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FINAL

PROJECT PLANS

CONTAMINATED SOIL AND GROUNDWATER REMEDIAL DESIGN

OPERABLE UNIT NO. 2

MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

CONTRACT TASK ORDER 0222

Prepared for:

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

Under:

LANTDIV CLEAN Program
Contract N62470-89-D-4814

Prepared by:

BAKER ENVIRONMENTAL, INC.
Coraopolis, Pennsylvania

FEBRUARY 28, 1994

PREFACE

This document contains the Project Plans for the design of a remedial action for contaminated soil and groundwater at Operable Unit No. 2 at Marine Corps Base, Camp Lejeune, North Carolina.

In an effort to consolidate and avoid repetition of site background information and history, which is typically presented in each document of the Project Plans (i.e., Work Plan, Sampling and Analysis Plan, etc.), a separate Project Introduction, Part I, has been written to present this information. Using this format, the Project Plans are presented as follows:

Part I	Project Introduction
Part II	Remedial Design Work Plan
Part III	Sampling and Analysis Plan
Part IV	Quality Assurance Project Plan
Part V	Health and Safety Plan

FINAL

PART I
PROJECT INTRODUCTION

CONTAMINATED SOIL AND GROUNDWATER REMEDIAL DESIGN

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LIST OF ACRONYMS AND ABBREVIATIONS

AOC	Area of Concern
ARARs	Applicable or Relevant and Appropriate Requirements
AWQC	Federal Ambient Water Quality Criteria
Baker	Baker Environmental, Inc.
bgs	below ground surface
BOD	biological oxygen demand
BFB	bromofluorobenzene
BTEX	benzene, toluene, ethylbenzene, xylenes
CDI	Chronic Daily Intake
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CH	high plasticity clay
CL	low plasticity clay
CLEAN	Comprehensive Long-Term Environmental Action Navy
CLP	Contract Laboratory Program
COC	Contaminant of Concern
COD	chemical oxygen demand
CSF	Cancer Slope Factor
CTO	Contract Task Order
1,1-DCA	1,1-dichloroethane
1,1-DCE	1,1-dichloroethene
1,2-DCE	1,2-dichloroethene
DCS	Document Control System
DFTPP	decafluorotriphenyl phosphine
DON	Department of the Navy
EPIC	Environmental Photographic Interpretation Center
ERA	Ecological Risk Assessment
ER-M	Effects Range-Median
ESE	Environmental Science and Engineering, Inc.
FFA	Federal Facilities Agreement
FID	flame ionization detector
FWQSV	Freshwater Water Quality Screening Values
gpm	gallons per minute
GPR	ground penetrating radar
GC/MS	gas chromatograph/mass spectrometer
HA	Health Advisory
HASP	Health and Safety Plan
HEAST	Health Effects Assessment Summary Tables
HI	hazard index
HQ	hazard quotient
i	hydraulic gradient
IAS	Initial Assessment Study

ICR	Incremental Cancer Risk
ID	inside diameter
IDW	Investigative Derived Wastes
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
ISM	individual standard mixtures
k	hydraulic conductivity
LANTDIV	Atlantic Division, Naval Facilities Engineering Command
LANTNAVFAC-ENGCOM	Atlantic Division, Naval Facilities Engineering Command
LEL	lower explosive limit
LOAEL	Lowest Observed Adverse Effect Level
LQAP	Laboratory Quality Assurance Plan
MCB	Marine Corps Base
MCL	Maximum Contaminant Level
mg/kg	milligram per kilogram
msl	mean sea level
MW	monitoring well
NACIP	Navy Assessment and Control of Installation Pollutants Program
NBS	National Bureau of Standards
N.C. DEHNR	North Carolina Department of Environment, Health and Natural Resources
NCR	NEESA Contract Representative
NCSPCS	North Carolina State Plane Coordinate System
NCWQS	North Carolina Water Quality Standards
NEESA	Naval Energy and Environmental Support Activity
NOAA	National Oceanic and Atmospheric Administration
NOAEL	No Observed Adverse Effect Level
NPL	National Priorities List
NTR	Navy Technical Representative
PAH	polynuclear aromatic hydrocarbon
PCBs	polychlorinated biphenyls
PEM	performance evaluation mixtures
PHA	Public Health Assessment
PID	photoionization detector
ppb	parts per billion
ppm	parts per million
PVC	polyvinyl chloride
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RA	Risk Assessment
RCM	resolution check mixture
RCRA	Resource Conservation and Recovery Act
RfD	Reference Dose
ROD	Record of Decision
RPD	Relative Percent Difference

RRF	Relative Response Factor
RI/FS	Remedial Investigation/Feasibility Study
S, S	storativity, solubility
SA	Site Assessment
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SCS	Soil Conservation Service
SM	silty sand
SMCL	Secondary Drinking Water Regulations
SOW	Statement of Work
SQC	Sediment Quality Criteria
SOPs	Standard Operating Procedures
SSV	Sediment Screening Values
STP	sewage treatment plant
SVOCs	semivolatile organic compounds
SWQSVs	Surface Water Quality Screening Values
T	transmissivity
TAL	Target Analyte List
TBC	to be considered
TCE	trichloroethane
TCL	Target Compound List
TCLP	toxicity characteristic leaching procedure
TDS	total dissolved solids
TEF	Toxicity Equivalency Factor
TSS	total suspended solids
TVS	total volatile solids
TOC	total organic carbon
TRC	Technical Review Committee
UCL	Upper Confidence Limit
UF	Uncertainty Factor
µg/L	micrograms per liter
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UXO	unexploded ordnance
VOCs	volatile organic compounds
VP	Vapor Pressure
WAR	Water and Air Research, Inc.
Weston	Weston Geophysical Corporation
WQS	Water Quality Standards
WQSV	Water Quality Screening Values

1.0 INTRODUCTION

Marine Corps Base (MCB) Camp Lejeune was placed on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priorities List (NPL) effective October 4, 1989 (54 Federal Register 41015, October 4, 1989). Subsequent to this listing, the United States Environmental Protection Agency (USEPA) Region IV, the North Carolina Department of Environment, Health and Natural Resources (NC DEHNR), and the United States Department of the Navy (DON) entered into a Federal Facilities Agreement (FFA) for MCB Camp Lejeune. The primary purpose of the FFA was to ensure that environmental impacts associated with past and present activities at MCB Camp Lejeune were thoroughly investigated and appropriate CERCLA response/Resource Conservation and Recovery Act (RCRA) corrective action alternatives were developed and implemented as necessary to protect public health and the environment.

The Fiscal Year 1994 Site Management Plan for MCB Camp Lejeune, a primary document identified in the FFA, identifies 27 sites requiring Remedial Investigation/Feasibility Study (RI/FS) activities. Three of these sites (Sites 6, 9, and 82), have been grouped together to form Operable Unit (OU) No. 2 at MCB Camp Lejeune. The RI/FS activities have been completed for OU No. 2, and a remedial action alternative consisting of contaminated soil removal and treatment, and groundwater remediation has been selected as the preferred alternative.

The United States Navy, Naval Facilities Engineering Command, Atlantic Division (LANTDIV), has directed Baker Environmental, Inc. (Baker) to prepare a design for the remediation of contaminated soil and groundwater at OU No. 2 at MCB Camp Lejeune. This remedial action has been documented in a Final Record of Decision (ROD) for the Site. The Navy/Marine Corps has obtained concurrence from the State of North Carolina and the USEPA Region IV to proceed with the design and implementation of this remedial action.

The remainder of this Project Introduction presents site background information, a summary of previous investigations, a summary of the RI results, a summary of the FS, and the project objective for the remedial design.

2.0 SITE BACKGROUND

Camp Lejeune is a training base for the Marine Corps, located in Onslow County, North Carolina (Figure 2-1). The base covers approximately 236 square miles and is bounded to the southeast by the Atlantic Ocean, to the northeast by State Route 24, and to the west by U.S. Route 17. The town of Jacksonville, North Carolina is north of the base.

OU No. 2 is located approximately 2 miles east of the New River and 2 miles south of State Route 24 on the main section of MCB Camp Lejeune. The operable unit is bordered by Holcomb Boulevard to the west, Sneads Ferry Road to the south, Piney Green Road to the east, and by Wallace Creek, which makes up the north boundary. Camp Lejeune Railroad operates rail lines parallel to Holcomb Boulevard bordering OU No. 2. OU No. 2 covers an area of approximately 210 acres. Figure 2-2 is a site plan of OU No. 2. Background information pertaining to Sites 6, 9, and 82 is presented below. No soil or groundwater remediation was determined to be necessary at Site 9. Therefore, this remedial design focuses on the remediation of five areas of concern within Sites 6 and 82, and restoration of the shallow and Castle Hayne aquifers.

2.1 Site 6 - Open Storage Lots 201 and 203

Site 6 consists of four main areas of concern: Open Storage Lot 201, Open Storage Lot 203, a ravine, and wooded areas surrounding the storage areas. Open Storage Lot 201 is a 25 acre fenced lot currently used to store military equipment, vehicles, lumber, lubricants, non-polychlorinated biphenyl (PCB) transformers, and other supplies. This storage lot is currently active. Pesticides have reportedly been stored in the northeast and southeast portions of Lot 201. Transformers containing PCBs were reportedly stored in the southwest portion of Lot 201.

Open Storage Lot 203 is a 41 acre fenced lot situated in the northern portion of Site 6. Storage Lot 203 is no longer used as an active storage area. It still contains randomly stored scrap materials such as rubber rafts, shredded tires, communication wire, wooden pallets, metal debris, and spent ammunition casings. Storage Lot 203 previously served as a waste disposal and storage area from as early as the 1940s and extending into the late 1980s. Pesticides were reported to have been stored in a trailer on Lot 203 as well as in the southeast portion of the lot. Former employees at Lot 203 have reported disposal of various chemicals including PCBs, cleaning solvents, electrolytes from used batteries, and waste oils. Both surficial drums and buried debris have been identified at Lot 203. The debris included communication wire, shell casings, battery packs, small 5-gallon containers, and bivouac wastes. No buried 55-gallon drums were identified.

A ravine is located in the northwest section of Site 6 and bisects Site 82. The surface of the ravine area is littered with various debris including batteries, fencing, tires, empty unlabeled drums, wire cables, commercial ovens, commodes, and respirator cartridges. Empty and partially full 55-gallon drums and 5-gallon containers have been found in the upper portion of the ravine. Some of the small containers indicate that they contained "DDT."

Woods and open fields surround both Storage Lots 201 and 203 and make up the remaining area of Site 6. No organized disposal operations are documented for the wooded areas. These areas are randomly littered with debris including empty 55-gallon drums and 5-gallon containers, communication wire, battery packs, spent ammunition casings, bivouac wastes, construction debris and garbage. The small containers were rusted and destroyed to the point where their contents could not be identified.

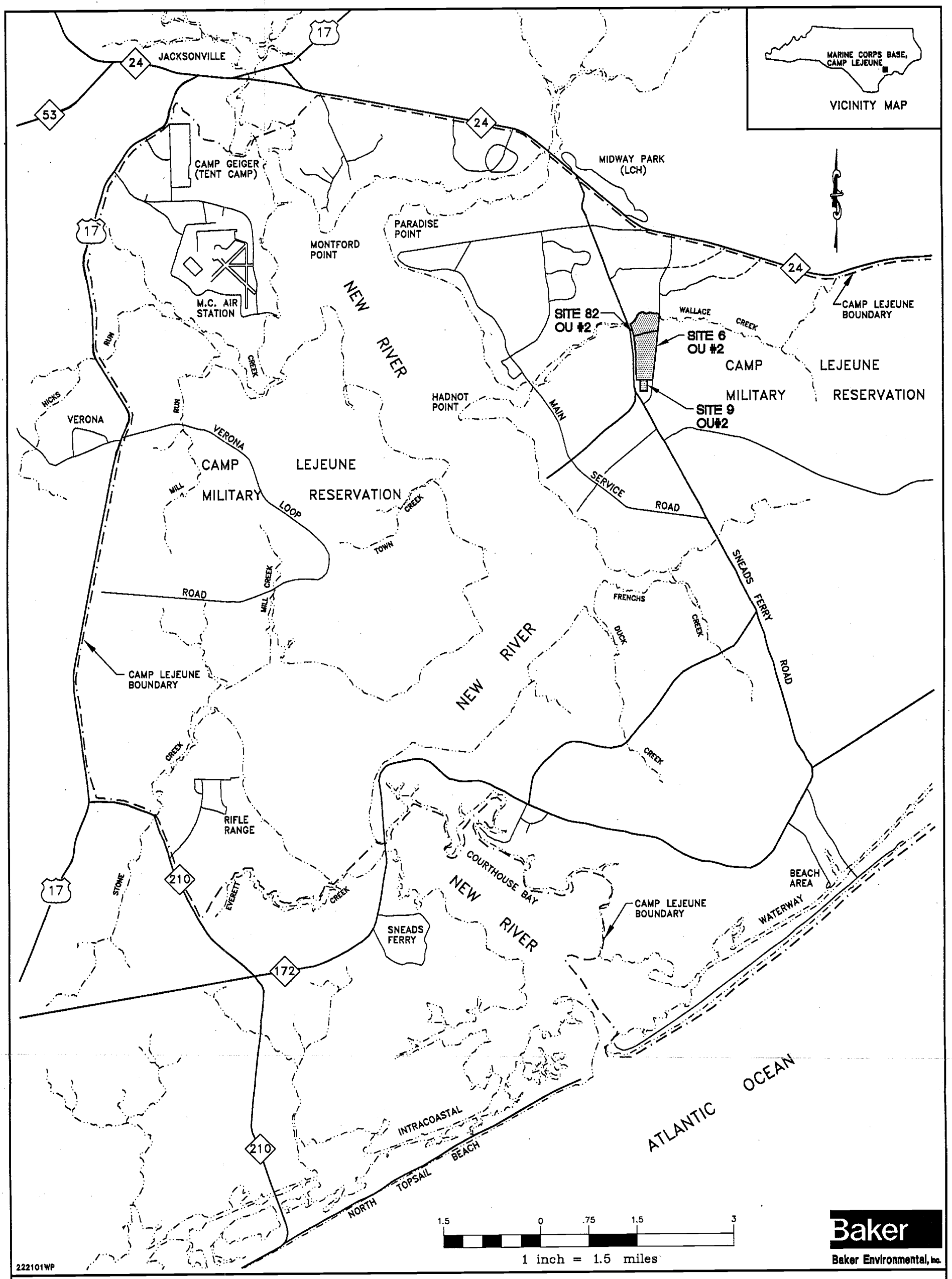

FIGURE 2-1
LOCATION MAP
OPERABLE UNIT No.2, SITES 6, 9, and 82
CONTAMINATED SOIL AND GROUNDWATER
REMEDIAL DESIGN CTO-0222
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

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2.2 Site 9 - Fire Fighting Training Pit at Piney Green Road

Site 9, the Fire Fighting Training Pit at Piney Green Road, covers an area of approximately 2.6 acres. Site 9 has been used for fire fighting training exercises from the early 1960s to the present. Until 1981, training exercises were conducted in an unlined pit located in the southern area of the site. The pit is currently asphalt lined. Flammable liquids including used oil, solvents, and contaminated fuels (unleaded) were used as accelerants during training exercises. Approximately 30,000 to 40,000 gallons of JP-4 and JP-5 fuels were also burned in the fire training pit. A smoke house, located in the northern part of the site, is also used for training exercises. No fuel products are used in this area.

2.3 Site 82 - Piney Green Road VOC Site

Site 82, the Piney Green Road VOC Site, is located directly north and adjacent to Site 6. Site 82 encompasses approximately 30 acres and is predominantly covered by woodlands.

No organized disposal operations are documented for Site 82. It appears that the site area was used for disposal of miscellaneous debris from Lot 203, since similar items were identified at both sites. Although the name of the site implies the disposal of volatile organic compounds (VOCs), there is no known documentation of the quantity or the location of VOC disposal.

The site is randomly littered with surficial drums and buried containers. The former contents of the surficial drums (which are empty) have not been identified. Numerous buried containers have been found full of lubrication oils, No. 6 fuel oil, and unknown substances. Many of the containers are leaking and will be removed as part of a non-time critical removal action.

3.0 PREVIOUS INVESTIGATIONS

In 1983 an Initial Assessment Study (IAS) was conducted at MCB Camp Lejeune by Water and Air Research, Inc. The study identified a number of areas within the facility, including Sites 6 and 9, as potential sources of contamination. As a result of this study, Environmental Science and Engineering, Inc. (ESE) was contracted by the DON to further investigate these sites.

During 1984 through 1987, ESE conducted a Confirmation Study at OU No. 2 which focused on potential source areas identified in the IAS and the administrative record file. The study consisted of collecting a limited number of environmental samples (soil, sediment, surface water, and groundwater) for purposes of constituent analysis. In general, the results detected the presence of pesticides in Lot 203, VOCs in the groundwater, and VOCs in the surface water.

A soil gas survey was conducted at Lot 203 in February 1989. The purpose of this survey was to identify the presence of VOCs that may potentially affect personnel working within Lot 203. No imminent hazards were observed from the results of the survey.

On October 4, 1989, Camp Lejeune was placed on the NPL. The DON, the USEPA, and the NC DEHNR entered into a FFA on February 13, 1991.

In June 1991, a Site Investigation was conducted at Site 82 by Halliburton NUS Environmental Corporation. The investigation consisted of drilling and sampling six shallow soil borings; installing and sampling three shallow monitoring wells; and sampling surface water and sediment of Wallace Creek. The results indicated that Wallace Creek was contaminated. During this investigation, it was determined that the source of VOCs detected in Wallace Creek was not likely from Site 6. Therefore, the area north of Lot 203 was considered a new site, Site 82.

A Site Assessment Report was prepared by ESE in March 1992. This report contained a summary of the previously conducted Confirmation Study in addition to a preliminary risk evaluation for Site 6. This report recommended that a full human health and ecological risk assessment be performed at Site 6.

In 1992, Baker Environmental, Inc. (Baker) conducted a Remedial Investigation(RI) field program at OU No. 2 to characterize potential environmental impacts and threats to human health resulting from previous storage, operational, and disposal activities. The RI field program was conducted in two phases. The first phase was initiated on August 21, 1992 and continued through November 10, 1992. A second phase commenced in early 1993 and was completed by May 1993. The results of the RI are summarized in the next section.

4.0 SUMMARY OF REMEDIAL INVESTIGATION RESULTS

Based on the results of the various environmental investigations conducted at OU No. 2 during the RI, conclusions with respect to the nature and extent of contamination at the three sites were developed. Please note that various drums and containers were noted throughout Sites 6 and 82. All surficial drums/containers and known buried drums are being removed from OU No. 2 through a Time Critical Removal Action which will be conducted prior to implementing this remedial alternative.

Specific results from the RI with respect to each of the three sites and the two nearby surface water bodies are presented below.

Site 6

- The northeast corner of Lot 201 at the former pesticide storage area is contaminated with pesticides and VOCs that may be associated with former waste storage/handling activities. The extent of soil contamination is limited in area since only two sampling locations, approximately 50 feet apart, exhibited elevated contaminant levels.

- Former waste storage/handling activities at Lot 201 have not adversely impacted groundwater quality in this portion of OU No. 2.

- The area of Lot 203 near the former railroad spur may be associated with previous disposal activities. A limited number of surface and subsurface soil samples collected near the former railroad spur have revealed PCBs (Aroclor-1260) and polynuclear aromatic hydrocarbons (PAHs). Historical aerial photographs indicate significant activity (i.e., surficial anomalies) in this area of Lot 203.

- Disposal activities may have occurred in the north central portion of Lot 203 where PCBs were detected in subsurface soil samples. In addition to PCBs, PAHs were also detected in this area.

- Military training operations at Lot 203 resulted in a substantial amount of buried debris including communication wire, shell casings, battery packs, small 5-gallon containers, and bivouac wastes. Generally, it appears that trenches identified in historical photographs were primarily excavated as a means to dispose of military-type wastes and not for purposes of disposing hazardous wastes. However, the battery packs may contain hazardous or may potentially leach materials which are considered hazardous. These materials can include mercury and cadmium.

- Numerous drums on the surface of Lot 203 present a potential impact to human health and the environment. Samples collected from these drums indicate that some of the drum contents are characteristically hazardous. None of the surficial drums were noted to be leaking.

- Groundwater quality at Lot 203 has not been significantly impacted by former disposal and storage practices. Trace levels of trichloroethene (TCE) were detected in one well located in the north central portion of Lot 203 where disposal activities may have occurred. Trace levels of TCE and tetrachloroethene (PCE) were detected in a second well located near the south central portion of Lot 203. The source of VOC contamination in this well is unknown. The analysis of soil samples collected from this borehole as well as other nearby soil borings did not indicate a source.

- Groundwater quality in the wooded area south of Lot 203 (near the above-mentioned disposal area) has been impacted by former disposal practices. Low levels of VOCs (chloroform and chlorobenzene) and SVOCs (phenol) were encountered in two wells.

- The presence of PAHs in soil and low levels of PCBs in sediment in the upper portion of the ravine (i.e., near Lot 203) is most likely due to former disposal practices. This portion of the ravine is filled with debris, including empty and partially-filled 55-gallon drums and battery packs. In addition, canisters with "DDT" markings were found in the middle section of the ravine (between Lot 203 and Wallace Creek). However, only low levels of pesticides were detected in the ravine sediments.

- Soil contamination detected in the ravine has likely migrated to Wallace Creek via surface runoff. Wallace Creek sediments revealed the same constituents detected in ravine soils and sediments.

- PCBs were detected in surface soil near Piney Green Road east of Lot 201. Disposal activities may have occurred in this area, which once served as a training area.

- Disposal activities may have occurred in the wooded area between Lot 201 and 203. One location exhibited moderate levels of PCBs, PAHs, and pesticides in surface soil. The horizontal and vertical extent of this contamination is limited.

- A former disposal area was identified during the test pit investigation in the wooded area between Lot 201 and Lot 203. Numerous 5-gallon containers, bivouac wastes, and battery packs were encountered. All of the containers were rusted and destroyed to the point where their contents could not be identified; however, solvent-like odors were observed by the sampling team. A sample of the sludge material near the containers revealed that the material is characteristically hazardous due to elevated levels of lead. Chloroform was also detected, but was below Toxicity Characteristics Leaching Procedure (TCLP) regulatory levels.

Site 9

- Ongoing fire training exercises at Site 9 have not significantly impacted either soil or groundwater quality.

- Low levels of pesticides present at Site 9 are likely the result of former pest control practices and not associated with waste disposal.

Site 82

- Shallow (less than 30 feet) and deep (greater than 100 feet) groundwater exhibited elevated levels of VOC contaminants. Deep groundwater quality was found to be significantly more contaminated than shallow groundwater quality.

- The horizontal extent of shallow groundwater contamination is defined. The plume apparently originates just north of Lot 203 (in the southern portion of Site 82) and discharges into Wallace Creek. Trace levels of VOCs were also detected in one well on the other side of Wallace Creek. Contaminants have migrated into the deeper portion of the aquifer as evidenced by elevated VOC levels in deep groundwater monitoring wells.

- The horizontal and vertical extent of deep groundwater contamination has been evaluated. Groundwater samples obtained from monitoring wells outside of Site 82

indicated that VOC contamination has migrated just north of Wallace Creek, south into Site 6, west to Holcomb Boulevard, and east across Piney Green Road. Moreover, the vertical extent has been evaluated to a depth of 263 feet. Low levels of TCE (6.5 µg/L) were detected in a well installed below a semiconfining layer, which is located near the apparent source area.

- A large quantity of drums and debris were observed on the surface and subsurface just near the southeastern corner of Site 82. Samples collected of the waste material analyzed the waste as No. 6 fuel, which is typically used for heating. Other drums uncovered could not be identified. This area may also be a source of groundwater contamination at Site 82.

Wallace Creek

- The presence of TCE, PCE, and other VOC contaminants in Wallace Creek is due to shallow and possibly deep groundwater discharge.

- Surface runoff from the ravine has impacted sediment quality. Elevated levels of PAHs and PCBs are present in Wallace Creek. These contaminants were also detected in the ravine.

- The source of pesticide contamination may be due to either runoff from the ravine and/or historical pest control spraying practices. The highest levels of pesticides were detected in two sampling stations that were located just downstream of where the ravine discharges into Wallace Creek.

- The fish population and diversity in Wallace Creek appears to be healthy, based on population statistics. No anomalies were observed on any of the fish collected during the aquatic survey.

- Some of the fish collected in Wallace Creek exhibited tissue concentrations of PCBs, pesticides, and TCE, which may be attributable to Site 82 and the ravine area. The levels detected in the fish do not exceed U.S. Food and Drug Administration (FDA) levels for "safe" consumption. The risk to human health for fish consumption is within USEPA's acceptance range of 1.0E-04 to 1.0E-06.

Bearhead Creek

- Sediment quality in Bearhead Creek may be impacted via surface runoff from the wooded areas. Low levels of PAHs, pesticides, and PCBs were detected in sampling stations which border Site 6. VOC contaminants were also detected in sediment samples; however, the source of VOC contamination is unknown given that soil and groundwater in this area were not found to be contaminated with VOCs. Pesticides in sediment are not likely associated with disposal practices.

- Inorganic constituents detected in sediment are not likely the result of disposal practices at Sites 6 or 9.

- The fish community at Bearhead Creek appears to be healthy, based on population statistics and observations. None of the fish collected exhibited lesions or other anomalies that would represent adverse conditions.

- Fish samples collected from Bearhead Creek revealed low levels of pesticides, PCBs, and zinc.

5.0 SUMMARY OF FEASIBILITY STUDY

Based on the information collected during the RI, and the evaluation of potential human health and ecological risks, remedial action alternatives (RAAs) were developed as part of the FS to address contaminated media at various areas of concern (AOCs) within OU No. 2. Note that no AOCs were identified within Site 9. Wallace Creek will not be remediated since additional adverse environmental impacts could result via direct remediation, and the sources of the surface water and sediment contamination will be addressed (i.e., contaminated groundwater and the ravine). In addition, areas where drums and containers have been identified are not being considered as AOCs. All surficial drums and known buried drums/containers are being removed from OU No. 2 through a Time Critical Removal Action.

The Groundwater AOCs identified in the FS included:

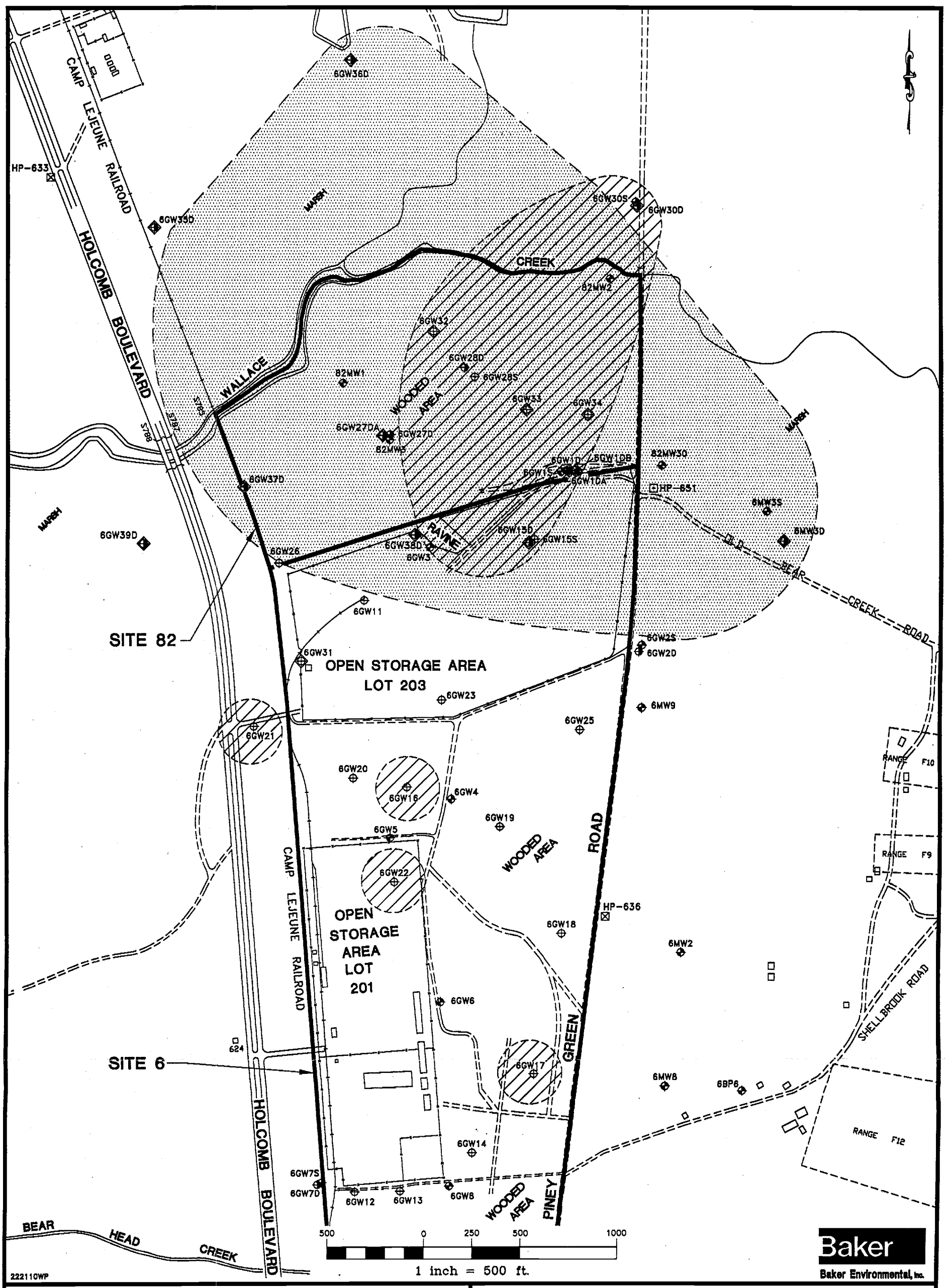
- VOC contaminated groundwater plumes [shallow (i.e., less than 30 feet) and deep (i.e, greater than 100 feet) originating from Site 82.
- Four small areas of groundwater contamination south and west of Storage lot 203.

Figure 5-1 shows the locations of the groundwater AOCs. Groundwater sampling from monitoring wells 6GW16, 6GW17, 6GW21, and 6GW22 detected only one contaminant from each well that slightly exceeded federal MCLs or State groundwater standards. Therefore, no active groundwater remediation is planned at this time at these four areas. Groundwater monitoring will continue at these locations and additional actions will be considered if the monitoring indicates a change in groundwater quality.

The Soil AOCs identified in the FS included:

- Source of groundwater VOC contamination at Site 82 (Soil AOC1).
- Upper portion of the ravine at Site 6 with detected levels of PAHs, PCBs and metals in soil and sediment (Soil AOC2). This may be the source of contamination to Wallace Creek.
- North central portion of Lot 203 with detected levels of PCBs in soil (Soil AOC3).
- Northwestern portion of Lot 203 with detected levels of PCBs in soil (Soil AOC4).
- Northeastern corner of Lot 201 with detected levels of pesticides in soil (Soil AOC5).
- Wooded area east of Lot 201 and adjacent to Piney Green Road with detected levels of PCBs in soil (AOC6).

Figure 5-2 shows the locations of the soil AOCs.

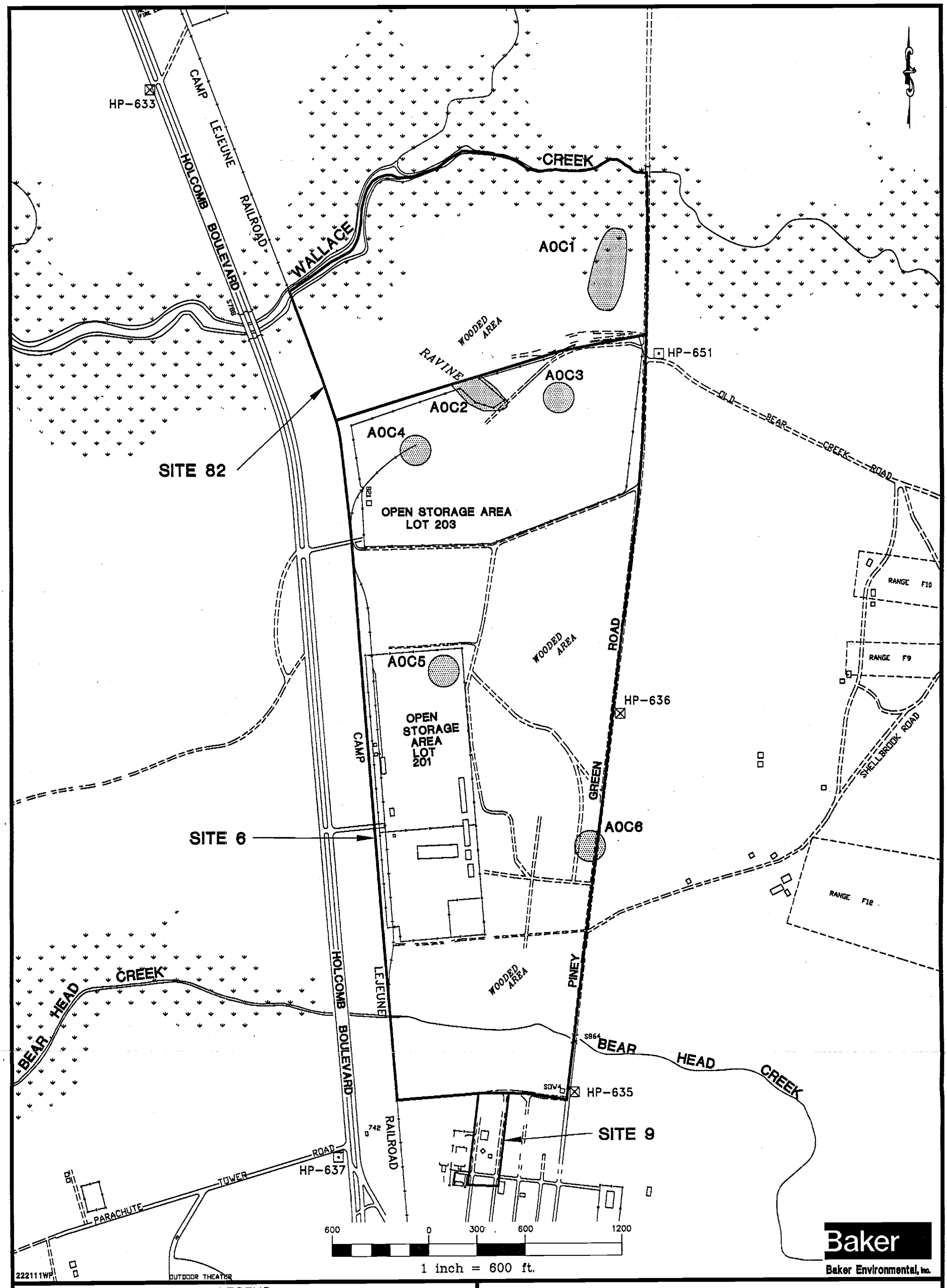


LEGEND

- 6GW1S — EXISTING MONITORING WELL
- 6GW12 — PHASE I SHALLOW MONITORING WELL
- 6GW1D — PHASE I DEEP MONITORING WELL
- HP-651 — WATER SUPPLY WELL (CURRENTLY INACTIVE)
- HP-636 — WATER SUPPLY WELL (CURRENTLY ACTIVE)
- 6GW31 — PHASE II SHALLOW MONITORING WELL
- SOURCE: LANTDIV, FEBRUARY 1992
- APPROXIMATE AREA OF GROUNDWATER (DEEPER PORTION) CONTAMINATION EXCEEDING REMEDIATION GOALS
- APPROXIMATE AREA OF GROUNDWATER (SHALLOW PORTION) CONTAMINATION EXCEEDING REMEDIATION GOALS
- 6GW1DA — PHASE II DEEP MONITORING WELL

FIGURE 5-1
APPROXIMATE LOCATION OF
GROUNDWATER CONTAMINATION
CONTAMINATED SOIL AND GROUNDWATER
REMEDIAL DESIGN CTO-0222
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

01484 DDB12



LEGEND

HP-651 WATER SUPPLY WELL (CURRENTLY INACTIVE)

HP-637 WATER SUPPLY WELL (CURRENTLY ACTIVE)

A0C1 APPROXIMATE LOCATION OF SOIL AREAS OF CONCERN

SOURCE: LANTDIV, FEBRUARY 1992

FIGURE 5-2
APPROXIMATE LOCATION OF
SOIL AREAS OF CONCERN
CONTAMINATED SOIL AND GROUNDWATER
REMEDIAL DESIGN CTO-0222
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

6.0 PROJECT OBJECTIVE

The objective of this project is to develop a single design package that is consistent with the selected remedial action for OU No. 2, and that meets LANTDIV's and regulatory requirements. The selected remedial action includes (1) soil removal, (2) soil treatment by vapor extraction, and (3) intensive groundwater extraction and treatment. Additional tasks required to support the design of the remedial action include: (1) providing an accurate survey of the site; (2) conducting soil screening of the areas targeted for a removal action; (3) conducting an air permeability test for soil vapor extraction; and (4) determining aquifer characteristic by reviewing existing information pertaining to the aquifer systems underlying OU No. 2. Details of the remedial design tasks are provided in the work plans included as Parts II through V of this document.

FINAL

PART II
WORK PLAN

CONTAMINATED SOIL AND GROUNDWATER REMEDIAL DESIGN

OPERABLE UNIT NO. 2

MARINE CORPS BASE,
CAMP LEJEUNE, NORTH CAROLINA

CONTRACT TASK ORDER 0222

Prepared for:

DEPARTMENT OF THE NAVY
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FEBRUARY 28, 1994

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1.0 INTRODUCTION

The United States Navy, Naval Facilities Engineering Command, Atlantic Division (LANTDIV) has contracted Baker Environmental, Inc. (Baker) to conduct a remedial design for the remediation of contaminated groundwater and soil at Operable Unit (OU) No. 2 at MCB Camp Lejeune. This remedial alternative (RA) has been documented in a Final Record of Decision (ROD) for the Site. The Navy/Marine Corps has obtained concurrence from the North Carolina Department of Environment, Health and Natural Resources (NC DEHNR) and the United States Environmental Protection Agency (USEPA) Region IV on this RA.

The initial phase of this project requires Baker to develop the following project control documents:

- Part I Project Introduction
- Part II Remedial Design Work Plan (RDWP)
- Part III Sampling and Analysis Plan (SAP)
- Part IV Quality Assurance Project Plans (QAPP)
- Part V Health And Safety Plan (HASP)

This document presents Part II, the Remedial Design Work Plan. The other plans are contained in separate documents which are included in this binder. Each of these plans outline specific activities related to the remediation of OU No. 2.

The intent of all of these project plans is to present the scope of work necessary to execute a technically sound and cost effective remedial design that satisfies the requirements of the ROD, and the requirements of LANTDIV, NC DEHNR, and USEPA Region IV. The design will be prepared in a format suitable for implementation by LANTDIV's Remedial Action Contractor (RAC).

The level of detail provided in these documents varies according to the current information available on which to base the activities associated with each element. As the project progresses and decisions are made regarding specific details of the remedial design, the work plan elements can be better defined.

The following discussion provides project background, the purpose and objectives of the work plans, and the organization of this document.

1.1 Objectives of the Remedial Design Work Plan

The objectives of the Remedial Design Work Plan are:

- Summarize the results of the Remedial Investigation/Feasibility Study (RI/FS) activities completed at OU No. 2.

- Identify and describe the tasks to be performed in order to complete the remedial design for OU No. 2.

- Identify any anticipated technical problems that may be encountered during the remedial design, and determine appropriate courses of action for these problems.

The project described here, and in the other project control documents, will conform with the requirements of the remedial action in the ROD, according to the appropriate and applicable guidance and regulations of CERCLA, RCRA and other relevant environmental programs, and in accordance with standard engineering practice.

The selected remedial alternative for OU No. 2 includes three separate remedial actions:

- In situ volatilization of soils within Area Of Concern (AOC) 1 at Site 82.

- Excavation and removal of approximately 2,500 cubic yards of PCB and pesticide contaminated soils and debris from five AOCs within the OU.

- Intensive groundwater extraction and treatment from the shallow and deep aquifer at Site 82. Extracted groundwater will be collected via a network of extraction wells placed in the plume with the highest contaminant levels. Approximately two deep extraction wells (110 feet deep) will be installed. Each deep extraction well will be pumped at a rate up to approximately 150 gallons per minute (gpm). In addition, approximately three shallow extraction wells (35 feet deep) will be installed. Each shallow extraction well will be pumped at a rate up to 5 gpm. Extracted groundwater will be treated on site using a treatment system designed to remove metals and Volatile Organic Compounds (VOCs), and will be discharged to Wallace Creek.

This remedial action is designed to protect human health and the environment from exposure to VOCs in the aquifer and PCBs and pesticides in the soils.

1.2 Remedial Design Work Plan Format

The RDWP presented in this document addresses the major components of the remedial design, and includes the following sections:

- Section 2: Background and History
- Section 3: Predesign Studies
- Section 4: Soil Removal Action, Soil Vapor Extraction, and Groundwater Extraction and Treatment System Design
- Section 5: Data Management
- Section 6: Community Relations
- Section 7: Reports
- Section 8: Project Schedule
- Section 9: Management and Staffing
- Section 10: References

2.0 BACKGROUND AND HISTORY

Site background information and history for OU No. 2 is provided in Part I, Project Introduction. Part I includes a description of the site, and a summary of the results of the RI/FS activities previously conducted.

3.0 PREDESIGN STUDIES

This section discusses the overall scope and purpose of planned Predesign Studies. The purpose of these studies is to provide additional data to support the design of the soil removal action, soil vapor extraction system, and groundwater treatment system at OU No. 2. The predesign activities to be performed are described in the following subsections:

3.1 Site Survey
3.2 Confirmatory Soil Sampling Investigation
3.3 Soil Permeability Testing
3.4 Evaluation of Aquifer Characteristics
3.5 Sampling and Analysis Plan
3.6 Quality Assurance Project Plan
3.7 Health and Safety Plan

3.1 Site Survey

In order to identify topographic and surface feature details, which are necessary for the design of the components of the remedial action, specific portions of OU No. 2 will be surveyed. These areas will include the six soil areas of concern (AOC 1 through AOC 6); the proposed sites for the shallow and deep groundwater extraction wells, and the groundwater treatment system; and the alignment of the treated groundwater discharge line to Wallace Creek (see Figure 3-1).

Baker will subcontract the survey services and prepare topographic maps using a vertical contour interval of 2 feet and a horizontal scale of 1 inch = 25 feet.

In addition, the survey data will be used to set up grids for the soil screening and sampling to be conducted at AOCs 3, 4, 5, and 6.

3.2 Confirmatory Soil Sampling Investigation

Five soil AOCs (AOCs 2, 3, 4, 5, and 6) were identified during the RI/FS that require excavation of contaminated soils (i.e., soils which exhibit concentrations above the derived cleanup levels). The extent of contamination at AOCs 3, 4, 5, and 6 was approximated during the RI field program. In order to further delineate the extent of contamination and the subsequent areas of soil excavation at these AOCs, Baker will collect soil samples at these four AOCs which will be subject to field screening tests. Based on the results of the RI/FS and the nature of the contamination of AOC 2 (i.e., partially buried drums, battery packs, communication wire, etc.), the extent of contamination is sufficiently defined. Therefore, no soil sampling activities are planned at AOC 2 during the predesign studies.

Sampling grids will be established around each AOC prior to sample collection. At AOCs 3, 4, and 6 where PCBs are the contaminants of concern (COC), soils will initially undergo field screening tests to delineate the outer extent of contamination. Field screening tests will be conducted using an Enzyme-Linked Immunosorbent Assay (ELISA) kit. Once the extent of contamination has been delineated based on the screening results, samples along the outer boundary will be submitted to a fixed-based laboratory to confirm the extent of soil contamination. At AOC 5 where 4,4'-DDT (a pesticide) is the COC, soil samples will initially undergo field screening tests to delineate the outer extent of contamination. Field screening will be performed utilizing a similar assay test, as described for PCBs. Upon delineation of the extent, samples along the outer boundary will be submitted for confirmation analyses. A detailed description of the field sampling procedures and methodologies to be employed at the four AOCs is provided in Section 3 of the SAP.

3.3 Soil Air Permeability Testing

As noted in the ROD, soil vapor extraction has been selected as the remedial alternative for AOC 1. In order to determine engineering parameters needed for the design of the system, a field test will be conducted at AOC 1. The field test will be used to determine the air permeability of the soils in AOC 1, the associated vapor flow rates through the soil, and the optimum spacing of the vapor extraction wells.

The following equipment will be used for the field test:

- One vapor extraction well will be constructed at AOC 1. A 6-inch diameter bore hole will be augured to a depth of approximately 15 feet (or to a depth less than the groundwater level). A 2-inch diameter PVC well screen will be inserted to the bottom of the augured hole. After the screen is installed, a sand filter pack will be placed around the screened interval, and a seal (rehydrated bentonite) extending from the filter pack to the surface will be installed above the filter pack. A wellhead fitting will be attached to the top of the vapor extraction well.

- An explosion-proof vacuum pump will be connected to the wellhead fitting. The vacuum pump is rated at a maximum air flow rate of 28.8 cubic feet per minute (cfm) at 0 inches mercury (in Hg), and a maximum vacuum level of 27.9 in Hg at 0 cfm. Vapors collected from the extraction well will be piped to an air/water separator to remove entrained water and water vapor, and to an air filter to remove particulates, prior to discharge to the atmosphere.

- Four to eight vacuum monitoring points will be placed around the vapor extraction well, as determined by field conditions. Each vacuum monitoring point will be installed by driving a steel pipe to a depth of 12 to 15 feet. The pipe will be removed and a vacuum monitoring probe will be inserted in each boring. A filter pack will be placed around each probe, and the hole will be sealed with rehydrated bentonite.

- Each vapor monitoring probe will have a high sensitivity vacuum gauge/transducer attached to a sealed connector at the top of each monitoring point.

- A computerized data logger will be used to continuously monitor and record vacuum flow rates and pressures from the monitoring probes.

The field air permeability test is designed to establish the relationship between air flow rate and wellhead vacuum by modifying the vacuum pump flow rate periodically during the test. The field test will be conducted as follows:

- After the vacuum pump is started, vacuum measurements will be taken at the extraction wellhead and at the monitoring probes at four different flow rates. Air flow rates, soil vapor temperature and ambient temperatures will also be monitored at each vacuum pump flow rate.

- Vapor samples will be collected from the extraction wellhead at the start, midpoint, and at the end of each test at a selected flow rate (i.e., 3 samples x 4 flow rates = 12 samples).

- 12 vapor samples will be analyzed on a gas chromatograph equipped with an electron capture detector for the chlorinated VOCs following EPA modified Method 601.

The field test will provide specific information on site soil air permeability, radius of influence, and VOC removal rates. Data to be reported will include:

- Pressure decline versus time at each vacuum monitoring point
- Calculated air permeabilities at each vacuum monitoring point
- Pressure decline versus distance (from extraction well to monitoring points)
- VOC concentrations

The data generated from the soil permeability test will be used to develop the necessary design parameters for the soil vapor extraction system.

