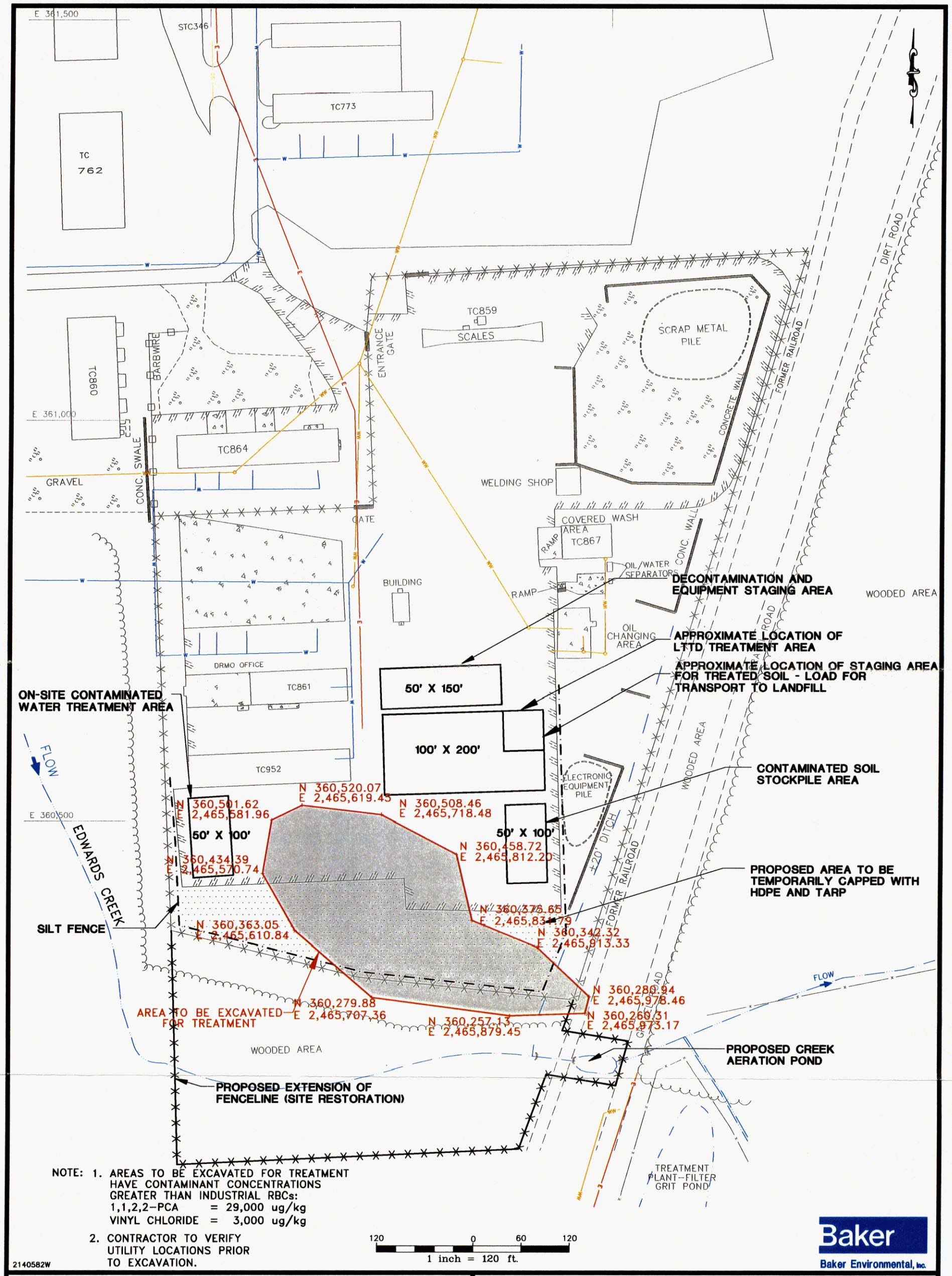
BAKER ENVIRONMENTAL, Inc.
Coraopolis, Pennsylvania

Baker
Baker Environmentalpc

VOLATILE ORGANIC COMPOUNDS IN GROUNDWATER - SITE 89

SCALE 1" = 80' | DATE APRIL 2000

FIGURE 7



NOTE: 1. AREAS TO BE EXCAVATED FOR TREATMENT HAVE CONTAMINANT CONCENTRATIONS GREATER THAN INDUSTRIAL RBCs:
1,1,2,2-PCA = 29,000 ug/kg
VINYL CHLORIDE = 3,000 ug/kg

2. CONTRACTOR TO VERIFY UTILITY LOCATIONS PRIOR TO EXCAVATION.

LEGEND

- DRMO EXISTING FENCE LINE
- PROPOSED FENCE
- EDGE OF EXISTING PAVEMENT
- STORM SEWER LINE
- WASTEWATER LINE
- WASTEWATER MANHOLE
- ELECTRIC LINE
- WATER LINE

SOURCE: LANTDIV, OCT. 1991

FIGURE 8
TIME CRITICAL REMOVAL ACTION
SITE LAYOUT
SITE 89
CTO - 0140
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

ATTACHMENT B
RESPONSE TO COMMENTS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
SAM NUNN ATLANTA FEDERAL CENTER
61 FORSYTH STREET, S.W.
ATLANTA, GEORGIA 30303

March 10, 2000

4WD-FFB

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Ms. Katherine Landman
Department of the Navy - Atlantic Division
Naval Facilities Engineering Command
Code 1823
Norfolk, Virginia 23511-6287

SUBJ: MCB Camp Lejeune
Draft Action Memorandum
Time Critical Removal Action
OU 16 - Site 89

Dear Ms. Landman:

The Environmental Protection Agency has completed its review of the above subject document. The groundwater action should be clearly defined. The report states the groundwater will be continuously pumped from the excavation area and treated on site before discharging into the base sanitary sewer. What is the method of groundwater treatment and what are the remedial goals? This information should be included in the action memorandum.

If you have any questions or comments, please call me at (404) 562-8538

Sincerely,

Gena D. Townsend
Senior Project Manager

cc: David Lown, NCDEHNR
Neal Paul, MCB Camp Lejeune

Response to EPA Comment from March 10, 2000 letter from Gena Townsend (EPA) to Kate Landman (LANTDIV):

Groundwater will be pumped from the excavation only if required to facilitate the excavation process. If contaminated groundwater is pumped from the excavation, the remedial action contractor (RAC) has the following options for management of the contaminated water:

- *Haul directly to Lot 203 existing groundwater treatment system*
- *Pre-treat and haul to Lot 203 groundwater treatment system*
- *Pre-treat and discharge to Base sanitary sewer*

The method of managing contaminated water will be selected by the RAC. If the RAC determines that it is most cost-effective to discharge to the base sanitary sewer, then the RAC will coordinate with Base personnel to determine appropriate discharge limits. If the water is treated at the Lot 203 treatment system, then the discharge limits will correspond to the effluent limits of the groundwater treatment system, which are regulated under an NPDES permit.

This issue will be clarified in the Final Action Memo and will also be addressed in the Remedial Design.

March 10, 2000

Commander, Atlantic Division
Naval Facilities Engineering Command
1510 Gilbert Street (Building N-26)
Norfolk, Virginia 23511-2699

Attention: Ms. Katherine Landman, PE
Navy Technical Representative
Code 18232

Commanding General
Marine Corps Base
PSC Box 20004
Camp Lejeune, NC 28542-0004

Attention: AC/S, EMD/IRD

RE: NC Superfund Comments
Draft Action Memorandum
OU16, Site 89
MCB Camp Lejeune

Dear Ms. Landman:

The Superfund Section received and reviewed this document and has the following comments:

1. Page 10, first paragraph, last 3 sentences. The North Carolina Water Quality Standard for 1,1,2,2-PCA is an interim standard set at 0.17 ug/l. Interim standards are set by the Groundwater Section as specified by NCAC 2L and are considered ARARs. The interim standards can be found at the Groundwater Section web site (http://gw.ehnr.state.nc.us/index.htm).

   Response: Comment noted. This will be addressed in the Final Action Memo.

2. Page 17, next to the last paragraph. Treating the soils to levels below health-based or groundwater-protection levels so that they can returned to the site would be preferable; however, if the treated soils are going to a Subtitle D landfill, then they must past the TCLP test. This is in addition to meeting the LDRs. For contaminants not found on the TCLP list, the leachate should contain no more than 100 times the 2L standard. In the case of 1,1,2,2-PCA, this is 17 ug/l.

   Response: At the June 4, 2000 partnering meeting, NCDENR approved a remediation and treatment goal of 1000 ppb for 1,1,2,2-PCA and indicated that placement of the treated soil back into the excavation was acceptable at Site 89. Target remediation goals for the other contaminants (trichloroethene, tetrachloroethene, and vinyl chloride) will be defined based on Region IX Industrial Preliminary Remediation Goals (PRGs),

since the 1000 ppb goal for PCA was close to the Region IX Industrial PRG of 900 ppb for 1,1,2,2-PCA. It is anticipated that treatment goals for the other contaminants will be defined based on the lower of the Region IX Industrial PRG and the Land Disposal Restriction (LDR) limit for each contaminant.

3. Page 17, last paragraph. The asphalt cap should contain an impermeable membrane to stop infiltration of rainwater.

   Response: Since submittal of the Draft Action Memo, it has been determined that an asphalt cap will not be constructed over the southern portion of the DRMO immediately following implementation of the soil removal action because a remedial follow-on action to address residual soil and groundwater contamination is planned following implementation of this TCRA. As remedial actions to address residual soil and groundwater contamination will likely involve invasive activities that would compromise the integrity and/or negate the effectiveness of the asphalt cap, a permanent cap will not be constructed at this time. The temporary cap, consisting of HDPE liner and tarp, will be maintained until completion of the follow-on remedial action.

4. Page 18, second paragraph. Pemits are not required. However, the substantive requirements of discharge permits must be determined and met.

   Response: Comment noted. This will be revised in the Final Action Memo.

5. Pages 22 & 23. ARARs.

   Additional chemical-specific ARARs include:

North Carolina Groundwater Standards	15A NCAC 2L
North Carolina Water Quality Standards	15 A NCAC 2B.0100 & .0200
North Carolina Surface Water Effluent Limitations	15A NCAC 2B.0400
North Carolina Hazardous Waste Rules	15A NCAC 13A

   Additional location-specific ARARS can be found in the following regulations:

North Carolina Hazardous Waste Management Rules	15A NCAC 13A
North Carolina Solid Waste Management Rules	15A NCAC 13B

   Other action-specific ARARs include the following:

NC Groundwater Corrective Action	15A NCAC 2L.0106
NC Well Construction Standards	15A NCAC 2C.0100
NC Injection Well Construction Standards	15A NCAC 2C.0200
NC Water Quality Discharge Requirements	15A NCAC 2H.0100&.0200
NC Sediment Control Rules	15A NCAC 2H.1000

   Response: Comment noted. These ARARs will be added to the Final Action Memo.

We appreciate the opportunity to review this document. If you have any questions or comments, please contact me.