3.4 Evaluation of Aquifer Characteristics

The hydrogeologic setting in the vicinity of OU No. 2 consists of two principal aquifer systems, the surficial and Castle Hayne aquifers. The surficial aquifer is a series of sediments, primarily sand and clay, which commonly extend to depths of 50 to 100 feet below ground surface (bgs) (Harned et al, 1989). In the vicinity of OU No. 2, the surficial aquifer extends to a depth of approximately 90 feet bgs based on soil information obtained during the RI field program. This aquifer is not used for water supply on the Base (Harned et al., 1989). The Castle Hayne aquifer, in the vicinity of OU No. 2, underlies the surficial aquifer but is not separated by a confining or low permeability unit. This aquifer consists of a series of sand and limestone beds and is about 150 to 300 feet thick in the vicinity of MCB Camp Lejeune. Further, this aquifer serves as the principal water supply aquifer for the Base (Harned et al., 1989).

Understanding the hydrogeologic characteristics of an aquifer system is an important consideration for the design of a groundwater remediation system. Estimates of aquifer hydraulic parameters are critical for determining such items as extraction well placement and anticipated flow rates. The parameters which are commonly determined for any hydrogeologic investigation are the Coefficient of Transmissivity (T), Coefficient of Storativity (S), and hydraulic conductivity (K). These parameters provide important information regarding the: (1) volume of water that can be transmitted horizontally by the full saturated thickness of the aquifer (T); (2) volume of water that an aquifer can release from or take into storage (S); and, (3) rate at which water can move through a permeable medium (K) (Fetter, 1980). Additionally, calculations of groundwater flow velocities, the radius of influence by pumping, and iterative remedial volumes are also useful in the design of groundwater remediation systems and can be determined given that certain information is available.

Numerous hydrogeologic investigations/studies have been conducted on the surficial and Castle Hayne aquifers in the vicinity of OU No. 2 (O'Brien and Gere, 1988; Harned et al., 1989; Geophex, 1991; S&ME, 1991; and Baker, 1993) to determine their hydraulic parameters and other flow characteristics. Consequently, Baker is not recommending that any additional aquifer testing be conducted for the purpose of this design. Aquifer parameters will be estimated based on a review of the investigations listed on Table 3-1.

Estimates for the radius of pumping influences (i.e., capture zones), which are used to assist in determining the placement of the extraction wells, are also provided on the table for both the surficial and Castle Hayne aquifers. Values for radius of pumping influences for both aquifers were determined by previous investigators by performing aquifer pump and recovery tests. Further, a numerical groundwater flow simulation model (WHIP-MWCAP) was employed by Geophex (1991) during a Wellhead Protection Study for the Base water supply wells which also provided estimated areas for zones of capture created by the pumping supply wells. A groundwater flow simulation model (FLOWPATH) may also be employed by Baker to further assist in determining the location of the extraction wells.

TABLE 3-1

SUMMARY OF AQUIFER PARAMETERS, RADIUS OF INFLUENCES, AND PRODUCTION RATES FOR THE SURFICIAL AND CASTLE HAYNE AQUIFERS IN THE VICINITY OF OPERABLE UNIT NO. 2 CONTAMINATED SOIL AND GROUNDWATER REMEDIAL DESIGN - CTO-0222 MCB CAMP LEJEUNE, NORTH CAROLINA

Aquifer	Hydraulic Conductivity (feet/day)	Transmissivity (gal/day/foot)	Storativity	Radius of Influence (feet)	Production Rates (gal/min)	Source/Method of Evaluation
Surficial(1)	1.1	Not Determined	Not Determined	Not Determined	3 to 5	S&ME, 1991/Slug tests
	3.0	454	0.028	60 to 75	1 to 2	Baker, 1993/ Pump and recovery tests
	3.3	500	0.10	300 to 400	3	O'Brien and Gere, 1990/ Pump and recovery tests
Castle Hayne(2)	35	7,500 to 15,000	Not Determined	Not Determined	174	Harned, et al., 1989/ Well acceptance tests
	Not Determined	9,600	0.0008	1,000	85	ESE, 1988/ Pump and recovery tests
	Not Determined	Not Determined	Not Determined	Not Determined	50 to 150	MCB Camp Lejeune EMD/ Well acceptance tests
	Not Determined	Not Determined	Not Determined	1,900	Not Determined	Geophex, 1991/ Groundwater model

Notes: (1) Surficial aquifer is a series of sediments which extend from 50 to 100 feet below ground surface (Harned, et al., 1989).
(2) Castle Hayne aquifer is a series of sand and limestone beds (Harned, et al., 1989; upper portion of aquifer occurs at approximately 100 feet below ground surface.

3.5 Sampling and Analysis Plan

The Sampling and Analysis Plan (SAP) addresses field sampling to be conducted to support the remedial design. The SAP helps to ensure that the samples are representative and that the quality of the analytical data generated is generally known. The SAP for this project has been prepared as a separate plan, which is included in these Work Plans as Part III.

3.6 Quality Assurance Project Plan

The Quality Assurance Project Plan (QAPP) addresses the quality assurance and quality control procedures that will be used during the field sampling and analysis to be performed to support the remedial design. The QAPP for this project has been prepared as a separate plan, which is included in these Work Plans as Part IV.

3.7 Health and Safety Plan

The Health and Safety Plan (HASP) for the field activities for this project addresses the chemical and physical hazards which may be encountered by field workers. The HASP is presented as a separate plan, which is included in these Work Plans as Part V.

4.0 SOIL REMOVAL ACTION, SOIL VAPOR EXTRACTION, AND GROUNDWATER EXTRACTION AND TREATMENT SYSTEM DESIGN

Following approval of the Final RDWP and conclusion of the predesign activities, Baker will initiate the preparation of the remedial design package for the soil removal action, the soil vapor extraction (SVE) system, and the groundwater extraction and treatment system. This section presents a description of the components of the remedial design and discusses the design activities that will be performed.

The remedial design activities will be performed in accordance with LANTDIV's Guide for Architect - Engineer Firms Performing Services for the Atlantic Division (A&E Guide), U.S. EPA's OSWER Directive 9355.0-4A, and with standard engineering practices. During all phases of the remedial design, Baker will be cognizant of elements that may pose special technical or implementational problems with the project, such as:

- Availability of site access for construction and operation of groundwater extraction wells, SVE wells, and the associated piping, treatment, and discharge systems.
- Availability of required utilities for the extraction and treatment systems.
- Any easements or special access that may be required for the groundwater extraction wells, SVE wells, and associated piping, treatment, and discharge systems.
- The need for any formal community relation activities associated with the project.
- The impact of the extraction wells on the local hydrogeology, including any areas where ground subsidence may pose a potential problem.

The Design Requirements Package for the soil removal action, the SVE, and the groundwater extraction and treatment system will be submitted as follows:

- 35% Submittal Package
- 90% Submittal Package
- 100% Submittal Package

The purpose of the 35% Submittal Package is to clarify and establish the specific requirements for the project. The 35% Submittal will allow LANTDIV to review and concur with Baker's interpretation of the functional and organizational requirements of the design project. This submittal will include drawings, the basis of design, outline specifications, a cost estimate, and the proposed construction schedule. The purpose of the 90% Submittal Package is to allow a technical review to ensure compliance with DOD and LANTDIV requirements and constructability adequacy. This submittal will include plans, mechanical drawings, specifications, detailed construction cost estimate, calculations, manufacturer's catalog data, and marked materials from previous submittals. The 100% Submittal Package will finalize the design phase and prepare the documents for construction contract negotiation.

All requirements package submittals will be subjected to a concurrent review by LANTDIV, USEPA Region IV, NC DEHNR, and the Activity. In addition, copies of the design requirements package will be submitted to LANTDIV's RAC Contractor for a constructability review. Responses to comments on the 35% Submittal will be provided with the 90% Submittal. Similarly, responses to comments on the 90% Submittal will be provided with the 100% Submittal. Response will be provided for each comments indicating compliance or reason for disagreement. Any disagreements will be resolved with the person who made the comment prior to submission of the next submittal.

A brief description of the items to be included in each design submittal is presented in Sections 4.2 through 4.7. A summary of the design submittals is discussed in Section 4.8.

4.1 Description of the Proposed Remedial Design Components

The remedial design will include the components of a soil removal action, a SVE system, and a groundwater extraction and treatment system. Baker will provide a detailed design of the soil removal action and of the intensive groundwater extraction/treatment system which is suitable for placing a combined Work Plan/Construction Delivery Order with the LANTDIV RAC Contractor. Baker will also provide a performance-based specification for a SVE system. This section presents a description of these components.

4.1.1 Soil Removal Action

The soil removal action planned for OU No. 2 will include the excavation and off-site disposal of PCB- and pesticide-contaminated soils (AOCs 3 through 6), and soil and debris removal for AOC 2 (in the ravine). Figure 4-1 identifies the location of the soil AOCs and the remedial actions to be performed at each area. The soil removal action will be conducted under three primary steps: site preparation, excavation, and disposal.

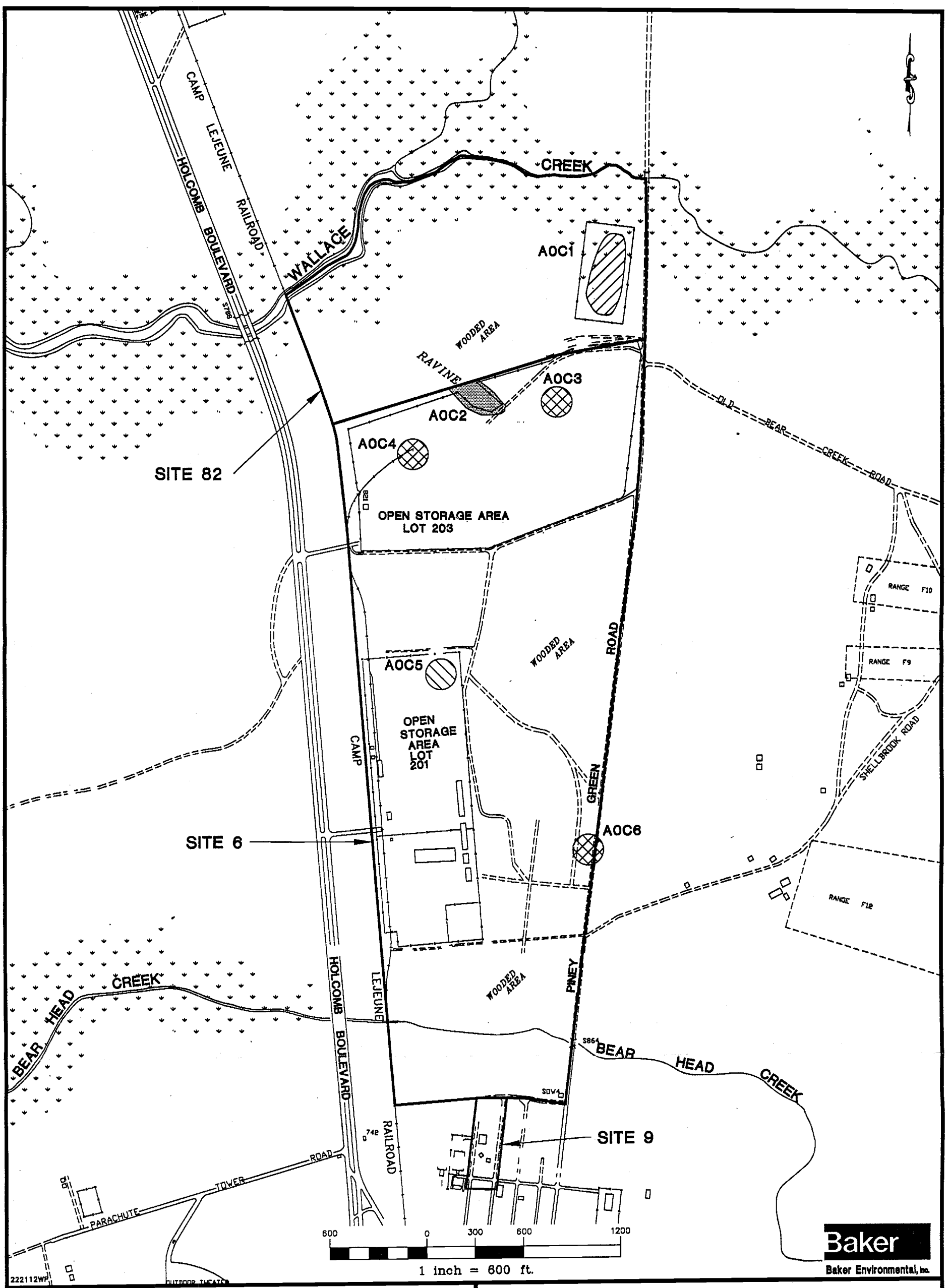
Site preparation activities will include, but not be limited to: staking out the AOCs; mobilizing equipment; mobilizing the field office and utilities; installing erosion and sedimentation controls; clearing and grubbing; constructing staging areas and decontamination areas; performing the appropriate utility/ordnance clearances; applying for and obtaining necessary permits for the off-site transportation and disposal of the soil/debris. Excavation activities will include: removing visible debris from the ravine; excavating the soil within the staked limits; placing the excavated soils and debris in the staging area; performing confirmatory sampling on the walls and floor of the excavations; and backfilling the excavations with certified clean material or continue excavating/testing activities, then backfilling the excavation. Following the excavation activities, the soil will be prepared for disposal at an off-site facility. The staged soil will be sampled for characterization analysis and for any testing required by the disposal facility. The soil/debris will then be loaded into regulatory-approved trucks and transported to an approved disposal facility.

4.1.2 Soil Vapor Extraction

The SVE system for OU No. 2 will be designed to treat the VOC-contaminated soils located at AOC 1 (see Figure 4-1) within Site 82. Baker will provide performance-based specifications and calculations to guide the LANTDIV RAC Contractor in the installation of an effective SVE system.

The site preparation activities associated with the installation of the SVE system will include, but not be limited to: mobilizing construction equipment and treatment equipment (e.g., vacuum blowers, vapor-liquid separator, emission control devices, off-gas treatment equipment); clearing and grubbing; constructing equipment staging area; locating existing utilities; obtaining ordnance clearance; and providing utility installation for the treatment equipment operation.

Following the site preparation activities, the SVE system will be constructed. Placement of the vapor extraction wells will be based on soil permeability testing (Section 3.0). Piping will be installed to connect the wells to the treatment system.



LEGEND

AOC1 — SOILS TO BE TREATED VIA IN SITU VOLATILIZATION – VOC CONTAMINATED SOILS

AOC5 — SOILS TO BE EXCAVATED AND REMOVED – PESTICIDE CONTAMINATED SOILS

AOC3,AOC4,AOC6 — SOILS TO BE EXCAVATED AND REMOVED – PCB CONTAMINATED SOILS

AOC2 — DRUM, DEBRIS, AND SOIL REMOVAL AREA

SOURCE: LANTDIV, FEBRUARY 1992

FIGURE 4-1
SOIL AREAS OF CONCERN
CONTAMINATED SOIL AND GROUNDWATER
REMEDIAL DESIGN CTO-0222

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

01484 DD022

4.1.3 Groundwater Extraction and Treatment

The groundwater extraction and treatment system for OU No. 2 will be designed to collect and treat the groundwater contamination originating from Site 82. For the initial design two extraction wells will be placed in the plume area with the highest contaminant levels. One deep extraction well (approximately 110 feet deep) pumping at a rate of 150 gallons per minute (gpm) and one shallow extraction well (approximately 35 feet deep) pumping at a rate of 5 gpm will be installed. Once extracted, the groundwater will be pumped to an on-site treatment system consisting of air stripping, carbon adsorption, and metals removal. The treated groundwater will be discharged to Wallace Creek. The approximate location of the extraction wells and the treatment system are identified on Figure 4-2.

After completion of the two initial extraction wells and the groundwater treatment system, aquifer tests will be performed to evaluate actual performance of the extraction well system. Using data from the aquifer tests, the location of the remaining deep and shallow extraction wells, and the interconnecting piping will be determined. The RAC Contractor will then install the remaining extraction wells and interconnected piping. Performance tests should then be performed on each of the additional shallow and deep extraction wells, to verify that each well is producing the desired yield. Based on a cursory review of aquifer characteristics from nearby wells (see Section 3.4), Baker estimated that a total of three shallow and two deep extraction wells would be installed.

Aspects relating to the treatment system design and construction are described below.

Equalization

Extracted groundwater will be pumped to the treatment facility and is stored in an equalization/holding tank. From this tank, the rate of flow to the treatment facility can be controlled, and therefore the operation of the treatment units optimized.

Mixing/Flocculation

In the mixing/flocculation area, chemicals will be added to the water to adjust the pH and to precipitate the dissolved metals of concern. The chemically treated water will then flow to the flocculation chamber where the water will be slowly mixed to combine particles and aid in settling. For this design, the flocculation and mixing steps will be combined in one unit.

Sedimentation

In the sedimentation step, solids will be removed from the water by simple gravity separation. For purposes of this design, an inclined plate separator has been assumed for the sedimentation step. These units are more efficient in operation and use less floor space than conventional settling tanks.

Filtration

After the sedimentation step, the water will be collected in a surge tank and pumped through mixed media or sand filters. For this design, the filter system will consist of a three unit group of filters working in parallel. The three filter system allows the filter backwashing to be completed without using a separate backwash tank. During backwash, water filtered by two units will be used to backwash the third. Since the filters are under pressure, water exiting the filters can flow directly to the next treatment step without additional pumping. Backwash water from these units will be directed to the flocculation chamber for reprocessing through the treatment system.

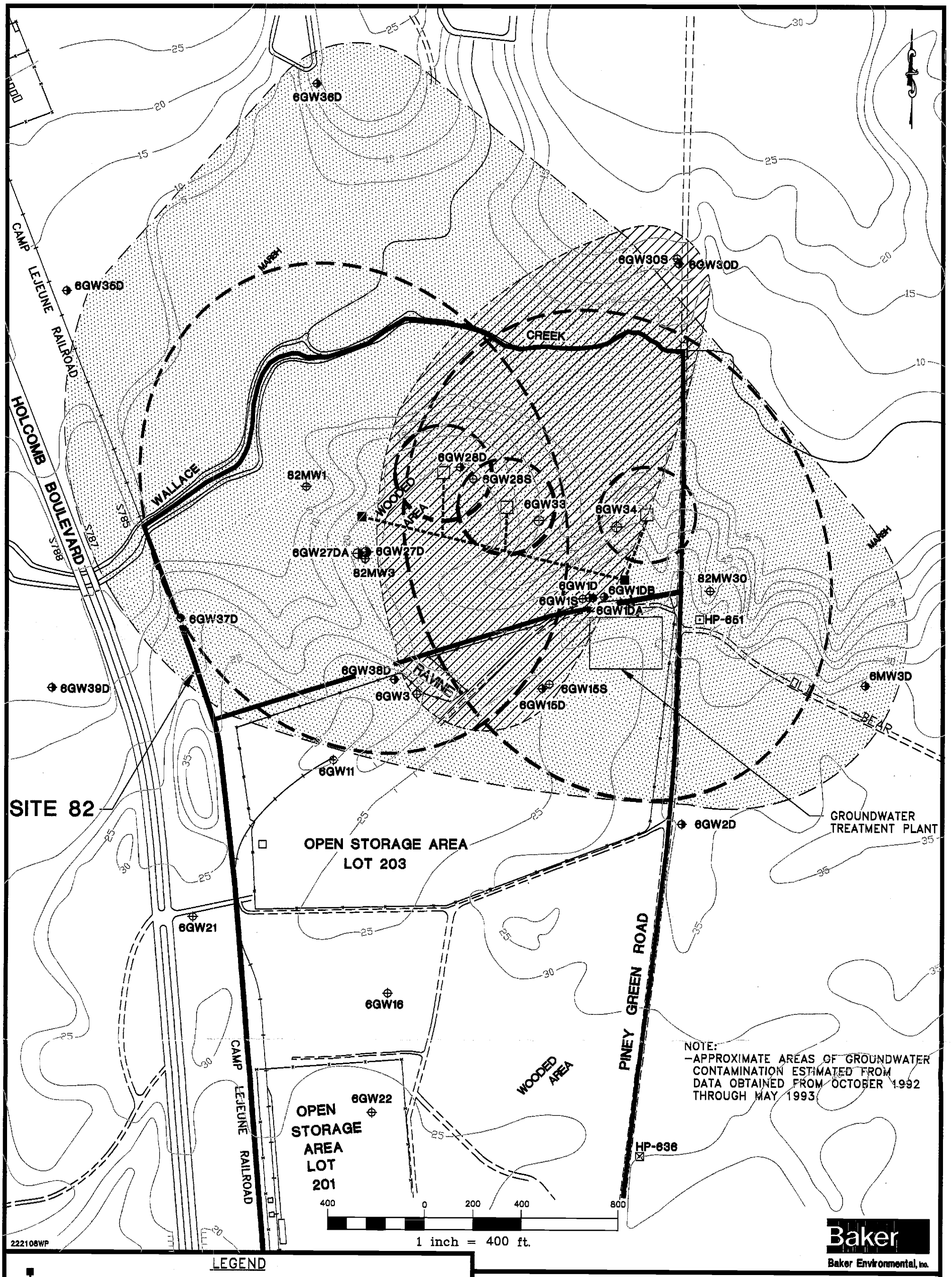


FIGURE 4-2
PROPOSED SITE DRAWING OF GROUNDWATER EXTRACTION AND TREATMENT SYSTEM
CONTAMINATED SOIL AND GROUNDWATER
REMEDIAL DESIGN CTO-0222
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

01484DD03Z

Air Stripping

After filtration, the water will flow to the air stripping tower where the VOCs will be removed. For this design, a typical low profile air stripping tower has been assumed with the size based on flow rates. The low profile design allows the unit to be placed within a building for easy maintenance and eliminating the aesthetic problems caused by tall conventional towers.

Carbon Adsorption

From the air stripping tower, the water will be pumped through particulate filters to remove any fine particulates remaining in the water and then through carbon adsorption units to remove remaining VOCs and SVOCs in the groundwater. The particulate filters are needed to prevent solids from fouling the carbon media.

Effluent Storage and Discharge

Following the carbon polishing step, some of the treated groundwater will be stored in an effluent storage tank to be used for backwashing the carbon adsorption units. The remaining treated groundwater will be discharged to Wallace Creek.

Solids Handling Facilities

Solids produced in the treatment process will be collected in the inclined plate clarifier. Solids will be pumped from the inclined plate clarifier to the sludge holding tank. In the sludge holding tank, the concentration of solids will increase while clear supernatant is drawn from the surface of the tank and returned to the head of the treatment system for reprocessing.

Concentrated solids in the tank will be periodically dewatered in a plate and frame filter press. Filtrate from the press will be returned to the equalization tank and subsequently reprocessed through the treatment system. Solids generated as a result of the treatment process will be sampled and analyzed to verify that the solids are nonhazardous. These solids will be hauled to an approved disposal site (such as a municipal landfill).

Treatment System Building

The on-site groundwater treatment system (and the SVE system) described above will be housed in a permanent structure, including masonry walls and a timber truss roof. The building conceptual design will include an interior office and restroom, insulated roof and wall systems, a concrete floor system, and electrical lighting, heating, and ventilating systems.

The treatment facility floor would consist of a concrete slab placed on a compacted layer of soil. The slab would be constructed with a containment curb along the perimeter to contain the contents of the treatment tanks. The floor drains would gravity discharge to a concrete sump; sump contents would be pumped into the treatment system.

4.2 Statement of Work

A Draft Statement of Work will be prepared in a format provided by and accepted by LANTDIV (the format is currently being determined by LANTDIV). This Statement of Work will be developed to assist LANTDIV in the procurement process under a RAC program. The Statement of Work will outline the scope and requirements of the remedial action. Attached as references to the Statement of Work will be the plans and specifications. Based on this Statement of Work, the RAC Contractor will prepare a Work Plan Package which includes a

detailed design of the remedial action. The Statement of Work may be incorporated into Section 01010, General Paragraph of the specifications.

4.3 Basis of Design

The Basis of Design Report will be a bound presentation of the assumptions, facts, background information, and general calculations used in preparing the remedial action design. The Basis of Design Report will also present the results of the soil screening study and the soil vapor permeability test. This report will provide detailed information on the civil, mechanical, electrical, and structural components of the various systems proposed for this design. The report will also be an energy evaluation to determine the proper source of energy for heating the proposed treatment facility.

4.4 Drawings

For all Requirements Package submittals, drawings will be on "D" size paper in stapled and rolled packages. The drawings will supplement the specifications. The drawings will be supplied concurrently to LANTDIV and the Activity for review.

4.5 Specifications

Specifications for construction of the remedial designs will be prepared by Baker using the SPECSINTACT format and will be supplied concurrently to LANTDIV and the Activity. A Submittal Approval and Distribution Chart for the Service/Construction Delivery Order will be included with each submittal of the specifications. The Submittal Approval and Distribution Chart will consist of a tabulation of all submittals referenced in the specifications, which are to be submitted by the LANTDIV RAC Contractor, such as work plans, shop drawings, catalog data, field and factory testing certifications, and permits.

4.6 Construction Cost Estimate

The construction cost estimate will be prepared using the Hazardous, Toxic, and Radiological Waste (HTRW) Remedial Action Work Breakdown Structure (WBS) and will include a third level summary table and a forth level detailed estimate. All categories of labor, materials, equipment, indirect costs, subcontractors, travel and overhead costs will be quantified and summarized to correspond with the construction drawings and specifications.

Detailed costs for the groundwater remediation and soil removal will be provided. However, the cost estimate for the SVE system will be based upon a preliminary design. Therefore, the final construction cost estimate for the SVE system will need to be prepared following completion of the final SVE design prepared by the RAC Contractor.

4.7 Construction Schedule

The construction schedule will be a graphical representation of the work proposed as part of this design package. The construction schedule will include all project milestones and their estimated start date, finish date, and duration. The tasks identified on the construction schedule will be in accordance with the third level of the HTRW Remedial Action WBS and will directly correspond with the tasks identified in the cost estimate.

4.8 Design Submittal Summary

A summary of the items required for each submittal of the design package (i.e., 35%, 90%, and 100%) is shown on Table 4-1. This table provides a brief description of the submittal items for quick reference.

TABLE 4-1 (Continued)

DESIGN SUBMITTAL REQUIREMENTS SUMMARY
CONTAMINATED SOIL AND GROUNDWATER REMEDIAL DESIGN - CTO-0222
MCB CAMP LEJEUNE, NORTH CAROLINA

Design Submittal	Basis of Design	Drawings	Specifications	Construction Cost Estimate	Construction Schedule
90% (Cont.)		Groundwater Remediation • Soil Removal (5) ▸ Site Plans - 2 AOCs per plan (2) ▸ Restored Site Plans (2) ▸ Detail Sheet • Soil and Debris Removal (2) ▸ Site Plan ▸ Restored Site Plan			
100%	• Final report incorporating LANTDIV's 90% comments	• Final drawings (as summarized above) incorporating LANTDIV's 90% comments • Drawing will be stamped and signed by a registered professional engineer • Autocad files of drawings	• Final specifications incorporating LANTDIV's 90% comments • Disk copy of final specifications in SPECSINTACT format	• Final cost estimate incorporating LANTDIV's 90% comments	• Final construction schedule incorporating LANTDIV's 90% comments

5.0 DATA MANAGEMENT

Because of the importance of the data to be collected during the predesign studies, the methods used to record and document field data and samples becomes very important. The following information provides overall guidance in the documentation of field data and samples. Additional information is presented in the SAP.

Five types of documentation will be used in tracking and shipping analytical samples:

- Field logbook;
- Sample labels;
- Chain-of-Custody Records;
- Custody Seals; and
- Commercial carrier air bills.

At a minimum, the label for each sample bottle shall contain the following information:

- Site Name;
- Sample number;
- Monitoring Well I.D. number;
- Date and time of collection;
- Sample type (grab or composite);
- Preservatives;
- Sample Matrix; and,
- Samplers initials.

The sample information, as well as the analysis to be performed on the sample will be entered into the field logbook for sampling location. Additionally, the following items also will be entered:

- Date and time;
- Name of field personnel on site;
- Names of visitors on site;
- Field conditions;
- Description of activities;
- Sampling remarks and observations;
- QA/QC samples collected; and,
- Sketch of sample location and site conditions.

Custody of the samples will be maintained by field personnel from the time of sampling until the time they are forwarded to the analytical laboratory. A sample is considered to be in an individual's possession if:

- It is in the sampler's possession or view after being in their possession;
- It was in the sampler's possession and then locked or sealed to prevent tampering; or
- It is in a secure area.

The sample custody will be documented using Chain-of-Custody (COC) records. Field personnel will complete a COC record in waterproof ink to accompany each cooler forwarded from the site to the laboratory. Any errors in the COC record will not be erased; instead, a line will be drawn through the error and initialed by the person completing the form. The original copy will be placed in a sealable plastic bag, placed in the appropriate cooler, and secured to the cooler's lid.

If the sample cooler is to be shipped by commercial air carrier, the cooler must be secured with custody seals so that the seals would be broken if the cooler was opened. The commercial air carrier is not required to sign the COC record as long as the custody seals remain intact and the COC record stays in the cooler. The only other documentation required is the completed air bill.

If the sample shipment is hand delivered to the laboratory by field personnel or retrieved by laboratory personnel at the site, then the custody seals are not necessary. The laboratory sample custodian, or their designee, will sign the COC record upon receipt of the samples. The original COC record will be returned along with the final data report. The laboratory will be responsible for maintaining internal logbooks and records that provide a custody record during sample preparation and analysis. Specific laboratory COC procedures are discussed in the Laboratory Quality Assurance Project Plan.

6.0 COMMUNITY RELATIONS

A public meeting was held on August 24, 1993, to present the Proposed Remedial Action Plan (PRAP) and answer any questions which may be a concern to the public. The turnout was very low, probably because the remedial action will take place at Lot 203, away from base housing. The DON has been keeping members of the Technical Review Committee aware of ongoing process applicable to this remedial action. In accordance with Section 300.435 (40 CFR) a Fact Sheet will be prepared detailing the results of the remedial design. In addition, the Community Relations Plan for MCB Camp Lejeune is being updated at present. The CRP will summarize all CRP activities that are anticipated for active CERCLA sites throughout MCB Camp Lejeune, in addition to this remedial design.

7.0 REPORTS

The results of the predesign studies will be documented in the Basis of Design report which is part of the design submittal package. The report will describe the predesign studies, and provide an evaluation of the test results. Any modifications to the design of the remedial action that may be necessary to implement the alternative, based on the results of the predesign studies, will be identified.

All laboratory results, chain-of-custody forms, and any other back-up information will be appended. The Basis of Design Report will be distributed in accordance with the Request for Proposal (RFP).

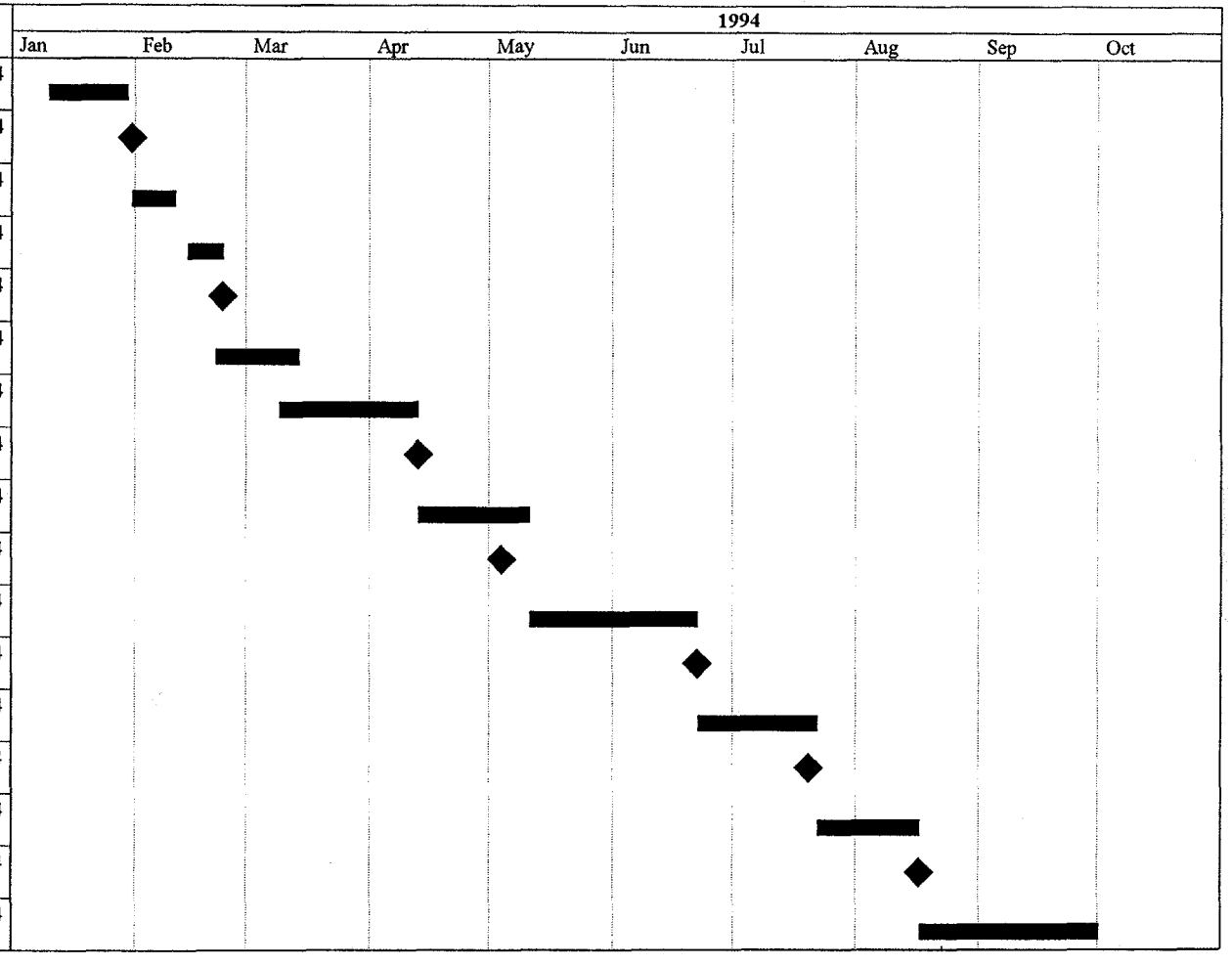
8.0 PROJECT SCHEDULE

The project will be performed in accordance with the schedule identified in Figure 8-1.

Factors that may effect this schedule causing an increase (or decrease) in the schedule include Government review periods, site access, weather conditions, or other unforeseen factors beyond Baker's control.

Figure 8 - 1
Remedial Design Project Schedule
Sites 6, 9 and 82 (Operable Unit No.2), MCB Camp Lejeune, NC CTO - 0222

Task	Days	Start	Finish
Prepare Draft RD Work Plan	20ed	1/10/94	1/30/94
Submit Draft RD Work Plan to Agencies	0ed	1/31/94	1/31/94
Agency Review	11ed	1/31/94	2/11/94
Prepare Final RD Work Plan	9ed	2/14/94	2/23/94
Submit Final RD Work Plan	0ed	2/23/94	2/23/94
Conduct Pre-Design Studies	21ed	2/21/94	3/14/94
Prepare 30% Design / Draft Design Report / Draft RA	35ed	3/9/94	4/13/94
Submit 30% Design / Draft Design Report / Draft RA	0ed	4/13/94	4/13/94
Agency Review	28ed	4/13/94	5/11/94
30% Design Review Meeting	0ed	5/4/94	5/4/94
Prepare 90% Design / Draft Final Design Report	42ed	5/11/94	6/22/94
Submit 90% Design / Draft Final Design Report	0ed	6/22/94	6/22/94
Agency Review	30ed	6/22/94	7/22/94
90% Design Review Meeting	0ed	7/20/94	7/20/94
Prepare Final Design / Final Design Report / Final RA Work Plan	26ed	7/22/94	8/17/94
Submit Final Design / Final Design Report / Final RA Work Plan	0ed	8/17/94	8/17/94
Procure RAC	45ed	8/17/94	10/1/94



Date Prepared: 1/26/94
Revised: 2/25/94

9.0 MANAGEMENT AND STAFFING

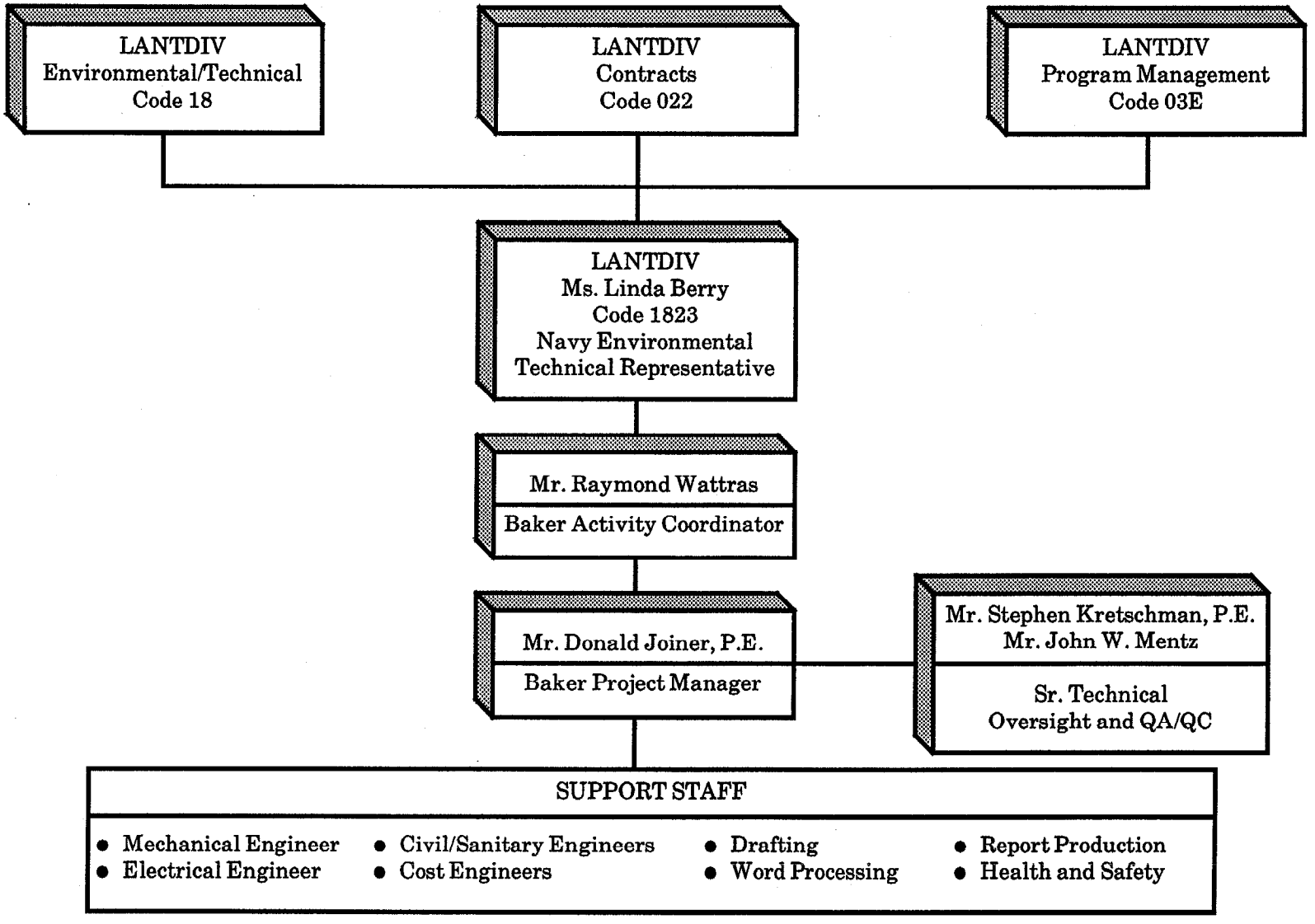
The Baker Project Team for the predesign studies will be managed by Mr. Don P. Joiner, P.E. Mr. Joiner will be responsible for monitoring the technical performance of the project, project costs and schedule, reporting, and maintaining close communication with the LANTDIV Engineer-in-Charge (EIC), Ms. Linda Berry, P.E. As shown on Figure 9-1, Mr. Joiner will report to Mr. William D. Trimbath, P.E. Mr. John W. Mentz will be responsible for overall QA/QC. Mr. Raymond P. Wattras, MCB Camp Lejeune Activity Coordinator, will provide additional administrative and/or technical support and coordination as needed.

In terms of assigning project personnel, Baker tentatively has identified the following team members and their primary responsibilities.

- Project Engineer - Ms. Tammi A. Halapin: Soil Removal and Soil Vapor Extraction Design
- Project Engineer - Mr. John Murawski: Groundwater Extraction and Treatment System Design
- Project Engineer - Ms. Coreen M. Casadei: Civil/Site Design
- Project Geologist - Mr. Richard E. Bonelli: Aquifer Study

Other project support and resources are illustrated in Figure 9-1.

FIGURE 9-1
PROJECT ORGANIZATION



10.0 REFERENCES

Baker Environmental, Inc. 1993. Treatability Study Report for the Hadnot Point Industrial Area, Operable Unit. Final. Prepared for the Department of the Navy, Naval Facilities Engineering Command, Atlantic Division, Norfolk, Virginia. May 1993.

Baker Environmental, Inc. 1993. Remedial Investigation Report for Operable Unit No. 2 (Sites 6, 9, and 82). Final. Prepared for the Department of the Navy, Naval Facilities Engineering Command, Atlantic Division, Norfolk, Virginia. August 1993.

Baker Environmental, Inc. 1993. Feasibility Study for Operable Unit No. 2 (Sites 6, 9, and 82). Final. Prepared for the Department of the Navy, Naval Facilities Engineering Command, Atlantic Division, Norfolk, Virginia. August 1993.

Environmental Science and Engineering, Inc. (ESE), 1988. Characterization Step Report for Hadnot Point Industrial Area, Confirmation Study to Determine Existence and Possible Migration of Specific Chemicals In-Situ. Prepared for Naval Facilities Engineering Command Atlantic Division.

Harned, Douglas A., Orville B. Lloyd, Jr., and M. W. Treece, Jr. 1989. Assessment of Hydrologic and Hydrogeologic Data at Camp Lejeune Marine Corps Base, North Carolina. USGS, Water Resources Investigations Report 89-4089.

O'Brien and Gere. 1990. Product Recovery System Design - Hadnot Point Fuel Farm, Marine Corps Base, Camp Lejeune. Prepared for Naval Facilities Engineering Command, Atlantic Division.

S&ME. 1992. Groundwater Characterization Study for Camp Lejeune Sanitary Landfill, Onslow County, North Carolina. MACON Project P-948, Landfill. Prepared for the Department of the Navy, Marine Corps Base, Camp Lejeune, North Carolina. September 1992.

FINAL

PART III
SAMPLING AND ANALYSIS PLAN

CONTAMINATED SOIL AND GROUNDWATER REMEDIAL DESIGN

OPERABLE UNIT NO. 2

MARINE CORPS BASE,
CAMP LEJEUNE, NORTH CAROLINA

CONTRACT TASK ORDER 0222

Prepared for:

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

Under:

LANTDIV CLEAN Program
Contract N62470-89-D-4814

Prepared by:

BAKER ENVIRONMENTAL, INC.
Coraopolis, Pennsylvania

FEBRUARY 28, 1994

TABLE OF CONTENTS

LIST OF FIGURES

1.0 INTRODUCTION

This section presents the Sampling and Analysis Plan (SAP) for Contract Task Order (CTO) 0222, Contaminated Soil and Groundwater Remedial Design for Operable Unit (OU) No. 2, Marine Corps Base (MCB), Camp Lejeune, North Carolina. Baker Environmental, Inc. (Baker) is the prime contractor for the Comprehensive Long-Term Environmental Action Navy (CLEAN) Program under which this project is being performed. Figure 1-1 in Part I of these Project Plans presents the Site Location Map of OU No. 2.

1.1 Sampling and Analysis Plan Objective

The primary objective of the SAP is to provide guidance for all field activities by describing in detail the sampling and data collection methods to be used to implement the various field tasks identified in the Work Plan (Part II). The SAP also helps to ensure that sampling and data collection activities are carried out in accordance with generally acceptable practices [e.g., USEPA Region IV's Standard Operating Procedures (SOPs)] so that data obtained during the predesign studies supports the design of the remedial action.

1.2 Sampling and Analysis Plan Contents

Section 1.0 of this SAP identifies the objective and contents of this report. Information regarding site background and history is presented in Part I and, therefore, was omitted in Section 2.0. Section 3.0 describes the field activities. Section 4.0 provides a description of the SOPs for each field investigation method conducted in accordance with the predesign studies.

2.0 SITE BACKGROUND

A detailed description of site background and history of OU No. 2 is provided in Part I of these Project Plans. Please refer to this section for additional information.

3.0 INVESTIGATION ACTIVITIES

Investigations to be conducted for OU No. 2 will include both "off-site" support activities and "on-site" field activities. Each of these items is discussed in the subsections to follow.

3.1 Support Activities

Prior to the commencement of field activities, "off-site" support activities will be conducted that will include project management subcontractor procurement, and an evaluation of aquifer characteristics.

3.1.1 Project Management

A discussion of project management responsibilities for this project is provided in Part II, Work Plan.

3.1.2 Subcontractor Procurement

Upon approval and finalization of the Project Plans, Baker will finalize the Scope of Work for selected subcontractors including, the analytical laboratory, the land surveyor, and the soil permeability test subcontractor. Prior to the initiation of field work, Baker will finalize the negotiations with the analytical laboratory, land surveyor, unexploded ordnance (UXO) clearance, and soil permeability test subcontractor.

3.1.3 Evaluation of Aquifer Characteristics

For this predesign study, Baker will not conduct aquifer tests to determine aquifer hydraulic parameters and capture zones. Baker will, however, review data from previous hydrogeologic studies conducted at the Base, including a wellhead protection study conducted by Geophex (1991) for production wells adjacent to OU No. 2. With this information, Baker will provide estimates of the aquifer parameters (e.g., transmissivity), the radius of pumping influence, and production rates for the aquifer systems underlying OU No. 2. Additionally, numerical groundwater flow models may be employed to further evaluate the hydrogeologic characteristics near OU No. 2.

3.2 Field Activities

"On-site" work to be performed will include the following tasks:

- Mobilization
- Unexploded Ordnance (UXO) Clearance
- Site Survey
- Soil Sampling and Screening
- Soil Vapor Pilot Test
- Demobilization

Each of these field activities is discussed in the sections below.

3.2.1 Mobilization

The field investigation will be initiated through mobilization activities such as equipment procurement. Since previous investigations have already been performed in these areas, utility clearances will not be required. All sampling and decontamination equipment, and associated personal protective equipment will be provided by the Baker field team.