Sincerely,

David J. Lown, LG, PE
Geological Engineer
Superfund Section

cc: Neal Paul, MCB Camp Lejeune
Gena Townsend, USEPA

From: "Simmons, Mary Ann" <SIMMONSM@nehc.med.navy.mil>
To: "Kate H. Landman (E-mail)" <LandmanKH@efdlant.navfac.navy.mil>, "Rich Bonelli (E-mail)" <RBONELLI@mbakercorp.com>
Date: 4/19/00 3:14PM
Subject: comments on the draft action memo for Site 89

1. We are concerned that site-specific risk based screening values were used to estimate the potential risk in the decision making process. We do not agree with the statement on page 14 that states risk based screening provides accurate risk estimates in the absence of comprehensive risk assessment results. Risk based screening values should be used for screening purposes only. Risk based screening values should be used as a "point of departure," for risk management decisions, not the ultimate clean-up goal. If the site were to remain industrial, and soil to groundwater was not consideration, a detailed human health risk assessment would most likely result in an acceptable health risk. The risk screening approach is accepted by USEPA Region III because it overestimates the risk, not because it accurately estimates site specific risk.

Response: Agreed. The risk screening values presented in the Draft Action Memo were used only to estimate relative risks presented by the site. This risk screening approach was used as a means of assessing potential risk in order to give some direction from a risk perspective in the decision-making process for this TCRA. The screening values are not being used in lieu of conducting a human health risk assessment. The site-specific acceptable concentrations developed using this risk screening approach are not being used to establish cleanup goals for the site. The text in the Final Action Memo will be changed to eliminate potential implications that this process results in cleanup goals for the site.

2. Page 16, bottom of the second paragraph states that USEPA Region III industrial RBC (29 mg/kg for 1,1,2,2 PCA) was selected as a "conservative, yet achievable, goal that is protective of human health and the environment." (yes it is conservative)

Page 17, under item 2, states "This time critical removal action includes the removal of soils whose contaminant concentrations exceed their respective industrial RBC clean-up goals. The removal action will be protective of human health for industrial use at this site. The section also states that the "action will remove a source of groundwater, surface water, and sediment contamination, thereby reducing the possibility of future significant contamination releases from the site." As stated above the screening values are being used in lieu of conducting a human health risk assessment. We do not feel the conservative screening values are representative of actual site specific risk. We are not convinced that the describe removal will achieve the desired outcome. Leap of Faith....

Page 18, in the first paragraph under the section "Immediate Threats to be Addressed" states that the threat of future significant releases of contaminants to Edwards Creek will be addressed.

Several times (pg. 6 and pg. 9 for example), the report notes that the soil to water screening criteria is exceeded. Since the industrial RBCs are orders of magnitude higher than these Soil Screening Levels (SSL) for soil to groundwater, (example -the SSL for 1,1,2,2 PCA is 0.00068 mg/kg), how do you know that the soil, cleaned up to the industral RBCs, will still not serve as a source of contamination to Edwards Creek? In other words, address how the industrial RBC is applicable to the groundwater issue. We recommend that the "clean-up" goals be reevaluated to assure that the "clean-up objectives" are accomplished.

Response: At the June 4, 2000 partnering meeting, NCDENR approved a remediation and treatment goal of 1.0 ppm (1000 ppb) for 1,1,2,2-PCA and indicated that placement of the treated soil back into the excavation was acceptable at Site 89. Target remediation goals for the other contaminants (trichloroethene, tetrachloroethene, and vinyl chloride) will be defined based on Region IX Industrial Preliminary Remediation Goals (PRGs), since the 1000 ppb goal for PCA was close to the Region IX Industrial PRG of 900 ppb for 1,1,2,2-PCA. It is anticipated that treatment goals for the other contaminants will be defined based on the lower of the Region IX Industrial PRG and the Land Disposal Restriction (LDR) limit for each contaminant.

This TCRA is not proposed as the final solution for Site 89. The prupose of this TCRA is to remove a significant source of contamination in the unsaturated soil zone and is the proposed "first step" in the long-term remediation plan for Site 89. An EE/CA is planned this summer to evaluate appropriate follow-on remedial actions for residual soil and groundwater contamination that will remain on site.

3. Page 22 The first paragraph states how/where the community information and documents will be distributed. In addition to the RAB and the Onslow public library, I suggest exploring distributing this information via on-base channels. The RAB is probably not the best way to distribute information to the base residents.

Response: We agree that the RAB is not the best way to distribute information to Base residents. The Base has taken a number of actions to date to inform the public of potential risks associated with Site 89 including handing out flyers to residents of the nearby housing development and publishing information in Base and local newspaper. In addition, the Base Facilities Department and the Base Industrial Health Department have been notified such that appropriate actions are implemented at the Base. These actions will be presented in the Final Action Memo. The referenced paragraph will be deleted from the Final Action Memo.

UNITED STATES MARINE CORPS
MARINE CORPS BASE
PSC BOX 20004
CAMP LEJEUNE, NORTH CAROLINA 28542-0004

IN REPLY REFER TO:
6286
BEMD
05 MAY 2000

From: Commanding General, Marine Corps Base, Camp Lejeune
To: Commander, Atlantic Division, Naval Facilities Engineering Command, (Code 1823), 1510 Gilbert Street, Norfolk, Virginia 23511-2699

Subj: ACTION MEMORANDUM FOR TIME CRITICAL REMOVAL ACTION OU16, SITE 89, MARINE CORPS BASE CAMP LEJEUNE, NORTH CAROLINA

Encl: (1) Comments on the ~~Draft Design~~ Action Memo Package, Site 89 OU16

1. The subject document has been reviewed by the Installation Restoration Division. The comments are contained in the enclosure.

2. It is requested that the Installation Restoration Division, Environmental Management Department, Marine Corps Base (MCB), Camp Lejeune be notified of the actions taken to accommodate the comments.

3. If you have any questions or comments, please contact Mr. Rick Raines, Installation Restoration Division, Environmental Management Department, at DSN 751-5068, or commercial telephone (910) 451-5068.

for

SCOTT A. BREWER, PE
By direction

Marine Corps Base Camp Lejeune
Comments on the Action Memorandum Site 89, OU16

1. Section I Purpose Page 1
The new IR Manual is still in draft form. We should continue to use the 1992 edition until such time as the manual is finalized.

2. Section 2 Site Description Page 2
We are currently putting together a time line of past uses of the site. At this time we will continue to associate the contamination with the past Motor T operations that were performed there.

3. Section 2 Site Description Page 2
The second paragraph in this section discusses the original investigations. This paragraph should be moved to the third page before the paragraph that begins "The initial UST investigation . . . " for consistency and readability.

4. Section 3 Release or Threatened Release Page 4
The third paragraph discusses temporary well 89-TW102. I could not locate this well on any of the maps supplied either with this report or the others that preceded it. Where is this map? The fourth paragraph, fourth line has a spelling error. Please change "is" to "this."

5. Section 3 Release or Threatened Release Page 5
The second paragraph has a typographical error. There should be a space between the first and second sentences.

6. Section 3 Release or Threatened Release Page 5
The third paragraph states that the purpose of this TCRA is to reduce the exposure to current users of the site. This is incomplete and inaccurate. There are many reasons for this TCRA and multiple parts to it, each equally important. We are permanently removing DRMO employees from the site to protect them. We are removing the contaminated soil hot spots because this is a source of contamination to the surface and groundwater in the vicinity of the site. We are installing fencing to keep people out of contaminated areas. This will not only be protective to future industrial worker safety but also hunter and housing resident safety.

7. Section 3 Release or Threatened Release Page 5
The last paragraph states that the TCRA includes LTTD and fencing. The TCRA also includes the aeration of the creek to stop contaminant migration in the creek and possibly reaching the New River. The last sentence states that further remedial action will be taken if necessary. We have already stated to the regulators that we will be following up with an SVE system or a technology that is equally effective. Please remove the statement "if necessary."

8. Section 2 Current Actions - Actions Page 7
The first item starts "worked with the RAC. . . " It would be better to start the bullet with "Installed an aeration System . . . " The last sentence discusses the health and safety benefits of these actions. Please include the family housing residents in this discussion.

9. Section 2 Current Actions – Notifications Page 7
The first sentence has a typographical error. Please change "also has" to "have also."

10. Section 3D Phase I and II RI Page 8
The first sentence has a typographical error. Please change "two during phases" to "two phases during." The last sentence on the page also has a typographical error. The sentence should read,". . . investigations are summarized in 'THE' paragraphs."

11. Section 3D Groundwater Page 12
The second sentence contains a spelling error. Please change creening to screening.

12. Section 3D Pre-Construction Soil Delineation – April 2000 Page 15
Please correct the font changes in this section.

13. Section VA1 Proposed Action Description Page 20
This section discusses the replacement of the treated soils back into the excavated area. Are we sure that the treatment of the soils will allow the placement back in the pit? We should also have a contingency plan for this action.

14. Section VA1 Proposed Action Description Page 21
The third paragraph, fourth line contains a spelling error. Treatment and in are not one word. Please correct.

15. Section 2 Immediate Threats to Be Addressed Page 23
There is also the threat to the environment of the groundwater becoming significantly more contaminated if the soils are not removed.

16. Section IX Recommendation Page 29
According to the IR Manuals (both 1992 and draft 2000), the commanding General of the Installation is responsible for signing this document. Please change Neal's info for the General's in this area since he will be signing.

Response to MCB Camp Lejuene Comments on the Site 89 Action Memorandum Letter from Scott Brewer, P.E., dated May 5, 2000

Response to Comment # 1

Comment noted. 1992 IR Manual will be referenced.

Response to Comment # 2

Comment noted. No change will be made in this section.

Response to Comment # 3

Comment noted. Suggested revision incorporated.

Response to Comment # 4

Temporary well 89-TW102 is shown on Figure 3 – Sample Location Map. The "89" designation refers to Site 89, but will be deleted from the text to avoid confusion. It is shown simply as TW102 on Figure 3.

Response to Comment # 5

Comment noted.

Response to Comment # 6

Comment noted. These other actions that have been/are being taken to address hunter and housing resident safety have been incorporated into the Action Memo under Section II – B, "Other Actions".

Response to Comment # 7

The Action Memo has been revised to state that residual soil and groundwater contamination remaining following implementation of the TCRA will be addressed by follow-on remedial actions, including an EE/CA to evaluate potential technologies and remedial alternatives to address the residual contamination.

Response to Comment # 8

Comment noted. Suggested revisions made.

Response to Comment # 9

Comment noted. Suggested revisions made.

Response to Comment # 10

Comment noted. Suggested revisions made.

Response to Comment # 11

Comment noted. Suggested revisions made.

Response to Comment # 12

Comment noted. Suggested revisions made.

Response to Comment # 13

Text in this section was edited to indicate that soil not meeting treatment standards following LTTD treatment will be re-processed through the LTTD unit until treatment standards are met. As a contingency, if soil cannot be treated to treatment standards, it may be disposed in the Base landfill, assuming that it meets Land Disposal Restrictions.

Response to Comment # 14

Comment noted. Suggested revisions made.

Response to Comment # 15

Comment noted. Suggested revisions made.

Response to Comment # 16

Comment noted. Suggested revisions made.

ATTACHMENT C
HEALTH ADVISORIES AND MEMOS

DRAFT CARCINOGENIC RELATIVE RISK SCREENING
FOR CHILD TRESPASSER SCENARIO
SURFACE WATER/SEDIMENT EXPOSURE
SITE 89/EDWARDS CREEK
MCB CAMP LEJEUNE, NORTH CAROLINA

		SURFACE WATER					SEDIMENT					
Sample Location	Date Collected	Compound	Conc. (ug/L)	Qualifier	Site-specific Acceptable Concentration (ug/L)	Relative Risk-Carc.	Compound	Conc. (ug/kg)	Qualifier	Site-specific Acceptable Concentration (ug/kg)	Relative Risk-Carc.	**RELATIVE RISK**
89-SW06	Oct-99	TCE	ND		350		NA			381,000		
		1,1,2,2-PCA	6	J	20	3.00E-07	NA			21,000		**3.00E-07**
89-SW/SD07	Oct-99	TCE	ND		350		TCE	ND		381,000		
		1,1,2,2-PCA	10		20	5.00E-07	1,1,2,2-PCA	ND		21,000		**5.00E-07**
89SW/SD02	Oct-99	TCE	6	J	350	1.71E-08	TCE	ND		381,000		
		1,1,2,2-PCA	45		20	2.25E-06	1,1,2,2-PCA	ND		21,000		**2.27E-06**
89-SW/SD03	Oct-99	TCE	5	J	350	1.43E-08	TCE	ND		381,000		
		1,1,2,2-PCA	48		20	2.40E-06	1,1,2,2-PCA	ND		21,000		**2.41E-06**
89-SW/SD13	Oct-99	TCE	420		350	1.20E-06	TCE	890		381,000	2.34E-09	
		1,1,2,2-PCA	1200		20	6.00E-05	1,1,2,2-PCA	490		21,000	2.33E-08	**6.12E-05**
89-SW/SD12	Oct-99	TCE	100		350	2.86E-07	TCE	ND		381,000		
		1,1,2,2-PCA	91		20	4.55E-06	1,1,2,2-PCA	ND		21,000		**4.84E-06**
89-SW/SD04	Oct-99	TCE	92		350	2.63E-07	TCE	ND		381,000		
		1,1,2,2-PCA	82		20	4.10E-06	1,1,2,2-PCA	ND		21,000		**4.36E-06**
89-SW/SD09	Oct-99	TCE	75		350	2.14E-07	TCE	ND		381,000		
		1,1,2,2-PCA	67		20	3.35E-06	1,1,2,2-PCA	ND		21,000		**3.56E-06**
89-SW/SD11	Oct-99	TCE	75		350	2.14E-07	TCE	10	J	381,000	2.62E-11	
		1,1,2,2-PCA	66		20	3.30E-06	1,1,2,2-PCA	ND		21,000		**3.51E-06**
89-EC-SW/SD01	Jul-96	TCE	3	J	350	8.57E-09	TCE	ND		381,000		
		1,1,2,2-PCA	ND		20		1,1,2,2-PCA	ND		21,000		**8.57E-09**
89-EC-SW/SD02	Jul-96	TCE	18		350	5.14E-08	TCE	ND		381,000		
		1,1,2,2-PCA	150	J	20	7.50E-06	1,1,2,2-PCA	ND		21,000		**7.55E-06**
89-EC-SW/SD03	Jul-96	TCE	16		350	4.57E-08	TCE	2400		381,000	6.30E-09	
		1,1,2,2-PCA	130	J	20	6.50E-06	1,1,2,2-PCA	1700		21,000	8.10E-08	**6.63E-06**
89-EC-SW/SD04	Jul-96	TCE	26		350	7.43E-08	TCE	ND		381,000		
		1,1,2,2-PCA	72		20	3.60E-06	1,1,2,2-PCA	ND		21,000		**3.67E-06**
89-EC-SW/SD05	Jul-96	TCE	24		350	6.86E-08	TCE	ND		381,000		
		1,1,2,2-PCA	80		20	4.00E-06	1,1,2,2-PCA	ND		21,000		**4.07E-06**

ND - Not Detected
NA - Not Applicable
The USEPA stipulates an acceptable cancer risk range of 1×10^{-6} to 1×10^{-4}.

NOTE: The values calculated here are ***PRELIMINARY*** Risk Screening Values only and are considered ***CONFIDENTIAL***.

DRAFT NONCARCINOGENIC RELATIVE RISK SCREENING
FOR CHILD TRESPASSER SCENARIO
SURFACE WATER/SEDIMENT EXPOSURE
SITE 89/EDWARDS CREEK
MCB CAMP LEJEUNE, NORTH CAROLINA

		SURFACE WATER					SEDIMENT					
Sample Location	Date Collected	Compound	Conc. (ug/L)	Qualifier	Site-specific Acceptable Concentration (ug/L)	Relative Risk-Noncarc.	Compound	Conc. (ug/kg)	Qualifier	Site-specific Acceptable Concentration (ug/kg)	Relative Risk-Noncarc.	**RELATIVE HAZARD QUOTIENT**
89-SW06	Oct-99	TCE	ND		1,000		NA			1,436,000		
		1,1,2,2-PCA	6	J	17,000	3.5E-04	NA			14,361,000		**3.5E-04**
89-SW/SD07	Oct-99	TCE	ND		1,000		TCE	ND		1,436,000		
		1,1,2,2-PCA	10		17,000	5.9E-04	1,1,2,2-PCA	ND		14,361,000		**5.9E-04**
89SW/SD02	Oct-99	TCE	6	J	1,000	6.0E-03	TCE	ND		1,436,000		
		1,1,2,2-PCA	45		17,000	2.6E-03	1,1,2,2-PCA	ND		14,361,000		**0.01**
89-SW/SD03	Oct-99	TCE	5	J	1,000	5.0E-03	TCE	ND		1,436,000		
		1,1,2,2-PCA	48		17,000	2.8E-03	1,1,2,2-PCA	ND		14,361,000		**0.01**
89-SW/SD13	Oct-99	TCE	420		1,000	4.2E-01	TCE	890		1,436,000	6.2E-04	
		1,1,2,2-PCA	1200		17,000	7.1E-02	1,1,2,2-PCA	490		14,361,000	3.4E-05	**0.49**
89-SW/SD12	Oct-99	TCE	100		1,000	1.0E-01	TCE	ND		1,436,000		
		1,1,2,2-PCA	91		17,000	5.4E-03	1,1,2,2-PCA	ND		14,361,000		**0.11**
89-SW/SD04	Oct-99	TCE	92		1,000	9.2E-02	TCE	ND		1,436,000		
		1,1,2,2-PCA	82		17,000	4.8E-03	1,1,2,2-PCA	ND		14,361,000		**0.10**
89-SW/SD09	Oct-99	TCE	75		1,000	7.5E-02	TCE	ND		1,436,000		
		1,1,2,2-PCA	67		17,000	3.9E-03	1,1,2,2-PCA	ND		14,361,000		**0.08**
89-SW/SD11	Oct-99	TCE	75		1,000	7.5E-02	TCE	10	J	1,436,000	7.0E-06	
		1,1,2,2-PCA	66		17,000	3.9E-03	1,1,2,2-PCA	ND		14,361,000		**0.08**
89-EC-SW/SD01	Jul-96	TCE	3	J	1,000	3.0E-03	TCE	ND		1,436,000		
		1,1,2,2-PCA	ND		17,000		1,1,2,2-PCA	ND		14,361,000		**3.0E-03**
89-EC-SW/SD02	Jul-96	TCE	18		1,000	1.8E-02	TCE	ND		1,436,000		
		1,1,2,2-PCA	150	J	17,000	8.8E-03	1,1,2,2-PCA	ND		14,361,000		**0.03**
89-EC-SW/SD03	Jul-96	TCE	16		1,000	1.6E-02	TCE	2400		1,436,000	1.7E-03	
		1,1,2,2-PCA	130	J	17,000	7.6E-03	1,1,2,2-PCA	1700		14,361,000	1.2E-04	**0.03**
89-EC-SW/SD04	Jul-96	TCE	26		1,000	2.6E-02	TCE	ND		1,436,000		
		1,1,2,2-PCA	72		17,000	4.2E-03	1,1,2,2-PCA	ND		14,361,000		**0.03**
89-EC-SW/SD05	Jul-96	TCE	24		1,000	2.4E-02	TCE	ND		1,436,000		
		1,1,2,2-PCA	80		17,000	4.7E-03	1,1,2,2-PCA	ND		14,361,000		**0.03**

ND - Not Detected
NA - Not Applicable
The USEPA stipulates an acceptable hazard level of less than or equal to 1.0

NOTE: The values calculated here are ***PRELIMINARY*** Risk Screening Values only and are considered ***CONFIDENTIAL***.

CURRENT CHILD TRESPASSER
SURFACE WATER EXPOSURE ASSESSMENT FOR RELATIVE RISK SCREENING
DETERMINING ACCEPTABLE CONCENTRATIONS
COMBINING INGESTION AND DERMAL ROUTES OF EXPOSURE
SITE 89/EDWARDS CREEK
MARINE CORPS BASE CAMP LEJEUNE, NORTH CAROLINA

PRGs from ingestion and dermal contact with surface water are calculated as follows:

PRGc (mg/L) = ICR/([Ing + Derm][CSF])
PRGnc (mg/L) = HQ*RfD/(Ing + Derm)

Ing = IR*EF*ET*ED/(ATc or ATnc*BW)
Derm = SA*EF*ET*PC*ED*CF/(ATc or ATnc*BW)

Where:	INPUTS
ICR = incremental cancer risk (unitless)	1.00E-06
HQ = hazard quotient (unitless)	1
PRGc = carcinogenic contaminant concentration in water (ug/L)	calculated
PRGnc = noncarcinogenic contaminant concentration in water (ug/L)	calculated
ATc = averaging time for carcinogen (days)	25550
ATnc = averaging time for noncarcinogen (days)	1460
CF = conversion factor (0.001 L/cm3)	0.001
CSF = cancer slope factor (mg/kg-day)-1	specific
RfD = reference dose (mg/kg-day)	specific
EF = exposure frequency (days/year)	100
IR = water ingestion rate (L/hour)	0.05
SA = skin surface area available for contact (cm2)	2300
ED = exposure duration (years)	4
BW = body weight (kg)	15
ET = exposure time (hours/day)	2.6
PC = permeability constant (cm/hr)	specific

Note: Inputs are scenario and site specific

Contaminant	ICR	HQ	Permeability Constant (cm/hr)	Slope Factor (mg/kg-day)-1	Dermally Adj. Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Dermally Adj. Ref. Dose (mg/kg-day)	Ingestion Dose Carc	Dermal Dose Carc	Ingestion Dose Noncarc	Dermal Dose Noncarc	PRG Carc (mg/L)	PRG Noncarc (mg/L)
Volatile Organic Compounds:													
Trichloroethene	1.00E-06	1.00E+00	1.60E-02	1.10E-02	1.38E-02	6.00E-03	4.80E-03	1.36E-04	9.99E-05	2.37E-03	1.75E-03	0.35	1
1,1,2,2-Tetrachloroethane	1.00E-06	1.00E+00	9.00E-03	2.00E-01	2.50E-01	6.00E-02	4.80E-02	1.36E-04	5.62E-05	2.37E-03	9.83E-04	0.02	17

Note: Inputs for the exposure parameters were taken from the Final Remedial Investigation Report for OU No. 16 (Sites 89 and 93), June 1998.