3.2.2 Unexploded Ordnance (UXO) Clearance

Prior to initiating intrusive activities at AOCs 1 through 4, Baker's UXO Subcontractor will "clear" each borehole/sample location. If needed, a proposed location will be moved if concerns are raised at the safety of that particular location.

3.2.3 Site Survey

In order to provide the topographic and surface feature details necessary for the design and construction of the Remedial Action, Baker will conduct a survey of the AOCs identified at Sites 6 and 82. This survey will include the six soil action areas as well as the location of the groundwater action. Baker will subcontract the survey services and prepare topographic maps using a contour interval of 2 feet and a horizontal scale of 1 inch = 25 feet. These maps will be used in preparing the site plans for the groundwater remediation, the soil vapor extraction system, and the six soil removal actions. Additionally, a one-day land survey will be provided to establish a baseline for each AOC tied into a fixed physical feature of the site. The sampling grids will be laid out from this baseline.

The surveyor will perform these services in accordance with standard, acceptable surveying practices as required by the State of North Carolina. All work will be conducted under the supervision of a Registered Land Surveyor, duly licensed to work in the State of North Carolina. Section 4.1 presents the "Land Surveying SOP."

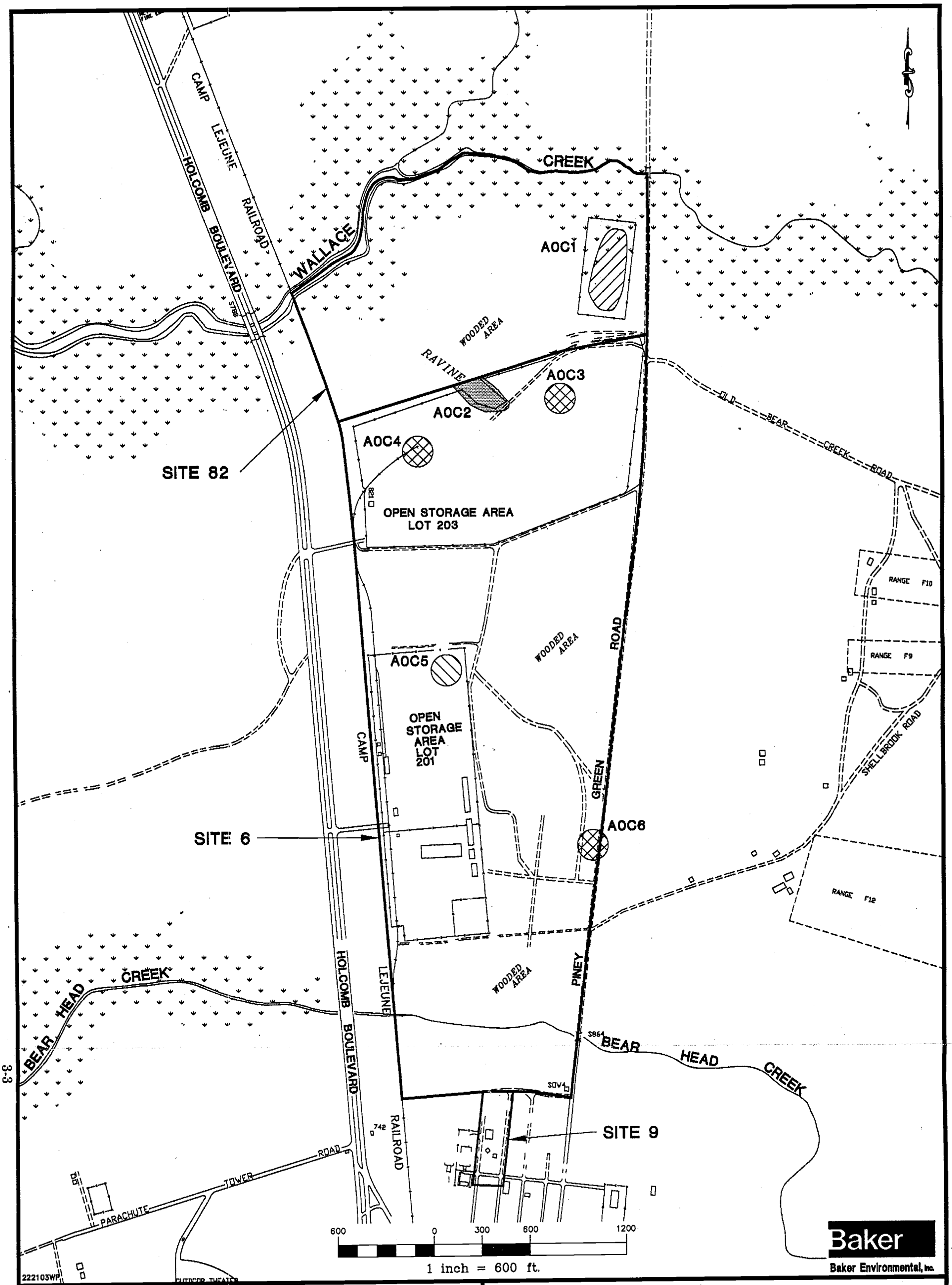
3.2.4 Soil Sampling

In order to delineate the extent of soil contamination at AOCs 3, 4, 5, and 6, Baker will collect soil samples for field screening and laboratory analysis. Figure 3-1 shows the location of these AOCs. Screening techniques and confirmatory sampling will be performed collectively at the pesticide AOC and PCB AOCs, to delineate the extent of pesticide and PCB contamination. Once the extent of contamination has been assessed (using the screening technique), confirmation samples will be collected for laboratory analysis to substantiate the screening results. The subsections below will describe the procedures for establishing the sample grids, pesticide and PCB soil screening, and soil sampling acquisition. Section 4.2 provides the SOP for "Soil and Rock Sample Acquisition."

3.2.4.1 Establishment of Systematic Sample Grids

Prior to sampling activities, systematic grids will be established around each AOC to assist in sample collection. Identifying the approximate location of each sample point is essential to obtain representative samples relevant to the sampling objectives (especially source identification and delineating contamination). Therefore, sampling points will be initially established utilizing an engineering tape measure and expanding outward from a control point that has been established at each AOC. Areal coordinates will then be plotted on a figure with sample points marked for future reference. Subsequent to sample collection the grid points will be surveyed in place as described in Section 3.2.3.

For PCB AOCs (3, 4 and 6), a sampling grid will be established at five foot intervals outward (i.e., in four radial directions) from the center of each AOC. The grid systems to be implemented for these AOCs were developed and modified based on the USEPA's Field Manual for Grid Sampling of PCB Spill Sites to Verify Cleanup (USEPA, 1986). A projected number of seven samples will be collected along each grid line (i.e., a maximum of 28 samples will be collected from each AOC) for the initial screening tests.



LEGEND

- **AOC1** — SOILS TO BE TREATED VIA IN SITU VOLATILIZATION – VOC CONTAMINATED SOILS
- **AOC5** — SOILS TO BE EXCAVATED AND REMOVED – PESTICIDE CONTAMINATED SOILS
- **AOC3, AOC4, AOC6** — SOILS TO BE EXCAVATED AND REMOVED – PCB CONTAMINATED SOILS
- **AOC2** — DRUM, DEBRIS, AND SOIL REMOVAL AREA

SOURCE: LANTDIV, FEBRUARY 1992

FIGURE 3–1
SOIL AREAS OF CONCERN
CONTAMINATED SOIL AND GROUNDWATER
REMEDIAL DESIGN CTO–0222

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

01484 DD042

For the pesticide AOC (i.e., AOC No. 5), a grid area of approximately 200 square feet will be established in a downgradient direction from the center of the AOC. Samples collected from within the grid will be screened with an assay test similar to that for PCBs. A projected number of 12 to 16 sample locations will be established within the grid.

The center of each AOC is defined as the boring/sample location, identified during the RI field program, which exhibited the highest concentration above the remediation cleanup level. Note that the grids established for all AOCs are subject to modification in the field if conditions warrant (e.g., underground obstruction and presence or absence of contamination). Sample grids for each AOC are depicted on Figures 3-2 through 3-5.

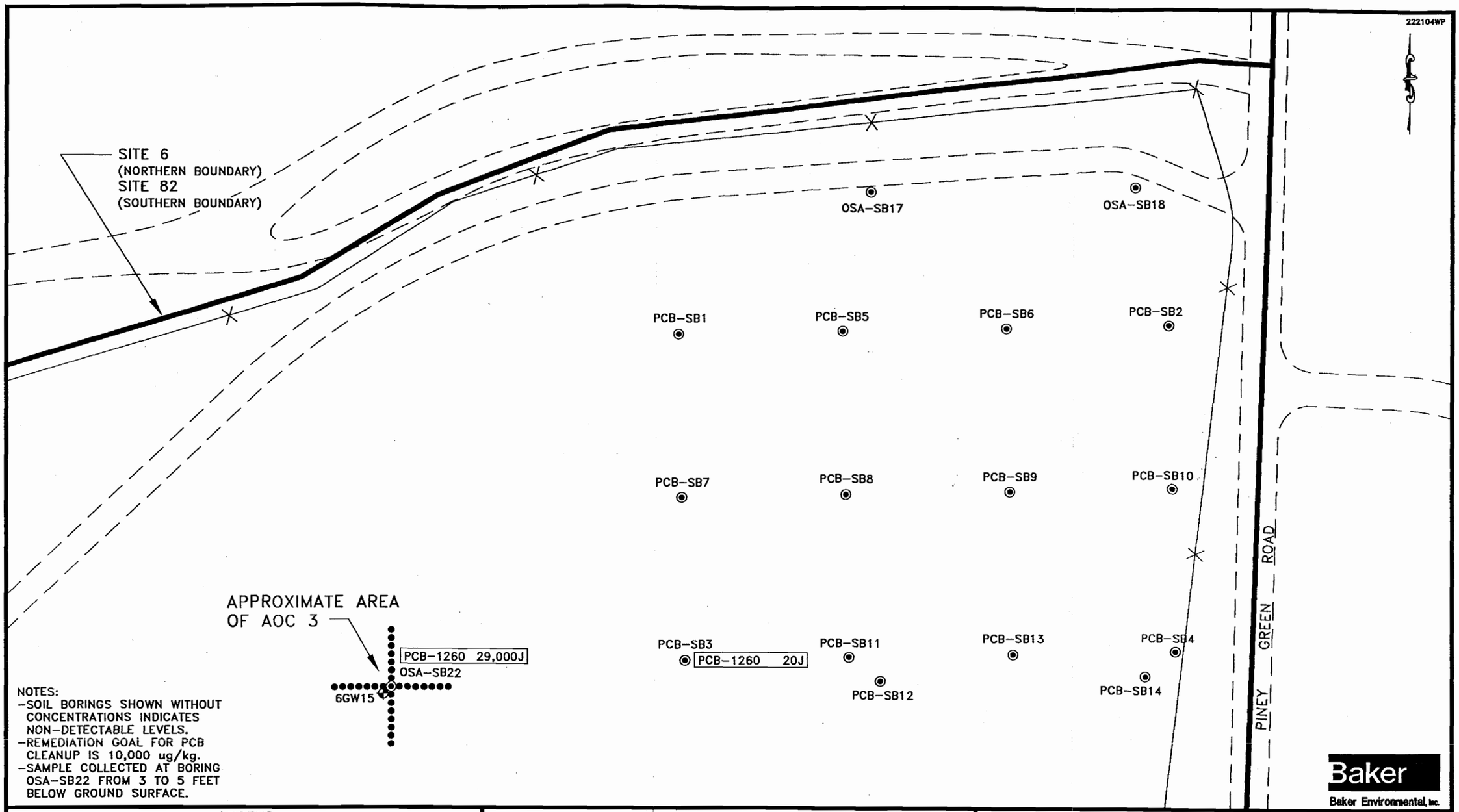
3.2.4.2 Determining the Extent of PCB Contaminated Soils

An Enzyme-Linked Immunosorbent Assay (ELISA) field screening kit will be utilized in the field for PCB-contaminated soils. It should be noted that this test system conforms to proposed USEPA Method 4020 for immunoassay-based field screening for PCBs in soil. The test kit has a minimum detection limit of 0.4 mg/kg which is adequate for this site. The test gives equal response at this level to Aroclors-1254 and -1260. Aroclors-1248, -1242, -1016, and -1232 are measured with minimum detection levels of 1, 2, 4, and 4 mg/kg, respectively. The manufacturer will provide the field test kit with the following action levels, 1.0 mg/kg and 10 mg/kg. These action levels have been established to inform the data users of the presence or absence of PCBs and to delineate the extent of contamination based on the action levels developed as part of the Feasibility Study. Because this test is specific for PCBs, no interferences are expected, due to chlorinated compounds that may be present at the site. This test also has an accuracy of 95% for samples testing positive.

As described in Section 3.2.4.1, a systematic sampling grid will be established around each AOC. Samples will be obtained with a hand auger or stainless-steel scoop and placed into a stainless-steel bowl. For AOCs 4 and 6, samples will be obtained from 0 to 12 inches below ground surface (bgs) (i.e., surface sample). This sampling interval was selected for these AOCs based on the analytical results of the RI field program which identified PCB contamination (i.e., concentrations above the remediation cleanup level) within the first twelve inches of soil. For AOC 3, three samples will be obtained from each boring. Samples will be collected from the surface (0 to 12 inches) and depth intervals of 3 to 4 feet bgs and 5 to 6 feet bgs. These sampling intervals were selected for AOC 3 because analytical results from the RI field program identified PCB contamination in soils at a depth of 5 feet. In order to accurately delineate the vertical extent of contamination the samples at depth will be implemented at two distinct intervals.

Following collection, each sample will be homogenized to ensure that the sample is mixed in a manner that provides uniformity throughout the sample prior to placing it in the appropriate container. This procedure of sample homogenizing will also ensure that the soil sample is representative of that specific interval. After homogenization, a representative amount of each sample will be placed in a plastic bag and cooled to 4°C. Once the required number of samples are collected, 10 grams from each sample will be selected for analysis via the ELISA screening technique; the results of each sample will establish whether additional sampling is needed to better define the extent of contamination. The screening procedures are identified in Attachment A.

After the extent of PCB contamination has been determined at each AOC, based on the field screening tests, four samples containing PCB concentrations below the established soil screening action levels, will be taken from each AOC and sent to the NEESA certified laboratory for confirmatory analysis of PCBs. The portion sent to the laboratory will be acquired from the homogenized sample; this will ensure that the laboratory portion is



NOTES:
- SOIL BORINGS SHOWN WITHOUT CONCENTRATIONS INDICATES NON–DETECTABLE LEVELS.
- REMEDIATION GOAL FOR PCB CLEANUP IS 10,000 ug/kg.
- SAMPLE COLLECTED AT BORING OSA–SB22 FROM 3 TO 5 FEET BELOW GROUND SURFACE.

LEGEND

PCB–SB1/OSA–SB22	SOIL BORING ADVANCED DURING THE RI
6GW15	SOIL BORING (MONITORING WELL BORING) ADVANCED DURING THE RI
PCB–1260 29,000J	PCB CONCENTRATION (ug/kg) DETECTED DURING THE RI
•	PROPOSED SOIL SAMPLE LOCATION FOR FIELD SCREENING ANALYSIS

SOURCE: LANTDIV, FEB. 1992

60 0 30 60 120

1 inch = 60 ft.

FIGURE 3–2
PROPOSED SAMPLING GRID FOR SOIL
AOC 3– PCB CONTAMINATED SOILS
LOT 203 SITE 6
CONTAMINATED SOIL AND GROUNDWATER
REMEDIAL DESIGN CTO–0222
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

01484DDB22

222105WP

SITE 6
(NORTHERN BOUNDARY)
SITE 82
(SOUTHERN BOUNDARY)

APPROXIMATE AREA
OF AOC 4

PCB-1248 580J
PCB-1254 2100J
PCB-1260 550J
OSA-SB38

OSA-SB23

6GW11
OSA-SB24
PCB-1260 42,000J

OSA-SB25

PCB-1254 170J
PCB-1260 700J
OSA-SB39

OSA-SB40

OSA-SB41

OSA-SB28

OSA-SB42

OSA-SB29

OSA-SB30

821

NOTES:
-SOIL BORINGS SHOWN WITHOUT CONCENTRATIONS INDICATES NON-DETECTABLE LEVELS.
-REMEDIATION GOAL FOR PCB CLEANUP IS 10,000 uk/kg.
-SAMPLE COLLECTED AT BORING OSA-SB24 FROM 0 TO 6 INCHES BELOW GROUND SURFACE.

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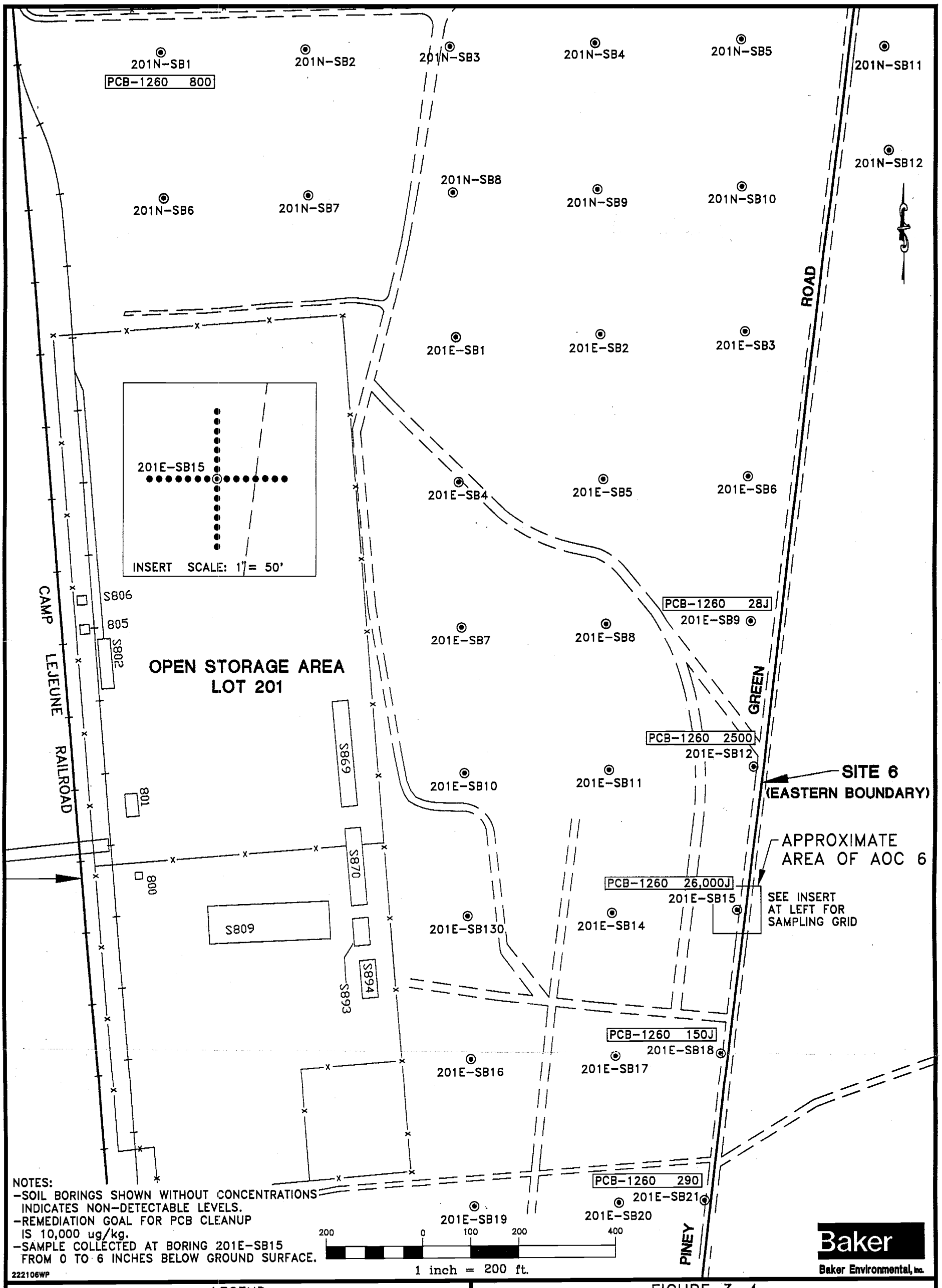
LEGEND

OSA-SB24	SOIL BORING ADVANCED DURING THE RI
6GW11	SOIL BORING (MONITORING WELL BORING) ADVANCED DURING THE RI
PCB-1260 42,000J	PCB CONCENTRATION (ug/kg) DETECTED DURING THE RI
	PROPOSED SOIL SAMPLE LOCATION FOR FIELD SCREENING ANALYSIS

SOURCE: LANTDIV, FEB. 1992

60 0 30 60 120
1 inch = 60 ft.

FIGURE 3-3
PROPOSED SAMPLING GRID FOR
AOC 4 - PCB CONTAMINATED SOILS
LOT 203, SITE 6
CONTAMINATED SOIL AND GROUNDWATER
REMEDIAL DESIGN CTO-0222
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



LEGEND

201E-SB15 ◉	SOIL BORING ADVANCED DURING THE RI.
PCB-1260 26,000J	PCB CONCENTRATION (ug/kg) DETECTED DURING THE RI
•	PROPOSED SOIL SAMPLE LOCATION FOR FIELD SCREENING ANALYSIS.

SOURCE: LANTDIV, FEB. 1992

FIGURE 3-4
PROPOSED SAMPLING GRID FOR SOIL AOC 6 – PCB CONTAMINATED SOILS WOODED AREA, SITE 6 CONTAMINATED SOIL AND GROUNDWATER REMEDIAL DESIGN CTO-0222
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

SB2
4,4'-DDE 210
4,4'-DDT 99

SB3
4,4'-DDE 500J
4,4'-DDD 48J
4,4'-DDT 350

SB4
4,4'-DDD 8.9J
4,4'-DDT 44J

SOIL ROAD

SB39

SB17
4,4'-DDE 17,000J
4,4'-DDD 180,000J
4,4'-DDT 1,200,000J

SB38

SB16
4,4'-DDE 1,400J
4,4'-DDD 2,500J
4,4'-DDT 8,100J

SB15
4,4'-DDE 210
4,4'-DDT 280

SB14
4,4'-DDE 61
4,4'-DDT 62

APPROXIMATE
AREA OF AOC 5

SB12
DIELDRIN 6.4J
4,4'-DDE 7.7
4,4'-DDT 22J

SB22
4,4'-DDT 4J

SB21
4,4'-DDE 79
4,4'-DDT 94

SB20
4,4'-DDT 770
DIELDRIN 46
4,4'-DDE 450
4,4'-DDD 96J

SB19
4,4'-DDT 120

SB27
GATE
4,4'-DDT 17

SB26
4,4'-DDT 340
DIELDRIN 11J
4,4'-DDE 53
4,4'-DDD 31J

SB25
4,4'-DDE 41
4,4'-DDD 89J
4,4'-DDT 300J

SB24
4,4'-DDE 81J
4,4'-DDD 33J
4,4'-DDT 350

SB11
4,4'-DDE 19
4,4'-DDT 23J

SB32
4,4'-DDE 7.4
4,4'-DDT 14

SB31
4,4'-DDE 8.4

SB30
4,4'-DDT 64

SB29
4,4'-DDT 4

SB37
4,4'-DDD 4.4J
4,4'-DDT 16

SB36
4,4'-DDT 4.6J

SB35
4,4'-DDE 8.1J
4,4'-DDT 32J

SB34
4,4'-DDE 160
4,4'-DDD 20J
4,4'-DDT 320

OPEN STORAGE AREA
LOT 201

SB10

SB9
4,4'-DDE 18
4,4'-DDT 55J

SB8
DIELDRIN 5.6J
4,4'-DDE 25J
4,4'-DDT 27J

NOTES:
- SOIL BORINGS SHOWN WITHOUT CONCENTRATIONS INDICATES NON-DETECTABLE LEVELS.
- REMEDIATION GOAL FOR PESTICIDE CLEANUP IS 60,000 ug/kg (4,4'-DDT)
- SAMPLE COLLECTED AT BORING SB17 FROM 0 TO 6 INCHES BELOW SURFACE.

AREA A

30 0 15 30 60

1 inch = 30 ft.

222109WP

Baker
Baker Environmental, Inc.

LEGEND

SB17 — SOIL BORING ADVANCED DURING THE RI

4,4'-DDT 1,200,000J — PESTICIDE CONCENTRATION (ug/kg) DETECTED DURING THE RI

● — PROPOSED SOIL SAMPLE LOCATION FOR LABORATORY ANALYSIS

SOURCE: LANTDIV, FEB. 1992

FIGURE 3-5
PROPOSED SAMPLING GRID FOR SOIL AOC 5 - PESTICIDE CONTAMINATED SOILS, LOT 201, SITE 6
CONTAMINATED SOIL AND GROUNDWATER
REMEDIAL DESIGN CTO-0222
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

identical in composition to the portion which was screened with the ELISA Kit. The results of the confirmatory sampling will verify the extent of contamination at each AOC.

3.2.4.3 Determining the Extent of Pesticide Contaminated Soils

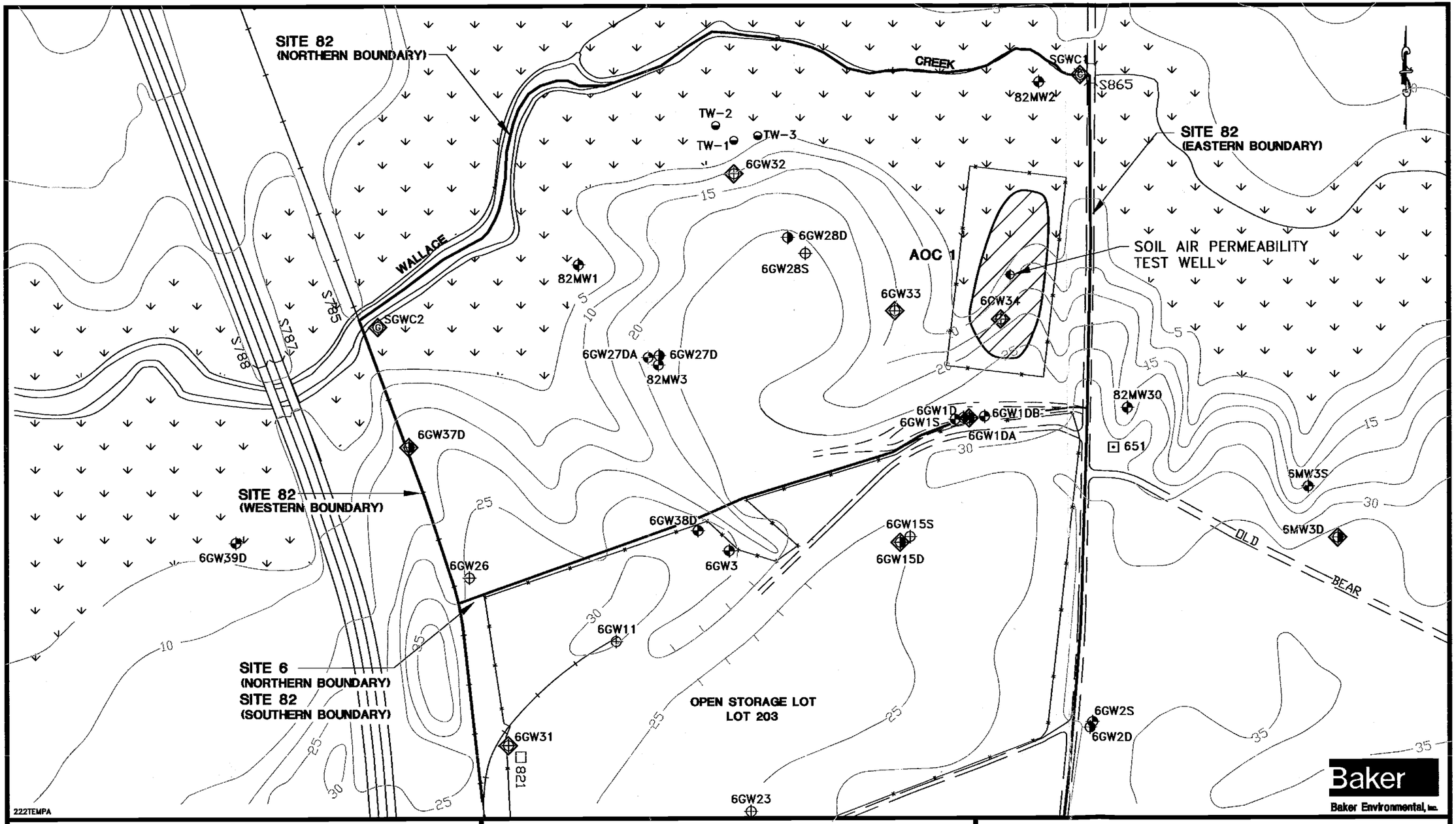
Twelve to sixteen soil samples will be collected from 0 to 12 inches bgs and analyzed for DDT content using a field test. Actual quantitation of DDT by immunoassay is not possible due to the test kits cross-reactivity with DDT breakdown products (i.e., DDD and DDE) and other similar compounds. In addition, actual quantitation is limited based on the variations in extraction efficiency inherent in the fast extraction protocol. As this screening process will not differentiate between DDT and its metabolites and other structurally similar compounds, it will provide an indication of their presence to differing degrees. The concentrations at which DDT will be screened in the field are in the ppm ranges. To categorize samples at AOC 5, DDT will be screened at 1.0 ppm and 50 ppm. To obtain a detection of 50 ppm, a series of dilutions will take place with the extract solution. Four samples containing DDT concentrations, suspected to be below the established soil screening action levels, will be collected from AOC 5 and sent to a NEESA-certified laboratory for confirmatory analyses of pesticides. The portion sent to the laboratory will be acquired from the homogenized sample; this will ensure that the laboratory portion is identical in composition to the portion which was screened with the assay test. The results of the confirmatory sampling will verify the extent of contamination at AOC 5.

For the pesticide AOC 5, a circular grid system will be implemented around the control point. Systematic random sampling will be performed in this area as this most accurately estimates the extent of contamination with or without trends being present. An area of approximately 200 square feet will be addressed over AOC 5. This grid size was selected because the area within each quadrant can be considered reasonably homogeneous, based on past site activities and current use. This grid system and proportionality of the number of random samples has been adjusted so that a ratio of one random sample per 13 square feet of area is maintained. However, this grid system is subject to change should screening results indicate positive or negative results. Grid expansion or truncation may occur to better define the extent of pesticide contamination. Samples will be collected using the same methods as those described in Section 3.2.4.2.

3.2.5 Soil-Air Permeability Testing

Baker's subcontractor, Target Environmental Services, Inc., will conduct a soil permeability test at AOC 1, under the supervision of Baker's Field Team Leader, to provide the engineering parameters needed to optimally design a soil vapor extraction system for soil remediation. The data to be provided includes air permeability of the soil, radius of vacuum influence, and VOC removal rates. Figure 3-6 shows the location of AOC 1.

The soil permeability test will include the installation of a vacuum extraction well with a 2-inch diameter PVC well screen to a depth of 15 feet in an area known to contain soil contamination. Four to eight vacuum monitoring points and two soil gas sampling points will be installed to a depth of 12 to 15 feet in the vicinity of the extraction well. A vacuum pump will extract vapors and direct them through an air/water separator and a waste recovery system consisting of carbon canisters to capture organic vapors. Vacuum levels at each monitoring point will be measured by high sensitivity vacuum transducers and logged on an on-site computerized data logger. Vapor samples will be collected from the extraction wellhead at the start, midpoint, and end of each test at a selected flow rate (i.e., 3 samples x 4 flow rates = 12 samples). Samples will be analyzed on-site using a gas chromatograph equipped with an electron capture detector for chlorinated compounds following USEPA Method 601 procedures.



LEGEND

- 6GW1S — EXISTING SHALLOW MONITORING WELL
- 6GW9 — PHASE I SHALLOW MONITORING WELL INSTALLED BY BAKER ENVIRONMENTAL, Inc., SEPT.– OCT. 1992
- 6GW1D — PHASE I DEEP MONITORING WELL INSTALLED BY BAKER ENVIRONMENTAL, Inc., SEPT.– NOV. 1992
- BHSG1 — PHASE I STAFF GAUGE INSTALLED BY BAKER ENVIRONMENTAL, Inc., OCT. 1992
- 6GW31 — PHASE II SHALLOW MONITORING WELL INSTALLED BY BAKER ENVIRONMENTAL, Inc., MARCH–APRIL 1993
- 6GW1DA — PHASE II DEEP MONITORING WELL INSTALLED BY BAKER ENVIRONMENTAL, Inc., MARCH–APRIL 1993
- SCWC1 — PHASE II STAFF GAUGE INSTALLED BY BAKER ENVIRONMENTAL, INC., DECEMBER 1992
- TW-1 — TEMPORARY WELL INSTALLED BY BAKER ENVIRONMENTAL, Inc., MARCH 1993
- APPROXIMATE LOCATION OF TEST WELL

SOURCE: LANTDIV, OCT. 1991

300 0 150 300 600

1 inch = 300 ft.

FIGURE 3–6
LOCATION FOR SOIL AIR PERMEABILITY TEST
AT AOC 1, SITE 82
CONTAMINATED SOIL AND GROUNDWATER
REMEDIAL DESIGN CTO–0222
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

01484DD052

3.2.6 Demobilization

The field investigation will be concluded through demobilization activities such as returning equipment to the office. All sampling and decontamination equipment, and associated personal protective equipment used by the Baker field team will be either properly disposed or decontaminated and returned to the office.

3.3 Field Personnel and Responsibilities

Baker intends to staff the investigation with a Project Manager, and two Environmental Scientists, one serving as the Field Team Leader and the other as the Health and Safety Officer. Additionally, administrative and technical support staff will be available off-site for various tasks of the project. Figure 4-1 in the QAPP presents the Project Organization Summary.

The Project Manager will have as primary responsibilities: (1) monitoring technical, cost and schedule performance; (2) orchestrating Baker's overall QA efforts--document reviews, cost/schedule reviews--with the Program Manager and senior technical staff; and, (3) maintaining close communication with the LANTDIV NTR and Activity personnel.

Each of the Environmental Scientists aside from the health and safety activities will share the site duties such as: (1) locating the extraction well, vacuum monitoring points/soil gas sampling points, and the soil screening points; (2) responsibility for the technical aspects of the project in accordance with the SAP, and will be the primary contact with Activity personnel; and (3) maintaining the master logbook, all sample documentation (i.e., Chain-of-Custody, sample labels, sample tags, etc.), project photographs, and performing sample packaging.

3.4 Sample Numbering System

Samples collected for field screening evaluation and laboratory analysis will be designated with a unique sample number. The number will serve to identify the site, location, boring number, the depth, and QA/QC qualifiers. The sample designation format is as follows:

Site # - AOC - Boring - Depth (QA/QC)

3.5 Sample Preservation/Shipping Techniques

All environmental soil samples subject to laboratory analysis and corresponding aqueous/soil QA/QC samples (rinsates, field blanks, and duplicates) will be preserved with ice to a temperature of 4° C prior to shipment to the analytical laboratory. Table 7-1 of the QAPP presents summaries of sample containers, preservation, and holding times for soil and aqueous samples, respectively. Section 4.3 provides the SOP for "Sample Preservation and Handling."

Samples will be shipped via an overnight courier to arrive before 12:00 noon the following day. The only exception is that samples shipped on Saturday will not arrive at the laboratory until Monday. Baker's SOP for sample "Chain-of-Custody" has been included in Section 4.4.

3.6 Sample Analysis

All confirmation samples (PCBs or pesticides) will be analyzed using Contract Laboratory Procedures (CLP) procedures and following USEPA Level III Data Quality Objectives (DQO).

The appropriate number of field QA/QC samples will be analyzed in addition to laboratory QA/QC samples.

A subcontracted NEESA-certified laboratory will be used to perform the sample analysis. Baker personnel will be responsible to track analysis of the samples and obtain results from the laboratory.

3.7 Personal Protection

Baker currently anticipates that field activities at OU No.2 will be conducted in Level C personal protection. Level C will include chemical-resistant clothing, steel-toed/chemical-resistant boots, chemical resistant gloves and respiratory protection. Details concerning the level of protection are contained in the Health and Safety Plan (Section V of these Project Plans). Protection downgrades will be considered according to the action levels set forth in the HASP for the MINIRAM Personal Monitor, or after consultation with the Project Health and Safety Officer. Section 4.5 provides the SOP for the "MINIRAM Personal Monitor."

3.8 Decontamination

Decontamination procedures for both equipment and personnel are discussed in the subsections below.

3.8.1 Equipment Decontamination

All associated sampling equipment (stainless-steel scoops, auger bucket) will be thoroughly cleaned before sampling commences, between each soil boring location, and prior to leaving the site in accordance with USEPA Region IV's SOPs. These procedures are described below:

1. Clean with tap water and laboratory detergent (Liquinox) using a brush if necessary to remove particulate matter and surface soil.
2. Rinse thoroughly with tap water.
3. Rinse thoroughly with deionized water.
4. Rinse twice with solvent.
5. Rinse thoroughly with organic-free water and allow to air dry as long as possible.
6. If organic-free water is not available, allow equipment to air dry as long as possible. Do not rinse with deionized or distilled water.

Decontamination fluids will be containerized in properly labeled 55 gallon drums and stored on-site in a secure area until final disposal. A proposed staging area will be within Lot 203. Auger cuttings from the hand auger will be returned to each borehole.

A description of decontamination procedures is also provided in Section 4.6 "Decontamination of Sampling and Monitoring Equipment" SOP.

3.8.2 Personnel Decontamination

Personnel decontamination is discussed in the Health and Safety Plan (Part V of the Project Plans).

3.9 Quality Assurance/Quality Control

The appropriate number of field QA/QC samples, including field blanks, rinsate blanks, and duplicates will be analyzed in addition to laboratory QA/QC samples, including matrix spike and matrix spike duplicate samples. A NEESA-certified subcontracted laboratory will be used to perform sample analysis.

Standard IRP QA/QC samples that are applicable to this project, will be collected at the following frequencies:

- Field Blank (Ambient Conditions Blank) - two samples per sampling event (one potable and one deionized water)
- Equipment Rinsate Blank - one sample submitted every other day (per LANTDIV directive) for subsurface soil sampling, (hand auger, shovel, post-hole digger and/or trowel)
- Field Replicate - one sample for every 10 (10%) environmental soil/sediment samples collected

Additional sample volumes for internal laboratory QA/QC (i.e., matrix spikes, etc.) will be collected. Refer to Table 11-1 in Part IV for a summary of QA/QC sample requirements.

3.10 Field Change and Corrective Action

If changes become necessary due to field conditions (e.g., weather problems, obstruction to sampling, etc.) the proposed changes will be communicated from Baker's Field Team Leader to Baker's Project Manager, and then to the NTR and Base environmental coordinator. Upon mutual agreement of the best method of solving the problem, the method will be implemented and the change will be documented, and information placed in the project file.

3.11 Field Instrument Calibration

Equipment calibration will be performed at the frequency and according to the instructions provided by the manufacturer of each piece of equipment. Calibration will be performed daily, at a minimum, prior to initiation of field activities.

3.12 Contaminated Materials Handling Plan

Excess soil cuttings will be returned to the borehole since the areas from which the samples will be collected will undergo excavation for disposal. Disposable sampling materials, field screening waste, decontamination water, and disposable personal protective equipment will be containerized in appropriate containers, and properly labeled. Baker will coordinate removal, transport, and disposal of all investigation derived wastes (IDW). However, the Base is responsible for signing waste profiles and manifests.

Health and safety disposables, such as sampling gloves, outer boots, Tyvek coveralls, paper towels, plastic sheeting, or other materials which may come in contact with potentially contaminated materials will be placed in large, plastic bags during the field effort. These IDWs should not be grossly contaminated and are, therefore, will not be handled as a hazardous waste. At end of the field program, the bags will be containerized in a one-cubic yard container and transported to a solid waste landfill by a licensed waste disposal contractor. Section 4-7 presents the SOP entitled "Handling of Site Investigation Derived Wastes."

3.13 Documentation

A single notebook will be issued to each field crew member for use during the investigation and will serve as a daily logbook detailing the weather and activities of the day. Documentation will include work accomplished, those present on site, as well as technical issues such as sampled numbers, descriptions of sample locations, and problems encountered during sample collection, and sample handling and preservation methods. Section 4-8 presents the SOP entitled "Field Logbook."

4.0 STANDARD OPERATING PROCEDURES

4.1 Land Survey SOP

4.2 Soil and Rock Sample Acquisition SOP

4.3 Sample Preservation and Handling SOP

4.4 Chain-of-Custody SOP

4.5 MINIRAM Personal Monitor SOP

4.6 Decontamination of Sampling and Monitoring Equipment SOP

4.7 Handling of Site Investigation Derived Wastes SOP

4.8 Field Logbook SOP

Attachment a - EnSys PCB Field Screening User's Guide

Attachment B - Millipore EnviroGard DDT Soil Test Kit

NOTE: SOPs and attachments will be included in copies of Project Plans distributed to field personnel only.

FINAL

PART IV
QUALITY ASSURANCE PROJECT PLAN

CONTAMINATED SOIL AND GROUNDWATER REMEDIAL DESIGN

OPERABLE UNIT NO. 2

MARINE CORPS BASE,
CAMP LEJEUNE, NORTH CAROLINA

CONTRACT TASK ORDER 0222

Prepared for:

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

Under:

LANTDIV CLEAN Program
Contract N62470-89-D-4814

Prepared by:

BAKER ENVIRONMENTAL, INC.
Coraopolis, Pennsylvania

FEBRUARY 28, 1994

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1.0 INTRODUCTION

This Quality Assurance Project Plan (QAPP) has been developed for the field investigation to be conducted at Operable Unit (OU) No. 2, Marine Corps Base (MCB), Camp Lejeune, North Carolina. OU No. 2 consists of the following three sites:

- Site 6 - Storage Lots 201 and 203
- Site 9 - Fire Fighting Training Pit
- Site 82 - Piney Green Road VOC Site

Field investigation activities to be conducted for this project, however, will only be conducted at Sites 6 and 82, and are intended to provide data to support the design of the soil remedial actions at OU No.2.

The preparation of this QAPP, and other related project plans, is being performed under the Navy CLEAN Contract Task Order 0222. Baker Environmental, Inc. (Baker), a wholly owned subsidiary of the Michael Baker Corporation, is the prime contractor for the implementation of this project.

This QAPP addresses the quality assurance and quality control (QA/QC) steps and procedures that will be administered for the sample collection and analysis for this investigation. Detailed information regarding sample handling and analytical methods are provided in Sections 6.0 and 9.0, respectively. Sample collection procedures are provided in the Sampling and Analysis Plan (SAP). Note that only soil samples will be collected and analyzed during this investigation.

2.0 SCOPE OF QUALITY ASSURANCE PROJECT PLAN

This QAPP addresses sample collection and analysis to be conducted for the field investigation of Sites 6 and 82 of MCB Camp Lejeune, North Carolina. The QAPP has been developed for the Department of Navy (DON) in accordance with U. S. Environmental Protection Agency (USEPA) guidelines.

In order to provide adequate QA/QC, this investigation will require:

1. Use of a Naval Energy and Environmental Support Activity (NEESA) certified analytical laboratory;

2. Use of accepted analytical methods for the samples outlined in the SAP. Analysis of samples for hazardous constituents parameters will be performed using the following documents:

   - U.S. EPA "Test Methods for Evaluating Solid Waste", SW-846, November 1986.

3. Field audit(s) during initial sampling activities to verify that sampling is being performed according to the QAPP.

The structure of this QAPP and the QA elements addressed are:

- Title Page
- Table of Contents
- Introduction
- QAPP Scope
- Project Description
- Project Organization
- QA Objectives for Data Measurement
- Sampling Procedures
- Sample and Document Custody
- Calibration Procedures and Frequency
- Analytical Procedures
- Data Reduction,Validation, and Reporting
- Internal QC Checks
- Performance and System Audits
- Preventive Maintenance
- Data Measurement Assessment Procedures
- Corrective Action
- QA Reports to Management

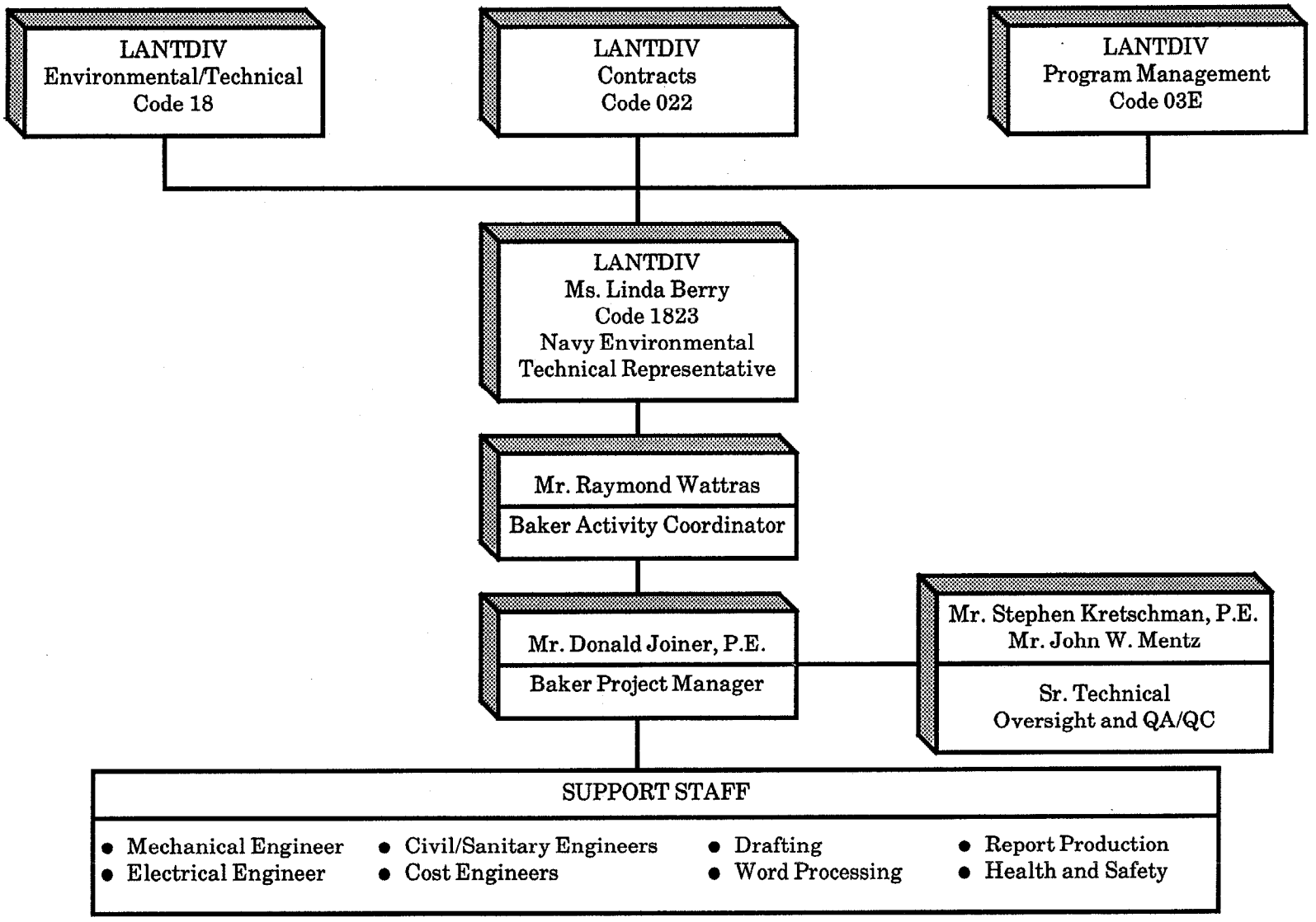
3.0 PROJECT DESCRIPTION

An introduction to the field investigation of OU No. 2 (Sites 6 and 82) describing the project objectives and scope are given in Parts I (Introduction) and II (Work Plans) of these Project Plans. These sections discuss the objectives of the study, and the various field sampling and analytical programs. A detailed description of the field investigations, including sample location and designation, sampling procedures and frequency, is presented in Sections 3.0 and 4.0 of the SAP.