CURRENT CHILD TRESPASSER
SEDIMENT EXPOSURE ASSESSMENT FOR RELATIVE RISK SCREENING
DETERMINING ACCEPTABLE CONCENTRATIONS
COMBINING INGESTION AND DERMAL ROUTES OF EXPOSURE
SITE 89/EDWARDS CREEK
MARINE CORPS BASE CAMP LEJEUNE, NORTH CAROLINA

PRGs from accidental ingestion and dermal contact with sediment are calculated as follows:

PRGc (mg/kg) = ICR/[(Ing *CSFo)+ (Derm*CSFd)]
PRGnc (mg/kg) = HQ/[(Ing/RfDo) + (Derm/RfDd)]

Ing = IR*ED*EF*CF/ATc or ATnc*BW
Derm = SA*ED*EF*AF*ABS*CF/ATc or ATnc*BW

Where:

	INPUTS	
ICR = apportioned target incremental cancer risk, unitless	1E-06	
HQ = target hazard quotient, unitless	1.0	
PRGc = carcinogenic contaminant concentration in surface soil, mg/kg	calculated	
PRGnc = noncarcinogenic contaminant concentration in surface soil, mg/kg	calculated	
ATc = averaging time for carcinogen, days	25550	
ATnc = averaging time for noncarcinogen, days	1460	
CF = conversion factor, kg/mg	0.000001	
CSFo = oral cancer slope factor, (mg/kg-day)-1	CS	(chemical specific value)
CSFd = dermally adjusted cancer slope factor, (mg/kg-day)-1	CS	
RfDo = oral reference dose, mg/kg-day	CS	
RfDd = dermally adjusted reference dose, mg/kg-day	CS	
ED = exposure duration, years	4	
EF = exposure frequency, days/year	100	
IR = ingestion rate, mg/day	200	
BW = body weight, kg	15	
SA = skin surface area available for contact, cm2	2300	
AF = soil to skin adherence factor, mg/cm2	1	
ABS = Absorption Factor, unitless	CS	

Note: Inputs are scenario and site specific

Contaminant	Target ICR	Target HQ	Absorption Factor (unitless)	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	Dermally Adj. Slope Factor (mg/kg-day)-1	Derm. Adj. Ref. Dose (mg/kg-day)	Ingestion Dose Carc	Dermal Dose Carc	Ingestion Dose Noncarc	Dermal Dose Noncarc	PRG Carc (mg/kg)	PRG Noncarc (mg/kg)
Volatile Organic Compounds:													
Trichloroethene	1.0E-06	1.0	0.010	1.10E-02	6.00E-03	1.38E-02	4.80E-03	2.09E-07	2.40E-08	3.65E-06	4.20E-07	381	1,436
1,1,2,2-Tetrachloroethane	1.0E-06	1.0	0.010	2.00E-01	6.00E-02	2.50E-01	4.80E-02	2.09E-07	2.40E-08	3.65E-06	4.20E-07	21	14,361

Note: Inputs for the exposure parameters were taken from the Final Remedial Investigation Report for OU No. 16 (Sites 89 and 93), June 1998.

DRAFT CARCINOGENIC RELATIVE RISK SCREENING
FOR INDUSTRIAL WORKER SCENARIO
SURFACE SOIL/SUBSURFACE SOIL EXPOSURE
SITE 89
MCB CAMP LEJEUNE, NORTH CAROLINA

		SURFACE SOIL					SUBSURFACE SOIL					
Sample Location	Date Collected	Compound	Conc. (ug/kg)	Qualifier	Site-specific Acceptable Concentration (ug/kg)	Relative Risk-Carc.	Compound	Conc. (ug/kg)	Qualifier	Site-specific Acceptable Concentration (ug/kg)	Relative Risk-Carc.	RELATIVE RISK
89-SB04-01	Oct-99	Vinyl Chloride	NA		100		Vinyl Chloride	5900	J	100	5.90E-05	
		TCE	NA		6,000		TCE	ND		6,000		
		1,1,2,2-PCA	NA		1,000		1,1,2,2-PCA	ND		1,000		**5.90E-05**
89-SB04-02	Oct-99	Vinyl Chloride	NA		100		Vinyl Chloride	1400		100	1.40E-05	
		TCE	NA		6,000		TCE	1400		6,000	2.33E-07	
		1,1,2,2-PCA	NA		1,000		1,1,2,2-PCA	5300		1,000	5.30E-06	**1.95E-05**
89-SB05-01	Oct-99	Vinyl Chloride	NA		100		Vinyl Chloride	ND		100		
		TCE	NA		6,000		TCE	25000		6,000	4.17E-06	
		1,1,2,2-PCA	NA		1,000		1,1,2,2-PCA	780000		1,000	7.80E-04	**7.84E-04**
89-SB05-02	Oct-99	Vinyl Chloride	NA		100		Vinyl Chloride	ND		100		
		TCE	NA		6,000		TCE	ND		6,000		
		1,1,2,2-PCA	NA		1,000		1,1,2,2-PCA	18000000		1,000	1.80E-02	**1.80E-02**
89-SB33-01	Oct-99	Vinyl Chloride	NA		100		Vinyl Chloride	ND		100		
		TCE	NA		6,000		TCE	120000		6,000	2.00E-05	
		1,1,2,2-PCA	NA		1,000		1,1,2,2-PCA	1200000		1,000	1.20E-03	**1.22E-03**
89-SB33-02	Oct-99	Vinyl Chloride	NA		100		Vinyl Chloride	ND		100		
		TCE	NA		6,000		TCE	190000		6,000	3.17E-05	
		1,1,2,2-PCA	NA		1,000		1,1,2,2-PCA	2000000		1,000	2.00E-03	**2.03E-03**

ND - Not Detected
NA - Not Applicable
USEPA Region IV stipulates an acceptable cancer risk level of 1 x 10^{-6} or less.

NOTE: The values calculated here are PRELIMINARY Risk Screening Values only.

DRAFT NONCARCINOGENIC RELATIVE RISK SCREENING
FOR INDUSTRIAL WORKER SCENARIO
SURFACE SOIL/SUBSURFACE SOIL EXPOSURE
SITE 89
MCB CAMP LEJEUNE, NORTH CAROLINA

		SURFACE SOIL					SUBSURFACE SOIL					
Sample Location	Date Collected	Compound	Conc. (ug/kg)	Qualifier	Site-specific Acceptable Concentration (ug/kg)	Relative Risk-Noncarc.	Compound	Conc. (ug/kg)	Qualifier	Site-specific Acceptable Concentration (ug/kg)	Relative Risk-Noncarc.	**RELATIVE HAZARD QUOTIENT**
89-SB04-01	Oct-99	TCE	NA		5,630,000		TCE	ND		5,630,000		
		1,1,2,2-PCA	NA		56,296,000		1,1,2,2-PCA	ND		56,296,000		**ND**
89-SB04-02	Oct-99	TCE	NA		5,630,000		TCE	1400		5,630,000	2.5E-04	
		1,1,2,2-PCA	NA		56,296,000		1,1,2,2-PCA	5300		56,296,000	9.4E-05	**0.0**
89-SB05-01	Oct-99	TCE	NA		5,630,000		TCE	25000		5,630,000	4.4E-03	
		1,1,2,2-PCA	NA		56,296,000		1,1,2,2-PCA	780000		56,296,000	1.4E-02	**0.0**
89-SB05-02	Oct-99	TCE	NA		5,630,000		TCE	ND		5,630,000		
		1,1,2,2-PCA	NA		56,296,000		1,1,2,2-PCA	18000000		56,296,000	3.2E-01	**0.3**
89-SB33-01	Oct-99	TCE	NA		5,630,000		TCE	120000		5,630,000	2.1E-02	
		1,1,2,2-PCA	NA		56,296,000		1,1,2,2-PCA	1200000		56,296,000	2.1E-02	**0.04**
89-SB33-02	Oct-99	TCE	NA		5,630,000		TCE	190000		5,630,000	3.4E-02	
		1,1,2,2-PCA	NA		56,296,000		1,1,2,2-PCA	2000000		56,296,000	3.6E-02	**0.07**

ND - Not Detected
NA - Not Applicable
USEPA stipulates an acceptable hazard level of less than or equal to 1.0

NOTE: The values calculated here are PRELIMINARY Risk Screening Values only.
Vinyl chloride does not appear on this table because it is considered a carcinogen only.

CURRENT INDUSTRIAL WORKER
SURFACE SOIL AND SUBSURFACE SOIL EXPOSURE ASSESSMENT FOR RELATIVE RISK SCREENING
DETERMINING ACCEPTABLE CONCENTRATIONS
COMBINED INGESTION, DERMAL CONTACT, AND INHALATION ROUTES OF EXPOSURE
SITE 89
MARINE CORPS BASE CAMP LEJEUNE, NORTH CAROLINA

Cleanup Levels (CL) from accidental ingestion, dermal contact, and inhalation with/of soil are calculated as follows:

CLc (mg/kg) = ICR/[(Ing*CSFo) + (Derm*CSFd) + (Inh*CSFi)]
CLnc (mg/kg) = HQ/[(Ing/RfDo) + (Derm/RfDd) + (Inh/RfDi)]

Ing = IRs*ED*EF*CF/ATc or ATnc*BW
Derm = SA*ED*EF*AF*ABS*CF/ATc or ATnc*BW
Inh = IRa*(1/PEF) or (1/VF)*ED*EF/ATc or ATnc*BW

Where:

	INPUTS	
ICR = target incremental cancer risk, unitless	1E-06	
HQ = target hazard quotient, unitless	1.0	
CLc = carcinogenic contaminant concentration in surface soil, mg/kg	calculated	
CLnc = noncarcinogenic contaminant concentration in surface soil, mg/kg	calculated	
ATc = averaging time for carcinogen, days	25550	
ATnc = averaging time for noncarcinogen, days	9125	
CF = conversion factor, kg/mg	0.000001	
CSFo = oral cancer slope factor, (mg/kg-day)-1	CS	(chemical specific value)
CSFd = dermally adjusted cancer slope factor, (mg/kg-day)-1	CS	
CSFi = inhalation cancer slope factor, (mg/kg-day)-1	CS	
RfDo = oral reference dose, mg/kg-day	CS	
RfDd = dermally adjusted reference dose, mg/kg-day	CS	
RfDi = inhalation reference dose, mg/kg-day	CS	
ED = exposure duration, years	25	
EF = exposure frequency, days/year	250	
IRs = soil ingestion rate, mg/day	50	
IRa = inhalation rate, m3/day	20	
FI = Fraction Ingested, unitless	1	
BW = body weight, kg	70	
SA = skin surface area available for contact, cm2	4714	
AF = soil to skin adherence factor, mg/cm2	1	
ABS = Absorption Factor, unitless	CS	
PEF = Particulate Emission Factor, m3/kg	1.32E+09	
VF = Volitilization Factor, m3/kg	2.66E+03	(CS for Trichloroethene)
	1.20E+04	(CS for 1,1,2,2-Tetrachloroethane)
	1.11E+03	(CS for Vinyl Chloride)

Note: *Inputs are scenario and site specific*

Contaminant	Target ICR	Target HQ	Absorption Factor (unitless)	Oral Slope Factor (mg/kg-day)-1	Oral Reference Dose (mg/kg-day)	Dermally Adj. Slope Factor (mg/kg-day)-1	Derm. Adj. Ref. Dose (mg/kg-day)	Inhalation Slope Factor (mg/kg-day)-1	Inhalation Reference Dose (mg/kg-day)	Ingestion Dose Carc	Dermal Dose Carc	Inhalation Dose Carc	Ingestion Dose Noncarc	Dermal Dose Noncarc	Inhalation Dose Noncarc	Cleanup Level Carc (mg/kg)	Cleanup Level Noncarc (mg/kg)
Volatiles:																	
Trichloroethene	1.00E-06	1.0	1.00E-02	1.10E-02	6.00E-03	1.38E-02	4.80E-03	6.00E-03	--	1.75E-07	1.65E-07	2.63E-05	4.89E-07	4.61E-07	1.48E-10	6	5,630
1,1,2,2-Tetrachloroethane	1.00E-06	1.0	1.00E-02	2.00E-01	6.00E-02	2.50E-01	4.80E-02	2.00E-01	--	1.75E-07	1.65E-07	5.81E-06	4.89E-07	4.61E-07	1.48E-10	1	56,296
Vinyl Chloride	1.00E-06	1.0	1.00E-02	1.90E+00	--	2.38E+00	--	3.00E-01	--	1.75E-07	1.65E-07	6.32E-05	4.89E-07	4.61E-07	1.48E-10	0.1	--