4.0 PROJECT ORGANIZATION

Technical performance of the investigation of OU No. 2 at MCB Camp Lejeune and key personnel responsible for quality assurance throughout its duration are described in Section 9 of the Work Plan. The contractor will utilize subcontractors to perform laboratory analysis, data validation, ordnance clearance, and surveying. Specific subcontractors have not yet been identified. Figure 4-1 shows the project organization, lines of authority, and support personnel/organizations.

FIGURE 4-1
PROJECT ORGANIZATION



5.0 QUALITY ASSURANCE OBJECTIVES FOR DATA MEASUREMENT

The purpose of a Quality Assurance (QA) Program is to establish policies for the implementation of regulatory requirements and to provide an internal means for control and review so that the work performed is of the highest professional standards.

5.1 Project Quality Assurance Objectives

Project QA objectives are:

- Scientific data will be of a quality sufficient to meet scientific and legal scrutiny;
- Data will be gathered/developed in accordance with procedures appropriate for the intended use of the data; and
- Data will be of acceptable precision, accuracy, completeness, representativeness, and comparability as required by the project.

The fundamental mechanisms that will be employed to achieve these quality goals can be categorized as prevention, assessment, and correction:

- Prevention of errors through planning, documented instructions and procedures, and careful selection and training of skilled, qualified personnel;
- Assessment of all quality assurance sampling reports furnished by the contract laboratory;
- Assessment of data through data validation, and of procedures through laboratory and field audits; and
- Correction for prevention of reoccurrence of conditions adverse to quality.

This QAPP, prepared in direct response to these goals, describes the QA Program to be implemented and the quality control (QC) procedures to be followed by the laboratory during the course of the project.

This QAPP presents the project organization and specifies or references technical procedures, documentation requirements, sample custody requirements, audit, and corrective action provisions to be applied to provide confidence that all activities meet the intent of the QA program. This QAPP has been prepared in accordance with USEPA guidance as presented in "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans," QAMS-005/80.

The procedures contained or referred to herein have been taken from:

- U.S. EPA "Test Methods for Evaluating Solid Waste", SW-846, November 1986.

5.2 Data Quality Objectives

Data quality objectives (DQOs) are qualitative or quantitative statements developed by the data users to specify the quality of data needed from a particular data collection activity to support a specific decision. The DQOs are expressed in terms of precision, accuracy, representativeness, completeness, and comparability. Definitions for these terms, as well as for the more general term uncertainty, are given in Table 5-1.

TABLE 5-1

DEFINITIONS OF DATA QUALITY INDICATORS

PRECISION - A measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. Precision is expressed in terms of the standard deviation. Comparison of replicate values is best expressed as the relative percent difference (RPD). Various measures of precision exist depending upon the "prescribed similar conditions".

ACCURACY - The degree of agreement of a measurement (or an average of replicate measurements), X, with an accepted reference or true value, T, expressed as the difference between the two values, X-T. Accuracy is a measure of the bias in a system.

REPRESENTATIVENESS - Expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental concern.

COMPLETENESS - A measure of the amount of the valid data obtained from the measurement system compared to the amount that was expected under "normal" conditions.

COMPARABILITY - Expresses the confidence with which one data set can be compared with another.

UNCERTAINTY - The likelihood of all types of errors associated with a particular decision.

The Project Manager, in conjunction with the Navy Technical Representative (NTR), is responsible for defining the DQOs. The intended use of the data, analytical measurements, and the availability of resources are integral in development of DQOs. DQOs define the level of uncertainty in the data that is acceptable for each specific activity during the investigation. This uncertainty includes both field sampling error and analytical instrument error. Ideally, zero uncertainty is the goal; however, the variables associated with sampling and analysis contribute to a degree of uncertainty in any data generated. It is an overall program objective to keep the total uncertainty within an acceptable range, so as not to hinder the intended use of the data. To achieve this objective, specific data quality requirements such as detection limits, criteria for accuracy and precision, sample representativeness, data comparability, and data completeness have been specified.

The DQO for this project is Level C (or Level III per USEPA), which is defined in Section 1.3.1 of "Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program" (NEESA 20.2-047B). Level C allows the use of Non-Contract Laboratory Program (CLP) methods for the analytes described in the CLP Statement of Work (SOW), requires that the methods used must be USEPA methods or be equivalent to USEPA methods as presented in Tables 7.1 through 7.5 of the NEESA 20.2-047B document. The laboratory that will be contacted to conduct these analyses will be NEESA approved, i.e., the laboratory must successfully analyze a performance sample, undergo an on-site audit, correct any deficiency found during the audit, and provide Monthly Progress Reports to the NEESA.

The data set deliverables for Level C QA are given in Table 7.6, Section 7.2 of NEESA 20.2-047B. This includes a case narrative, initial and continuing calibration, matrix spikes, matrix spike duplicates, blanks, duplicates, surrogate recoveries, and chromatograms.

All measurements will be made so that results are representative of the media and conditions being measured. All data will be calculated and reported in units consistent with the practice for reporting similar data to allow comparability of data bases among organizations. The data collected during the course of the investigation will be used to confirm the extent of soil contamination within several areas of concern.

6.0 SAMPLING PROCEDURES

Descriptions of the procedures to be used for sampling the soil at the site are provided in Sections 3.0 and 4.0 of the SAP. The number of samples, sampling locations, and sampling rationale also are presented in the SAP. Sample handling procedures, including sample containers, preservatives, holding times, etc., are discussed in Section 7.1 and summarized in Table 7-1.

The laboratory will provide the high purity water and solvents required in the field (e.g., decontamination of sampling equipment).

The Project Manager has the responsibility for coordination of all activities required to achieve the objectives of this project. This includes the sampling activities and the required analytical services. The Project Manager or his/her designee will coordinate sample collection and delivery to the laboratory.

7.0 SAMPLE AND DOCUMENT CUSTODY PROCEDURES

Sample custody procedures outlined in this section have been developed from "User's Guide to the Contract Laboratory Program," December 1988, OSWER Directive No. 9240.0-01. These procedures are in accordance with "EPA NEIC Policies and Procedure Manual," May 1978, revised November 1984, EPA 330-78-001-R and "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans," December 1980, QAMS-005/80.

The purpose of this section is to outline the sample handling and sample documentation procedures to be used during implementation of the SAP. The objective of the sample handling procedures is to deliver representative samples to the laboratories for analysis. The objectives of the sample documentation procedures are to: (1) ensure complete analysis of the requested parameters within the required turnaround times; and (2) document the sample from the point of collection to the final data report.

7.1 Sampling Handling

New polyethylene or glass bottles containing the proper preservatives will be provided by the laboratory for sample collection. In addition to the chemical preservatives, samples will be stored on ice at 4°C in a waterproof metal or sturdy plastic cooler, if required (see Table 7-1 for summaries of containers, preservation, and holding times for aqueous and soil respectively).

7.2 Chain-of-Custody Procedures

A sample is considered to be in an individual's possession if:

- It is in the sampler's possession or it is in the sampler's view after being in his or her possession;
- It was in the sampler's possession and then locked or sealed to prevent tampering; or
- It is in a secure area.

Five kinds of documentation will be used in tracking and shipping the analytical samples:

- Field log book;
- Sample labels;
- Chain-of-Custody (COC) records;
- Custody seals; and
- Commercial carrier airbills.

At a minimum, the label for each sample bottle will contain the following information:

- Site name;
- Sample number;
- Date and time of collection;
- Sample type (grab or composite);
- Matrix; and
- Sampler's initials.

The sample information, as well as the analysis to be performed on the sample, will be entered in the field log book for each sampling point. Additionally, the following items will be entered:

TABLE 7-1

SUMMARY OF CONTAINERS, PRESERVATION, AND HOLDING TIMES FOR AQUEOUS AND SOIL SAMPLES CONTAMINATED SOIL AND GROUNDWATER REMEDIAL DESIGN CTO-0222 MCB CAMP LEJEUNE, NORTH CAROLINA

Parameter	Media	Container	Preservation	Holding Time
TCL pesticides/PCBs	Aqueous	1-liter amber glass bottle with teflon caps	Cool, 4°C	7 days to extraction; 40 days after extraction for analysis
TCL pesticides/PCBs	Solid	One 8-ounce wide-mouth glass jar	Cool, 4°C	7 days to extraction; 40 days after extraction for analysis

Note: Environmental samples will consist of soil samples only. Aqueous samples only collected for QA/QC purposes (i.e., equipment rinsates and field blanks).

- Dates and times of entry;
- Names of field personnel on site;
- Names of visitors on site;
- Field conditions;
- Description of activities;
- Sampling remarks and observations;
- QA/QC samples collected;
- List of photographs taken; and
- Sketch of site conditions.

Custody of the samples will be maintained by field personnel from the time of sampling until the time they are forwarded to the analytical laboratory.

The sample custody is documented using COC records. Field personnel will complete a COC record, in waterproof ink, to accompany each cooler forwarded from the site to the laboratory. Chemical reagents used to preserve the samples will be recorded on the COC record. Any errors on the COC records will not be erased; instead, a line will be drawn through the error and initialed by the person completing the form. The original copy will be placed in a sealable plastic bag and put inside the appropriate cooler, secured to the cooler's lid.

If the sample cooler is to be shipped by commercial air carrier, the cooler must be secured with custody seals so that the seals would be broken if the cooler was opened. The commercial carrier is not required to sign the COC record as long as the custody seals remain intact and the COC record stays in the cooler. The only other documentation required is the completed airbill.

If the sample shipment is hand delivered to the laboratory by field personnel or retrieved by laboratory personnel at the site, then the custody seals are not necessary. The laboratory sample custodian, or his/her designee accepting the sample shipment, whether it is from the air carrier or the field personnel, signs and dates the COC record upon sample receipt. The original COC record will be returned along with the final data report. The laboratory will be responsible for maintaining internal log books and records that provide a custody record during sample preparation and analysis.

Laboratory Chain-of-Custody Procedures

Upon sample receipt the steps below are performed.

- Samples are received and unpacked in the laboratory where the staff checks for bottle integrity (loose caps, broken bottles, etc.).

- Samples are verified with incoming paperwork (packing slip, etc.) by type of bottle and stabilizer. The paperwork is either signed or initialed.

- Information concerning the sample (from the sampling record, COC, and observation) is recorded along with parameters to be analyzed, date of sampling, and date the sample is received in the laboratory.

- Samples are placed in an appropriate secured storage area, e.g. refrigeration, until analysis.

- When analysis is complete, samples are stored for a 30-day period unless otherwise specified.

If collected samples arrive without COC or incorrect COC records, the following steps are taken:

- The laboratory prepares a nonconformance form stating the problem;
- The site supervisor and Project Manager are notified; and
- If the missing information cannot be reconstructed by the Project Manager or field staff, the samples affected are removed from the sampling program.

Primary considerations for sample storage are:

- Secured storage;
- Maintain prescribed temperature, if required, which is typically 4° C; and
- Extract and/or analyze samples within the prescribed holding time for the parameters of interest.

The Laboratory Quality Assurance Plan (LQAP) will provide more detail concerning procedures for disbursement of samples for analysis, sample tracking, procurement of chemicals, and lab disposal practices.

7.3 Document Custody Procedures

Project records are necessary to support the validity of the work, to allow it to be recreated if necessary, and to furnish documentary evidence of quality. The evidentiary value of data is dependent upon the proper maintenance and retrieval of quality assurance records. Therefore, procedures are established to assure that all documents attesting to the validity of work are accounted for when the work is completed.

Records are legible, filled out completely, and adequately identified as to the item or activity involved. Records are considered valid only if initialed, signed, or otherwise authenticated and dated by authorized personnel. These records may either be originals or reproduced copies. Records submitted to the files, with the exception of correspondence, are bound, placed in folders or binders, or otherwise secured for filing.

Following receipt of information from external sources, completion of analyses, and issuance of reports or other transmittals, associated records are submitted to the proper file. In addition, records transmitted are adequately protected from damage and loss during transfer (e.g., hand carrying or making copies prior to shipment).

The following documents will be transferred to the proper files during the course of this project: calculations and checkprints; reports and other data transmittals; copies of proposals, purchase orders for project services, and contracts; correspondence including incoming and outgoing letters, memoranda, and telephone records; and reference material.

All individuals on the project staff are responsible for reporting obsolete or superseded project-related information to the Project Manager. In turn, the Project Manager notifies the project and laboratory staffs of the resulting status change in project documents, such as drawings and project procedures.

In general, outdated drawings and other documents are marked "void." However, the Project Manager may request the copies be destroyed. One copy of void documents is maintained in the project files with the reasons for, and date of voiding clearly indicated.

Documents are marked "preliminary" to denote calculations and other material which have not been formally checked, or based on information which has not been checked, or do not contribute to final project information.

8.0 CALIBRATION PROCEDURES AND FREQUENCY

8.1 Field Instruments

One field instrument will be used for health and safety monitoring: the MINI-RAM (dust meter). This instrument will be calibrated on site daily according to the manufacturer's instructions in addition to the factory calibration it will receive prior to the start of site sampling. The calibration standards will be recorded in the field log book.

All standards used for calibration must be from the National Institute of Standards and Technology (NIST), traceable to NIST Standards, or other accepted standards (e.g., USEPA).

8.2 Laboratory Instruments

The laboratory's procedures for calibration and related quality control measures are to be in accordance with the protocols presented in the following documents:

- U.S. EPA "Test Methods for Evaluating Solid Waste," SW-846, November 1986.

Formal calibration procedures are established to ensure that instrumentation and equipment used for sample analysis are accurately calibrated and properly functioning. These procedures apply to all instruments and equipment quantities. All calibrations are performed by laboratory personnel or external agencies using standard reference materials.

All calibrations are recorded on in-house calibration forms or instrument vendor forms or in dedicated bound notebooks. The following data are recorded for all calibrations: the date, target readings, actual readings, instrument identification number, and the analyst's initials. Other data may be recorded depending upon the calibration performed.

Only properly calibrated and operating equipment and instrumentation are used. Equipment and instrumentation not meeting the specified calibration criteria are to be segregated from active equipment whenever possible. Such equipment is repaired and recalibrated before reuse.

All equipment is uniquely identified, either by serial number or internal calibration number, to allow traceability between equipment and calibration records. Recognized procedures (USEPA SOPs, or manufacturer's procedures) are used for calibration whenever available.

8.2.1 Calibration Standards

Calibration standards at a minimum of five concentration levels for each parameter of interest are prepared through dilution of the stock standards. One of the concentration levels should be at a concentration near, but above, the method detection limit. The remaining concentration levels should correspond to the expected range of concentrations found in real samples or should define the working range of the GC.

8.2.2 GC System Calibration Procedure

This section outlines the requirements for the calibration of GC systems for the determination of pesticides/PCBs which are the two contaminants of concern for this investigation. The following operations are performed in support of these requirements:

- DDT and endrin are easily degraded in the injection port if the injection port or front of the column is dirty. This is the result of buildup of high boiling residue from sample injection. Check for degradation problems by injecting a mid-level standard containing only 4,4'-DDT and endrin. Look for the degradation products of 4,4'-DDT (4,4'-DDE and 4,4'-DDD) and endrin (endrin ketone and endrin aldehyde). If degradation of either DDT or endrin exceeds 20 percent, take corrective action before proceeding with calibration.

- Using either the internal or external calibration procedure, determine the identity and quantity of each component peak in the sample chromatogram which corresponds to the compounds used for calibration purposes.

- If peak detection and identification are prevented due to interferences, the hexane extract may need to undergo cleanup. The resultant extract(s) may be analyzed by GC directly or may undergo further cleanup to remove Sulfur.

8.2.3 Periodic Calibration

Periodic calibration is performed on equipment required in analyses but not routinely calibrated as part of the analytical methodology. Equipment that falls within this category includes ovens, refrigerators, and balances. The calibration is recorded either on specified forms or in bound notebooks. Discussed below are the equipment, the calibration performed, and the frequency at which the calibration is performed.

- Balances are calibrated weekly with class S weights.

- The pH Meter meter is calibrated daily with pH 4 and 7 buffer solutions and checked with pH 10 buffer solution.

- The temperatures of the refrigerators are recorded daily.

- All liquid in glass thermometers are calibrated annually with the National Bureau of Standards (N.B.S.) Certified Thermometer. Dial thermometers are calibrated quarterly.

- The N.B.S. Certified Thermometer is checked annually at the ice point.

The following equipment must maintain the following temperatures:

- Sample Storage and Refrigerators - within 2° of 4° C; and
- Water Bath, Mercury - within 2° of 95° C.

9.0 ANALYTICAL PROCEDURES

9.1 Field Analysis

A Mini-Ram (dust meter) will be used to monitor ambient air for health and safety purposes. This instrument will be operated in accordance with the manufacturer's instructions.

9.2 Laboratory Analysis

The samples that will be collected during the investigation will be analyzed for constituents listed in Table 9-1. Parameters will be analyzed using USEPA methods as noted in Table 9-1. Compounds and the corresponding method performance limits also are listed in Table 9-1.

The subcontracted laboratory to perform the analyses will be NEESA approved. The NEESA approval process is described in the NEESA 20.2-047B document. As part of this process the laboratory must furnish their LQAP. This LQAP will provide a description of the laboratory facilities, laboratory credentials, laboratory equipment and source of supplies. In addition, the QA/QC procedures the laboratory will use to ensure the generation of scientifically valid and defensible data will be presented. The LQAP will also contain the necessary SOPs which describe the analytical procedures in sufficient detail to allow selection of the methods that will meet the DQOs of the project.

TABLE 9-1

METHOD PERFORMANCE LIMITS
CONTAMINATED SOIL AND GROUNDWATER REMEDIAL DESIGN CTO-0222
MCB CAMP LEJEUNE, NORTH CAROLINA

Compound	Water CRQL (µg/L)	Soil CRQL (µg/kg)	Analytical Method
Pesticides/PCBs			SW-846 EPA 8080
alpha-BHC	0.05	8.0	
beta-BHC	0.05	8.0	
delta-BHC	0.05	8.0	
gamma-BHC (Lindane)	0.05	8.0	
Heptachlor	0.05	8.0	
Aldrin	0.05	8.0	
Heptachlor epoxide	0.05	8.0	
Endosulfan I	0.05	8.0	
Dieldrin	0.10	16.0	
4,4'-DDE	0.10	16.0	
Endrin	0.10	16.0	
Endosulfan II	0.10	16.0	
4,4'-DDD	0.10	16.0	
Endosulfan sulfate	0.10	16.0	
4,4'-DDT	0.10	16.0	
Methoxychlor	0.5	80.0	
Endrin ketone	0.10	16.0	
alpha-Chlordane	0.5	80.0	
gamma-Chlordane	0.5	80.0	
Toxaphene	1.0	160.0	
Aroclor-1016	0.5	80.0	
Aroclor-1221	0.5	80.0	
Aroclor-1232	0.5	80.0	
Aroclor-1242	0.5	80.0	
Aroclor-1248	0.5	80.0	
Aroclor-1254	1.0	160.0	
Aroclor-1260	1.0	160.0	

10.0 DATA REDUCTION, VALIDATION AND REPORTING

10.1 Field Data Procedures

Data validation practices as described by "Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses," USEPA, June 1988, and "Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses - Draft," USEPA, June 1991 will be followed to insure that raw data are not altered and that an audit trail is developed for those data which require reduction. The documentation of sample collection will include the use of bound field log books in which all information on sample collection will be entered in indelible ink. Appropriate information will be entered to reconstruct the sampling event, including: site name (top of each page), sample identification, brief description of sample, date and time of collection, sampling methodology, field measurements and observations, and sampler's initials (bottom of each page, and dated).

A rigorous data control program will insure that all documents for the investigations are accounted for when they are completed. Accountable documents include items such as log books, field data records, correspondence, COC records, analytical reports, data packages, photographs, computer disks, and reports. The project manager is responsible for maintaining a project file in which all accountable documents will be inventoried. The project records will be retained for a period of three years after project close-out; then the files will be forwarded to the DON.

All the field data, such as those generated during field measurements, observations and field instrument calibrations, will be entered directly into a bound field notebook. Each project team member will be responsible for proofing all data transfers made, and the Project Manager or his designee will proof at least ten percent of all data transfers.

10.2 Laboratory Data Procedures

The following procedures summarize the practices routinely used by laboratory staff for data reduction, validation, and reporting. Numerical analyses, including manual calculations, are documented and subjected to quality control review. Records of numerical analyses are legible and complete enough to permit reconstruction of the work by a qualified individual other than the originator.

Laboratory Data Validation

Data validation begins with data reduction and continues through to the reporting of data.

Data processing is checked by an individual other than the analyst who performed the data processing. The checker reviews the data for the following:

- Utilization of the proper equations;
- Correctness of numerical input;
- Correctness of computations;
- Correct interpretation of raw data (chromatographs, strip charts, etc.); and
- Data is transferred to the proper forms and checked for transcription errors.

The checking process is thorough enough to verify the results.

All entries made in benchbooks, data sheets, computation sheets, input sheets, etc. are made in ink. No entry will be rendered unreadable.

Data validation will be performed by a third party (not laboratory personnel) according to the guidelines referenced above.

Analytical Reports

The items listed below are required of analytical reports.

- Data is presented in a tabular format.
- Analytical reports are approved by appropriate laboratory personnel.
- The following information is included on the report: client name and address, report date, sample date, analysis dates, number of samples, purchase order number, project number, and project type. All pages are numbered.
- The sample numbers and corresponding laboratory numbers are identified.
- The parameters analyzed, report units, and values are identified.
- Method and field blank results are reported.
- Matrix spike, matrix spike duplicate, and replicate recoveries are reported.
- Calibration summaries are reported.
- Surrogate recoveries are reported.
- Holding times and sample analysis dates are reported.
- The quantitation limit of the procedure is identified.
- Consistent significant figures are used.
- Referenced footnotes are used when applicable.
- A letter of transmittal accompanies the report if any anomalies are associated with the data. The letter specifies these anomalies.

All laboratory procedures for data reduction,validation, and reporting will be presented in the LQAP. The laboratory selected for this project will be NEESA approved. The subcontractor's LQAP shall describe the mechanism for periodic reporting to management on the performance of measurement systems and data quality. These reports should include:

- Periodic assessment of analytical data accuracy, precision, and completeness;
- Performance audits results;
- System audits results;
- Significant QA problems and recommended solution; and
- Corrective action results.

The analytical laboratory shall maintain detailed procedures of laboratory recordkeeping in order to support the validity of all analytical work. Each data set report submitted to the Project Manager should contain the laboratory Project Manager's and QA Officer's written verification that the approved analytical method (without modification) was performed and all QA/QC checks were within the established protocol limits on all samples. If any QA problems are encountered during sample analysis, the laboratory will inform the Project Manager in writing. The laboratory QA Officer will provide the Project Manager reports of their QA audits by external agencies and of internal audits by their QA department upon request.

The Field Team Leader will report to the Project Manager on a frequent basis regarding progress of the field work and quality control issues associated with the field activities. All reports will be documented in the field logbook.

After the field work has been completed and the final analyses have been performed and checked, a final quality assurance report may be prepared for inclusion into the project final report (e.g., Site Characterization and Evaluation Report). The Project Manager or his/her designate will prepare this final summary in coordination with the contract laboratory.

11.0 INTERNAL QUALITY CONTROL CHECKS

11.1 Field Internal Quality Control Checks

Field internal quality control checks to be used during this investigation include field duplicates, equipment rinsates, and field blanks. The results from the field quality control samples will be used by the data validator to determine the overall quality of the data.

11.2 Types of QC Samples

Documentation of the analyses of the following types of QC samples is maintained in the laboratory bench notebooks and/or the specific client or project files.

Equipment Rinsates

Equipment rinsates are the final organic-free deionized water rinse from equipment cleaning collected daily during a sampling event. Initially, samples from every other day should be analyzed. If analytes pertinent to the project are found in the rinsate, the remaining samples must be analyzed. The results of the blanks will be used to flag or assess levels of analytes in the samples. This comparison is made during validation. The rinsates are analyzed for the same parameters as the related samples.

Method Blank

Analysis of method blanks is performed to verify that method interferences caused by contamination in reagents, glassware, solvents, etc. are minimized and known. Method blanks are initiated by the analyst prior to the preparation and/or analysis of the sample set. A method blank consists of a volume of organic-free deionized water equal to the sample volume which is carried through the entire analytical procedure. A method blank is analyzed with each set of samples or at the very least, daily. If the analytical data of the method blank indicates excessive contamination, the source of contaminant will be determined. The samples may be re-analyzed or the data may be processed as is depending upon the nature and extent of the contamination.

Spike Analysis

Spike analysis is performed to demonstrate the accuracy of an analysis. The analyst initiates the spike prior to sample preparation and analysis by adding a known amount of analyte(s) to a sample. The spike sample is carried through the entire analytical procedure. The frequency of spike analysis for pesticides/PCBs is 5 percent.

Internal Standards

Internal standard analyses are performed to monitor system stability. Prior to injection or purging, internal standards are added to all blanks and samples analyzed by GC.

11.3 Laboratory Control Limits

Control limits are established for QC checks (spikes, duplicates, blanks, etc.). CLP control limits for surrogate standards spikes, and duplicates associated with pesticide/PCB analyses are adopted. Control limits for spikes, duplicates, and reference samples are determined internally through statistical analysis.

Whenever an out-of-control situation occurs, the cause is determined. Any needed corrective actions are taken.

Method Blanks

For GC analyses, the criteria below are used for method blank analysis.

- For pesticides/PCBs, the method blank must contain less than the detection limit of any single compound. If a method blank exceeds the criteria, the analytical system is considered to be out of control. The source of the contamination is investigated and appropriate corrective measures are taken and documented before sample analysis proceeds. All samples processed with a method blank that is out of control (i.e., contaminated), are reextracted and reanalyzed, when possible. If the affected samples cannot be reextracted and reanalyzed within method holding times, the flagged sample result and the blank result are both to be reported. The sample value is not corrected for the blank value.

- No positive result for pesticides/PCBs should be reported unless the concentration of the compound exceeds five times the amount in the blank.

- A method blank for pesticides/PCBs must contain no greater than five times the detection limit for any pesticides/PCBs.

Surrogate Standards

For method blank surrogate standard analysis, corrective action is taken if any one of the conditions below exist.

- Recovery of any one surrogate compound in the volatile fraction is outside the required surrogate standard recovery limit.

- Recovery of any one surrogate compound in the semivolatile fraction is outside surrogate standard recovery limits.

Corrective action will include steps listed below.

- A check of: the calculations for errors; the internal standard and surrogate spiking solutions for degradation, contamination, etc.; and instrument performance.

- Recalculation or reinjection of the blank or extract if the above corrective actions fail to solve the problem.

- Reextraction and reanalysis of the blank. For sample surrogate standard analysis, corrective action is taken if any one of the following conditions exist:

    - Recovery of the surrogate compound in the pesticide/PCB fraction is outside surrogate recovery limits.
    - Recoveries of two or more surrogate compounds in either semivolatile fraction are outside surrogate spike recovery limits.

Corrective action will include the steps listed below.

- A check of: the calculations for errors; of the surrogate spiking solution for degradation, contamination, etc.; and of instrument performance.

- Recalculating or reanalysis the sample or extract if the above corrective action fails to solve the problem.

- Reextraction and reanalysis of the sample if none of the above are a problem.

11.4 Quality Assurance Review of Reports, Plans, and Specifications

Prior to issuance of a final report, it is reviewed by senior-level program staff, the Project Manager, or a designated representative. This review addresses whether:

- The report satisfies the scope of work, client requirements, and pertinent regulatory requirements;

- Assumptions are clearly stated, justified, and documented;

- A reference is cited for any information utilized in report preparation that was originated outside the project;

- The report correctly and accurately presents the results obtained by the work;

- The tables and figures presented in the report are prepared, checked, and approved according to requirements;

- The report figures are signed and dated by the appropriate members of the project staff and project management; and

- The typed report has been proofread and punctuation, grammar, capitalization, and spelling are correct.

11.5 Laboratory Quality Assurance

Field Quality Assurance

Three types of field QA/QC samples will be submitted to the laboratory: equipment rinsates, field blanks, and field duplicates. A breakdown by type of sample with which the QA/QC samples will be submitted to the laboratories is given in Table 11-1. A summary of the number of environmental and QA/QC samples to be submitted for analysis is given in the SAP.

TABLE 11-1

QA/QC SAMPLE FREQUENCY

Type of Sample	Organic
Equipment Rinsate(1)	One per day

(1) Samples are collected daily; however, only samples from every other day are analyzed. Other samples are held and analyzed only if evidence of contamination exists.

- Assumptions are clearly stated, justified, and documented;
- A reference is cited for any information utilized in report preparation that was originated outside the project;
- The report correctly and accurately presents the results obtained by the work;
- The tables and figures presented in the report are prepared, checked, and approved according to requirements;
- The report figures are signed and dated by the appropriate members of the project staff and project management; and
- The typed report has been proofread and punctuation, grammar, capitalization, and spelling are correct.

11.5 Laboratory Quality Assurance

Field Quality Assurance

Three types of field QA/QC samples will be submitted to the laboratory: equipment rinsates, field blanks, and field duplicates. A breakdown by type of sample with which the QA/QC samples will be submitted to the laboratories is given in Table 11-2. A summary of the number of environmental and QA/QC samples to be submitted for analysis is given in the SAP.

TABLE 11-2

QA/QC SAMPLE FREQUENCY

Type of Sample	Organic
Equipment Rinsate(1)	One per day
Field Blank	One per source per event(2)
Field Duplicate(3)	10%

(1) Samples are collected daily; however, only samples from every other day are analyzed. Other samples are held and analyzed only if evidence of contamination exists.

(2) Source water includes water used in decontamination, steam cleaning, and drilling.

(3) The duplicate must be taken from the sample which will become the laboratory matrix spike/matrix duplicate for organics.

12.0 PERFORMANCE AND SYSTEM AUDITS

A field audit will not be conducted during the field investigation due to the short duration of the Sampling Program.

The analytical subcontractor's LQAP must describe the external and internal performance evaluation tests and audits required to monitor the capability and performance of the total measurement process. These include system audits as required by Federal and State regulatory agencies to obtain and maintain laboratory certifications, commercial clients with auditing programs, and subscription to commercial auditing agencies. In addition, performance audits such as USEPA's Performance Evaluation Studies (drinking water and wastewater series), client sponsored performance evaluations, various government proficiency test samples to maintain laboratory certifications, and internal blind quality assurance samples should be discussed. In addition, the LQAP should define the acceptance criteria for the laboratory.

Laboratories that participate in the CLEAN Installation Restoration Program are required to obtain NEESA approval. This process consists of on-site laboratory audits, submittal of the LQAP, monthly reports, and periodic analyses of performance evaluation samples. Baker's responsibility is to ensure that the laboratory subcontractors selected have current NEESA certification. The NEESA Approval Process is described in the NEESA 20.2-047B document.

13.0 PREVENTIVE MAINTENANCE

13.1 Field Maintenance

A MINI-RAM is to be used for air monitoring and will be maintained as described by the manufacturer's instructions. The manufacturer's instructions contain a spare parts list to be kept by the user and the manufacturers provide a repair/maintenance service.

13.2 Laboratory Maintenance

Preventive maintenance is an organized program of actions to prevent instruments and equipment from failing during use and to maintain proper performance of equipment and instruments. A comprehensive preventive maintenance program is implemented to increase the reliability of the measurement system. The preventive maintenance program addresses the following:

- Schedules of important preventive maintenance tasks that are carried out to minimize downtime; and
- Lists of critical spare parts that are available to minimize downtime.

The laboratory maintains histories, in instrument/equipment logs, of all major equipment. Trouble shooting, maintenance, and spare parts inventory are recorded in the logs. Instruments and equipment are maintained periodically in accordance with procedures described in individual analytical methods, manufacturer's recommendation, and/or service contracts.

The modern analytical laboratory depends heavily upon instrumentation and equipment; therefore, cleaning and preventive maintenance are primary considerations in the sustained production of satisfactory data. Specific requirements for proper care of laboratory instrumentation and equipment are contained in the manufacturer's instructions; however, some general guidelines are considered, and are listed below.

- Special precautions are taken to avoid spillage of corrosive chemicals on or around equipment and instrumentation not only to extend the life of the item, but also to eliminate contamination.
- Where available, covers are placed on instrumentation when not in use.
- Instrument parts are cleaned as required (i.e., mirrors, probes, detector cells).

14.0 DATA MEASUREMENT ASSESSMENT PROCEDURES

14.1 Overall Project Assessment

Overall data quality will be assessed by a thorough understanding of the data quality objectives which are stated during the design phase of the investigation. By maintaining thorough documentation of all decisions made during each phase of sampling, performing field and laboratory audits, thoroughly reviewing the analytical data as they are generated by the laboratory, and providing appropriate feedback as problems arise in the field or at the laboratory, data accuracy, precision, and completeness will be closely monitored.

14.2 Field Quality Assessment

To assure that all field data are collected accurately and correctly, specific written instructions will be issued to all personnel involved in field data acquisition by the Project Manager. The Project Manager will perform field audit(s) during the investigation to document that the appropriate procedures are being followed with respect to sample (and blank) collection. These audits will include a thorough review of the field books used by the project personnel to insure that all tasks were performed as specified in the instructions. The field audits will necessarily enable the data quality to be assessed with regard to the field operations.

The evaluation (data review) of field blanks, and other field QC samples will provide definitive indications of the data quality. If a problem that can be isolated arises, corrective actions can be instituted for future field efforts.

14.3 Laboratory Data Quality Assessment

As part of the analytical QA/QC program, the laboratory applies precision and accuracy criteria for each parameter that is analyzed. When analysis of a sample set is completed, QC data generated are reviewed and evaluated to ensure acceptance criteria are met. These criteria are method and matrix specific.

QA/QC data review is based on the following criteria:

- Method Blank Evaluation - The method blank results are evaluated for high readings characteristic of background contamination. If high blank values are observed, laboratory glassware and reagents are checked for contamination and the analysis of future samples halted until the system can be brought under control. A high background is defined as a background value sufficient to result in a difference in the sample values, if not corrected, greater than or equal to the smallest significant digit known to be valid. A method blank must contain no greater than two times the parameter detection limit for most parameters.

- Standard Calibration Curve Verification - The calibration curve or midpoint calibration standard (check standard) is evaluated daily to determine curve linearity through its full range and that sample values are within the range defined by the low and high standards. If the curve is not linear, sample values are corrected. If average response factors are used to calculate sample concentrations, these factors are verified on a daily basis. Verification of calibration curves and response factors is accomplished when the evaluated response for any parameter varies from the calibrated response by less than ranges specified in Section 7.0.

- Reference Sample Analyses - The results of reference sample analysis are compared with true values, and the percent recovery of the reference sample is calculated. If

correction is required (excessive or inadequate percent recovery), the reference sample is reanalyzed to demonstrate that the corrective action has been successful.

- Surrogate Standard Analyses - Surrogate standard determinations are performed on all samples and blanks for GC analyses. All samples and blanks are fortified with a surrogate spiking compound before extraction to monitor preparation and analysis of samples. Recoveries must meet specific criteria. If acceptance criteria are not met, corrective action is taken to correct the problem and the affected sample is reanalyzed.

For completeness, it is expected that the methodology proposed for chemical characterization of the samples will meet QC acceptance criteria for at least 95 percent of all sample data. To ensure this completeness goal, sample data that does not meet the established criteria will be recollected, reextracted, or reanalyzed.

Data representativeness will be ensured through the use of appropriate analytical procedures, and analysis of samples performed within the allowed holding times.

Comparability is a qualitative characteristic of the data. By using standard methods for sampling and analyses, data generated in past or future investigations will be comparable with this investigation data.

14.4 Laboratory Data Validation

Review of analyses will be performed. A preliminary review will be performed by the project manager to verify all necessary paperwork (e.g., chain-of-custodies, traffic reports, analytical reports, and laboratory personnel signatures) and deliverables are present. A detailed quality assurance review will be performed by a data validation subcontractor to verify the qualitative and quantitative reliability of the data presented. This review will include a detailed review and interpretation of all data generated by the laboratory. The primary tools which will be used by experienced data validation personnel will be guidance documents, established criteria, and professional judgment.

A quality assurance report stating the qualitative and quantitative reliability of the analytical data will be prepared for NEESA. This report will consist of a general introduction section, followed by qualifying statements that should be taken into consideration for the analytical results to be best utilized. The report will reference NEESA 20.2-047B for applicable guidance, format, and standards.

During the data review, a data support documentation package will be prepared which will provide the back-up information that will accompany all qualifying statements present in the quality assurance review.

15.0 CORRECTIVE ACTION

Corrective action is taken whenever a nonconformance occurs. A nonconformance is defined as an event which is beyond the limits established for a particular operation by the plan. Nonconformances can occur in a number of activities. Such activities include sampling procedures, sample receipt, sample storage, sample analysis, data reporting, and computations.

The following personnel are responsible for detecting and reporting nonconformances:

- Project Staff - during testing and preparation and verification of numerical analyses; and

- Laboratory Staff - during the preparation for analyses, performance of analytical procedures, calibration of equipment, and quality control activities.

15.1 Corrective Action

Nonconformances are documented by the person originating or identifying it. Documentation includes the following:

- Identification of the individual(s) originating or identifying the nonconformance;
- Description of the nonconformance;
- Any required approval signatures (initials);
- Corrective action taken; and
- Corrective action completion date.

The NEESA Contract Representative (NCR), along with the contract project director. will be notified of a nonconformance and corrective action taken, if one of the following is true:

- A nonconformance causes a delay in work beyond the schedule completion date;
- A nonconformance affects information already reported; and
- A nonconformance affects the validity of the data.

15.2 Limits of Operation

The limits of operation that are used to identify nonconformances are established by the contents of the plan and by control limits produced by statistical analyses.

16.0 QUALITY ASSURANCE REPORTING PROCEDURES

The Project Manager will be responsible for assessing the performance of measurement systems and data quality related to the field investigation. A written record will be maintained of: the results of laboratory QC reports and other periodic assessments of measurement, data accuracy, precision, and completeness; performance and system audits; and any significant QA problems and recommended solutions. Each deliverable will contain a QA/QC assessment section. Also, a QA/QC assessment will be performed any time a significant problem is identified.

The contractor's Project Manager will keep in contact with the NTR at the U.S. Naval Base in Norfolk, Virginia, through informal, verbal reports during the project as well as through monthly progress reports. These reports will include any changes in the QAPP. The final report for the project will include a separate QA section which summarizes data quality information contained in the periodic reports submitted to management and the client.

All reports are managed and secured in accordance with Baker's document control system (DCS)., The documents to be managed by the DCS include CTO work plans, cost estimates, design documents, data and reports generated by CTO technical teams, results of laboratory analyses, agency file documents, QA reports and status reports. The DCS system also provides accountability for field documentation including such items as field logbooks, field data records, sample tags, chain-of-custody records and photographs.

APPENDIX A

FIELD WATER QUALITY INSTRUMENTS

A. Calibration and Preventive Maintenance

Activity Before Site Visit

Field meters to be used during sampling, specifically the pH and specific conductance/thermistor meters will be checked against the contractor laboratory meters to insure proper calibration and precision response. Thermometers will be checked against a precision thermometer certified by the National Bureau of Standards. These activities will be performed by the contractor laboratory manager. In addition, buffer solutions and standard KCl solutions to be used to field calibrate the pH and conductivity meters will be laboratory tested to insure accuracy. The preparation date of standard solutions will be clearly marked on each of the containers to be taken into the field. A log which documents problems experienced with the instrument, corrective measures taken, battery replacement dates, when used and by whom for each meter and thermometer will be maintained by the contractor's laboratory manager. Appropriate new batteries will be purchased and kept with the meters to facilitate immediate replacement, when necessary in the field.

All equipment to be utilized during the field sampling will be examined to certify that it is in operating condition. This includes checking the manufacturer's operating manuals and the instructions with each instrument to ensure that all maintenance items are being observed. A spare electrode will be sent with each pH meter that is to be used for field measurements. Two thermometers will be sent to each field site where measurement of temperature is required, including those sites where a specific conductance/thermistor meter is required.

Activity at Site

The pH meter must be calibrated a minimum of twice each day using at least two different pH buffer solutions expected to bracket the pH range of field samples. Rinse the probe thoroughly between buffer measurements with distilled water and again after calibration is completed. Record in the field log book what buffer solutions were used. When the meter is moved, check pH reading by measuring the pH value of the buffer solution closest to the expected range of the sample. If the reading deviates from the known value by more than 0.1 standard units, recalibrate the instrument as described above. If unacceptable deviations still occur, consult the operating manual for remedial course of action.

The specific conductance/thermistor meter is less likely to exhibit random fluctuations and will only require daily checks against a known KCl solution, which should be chosen to be within the expected conductivity range. Note that specific conductance is temperature-dependent and, therefore, the meter readings must be adjusted to reflect the temperature of the standard solution. Thoroughly rinse the probe with distilled water after immersing in KCl standard solution. In addition to daily checks of the conductivity readings, the thermistor readings must also be checked daily. This is accomplished by taking a temperature reading of the KCl standard solution with both the conductivity probe and a mercury thermometer.

Before use, visually inspect the thermometer to assure there is no break in the mercury column. If there is a break, visually inspect the spare thermometer. If both thermometers have a break in the mercury, neither can be used until the break is corrected. This may be done by cooling the bulb until the mercury is all contained in the bulb.

B. Analytical Methods

All field measurements will be obtained in accordance with "Handbook for Sampling and Sample Preservation of Water and Wastewater," EPA-600/4-82-029, September 1982 or "Test Methods for Evaluating Solid Wastes," SW-846, November 1986. The quality assurance procedures for field analysis and equipment are detailed in these documents cited.

FINAL

PART V
HEALTH AND SAFETY PLAN

CONTAMINATED SOIL AND GROUNDWATER REMEDIAL DESIGN

OPERABLE UNIT NO. 2

MARINE CORPS BASE,
CAMP LEJEUNE, NORTH CAROLINA

CONTRACT TASK ORDER 0222

Prepared For:

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

Under the:

LANTDIV CLEAN Program
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FEBRUARY 28, 1994

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EXECUTIVE SUMMARY

The chemical hazards associated with the field activities to be performed at Areas of Concern (AOCs) 1 through 6 are expected to include potential exposure to varying levels of polychlorinated biphenyls and pesticides for Baker personnel and volatile organics for the soil gas subcontractor personnel.

The physical hazards include working around heavy equipment, underground/overhead utilities, uneven/sloped terrain, unexploded ordnance, and cold stress. The environmental hazards may include potentially hazardous flora and fauna. Each of this hazards is described in Section 3.0.

Section 5.0 describes the environmental monitoring requirements for Baker personnel which consists of using a MINIRAM personal monitor. The soil gas subcontractor will provide their own monitoring instrumentation.

Due to the amount of information provided from previous investigations, assigned protection levels at these AOCs are conservative in nature. The level of personal protection assigned for work tasks and other operations will be Levels D through C with protection upgrades/downgrades dependent on monitoring results and the Site Health and Safety Officer's discretion. Section 6.0 describes the personal protective equipment to be used.

Section 8.0 describes emergency procedures, which includes Figure 8-1, showing the route to the nearest public and base hospital, along with first aid procedures, communication procedures, and other site concerns.

1.0 INTRODUCTION

This Health and Safety Plan (HASP) is designated as Part V of the Project Plans and is a Site-Specific HASP for the Contaminated Soil and Groundwater Remedial Design at Operable Unit No. 2, Marine Corps Base (MCB), Camp Lejeune, North Carolina.

1.1 Policy

It is the policy of Baker Environmental, Inc. (Baker) that all on-site hazardous waste management activities be performed in conformance with a Site-Specific HASP. The HASP is written based on the anticipated hazards and expected work conditions and applies to activities performed by both Baker and Baker's subcontractors. However, Baker's soil gas subcontractor is required to submit a HASP that will be specific to their site activities. Upgrades/downgrades in levels of personal protection will be based on monitoring performed by the soil gas subcontractor, according to their action levels.

This HASP may be modified/updated with the approval of the Project Health and Safety Officer (PHSO) and Project Manager. Proper notification will be given to the Atlantic Division, Naval Facilities Engineering Command (LANTDIV) Navy Technical Representative (NTR) when significant changes to the HASP are implemented.

The HASP is based on an outline developed by the United States Coast Guard (USCG) for responding to hazardous chemical releases (USCG Pollution Response COMDTINST-M16456.30) and by NIOSH, OSHA, USCG, and USEPA's recommended health and safety procedures (Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities). This HASP, at a minimum, meets the requirements under OSHA Standard 29 CFR 1910.120 (Hazardous Waste Operations and Emergency Response).

1.2 Project Plans

Information pertaining to Operable Unit No. 2 and each AOC is provided in Part I of the Project Plans. The Work Plan (detailing the tasks to be performed at each site), the Sampling and Analysis Plan (SAP), and Quality Assurance Project Plan (QAPP) precede this HASP, as Parts II, III, and IV, respectively.

1.3 References

The following publications have been referenced in the development and implementation of this HASP.

- American Conference of Governmental Industrial Hygienists (ACGIH). 1993. Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices for 1993-1994.

- The Center for Labor Education and Research, Lori P. Andrews, P.E., Editor. 1990. Worker Protection During Hazardous Waste Remediation, Van Nostrand Reinhold, New York, New York.

- Lewis, Richard J., Sr. 1991. Hazardous Chemicals Desk Reference, 3rd Edition, Van Nostrand Reinhold, New York, New York.

- National Institute for Occupational Safety and Health/Occupational Safety and Health Administration/U.S. Coast Guard/U.S. Environmental Protection Agency

(NIOSH/OSHA/USCG/EPA). 1985. Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities. October 1985.

- Occupational Safety and Health Administration. 1993. Title 29 Code of Federal Regulations, Parts 1910 and 1926.

- United States Coast Guard. 1991. Policy for Response to Hazardous Chemical Releases. USCG Pollution Response COMDTINST-M16465.30.

- United States Department of Health and Human Services, Public Health Service, Centers for Disease Control, NIOSH. 1990. NIOSH Pocket Guide to Chemical Hazards. June 1990.

- United States Environmental Protection Agency, Office of Emergency and Remedial Response, Emergency Response Division. 1992. Standard Operating Safety Guides. June 1992.

1.4 Pre-Entry Requirements

During site mobilization, the Site Health and Safety Officer (SHSO) will perform a reconnaissance of each AOC as identified in the Work Plan, establish or confirm emergency points of contact and procedures, and review any other issues deemed necessary to address site safety and health. The SHSO will then conduct a health and safety briefing with site personnel (as identified in Section 2.0) to discuss data obtained from the previous site reconnaissance, provisions outlined in this HASP, and appropriate safety and health related procedures and protocols. The SHSO will also review the HASP provided by the soil gas subcontractor to assure consistently with this Site HASP.

2.0 PROJECT PERSONNEL AND RESPONSIBILITIES

The following personnel are designated to carry out the stated job functions for both project and site activities. (Note: One person may carry out more than one job function; personnel identified are subject to change.) The responsibilities that correspond with each job function are outlined below.

PROJECT MANAGER: Donald Joiner

The project manager will be responsible for assuring that all activities are conducted in accordance with the HASP. The Project Manager has the authority to suspend field activities if employees are in danger of injury or exposure to harmful agents. In addition, the Project Manager is responsible for:

- Assisting the Project Health and Safety Officer (PHSO), as designated below, in Site-Specific HASP development for all phases of the project.
- Designating a SHSO and other site personnel who will assure compliance with the HASP.
- Reviewing and approving the information presented in this HASP.

PROJECT HEALTH AND SAFETY OFFICER: Barbara Cummings

The PHSO will be responsible for general development of the HASP and will be the primary contact for inquiries as to the contents of the HASP. The PHSO will be consulted before changes to the HASP can be approved or implemented. The PHSO will also:

- Develop new protocols or modify the HASP as appropriate and issue amendments.
- Resolve issues that arise in the field with respect to interpretation or implementation of the HASP.
- Monitor the field program through a regular review of field health and safety records, on-site activity audits, or a combination of both.
- Determine that all Baker personnel have received the required training and medical surveillance prior to entry onto a site.
- Coordinate the review, evaluation, and approval of the HASP.

SITE MANAGER: Not Assigned

A Site Manager will not be assigned for the scheduled field activities. However, the Site Manager's responsibilities will be delegated to the SHSO. The SHSO will have the immediate authority to suspend field activities if employees are subjected to a situation that can be immediately dangerous to life or health. The Site Manager's responsibilities include:

- Assuring that the appropriate health and safety equipment and personal protective equipment (PPE) has arrived on site and that it is properly maintained.
- Coordinating overall site access and security measures, including documenting all personnel arriving or departing the site (e.g., name, company and time).

- Approving all on site activities, and coordinating site safety and health issues with the SHSO.
- Assisting the SHSO in coordinating emergency procedures with the Naval Activity, emergency medical responders, etc., prior to or during site mobilization activities.
- Assuring compliance with site sanitation procedures and site precautions.
- Coordinating activities with Baker and subcontractor personnel.
- Overseeing the decontamination of field sampling equipment.
- Serving as the backup/alternate Emergency Coordinator.
- Assuming the responsibilities as indicated under "Field Team Leader," in their absence.

SITE HEALTH AND SAFETY OFFICER: Kenneth Martin

The SHSO will be responsible for the on-site implementation of the HASP. The SHSO also has the immediate authority to suspend field activities if the health or safety of site personnel is endangered, and to audit the subcontractor training, fit testing, and medical surveillance records to verify compliance. These records will be maintained at the Baker Command Post. The SHSO will also:

- Coordinate the pre-entry briefing and subsequent briefings.
- Assure that monitoring equipment is properly calibrated and properly operated.
- Assure compliance with the Standard Operating Procedures (SOPs) in Attachment A.
- Inform personnel of the material safety data sheets (MSDSs) located in Attachment B and emergency procedures for exposure to hazardous materials/waste presented in Attachment C.
- Manage health and safety equipment, including instruments, respirators, PPE, etc., that is used during field activities.
- Confirm emergency response provisions, as necessary, in cooperation with Naval Activity, emergency medical care, etc., prior to or during site mobilization activities.
- Monitor conditions during field activities to assure compliance with the HASP and evaluate if more stringent procedures or a higher level of PPE should be implemented, and informing the PHSO and Project Manager.
- Document, as necessary, pertinent information such as accident investigation and reporting, safety inspections, a record of site conditions, personnel involved in field activities, and any other relevant health and safety issues.
- Oversee the decontamination of personnel and determine safe boundary procedures for activities requiring Level C or higher protection levels.
- Act as the Emergency Coordinator.

FIELD TEAM LEADER: Mark Kimes

The Field Team Leader will be responsible for:

- Safety issues relevant to the tasks under their direction.
- Determining safe boundary procedures for activities requiring Level D or D+ protection levels.
- Assuring that PPE is properly maintained.
- Complying with the conditions as outlined under Field Team Members.

FIELD TEAM MEMBERS: Not Assigned

The Field Team Members will be responsible for:

- Familiarity with the HASP.
- Complying with the contents of the HASP.
- Attending training sessions to review the HASP, and staying informed of additional safety and health information.
- Being alert to identified and unidentified hazards, and reporting unidentified hazards to the SHSO and Site Manager, as soon as possible.
- Offering suggestions, ideas, or recommendations that may improve or enhance site safety.
- Conducting site activities in an orderly and appropriate manner.
- Reporting accidents/injuries, however minor, to the SHSO as soon as possible.

Subcontractor personnel are responsible for:

- Complying with the conditions as outlined under Field Team Members.
- Obtaining the appropriate training, fit testing, and medical surveillance requirements under 29 CFR 1910.120 and 1910.134 and providing this documentation to the Site Manager prior to or during site mobilization.
- Complying with the training and medical surveillance requirements as outlined in Sections 9.0 and 10.0, respectively, and providing their own PPE that meets or exceeds the level of protection as outlined in this HASP.

SUBCONTRACTOR COMPANIES:

Survey Operations:	(To be provided in the Final HASP submission)
Soil Gas Operations:	(To be provided in the Final HASP submission)
Analytical Services:	(To be provided in the Final HASP submission)
UXO Identification:	(To be provided in the Final HASP submission)

LANTDIV REPRESENTATIVES:

- Ms. Linda Berry, NTR (804) 322-4818

ACTIVITY/STATION/BASE REPRESENTATIVES:

- Mr. Neal Paul, CLEJ EMD (910) 451-5063

FEDERAL/STATE/LOCAL REPRESENTATIVES:

- Ms. Gena Townsend, USEPA Region IV (404) 347-3016
- Mr. Patrick Walters, NC DEHNR (919) 733-2801

3.0 SITE CHARACTERIZATION

This section provides information on the background, description, and hazard evaluation for each AOC.

3.1 Background

Operable Unit No. 2, which covers an area of approximately 210 acres, is comprised of three IRP sites: Sites 6, 9, and 82; Site 9 is not considered in the scope of these activities. Operable Unit No. 2 is located approximately two miles east of the New River and two miles south of State Route 24. The operable unit is bordered to the north by Wallace Creek, to the west by Holcomb Boulevard, to the east by Piney Green Road, and to the south by Sneads Ferry Road. Section 3.2 will describe in detail the most recent analytical information and background for each AOC.

Location: Camp Lejeune, North Carolina

Start-Up Date: February 1994

Investigation Duration: Approximately 2 weeks

3.2 Description of Areas of Concern

Based on the results of the various environmental investigations conducted at Operable Unit No. 2 during the RI, conclusions with respect to the nature and extent of contamination at the two sites under consideration were developed as listed below. Please note that various drums and containers were noted throughout Sites 6 and 82. All surficial drums/containers and known buried drums are being removed from Operable Unit No. 2 through a Time Critical Removal Action (TCRA) which will be conducted prior to implementing any remedial alternative at the operable unit.

Site 6 (AOC 2 through 6)

- The northeast corner of Lot 201 at the former pesticide storage area is contaminated with detectable levels of pesticides and VOCs that may be associated with former waste storage/handling activities. The extent of soil contamination is limited in area since only two sampling locations exhibited elevated contaminant levels.

- The area of Lot 203 near the former railroad spur may be associated with previous disposal activities. A limited number of surface and subsurface soil samples collected near the former railroad spur have revealed detectable levels of PCBs (Aroclor-1260) and polynuclear aromatic hydrocarbons (PAHs). Historical aerial photographs indicate significant activity (i.e., surficial anomalies) in this area of Lot 203.

- Disposal activities may have occurred in the north central portion of Lot 203 where detectable levels of PCBs were detected in subsurface soil samples. In addition to PCBs, detectable levels of PAHs were also detected in this area.

- Numerous drums on the surface of Lot 203 present a potential impact to human health and the environment. Samples collected from these drums indicate that some of the drum contents are characteristically hazardous. None of the drums were noted to be leaking.

- The presence of detectable levels of PAHs in soil and low levels of PCBs in sediment in the upper portion of the ravine (i.e., near Lot 203) is most likely due to former disposal practices. This portion of the ravine is filled with debris, including empty and partially-filled 55-gallon drums. In addition, canisters with "DDT" markings were found in the middle section of the ravine (between Lot 203 and Wallace Creek). However, only low levels of pesticides were detected in the ravine sediments.

- Soil contamination detected in the ravine has likely migrated to Wallace Creek via surface runoff. Wallace Creek sediments revealed the same constituents detected in ravine soils and sediments.

- PCBs were detected in surface soil near Piney Green Road east of Lot 201. Disposal activities may have occurred in this area, which once served as a training area.

- Disposal activities may have occurred in the wooded area between Lot 201 and 203. One location exhibited moderate levels of PCBs, PAHs, and pesticides in surface soil. The horizontal and vertical extent of this contamination is limited.

Site 82 (AOC 1)

Site 82, the Piney Green Road VOC Site, is located directly north and adjacent to Site 6 and encompasses approximately 30 acres. The site is predominantly covered by woodlands and is randomly littered with debris such as communication wire, spent ammunition casings, and empty or rusted drums.

- Shallow (less than 30 feet) and deep (greater than 100 feet) groundwater exhibited elevated levels of VOC contaminants. Deep groundwater was found to be significantly more contaminated than shallow groundwater.

- The horizontal extent of shallow groundwater contamination is defined. The plume apparently originates just north of Lot 203 (in the southern portion of Site 82) and discharges into Wallace Creek. Contaminants have migrated into the deeper portion of the aquifer as evidenced by elevated VOC levels in deep groundwater monitoring wells.

- The horizontal and vertical extent of deep groundwater contamination has been evaluated. Groundwater samples obtained from monitoring wells outside of Site 82 indicated that VOC contamination has migrated just north of Wallace Creek, south into Site 6, west across Holcomb Boulevard and east across Piney Green Road. Moreover, the vertical extent has been evaluated to a depth of 263 feet. A low level of TCE (6.5 µg/L) was detected in a well installed below a semiconfining layer which is located near the apparent source area.

- A large quantity of surficial drums and debris were observed near the southeastern corner of Site 82. Samples collected of the waste material analyzed the waste as No. 6 fuel, which is typically used for heating. Other drums uncovered could not be identified. This area may also be a source of groundwater contamination at Site 82.

3.3 Hazard Evaluation

The pre-entry briefing and subsequent safety meetings will serve to address the hazards particular to each AOC, such as sloping ground, uneven terrain, etc. If new hazards are identified, the SHSO will then add them to the HASP in the field along with the date of

modification. Additionally, site personnel are expected to follow "safe" work practices as described in this HASP.

3.3.1 Chemical Hazards

Hazardous chemicals can be absorbed into the body through various pathways. These pathways include:

- Inhalation of vapors, gases, or particulates.
- Ingestion of contaminated particulates from hand-to-mouth contact.
- Dermal and eye contact from direct, unprotected contact.
- Absorption through the eye or skin from exposure to concentrations in the air.

The chemical exposure potential for personnel working at Camp Lejeune, Operable Unit No. 2 is expected to relate directly to the chemicals detected during the Remedial Investigation sampling investigations at each AOC. Therefore, Tables 3-1 and 3-2 identify the chemical/physical properties and exposure symptoms/routes of entry, respectively, for the chemicals detected at each AOC.

At AOCs 3 through 6, an effort will be made to eliminate or reduce potential routes of exposure through the use of engineering controls (i.e., performing investigative activities in an upwind location according to safe sampling techniques), administrative controls (i.e., effective training programs), and PPE (i.e., chemical protective clothing, hard hats, etc.). The Health and Safety Officer (HSO) for the soil gas subcontractor will be responsible for the control measures used to reduce the exposure potential at AOC 1.

MSDSs for constituents that were previously identified at Camp Lejeune, Operable Unit No. 2 have been compiled and are included as Attachment B. The data presented herein reflects the chemical and toxicological properties of the specific compound in a pure, non-diluted state. As such, when these compounds are detected in environmental media (i..e, soil, groundwater, sediment, and surface water), the hazards are anticipated to be substantially less than those associated with exposure to "pure" compounds. The data presented in the MSDSs will, therefore, be utilized as reference information when questions arise as to a constituents' chemical and toxicological property or measures for emergency response.

3.3.2 Physical Hazards

Physical hazards that are potential concerns for Camp Lejeune, Operable Unit No. 2 are discussed in the subsections below.

3.3.2.1 Confined Space Entry

Confined space entry is not anticipated during activities to be conducted at Camp Lejeune, Operable Unit No. 2, therefore, confined space entry procedures have not been provided. However, should circumstances arise that may require entry into a confined space, the PHSO will be contacted and entry-specific procedures according to 29 CFR 1910.146 will be provided at that time.

3.3.2.2 Thermal Stress

Provisions for monitoring cold stress are outlined in Attachment A - Baker Safety SOPs.

TABLE 3-1

CHEMICAL/PHYSICAL PROPERTIES OF CONSTITUENTS DETECTED DURING REMEDIAL INVESTIGATION SAMPLING AT CAMP LEJEUNE, OPERABLE UNIT NO. 2

Chemical	Source	Media	Exposure Limit (EL)[a]	IDLH[b]	Vapor Pressure[c]	Specific Gravity[d]	Ionization Potential (eV)
Pesticides DDT (includes DDE and DDD)	AOC 5	Soil	1 mg/m^3 (skin)	NA (CA)	0.00000015 mm	0.99	NA
gamma-Chlordane	AOC 5	Soil	0.5 mg/m^3 (skin)	500mg/m^3 (CA)	0.00001 mm	1.56 (at 77°F)	NA
Polychlorinated Biphenyls as Aroclor 1254	AOCs 2, 3, 4, and 6	Soil	0.5 mg/m^3 (skin)	5 mg/m^3 (CA)	0.00006 mm	1.38 (at 77°F)	NA
Polynuclear Aromatic Hydrocarbons as Coal Tar Pitch Volatiles	AOCs 2 and 4	Soil	0.2 mg/m^3	700mg/m^3 (CA)	NA	NA	NA
Volatile Organic Compounds 1,1,1 - Trichloroethane (Methyl Chloroform)	AOCs 1 and 5	Soil	350 ppm	1,000 ppm	100 mm	1.34	11.00
1,1,2,2 - Tetrachloroethane	AOC 1	Soil	5 ppm (skin)	150 ppm (CA)	9 mm (at 86°F)	1.59 (at 77°F)	11.10
1,2 - Dichloroethene	AOC 1	Soil	200 ppm	4,000 ppm	180 - 264 mm	1.27 (at 77°F)	9.65

(a) EL - Exposure Limit = A time-weighted average concentration for a normal eight-hour work day and 40-hour work week to which nearly all workers may be repeatedly exposed day after day without expected adverse effect. The EL represents published Exposure Levels according to the following hierarchical order: (1) OSHA PELs according to 1993 Z-tables; (2) NIOSH RELs; (3) ACGIH TLVs; and, (4) other recognized sources.

(b) IDLH - Immediately Dangerous to Life or Health.

(c) Vapor Pressure = Expressed as mm/Hg at 68°F (unless otherwise mentioned).

(d) Specific Gravity = At 68°F (unless otherwise mentioned).

CA - Suspected or Proven Carcinogen
NA - Not Available
ppm - parts per million (in air)
mg/m^3 - milligrams per cubic meter (in air)
Skin - Potential for dermal absorption

TABLE 3-1 (continued)

CHEMICAL/PHYSICAL PROPERTIES OF CONSTITUENTS DETECTED DURING REMEDIAL INVESTIGATION SAMPLING AT CAMP LEJEUNE, OPERABLE UNIT NO. 2

Chemical	Source	Media	Exposure Limit (EL)[a]	IDLH[b]	Vapor Pressure[c]	Specific Gravity[d]	Ionization Potential (eV)
1,4-Dichlorobenzene	AOC 1	Soil	75 ppm	1,000 ppm (CA)	0.4 mm (at 77°F)	1.25	8.98
Tetrachloroethene (PCE)	AOC 1	Soil	100 ppm	500 ppm (CA)	14 mm	1.62	9.32
Toluene	AOC 1	Soil	200 ppm	2,000 ppm	20 mm (65°F)	0.87	8.82
Trichloroethene	AOC 1	Soil	100 ppm	1,000 ppm	58 mm	1.46	9.45

(a) EL - Exposure Limit = A time-weighted average concentration for a normal eight-hour work day and 40-hour work week to which nearly all workers may be repeatedly exposed day after day without expected adverse effect. The EL represents published Exposure Levels according to the following hierarchical order: (1) OSHA PELs according to 1993 Z-tables; (2) NIOSH RELs; (3) ACGIH TLVs; and, (4) other recognized sources.

(b) IDLH - Immediately Dangerous to Life or Health.

(c) Vapor Pressure = Expressed as mm/Hg at 68°F (unless otherwise mentioned).

(d) Specific Gravity = At 68°F (unless otherwise mentioned).

CA - Suspected or Proven Carcinogen
NA - Not Available
ppm - parts per million (in air)
mg/m^3 - milligrams per cubic meter (in air)
Skin - Potential for dermal absorption

TABLE 3-2

CHEMICAL EXPOSURE INFORMATION

A summary of routes of entry/exposure symptoms for constituents detected during Remedial Investigation sampling at Camp Lejeune, Operable Unit No. 2 is provided in the table below.

Substance	Routes of Entry	Exposure Symptoms
Pesticides DDT (includes DDE and DDD)	Inhalation, Absorption, Ingestion, Skin/Eye Contact	Paresthesia of tongue, lips and face; tremor; apprehension; dizziness; confusion; malaise; headache; fatigue; skin and eye irritant
gamma-Chlordane	Inhalation, Absorption, Ingestion, Skin/Eye Contact	Blurred vision; confusion; ataxia; delirium; cough; nausea; vomiting; diarrhea; irritability
Polychlorinated Biphenyls as Aroclor 1254	Inhalation, Absorption, Ingestion, Skin/Eye Contact	Eye and skin irritant; acne-forming dermatitis; liver damage in animals
Polynuclear Aromatic Hydrocarbons as Coal Tar Pitch Volatiles	Inhalation, Skin/Eye Contact	Dermatitis; bronchitis; (carcinogen)
Volatile Organic Compounds 1,1,1-Trichloroethane (Methyl Chloroform)	Inhalation, Ingestion, Skin/Eye Contact	Headache; lassitude; CNS depression; poor equilibrium; eye irritation; dermatitis
1,1,2,2-Tetrachloroethane	Inhalation, Absorption, Ingestion, Skin/Eye Contact	Nausea; vomiting; abdominal pain; tremor in fingers; jaundice; dermatitis
1,2-Dichloroethene	Inhalation, Ingestion, Skin/Eye Contact	Eye/respiratory irritant; CNS depression
1,4-Dichlorobenzene	Inhalation, Ingestion, Skin/Eye Contact	Headache; eye irritant; swelling; perfuse rhinitis; anorexia; nausea; vomiting ; (carcinogen)
Tetrachloroethene (PCE)	Inhalation, Ingestion, Skin/Eye Contact	Eye/nose/throat irritant; nausea; flushed face/neck; vertigo; dizziness; headache; (carcinogen)
Toluene	Inhalation, Absorption, Ingestion, Skin/Eye Contact	Fatigue; weakness; confusion; euphoria; dizziness; headache; dilated pupils; muscle fatigue; dermatitis
Trichloroethene	Inhalation, Ingestion, Skin/Eye Contact	Headache; vertigo; visual disturbance; tremors; nausea; vomiting; eye irritation; dermatitis; (carcinogen)

3.3.2.3 Noise

Elevated noise levels may be produced during drilling and other heavy equipment operations; therefore, hearing protection may be required. The Baker SHSO will determine if hearing protection is needed for Baker personnel and visitors. The HSO for the soil gas subcontractor will be responsible for making this determination for their employees.

3.3.2.4 Explosion and Fire

In general, the following items present potential explosion or fire hazards and will be monitored closely as they pertain to each AOC:

- Explosion and fire resulting from:
  - Heavy equipment malfunction
  - Penetration into underground utility/service lines (gas, electric, fuel)
  - Ignition of trapped flammable vapors
  - Vehicular accidents
  - Puncturing of drums or containers during the installation of the vacuum extraction well by the soil gas subcontractor
  - Potential UXO detonation

Provisions for monitoring for potential fire/explosive conditions will include the review of information provided from previous utility checks and geophysical operations prior to conducting intrusive activities. As additional concerns are identified, provisions for making changes to the HASP will be presented by the SHSO, as needed. Concerns related to soil gas operations will be monitored closely by the subcontractor's HSO. The UXO subcontractor will be responsible for "clearing" sample areas prior to intrusive activities.

3.3.2.5 Utilities

The results of previous underground utility clearances and geophysical operations must be obtained before any intrusive activities are performed. If underground utilities are identified in these areas, the ground above the utility lines will be physically marked (e.g., spray paint or flags).

For the soil gas subcontractor, energized overhead electric lines may present a risk of electrocution. OSHA standards require that equipment maintain certain distances from power lines. For lines 0 to 50 kilovolts (kV), the minimum distance is 10 feet. Lines carrying over 50 kV require that equipment maintain 10 feet, plus an additional 0.4 inch for each 1 kV over 50.

3.3.2.6 Heavy Equipment

One of the primary physical hazards on the site is associated with the use of heavy equipment; this includes the use of a drill rig, which will be used by the soil gas subcontractor to install the vacuum extraction well. Only operators trained, qualified, and authorized will be permitted to operate the heavy equipment.

General hazards associated with the drill rig include moving parts, such as the auger and cathead. Personnel must remain clear of moving parts and must avoid loose-fitting clothing that can become entangled in the moving parts. Personnel working near a drill rig must be aware of the location and operation of the emergency shut off devices. Personnel are to stand clear of the drill rig immediately prior to starting the engine.

Noise from the operation of the heavy equipment will limit verbal warning abilities. Hand signals will be prearranged between operators and personnel working in and around heavy equipment. Backup alarms must operate properly on the heavy equipment.

The soil gas subcontractor HSO is to provide any other precautions that need to be observed when working around this equipment during the HASP pre-entry briefing.

3.3.2.6 Unexploded Ordnance

Fired and unfired ordnance have been reported at Sites 6 and 82. All identification and management of unexploded ordnance (UXO) will be controlled by the UXO subcontractor. The UXO subcontractor will clear AOCs 1 through 4 prior to initiating activities. Removal of live UXO will be handled by military personnel at Camp Lejeune. The UXO subcontractor will present all applicable standard operating procedures and safety guidelines during the initial HASP training.

3.3.3 Radiation Hazards

The potential for exposure to radiological wastes or radioisotopes at Camp Lejeune is considered low, therefore, a radiation survey meter will not be used during these activities.

3.3.4 Environmental Hazards

The following paragraphs identify the potential hazards associated with flora and fauna at Camp Lejeune, Operable Unit No. 2. If additional concerns are identified, they will be added to this HASP.

3.3.4.1 Hazardous Flora

Incidence of contact by individuals to poisonous/thorny plants is considered low during this time of year, therefore, only pertinent information is provided in this section. When working in forested or densely vegetated areas, bare skin should be covered (i.e., long pants and shirt, steel toe boots, leather or cotton gloves, safety glasses, and head protection) as much as practical. Care should also be taken when walking in such areas as uneven terrain or vines may present a tripping hazard.

While attempting to cut into dense underbrush, hazards exist from the sharp machete and gas-powered weed cutter, therefore, care should be taken when using such devices. (Note: Hearing protection, steel toe boots, gloves, and safety glasses are required when using weed cutters.) Rashes or other injuries will be reported to the SHSO as soon as they occur or are recognized.

3.3.4.2 Hazardous Fauna

The potential to contact hazardous fauna during this time of year is considered low, therefore, only pertinent information is provided in this section.

There is a slight potential to come in contact with dangerous insects as temperatures increase; these include fire ants, chiggers, bees, wasps, hornets, mites, fleas, spiders, and ticks.[1] All

[1] *Site personnel have been provided with a copy of Baker's policy (per our medical consultant) regarding the signs and symptoms of exposure for Lyme Disease.*

personnel should perform "checks" on each other periodically and at the end of the work shift, especially when working in grassy or forested areas. All insect bites must be reported to the SHSO.

Poisonous snakes such as the rattlesnake, copperhead, and cottonmouth (water moccasin), all known as pit vipers, are common to the United States. Snakes typically do not attack people but will bite when provoked, angered, or accidentally injured (as when stepped on). If encountering a snake, avoid quick/jerky motions, loud noises, and retreat slowly; do not provoke the snake. If bitten, follow procedures outlined in Section 8.7, Emergency Medical Treatment.

Prior to initiating site activities, each individual shall be questioned as to any known sensitivities to the previously mentioned organisms or agents.

3.3.5 Task-Specific Hazards

Listed below are summaries for the hazards associated with each task associated with each AOC. Levels of protection outlined in Section 6.0 were selected based on this task-specific hazard identification, information obtained from the Remedial Investigation, and previous experience with similar investigations or activities.

3.3.5.1 Task 1 - Land Surveying (AOCs 1 through 6)

Chemical

- Skin contact with potentially-contaminated soil.
- Ingestion of contaminated material from hand-to-mouth contact.

Physical/Environmental

- Slips/trips/falls - sloped, uneven terrain; crawling over and under obstacles.
- Skin irritation from contact with insects and vegetation.
- Interaction with native and feral animal life.
- Contact with UXO.

3.3.5.2 Task 2 - Surface Soil Sampling (AOCs 3 through 6)

Chemical

- Skin contact with potentially-contaminated soil.
- Ingestion of contaminated materials from hand-to-mouth contact.
- Inhalation of volatile contaminants or volatile fraction of semivolatile contaminants.
- Absorption of constituents through the skin.

Physical/Environmental

- Slips/trips/falls - sloped, uneven terrain; crawling over and under obstacles.
- Skin irritation from contact with insects and vegetation.
- Interaction with native and feral animal life.
- Muscle strain from boring with hand auger.
- Contact with UXO.

3.3.5.3 Task 3 - Vacuum Extraction Well Installation (AOC 1)

Chemical

- Potentially-contaminated mud or soil to be splashed onto body or in eyes.
- Ingestion of contaminated materials from hand-to-mouth contact.
- Inhalation of volatile contaminants or volatile fraction of semivolatile contaminants.
- Absorption of constituents through the skin.

Physical/Environmental

- Heavy objects landing on foot/toe or head.
- Elevated noise levels from heavy equipment operation.
- Slips/trips/falls - sloped, uneven terrain; crawling over and under obstacles.
- Skin irritation from contact with insects and vegetation.
- Overhead hazards from drill rig operations.
- Interaction with native and feral animal life.
- Contact with underground utility lines and/or UXO.
- Muscle strain from lifting hazards.

3.3.5.4 Task 4 - Soil Gas Sampling (AOC 1)

Chemical

- Inhalation of volatile contaminants or volatile fraction of semivolatile contaminants.
- Ingestion of contaminated materials from hand-to-mouth contact.
- Skin contact with potentially-contaminated material.

Physical/Environmental

- Slips/trips/falls - sloped, uneven terrain; crawling over and under obstacles.
- Skin irritation from contact with insects and vegetation.
- Contact with underground utilities, fuel lines, etc.
- Interaction with native and feral animal life.
- Contact with UXO.

3.3.6 Summary

The information provided in Section 3.3 details the hazards associated with the the Activities at Camp Lejeune, Operable Unit No. 2. This information is used to ascertain what levels of protection will be required for each field activity at each AOC. In determining the levels of protection, the following items are considered:

- Quantity that is available for absorption
- Amount of time that is available for absorption
- Frequency with which the exposure occurs
- Physical form of the constituents
- Presence of other constituents
- Toxicity of the constituents
- Ventilation, natural or otherwise
- Appropriate hygienic practices
- Protective equipment in use
- HASP training

Based on this section and the information furnished in Section 3.3, levels of protection will be assigned. Refer to Section 6.2, Site-Specific Levels of Protection.

4.0 SITE CONTROL

Measures need to be addressed in the HASP for managing the daily control (i.e., access, site conditions, etc.). The following subsections provide a discussion of each site control measure that will be consistent for site activities at Camp Lejeune, Operable Unit No. 2.

4.1 Site Access

The Field Team Leader is designated to coordinate overall access and security at each AOC. Perimeters for activities to be conducted at AOCs 3 through 6 will be established according to the site boundary procedures identified in Section 4.3, local conditions, the items listed below, and Navy Activity requirements. AOC 1 access will be coordinated by the soil gas subcontractor's HSO.

- Personnel will not be permitted within the Work Zone (i.e., Exclusion Zone) or Contamination Reduction Zone without proper authorization from the SHSO.
- All personnel arriving or departing the site will be documented in the site logbook.
- All activities on site must be cleared through the Field Team Leader and documented in the site logbook.
- The on-site Command Post will be established at the Baker Field Trailer located in Lot 201, which will be in the Support Zone and oriented upwind from all Work Zones.
- Figure 4-1 identifies the location of each AOC.

4.2 Site Conditions

Specific site conditions are as follows:

- The prevailing wind conditions are from the north-northwest.
- Anticipated weather conditions are cold, 35 to 50°F.
- Site topography consists of a variety of open and wooded terrain, some clearing may be needed.

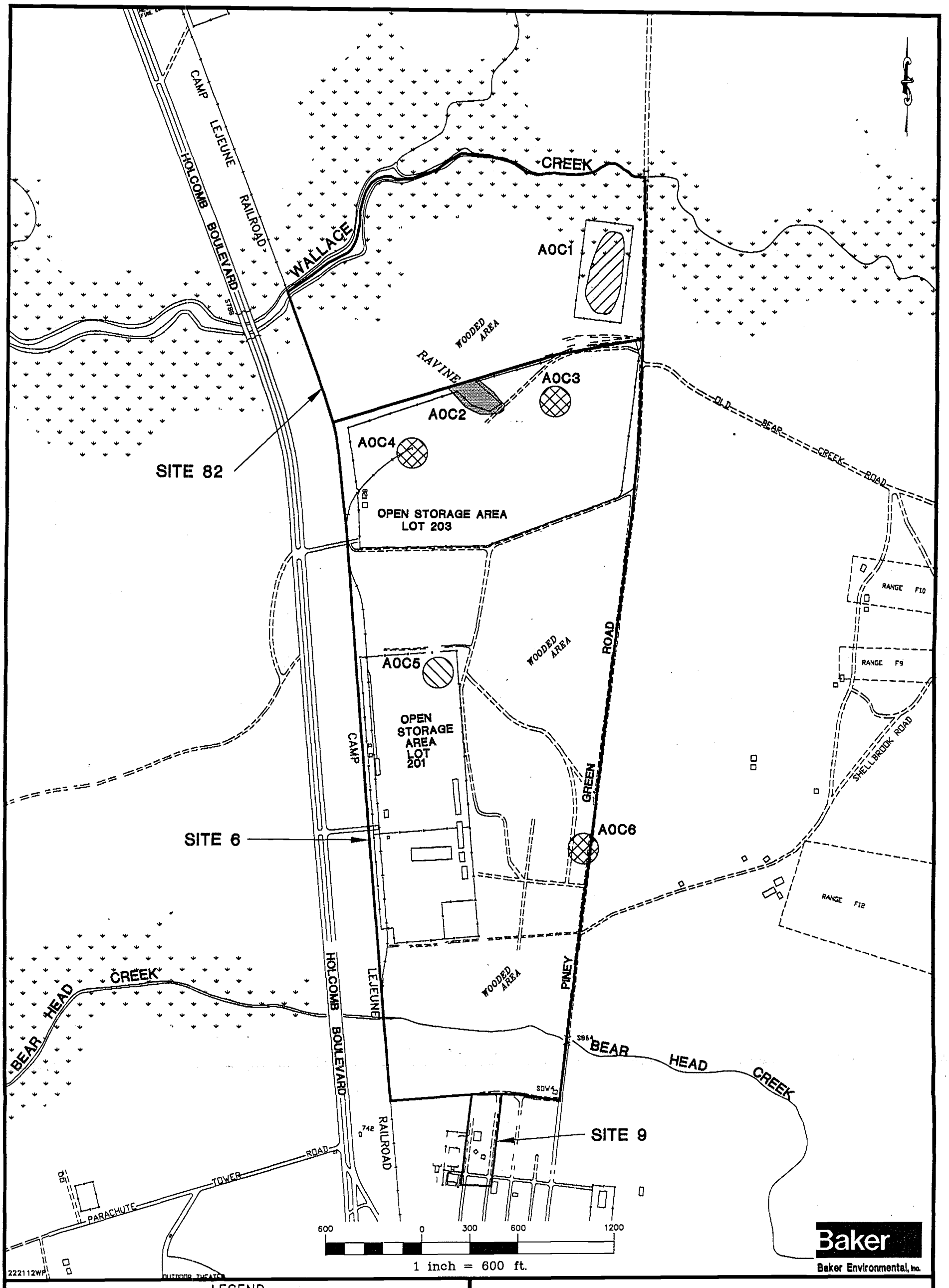
4.3 Work Zones

To reduce the accidental spread of hazardous substances by workers from a potentially-contaminated area to a clean area, zones will be delineated to ensure that work activities and contamination are confined to the appropriate areas, and to keep unauthorized personnel from entering the work zones. The sections below identify the requirements based on the level of protection in use.

4.3.1 Level C Activities

All zones for activities conducted under Level C shall be established utilizing control boundaries between the Work Zone, the Contamination Reduction Zone (CRZ), and the Support Zone (i.e., Clean Zone). These boundaries shall be defined as follows:

- Work Zone - The area where the primary investigation activity occurs.



LEGEND

AOC1 — SOILS TO BE TREATED VIA IN SITU VOLATILIZATION – VOC CONTAMINATED SOILS	AOC3,AOC4,AOC6 — SOILS TO BE EXCAVATED AND REMOVED – PCB CONTAMINATED SOILS
AOC5 — SOILS TO BE EXCAVATED AND REMOVED – PESTICIDE CONTAMINATED SOILS	AOC2 — DRUM, DEBRIS, AND SOIL REMOVAL AREA

SOURCE: LANTDIV, FEBRUARY 1992

FIGURE 4–1
SOIL AREAS OF CONCERN
CONTAMINATED SOIL AND GROUNDWATER
REMEDIAL DESIGN CTO–0222

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

01484DD062

- Hotline - The boundary between the Work Zone and CRZ.
- CRZ - The area between the Work Zone and the Support Zone which is located upwind of the site investigative activities.
- Contamination Control Line - The boundary between the CRZ and the Support Zone.
- Support Zone - The outermost area next to the CRZ and upwind of the site investigative activities.

These boundaries will be demarcated using colored boundary tape, cones, or equivalent for the Hotline or the Decontamination Corridor of the CRZ and/or barriers for the Contamination Control Line such as posted signs and/or barricades.

Refer to Figure 4-2 for a "General Contamination Reduction Zone Layout." Exact locations of the demarcated zones will be field determined by the SHSO during site mobilization.

4.3.2 Level D and D+ Activities

All zones for activities conducted under Levels D or D+ shall be established according to the guidelines set forth in the subsections below.

4.3.2.1 Populated Areas

In populated areas, Work Zones for activities conducted under Level D or D+ protection levels shall be established in such a manner as to preclude unauthorized personnel from entering the investigative area. A boundary will be established to separate the Work Zone from the Support Zone using available materials such as the Baker Field Vehicle, natural boundaries (e.g., buildings, structures, fences), or signs/placards, boundary tape, cones, barricades, etc.

4.3.2.2 Unpopulated/Secluded Areas

In unpopulated or secluded areas, the aforementioned materials may not be used due to the exclusive nature of the site, the short duration of the activity, and the low risk to outside populations. The SHSO and/or Field Team Leader is responsible for making this determination.

4.4 "Buddy System"

All site activities that involve hazards and/or the potential for contact with hazardous materials will be performed by a work team of no fewer than two people (i.e., Buddy System). For potential "high-hazard" activities, a third person located in the Support Zone will serve as an observer or respond to a rescue situation.

4.5 Safe Work Practices

Routine safe work practices may consist of:

- Conducting operations in a manner to reduce exposure of personnel and equipment.
- Implementing appropriate decontamination procedures.
- Conducting sampling activities from an upwind location.
- Adherence to applicable safety regulations in OSHA Standards 29CFR 1910 and 1926.

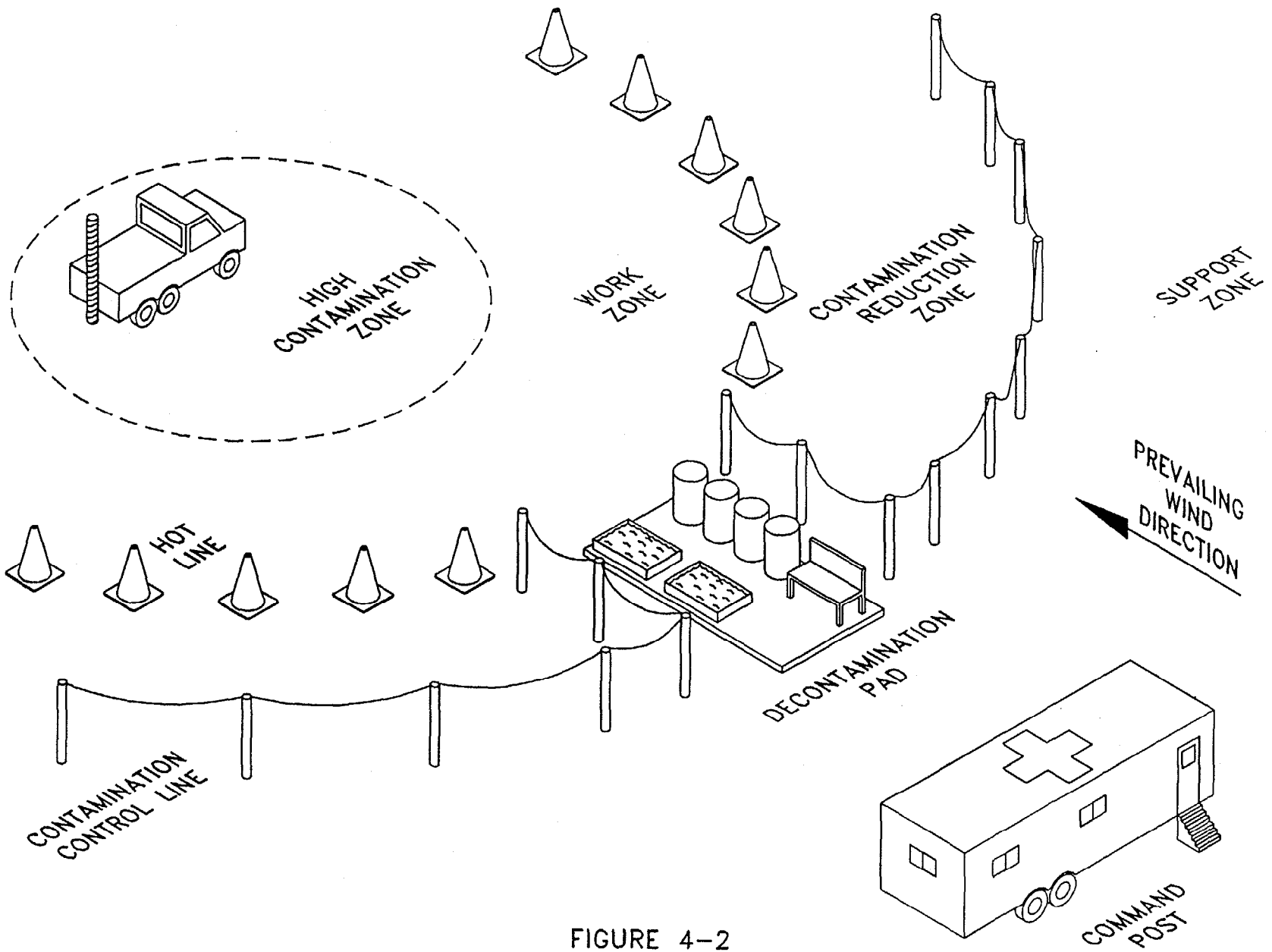


FIGURE 4-2
SCHEMATIC DIAGRAM
GENERAL CONTAMINATION
REDUCTION ZONE LAYOUT

- Setting up barriers to exclude unauthorized personnel from contaminated areas.
- Minimizing the number of personnel and equipment at each area under investigation.
- Establishing work zones within each area under investigation.
- Establishing control points for ingress to and egress from work zones.

4.6 Sanitation Procedures/Site Precautions

Provisions for sanitation procedures and site precautions to be followed on site are outlined below.

- A supply of clearly marked potable water, tightly closed, and equipped with a tap.

- Single service disposal cups.

- Outlets for non-potable water, clearly marked, for fire fighting or other purposes. Cross-contamination of the potable supply shall be prevented.

- One toilet facility for up to 20 personnel which is either chemical, recirculating, combustion, or flush, depending on local code requirements. Two toilet facilities will be required for greater than 20 personnel.

- A place for food handling meeting applicable laws or suitable alternatives to such facilities will be provided (i.e., nearby restaurants, food wagons, etc.).

- Clean wash water will be available in the decontamination zone during Level C activities, and the Baker Field Trailer for all other operations. Disposable towelettes will be available in each Baker Field Vehicle for periodic cleanups.

- Eating, drinking, chewing gum or tobacco, smoking, or any practice that increases the probability of hand-to-mouth transfer and ingestion of material is prohibited in any area designated as contaminated. Smoking will also not be allowed in areas where flammable materials are present. Hands and face must be thoroughly washed before breaking for meals and upon leaving the site. "Contaminated" work garments are not to be worn off site.

- Whenever decontamination procedures for outer garments are in effect, the entire body should be thoroughly washed as soon as possible after the protective garment is removed.

- Contact lenses are not permitted to be worn on site.

- Facial hair, which interferes with a satisfactory fit of the mask-to-face seal, is not permitted on personnel who are or may be required to wear respirators.

- Contact with contaminated or potentially-contaminated surfaces should be avoided. Wherever possible, do not walk through puddles, leachate, discolored surfaces, kneel on ground, lean, sit or place equipment on drums/containers.

- Medicine and alcohol can potentiate the effects of exposure to toxic chemicals, therefore, prescribed drugs should only be taken by personnel when approved by a qualified physician. Alcoholic beverage intake should be minimized or avoided during after-hour operations.

- Alcoholic beverages and firearms are prohibited on site.

- All site personnel will observe any posted sign, warning, fence, or barrier posted around contaminated areas.

- Site personnel must wear the proper attire while on site. At a minimum, this will include steel-toed boots, work pants (e.g., jeans or other durable material), and work shirt (e.g., short or long-sleeved, made of a durable material). Tank tops, muscle shirts, and sweat pants are not permitted.

5.0 ENVIRONMENTAL MONITORING

Environmental monitoring will be performed at each AOC; for AOCs 3 through 6, monitoring will consist of using the MINIRAM personal monitor. At AOC 1, the HSO for the soil gas subcontractor will be responsible for determining the extent of environmental monitoring.

5.1 Personal Monitoring

Personal monitoring will be accomplished using realtime environmental monitoring instrumentation directed at the breathing zone (BZ) (the area bordered by the outside of the shoulders and from the mid-chest to the top of the head) of work party personnel. Breathing zone monitoring will be performed each time a reading is taken at the point source (i.e., after well is opened for groundwater sampling, after breaking ground for soil sampling, etc.). The guidelines below identify the protection levels required according to the concentrations measured using each piece of equipment.

PCBs and/or pesticides are the primary contaminants at AOCs 3 through 6, therefore, environmental monitoring of these soil sampling activities will include the use of a MINIRAM (miniature realtime aerosol monitor). Additionally, the on-site screening for PCBs will be performed using the Ensys PCB kit (according to the proposed EPA Method 4020 for the immunoassay-based field screening for PCBs in soil) at AOCs 3, 4, and 6. This method will serve to alert site personnel as to the areas of elevated PCB concentration. A screening method is not available for pesticides at this time.

The action levels associated with the MINIRAM personal monitor are presented in Section 6.2.

5.2 Point Source Monitoring

Point source monitoring which is monitoring performed at the source of the sampling/investigative activity (i.e., borehole) will not be performed during these field activities.

As work progresses, the scope of monitoring may be extended based on monitoring results, odor detection, changing work conditions, and signs or symptoms of exposure. Any or all of these conditions will be immediately investigated and acted upon by the SHSO.

5.3 Perimeter Monitoring

Perimeter monitoring which is defined as monitoring performed at borders beyond the Support Zone and often at the "fence line" will not be required for these activities.

5.4 Specific Air Monitoring Equipment and Frequency

Monitoring equipment and frequency for each AOC has been identified in Section 6.2.

5.5 Equipment Maintenance and Calibration

Baker's procedures for the return of equipment to inventory and for maintenance of the equipment shall be followed in order to assure that the optimum level of operation is maintained for the item. Equipment calibration under the direction of the SHSO will be completed daily before use and calibration information entered onto the equipment calibration form. All forms will be maintained on site for the duration of the project with copies to be given to the Equipment Manager once the equipment has been returned to the office. Procedures for equipment maintenance and calibration follow those guidelines found in the

operating manual provided by the manufacturer (included with each piece of equipment) or in Baker's Standard Operating Procedures for Administrative, Field, and Technical Activities Manual.

5.6 Monitoring Documentation

As environmental monitoring is performed, documentation of the results will be entered into the Field Log Book of the SHSO or other personnel performing the monitoring. Documentation is to include the date, time, instrument result, general location, and specific location such as point source, breathing zone, or area. Copies of the Field Log Book will be placed in a binder and remain in the Baker Field Trailer on site until the end of the field activities, whereby the log sheets will become part of the permanent file.

6.0 PERSONAL PROTECTIVE EQUIPMENT

6.1 Personal Protective Equipment Selection

The personal protective equipment available for the various levels of protection is listed in the table below. The assigned item number will correspond to each field activity as defined in Section 6.2.