DRAFT CARCINOGENIC RELATIVE RISK SCREENING
FOR CONSTRUCTION WORKER SCENARIO
SURFACE SOIL/SUBSURFACE SOIL EXPOSURE
SITE 89
MCB CAMP LEJEUNE, NORTH CAROLINA

		SURFACE SOIL					SUBSURFACE SOIL					
Sample Location	Date Collected	Compound	Conc. (ug/kg)	Qualifier	Site-specific Acceptable Concentration (ug/kg)	Relative Risk-Carc.	Compound	Conc. (ug/kg)	Qualifier	Site-specific Acceptable Concentration (ug/kg)	Relative Risk-Carc.	**RELATIVE RISK**
89-SB04-01	Oct-99	Vinyl Chloride	NA		1,000		Vinyl Chloride	5900	J	1,000	5.90E-06	
		TCE	NA		140,000		TCE	ND		140,000		
		1,1,2,2-PCA	NA		16,000		1,1,2,2-PCA	ND		16,000		**5.90E-06**
89-SB04-02	Oct-99	Vinyl Chloride	NA		1,000		Vinyl Chloride	1400		1,000	1.40E-06	
		TCE	NA		140,000		TCE	1400		140,000	1.00E-08	
		1,1,2,2-PCA	NA		16,000		1,1,2,2-PCA	5300		16,000	3.31E-07	**1.74E-06**
89-SB05-01	Oct-99	Vinyl Chloride	NA		1,000			ND		1,000		
		TCE	NA		140,000		TCE	25000		140,000	1.79E-07	
		1,1,2,2-PCA	NA		16,000		1,1,2,2-PCA	780000		16,000	4.88E-05	**4.89E-05**
89-SB05-02	Oct-99	Vinyl Chloride	NA		1,000			ND		1,000		
		TCE	NA		140,000		TCE	ND		140,000		
		1,1,2,2-PCA	NA		16,000		1,1,2,2-PCA	18000000		16,000	1.13E-03	**1.13E-03**
89-SB33-01	Oct-99	Vinyl Chloride	NA		1,000					1,000		
		TCE	NA		140,000		TCE	120000		140,000	8.57E-07	
		1,1,2,2-PCA	NA		16,000		1,1,2,2-PCA	1200000		16,000	7.50E-05	**7.59E-05**
89-SB33-02	Oct-99	Vinyl Chloride	NA		1,000					1,000		
		TCE	NA		140,000		TCE	190000		140,000	1.36E-06	
		1,1,2,2-PCA	NA		16,000		1,1,2,2-PCA	2000000		16,000	1.25E-04	**1.26E-04**

ND - Not Detected
NA - Not Applicable
USEPA Region IV stipulates an acceptable cancer risk level of 1 x 10^{-6} or less.

NOTE: The values calculated here are PRELIMINARY Risk Screening Values only.

DRAFT NONCARCINOGENIC RELATIVE RISK SCREENING
FOR CONSTRUCTION WORKER SCENARIO
SURFACE SOIL/SUBSURFACE SOIL EXPOSURE
SITE 89
MCB CAMP LEJEUNE, NORTH CAROLINA

		SURFACE SOIL					SUBSURFACE SOIL					
Sample Location	Date Collected	Compound	Conc. (ug/kg)	Qualifier	Site-specific Acceptable Concentration (ug/kg)	Relative Risk-Noncarc.	Compound	Conc. (ug/kg)	Qualifier	Site-specific Acceptable Concentration (ug/kg)	Relative Risk-Noncarc.	**RELATIVE HAZARD QUOTIENT**
89-SB04-01	Oct-99	TCE	NA		1,110,000		TCE	ND		1,110,000		
		1,1,2,2-PCA	NA		11,099,000		1,1,2,2-PCA	ND		11,099,000		**ND**
89-SB04-02	Oct-99	TCE	NA		1,110,000		TCE	1400		1,110,000	1.3E-03	
		1,1,2,2-PCA	NA		11,099,000		1,1,2,2-PCA	5300		11,099,000	4.8E-04	**0.0**
89-SB05-01	Oct-99	TCE	NA		1,110,000		TCE	25000		1,110,000	2.3E-02	
		1,1,2,2-PCA	NA		11,099,000		1,1,2,2-PCA	780000		11,099,000	7.0E-02	**0.1**
89-SB05-02	Oct-99	TCE	NA		1,110,000		TCE	ND		1,110,000		
		1,1,2,2-PCA	NA		11,099,000		1,1,2,2-PCA	18000000		11,099,000	1.6E+00	**1.6**
89-SB33-01	Oct-99	TCE	NA		1,110,000		TCE	120000		1,110,000	1.1E-01	
		1,1,2,2-PCA	NA		11,099,000		1,1,2,2-PCA	1200000		11,099,000	1.1E-01	**0.22**
89-SB33-02	Oct-99	TCE	NA		1,110,000		TCE	190000		1,110,000	1.7E-01	
		1,1,2,2-PCA	NA		11,099,000		1,1,2,2-PCA	2000000		11,099,000	1.8E-01	**0.35**

ND - Not Detected
NA - Not Applicable
USEPA stipulates an acceptable hazard level of less than or equal to 1.0

NOTE: The values calculated here are PRELIMINARY Risk Screening Values only.
Vinyl chloride does not appear on this table because it is considered a carcinogen only.

FUTURE CONSTRUCTION WORKER
SURFACE SOIL AND SUBSURFACE SOIL EXPOSURE ASSESSMENT FOR RELATIVE RISK SCREENING
DETERMINING ACCEPTABLE CONCENTRATIONS
COMBINED INGESTION, DERMAL CONTACT, AND INHALATION ROUTES OF EXPOSURE
SITE 89
MARINE CORPS BASE CAMP LEJEUNE, NORTH CAROLINA

Cleanup Levels (CL) from accidental ingestion, dermal contact, and inhalation with/of soil are calculated as follows:

CLc (mg/kg) = ICR/[(Ing*CSFo) + (Derm*CSFd) + (Inh*CSFi)]
CLnc (mg/kg) = HQ/[(Ing/RfDo) + (Derm/RfDd) + (Inh/RfDi)]

Ing = IRs*ED*EF*CF/ATc or ATnc*BW
Derm = SA*ED*EF*AF*ABS*CF/ATc or ATnc*BW
Inh = IRa*(1/PEF) or (1/VF)*ED*EF/ATc or ATnc*BW

Where:

	INPUTS	
ICR = apportioned target incremental cancer risk, unitless	1E-06	
HQ = target hazard quotient, unitless	1.0	
CLc = carcinogenic contaminant concentration in surface soil, mg/kg	*calculated*	
CLnc = noncarcinogenic contaminant concentration in surface soil, mg/kg	calculated	
ATc = averaging time for carcinogen, days	25550	
ATnc = averaging time for noncarcinogen, days	365	
CF = conversion factor, kg/mg	0.000001	
CSFo = oral cancer slope factor, (mg/kg-day)-1	CS	(chemical specific value)
CSFd = dermally adjusted cancer slope factor, (mg/kg-day)-1	CS	
CSFi = inhalation cancer slope factor, (mg/kg-day)-1	CS	
RfDo = oral reference dose, mg/kg-day	CS	
RfDd = dermally adjusted reference dose, mg/kg-day	CS	
RfDi = inhalation reference dose, mg/kg-day	CS	
ED = exposure duration, years	1	
EF = exposure frequency, days/year	250	
IRs = soil ingestion rate, mg/day	480	
IRa = inhalation rate, m3/day	20	
FI = Fraction Ingested, unitless	1	
BW = body weight, kg	70	
SA = skin surface area available for contact, cm2	5800	
AF = soil to skin adherence factor, mg/cm2	1	
ABS = Absorption Factor, unitless	CS	
PEF = Particulate Emission Factor, m3/kg	1.32E+09	
VF = Volitilization Factor, m3/kg	2.66E+03	(CS for Trichloroethene)
	1.20E+04	(CS for 1,1,2,2-Tetrachloroethane)
	1.11E+03	(CS for Vinyl Chloride)

Note: Inputs are scenario and site specific

Contaminant	Target ICR	Target HQ	Absorption Factor (unitless)	Oral Slope Factor (mg/kg-day)-1	Oral Reference Dose (mg/kg-day)	Dermally Adj. Slope Factor (mg/kg-day)-1	Derm. Adj. Ref. Dose (mg/kg-day)	Inhalation Slope Factor (mg/kg-day)-1	Inhalation Reference Dose (mg/kg-day)	Ingestion Dose Carc	Dermal Dose Carc	Inhalation Dose Carc	Ingestion Dose Noncarc	Dermal Dose Noncarc	Inhalation Dose Noncarc	Cleanup Level Carc (mg/kg)	Cleanup Level Noncarc (mg/kg)
Volatiles:																	
Trichloroethene	1.00E-06	1.0	1.00E-02	1.10E-02	6.00E-03	1.38E-02	4.80E-03	6.00E-03	--	6.71E-08	8.11E-09	1.05E-06	4.70E-06	5.68E-07	7.36E-05	140	1,110
1,1,2,2-Tetrachloroethane	1.00E-06	1.0	1.00E-02	2.00E-01	6.00E-02	2.50E-01	4.80E-02	2.00E-01	--	6.71E-08	8.11E-09	2.33E-07	4.70E-06	5.68E-07	1.63E-05	16	11,099
Vinyl Chloride	1.00E-06	1.0	1.00E-02	1.90E+00	--	2.38E+00	--	3.00E-01	--	6.71E-08	8.11E-09	2.53E-06	4.70E-06	5.68E-07	1.77E-04	1	--

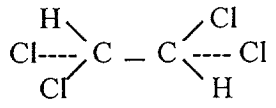
Note: Inputs for the exposure parameters were taken from the Final Remedial Investigation Report for OU No. 16 (Sites 89 and 93), June 1998.

Date of Last Revision: 12/14/99
Reviser: Heather L. Govenor

1,1,2,2-TETRACHLOROETHANE

INTRODUCTION:

Chemical Name: 1,1,2,2-Tetrachloroethane
CAS Number: 79-34-5
Molecular Formula: $C_2H_2Cl_4$
Molecular Weight (1): 167.86 g/mole
Chemical Structure:



Synonyms (1): acetylene tetrachloride; bonoform; cellon; 1,1-di-chloro-2,2-dichloroethane; sym-tetrachloroethane; tetrachloroethane; TCE; westron; NCI-C03554; acetosol; boroform; RCRA Waste Number U209; tetrachloroethane; UN1702

PHYSICAL PROPERTIES:

Liquid (1)
Clear, colorless to pale yellow (1)
Sweet, pungent, chloroform-like odor; odor threshold 0.5 ppm (1)
Melting Point (1): -36 °C
Boiling Point (1): 146 °C
Flash Point (1): non-flammable
Upper Explosivity Limit (UEL) (1): Not available
Lower Explosivity Limit (LEL): (1) Not available
Water Solubility (2): 2.90E+03 mg/L
Vapor Pressure (1): 5 mmHg @ 21 °C
Specific Gravity (1): 1.58658 @ 25 / 4 °C (sinks in water)
Density (1): 1.586 g/mL
Evaporation Rate (1): 0.65

CHEMICAL CHARACTERISTICS:

Henry's Law Constant (2): 3.81E-04 atm-m3/mole
Octanol carbon coefficient (Koc) (3): Log Koc (2): 2.35
Octanol water coefficient (Kow) (3): Log Kow (2): 2.39
Bioconcentration factor (BCF), fish (2): 42 L/kg:

FATE AND TRANSPORT:

1,1,2,2-Tetrachloroethene, when released into the environment, will move into the air or groundwater. It is not known to attach to soil particles. This compound is sensitive to ultraviolet light and heat. In surface water environments, much of the chemical will evaporate into the air, where half of it will break down within two months. Hydrolysis will occur upon contact with water; however, breakdown is slow. Half of the amount present in groundwater can be expected to degrade in thirteen months (1, 4).