Item No.	Personal Protective Equipment
1	Chemical-Resistant Clothing (Polyethylene-coated Tyvek®)
2	Chemical-Resistant Clothing (Saranex®)
3	Uncoated Tyvek®/Kleenguard® Coveralls
4	Normal Work Clothes or Coveralls
5	Air-Line Respirator (ALR) with 5-minute escape pack
6	Self-Contained Breathing Apparatus (SCBA) for rescue
7	NIOSH 5-minute Escape Pack (on standby)
8	Full-face Cartridge Respirator
9	Half-face Cartridge Respirator
10	Full-face Cartridge Respirator (on standby)
11	Half-face Cartridge Respirator (on standby)
12	Chemical-Resistant Gloves (Nitrile inner - double layer)
13	Chemical-Resistant Gloves (Nitrile inner - single layer)
14	Chemical-Resistant Gloves (Rubber/Neoprene outer)
15	Chemical-Resistant Gloves (Nitrile outer)
16	Work Gloves (outer), as needed
17	Chemical-Resistant Overboots (with steel toe and shank)
18	Chemical-Resistant Overboots (w/o steel toe)
19	Steel Toe Boots
20	Safety Glasses
21	Safety Goggles
22	Face Shield
23	Hard Hat
24	Hearing Protection (as necessary)
25	Chest/Hip Waders (as necessary)
26	Safety Vests

6.2 Site-Specific Levels of Protection

Several assumptions were made in determining the level of personal protective equipment for AOCs 3 through 6. These assumptions are as follows:

- Dermal contact/absorption is a major consideration with regard to PCB and chlorinated pesticide (i.e., DDT) exposure, therefore, Level D+ (which constitutes Level C protection with respiratory protection on standby) is assigned for these PCB sampling activities.

- Incidental ingestion via hand-to-mouth contact is a consideration, therefore, site personnel will need to employ strict hygiene measures and other precautions to avoid exposure.

- Inhalation due to volatilization of PCBs or chlorinated pesticides (i.e., DDT) is considered to be a secondary route of exposure. This is based on a vapor pressure of Aroclor-1254 at 0.00006 mm/Hg, where at atmospheric saturation, a maximum level of 0.08 ppm or approximately 1 mg/m^3 would be volatilized. Note the vapor pressure of DDT is 0.00000015, therefore, the vapor pressure of Aroclor-1254 will be used in the calculations as a "worst case" scenario. In an outdoor environment with periodic winds and temperatures between 30 and 50°F, exposure through inhalation is remote.

Another consideration is that PCBs or pesticides could adsorb to soil particulates, become suspended in the air during sampling activities, and then inhaled. Therefore, assuming that 5 percent of the soil contains PCBs, the following action level can be derived:

$$0.5\ mg/m^3 \text{ divided by } 5\%\ (0.05) = 10\ mg/m^3 \text{ in the breathing zone}$$

To monitor for this action level, a MINIRAM personal monitor will be worn by site personnel in the breathing zone. Levels nearing or reaching this level shall require Level C protection for the remainder of the work day. The next day of sampling would constitute Level D+ until the action level would be reached. Should areas with noticeable staining be encountered, Level C protection will be required as a precautionary measure.

Location(s)	Field Activity	Level of Protection					Personal Protective Equipment (Item No.)
		B	C	D+	D	Other	
AOCs 1 through 6	Land Surveying				X		4, 13, 16, 19, 20
AOCs 1 through 6	Surface Soil Sampling			X			1, 10 or 11, 13, 14, 16, 18, 19, 20 or 21
AOC 1	Vacuum Extraction Well Installation					X(1)	4, 10, 12, 16, 19, 20, 23, 24
AOC 1	Soil Gas Sampling					X(1)	4, 10, 12, 16, 19, 20, 23, 24

(1) The level of protection for the soil gas subcontractor is assumed to be Level D (D+), however, the subcontractor's HSO will be responsible for maintaining or upgrading this level of protection while conducting activities at AOC 1.

Note: No single combination of protective equipment and clothing is capable of protection against all hazards. PPE should be used in conjunction with safe work practices, effective decontamination, and good personal hygiene.

Except in emergency situations, changes to the specified levels of protection shall only be made with the approval of the SHSO and the Site Manager, in consultation with the PHSO and Project Manager.

6.3 Respiratory Protection

Site-specific respiratory protection requirements as outlined below will comply with the procedures in Attachment A - Baker Safety SOPs.

6.3.1 Level C

The "North" or "MSA" full-face or half-face NIOSH-certified negative pressure Air-Purifying Respirator with an organic vapor/HEPA cartridge is the appropriate cartridge for use with the detected hazardous materials and the measured contaminant concentrations will be used at this level. Upgrades/downgrades in this level of respiratory protection will be based on measured realtime air contaminant concentrations (see Section 6.2) and the SHSO's observations.

Cartridge changeover will occur when one or more of the following have been observed: exposure duration greater than eight hours for vapor/gas cartridges; breathing resistance; a noticeable odor or taste; eye/throat irritation; and other indicators such as end-of-service life indicators for specialty filter cartridges.

6.3.2 Level D+

A NIOSH-certified negative pressure air purifying respirator, meeting all the requirements identified under Level C, will remain on standby at this level.

6.4 Care and Cleaning of Personnel Protective Equipment

Provisions for the care and cleaning of personal protective equipment used on site can be found in Attachment A - Baker Safety SOPs.

7.0 DECONTAMINATION PROCEDURES

Procedures to follow for the decontamination of personnel and equipment, as well as handling of materials generated during decontamination, are discussed in the following sections.

7.1 Personnel Decontamination

Personnel leaving the Work Zone will be thoroughly decontaminated. The following protocol will be used for the decontamination stations according to levels of protection assigned to each field activity:

Level D	Level D+	Level C
1. Equipment drop	1. Equipment drop	1. Equipment drop
2. Boot and glove gross contamination removal*	2. Outer boot and glove wash	2. Outer boot and glove wash
3. Boot and glove wash*	3. Outer boot and glove rinse	3. Outer boot and glove rinse
4. Boot and glove rinse*	4. Tape Removal	4. Tape Removal
5. Tape Removal*	5. Outer boot and glove removal	5. Outer boot and glove removal
6. Boot removal*	6. Coverall removal/ disposal	6. Coverall removal/ disposal
7. Glove removal*	7. Inner glove removal/disposal	7. Respirator removal
8. Hand/Face wash	8. Hand/face wash	8. Inner glove removal/disposal
9. Equipment wipe down	9. Equipment cleaning	9. Hand/face wash
		10. Respirator cleaning/ sanitizing
		11. Equipment cleaning

*Optional - depends on degree of contamination and type of PPE used.

The following decontamination equipment is required for Level C and higher protection levels and recommended for Level D+ protection:

- Two small tubs (one set of wash and rinse water)
- Scrub brush
- Towels*
- Disposable wipes*
- Pressurized sprayers for rinsing
- Contaminated clothing disposal bag or drum*
- Contaminated liquids disposal drum
- Respirator cleaning solution
- Liquinox and water as the decontamination solution

*Minimum for Level D decontamination.

The decontamination liquids and clothing will be contained and disposed according to policy defined in SAP, Part III of the Project Plans.

7.2 Effectiveness of Personnel Decontamination

The effectiveness of site decontamination methods will be evaluated by the SHSO on a periodic basis. This evaluation may include the observation of personnel decontamination, inspection of PPE before and after decontamination, and questioning site personnel for signs and symptoms of exposure. Additional measures may also be employed by the SHSO at their discretion.

7.3 Equipment Decontamination

Provisions for the decontamination of equipment will be based on the size and type of equipment used. Specific decontamination procedures for Camp Lejeune, Operable Unit No. 2 will be found in the SAP.

7.4 Decontamination Materials

The protocols outlined in the SAP for the handling of materials used for decontamination such as packaging, storing, and disposing will be followed to: (1) minimize the risk of off-site exposures that could endanger public health; and (2) limit the potential for liabilities associated with handling, containment, storage, and transportation of contaminated materials. These protocols comply with Baker's SOP on "Site Investigation-Derived Wastes," located in Section 4.0 of the SAP.

8.0 EMERGENCY PROCEDURES

8.1 Scope

The activities to be conducted under this HASP are not remediation (cleanup), but investigative; therefore, emphasis has been placed on those procedures that would most likely be implemented in the event of an emergency.

8.2 Pre-Emergency Planning

All applicable Navy/local emergency response contacts [On-Scene Commander (Fire Chief), Security, Ambulance, Hospital, etc.] at MCB, Camp Lejeune will be contacted prior to or during site mobilization activities. This notification will be performed by the SHSO and/or Field Team Leader. The information discussed may include:

- A description of site activities.
- Anticipated site hazards.
- Hazardous chemicals/materials brought on site.
- Expected length of time on site.
- Specific requirements the emergency response facilities may require.
- Confirmation of emergency phone numbers.
- Security measures that must be followed by site personnel.

Specific points of contact, where applicable, will be established and added to the HASP. If requested, Material Safety Data Sheets which are maintained at the Command Post will be provided at this time.

8.3 Emergency Coordinator

The SHSO acting as the Emergency Coordinator is responsible for field implementation of these Emergency Procedures. As the Emergency Coordinator, specific duties include:

- Familiarizing all on-site personnel with the emergency procedures and the emergency coordinator's authority.
- Identifying the nearest telephone in the event of an emergency.
- Communicating site emergency procedures and requirements to all Baker and subcontractor personnel.
- Specifying the Field Team Leader as the backup/alternate Emergency Coordinator.
- Controlling activities of subcontractors and contacting the emergency response groups, as necessary.
- Anticipating, identifying, and assessing fires, explosions, chemical releases, and other emergency situations to the best of the coordinator's ability.
- Familiarity with site personnel trained in emergency first aid and adult CPR.

All on-site personnel, whether involved in emergency response or not, will be notified of their responsibilities by the Emergency Coordinator in an emergency. They will be familiar with the emergency procedures and the Emergency Coordinator's authority.

8.4 Communications/Telephone Numbers

Internal communications will rely on direct communication (via verbal and two-way radios) between site personnel. External communications will employ a telephone located in the Baker Field Trailer and various telephones located throughout the Base (near the investigation areas). Telephone communication at the Command Post, Baker Field Trailer is already established; the telephone number is (910) 451-1725.

The "Buddy System" will be in effect at all times; any failure of communication requires an evaluation of whether personnel should discontinue activities.

Air horns will be used for communication during emergency evacuation of personnel. One long (3 second) air horn blast is the emergency signal to indicate that all personnel should evacuate the Work Zone.

Coordination between Baker and subcontractor personnel is the responsibility of the Field Team Leader. The best means for securing the lines of communication will be determined at the pre-entry briefing.
Hand signals, as outlined below, will be used in the event that radio communications fail:

Hand gripping throat	-	Can't breathe (typically Level C/B activities)
Grip partner's wrist or both hands around waist	-	Leave area immediately
Hands on top of head	-	Need assistance
Thumbs up	-	OK, I am all right, I understand
Thumbs down	-	No, I do not understand

Emergency telephone numbers will be posted in the Baker Field Trailer and maintained in each Baker Field Vehicle. The list of emergency phone numbers is presented in Table 8-1.

8.5 Assembly Area

In the event of an emergency, personnel will be instructed to meet initially at the Baker Field Vehicle and eventually at the Baker Field Trailer. Where applicable, personnel will exit the work area through the contamination reduction zone. If either of these assembly areas is inappropriate, an alternate assembly area will be designated by the Emergency Coordinator in an upwind location from the AOC. At this location, emergency needs will be provided such as:

- Assembly for evacuated personnel
- First aid for injured personnel
- Decontamination material
- Communications

8.6 Emergency Hospital Route

An emergency hospital route map (Figure 8-1) showing the location of the local Base and public hospitals will be posted in the Baker Field Trailer and maintained in the Baker Field Vehicle. Personnel will be informed of the location of the map and the directions to the hospital.

TABLE 8-1

EMERGENCY TELEPHONE NUMBERS

Facility	Telephone Number	Contact*
Security	911 or (910) 451-3855	Response Operator
Fire	911	Emergency Services Operator
Ambulance (On-Base)	911 or (910) 451-4554	Emergency Services Operator/HM1 Cesse
Ambulance (Off Base)	(919) 455-9119	Response Operator
Hospital (On-Base)	911 or (910) 451-4840, 4841, and 4842	Response Operator
Hospital (Off Base) (Emergency Room)	(919) 577-2240	Emergency Room Physician
Hospital (Off-Base) (Information)	(919) 577-2345	Onslow County Hospital Information
Hazardous Materials Team	911	Emergency Services Operator
On-Scene Commander	911 or (910) 451-5815	Fire Chief Piner
MCB Camp Lejeune Directory Assistance	(910) 451-1115	Directory Assistance Operator
Public Works Department (Underground Utilities via EMD Contact)	(910) 451-5063	Mr. Neal Paul
Poison Control Center	1-800-672-1697	Response Operator
National Response Center	1-800-424-8802	Response Operator
CHEMTREC	1-800-424-9300	Response Operator
Agency for Toxic Substances and Disease Registry	1-404-639-0615	Response Operator

*Remaining points of contact will be identified prior to the start of activities.

Notes:
1. When using the portable cellular telephone in the Jacksonville, North Carolina, area, dial the appropriate area code (919) or (910) first in addition to the local telephone number.
2. When calling 911 on a non-base telephone, ask emergency services operator to transfer call to Base 911 system and report emergency.
3. When using an on-base telephone, first dial extension 99 for local calls or extension 92 for long distance calls.

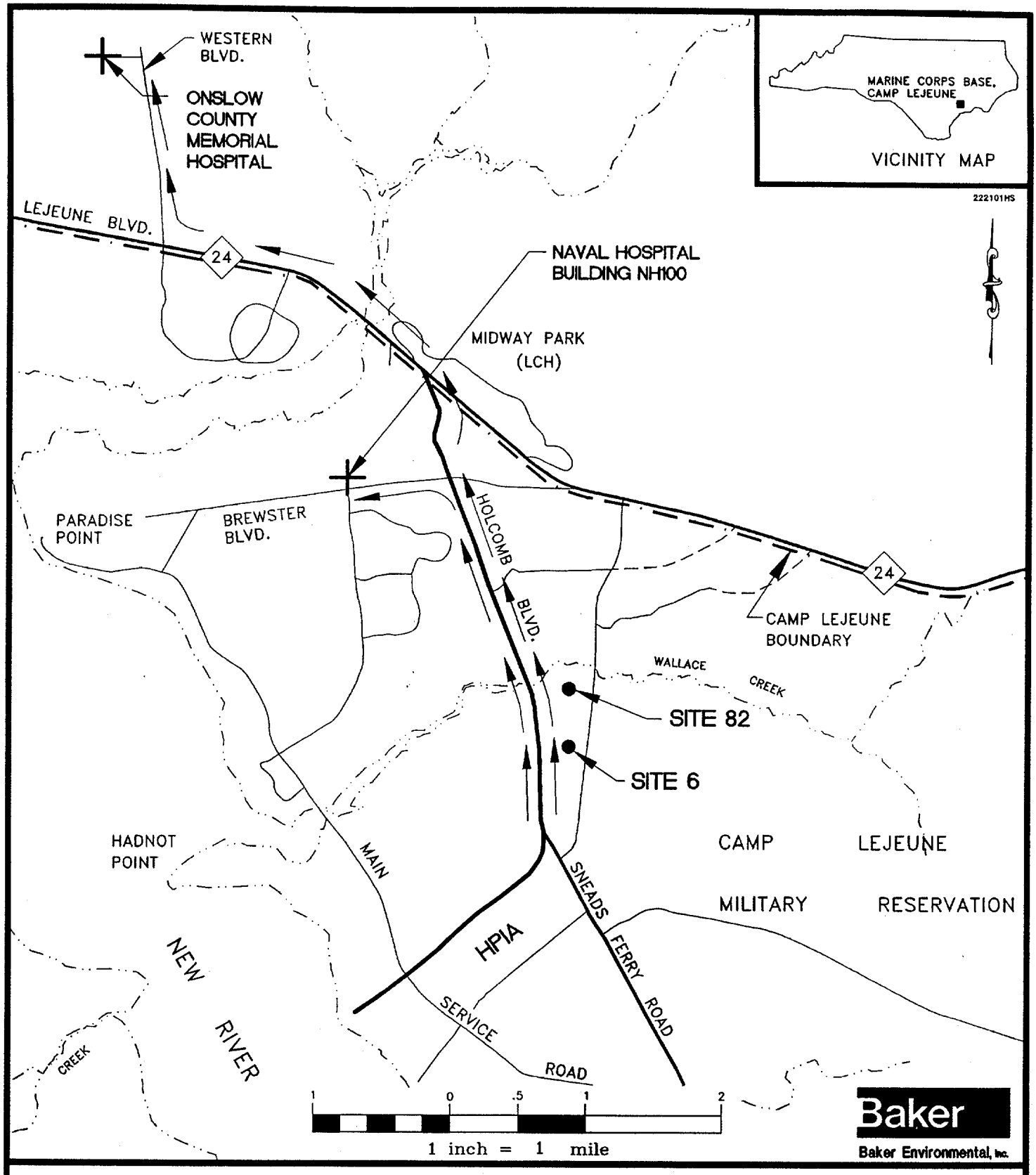


FIGURE 8–1
HOSPITAL ROUTE MAP
MARINE CORPS BASE CAMP LEJEUNE

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

Directions to the Base Naval Hospital (Building NH100) are as follows:

1. Proceed north on Holcomb Boulevard approximately 2.25 miles.

2. Turn left at the light onto Brewster Boulevard (west) until intersecting with the driveway to Naval Hospital on right (approximately 0.75 miles).

3. Follow signs for emergency room entrance (bear to the right).

Directions to Onslow County Memorial Hospital are as follows:

1. Proceed north on Holcomb Boulevard and exit MCB, Camp Lejeune through the main gate.

2. Follow Highway 24 west (approximately 2.5 miles) to Western Boulevard and turn right (north).

3. Continue on Western Boulevard (approximately 1.5 miles) to the fifth stoplight and the hospital will be on the left-hand side.

4. Follow signs for emergency room entrance.

8.7 Emergency Medical Treatment

This section provides information on the nearest emergency medical facility and corresponding emergency telephone numbers.

Emergency Medical Services

For nonchemical exposure incidents, the nearest public hospital is:

Name Onslow County Memorial Hospital
Address 317 Western Boulevard, Jacksonville, North Carolina
On-Base Telephone No. (99) 577-2240
Off-Base Telephone No. (919) 577-2240 or 911

Note: In extreme emergencies, personnel may be transported to Building NH100 (Naval Hospital) for initial treatment of both chemical and nonchemical exposures.

Local ambulance service is available from:

Name Naval Ambulance Service or City of Jacksonville
On-Base Telephone No. 911
Off-Base Telephone No. 911 or 455-9119

Contact will be made with emergency personnel prior to the start of activities (see Section 8.2).

8.8 Injuries

If injuries are not serious or life threatening, affected personnel may be transported by other site personnel to the local medical facility, if necessary. Emergency medical response personnel will be contacted in the event of serious or multiple injuries. Medical personnel will be provided with all available information regarding the nature of the incident, chemicals involved, etc. Instances requiring treatment beyond "first aid" will be handled at appropriate

facilities and reported to the Project Manager and PHSO within 24 hours. There will be a minimum of one person during these field activities that will be trained in standard first aid and adult CPR. This person will also be familiar with Baker's program for potential exposure to bloodborne pathogens as outlined in the Baker Safety SOPs in Attachment A. Subcontractors will be responsible for securing proper medical attention for their employees. Baker may assist the subcontractor, if necessary.

8.8.1 Physical Injury

If an employee working in a contaminated area is physically injured, first aid procedures are to be followed. Depending on the severity of the injury, emergency medical response from the Navy Hospital personnel may be sought to stabilize victim for transport to public hospitals. If the employee can be moved, he/she will be taken to the edge of the work area and decontaminated, if necessary (refer to Section 8.9). Then, if circumstances permit, administer emergency first aid and transport to an awaiting ambulance or to a local emergency medical facility.

8.8.2 Chemical Injury

If the injury to a worker is chemical in nature (e.g., direct contact/exposure), the following first aid procedures are to be instituted:

- Eye Exposure - If contaminated solid or liquid gets into the eyes, wash the eyes immediately at the 15-minute emergency eyewash station (or with the emergency eye wash bottle when an eye wash station is not available). Obtain medical attention immediately.

  NOTE: Contact lenses will not be worn while working at any site.

- Skin Exposure - If contaminated solid or liquid gets on the skin, promptly wash the contaminated skin using soap or mild detergent and water. If solids or liquids penetrate through the clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. Obtain medical attention immediately.

- Swallowing - If contaminated solid or liquid has been swallowed, immediately contact the Poison Control Center at the Duke University Medical Center, Durham, North Carolina, at 1-800-672-1697. Do not induce vomiting in an unconscious person. Obtain medical attention as directed by the Poison Control Center.

- Breathing - If a person has difficulty breathing, move the exposed person to fresh air at once. If breathing is not evident, check for pulse and perform appropriate first aid, either rescue breathing or CPR, depending on the condition. Obtain medical attention immediately.

Procedures to follow in the event of a chemical exposure are included in Attachment C.

8.8.3 Snakebite Injury

In the event of a snakebite injury, the following procedures will be followed.

Look for signs and symptoms such as the characteristic appearance of two small holes, usually about a half inch apart, with surrounding discoloration, swelling, and pain. Systemic signs (which may or may not occur) include weakness, sweating, faintness, and signs of shock.

Provide treatment as follows:

1. Calm the victim and keep affected area still.
2. Contact ambulance if victim needs transportation to the nearest hospital.
3. Wash the wound.
4. Keep the affected area below the level of the heart if bite is on the arm or leg.
5. Treat for shock.
6. Monitor airway, breathing, and circulation.
7. Obtain physical description of snake, if possible.
8. Transport victim to the nearest medical facility.
9. Provide the emergency medical responder (either the ambulance attendant or the emergency room at the hospital) with all pertinent information such as how long ago the bite occurred, the type of snake (if known), any known allergic conditions (if known), etc.
10. Inform the SHSO as soon as possible.

8.9 Emergency Decontamination Procedures

In the event of a medical emergency, patients are to be adequately decontaminated before transfer (if possible) to prevent contamination of the medical transport vehicle and medical facility. Emergency personnel decontamination will include the following, depending on the level of protection.*

Level D	Level D+	Level C
• Equipment drop • Tape, boot, and glove removal • Coverall removal	• Equipment drop • Tape, outer boot, and glove removal • Coverall removal/ disposal • Inner glove removal/ disposal	• Equipment drop • Tape, outer boot, and glove removal • Coverall removal/ disposal • Respirator removal • Inner glove removal/ disposal

* If circumstances dictate that contaminated clothing cannot be readily removed, then remove gross contamination and wrap injured personnel with clean garments/blankets to avoid contaminating other personnel or transporting equipment.

All emergency personnel are to be immediately informed of the injured person's condition, potential contaminants, and provided with all pertinent chemical data.

If necessary, one of the site personnel equipped with appropriate PPE may accompany the injured worker and perform decontamination with supervision of medical personnel.

8.10 Personal Protection and First Aid Equipment

PPE available for emergency response will include the following:

- Polyvinyl chloride boots
- Saranex® suits
- Tyvek® suits, polyethylene coated and uncoated
- Nitrile gloves (inner and outer)
- Neoprene gloves (outer)
- Face shields and goggles
- SCBA

PPE and first aid equipment will be available in the support zone (i.e., Baker Field Vehicle or Baker Field Trailer).

Emergency and first aid equipment can be found at the following locations:

Fire Extinguisher:	Baker Field Trailer and Contractor Field Vehicle
First aid kit:	Baker Field Trailer and Baker Field Vehicle
Emergency eye wash bottle:	Baker Field Trailer and Baker Field Vehicle
Air Horn:	With Personnel
15-minute Emergency Eye Wash Station:	Near Area With Greatest Potential for Chemical Splash/Exposure

8.11 Notification

If the Emergency Coordinator determines that the site has an uncontrolled situation, such as a spill, fire, or explosion, that could threaten human health or the environment, the coordinator will immediately call the Base Fire Department, the Activity Contact, the Project Manager, and the NTR as soon as possible. The notification report will include:

- Description of incident (e.g., release, fire).
- Name and telephone number of individual reporting the emergency.
- Location of incident.
- Name and quantity of material (s) involved (if known).
- The extent of injuries and number of casualties.
- The possible hazards to human health or the environment and recommended cleanup procedures.
- Assistance that is requested.

8.12 Hazard Assessment

For the purpose of providing information to the Navy On-Scene Commander, the Emergency Coordinator will assess possible hazards to human health or the environment that may result from an uncontrolled situation, to the best of the individual's abilities, incorporating the following steps, as appropriate.

- Assess the immediate need to protect human health and safety.

- Identify the materials involved in the incident including exposure and/or release pathways and the quantities of materials involved.

- Inform appropriate personnel, as identified in Section 8.10, who will determine if release of material(s) meets USEPA requirements for reportable quantities for spills under the RCRA or CERCLA.

This assessment may consider both the direct and indirect effects of the chemical release, fire, explosion, or severe weather conditions (e.g., the effects of any toxic, irritating, or asphyxiating gases that are liberated).

8.13 Security

During activation of these Emergency Procedures, the Emergency Coordinator or the designated representative will control access to the site and maintain an incident log until the appropriate personnel, such as the Navy On-Scene Commander, arrives and takes control. The incident log will include:

- Activities that have occurred since the incident was first reported.
- Rescue, response, and PPE used to evacuate personnel.

8.14 Emergency Alerting

This section outlines the emergency alerting procedures according to the location and type of emergency.

Personnel Injury in the Work Zone:

- Initiate a verbal warning or one long airhorn blast and move all unaffected site personnel to the support zone (for Level D/D+) or the CRZ (for Level C or higher).

- Send the rescue team into the Work Zone (if required) to remove the injured person to the hotline.

- Have the SHSO and/or Field Team Leader evaluate the nature of the injury and assure that the affected person is decontaminated according to Section 8.9.

- If required, contact an ambulance and/or the designated medical facility.

In all situations when an on-site emergency results in evacuation of the Work Zone, personnel shall not reenter until:

1. The conditions resulting in the emergency have been corrected.
2. The hazards have been reassessed.
3. The HASP has been reviewed and, if appropriate, modified.
4. Site personnel have been briefed on any changes in the HASP.

Personnel Injury in the Support Zone:

- The Field Team Leader and SHSO will assess the nature of the injury; if the cause of the injury or loss of the injured person does not affect the performance of other site personnel, operations may continue.

- If the injury increases the risk to others, a verbal warning or one long airhorn blast shall be sounded and all remaining site personnel will move to the command post for further instructions.

- Activities on site will stop until the added risk is mitigated.

Fire/Explosion:

- Initiate a verbal warning or one long airhorn blast and move all site personnel to the support zone (for Level D/D+) or the CRZ (for Level C or higher).
- Alert the fire and security departments and move all nonessential personnel to the Baker Command Post to await further instructions.
- Activities will stop until the added risk is mitigated.

Personal Protective Equipment Failure:

- If any site worker experiences difficulty, failure, or alteration of protective equipment that affects the protection factor, that person and his/her buddy shall immediately cease work activities, leave the Work Zone, and repair or replace the defective equipment.
- Reentry will not be permitted until the equipment has been repaired or replaced.

Other Equipment Failure:

- If any other equipment on site fails to operate properly, the Field Team Leader shall notify the SHSO to determine the effect of this failure on site operations. If the failure affects the safety of site personnel, work with the equipment will cease until the situation is evaluated and appropriate actions taken.

8.15 Training

Site personnel will read the details in the Emergency Procedures prior to the pre-entry briefing. The Emergency Procedures will be reviewed by site personnel during the pre-entry briefing.

8.16 Spill Containment Procedures

In the event that a small (less than the reportable quantity), easily-controlled spill of hazardous substances (gasoline, oil, etc.) occurs during the implementation of field activities, spill containment will be utilized to prevent the additional migration of contaminants through the site area. Large, uncontrolled spills will be handled by qualified response organizations under the direction of qualified Base personnel and/or Navy On-Scene Commander. Any release to soils or surface waters equaling or exceeding the reportable quantities under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (40 CFR 304) or the USEPA Clean Water Act (40 CFR 116 and 177) will be reported to the Base Environmental Management Department (EMD) who in turn will report it to the appropriate authorities.

Specific spill containment procedures will be dependent on the type of materials spilled and the type of environment affected. Potential spill containment procedures may include diking with absorbent material/pads, then removal or containment of the contaminated materials. Spill containment materials will be located within close proximity to the storage area of the hazardous substances in a manner such that the pathway remains accessible and free of obstructions. Spill containment materials available on site may include:

- Vermiculite
- Ground corn cobs
- Dirt or sand
- Shovel

9.0 TRAINING REQUIREMENTS

Training requirements for site personnel are outlined in the sections below.

9.1 General

All Baker employees, subcontractors, or other personnel entering the site will need to have received training in compliance with the OSHA Standard 29CFR 1910.120. Baker employees engaged in field activities which potentially expose workers to hazardous substances receive a minimum of 40 hours of instruction off site, and a minimum of three days actual field experience under the direct supervision of a trained, experienced supervisor. Key points of the 40-hour training include field demonstrations, respiratory fit testing and training, risk assessment, toxicology, chemical reactivity, use of monitoring equipment, downrange work procedures, site safety procedures, levels of protection, protective clothing, decontamination, and practical field exercises (e.g., donning, doffing, and working in personal protective ensembles for personal protection Levels A, B, and C).

In addition to the initial 40-hour training program, Baker requires site employees to receive an annual 8-hour refresher training course on the items specified by the 29 CFR 1910.120 standard. The general purpose of the 8-hour refresher is to ensure that personnel retain the knowledge necessary to be adequately protected and stay current with proper site health and safety procedures.

Baker also requires that personnel involved with on-site employee supervision receive, in addition to 40 hours initial training and three days of supervised field experience, at least eight additional hours of specialized training at the time of job assignment. Training topics include, but are not limited to, the employer's safety and health program and the associated employee training program, personal protective equipment program, spill containment program, and health hazard monitoring procedures and techniques. The 8-hour supervisory training is required to ensure that supervisors have the knowledge necessary to understand and use the various Health and Safety Programs and to implement the elements of the HASP. Table 9-1 provides the appropriate OSHA Training History for Baker Project Personnel.

9.2 Site-Specific Training

Site-specific training, as discussed in Section 1.3, will consist of an initial health and safety briefing on the following information:

- Names of individuals responsible for site health and safety and methods of communicating safety and health concerns.
- Roles and responsibilities of site personnel.
- Site-specific health and safety hazards.
- Use of PPE.
- Work practices by which employees can minimize risk.
- Safe use of equipment on site.
- Recognition of symptoms and signs of exposure to hazardous materials.
- Site control measures.

TABLE 9-1

OSHA TRAINING HISTORY OF BAKER PROJECT PERSONNEL*

Personnel	Title/Role	Training Status
Donald Joiner	• Project Manager	• 40-hr. training completed: 03/92 • Supervisory training: 03/92 • 8-hr. refresher completed: 10/93 • First Aid Training: NA • CPR Training: NA • Medical surveillance: 07/93
Barbara Cummings	• Project Health and Safety Officer	• 40-hr. training completed: 10/91 • Supervisory training: 09/91 • 8-hr. refresher completed: 08/93 • First Aid Training: 11/91 • CPR Training: 02/93 • Medical surveillance: 05/93
Mark Kimes	• Field Team Leader	• 40-hr. training completed: 07/91 • Supervisory training: 09/91 • 8-hr. refresher completed: 10/93 • First Aid Training: 11/91 • CPR Training: 11/91 • Medical surveillance: 10/93
Kenneth Martin	• Site Health and Safety Officer	• 40-hr. training completed: 03/89 • Supervisory training: 01/91 • 8-hr. refresher completed: 04/93 • First Aid Training: 11/90 • CPR Training: 02/93 • Medical surveillance: 05/93

* Training history for contractor personnel will be maintained at the Command Post.
NA - Not Applicable

- Decontamination procedures.
- Emergency procedures.

The SHSO will conduct the initial site-specific training prior to the initiation of field activities for each new area under investigation.

10.0 MEDICAL SURVEILLANCE REQUIREMENTS

10.1 General

All personnel who may be exposed to materials having potentially adverse and deleterious health effects, obtain medical clearance from Baker's Board Certified Occupational Health Physician in accordance with 29 CFR 1910.120(f) prior to entry onto any site. Baker's corporate medical surveillance program establishes a medical baseline and monitors for symptoms of overexposure for individuals who participate in Preliminary Assessments, Site Inspections, Remedial Investigations, Feasibility Studies, and construction-phase services at sites covered by the Department of Labor, OSHA, Hazardous Waste Operations and Emergency Response Standard, 29 CFR 1910.120. The program will include a medical and work history and is intended to determine the individual's capability for performing on-site work, including wearing chemical protective clothing and respiratory protective equipment in a thermally-stressed environment.

All Baker employees that will be engaged in site activities covered by the 29 CFR 1910.120 standard receive a Group III physical examination by a licensed physician who has provided information on the individual's site activities and exposure or anticipated exposure levels. This exam is received initially upon hire, then once every 12 months thereafter. More frequent medical examinations, consultations, and/or laboratory testing will be provided if the examining physician determines that an increased frequency of examination is required. A complete Group III medical exam includes parameters such as height, weight, vision, temperature, blood pressure, and a complete review of occupational and medical histories. Other tests in a Group III exam include chest x-rays, electrocardiogram, spirometry, urinalysis, and blood tests. Table 10-1 describes the medical surveillance testing parameters performed annually on Baker employees. The need for additional monitoring depending on site conditions will be evaluated on a case-by-case basis.

10.2 Site Specific

Prior to entry onto the site, all personnel, including subcontractors, will be required to provide medical clearance to the SHSO from their company physician in accordance with 29 CFR 1910.120(f), stating that they are physically capable of performing the activities required of them. The need for additional monitoring, dependent on information obtained during the site characterization, will be evaluated on a case-by-case basis. However, in the event that site employees are injured, receive a health impairment, develop signs or symptoms which may have resulted from exposure to hazardous substances resulting from an emergency incident, or are exposed during an emergency incident to hazardous substances at concentrations that are or may be above the permissible exposure limits or the published exposure levels without the necessary personal protective equipment being used, medical examinations and/or consultations shall be performed according to the following schedule:

1. As soon as possible following the emergency incident or development of signs or symptoms.

2. At additional times, if the examining physician determines that follow-up examinations or consultations are medically necessary.

Procedures to follow in the event of an exposure to a hazardous material/chemical are provided in Attachment C.

TABLE 10-1

MEDICAL SURVEILLANCE TESTING PARAMETERS*

Group II - Individuals Occasionally in the Field (10-30 days/year)

- Medical History (Physical Exam)
- Eye Exam
- EKG (baseline and for individuals over 40 years of age)
- Chest X-ray (baseline then every 5 years)
- Spirometry
- CBC with differential
- SMA 12 or 26 (liver enzyme scan)

Group III - Individuals Frequently in the Field (>30 days/year)

- Medical History (Physical Exam)
- Eye Exam
- EKG (baseline then annually for individuals over 40 years of age)
- Audiometry
- Chest X-ray (baseline then every 3 years)
- Spirometry
- CBC with differential
- SMA 12 or 26 (liver enzyme scan)
- Urinalysis (glucose scan)
- Specific Blood and Urine Tests (dependent on field exposure)**

Group III with Asbestos - Individuals frequently in the field whom also work with asbestos

- Group III testing with the Asbestos Medical Questionnaire w/Pulmonary Function Test ($FVC_{1.0}$ and $FEV_{1.0}$)

* The attending physician has the right to reduce or expand the medical monitoring on an annual basis as he/she deems necessary.

** To be performed for individuals identified by the attending physician as being chronically exposed to organic compounds.

11.0 HEALTH AND SAFETY PLAN APPROVAL

This HASP has been reviewed by the following personnel prior to submission to LANTDIV.

Barbara Cummings	PHSO	Barbara J. Cummings
Name (print)	Title (print)	Signature
Joseph Rozum	Technical Review	Joseph E. Rozum
Name (print)	Title (print)	Signature

12.0 DECLARATION OF HEALTH AND SAFETY PLAN REVIEW

All site personnel indicated below have reviewed and are familiar with this Health and Safety Plan for Contaminated Soils and Groundwater Remediation for Operable Unit No. 2, Marine Corps Base, Camp Lejeune, North Carolina.

(Name-Print)	(Company)
(Name-Sign)	(Date/Time)
(Name-Print)	(Company)
(Name-Sign)	(Date/Time)
(Name-Print)	(Company)
(Name-Sign)	(Date/Time)
(Name-Print)	(Company)
(Name-Sign)	(Date/Time)
(Name-Print)	(Company)
(Name-Sign)	(Date/Time)
(Name-Print)	(Company)
(Name-Sign)	(Date/Time)

Attachment A
Baker Environmental, Inc.
Safety Standard Operating Procedures

ATTACHMENT A

BAKER ENVIRONMENTAL, INC.
SAFETY STANDARD OPERATING PROCEDURES

TABLE OF CONTENTS

*Not applicable.

Baker

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2.0 - RESPIRATORY PROTECTION PROGRAM

2.1 INTRODUCTION

In accordance with OSHA requirements (29 CFR 1910.134), this document represents Baker Environmental, Inc.'s (Baker's) program governing the selection and use of respiratory protection for its employees. It is Baker's policy to provide its employees with the proper protective equipment, training, and medical surveillance necessary to protect individuals from any potential hazards which may be present during the tasks performed throughout the course of each individual's employment. This program specifically describes the procedures which have been established and implemented for the use of respiratory protection equipment. The effectiveness of this program shall be reevaluated on an annual basis and appropriate changes shall be made if deemed necessary.

2.2 EMPLOYER RESPONSIBILITY

Baker shall provide its employees the respiratory protection equipment which is appropriate and suitable for the purpose intended, when such equipment is necessary to protect the health of the employee.

2.3 EMPLOYEE RESPONSIBILITY

The employee shall use the respiratory protection provided in accordance with instructions and training received, and shall report any malfunction of the equipment to a responsible person. The employee shall not wear contact lenses in atmospheres where respiratory protection is required. Corrective lens inserts will be provided, at Baker's expense, for employees who require corrective lenses.

2.4 HAZARD ASSESSMENT

The key elements of a respiratory protection program must start with an assessment of the inhalation and ingestion hazards present in the work area. Because Baker's services involve a variety of environmental and industrial hygiene studies, it is not practical to identify all possible hazards to which all employees could be exposed within the scope of this document. Therefore, it is essential that a task specific assessment be conducted prior to the initiation of any activities on a given project. This task specific assessment may be part of the site-specific Health and Safety Plan.

After a task-specific assessment is completed and it is determined that airborne exposure concentrations exceed or may exceed the recommended limits, engineering and administrative controls should be implemented, whenever feasible.

If the exposure cannot be reduced, or it is not feasible to reduce the airborne exposure below the recommended limits, respirators will be selected by the Site Health and Safety Officer on the basis of:

- Toxicity
- Maximum Expected Concentration
- Oxygen Levels

- Warning properties of the substance(s) involved
- Sorbent Limitations
- Facepiece Fit
- Mobility Requirements
- Type of Use (routine, escape, or emergency entry)
- Possibility of Ingestion of Toxic Materials
- Respirator Attributes

2.5 TRAINING

Each respirator wearer shall be given training, by a qualified individual, which will include explanations and discussions of:

- Opportunity to wear respiratory protection in an uncontaminated environment.
- Respirator Fit Testing (qualitative)
- The respiratory hazard(s) and what may occur if the respirator is not used properly.
- The reasons for selecting a particular type of respirator.
- The function, capabilities, and limitations of the selected respirator.
- The method of donning the respirator and checking its fit and operation.
- The proper wearing of the respirator.
- Respirator maintenance, repair, and cleaning.
- Recognizing and handling emergency situations.

Respirator training will be conducted on an annual basis, at a minimum. Records of the training and fit-testing will be maintained for a minimum of 30 years following termination of employment for each employee.

2.6 TYPES OF RESPIRATORS

Baker provides employees with the North Brand half-face (Model 7700) and full-face (Model 7600) air purifying respirators, positive pressure 30-minute Self-Contained Breathing Apparatus (SCBAs) (Model 800), positive pressure supplied airline respirators, with 5-minute escape air cylinders (Model 85500). Only respiratory equipment certified by the appropriate approval agencies (e.g., NIOSH, MSHA) according to Title 30, Part II of the Code of Federal Regulations, will be distributed to Baker employees. As an alternate air purifying respirator, Baker will also keep, on-hand, the MSA ultra twin full-face respirator. All Baker employees who regularly perform tasks requiring respiratory protection will be issued their own half-face or full-face respirator, provided the employee can achieve a proper fit and is medically capable of wearing the equipment.

Because 30-minute SCBAs, positive pressure supplied airline respirators, and 5-minute escape air cylinders are used less frequently, this equipment will be distributed on an as-needed basis.

2.7 AIR QUALITY

Liquid air used for respiration shall be of high purity. Breathing air shall meet at least the requirements of the specification for Grade D Breathing Air (or higher) as described in Compressed Gas Association Commodity Specification G-7.1-1966. Breathing air may be supplied to respirators from cylinders; oxygen must never be used with air-line respirators.

Air cylinders shall be tested and maintained as prescribed in the Shipping Container Specification Regulations of the Department of Transportation (49 CFR Part 178). Air-line

couplings shall be incompatible with outlets for other gas systems to prevent inadvertent servicing of air-line respirators with nonrespirable gases or oxygen.

Breathing gas containers (air cylinders) shall be marked in accordance with American National Standard Method of marking Portable Compressed Gas Containers to Identify the Material Contained, A48.1-1954; Federal Specification BB-A-1034a, June 21, 1968, Air, Compressed for Breathing Purposes; or Interim Federal Specification GG-B00675b, April 27, 1965, Breathing Apparatus, Self-Contained.

Breathing air, as supplied by air compressors, shall be of high purity and meet the requirements of the specification for Grade D Breathing air (or higher) as described in Compressed Gas Association Commodity Specification G-7.1-1966.

The compressor for supplying air shall be equipped with necessary safety and standby devices. A breathing air-type compressor shall be used. Compressors shall be constructed and situated so as to avoid entry of contaminated air into the system and suitable in-line air purifying sorbent beds and filters installed to further assure breathing air quality. A receiver of sufficient capacity to enable the respirator wearer to escape from a contaminated atmosphere in the event of compressor failure, and alarms to indicate compressor failure and overheating shall be installed in the system. If an oil-lubricated compressor is used, it shall have a high-temperature or carbon monoxide alarm, or both. If only a high-temperature alarm is used, the air from the compressor shall be frequently tested for carbon monoxide to insure that it meets the specifications outlined above.

2.8 CLEANING AND MAINTENANCE

Respirator maintenance will be performed by each trained individual on a regular basis. The maintenance shall be carried out in a manner that ensures that each respirator wearer is provided with a respirator that is clean and in good operating condition.

Respiratory equipment that is used on an as-needed basis shall be maintained by qualified personnel. This equipment shall be cleaned/sanitized, then rinsed and air-dried, after each use. Inspections shall be conducted before and after each use.

Respiratory equipment that has been issued to an employee shall be cleaned/sanitized then rinsed and air-dried by the wearer, (specified by OSHA in 29 CFR 1910.134) which ensures that it will be maintained in clean and good operating condition. Inspections shall be conducted on a regular basis during usage and prior to each project requiring the potential usage of the equipment.

All respirators shall be stored in a plastic bag within a cool/dry location, in a manner that will protect them against dust, sunlight, heat, extreme cold, excessive moisture, or damaging chemicals. They shall be stored to prevent distortion of rubber or other elastomer parts.

Parts replacement and repairs shall be performed only by appropriate personnel. Equipment requiring repairs shall be reported to appropriate Baker personnel. Examples of inspection forms are included at the end of this text.

2.9 FIT-TESTING

Each respirator wearer shall be provided with a respirator that can properly form a secure face to mask seal. Each wearer shall be fit-tested prior to issuance of the respirator using either an irritant smoke or odorous vapor, or other suitable test agent (see example of form at end of text). Retesting shall be performed, at a minimum, on an annual basis or if a different model

respirator, other than the model he/she was previously fit-tested for, is to be used by the wearer. Air purifying respirators fit-tested qualitatively will be assigned a protection factor of 10 (APF = 10).

Facial hair, which interferes with the normally effective face to mask seal, is prohibited. Each respirator wearer shall be required to check the seal of the respirator by negative and positive pressure checks prior to entering a harmful atmosphere.

2.10 MEDICAL SURVEILLANCE

Personnel who are or may be assigned to tasks requiring use of respirators shall participate in a medical surveillance program on an annual basis. The medical surveillance program shall include, but may not be limited to, a physical and a pulmonary function test conducted by the company's physician and at the expense of the company. Test parameters included in Baker's medical surveillance program is in each site-specific Health and Safety Plan.

2.11 LIMITATIONS

Wearing any respirator, alone or in conjunction with other types of protective equipment, will impose some physiological stress on the wearer. Therefore, selection of respiratory protective devices will be based on the breathing resistance, weight of the respirator, the type and amount of protection needed as well as the individual's tolerance of the given device. Additional concerns regarding the limitations of different types of PPE and the monitoring requirements for heat stress/strain will be addressed in the "Heat Stress" SOP.

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SCBA AND SAR (WITH 5-MINUTE ESCAPE TANK) DAILY INSPECTION FORM

Type (SCBA or SAR)	Cylinder Condition (Damaged or Undamaged)	Cylinder (Full or MT)	Facepiece and Hoses (Damaged or Undamaged)	Connections (Damaged or Undamaged)	Apparatus Complete (Yes/No)	Cleaned and Sanitized (Yes/No)	Remarks	Inspected By (Initials)	Date Inspected

RESPIRATOR FIT TEST RECORD

Baker
Baker Environmental, Inc

TEST SUBJECT NAME _____
(last) (first) (initial)

DATE _____ DEPARTMENT _____

SEX (M/F) _____ AGE _____ SOCIAL SECURITY NUMBER _____

RESPIRATOR MEDICAL DATE _____ RESPIRATOR TRAINING DATE _____

SPECIAL/UNUSUAL CONDITIONS/CONSIDERATIONS:

___ Claustrophobia
___ Facial hair
___ Eyeglasses
___ Contacts
___ Other: _____

___ Scars
___ Broken or crooked nose
___ Extreme facial dimensions
___ Wrinkles

RESPIRATOR SELECTION

Manufacturer/Model	Size	Style	
_____	S ___ M ___ L ___	Half ___ Full ___	Pass ___ Fail ___
_____	S ___ M ___ L ___	Half ___ Full ___	Pass ___ Fail ___
_____	S ___ M ___ L ___	Half ___ Full ___	Pass ___ Fail ___

Testing Agent	Qualitative Test	Sensitivity Check
Isoamyl Acetate	Yes: ____ No: ____	Yes: ____ No: ____
Irritant Smoke	Yes: ____ No: ____	Yes: ____ No: ____

TEST EXERCISES
(Check all that apply)

Normal Breathing _____
Deep Breathing _____
Head, Side to Side _____
Head, Up and Down _____

Talking _____
Running _____
Bending _____
Rainbow Passage _____

COMMENTS: _____

_____

Signed: _____ (Test Subject)

Signed: _____ (Technician/Instructor)

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FULL-FACE AND HALF-FACE RESPIRATOR INSPECTION FORM

Inspection Date	Type	FACE PIECE					HEADSTRAPS OR HEADBANDS		RESPIRATOR INTERIOR		
		Clean and Sanitized	No Cracks, Tears, or Holes	Proper Shape and Flexibility	Air Purifying Element Holders Operate Correctly	Proper Storage Free From Heat, Dirt, Sunlight, etc.	No Signs of Wear or Tears	Buckles Function Properly	No Foreign Material Under Valve Seat	No Cracks or Tears in Valves or Valve Bodies	Valve Covers and Bodies in Good Condition and Installed Correctly

✔ = OK X = Not OK

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Baker Environmental, Inc

3.0 - CARE AND CLEANING OF PERSONAL PROTECTIVE EQUIPMENT

3.1 INTRODUCTION

The following procedures cover the care and cleaning of Levels D, C, and B personal protective equipment. Note: These are general procedures that apply to most situations and are not all inclusive. Procedures are subject to change at the direction of the Site Health and Safety Officer (SHSO).