USES (1,5):

- Solvent for fats, oils, waxes, resins, cellulose acetate, rubber, copal, phosphorous, sulfur, chlorinated rubber
- Used in the manufacture of paint, varnish, rust removers, herbicides, insecticides, lacquers, photographic film, bleach, cement, artificial silk, leather, and pearls
- Intermediate in the manufacture of trichloroethene and other chlorinated hydrocarbons
- Alcohol denaturant, dry cleaning agent

HUMAN HEALTH EFFECTS:

Acute/ Chronic Toxicity

1,1,2,2,-Tetrachloroethene is considered to be the most toxic of the common chlorinated hydrocarbons (1). It is highly toxic by ingestion, inhalation, skin absorption, and skin or eye contact. Target organs include the skin, liver, kidneys, central nervous system and gastrointestinal tract.

Teratogenic effects are unknown (1).

Symptoms of exposure may include the following (1,5,9).

- *Skin*: dryness, scaling, inflammation, irritation, dermatitis, jaundice, pupuric rashes, deep dusky coloration, sweating,
- *Liver*: acute yellow atrophy, cirrhosis, tenderness, dysfunction, necrosis, pain
- *Kidneys and Heart*: albumin and casts in the urine, kidney damage, fatty degeneration of the kidneys and heart, pulmonary damage, weak pulse, cardiac irregularity
- *Central nervous system*: drowsiness, headache, tremor, fatigue, insomnia, irritability, dizziness, changes in the brain and peripheral nerves, restlessness, unconsciousness, general anesthesia, somnolence, hallucinations, distorted perceptions, coma, death, delirium, convulsions, CNS depression, loss of knee-jerk, loss of ocular and pharyngeal reflexes, confusion, stupor
- *Gastrointestinal tract*: abdominal pain, constipation, loss of appetite, nausea, vomiting

Exposure Limits (4):

- Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL): 5 ppm; occupational 8 hr/day, 40 hr/wk.
- National Institute for Occupational Safety and Health (NIOSH) maximum exposure level: 1 ppm; occupational 10 hr/day, 40 hr/wk.
- The American Conference of Governmental Industrial Hygienists (ACGIH) exposure limit: 6.9 mg/m3; occupational 8 hr/day, 40 hr/wk.

Non-carcinogenic

Drinking water unit risk: 5.8E-6 per (ug/L) (6).
Oral Reference Dose (RfDo): 6.00E-02 per (mg/kg)/day (7)
Inhalation Reference Dose (RfDi): Not Available (7)

The following risk-based concentrations (RBCs) were derived by the USEPA (7):

Tap water RBC = 5.3E-02 μg/L
Ambient air RBC = 3.1E-02 μg/m^3
Fish RBC = 1.6E-02 mg/kg
Soil Industrial RBC = 2.9E+01 mg/kg
Soil Residential RBC = 3.2E+00 mg/kg

Carcinogenic

Carcinogenicity assessment by U.S. Environmental Protection Agency (USEPA): Class C – possible human carcinogen (based on the increased incidence of hepatocellular carcinomas in mice) (6).
Classified as a "de minimus" carcinogen by the U.S. Occupational Safety and Health Administration (OSHA) (meaning that the minimum amount of the chemical set by OSHA is considered to be carcinogenic) (5).

Drinking water unit risk (6) = 5.8 E-6 per μg/L
Oral CSFo (6) = 2.0E-01 per mg/kg/day
Inhalation CSFi (6) = Not Available
Inhalation unit risk (6)= 5.8 E-05 per μg/cubic m

Region III does provide an inhalation cancer slope factor in their risk based concentration tables (7).

ENVIRONMENTAL HEALTH EFFECTS:

No wildlife no-observed-adverse-effects-levels (NOAELS) have been established for 1,1,2,2,-Tetrachloroethane (10). Additionally no surface soil screening levels have been established (3,11).

USEPA Region IV screening values for freshwater surface water (12):
Acute: 932 μg/L
Chronic: 240 μg/L

REFERENCES:

1. NTP Chemical Repository – 1,1,2,2-Tetrachloroethane. Radian Corporation, August 29, 1991. http://ehis.niehs.nih.gov/ntp/chem_hs/NTP_Chem7/radian79-34-5.txt accessed December 13, 1999.

2. Superfund Public Health Evaluation Manual. Office of Emergency and Remedial Response, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C. October 1986. EPA 540/1-86/060

3. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota: 1997 Revision. D.S. Jones, G.W. Suter, II, and R.N. Hull. Prepared for the U.S. Department of Energy, Office of Environmental Management. November 1997. ES/ER/TM-95/R4.

4. 1,1,2,2-Tetrachloroethane ToxFAQs. U.S. Department of Health and Human Services Public Health Service, Agency for Toxic Substances and Disease Registry. http://www.atsdr.cdc.gov/tfacts93.html accessed December 13, 1999.

5. Environment Writer: 1,1,2,2-Tetrachloroethane (C2H2Cl4) Chemical Backgrounder. Environmental Health Center, National Safety Council. July 1, 1997. http://www.nsc.org/ehc/ew/chems/112tetra.htm accessed December 10, 1999.

6. 1,1,2,2-Tetrachloroethane. Integrated Risk Information System. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. 1999. http://www.epa.gov/IRIS/subst/0193.htm accessed December 10, 1999.

7. EPA Region III Risk-Based Concentration (RBC) Table. U.S. Environmental Protection Agency, Philadelphia, PA. October 7, 1999.

8. Drinking Water Regulations and Health Advisories. U.S. Environmental Protection Agency, Office of Water. Washington, D.C. October, 1996. EPA 822-B-96-002.

9. NIOSH Pocket Guide to Chemical Hazards. U.S. Department of Health and Human Services, Public health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. June 1997.

10. Toxicological Benchmarks for Wildlife: 1996 Revision. B.E. Sample, D.M. Opresko, G.W. Suter, II. Prepared for the U.S. Department of Energy, Office of Environmental Management. June 1996. ES/ER/TM-86/R3.

11. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision. R.A. Efroymson, M.E. Will, G.W. Suter, II, A.C. Wooten. Prepared for the U.S. Department of Energy, Office of Environmental Management. November 1997. ES/ER/TM-85/R3.

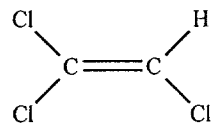
12. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Aquatic Biota: 1996 Revision. G.W. Suter, II, C.L. Tsao. Prepared for the U.S. Department of Energy, Office of Environmental Management. June 1996. ES/ER/TM-96/R2.

Date of Last Revision: 12/14/99
Reviser: Heather L. Govenor

TRICHLOROETHENE

INTRODUCTION:

Chemical Name: Trichloroethene
CAS Number: 79-01-6
Molecular Formula: C_2HCl_3
Molecular Weight (1): 131.40 g/mole
Chemical Structure:



Synonyms (1): acetylene trichloride; 1-chloro-2,2-dichloroethylene; 1,1-dichloro-2-chloroethylene; ethinyl trichloride; ethylene trichloride; trichloroethylene; 1,1,2-trichloroethylene; 1,2,2-trichloroethylene; algylen; anamenth; benzinol; blacosolv; cecolene; chlorilen; chlorylea; chlorylen; chorylen; circosolv; crawhaspol; densinfluat; dow-tri; dukeron; fleck-flip; flock flip; fluate; gemalgene; germalgene; lanadin; lethurin; narcogen; narkogen; narkosoid;; NCI-C04546; nialk; perm-a-chlor; perm-a-clor; petzinol; philex; RCRA Waste Number U228; TCE; threthylen; threthylene; trethylene; tri; triad; trial; triasol; trichloran; trichloren; tri-clene; trielene; trielin; triklone; trilen; trilene; triline; trimar; triol; tri-plus; tri-plus M; UN 1710;; vestrol; vitran; westrosol; trichloroethylene; trieline

PHYSICAL PROPERTIES:

Liquid (1)
Colorless (1)
Sweet odor similar to ether or chloroform (1)
Sweet, burning taste (1)
Melting Point (1): -79°C
Boiling Point (1): 87°C
Flash Point (1): >93.3°C; probably non-flammable
Upper Explosivity Limit (UEL) (1): 90%
Lower Explosivity Limit (LEL) (1): 12.5%
Water Solubility (1): <1 mg/mL @ 21°C
Vapor Pressure (2): 17.8 mmHg
Specific Gravity (1): 1.4649 @ 20 / 4°C (sinks in water)
Density (1): 1.460 – 1.466 g/mL @ 20°C
Evaporation Rate (1): 0.28
Manufactured; not naturally occurring (5)

CHEMICAL CHARACTERISTICS:

Henry's Law Constant (2): 2.59E-02 (atm-m^3/mol)
Octanol carbon coefficient (Koc) (3): Log Koc : 2.66
Octanol water coefficient (Kow) (3): Log Kow: 2.71
Bioconcentration factor (BCF) (2); fish: 10.6

FATE AND TRANSPORT:

Trichloroethene dissolves readily into water where it can remain for an extended period of time. It will volatilize from the top of surface water and can commonly be found as a vapor in the air. It is sensitive to light and moisture and is heat sensitive. Trichloroethene may adsorb to soil particles and can be persistent in soils. It also adsorbs to particulates in water, and may settle with particulates into the sediment (1,4).

USES (1,5):

- Dry cleaning agent, metal degreaser, dilutent for paints and adhesives
- Solvent for fats, greases, waxes, dyeing; oils, household cleaners, and industrial solvent
- Refrigerant, fumigant, heat exchange liquid, disinfectant, detergent, extractant in food processing
- Intermediate in synthesis of organic compounds, pesticides, gums, resins, tars, paints, varnishes

HUMAN HEALTH EFFECTS:

Acute/ Chronic Toxicity

Trichloroethene is toxic by inhalation, ingestion, and skin absorption. Target organs include eyes, skin, respiratory system, heart, liver, and the central nervous system (9).

Trichloroethene is an experimental teratogen (1).

Symptoms of exposure may include the following (1,5,9):

- *Skin*: irritation, jaundice associated with acute yellow atrophy of the liver, defatting with prolonged exposure may lead to erythema, burning sensation, "Degreaser's flush" (reddening of the skin if alcohol is consumed shortly before of after exposure), rashes
- *Eyes*: irritation, visual impairment, trigeminal and oculomotor nerve paralysis, optic or retrobulbar necrosis, optic atrophy, blurred vision
- *Kidneys*: kidney damage, hepatorenal failure
- *Heart*: death due to ventricular fibrillation resulting in cardiac failure, irregular pulse, ventricular arrhythmias, pulmonary edema
- *Central Nervous System (CNS)*: headache, dizziness, unconsciousness, hallucinations, distorted perceptions, drowsiness, incoordination, impaired judgement, CNS depression, excitement, mild euphoria, coma, mental confusion, amnesia, numbness, paralysis of the fingers, death upon inhalation of large amounts, damage to facial nerves, anorexia
- *Gastrointestinal tract*: nausea, vomiting, irritation, diarrhea, abdominal pain
- *Respiratory*: wheezing, respiratory failure, irritation
- *Other*: painful joints

Exposure Limits (9):

- Occupational Safety and Health Administration (OSHA) permissible exposure limit/ time-weighted average (PEL): 100 ppm
- OSHA short-term exposure limit: 200 ppm
- OSHA 5-minute maximum peak exposure in any two hours: 300 ppm

Non-carcinogenic

Federal Maximum Contaminant Level (MCL) in drinking water (8): 0.005 mg/L
Oral Reference Dose (RfDo) (6): Not Available
Inhalation Reference Dose (RfDi) (8): Not Available

The following risk-based concentrations (RBCs) were derived by the USEPA (8):

Tap water RBC = 1.6E+00 μg/L
Ambient air RBC = 1.0E+00 μg/m^3
Fish RBC = 2.9E-01 mg/kg
Soil Industrial RBC = 5.2E+02 mg/kg
Soil Residential RBC = 5.8E+01 mg/kg

Carcinogenic

- Carcinogenicity assessment by the USEPA is in preparation; the original assessment was withdrawn (6).
- Classified as a carcinogen by the National Institute for Occupational Safety and Health (NIOSH) (1).
- Not classifiable as to human carcinogenicity according to the International Agency for Research on Cancer (IARC) (4).