3.2 EQUIPMENT CARE

3.2.1 Chemical Resistant Suit (Levels C and B)

- Before donning, inspect suit for holes or tears; check to see that zippers are operable; and look for signs of suit degradation.
- When wearing, avoid contact with contaminated material where possible; be aware of sharp objects that can tear suit; periodically look over suit to check for major rips or tears.
- While decontaminating, remove gross excess of material from suit; remove suit so that material does not contact inner suit; place clothing in properly labeled disposal containers.

3.2.2 Inner/Outer Gloves (Levels D + through B)

- Look for rips, tears, or degradation of material. Replace as necessary or at the direction of the SHSO.

3.2.3 Chemically Resistant Boots (Levels D + through B)

- Nondisposable boots are to be examined on a daily basis before and after use. Disposable boots should be examined prior to donning and while in use, and disposed according to site procedures.

3.2.4 Safety Shoes/Boots (Levels D through B)

- Examine daily for gouges, open seams, etc., anything that would lessen the integrity of the boot. Replace as shoe/boot becomes worn.

3.2.5 Hard Hats (Levels D through B)

- Should be visually inspected before donning for fit, cracks, and overall condition.

3.2.6 Safety Glasses/Goggles (Levels D and C)

- Should be visually inspected before donning for cracks, deteriorated parts, and overall condition. Replace as necessary.

3.2.7 Respirators (Levels C and B)

- Procedures for care of respiratory protective equipment are covered in Baker's SOP for Respiratory Protection.

3.2.8 Hearing Protection (Levels D through B)

- Disposable - Replace daily, or as material becomes worn or dirty.
- Reusable - Inspect before use, clean regularly, replace parts as necessary.

3.3 EQUIPMENT CLEANING

General procedures for cleaning of equipment are listed below. Site-specific concerns will be addressed by the SHSO prior to and during site activities. Cleaning of respiratory equipment is covered under the "Respiratory Protection Program" SOP.

3.3.1 Gross Physical Removal

Large amounts of contaminated soil is scraped off with a tongue depressor, or wiped off using a disposable wipe.

3.3.2 Physical/Chemical Removal

The residual contamination will be scrubbed with a soft-bristled, long-handled brush using a nonphosphate detergent solution.

3.3.3 Rinsing/Dilution

The detergent solution and residual contaminants will be rinsed with tap water using a pressurized sprayer.

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4.0 - BLOODBORNE PATHOGENS (Safe Handling of First Aid Incidents)

4.1 PURPOSE

The purpose of the Baker Environmental (Baker) exposure control plan is to minimize the possibility of transmission of human immunodeficiency virus (HIV) [the virus that causes acquired immune deficiency syndrome (AIDS)], and hepatitis B virus (HBV) in the workplace by establishing procedures for the safe handling of first aid incidents that may expose personnel to blood or other potentially infectious materials.

The purpose of the Occupational Safety and Health Administration (OSHA) Bloodborne Pathogens Standard, Title 29 CFR Part 1910.1030, is to protect workers from bloodborne pathogens such as the (HIV) and (HBV) by reducing or eliminating workers' exposure to blood and other potentially infectious materials. Although HIV and HBV are specifically mentioned by OSHA, the standard includes any bloodborne pathogen, such as Hepatitis C, malaria, and syphilis. The standard requires the employer to develop a written exposure control plan that will reduce or eliminate employee exposure, thus reducing their risk of infection.

Since there is no population that is not free from risk, and we may have to respond to first aid incidents, we are taking a proactive approach and are developing and implementing an exposure control plan.

4.2 SCOPE

All personnel who may be exposed to blood or other potentially infectious materials from their job duties are required to follow the guidelines set forth in this SOP.

4.3 RESPONSIBILITY

The Project Health and Safety Office (PHSO) and Project Manager are responsible for implementing and administering this exposure control plan at project sites. These individuals will be assisted in the field by the Baker Site Health and Safety Officer (SHSO).

The exposure control plan shall be reviewed and updated at least annually; and whenever necessary to reflect new or modified tasks and procedures that affect occupational exposure, and to reflect new or revised employee positions with occupational exposure.

4.4 DEFINITIONS

Bloodborne Pathogens - Pathogenic microorganisms that may be present in human blood and has the potential to cause disease in humans. Two examples of bloodborne pathogens include, hepatitis B virus (HBV) and human immunodeficiency virus (HIV).

Contaminated - Means the presence or the reasonably anticipated presence of blood or other potentially infectious materials on an item or surface.

Decontamination - Physically or chemically removing, inactivating, or destroying bloodborne pathogens on a surface or item to the point where they are no longer capable of transmitting infectious particles, so that the surface or item is rendered safe for handling, use, or disposal.

Exposure Incident - A specific eye, mouth, other mucous membrane, non-intact skin, or parenteral contact with blood or other potentially infectious materials that result from the performance of an employee's duties.

Occupational Exposure - Reasonably anticipated skin, eye, mouth, mucous membrane, or parenteral contact with blood or other potentially infectious materials that may result from the performance of an employee's duties.

Other Potentially Infectious Materials - Includes the following human body fluids: semen, vaginal secretions, cerebrospinal fluid, synovial fluid, pleural fluid, pericardial fluid, peritoneal fluid, amniotic fluid, saliva in dental procedures, any body fluid that is visibly contaminated with blood, and all body fluids in situations where it is difficult or impossible to differentiate between body fluids; any unfixed tissue or organ (other than intact skin) from a human; and HIV-containing cell or tissue cultures, organ cultures, and HIV- or HBV-containing culture medium or other solutions; and blood, organs, or other tissues from experimental animals infected with HIV or HBV.

Parenteral - Piercing of the mucous membranes or the skin barrier through such events as needlesticks, human bites, cuts, and abrasions.

4.5 EXPOSURE DETERMINATION

The exposure determination lists the job classifications with occupational exposure potential and the activities in which these exposures can occur.

4.5.1 Job Classifications

The following job classifications may involve exposure to blood or other potentially infectious materials:

- Site Manager/Site Safety and Health Officer
- Environmental Scientists
- Geologists
- Other Baker Site Personnel

4.5.2 Exposure Activities

The following tasks may involve exposure to blood or other potentially infectious materials:

- Response to first aid incidents involving site personnel
- Decontamination of personnel, personal protective equipment, work surfaces, and equipment potentially exposed to blood or other potentially infectious materials

4.6 MODES OF VIRUS TRANSMISSION IN THE WORKPLACE

Modes of virus transmission are similar for the viruses of concern. Primarily, virus transmission occurs as the result of direct blood contact from percutaneous inoculation, contact with an open wound, non-intact skin (e.g. chapped, abraded, or dermatitis), or mucous membranes to blood, blood-contaminated body fluids, or concentrated virus. Protective measures for workers will focus on preventing exposure to blood and other body fluids that can result from an injury or sudden illness.

4.7 METHODS OF COMPLIANCE

4.7.1 Universal Precautions

The unpredictable and emergent nature of exposures likely to be encountered on a site may make differentiation between hazardous body fluids and those that are not hazardous very difficult.

Thus, all employees will observe "Universal Precautions" to prevent contact with blood or other potentially infectious materials. These "Universal Precautions" stress that all blood or other potentially infectious materials will be treated as if they are known to be infectious.

4.7.2 Standard Work Practices

Standard work practices are to be implemented at all times by all employees who may be exposed to blood or other potentially infectious materials. Work practices are defined as specific policies or procedures whose purpose is to reduce the potential for employee exposure to bloodborne pathogens. Work practices for use by site personnel are described in the balance of this section.

4.7.2.1 Personal Hygiene

All exposed employees will observe the following hygienic practices:

- During or immediately after exposure to blood or other potentially infectious materials eating, drinking, gum chewing, tobacco chewing, smoking, cosmetic application, application of balms or medications, or any other activity that increases the potential for hand to mouth, mucous membrane or skin contact is strictly forbidden.

- Following exposure to blood or other potentially infectious materials, personnel will wash their hands and any other exposed skin with a disinfectant soap and water after removal of chemical-protective gloves or other personal protective equipment (PPE), and before eating, urinating, defecating, applying make-up, smoking or undertaking any activity that may result in increased potential for hand to mouth, mucous membrane, or skin contact.

4.7.2.2 Personal Protective Equipment

The basic premise for wearing the appropriate PPE is that site personnel must be protected from exposure to blood and other potentially infectious materials. Appropriate PPE is available to all site personnel.

Responders to a medical emergencies will have access to the appropriate PPE. The PPE will be present in the site trailer and field vehicles. The PPE should be used in accordance with the level of exposure encountered. Minor lacerations or small amounts of blood do not merit the same extent of PPE use as required for massive arterial bleeding. Management of the patient who is not bleeding, and has no bloody body fluids present, should not routinely require the use of PPE.

The following PPE will be present in a specially-designed first aid kit.

1. Disposable chemical-protective gloves
2. Resuscitation mask

3. Safety glasses, goggles, or faceshields
4. Tyvek coveralls

* Resuscitation Equipment - Because the risk of salivary transmission of infectious disease during artificial ventilation of trauma victims, pocket mouth-to-mouth resuscitation masks will be present in the first aid kits. The pocket mouth-to-mouth resuscitation masks are designed to isolate response personnel from contact with the victims' blood and blood-contaminated saliva, respiratory secretions, and vomitus.

4.7.2.3 Decontamination Procedures

Decontamination procedures will follow those outlined in each site HASP.

4.7.2.4 Handling Regulated Wastes

OSHA defines a regulated waste as a liquid or semi-liquid blood or other potentially infectious materials; contaminated items that would release blood or other potentially infectious materials in a liquid state if compressed; items caked with dried blood or other potentially infectious materials that are capable of release of these materials during handling; contaminated sharps; and pathological and microbiological wastes containing blood or other potentially infectious materials.

With the exception of contaminated sharps, all other regulated wastes must be placed in closable, color-coded, labeled containers that prevent leakage of fluids. All applicable federal and state regulations must be followed for transporting and disposing of the wastes.

4.7.2.5 Training and Education

All employees with the potential for occupational exposure will receive training, at the time of initial assignment, and annually thereafter, on the safe handling of first aid incidents. See Appendix A for the Bloodborne Pathogens Training Outline.

4.8 MEDICAL MONITORING

All Baker personnel will follow the guidelines established by Baker's Board Certified Health Physician with EMR, Inc.

4.9 POST-EXPOSURE PROCEDURES AND FOLLOW-UP MANAGEMENT

The following subsections presents the procedures to follow when a first aid incident occurs involving the presence of blood or other potentially infectious material; specific steps need to be taken to safeguard the health of Baker site personnel.

4.9.1 First Aid Incident Report

If there is a reasonable cause to believe that a potential exposure to blood or other potentially infectious materials has been experienced, the employee must complete the steps listed below. These steps are required when non-HBV vaccinated first aid responders participate and regardless of whether an actual "exposure incident" occurred. The OSHA standard defines an "exposure incident" as a "specific eye, mouth, other mucous membrane, non-intact skin, or parenteral contact with blood or other potentially infectious materials."

1. Immediately notify the SHSO. The SHSO will determine whether an "exposure incident" occurred.

2. Wash area of contamination and remove contaminated clothing to ensure that no further contamination will occur.

3. All parties involved will complete the Supervisors Incident Report Form and the incident will be recorded on the OSHA 200 Form located in Baker's Human Resources office.

Non-HBV vaccinated employees who render first aid where blood or other potentially infectious materials are present must be seen by a designated EMR physician (Baker employees only) within 24 hours of the incident. The employee must take a copy of the Supervisors Incident Report Form and a copy of OSHA Standard 1910.1030 to the physician.

Employees who respond to first aid incidents involving the presence of blood or other potentially infectious materials where the determination was made that an "exposure incident" occurred have 90 days following baseline blood level collection to decide if they wish to have their blood tested for HIV.

The confidential medical evaluation and follow-up will include:

1. The circumstances of the exposure.

2. If consent has been obtained testing of the source individual's blood in order to determine HIV and/or HBV infectivity. If consent is not obtained this will be documented in writing.

3. If consent has been obtained, the exposed employee's blood will be tested.

The occupational physician will provide the employer with a confidential written opinion that includes verification that the employee has been informed of the results of the evaluation and also includes a recommendation for further evaluation or treatment. A copy of this written opinion will be provided within 15 days following the medical evaluation.

4.9.2 "Good Samaritan" Behavior

The OSHA standard does not cover "good Samaritan" behavior. However, employees who provide first aid as "good samaritans" should receive the same post incident evaluation either through an EMR designated physician (Baker employees only) or their personal physician. Depending upon the circumstances of the incident, including whether an "exposure incident" may have occurred, appropriate referral should be made.

4.10 REFERENCES

OSHA Title 29 CFR Part 1910.1030

U.S. Department of Labor, U.S. Department of Health and Human Services. Joint Advisory Notice: protection against occupational exposure to Hepatitis B virus and human immunodeficiency virus. Federal Register 1987; 52:41818-24.

Centers for Disease Control. Update on hepatitis B prevention. MMWR 1987; 36:353-360,366.

Centers for Disease Control. Update: Acquired immunodeficiency syndrome and human immunodeficiency virus infection among health- care workers. MMWR 1988; 37:229-34, 239.

OSHA Instruction CPL 2-2.44, February 13, 1992, Enforcement Procedures for the Occupational Exposure to Bloodborne Pathogens Standard.

Appendix A

SITE BLOODBORNE PATHOGENS TRAINING OUTLINE

I. **Introduction**

- A. Purpose of the training program
- B. Overview: Bloodborne Pathogen Standard 29 CFR 1910.1030
  - 1. Applicability to Site Personnel
  - 2. General requirements
  - 3. Overview of Baker exposure control plan

II. **Bloodborne Diseases**

- A. Types
- B. Modes of Transmission
- C. Signs and Symptoms

III. **Baker Exposure Control Plan**

- A. Purpose
- B. Plan availability
- C. Bloodborne pathogen hazard recognition steps
  - 1. Concept of universal precautions
  - 2. Blood and other potentially infectious materials
- D. Potential exposure minimization
  - 1. Work practices
  - 2. Personal protective equipment
  - 3. Hygienic practices
- E. Procedures for decontamination
  - 1. Personnel
  - 2. Personal protective equipment (PPE)
    - a. Tasks and procedures requiring PPE
    - b. Location of PPE
    - c. Disposal of PPE
  - 3. Equipment
  - 4. Work surfaces
- F. Medical monitoring
  - 1. Baker medical monitoring program
  - 2. Post exposure evaluation procedures
    - a. First aid incident report
    - b. HBV and non-HBV vaccinated responders
    - c. Exposure incidents (defined)
    - e. Confidential medical evaluation
- G. Emergency Preparedness
  - 1. First aid kits
  - 2. Personal injury

IV. **Conclusion/Discussion**

V. **Open Forum**

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6.0 - COLD STRESS

6.1 INTRODUCTION

The potential exists for either frostbite or hypothermia to occur when conducting work activities in an environment where air temperatures may fall below freezing or where wind-chill factors lower air temperatures below freezing. A brief description of the exposure symptoms (for both hypothermia and frostbite) and methods of prevention are listed in the sections below:

6.2 HYPOTHERMIA

Hypothermia is a condition in which the body loses heat faster than it is produced. At a body temperature of 95°F, an average man is considered to be hypothermia. Vasodilators, which include alcohol and drugs, allow the body to lose heat faster which can accelerate hypothermia. The five stages of hypothermia include: (1) shivering; (2) apathy, listlessness, or sleepiness; (3) unconsciousness, glassy stare, slow pulse or slow respiratory rate; (4) freezing; and (5) death.

6.3 FROSTBITE

Frostbite is a condition in which there is a freezing or partial freezing of some part of the body. Individuals previously exposed to frostbite are more susceptible to contracting it again. Vasoconstrictors, which include tobacco products, constrict blood vessels, and can accelerate frostbite. The three stages of frostbite include: (1) frostnip - the beginnings of frostbite whereby the skin begins to turn white; (2) superficial - similar to frostnip except the skin begins to turn numb; and (3) deep - the affected area is frozen to the bone, cold, numb, and very hard.

DO NOT:

- Rub the frostbitten part.
- Use ice, snow, gasoline, or anything cold on the frostbitten area.
- Use heat lamps or hot water bottles to rewarm the frostbitten area.
- Place the frostbitten area near a hot stove.

The need to seek medical attention and the urgency in seeking medical attention depends on the symptoms and the severity of the symptoms displayed by the affected individual. If the latent conditions of hypothermia or frostbite are noted or suspected, medical attention must be sought IMMEDIATELY to prevent permanent injury or death.

6.4 PREVENTION

To prevent conditions from occurring have personnel:

- Dress in a minimum of three layers (a skin layer to absorb moisture and keep skin dry, an insulating layer, and an outer chemical-protective layer).

- Avoid touching cold surfaces (especially metal) with bare skin, minimize exposed skin surfaces.
- Keep active, use shelter areas during rest cycles.
- Maintain body fluids.
- Use wind breaks whenever possible.

Attachment B
Material Safety Data Sheets

CHLORDANE

CDN

Common Synonyms	Liquid	Brown	Sharp odor
Chlordan 1,2,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-4,7-methanoindene Toxichlor; Octa-klor Velsicol 1068	Sinks in water.		

AVOID CONTACT WITH LIQUID. KEEP PEOPLE AWAY.
Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves).
Stop discharge if possible.
Call fire department.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

Not flammable but solution may be combustible.
POISONOUS GASES MAY BE PRODUCED IN FIRE.
Extinguish with dry chemicals, foam or carbon dioxide.
Water may be ineffective on fire.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.

LIQUID OR SOLUTION
POISONOUS IF SWALLOWED OR IF SKIN IS EXPOSED.
Irritating to skin and eyes.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
DO NOT RUB AFFECTED AREAS.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk and have victim induce vomiting.
IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS, do nothing except keep victim warm.

Water Pollution

HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS.
May be dangerous if it enters water intakes.

Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Issue warning-poison
Restrict access
Should be removed
Chemical and physical treatment

2. LABEL

2.1 **Category:** None
2.2 **Class:** Not pertinent

3. CHEMICAL DESIGNATIONS

3.1 **CG Compatibility Class:** Not listed
3.2 **Formula:** $C_{10}H_6Cl_8$
3.3 **IMO/UN Designation:** 6.1/2762
3.4 **DOT ID No.:** 2762
3.5 **CAS Registry No.:** 57-74-9

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquid
4.2 **Color:** Brown
4.3 **Odor:** Penetrating; aromatic; slightly pungent, like chlorine

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** Respirator for sprays, fogs, or dust; goggles; rubber gloves.
5.2 **Symptoms Following Exposure:** Moderately irritating to eyes and skin. Ingestion, absorption through skin, or inhalation of mist or dust may cause excitability, convulsions, nausea, vomiting, diarrhea, and some local irritation of the gastrointestinal tract.
5.3 **Treatment of Exposure:** INHALATION: administer oxgen and give fluid therapy; do not give epinephrine, since it may induce ventricular fibrillation; enforce complete rest. EYES: flush with water for at least 15 min. SKIN: wash off skin with adequate quantities of soap and water; do NOT scrub. INGESTION: induce vomiting and follow with gastric lavage and administration of saline cathartics; ether and barbiturates may be used to control convulsions; oxygen and fluid therapy are also recommended; do NOT give epinephrine. Since no specific antidotes are known, symptomatic therapy must be accompanied by complete rest.
5.4 **Threshold Limit Value:** 0.5 mg/m³
5.5 **Short Term Inhalation Limits:** 2 mg/m³ for 30 min.
5.6 **Toxicity by Ingestion:** Grade 3; oral LD_{50} = 283 mg/kg (rat)
5.7 **Late Toxicity:** Possible liver damage; loss of appetite and weight.
5.8 **Vapor (Gas) Irritant Characteristics:** Data not available
5.9 **Liquid or Solid Irritant Characteristics:** Data not available
5.10 **Odor Threshold:** Data not available
5.11 **IDLH Value:** 500 mg/m³

6. FIRE HAZARDS

6.1 **Flash Point:** Solution: 225°F O.C.; 132°F C.C. Solid is not flammable.
6.2 **Flammable Limits in Air:** 0.7%-5% (kerosene solution)
6.3 **Fire Extinguishing Agents:** Dry chemical, foam, carbon dioxide
6.4 **Fire Extinguishing Agents Not to be Used:** Water may be ineffective on solution fire.
6.5 **Special Hazards of Combustion Products:** Irritating and toxic hydrogen chloride and phosgene gases may be formed when kerosene solution of compound burns.
6.6 **Behavior in Fire:** Not pertinent
6.7 **Ignition Temperature:** 410°F (kerosene solvent)
6.8 **Electrical Hazard:** Data not available
6.9 **Burning Rate:** Not pertinent

(Continued)

7. CHEMICAL REACTIVITY

7.1 **Reactivity With Water:** No reaction
7.2 **Reactivity with Common Materials:** No reaction
7.3 **Stability During Transport:** Stable to 160°F
7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent
7.5 **Polymerization:** Not pertinent
7.6 **Inhibitor of Polymerization:** Not pertinent
7.7 **Molar Ratio (Reactant to Product):** Data not available
7.8 **Reactivity Group:** Data not available

8. WATER POLLUTION

8.1 **Aquatic Toxicity:** 0.5 ppm/96 hr/goldfish/TL_m/fresh water
8.2 **Waterfowl Toxicity:** LD_{50} = 1,200 mg/kg
8.3 **Biological Oxygen Demand (BOD):** Data not available
8.4 **Food Chain Concentration Potential:** High

9. SHIPPING INFORMATION

9.1 **Grades of Purity:** Technical. A variety of dusts, powders, and solutions in kerosene containing 2-80% chlordane are shipped.
9.2 **Storage Temperature:** Ambient
9.3 **Inert Atmosphere:** No requirement
9.4 **Venting:** Open (flame arrester)

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-X-Y

11. HAZARD CLASSIFICATIONS

11.1 **Code of Federal Regulations:** Combustible liquid
11.2 **NAS Hazard Rating for Bulk Water Transportation:** Not listed.
11.3 **NFPA Hazard Classification:** Not listed

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 **Physical State at 15°C and 1 atm:** Liquid
12.2 **Molecular Weight:** 409.8
12.3 **Boiling Point at 1 atm:** Decomposes
12.4 **Freezing Point:** Not pertinent
12.5 **Critical Temperature:** Not pertinent
12.6 **Critical Pressure:** Not pertinent
12.7 **Specific Gravity:** 1.6 at 25°C (liquid)
12.8 **Liquid Surface Tension:** (est.) 25 dynes/cm = 0.025 N/m at 20°C
12.9 **Liquid Water Interfacial Tension:** (est.) 50 dynes/cm = 0.05 N/m at 20°C
12.10 **Vapor (Gas) Specific Gravity:** Not pertinent
12.11 **Ratio of Specific Heats of Vapor (Gas):** Not pertinent
12.12 **Latent Heat of Vaporization:** Not pertinent
12.13 **Heat of Combustion:** (est.) —4,000 Btu/lb = —2,200 cal/g = —93 X 10^5 J/kg
12.14 **Heat of Decomposition:** Not pertinent
12.15 **Heat of Solution:** Not pertinent
12.16 **Heat of Polymerization:** Not pertinent
12.25 **Heat of Fusion:** Data not available
12.26 **Limiting Value:** Data not available
12.27 **Reid Vapor Pressure:** Data not available

*Properties refer to undiluted, technical-grade chlordane.

6. FIRE HAZARDS (Continued)

6.10 **Adiabatic Flame Temperature:** Data not available
6.11 **Stoichiometric Air to Fuel Ratio:** Data not available
6.12 **Flame Temperature:** Data not available

CDN	CHLORDANE

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot (estimate)	Temperature (degrees F)	British thermal unit per pound-F (estimate)	Temperature (degrees F)	British thermal unit-inch per hour-square foot-F (estimate)	Temperature (degrees F)	Centipoise (estimate)
52	100.400	60	.300	60	1.209	130	58.980
54	100.400	61	.300	61	1.209	140	51.140
56	100.299	62	.300	62	1.209	150	44.560
58	100.200	63	.300	63	1.209	160	38.990
60	100.200	64	.300	64	1.209	170	34.270
62	100.099	65	.300	65	1.209	180	30.240
64	100.000	66	.300	66	1.209	190	26.780
66	99.940	67	.300	67	1.209	200	23.810
68	99.879	68	.300	68	1.209	210	21.240
70	99.809	69	.300	69	1.209	220	19.020
72	99.740	70	.300	70	1.209	230	17.080
74	99.669	71	.300	71	1.209	240	15.390
76	99.599	72	.300	72	1.209	250	13.900
78	99.530	73	.300	73	1.209	260	12.590
80	99.459	74	.300	74	1.209	270	11.440
82	99.389	75	.300	75	1.209	280	10.420
84	99.320	76	.300	76	1.209	290	9.516
86	99.250	77	.300	77	1.209	300	8.710

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
	I	215	.000	215	.00001		N
	N	220	.000	220	.00001		O
	S	225	.000	225	.00002		T
	O	230	.000	230	.00002		
	L	235	.001	235	.00003		P
	U	240	.001	240	.00005		E
	B	245	.001	245	.00007		R
	L	250	.002	250	.00009		T
	E	255	.002	255	.00012		I
		260	.003	260	.00017		N
		265	.004	265	.00023		E
		270	.006	270	.00031		N
		275	.008	275	.00042		T
		280	.011	280	.00056		
		285	.015	285	.00074		
		290	.019	290	.00099		
		295	.026	295	.00131		
		300	.035	300	.00174		
		305	.046	305	.00228		
		310	.060	310	.00300		
		315	.079	315	.00391		
		320	.104	320	.00510		
		325	.136	325	.00662		
		330	.177	330	.00856		
		335	.230	335	.01104		
		340	.297	340	.01418		

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Material Safety Data Sheets Collection:

Sheet No. 757
Coal Tar Creosote

Issued: 7/91

Section 1. Material Identification

Coal Tar Creosote (molecular formula varies with purity) Description: Three main derivations: by distillation of coal tar produced by high-temperature carbonization of bituminous coal; by mixing strained naphthalene oil, wash oil, and strained or light anthracene oil; as a by-product of conventional coal coking. It typically contains up to 160 chemicals, mainly aromatic compounds such as phenol, pyrol and pyridine. Used mainly as a wood preservative for railroad ties, poles, fence posts, marine pilings, and other lumber for outdoor use; as a water-proofing agent, fuel oil constituent, frothing agent for mineral separation, hop defoliant, and lubricant for die molds; in manufacturing chemicals; and in medicine as an antiseptic, disinfectant, antipyretic, astringent, germicide, and styptic.
Other Designations: CAS No. 8001-58-9, Awpa,® brick oil, Caswell No. 225,® coal tar oil, creosote, creosote oil, creosotum, cresylic creosote, heavy oil, liquid pitch oil, naphthalene oil, Preserv-o-sote,® Sakresote,® tar oil, wash oil.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(TM) for a suppliers list.
Cautions: Flammable, liquid coal tar creosote is toxic by inhalation, ingestion, and skin contact. The IARC and NTP classify it as *a human carcinogen.*

R 1
I 4
S 4*
K 2
* Skin absorption

NFPA
2
2 0
-

HMIS
H 2
F 2
R 0
PPG†
† Sec. 8

* Skin absorption can occur with phenol, a major component of coal tar creosote.

Section 2. Ingredients and Occupational Exposure Limits

Coal tar creosote, ca 100%

1990 OSHA PEL
8-hr TWA: 0.2 mg/m³*

1990-91 ACGIH TLV
TWA: 0.2 mg/m³*

1987 IDLH Level
700 mg/m³

1990 NIOSH REL
0.1 mg/m³ (cyclohexane extractable portion)

1985-86 Toxicity Data†
Rat, oral, LD_{50}: 725 mg/kg; toxic effects not yet reviewed
Dog, oral, LD_{Lo}: 600 mg/kg; toxic effects not yet reviewed
Rat, TD_{Lo}: 52,416 mg/kg administered during 91 days prior to mating produces reproductive effects on fallopian tubes and ovaries
Mouse, skin, TD_{Lo}: 99 g/kg produces tumors in skin and appendages

* As coal tar pitch volatiles.
† See NIOSH, *RTECS* (GF8615000), for additional mutation, reproductive, tumorigenic, and other toxicity data.

Section 3. Physical Data

Boiling Point: 381 to 752 °F (194 to 400 °C)
Distillation Range: 446 to 554 °F (230 to 290 °C)
Heat of Combustion: -12,500 Btu/lb
Heat of Vaporization: 107 Btu/lb
Molecular Weight: Varies with purity
Density/Specific Gravity: 1.07 to 1.08 at 68 °F (20 °C)
Water Solubility: Slightly soluble

Appearance and Odor: Pure coal tar creosote is colorless, but the industrial product is a yellow to black oily liquid with an aromatic smoky smell and a burning caustic taste.

Section 4. Fire and Explosion Data

Flash Point: 165.2 °F (74 °C), CC	Autoignition Temperature: 637 °F (336 °C)	LEL: None reported	UEL: None reported

Extinguishing Media: For small fires, use dry chemical, carbon dioxide (CO_2), or regular foam. For large fires, use fog or regular foam. Since water is least effective, use it as an extinguishing agent only when the preferred measures are unavailable. However, use water spray to cool fire-exposed containers.
Unusual Fire or Explosion Hazards: Vapors may travel to an ignition source and flash back. Containers may explode in heat of fire. Coal tar creosote presents a vapor explosion hazard indoors, outdoors, and in sewers.
Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Also, wear full protective clothing. Stay away from ends of tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holders; if impossible, withdraw from area and let fire burn. Immediately leave area if you hear a rising sound from venting safety device or notice any fire-caused tank discoloration. Isolate area for 1/2 mile in all directions if fire involves tank, rail car or tank truck. Be aware of runoff from fire control methods. Do not release to sewers or waterways. Fully decontaminate or properly dispose of personal protective clothing.

Section 5. Reactivity Data

Stability/Polymerization: Coal tar creosote is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Creosote oil mixed with chlorosulfonic acid in a closed container causes an increase in temperature and pressure.
Conditions to Avoid: Avoid excessive heat and contact with chlorosulfonic acid.
Hazardous Products of Decomposition: Thermal oxidative decomposition of coal tar creosote can produce oxides of carbon and thick, black, acrid smoke.

Section 6. Health Hazard Data

Carcinogenicity: In 1990 reports, the IARC, NTP, and OSHA list coal tar creosote as a carcinogen.
Summary of Risks: Coal tar creosote is toxic by inhalation, ingestion, and skin contact. It contains a variety of hydrocarbons such as phenol and polycyclic aromatic hydrocarbons such as benzo[a]pyrene, benzanthracene, and phenol derivatives. The range of toxicity depends on the exposure concentration, amount, and duration. Effects may include irritation, burns, and several forms of cancer.
Medical Conditions Aggravated by Long-Term Exposure: Chronic respiratory or skin diseases.
Target Organs: Eyes, skin, bladder, kidneys, and respiratory system.
Primary Entry Routes: Inhalation, ingestion, and skin contact.
Acute Effects: Skin contact may cause irritation, burning, itching, redness, pigment changes, dermatitis (a rash of redness and small bumps), or burns. Photosensitization (worsening of rash with exposure to sunlight) may occur. Inhalation may be irritating to the respiratory tract. Eye contact may cause conjunctivitis (inflammation of the eye's lining), keratitis (corneal inflammation), or corneal burns with scarring. Ingestion may result in nausea, vomiting, abdominal pain, rapid pulse, respiratory distress, and shock. Systemic absorption by any route (including skin absorption) may cause trouble breathing, thready (continuous or drawn out) pulse, dizziness, headache, nausea, vomiting, salivation, and convulsions. Exposure to large doses (particularly by ingestion) may be fatal.
Chronic Effects: Dermatitis, skin cancer, and lung cancer.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. *Do not* let victim rub eyes or keep them tightly closed. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Wash affected area with soap and flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that *conscious* person drink 1 to 2 glasses of milk or water. *Do not induce vomiting!*
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Cresol may be detected in urine.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel. Isolate hazard area, deny entry, and stay upwind of spills. Shut off all ignition sources–no flares, smoking, or flames in hazard area. Cleanup personnel should protect against vapor inhalation and skin or eye contact. If possible with no risk, stop leak. Water spray may be used to reduce vapor but it may not prevent ignition in closed spaces. For small spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable containers for later disposal. For large spills, dike far ahead of liquid spill for later disposal. Follow applicable OSHA regulations (29 CFR 1910.120).
Environmental Degradation: Coal tar creosote is fouling to shoreline. Ecotoxicity values are: TL_{50}, goldfish (*Carassius auratus*), 3.51 ppm/24 hr (60:40) mixture of creosote and coal tar; LD_{50}, bob white quail (*Colinus virginianus*), 1,260 ppm/8 days (60:40) mixture of creosote and coal tar.
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33), Hazardous Material No. U051
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [* per RCRA, Sec. 3001]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed (as coal tar pitch volatiles) as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Since contact lens use in industry is controversial, establish your own policy.
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent all skin contact. Applying a layer of petroleum jelly or lanolin castor oil ointment to the face reduces vapor contact and penetration through skin. Frequent change of protective garments is an additional protective measure.
Ventilation: Provide general and local exhaust ventilation systems equipped with high-efficiency particulate filters to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Take particular care to avoid any contamination of drains or ventilation ducts. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Avoid physical damage to containers. Store in a cool, dry, well-ventilated area. Store coal tar creosote as close to area of use as possible to minimize transporting distance.
Engineering Controls: Use engineering controls to keep airborne concentrations below the OSHA PEL. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Always perform synthesis and purification procedures under a vertical ventilation hood and make regular operational safety checks. Label doors to rooms where coal tar creosote is produced, used, or stored as containing a carcinogen. Locate emergency equipment at well-marked and clearly identified stations in case emergency escape is necessary.
Other Precautions: Preplacement and periodic medical examinations of exposed workers emphasizing respiratory, skin, liver, and kidney disorders, including comprehensive work and medical history, physical examination, CXR, PFTs, urinalysis, LFT, and sputum cytology as the attending physician considers appropriate. Educate workers about coal tar creosote's carcinogenicity and proper handling procedures to avoid exposure.
Other Comments: Caution is in order when handling or sawing old creosote-treated lumber since it retains a considerable portion of creosote for up to 25 to 30 years.
Transportation Data (49 CFR 172.101)
DOT Shipping Name: Creosote
DOT Hazard Class: Flammable liquid
ID No.: UN1136
DOT Label: Flammable liquid

MSDS Collection **References:** 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 138, 139, 140, 142, 143, 146, 148, 153, 159
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** Mark Upfal, MD, MPH; **Edited by:** JR Stuart, MS

OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR DDT

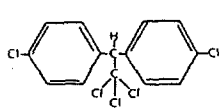
POTENTIAL HUMAN CARCINOGEN

INTRODUCTION

This guideline summarizes pertinent information about DDT for workers, employers, and occupational safety and health professionals who may need such information to conduct effective occupational safety and health programs. Recommendations may be superseded by new developments in these fields; therefore, readers are advised to regard these recommendations as general guidelines.

SUBSTANCE IDENTIFICATION

- **Formula:** $C_{14}H_9Cl_5$
- **Structure:**



- **Synonyms:** Citox; genitox; dichlorodiphenyltrichloroethane; 1,1,1-trichloro-2,2-bis(p-chlorophenyl)ethane
- **Identifiers:** CAS 50-29-3; RTECS KJ3325000; DOT 2761
- **Appearance and odor:** Colorless crystals or white to slightly off-white powder with a slightly aromatic odor

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**

1. Molecular weight: 354.48
2. Boiling point (at 760 mmHg): 260°C (500°F)
3. Specific gravity (water = 1): 1.56
4. Vapor density (air = 1 at boiling point of DDT): 12.2
5. Melting point: 105-109°C (221-228°F)
6. Vapor pressure at 20°C (68°F): 1.5×10^{-7} mmHg
7. Practically insoluble in water

- **Reactivity**

1. Incompatibilities: DDT should not be stored in iron containers; DDT should not be mixed with iron and aluminum salts or with alkaline materials. Temperatures greater than 100°C (212°F) may cause decomposition.
2. Hazardous decomposition products: Toxic vapors and gases (e.g., hydrogen chloride) may be released in a fire involving DDT.
3. Caution: DDT should be stored in a tightly closed container in a well-ventilated area.

- **Warning properties**

Evaluation of warning properties for respirator selection: Warning properties are not considered in recommending respirators for use with carcinogens.

EXPOSURE LIMITS

The current Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for DDT is 1 milligram of DDT per cubic meter of air (mg/m^3) as a time-weighted average (TWA) concentration over an 8-hour workshift (Skin). The notation "Skin" refers to the potential contribution to overall exposure by the cutaneous route including the mucous membranes and eyes. The National Institute for Occupational Safety and Health (NIOSH) recommends that DDT be controlled and handled as a potential human carcinogen in the workplace and that exposure be minimized to the lowest feasible limit. The NIOSH recommended exposure limit (REL) is 0.5 mg/m^3 as a TWA for up to a 10-hour workshift, 40-hour workweek. The NIOSH REL is the lowest concentration reliably detectable by current NIOSH-validated sampling and analytical methods. The American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value (TLV®) is 1 mg/m^3 as a TWA for a normal 8-hour workday and a 40-hour workweek; the short-term exposure limit (STEL) is 3 mg/m^3 (Table 1).

Table 1.—Occupational exposure limits for DDT

	Exposure limits mg/m^3
OSHA PEL TWA (Skin)*	1
NIOSH REL TWA (CA)†	0.5§
ACGIH TLV® TWA	1

* (Skin): Potential contribution to overall exposure by the cutaneous route including mucous membranes and eyes.
† (Ca): NIOSH recommends treating as a potential human carcinogen.
§ Lowest reliably detectable level.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health
Division of Standards Development and Technology Transfer

NOTE: A general ban was ordered by the Environmental Protection Agency on the registration of DDT, effective December 31, 1972. Effective the same date, the ban for uses of DDT by public health officials in disease control programs and by USDA and the military for health quarantine and prescription drugs use was lifted.

HEALTH HAZARD INFORMATION

• Routes of exposure

DDT may cause adverse health effects following exposure via inhalation, ingestion, or dermal or eye contact.

• Summary of toxicology

Effects on animals: Acute oral administration of DDT to rats caused tissue destruction (necrosis) of the liver, mild degeneration of kidney tubules, and changes in electroencephalograms. Chronic oral administration of DDT caused decreased fertility in rats and increased mortality of their offspring, toxic effects on the liver (including necrosis, fat deposition, increased weight, and increased enzyme activity), and liver cancer. In mice, chronic oral administration of DDT produced cancers of the liver, lungs, and lymphatic system.

• Signs and symptoms of exposure

Short-term (acute): Exposure to DDT can cause a prickling sensation of the tongue, lips, and face, a general feeling of ill health, headache, fatigue, vomiting, dizziness, tremors, convulsions, partial paralysis of the hands, and coma. DDT can also cause irritation of the eyes and skin.

RECOMMENDED MEDICAL PRACTICES

• Medical surveillance program

Workers with potential exposures to chemical hazards should be monitored in a systematic program of medical surveillance intended to prevent or control occupational injury and disease. The program should include education of employers and workers about work-related hazards, placement of workers in jobs that do not jeopardize their safety and health, earliest possible detection of adverse health effects, and referral of workers for diagnostic confirmation and treatment. The occurrence of disease (a "sentinel health event," SHE) or other work-related adverse health effects should prompt immediate evaluation of primary preventive measures (e.g., industrial hygiene monitoring, engineering controls, and personal protective equipment). A medical surveillance program is intended to supplement, not replace, such measures.

A medical surveillance program should include systematic collection and epidemiologic analysis of relevant environmental and biologic monitoring, medical screening, morbidity, and mortality data. This analysis may provide information about the relatedness of adverse health effects and occupational exposure that cannot be discerned from results in individual workers. Sensitivity, specificity, and predictive values of biologic monitoring and medical screening tests should be evaluated on an industry-wide basis prior to application in any given worker group. Intrinsic to a surveillance program is the dissemination of summary data to those who need to know, including employers, occupational health professionals, potentially exposed workers, and regulatory and public health agencies.

• Preplacement medical evaluation

Prior to placing a worker in a job with a potential for exposure to DDT, the physician should evaluate and document the worker's baseline health status with thorough medical, environmental, and occupational histories, a physical examination, and physiologic or laboratory tests appropriate for the anticipated occupational risks. These should concentrate on the function and integrity of the eyes, skin, liver, and reproductive and nervous systems.

A preplacement medical evaluation is recommended in order to detect and assess preexisting or concurrent conditions which may be aggravated or result in increased risk when a worker is exposed to DDT at or below the NIOSH REL. The examining physician should consider the probable frequency, intensity, and duration of exposure, as well as the nature and degree of the condition, in placing such a worker. Such conditions, which should not be regarded as absolute contraindications to job placement, include chronic liver disease. Workers should inform their physicians of their potential for exposures to DDT because internal absorption of this chemical pathologically increases the liver's ability to metabolize and eliminate medications which may be prescribed or taken "over the counter."

• Periodic medical screening and/or biologic monitoring

Occupational health interviews and physical examinations should be performed at regular intervals. Additional examinations may be necessary should a worker develop symptoms that may be attributed to exposure to DDT. The interviews, examinations, and appropriate medical screening and/or biologic monitoring tests should be directed at identifying an excessive decrease or adverse trend in the physiologic function of the eyes, skin, liver, and reproductive and nervous systems as compared to the baseline status of the individual worker or to expected values for a suitable reference population.

• Medical practices recommended at the time of job transfer or termination

The medical, environmental, and occupational history interviews, the physical examination, and selected physiologic and laboratory tests which were conducted at the time of placement should be repeated at the time of job transfer or termination. Any changes in the worker's health status should be compared to those expected for a suitable reference population. Because occupational exposure to DDT may cause adverse reproductive effects or diseases of prolonged induction-latency, the need for medical surveillance may extend well beyond termination of employment.

MONITORING AND MEASUREMENT PROCEDURES

• TWA exposure evaluation

Measurements to determine worker exposure to DDT should be taken so that the TWA exposure is based on a single entire workshift sample or an appropriate number of consecutive samples collected during the entire workshift. Under certain conditions, it may be appropriate to collect several short-term interval samples (up to 30 minutes each) to determine the average exposure level. Air samples should be taken in the worker's breathing zone (air that most nearly represents that inhaled by the worker).

• Method

Sampling and analysis may be performed by collecting DDT vapors with charcoal adsorption tubes followed by desorption with carbon disulfide and analysis by gas chromatography. Detector tubes or other direct-reading devices calibrated to measure DDT may also be used if available. A detailed sampling and analytical method for DDT may be found in the *NIOSH Manual of Analytical Methods* (method number S 274).

PERSONAL PROTECTIVE EQUIPMENT

Chemical protective clothing (CPC) should be selected after utilizing available performance data, consulting with the manufacturer, and then evaluating the clothing under actual use conditions.

Workers should be provided with and required to use CPC, gloves, and other appropriate protective clothing necessary to prevent skin contact with DDT.

SANITATION

Clothing which is contaminated with DDT should be removed immediately and placed in sealed containers for storage until it can be discarded or until provision is made for the removal of DDT from the clothing. If the clothing is to be laundered or cleaned, the person performing the operation should be informed of DDT's hazardous properties. Reusable clothing and equipment should be checked for residual contamination before reuse or storage.

Change and shower rooms should be provided with separate locker facilities for street and work clothes.

Workers should be required to shower following a workshift and prior to putting on street clothes. Clean work clothes should be provided daily.

Skin that becomes contaminated with DDT should be promptly washed with soap and water.

The storage, preparation, dispensing, or consumption of food or beverages, the storage or application of cosmetics, the storage or smoking of tobacco or other smoking materials, or the storage or use of products for chewing should be prohibited in work areas.

Workers who handle DDT should wash their faces, hands, and forearms thoroughly with soap and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

Common operations in which exposure to DDT may occur and control methods which may be effective in each case are listed in Table 2.

Table 2.—Operations and methods of control for DDT

Operations	Controls
During preparation and handling of insecticide	Process enclosure, local exhaust ventilation, personal protective equipment
During maintenance of equipment and storage containers	Personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, remove the victim from further exposure, send for medical assistance, and initiate emergency procedures.

• Eye exposure

Where there is any possibility of a worker's eyes being exposed to DDT, an eye-wash fountain should be provided within the immediate work area for emergency use.

If DDT gets into the eyes, flush them immediately with large amounts of water for 15 minutes, lifting the lower and upper lids occasionally. Get medical attention as soon as possible. Contact lenses should not be worn when working with this chemical.

• Skin exposure

Where there is any possibility of a worker's body being exposed to DDT, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.

If DDT gets on the skin, wash it immediately with soap and water. If DDT penetrates the clothing, remove the clothing immediately and wash the skin with soap and water. Get medical attention promptly.

• Rescue

If a worker has been incapacitated, move the affected worker from the hazardous exposure. Put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILLS AND LEAKS

Workers not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.

If DDT is spilled or leaked, the following steps should be taken:

1. Ventilate area of spill or leak.
2. For small quantities of liquids containing DDT, absorb on paper towels and place in an appropriate container.
3. Large quantities of liquids containing DDT may be absorbed in vermiculite, dry sand, earth, or a similar material and placed in an appropriate container.
4. If in solid form, DDT may be collected and placed in an appropriate container.
5. DDT dust may be collected by vacuuming with an appropriate high-efficiency filtration system.

WASTE REMOVAL AND DISPOSAL

U.S. Environmental Protection Agency, Department of Transportation, and/or state and local regulations shall be followed to assure that removal, transport, and disposal are in accordance with existing regulations.

RESPIRATORY PROTECTION

It must be stressed that the use of respirators is the least preferred method of controlling worker exposure and should not normally be used as the only means of preventing or

minimizing exposure during routine operations. However, there are some exceptions for which respirators may be used to control exposure: when engineering and work practice controls are not technically feasible, when engineering controls are in the process of being installed, or during emergencies and certain maintenance operations including those requiring confined-space entry (Table 3).

In addition to respirator selection, a complete respiratory protection program should be instituted which as a minimum complies with the requirements found in the OSHA Safety and Health Standards 29 CFR 1910.134. A respiratory protection program should include as a minimum an evaluation of the worker's ability to perform the work while wearing a respirator, the regular training of personnel, fit testing, periodic environmental monitoring, maintenance, inspection, and cleaning. The implementation of an adequate respiratory protection program, including selection of the correct respirators, requires that a knowledgeable person be in charge of the program and that the program be evaluated regularly.