The USEPA has not established inhalation or oral cancer slope factors (CSF) for trichloroethene (7).

Oral CSFo = Not Available
Inhalation CSFi = Not Available

Region III does provide cancer slope factors in their risk based concentration tables (7).

ENVIRONMENTAL HEALTH EFFECTS:

No surface soil screening levels have been established (3,11).
USEPA Region IV screening values for freshwater surface water (12):

Acute: 528 μg/L Chronic: 84 μg/L

Estimated wildlife No-observed-adverse-effects-level (NOAEL) (10):

Wildlife Species	Estimated NOAEL (mg/kg/day)
Little Brown Bat	0.990
Short-tailed Shrew	0.832
White-footed mouse	0.756
Meadow Vole	0.636
Mink	0.291
Cottontail Rabbit	0.278
Red Fox	0.200
River Otter	0.173
Whitetail Deer	0.106

REFERENCES:

1. NTP Chemical Repository – Trichloroethylene. Radian Corporation, August 29, 1991. http://ehis.niehs.nih.gov/ntp/chem_hs/NTP_Chem7/radian79-01-6.txt accessed December 13, 1999.

2. Superfund Public Health Evaluation Manual. Office of Emergency and Remedial Response, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C. October 1986. EPA 540/1-86/060

3. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota: 1997 Revision. D.S. Jones, G.W. Suter, II, and R.N. Hull. Prepared for the U.S. Department of Energy, Office of Environmental Management. November 1997. ES/ER/TM-95/R4.

4. Trichloroethylene (TCE) ToxFAQs. U.S. Department of Health and Human Services Public Health Service, Agency for Toxic Substances and Disease Registry. http://www.atsdr.cdc.gov/tfacts19.html accessed December 13, 1999.

5. Environment Writer: Trichloroethylene (C2HCl3) Chemical Backgrounder. Environmental Health Center, National Safety Council. July 1, 1997. http://www.nsc.org/ehc/ew/chems/trichlor.htm accessed December 10, 1999.

6. Trichloroethylene. Integrated Risk Information System. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. 1999. http://www.epa.gov/IRIS/subst/0199.htm accessed December 10, 1999.

7. EPA Region III Risk-Based Concentration (RBC) Table. U.S. Environmental Protection Agency, Philadelphia, PA. October 7, 1999.

8. Drinking Water Regulations and Health Advisories. U.S. Environmental Protection Agency, Office of Water. Washington, D.C. October, 1996. EPA 822-B-96-002.

9. NIOSH Pocket Guide to Chemical Hazards. U.S. Department of Health and Human Services, Public health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. June 1997.

10. Toxicological Benchmarks for Wildlife: 1996 Revision. B.E. Sample, D.M. Opresko, G.W. Suter, II. Prepared for the U.S. Department of Energy, Office of Environmental Management. June 1996. ES/ER/TM-86/R3.

11. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision. R.A. Efroymson, M.E. Will, G.W. Suter, II, A.C. Wooten. Prepared for the U.S. Department of Energy, Office of Environmental Management. November 1997. ES/ER/TM-85/R3.

12. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Aquatic Biota: 1996 Revision. G.W. Suter, II, C.L. Tsao. Prepared for the U.S. Department of Energy, Office of Environmental Management. June 1996. ES/ER/TM-96/R2.

TABLE 1

SITE 89 COST ESTIMATE
TIME CRITICAL REMOVAL ACTION
SOIL EXCAVATION AND TREATMENT BY LOW TEMPERATURE THERMAL DESORPTION (LTTD)
APRIL 19, 2000

Cost Component	Unit	Quantity	Unit Cost	Subtotal Cost	Total Cost	Source	Basis/Comments
General							
Pre-construction Submittals	LS	1	$20,000	$20,000		Engr. Est.	Work Plan, E&S Plan, H&S Plan, QC Plans; Shop Drawings
Mobilization/Demobilization	LS	1	$200,000	$200,000		Engr. Est.	Includes mob/demob for LTTD equipment
Post-Construction Submittals	LS	1	$10,000	$10,000		Engr. Est.	Record drawings, etc.
General - Subtotal					**$230,000**		
Site Work							
Clearing and Grubbing	Acre	0.5	2,275	$1,138		Engr. Est.; Means Site Work, 1999, 021-104-0010	Cut and chip light trees (up to 6" diameter) to extend chain-link fence south to encompass Edwards Creek.
Temporary Safety Fencing	LF	400	$3.38	$1,352		Engr. Est.; Means Site Work, 1999, 028-320-5000	Assumes safety fencing along northern boundary of work area
Temporary Silt Fencing	LF	700	$0.73	$511		Engr. Est.; Means Site Work, 1999, 022-704-1000	Assumes silt fencing downslope of excavation area
Concrete Pad for LTTD Equipment	CY	555	$67.00	$37,185		Means Site Work, 2000, 03310-220-0100	Dimensions of 100' x 100' x 18" thick (assume left on site)
Contaminated Soil Stockpile/Dewatering Pad	LS	1	$15,000	$15,000		Engr. Est.	Assumes geonet, concrete sumps, asphalt base/berms
Decontamination Pad	LS	1	$10,000	$10,000		Engr. Est.	Includes decon pad, equipment & supplies during construction
Replace Fence	LF	375	$7.17	$2,689		Engr. Est.: Means Site Work, 1999, 028-308-0920	Excavation will require removal of existing DRMO fence - Includes cost to reinstall existing fence around the DRMO; assumes that existing fencing materials will be reused
Install New Fence	LF	1085	$25.12	$27,255		Engr. Est.; Means Site Work, 1999, 028-308-0920	New fence will be installed as discussed during March 4, 2000 partnering meeting to enclose Edwards Creek; 8' high, 6-gage wire fence
Replace/Maintain Existing Temporary Cap (HDPE/tarp)	SY	4500	$1.50	$6,750		Engr Est	Assumes existing temporary cap materials will be replaced; additional materials will be purchased for 1/3 of area
Site Work - Subtotal					**$101,879**		

ATTACHMENT D
COST ESTIMATES

TABLE 1 (continued)

SITE 89 COST ESTIMATE
TIME CRITICAL REMOVAL ACTION
SOIL EXCAVATION AND TREATMENT BY LOW TEMPERATURE THERMAL DESORPTION (LTTD)
APRIL 19, 2000

Cost Component	Unit	Quantity	Unit Cost	Subtotal Cost	Total Cost	Source	Basis/Comments
On Site LTTD Operations							
Health and Safety Oversight (1)	HR	750	$50	$37,500		Engr. Est.	Assume H&S person on site for the duration of on-site excavation and/or treatment activities (15 weeks, 75 days, 10 hrs/day)
Construction Superintendent (1)	HR	1200	$75	$90,000		Engr. Est.	Assume superintendent on site for the duration of project (6 months, 120 days, 10 hrs/day)
Contractor Travel/Per Diem (2)	LS	1	$37,250	$37,250		Engr. Est.	Airfare, per diem, hotel, rental car for 195 days
Excavation of Contaminated Soil / On-Site Handling of Contaminated Soil	CY	10000	$5.04	$50,400		Means Site Work, 2000, A12.1-414, 2600	Assume 5 feet ave depth of excavation using 1-1/2 CY backhoe, 2 dump trucks, 1-mile round-trip haul
LTTD Performance Testing	LS	1	$60,000	$60,000		Average of vendor quotes (Four Seasons, Williams)	Assumes 3 - 4 day performance test, includes all labor, equipment, materials, testing
On Site LTTD Treatment	Ton	15,000	$80	$1,200,000		Average of vendor quotes (Four Seasons, Williams, Enviro-Klean, Roy F. Weston, Soil Solutions)	Includes off-gas treatment, fuel and other operating costs, operator labor. LTTD asumed to operate at 200 tons per day, 5 days per week; estimated duration of LTTD operation is 15 weeks (3.75 months); soils treated to Region IX Industrial PRGs;
Backfill of Treated Soil / On-Site Handling of Treated Soil	CY	10000	$3.38	$33,800		Means Site Work, 2000, A12.1-724, 1900	Assume backfill of excavation using 105 HP dozer & roller compactors, 150' haul, 8" lifts, 2 passes
Confirmatory Sampling - On-Site Mobile Laboratory / VOC Analysis	WK	15	$2,500	$37,500		Vendor Quote (S2C2, Inc.)	Up to 12 VOC analyses per day; includes mobilization, chemist, all mobile lab costs, per diem
Utilities Connections - Electric	LS	1	$15,000	$15,000		Engr Est.	Assume 3-phase power available at DRMO. Extension of power to LTTD and trailer, one transformer required.
Utilities Connections - Water	LS	1	$5,000	$5,000		Engr Est.	Extend existing water line to LTTD and trailer.
Utilities Connections - Telephone	LS	1	$1,000	$1,000		Engr Est.	Installation of 5 standard phone lines in on-site trailer.
Utilities Connections - Electric	MO	6	$1,000	$6,000		Engr Est.	Six months of electric service for LTTD and trailer
Utilities Connections - Telephone	MO	6	$1,000	$6,000		Engr Est.	Six months of telephone service for trailer
Construction Trailer	MO	6	$500	$3,000		Engr. Est.	Six months, one construction trailer
Miscellaneous Expenses	WK	15	$500	$7,500		Engr. Est.	Air monitoring equip, Hnu rental, H&S equip, PPE, sampling & decon expendables during excavation/LTTD activity
On Site LTTD Operations - Subtotal					**$1,589,950**		
TOTAL CAPITAL COSTS					**$1,921,829**		
GENERAL & ADMINSITRATIVE (8% of total capital cost)					**$153,746**		
TOTAL ESTIMATED PROJECT COST (excludes award fee)					**$2,075,576**		

Note 1 - Estimate assumes all other labor costs included in work items.

Note 2 - All other labor assumed to come from local labor pool. (no travel costs).

TABLE 2

SITE 89 COST ESTIMATE
ALTERNATIVE TIME CRITICAL REMOVAL ACTION
SOIL EXCAVATION AND TREATMENT BY OFF-SITE INCINERATION
APRIL 26, 2000

Cost Component	Unit	Quantity	Unit Cost	Subtotal Cost	Total Cost	Source	Basis/Comments
General							
Pre-construction Submittals	LS	1	$20,000	$20,000		Engr. Est.	Work, E&S, H&S, & QC Plans; Permits; Shop Drawings
Mobilization/Demobilization	LS	1	$20,000	$20,000		Engr. Est.	Includes mob/demob for excavation equipment
Post-Construction Submittals	LS	1	$10,000	$10,000		Engr. Est.	Record drawings, etc.
General - Subtotal					**$50,000**		
Site Work							
Clearing and Grubbing	Acre	0.5	2,275	$1,138		Means Site Work, 1999, 021-104-0010	Cut and chip light trees (up to 6" diameter) in order to install fence along Edwards Creek.
Temporary Safety Fencing	LF	400	$3.38	$1,352		Means Site Work, 1999, 028-320-5000	Assumes safety fencing around excavated areas
Temporary Silt Fencing	LF	700	$0.73	$511		Means Site Work, 1999, 022-704-1000	Assumes silt fencing downgradient from excavated areas
Contaminated Soil Stockpile/Dewatering Pad	LS	1	$15,000	$15,000		Engr. Est.	Assumes geonet, concrete sumps, asphalt base/berms
Decontamination Pad	LS	1	$10,000	$10,000		Engr. Est.	Includes decon/laydown area
Replace Fence	LF	375	$7.17	$2,689		Means Site Work, 1999, 028-308-0920	Includes labor and equipment to reinstall existing fence around the DRMO; assumes that existing fence will be reused (no material costs)
Install New Fence	LF	1085	$25.12	$27,255		Means Site Work, 1999, 028-308-0920	New fence will be installed; 8' high, 6 gage wire fence will be extended from the southeast and southwest corners of the existing DRMO fence to Edwards Creek. The fence will run along the southern side of creek so access to surface water and sediment will be prevented.
Replace/Maintain Existing Temporary Cap (HDPE/tarp)	SY	4500	$1.50	$6,750		Engr Est	Assumes existing temporary cap materials will be replaced; additional materials will be purchased for 1/3 of area
Site Work - Subtotal					**$64,694**		

TABLE 2 (continued)

SITE 89 COST ESTIMATE
ALTERNATIVE TIME CRITICAL REMOVAL ACTION
SOIL EXCAVATION AND TREATMENT BY OFF-SITE INCINERATION
APRIL 26, 2000

Cost Component	Unit	Quantity	Unit Cost	Subtotal Cost	Total Cost	Source	Basis/Comments
Off-Site Incineration Operations							
Health and Safety Oversight (1)	HR	200	$50	$10,000		Engr. Est.	H&S person for duration of on-site excavation activities (4 weeks); performs confirmatory sampling
Construction Superintendent (1)	HR	400	$75	$30,000		Engr. Est.	Assume superintendent on site for the duration of project (8 weeks, 40 days, 10 hrs/day)
Contractor Travel/Per Diem (2)	LS	1	$12,000	$12,000		Engr. Est.	Airfare, per diem, hotel, rental car for 60 days
Excavation of Contaminated Soil / On-Site Handling of Contaminated Soil	CY	10000	$3.42	$34,200		Means Site Work, 1999, 022-238-4200	
Loading of Soil	CY	12000	$1.97	$23,640		Means Site Work, 1999, 022-238-0260 Means Site Work, 1999, 022-238-0020	Assumes 1.2 bulking factor of in place cubic yards
Transportation and Off-Site Incineration	Ton	15,000	$600	$9,000,000		Vendor quote (Safety Kleen)	Includes transport, incineration and taxes
Loading & Hauling of Clean Backfill	CY	10000	$11.55	$115,500		2000 Means Site Work, 02320-200-1255	Assumes 20-mile round-trip from borrow pit
Backfill of Clean Soil / On-Site Handling of Clean Soil	CY	10000	$1.72	$17,200		2000 Means Site Work, 02315-120-3220 2000 Means site Work, 02315-300-5680	Sheepsfoot compactor, 12" lifts, 2 passes
Confirmatory Sampling - On-Site Mobile Laboratory / VOC Analysis	WK	4	$2,500	$10,000		Vendor Quote (S2C2, Inc.)	Up to 12 VOC analyses per day; includes mobilization, chemist, all mobile lab costs, per diem
Utilities Connections - Electric	LS	1	$5,000	$5,000		Engr Est.	Assume 3-phase power available at DRMO. Extension of power to trailer, one transformer required.
Utilities Connections - Water	LS	1	$5,000	$5,000		Engr Est.	Extend existing water line to trailer.
Utilities Connections - Telephone	LS	1	$1,000	$1,000		Engr Est.	Installation of 5 standard phone lines in on-site trailer.
Utilities Connections - Electric	MO	2	$1,000	$2,000		Engr Est.	Two months of electric service for trailer
Utilities Connections - Telephone	MO	2	$1,000	$2,000		Engr Est.	Two months of telephone service for trailer
Construction Trailer	MO	2	$500	$1,000		Engr. Est.	Two months, one construction trailer
Miscellaneous Expenses	WK	8	$500	$4,000		Engr. Est.	Air monitoring, H&S equip, PPE, sampling & decon expendables during excavation activity
Off-Site Incineration Operations - Subtotal					**$9,272,540**		
TOTAL CAPITAL COSTS					**$9,387,234**		
GENERAL & ADMINSITRATIVE (8% of total capital cost)					**$750,979**		
TOTAL ESTIMATED PROJECT COST (excludes award fee)					**$10,138,213**		

Note 1 - Estimate assumes all other labor costs included in work items.

Note 2 - All other labor assumed to come from local labor pool. (no travel costs).

TABLE 3

SITE 89 COST ESTIMATE
ALTERNATIVE TIME CRITICAL REMOVAL ACTION
SOIL EXCAVATION AND TREATMENT BY OFF-SITE LANDFILL DISPOSAL
APRIL 26, 2000

Cost Component	Unit	Quantity	Unit Cost	Subtotal Cost	Total Cost	Source	Basis/Comments
General							
Pre-construction Submittals	LS	1	$20,000	$20,000		Engr. Est.	Work, E&S, H&S, & QC Plans; Permits; Shop Drawings
Mobilization/Demobilization	LS	1	$20,000	$20,000		Engr. Est.	Includes mob/demob for excavation equipment
Post-Construction Submittals	LS	1	$10,000	$10,000	Engr. Est.	Record drawings, etc.	Record drawings, etc.
General - Subtotal					**$50,000**		
Site Work							
Clearing and Grubbing	Acre	0.5	2,275.00	$1,138		Means Site Work, 1999, 021-104-0010	Cut and chip light trees (up to 6" diameter) in order to install fence along Edwards Creek.
Temporary Safety Fencing	LF	400	3.38	$1,352		Means Site Work, 1999, 028-320-5000	Assumes safety fencing around excavated areas
Temporary Silt Fencing	LF	700	0.73	$511		Means Site Work, 1999, 022-704-1000	Assumes silt fencing downgradient from excavated areas
Contaminated Soil Stockpile/Dewatering Pad	LS	1	$15,000	$15,000		Engr. Est.	Assumes geonet, concrete sumps, asphalt base/berms
Decontamination Pad	LS	1	$10,000	$10,000		Engr. Est.	Includes decon/laydown area
Replace Fence	LF	375	7.17	$2,689		Means Site Work, 1999, 028-308-0920	Includes labor and equipment to reinstall existing fence around the DRMO; assumes that existing fence will be reused (no material costs)
Install New Fence	LF	1085	25.12	$27,255		Means Site Work, 1999, 028-308-0920	New fence will be installed; 8' high, 6 gage wire fence will be extended from the southeast and southwest corners of the existing DRMO fence to Edwards Creek. The fence will run along the southern side of creek so access to surface water and sediment will be prevented.
Replace/Maintain Existing Temporary Cap (HDPE/tarp)	SY	4500	1.50	$6,750		Engr Est	Assumes existing temporary cap materials will be replaced; additional materials will be purchased for 1/3 of area
Site Work - Subtotal					**$64,694**		

TABLE 3 (continued)

SITE 89 COST ESTIMATE
ALTERNATIVE TIME CRITICAL REMOVAL ACTION
SOIL EXCAVATION AND TREATMENT BY OFF-SITE LANDFILL DISPOSAL
APRIL 26, 2000

Cost Component	Unit	Quantity	Unit Cost	Subtotal Cost	Total Cost	Source	Basis/Comments
Off-Site Landfill Operations							
Health and Safety Oversight (1)	HR	200	$50	$10,000		Engr. Est.	H&S person for duration of on-site excavation activities (4 weeks); performs confirmatory sampling
Construction Superintendent (1)	HR	400	$75	$30,000		Engr. Est.	Assume superintendent on site for the duration of project (8 weeks, 40 days, 10 hrs/day)
Contractor Travel/Per Diem (2)	LS	1	$12,000	$12,000		Engr. Est.	Airfare, per diem, hotel, rental car for 60 days
Excavation of Contaminated Soil / On-Site Handling of Contaminated Soil	CY	10000	$3.42	$34,200		Means Site Work, 1999, 022-238-4200	
Loading of Soil	CY	12000	$1.97	$23,640		Means Site Work, 1999, 022-238-0260 Means Site Work, 1999, 022-238-0020	Assumes 1.2 bulking factor of in place cubic yards
Transport to Railroad (by Truck)	CY	12000	$11.36	$136,320		Means Site Work, 1999, 022-266-1255	Assumes 20 CY dump trailer and a 20 mile round trip; add 30% for medium traffic
Transportation to Landfill (by Rail)	Ton	15,000	$87	$1,305,000		Vendor quote (EQ)	Assumes 120 pcf; includes liners, tarps, loading ramp, supervision, drayage on the unloading end and loading end
Off Site Treatment and Disposal	Ton	15,000	$75	$1,125,000		Vendor quote (EQ)	Includes treatment of soils with greater than 6 ppm contaminant concentrations at landfill through chemical oxidation and disposal of treated soil
Loading & Hauling of Clean Backfill	CY	10000	$11.55	$115,500		2000 Means Site Work, 02320-200-1255	Assumes 20-mile round-trip from borrow pit
Backfill of Clean Soil / On-Site Handling of Clean Soil	CY	10000	$1.72	$17,200		2000 Means Site Work, 02315-120-3220 2000 Means site Work, 02315-300-5680	Sheepsfoot compactor, 12" lifts, 2 passes
Confirmatory Sampling - On-Site Mobile Laboratory / VOC Analysis	WK	4	$2,500	$10,000		Vendor Quote (S2C2, Inc.)	Up to 12 VOC analyses per day; includes mobilization, chemist, all mobile lab costs, per diem
Utilities Connections - Electric	LS	1	$5,000	$5,000		Engr Est.	Assume 3-phase power available at DRMO. Extension of power to trailer, one transformer required.
Utilities Connections - Water	LS	1	$5,000	$5,000		Engr Est.	Extend existing water line to trailer.
Utilities Connections - Telephone	LS	1	$1,000	$1,000		Engr Est.	Installation of 5 standard phone lines in on-site trailer.
Utilities Connections - Electric	MO	2	$1,000	$2,000		Engr Est.	Two months of electric service for trailer
Utilities Connections - Telephone	MO	2	$1,000	$2,000		Engr Est.	Two months of telephone service for trailer
Construction Trailer	MO	2	$500	$1,000		Engr. Est.	Two months, one construction trailer
Miscellaneous Expenses	WK	8	$500	$4,000		Engr. Est.	Air monitoring equip, H&S equip, PPE, sampling & decon expendables during excavation activity
Off-Site Landfill Operations - Subtotal					**$2,838,860**		
TOTAL CAPITAL COSTS					**$2,953,554**		
GENERAL & ADMINSITRATIVE (8% of total capital cost)					**$236,284**		
TOTAL ESTIMATED PROJECT COST (excludes award fee)					**$3,189,839**		

Note 1 - Estimate assumes all other labor costs included in work items.

Note 2 - All other labor assumed to come from local labor pool. (no travel costs).