Only respirators that have been approved by the Mine Safety and Health Administration (MSHA, formerly Mining Enforcement and Safety Administration) and by NIOSH should be used. **Remember! Air-purifying respirators will not protect from oxygen-deficient atmospheres.**

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Table 3.—Respiratory protection for DDT

Condition	Minimum respiratory protection*
Any detectable concentration	Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode
	Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive pressure mode
Planned or emergency entry into environments containing unknown or any detectable concentration	Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode
	Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive pressure mode
Firefighting	Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode
Escape only	Any air-purifying full facepiece respirator (gas mask) with a chin-style or front- or back-mounted organic vapor canister having a high-efficiency particulate filter
	Any appropriate escape-type self-contained breathing apparatus

* Only NIOSH/MSHA-approved equipment should be used.

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Material Safety Data Sheets Collection:

Sheet No. 514
p-Dichlorobenzene

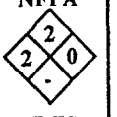
Issued: 10/83 Revision: A, 11/90

Section 1. Material Identification

***p*-Dichlorobenzene ($C_6H_4Cl_2$) Description:** Derived by chlorinating monochlorobenzene. Used as a general insecticide; a moth repellent; a germicide; a chemical intermediate in the production of polyphenylene sulfide; a plastic used in the electrical and electronics industries; a space deodorant in products such as room deodorizers, urinal and toilet bowl blocks, and diaper pail deodorizers; and in producing 1,2,4 trichlorobenzene.

R 1
I 3
S 1
K 2

NFPA



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Other Designations: CAS No. 0106-46-7, 1,4-dichlorobenzene, dichlorocide, Evola,® NCI-c 54955, Paracide,® Paracrystals, Paradi,® paradichlorobenzol, Paramoth,® *p*-chlorophenyl chloride, PDB,® Santochlor.®

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.

Cautions: *p*-Dichlorobenzene vapor is an eye and upper respiratory tract irritant. *It is toxic to the liver.* Prolonged exposure to high concentrations may cause weakness, dizziness, and weight loss. Flammable when exposed to heat, flame, or oxidizers.

Section 2. Ingredients and Occupational Exposure Limits

p-Dichlorobenzene, ca 100%

1989 OSHA PELs	1990-91 ACGIH TLVs	1988 NIOSH REL	1985-86 Toxicity Data*
8-hr TWA: 75 ppm, 450 mg/m³ 15-min STEL: 110 ppm, 675 mg/m³	TWA: 75 ppm, 451 mg/m³ STEL: 110 ppm, 661 mg/m³	None established	Human, oral, TD_{Lo}: 300 mg/kg produced sense organs and special senses (other eye effects); lungs, thorax, or respiration (other changes); and gastrointestinal (hypermotility, diarrhea) effects Human, eye: 80 ppm

1987 IDLH Level
1000 ppm

* See NIOSH, *RTECS* (CZ4550000), for additional irritative, mutative, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 345 °F (174 °C) at 760 mm Hg
Melting Point: 127.6 °F (53.1 °C)
Vapor Pressure: 10 mm Hg at 130.6 °F (54.8 °C)
Vapor Density (Air = 1): 5.08
Molecular Weight: 147.01
Specific Gravity: 1.248 at 131 °F (55 °C)
Water Solubility: Insoluble

Appearance and Odor: Volatile, white crystals with a distinctive mothball-like odor that becomes very strong at concentrations between 30 and 60 ppm. At concentrations of 80 to 160 ppm, vapors are painful to the eyes and nose. Odors and irritating effects are good warnings against overexposure to *p*-dichlorobenzene; however, individuals may develop tolerance to high concentrations.

Section 4. Fire and Explosion Data

Flash Point: 150 °F (66 °C), CC	Autoignition Temperature: None reported	LEL: 1.7% v/v	UEL: None reported

Extinguishing Media: Use dry chemical, carbon dioxide, alcohol foam, or water spray. Use water spray to cool fire-exposed container, to disperse vapors, or to blanket a pool fire.

Unusual Fire or Explosion Hazards: Explosive and toxic mixtures may form in air when this material is heated, such as in a fire.

Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective clothing. Thoroughly decontaminate firefighting equipment after use. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: *p*-Dichlorobenzene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

Chemical Incompatibilities: *p*-Dichlorobenzene is incompatible with strong oxidizers and oxidizing agents.

Conditions to Avoid: Avoid incompatibilities and heat or ignition sources.

Hazardous Products of Decomposition: Thermal oxidative decomposition of *p*-dichlorobenzene includes carbon monoxide, chlorides, and chlorine.

Section 6. Health Hazard Data

Carcinogenicity: *p*-Dichlorobenzene is an NTP anticipated human carcinogen and an IARC possible human carcinogen (Group 2B) with inadequate human evidence and sufficient animal evidence.
Summary of Risks: This material has a relatively low level of acute or chronic toxicity. It may be irritating to eyes, nose, upper airways, and intestinal tract upon inhalation or ingestion. Limited case reports link acute exposure to hemolytic anemia, jaundice, methemglobinemia, granulomas of the lung, liver atrophy, toxic hepatitis, kidney injury, and allergic pigmentation and purpura (tiny hemorrhages) of the skin. Occupational studies of PDB-exposed workers reveal none of the blood abnormalities noted with similar substances. Vapors may produce painful irritation of the eyes at 50 to 80 ppm and severe discomfort at 160 ppm.
Medical Conditions Aggravated by Long-Term Exposure: Individuals with liver disease should not be exposed to *p*-dichlorobenzene.
Target Organs: Liver, respiratory system, eyes, kidneys, and skin.
Primary Entry Routes: Inhalation and dermal contact.
Acute Effects: Acute exposures to PDB vapor may be irritating to mucous membranes of the eyes and upper respiratory tract. Ingestion of the solid resulted in toxicity to a 3-year old child, with hemolytic anemia, jaundice, and methemglobinemia. Nausea, vomiting, and diarrhea are seen in other cases. Prolonged skin exposure may cause skin irritation.
Chronic Effects: Limited case studies show chronic toxicity with exposure to PDB. Chronic ingestion is linked to anemia, leukemia, and kidney damage. In one case, chemical dependence was noted with signs of withdrawal when ingestion stopped. Chronic vapor exposure is suggested in cases of lung granulomatosis, liver abnormalities, kidney damage, anemia, other blood cell abnormalities, and cataract formation.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that *conscious* person drink 1 to 2 glasses of water, then induce vomiting. Consult a physician.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Urinary excretion of 2,5-dichlorophenol, a metabolite of *p*-dichlorobenzene, may be useful as an index of exposure.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate all unnecessary personnel, and remove or extinguish all heat and ignition sources. Cleanup personnel should protect against vapor inhalation and skin or eye contact. For liquid spills, take up spilled material with noncombustible absorbent material and place into clean metal containers for disposal. For large liquid spills, dike far ahead of spill to contain liquid. For dry spills, shovel spilled material into clean metal containers for disposal. Runoff to sewers or waterways may create health and explosion hazards. (96-hr LC_{50}, fathead minnow: 4.2 to 30 mg/l, moderately toxic.) Pesticide wastes are toxic. Follow applicable EPA and OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33), Hazardous Waste No. U072
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 100 lb (45.4 kg) [* per Clean Water Act, Sec. 311(b)(4), Sec. 307(a), and per RCRA, Sec. 3001]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. A gas mask with organic vapor canister and dust filter is suitable to 1000 ppm. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Neoprene gloves are recommended.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below OSHA PELs and ACGIH TLVs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in tightly closed containers in a cool, dry, well-ventilated area away from all heat and ignition sources and oxidizing agents. *p*-Dichlorobenzene melts at 127 °F (53 °C). Protect containers against physical damage.
Engineering Controls: Avoid dust or vapor inhalation and eye and skin contact (especially when heated). Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Practice good personal hygiene and housekeeping procedures.
Other Precautions: Provide preplacement and annual physical examinations that emphasize the liver (liver function tests), upper respiratory tract, and eyes.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Dichlorobenzene, para, solid
DOT Hazard Class: ORM-A
ID No.: UN1592
DOT Label: None
DOT Packaging Exceptions: 173.505
DOT Packaging Requirements: 173.510

IMO Shipping Name: *p*-Dichlorobenzene
IMO Hazard Class: 6.1
ID No.: UN1592
IMO Label: St. Andrews Cross
IMDG Packaging Group: III

MSDS Collection **References:** 1-7, 9, 10, 12, 14, 16, 23, 26, 31, 34, 38, 43, 48, 73, 84, 85, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 138, 139, 140, 142, 143, 146, 148
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD; **Edited by:** JR Stuart, MS

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Material Safety Data Sheets Collection:

Sheet No. 703
1,2-Dichloroethylene

Issued: 4/90

Section 1. Material Identification

31

1,2-Dichloroethylene Description: An industrial solvent composed of 60% cis- and 40% trans-isomers. Both isomers, cis and trans, are made by partial chlorination of acetylene. Used as a general solvent for organic materials, lacquers, dye extraction, thermoplastics, organic synthesis, and perfumes. The trans-isomer is more widely used in industry than either the cis-isomer or the mixture. Toxicity also varies between the two isomers.

Other Designations: CAS No. 0540-59-0; $C_2H_2Cl_2$; acetylene dichloride; *cis*-1,2-dichloroethylene; *sym*-dichloroethylene; *trans*-1,2-dichloroethylene, dioform.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*(TM) for a suppliers list.

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NFPA

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* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

1,2-Dichloroethylene, ca 100%

OSHA PEL
8-hr TWA: 790 mg/m³, 200 ppm

ACGIH TLV, 1989-90
TLV-TWA: 790 mg/m³, 200 ppm

NIOSH REL, 1987
790 mg/m³, 200 ppm

Toxicity Data*
Rat, oral, LD_{50}: 770 mg/kg; toxic effects not yet reviewed
Frog, inhalation, TC_{Lo}: 117 mg/m³ inhaled for 1 hr affects the peripheral nerve and sensation (flaccid paralysis without anesthesia); behavior (excitement); lungs, thorax, or respiration (respiratory depression)

* See NIOSH, *RTECS* (KV9360000), for additional toxicity data.

Section 3. Physical Data

Boiling Point: 119 °F/48 °C
Melting Point: -56 to -115 °F/-49 to -82 °C/
Vapor Pressure: 180 to 264 torr at 68 °F/20 °C
Vapor Density (Air = 1): 3.4

Molecular Weight: 96.95 g/mol
Specific Gravity (H_2O = 1 at 39 °F/4 °C): 1.27 at 77 °F/25 °C
Water Solubility: Insoluble

Appearance and Odor: A colorless, low-boiling liquid with a pleasant odor.

Section 4. Fire and Explosion Data

Flash Point: 37 °F/2.8 °C, CC	**Autoignition Temperature:** 860 °F/460 °C	**LEL:** 5.6% v/v	**UEL:** 12.8% v/v

Extinguishing Media: Use dry chemical, CO_2, halon, water spray, or standard foam. Water may be ineffective unless used to blanket the fire.
Unusual Fire or Explosion Hazards: This material's vapors are a dangerous fire hazard and moderate explosion hazard when exposed to any heat or ignition source or oxidizer.
Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and a fully encapsulating suit. Vapors may travel to heat or ignition sources and flash back. Stay upwind and out of low areas. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: This material is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: This material is incompatible with alkalies, nitrogen tetraoxide, difluoromethylene, strong oxidizers, and dihypofluorite. When in contact with copper or copper alloys or by reaction with potassium hydroxide, explosive chloroacetylene may be released.
Conditions to Avoid: Addition of hot liquid to cold 1,2-dichloroethylene may cause sudden emission of vapor that could flash back to an ignition source.
Hazardous Products of Decomposition: Thermal oxidative decomposition of 1,2-dichloroethylene can produce highly toxic fumes of chlorine (Cl^-).

Section 6. Health Hazard Data

Carcinogenicity: Neither the NTP, IARC, nor OSHA lists 1,2-dichloroethylene as a carcinogen.

Summary of Risks: 1,2-Dichloroethylene's most important effect is its irritation of the central nervous system (CNS) and narcosis. This material is toxic by inhalation, ingestion, and skin contact. It is also irritating to the eyes. The trans-isomer at 2200 ppm causes nausea, vertigo, and burning of the eyes. The trans-isomer is twice as potent as the cis-isomer. If renal effects occur, they are transient.

Medical Conditions Aggravated by Long-Term Exposure: None reported.

Target Organs: Central nervous system, eyes, respiratory system.

Primary Entry Routes: Inhalation, ingestion, skin and eye contact.

Acute Effects: Inhalation of 1,2-dichloroethylene causes narcosis, respiratory tract irritation, nausea, vomiting, tremor, weakness, central nervous depression, and epigastric (the abdomen's upper midregion) cramps. Contact with the liquid causes eye and skin (on prolonged contact) irritation. Ingestion causes slight depression to deep narcosis.

Chronic Effects: None reported.

FIRST AID

Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.

Skin: *Quickly* remove contaminated clothing. After rinsing affected skin with flooding amounts of water, wash it with soap and water.

Inhalation: Remove exposed person to fresh air and support breathing as needed. Have trained personnel administer 100% oxygen, preferably with humidification.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have a *conscious* person drink 1 to 2 glasses of water, then induce repeated vomiting until vomit is clear.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Physician's Note: Intravenous injections of calcium gluconate may relieve cramps and vomiting. Treat central nervous system effects symptomatically.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: *Design and practice a 1,2-dichloroethylene spill control and countermeasure plan (SCCP).* Notify safety personnel, remove all heat and ignition sources, evacuate hazard area, and provide adequate ventilation. Cleanup personnel should protect against vapor inhalation and skin or eye contact. Absorb small spills on paper towels. After evaporating the 1,2-dichloroethylene from these paper towels in a fume hood, burn the paper in a suitable location away from combustible material. Collect and atomize large quantities in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device. Follow applicable OSHA regulations (29 CFR 1910.120).

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.33)

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 100 lb (45.4 kg) [* per RCRA, Sec. 3001, per Clean Water Act, Sec. 307(a)]†

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1)

† Listed as 1,2-*trans*-dichloroethylene.

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respirator: Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.

Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.

Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. 1,2-dichloroethylene attacks some forms of plastics, rubber, and coatings.

Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PEL and ACGIH TLV (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in tightly closed containers in a cool, well-ventilated area away from all incompatible materials (Sec. 5) and oxidizing materials. Outside or detached storage is preferred. If stored inside, place containers in a standard flammable liquids storage cabinet or room. Protect containers from physical damage.

Engineering Controls: Avoid vapor inhalation and skin and eye contact. Use only with adequate ventilation and appropriate personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. 1,2-dichloroethylene is a dangerous fire hazard. All engineering systems should be of maximum explosion-proof design and electrically grounded and bonded. Provide preplacement questionnaires which emphasize detecting a history of chronic respiratory disease.

Transportation Data (49 CFR 172.101, .102): Not listed

MSDS Collection References: 7, 26, 38, 73, 84, 85, 87, 88, 100, 101, 103, 109, 126, 127, 136, 137

Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Hardies, MD

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Material Safety Data Sheets Collection:

Sheet No. 311
Methyl Chloroform

Issued: 11/75 Revision: F, 3/92 Errata: 6/92

Section 1. Material Identification

38

Methyl Chloroform ($C_2H_3Cl_3$) **Description:** Derived by catalytic addition of hydrogen chloride to 1,1-dichloroethylene or by re-fluxing chlorine monoxide with carbon tetrachloride and chloroethane. Available in technical and solvent grades which differ only in the amount of stabilizer added to prevent metal parts corrosion. Used as a solvent for oils, waxes, tars, cleaning precision instruments, and pesticides; as a component of inks and drain cleaners; in degreasing metals, and textile processing. In recent years, methyl chloroform has found widespread use as a substitute for carbon tetrachloride.

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* Sec. 8

Other Designations: CAS No. 71-55-6, α-trichloroethane; Inhibisol; 1,1,1-trichloroethane; Strobane.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(73) for a suppliers list.
Cautions: Methyl chloroform is a skin, eye, and respiratory tract irritant and can become narcotic with an anesthetic effect at high concentrations.
* Data on skin absorption via methyl chloroform is conflicting.(133) Some studies show definite absorption where others don't.

Section 2. Ingredients and Occupational Exposure Limits

Methyl chloroform, ca 92 to 97%*

1990 OSHA PELs
8-hr TWA: 350 ppm (1900 mg/m³)
15-min STEL: 450 ppm (2450 mg/m³)

1990 IDLH Level
1000 ppm

1990 NIOSH REL
15-min Ceiling: 350 ppm (1900 mg/m³)

1991-92 ACGIH TLVs
TWA: 350 ppm (1910 mg/m³)
STEL: 450 ppm (2460 mg/m³)

1990 DFG (Germany) MAKs
TWA: 200 ppm (1080 mg/m³)
Half-life: 2 hr to shift length
Peak Exposure Limit: 1000 ppm/30 min (average value)/2 per shift

1985-86 Toxicity Data†
Human, oral, TD_{Lo}: 670 mg/kg produced diarrhea, nausea, and vomiting
Human, inhalation, LC_{Lo}: 27 g/m³/10 min; toxic effects not yet reviewed
Man, eye: 450 ppm/8 hr produced irritation
Rat, inhalation, TC_{Lo}: 2100 ppm/24 hr for 14 days prior to mating and from 1 to 20 days of pregnancy produced specific developmental abnormalities of the musculoskelatal system

* Methyl chloroform usually contains inhibitors (3 to 8%) to prevent corrosion of aluminum and some other metals. Typical inhibitors are nitromethane, butylene oxide, secondary butyl alcohols, ketones, and glycol diesters.
† See NIOSH, *RTECS* (KJ2975000), for additional irritation, mutation, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 165 °F (75 °C)
Freezing Point: -22 °F (-30 °C)
Vapor Pressure: 100 mm Hg at 68 °F (20 °C)
Vapor Density (air = 1): 4.55
Corrosivity: Readily corrodes aluminum and its alloys
Refraction Index: 1.43765 at 69.8 °F (21 °C)
Viscosity: 0.858 cP at 68 °F (20 °C)
Molecular Weight: 133.42
Density: 1.3376 at 68/39.8 °F (20/4 °C)
Water Solubility: Insoluble
Other Solubilities: Soluble in acetone, alcohol, ether, benzene, carbon tetrachloride, and carbon disulfide
% in Saturated Air: 16.7% at 77 °F (25 °C)
Relative Evaporation Rate (butyl acetate = 1): 12.8
Appearance and Odor: Colorless liquid with a sweetish, chloroform-like odor. The odor threshold is 44 ppm.

Section 4. Fire and Explosion Data

Flash Point: None (in conventional CC tests)	Autoignition Temperature: 932 °F (500 °C)	LEL: 7% v/v	UEL: 16% v/v

Extinguishing Media: *Noncombustible liquid* whose *vapor* burns in the presence of excess oxygen or a strong ignition source. For small fires, use dry chemical or carbon dioxide (CO_2). For large fires use fog or regular foam. If these materials are unavailable, a water spray may be used but be aware that water reacts slowly with methyl chloroform to release hydrochloric acid.
Unusual Fire or Explosion Hazards: Vapors are heavier than air and may travel to a strong ignition source and flash back. Air/vapor mixtures may explode when heated. Container may explode in heat of fire. Exposure to open flames or arc welding can produce hydrogen chloride and phosgene.
Special Fire-fighting Procedures: Methyl chloroform's burning rate is 2.9 mm/min. Since fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing provides limited protection. Wear clothing specifically recommended by the manufacturer for use in fires involving methyl chloroform. Apply cooling water to container sides until after fire is extinguished. Stay away from ends of tanks. Isolate area for 1/2 mile if fire involves tank, truck, or rail car. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Methyl chloroform is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization can occur in contact with aluminum trichloride.
Chemical Incompatibilities: Methyl chloroform is incompatible with sodium hydroxide, nitrogen tetroxide, oxygen (liquid or gas), strong oxidizers, and chemically active metals like aluminum, zinc, and magnesium powders; reacts violently with caustics to form dichloroacetylene; reacts slowly with water to form hydrochloric acid; forms shock sensitive mixtures with potassium; and polymerizes in contact with aluminum trichloride.
Conditions to Avoid: Exposure to moisture, strong ignition sources, and arc-welding units, and contact with incompatibles.
Hazardous Products of Decomposition: Thermal oxidative decomposition (temperatures >500 °F, contact with hot metals, or under UV rays) of methyl chloroform can produce carbon dioxide (CO_2) and toxic dichloroacetylene, hydrogen chloride, and phosgene gases.

Section 6. Health Hazard Data

Carcinogenicity: The IARC (Class 3, inadequate evidence),(164) NTP,(142) and OSHA(164) do not list methyl chloroform as a carcinogen.
Summary of Risks: Methyl chloroform is considered one of the least toxic of the liquid chlorinated hydrocarbons. It is irritating to eyes, skin, and respiratory tract. Although low in systemic toxicity, methyl chloroform is an anesthetic capable of causing death at high concentrations (>15,000 ppm), generally in poorly ventilated, enclosed areas. Quick and complete recovery is observed after prompt removal of unconscious persons from area of exposure. Like many other solvents, methyl chloroform sensitizes the heart to epinephrine (blood pressure-raising hormone) and may induce cardiac arrhythmias and arrest.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Target Organs: Skin, eyes, central nervous (CNS) and cardiovascular (CVS) systems.

Continue on next page

Section 6. Health Hazard Data, *continued*

Primary Entry Routes: Inhalation, skin contact. **Acute Effects:** Methyl chloroform defats the skin causing irritation, redness, dryness, and scaling. Contact with eyes produces irritation and mild conjunctivitis. Vapor inhalation can cause headache, dizziness, equilibrium disturbances, and in high concentrations may lead to CNS depression, unconsciousness, and coma. During a 60-min exposure period these effects are observed: 100 ppm is the observed odor threshold, at 500 ppm there is obvious odor and decreased reaction time, 1000 ppm causes slight equilibrium loss, at 5000 ppm there is definite incoordination, and 20,000 ppm produces surgical strength anesthesia with possible death. Mild liver and kidney dysfunction may occur after CNS depression recovery. Although unlikely, if ingestion occurs, symptoms include nausea, vomiting, diarrhea, and possible esophageal burns. The acute lethal human dose is ~500 to 5000 mg/kg. **Chronic Effects:** None reported.

FIRST AID

Eyes: Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. *Do not* allow victim to rub or keep eyes tightly shut. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center, and unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water to dilute. When deciding whether to induce vomiting, carefully consider amount ingested, time since ingestion, and availability of medical help. If large amounts are recently ingested (absorption into the body is not yet likely to have occurred), and medical help or transportation to a medical facility is not readily available, induce vomiting. Otherwise, vomiting is not recommended since aspiration of vomitus can produce chemical pneumonitis. **Note to Physicians:** Do not use adrenaline or sympathomimetic amines in treatment because of the increased cardiac sensitivity involved.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Immediately notify safety personnel, isolate area, deny entry, and stay upwind. Shut off all ignition sources. If possible without risk, shut off leak. Cleanup personnel should wear fully encapsulating vapor-protective clothing. For small spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material. Using nonsparking tools, place in suitable containers for disposal or reclamation. For large spills, dike far ahead of liquid spill for later disposal or reclamation. Report any release in excess of 1000 lb. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Transport:** In water, methyl chloroform's half-life is hours to weeks depending on wind and mixing conditions. It is very persistent in groundwater. On land it volatilizes due to its high vapor pressure and leaches extensively. When released to the atmosphere, methyl chloroform can be transported long distances and returned to earth via rain. It is slowly degraded by reaction with hydroxyl radicals and has a half-life of 6 months to 25 years. The Natural Resources Defenses Council reported recently that methyl chloroform depletes ozone.
Ecotoxicity Values: *Pimephales promelas* (fathead minnow), LC_{50}: 52.8 mg/L/96 hr; *Poecilia reticulata* (guppy), LC_{50}: 133 ppm/7 day.
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33): No. U226
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Reportable Quantity (RQ), 1000 lb (454 kg) [* per RCRA, Sec. 3001, CWA, Sec. 307(a), and CAA, Sec. 112]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

ction 8. Special Protection Data

Goggles: Wear splash-proof, protective chemical safety goggles or faceshields, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy.
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a respiratory protection program that includes at least: training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.
Other: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent repeated or prolonged skin contact. Viton and butyl rubber [with breakthrough times (BTs) of >8 hr and 4 to 7.9 hr, respectively] are recommended materials for protective gear. *Do not use* neoprene, polyvinyl chloride (PVC), natural rubber, or polyethylene because these materials have a BT of <1 hr.
Ventilation: Provide general and local exhaust (in some cases, explosion-proof) ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder contaminated work clothing before wearing. Remove this material from your shoes and clean personal protective equipment.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Prevent physical damage to containers. Store in cool, dry, well-ventilated (use pressure-vacuum ventilation) area away from ignition sources, arc-welding operations, and incompatibles (Sec. 5). Regularly monitor inhibitor levels. *Do not* store in aluminum containers or use pressure-spraying equipment when methyl chloroform is involved.
Engineering Controls: To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. To prevent static sparks, electrically ground and bond all equipment used in methyl chloroform manufacturing, use, storage, transfer, and shipping.
Administrative Controls: Consider preplacement and periodic medical exams of exposed workers that emphasize CNS, CVS, liver and skin.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: 1,1,1-Trichloroethane
DOT Hazard Class: ORM-A
ID No.: UN2831
Label: None
DOT Packaging Exceptions: 173.505
DOT Packaging Requirements: 173.605

IMO Shipping Name: 1,1,1-Trichloroethane
IMO Hazard Class: 6.1
ID No.: UN2831
IMO Label: St. Andrews Cross
IMDG Packaging Group: III

MSDS Collection **References:** 26, 38, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 148, 153, 159, 162, 163, 164
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** D Wilson, CIH; **Medical Review:** AC Darlington, MPH, MD; **Edited by:** JR Stuart, MS

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Material Safety Data Sheets Collection:
Sheet No. 313
Perchloroethylene
Issued: 11/78 Revision: E, 9/92

Section 1. Material Identification

Perchloroethylene (C_2Cl_4) Description: By chlorination of hydrocarbons and pyrolysis of the carbon tetrachloride that is formed, or by catalytic oxidation of 1,1,2,2-tetrachloroethane. Used in dry cleaning and textile processing, metal degreasing, insulating fluid and cooling gas in electrical transformers, production of adhesives, aerosols, paints, and coatings; as a chemical intermediate, a solvent for various applications, extractant for pharmaceuticals, a pesticide intermediate, and an antihelminthic (parasitic worm removal) agent in veterinary medicine.
Other Designations: CAS No. 127-18-4, Ankilostin, carbon dichloride, Didakene, ethylene tetrachloride, Perchlor, Perclene, Perk, Tetracap, tetrachloroethylene.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(73) for a suppliers list.

R 1
I 3
S 2*
K 0
* Skin absorption

NFPA
0 / 2 0 / -

HMIS
H 2†
F 0
R 0
PPE‡
† Chronic effects
‡ Sec. 8

Cautions: Perchloroethylene is a central nervous system depressant, causes liver and kidney damage (from acute or chronic exposures), and is considered an IARC Class 2B carcinogen (animal sufficient evidence, human inadequate data).

Section 2. Ingredients and Occupational Exposure Limits

Perchloroethylene, < 99%. Impurities include a small amount of amine or phenolic stabilizers.

1991 OSHA PEL
8-hr TWA: 25 ppm (170 mg/m³)

1990 IDLH Level
500 ppm

1990 NIOSH REL
NIOSH-X Carcinogen
Limit of Quantitation: 0.4 ppm

1992-93 ACGIH TLVs
TWA: 50 ppm (339 mg/m³)
STEL: 200 ppm (1357 mg/m³)

1990 DFG (Germany) MAK
TWA: 50 ppm (345 mg/m³)
Category II: substances with systemic effects
Half-life: < 2 hr
Peak Exposure Limit: 100 ppm, 30 min average value, 4/shift

1985-86 Toxicity Data*
Man, inhalation, TC_{Lo}: 280 ppm/2 hr caused conjunctival irritation and anesthesia.
Human, lung: 100 mg/L caused unscheduled DNA synthesis.
Rat, oral, LD_{50}: 3005 mg/kg; caused somnolence, tremor, and ataxia.
Rat, inhalation, TC_{Lo}: 200 ppm/6 hr given intermittently over 2 years produced leukemia and testicular tumors.
Rabbit, eye: 162 mg caused mild irritation.
Rabbit, skin: 810 mg/24 hr caused severe irritation.

* See NIOSH, *RTECS* (KX3850000), for additional irritation, mutation, reproductive, tumorigenic, & toxicity data.

Section 3. Physical Data

Boiling Point: 250 °F (121.2 °C)
Freezing Point: -8 °F (-23.35 °C)
Vapor Pressure: 13 mm Hg at 68 °F (20 °C)
Surface Tension: 31.74 dyne/cm at 68 °F (20 °C)
Viscosity: 0.84 cP at 77 °F (25 °C)
Refraction Index: 1.50534 at 68 °F (20 °C)
Molecular Weight: 165.82

Density: 1.6311 at 59 °F (15/4 °C)
Water Solubility: 0.02% at 77 °F (25 °C)
Other Solubilities: Miscible with alcohol, ether, benzene, chloroform, and oils.
Odor Threshold: 47 to 71 ppm (poor warning properties since olfactory fatigue is probable)
Evaporation Rate: 0.15 gal/ft²/day at 77 °F (25 °C)
Saturated Vapor Density (Air = 0.075 lb/ft³ or 1.2 kg/m³): 0.081 lb/ft³ or 1.296 kg/m³

Appearance and Odor: Colorless liquid with an ether-like odor.

Section 4. Fire and Explosion Data

Flash Point: Nonflammable	**Autoignition Temperature:** Nonflammable	**LEL:** None reported	**UEL:** None reported

Extinguishing Media: For small fires, use dry chemical, carbon dioxide (CO_2). For large fires, use water spray, fog, or regular foam.
Unusual Fire or Explosion Hazards: Vapors are heavier than air and collect in low-lying areas.
Special Fire-fighting Procedures: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Apply cooling water to sides of container until well after fire is out. Stay away from ends of tanks. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Perchloroethylene is stable up to 932 °F (500 °C) in the absence of catalysts, moisture, and oxygen but deteriorates rapidly in warm, moist climates. It is slowly decomposed by light. Amine or phenolic stabilizers are usually added. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Slowly (faster in presence of water) corrodes aluminum, iron, and zinc. It is incompatible with chemically active metals (i.e., barium, beryllium, and lithium (explodes with lithium shavings), strong oxidizers, sodium hydroxide, caustic soda, potash, and nitric acid. Perchloroethylene forms an explosive mixture with dinitrogen tetraoxide and reacts with activated charcoal at 392 °F (200 °C) to yield hexachloroethane and hexachlorobenzene. **Conditions to Avoid:** Contact with moisture and incompatibles.
Hazardous Products of Decomposition: Thermal oxidative decomposition of perchloroethylene can produce carbon dioxide and toxic chlorine, hydrogen chloride, and phosgene gas (also produced by contact with UV light).

Section 6. Health Hazard Data

Carcinogenicity: Perchloroethylene is listed as a carcinogen by The IARC (Group 2B, animal sufficient evidence, human inadequate data),(164) NTP (Class 2, reasonably anticipated as a carcinogen, with limited human evidence and sufficient animal evidence),(169) NIOSH (Class-X, carcinogen defined with no further explanation),(164) and DFG (MAK-B, justifiably suspected of having carcinogenic potential)(164). There is some controversy regarding human carcinogenicity because even though there is an increased number of cancers of the skin, colon, lung, urogenital tract, and lympho-sarcomas; the dry cleaning workers studied were also exposed to other chemicals. **Summary of Risks:** Perchloroethylene is stored in the fatty tissue and slowly metabolized with the loss of chlorine. The half-life of its urinary metabolite (trichloroacetic acid) is 144 hours. Perchloroethylene exerts the majority of its toxicity on the central nervous system causing symptoms ranging from light-headedness and slight 'inebriation' to unconsciousness. Liver damage is possible after severe acute or minor long-term exposure. It has a synergistic effect with toluene.

Continue on next page

Section 6. Health Hazard Data, *continued*

Medical Conditions Aggravated by Long-Term Exposure: Nervous, liver, kidney, or skin disorders. **Target Organs:** Liver, kidney, eyes, upper respiratory tract, skin, and central nervous system. **Primary Entry Routes:** Inhalation and skin and eye contact. **Acute Effects:** Exposure to high levels can cause liver damage which may take several weeks to develop. Vapor exposure can cause slight smarting of the eyes and throat (in high concentrations). In human studies, exposure to 2000 ppm/5 min caused mild CNS depression; 600 ppm/10 min caused numbness around the mouth, dizziness, and incoordination; 100 ppm/7 hr caused mild eye, nose, and throat irritation, flushing of the face and neck, headache, somnolence, and slurred speech. Skin contact may produce dermatitis because of perchloroethylene's defatting action (more common after repeated exposure). Direct eye contact causes tearing and burning but no permanent damage. Ingestion is rare but can cause irritation of the lips, mouth and gastrointestinal tract, irregular heartbeat, nausea & vomiting, diarrhea (possibly blood stained), drowsiness, unconsciousness, and risk of pulmonary edema (fluid in lungs). **Chronic Effects:** Prolonged exposure can cause impaired memory, extremity (hands, feet) weakness, peripheral neuropathies, impaired vision, muscle cramps, liver damage (fatty degeneration, necrosis, yellow jaundice, and dark urine) and kidney damage (oliguric uremia, conjestion and granular swelling).

FIRST AID ***Rescuers must not enter areas with potentially high perchloroethylene levels without a self-contained breathing apparatus.*** **Eyes:** *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. *Never administer adrenalin!* **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting. Be sure victim's head is positioned to avoid aspiration of vomitus into the lungs. **Note to Physicians:** Monitor level of consciousness, EEG (abnormalaties may indicate chronic toxicity), blood enzyme levels (for 2 to 3 wk after exposure), EKG, adequacy of respirations & oxygenation, and liver and kidney function. ***BEIs:*** C_2Cl_4 in expired air (10 ppm), sample prior to last shift of work week; C_2Cl_4 in blood (1 mg/L), sample prior to last shift of work week; trichloroacetic acid in urine (7 mg/L), sample at end of workweek.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off ignition sources (although noncombustible, it forms toxic vapors from thermal decomposition). For small spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable containers for later disposal. For large spills, dike far ahead of spill and await reclamation or disposal. Report any release in excess of 1 lb. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Transport:** If released to soil, perchloroethylene evaporates and some leaches to groundwater. It may absorb slightly to soils with heavy organic matter. Biodegradation may be important in anaerobic soils. In water, it is subject to rapid volatilization with an estimated half-life from <1 day to several weeks. In air, it exists mainly in the vapor-phase and is subject to photooxidation with a half-life of 30 minutes to 2 months. **Ecotoxicity Values:** Guppy (*Poecilia reticulata*), LC_{50} = 18 ppm/7 days; fathead minnow (*Pimephales promelas*), LC_{50} = 18.4 mg/L/96 hr, flow through bioassay. **Disposal:** Consider recovery by distillation. A potential candidate for rotary kiln incineration at 1508 to 2912 °F (820 to 1600 °C) or fluidized bed incineration at 842 to 1796 °F (450 to 980 °C). Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33): No. U210
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 100 lb (45.4 kg) [* per CWA Sec. 307 (a)]
SARA Extremely Hazardous Substance (40 CFR 355), TPQ: Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear a faceshield (8 inch minimum) per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For any detectable concentration, use a supplied-air respirator or SCBA with a full facepiece operated in pressure demand or other positive-pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets made of butyl rubber, Neoprene, or Viton to prevent skin contact. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove this material from your shoes and clean personal protective equipment. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Prevent physical damage to containers. Store in a cool, dry, well-ventilated area away from sunlight, and incompatibles. Do not store sludge from vapor degreasers in tightly-sealed containers and keep outside until disposal is arranged. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. Check stabilizer levels frequently and ventilation equipment (air velocity, static pressure, air valve) at least every 3 months. Install an air dryer in ventlines to storage tanks to prevent moisture from rusting and weakening the tank and contaminating or discoloring its contents. Purge all tanks before entering for repairs or cleanup. Build a dike around storage tanks capable of containing all the liquid. Ground tanks to prevent static electricity. **Administrative Controls:** Consider preplacement and periodic medical exams of exposed workers that emphasize liver, kidney, and nervous system function, and the skin. Alcoholism may be a predisposing factor.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Tetrachloroethylene
DOT Hazard Class: 6.1
I.D No.: UN1897
DOT Packing Group: III
DOT Label: Keep away from food
Special Provisions (172.102): N36, T1

Packaging Authorizations
a) Exceptions: 173.153
b) Non-bulk Packaging: 173.203
c) Bulk Packaging: 173.241

Quantity Limitations
a) Passenger Aircraft or Railcar: 60 L
b) Cargo Aircraft Only: 220 L

Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: 40

MSDS Collection References: 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 140, 148, 149, 153, 159, 163, 164, 167, 168, 171, 174, 175, 176, 180.
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Material Safety Data Sheets Collection:

Sheet No. 683
Polychlorinated Biphenyls (PCBs)

Issued: 11/88 Revision: A, 9/92

Section 1. Material Identification

Polychlorinated Biphenyls [$C_{12}H_{10-n}Cl_n$ (n=3, 4, 5)] Description: A class of nonpolar chlorinated hydrocarbons with a biphenyl nucleus (two benzene nuclei connected by a single C-C bond) in which any or all of the hydrogen atoms have been replaced by chlorine. Commercial PCBs are mixtures of chlorinated biphenyl isomers with varying degrees of chlorination. Prepared industrially by the chlorination of biphenyl with anhydrous chlorine in the presence of a catalyst such as ferric chloride or iron filings. Except for limited research and development applications, PCBs have not been produced in the US since 1977. When large quantities of PCBs were manufactured in the US, they were marketed under the tradename Aroclor (Monsanto) and were characterized by four digit numbers. The first two digits indicating biphenyls (12), triphenyls (54), or both (25, 44); the last two digits indicating the weight percent of chlorine. PCBs' thermal stability, nonflammability, and high dielectric capability made them very useful in electrical equipment. Formerly used as additives in hydraulic fluids, heat transfer systems, lubricants, cutting oils, printer's ink, fire retardants, asphalt, brake linings, automobile body sealants, plasticizers, adhesives, synthetic rubber, floor tile, wax extenders, dedusting agents, pesticide extenders, and carbonless reproducing paper. PCBs are still used in certain existing electrical capacitors and transformers that require enhanced electrical protection to avoid heating from sustained electric faults.

Other Designations: CAS No. 1336-36-3, Aroclor, Clophen, Chlorextol, chlorinated biphenyls, chlorinated diphenyl, chlorinated diphenylene, chloro biphenyl, chloro-1,1-biphenyl, Dykanol, Fenclor, Inerteen, Kaneclor, Montar, Noflamol, Phenoclor, Pyralene, Pyranol, Santotherm, Sovol, Therminol FR-1

R 1
I 4
S 3*
K 1
* Skin absorption

NFPA

HMIS
H 2‡
F 1
R 0
PPE†
† Sec. 8
‡ Chronic Effects

Cautions: PCBs are potent liver toxins that may be absorbed through skin. Potentially, chronic or delayed toxicity is significant because PCBs accumulate in fatty tissue and may reasonably be anticipated to be carcinogens. PCBs are a bioaccumulative environmental hazard. When burned, decomposition products may be more hazardous than the PCBs.

Section 2. Ingredients and Occupational Exposure Limits

PCBs, contain various levels of polychlorinated dibenzofurans and chlorinated naphthalenes as contaminants

1991 OSHA PELs, Skin
8-hr TWA (Chlorodiphenyl, 42% chlorine): 1 mg/m^3
8-hr TWA (Chlorodiphenyl, 54% chlorine): 0.5 mg/m^3

1990 DFG (Germany) MAK, Danger of Cutaneous Absorption
TWA (Chlorodiphenyl, 42% chlorine): 0.1 ppm (1 mg/m^3)
Category III: Substances with systemic effects, onset of effect > 2 hr., half-life > shift length (strongly cumulative)
Short-term Level: 1 ppm, 30 min., average value, 1 per shift
TWA (Chlorodiphenyl, 54% chlorine): 0.05 ppm (0.5 mg/m^3)
Category III: (see above)
Short-term Level: 0.5 ppm, 30 min., average value, 1 per shift

1985-86 Toxicity Data*
Rat, oral, TD: 1250 mg/kg administered intermittently for 25 weeks produced liver tumors.
Mammal, oral, TD_{Lo}: 325 mg/kg administered to female for 30 days prior to mating and from the 1st to the 36th day of gestation produced effects on newborn (stillbirth; live birth index; viability index).

1990 NIOSH REL
TWA (Chlorodiphenyl, 42% chlorine): 0.001 mg/m^3
TWA (Chlorodiphenyl, 54% chlorine): 0.001 mg/m^3

1992-93 ACGIH TLVs, Skin *
TWA (Chlorodiphenyl, 42% chlorine): 1 mg/m^3
TWA (Chlorodiphenyl, 54% chlorine): 0.5 mg/m^3

* These guidelines offer reasonably good protection against systemic intoxication, but may not guarantee that chloroacne won't occur.
† See NIOSH, *RTECS* (TQ1350000), for additional reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data*

Boiling Point: 644-707 °F (340-375 °C)
Melting Point: 42%: -2.2 °F (-19°C); 54%: 14 °F (-10 °C)
Vapor Pressure: 1 mm Hg at 100 °F (38 °C); 10^{-6} to 10^{-3} mm at 20 °C
Molecular Weight: 188.7 to 398.5

Specific Gravity: 1.3 to 1.8 at 20 °C
Water Solubility: Low solubility (0.007 to 5.9 mg/L)
Other Solubilities: Most common organic solvents, oils, and fats; slightly soluble in glycerol and glycols.

Appearance and Odor: PCBs vary from mobile oily liquids to white crystalline solids and hard non-crystalline resins, depending upon chlorine content.

* Physical and chemical properties vary widely according to degree and to the position of chlorination.

Section 4. Fire and Explosion Data

Flash Point: 286-385 °F (141-196 °C) OC*	Autoignition Temperature: 464 °F (240 °C)	LEL: None reported	UEL: None reported

Extinguishing Media: Use extinguishing media suitable to the surrounding fire. Use dry chemical, foam, carbon dioxide (CO_2), or water spray. Water spray may be ineffective. Use water spray to cool fire-exposed containers or transformers. Do not scatter PCBs with high-pressure water streams. **Unusual Fire or Explosion Hazards:** Combustion products (hydrogen chloride, phosgene, polychlorinated dibenzofurans, and furans) are more hazardous than the PCBs themselves. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Approach fire from upwind to avoid highly toxic decomposition products. Structural firefighter's protective clothing will provide *limited* protection. Do not release runoff from fire control methods to sewers or waterways. Dike for later disposal.

* Flash points shown are a range for various PCBs. Some forms do not have flash points.

Section 5. Reactivity Data

Stability/Polymerization: PCBs are very stable materials but are subject to photodechlorination when exposed to sunlight or UV (spectral region above 290 nanometers). Hazardous polymerization cannot occur. **Chemical Incompatibilities:** PCBs are chemically inert and resistant to oxidation, acids, and bases. **Conditions to Avoid:** Avoid heat and ignition sources.
Hazardous Products of Decomposition: Thermal oxidative decomposition [1112-1202 °F (600-650 °C)] of PCBs can produce highly toxic derivatives, including polychlorinated dibenzo-para-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), hydrogen chloride, phosgene and other irritants.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,[164] and NTP[169] list PCBs as an IARC probable carcinogen (overall evaluation is 2A; limited human data; sufficient animal data) and NTP anticipated carcinogen, respectively. **Summary of Risks:** PCBs are potent liver toxins that can be absorbed through unbroken skin in toxic amounts without immediate pain or irritation. PCBs have low acute toxicity, but can accumulate in fatty tissue and severe health effects may develop later. Generally, toxicity increases with a higher chlorine content; PCB-oxides are more toxic. The toxic action on the liver also increases with simultaneous exposure to other liver toxins, e.g. chlorinated solvents, alcohol, and certain drugs. Pathological pregnancies (abnormal pigmentations, abortions, stillbirths, and underweight births) have been associated with increased PCB serum levels in mothers; PCBs can be passed in breast milk. PCBs can affect the reproductive system of adults. **Medical Conditions Aggravated by Long-Term Exposure:** Skin, liver, and respiratory disease. **Target Organs:** Skin, liver, eyes, mucous membranes, and respiratory tract. **Primary Entry Routes:** Inhalation, dermal contact, ingestion. **Acute Effects:** Exposure to PCB vapor or mist is severely irritating to the skin, eyes, nose, throat, and upper respiratory tract. Intense acute exposure to high concentrations may result in eye, lung, and liver injury. Systemic effects include nausea, vomiting, increased blood pressure, fatigue, weight loss, jaundice, edema and abdominal pain. Cognitive, neurobehavior and psychomotor impairment and memory loss have also been seen after acute exposure. **Chronic Effects:** Repeated exposure to PCBs can cause chloroacne; redness, swelling, dryness, thickening and darkening of the skin and nails; swelling and burning of the eyes, and excessive eye discharge; distinctive hair follicles; gastrointestinal disturbances; neurological symptoms including headache, dizziness, depression, nervousness, numbness of the extremities, and joint and muscle pain; liver enlargement; menstrual changes in women; and chronic bronchitis. Cancer, primarily liver, is also a possible result of exposure, but data is inconclusive.

FIRST AID **Eyes:** *Do not* allow victim to rub or keep eyes tightly shut. Rinsing eyes with medical oil (olive, mineral) initially may remove PCB and halt irritation better than water rinsing alone. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. *Multiple soap and water washings are necessary.* Avoid the use of organic solvents to clean the skin. For reddened or blistered skin, consult a physician. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** In most cases, accidental PCB ingestion will not be recognized until long after vomiting would be of any value. Never give anything by mouth to an unconscious or convulsing person. Vomiting of the pure substance may cause aspiration. Consult a physician. **Note to Physicians:** Monitor patients for increased hepatic enzymes, chloroacne, and eye, gastrointestinal, and neurologic symptoms listed above. Diagnostic tests include blood levels of PCBs and altered liver enzymes.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate all unnecessary personnel, provide adequate ventilation, and isolate hazard area. Cleanup personnel should protect against vapor inhalation and skin or eye contact. For small spills, take up with sand or other noncombustible material and place into containers for later disposal. For larger spills, dike far ahead of spill to contain for later disposal. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Transport:** PCBs have been shown to bio-concentrate significantly in aquatic organisms. **Ecotoxicity:** Bluegill, TLm: 0.278 ppm/96 hr. Mallard Duck, LD_{50}: 2000 ppm. **Environmental Degradation:** In general, the persistence of PCBs increases with an increase degree of chlorination. **Soil Absorption/Mobility:** PCBs are tightly absorbed in soil and generally do not leach significantly in most aqueous soil systems. However, in the presence of organic solvents, PCBs may leach rapidly through the soil. Volatilization of PCBs from soil may be slow, but over time may be significant. **Disposal:** Approved PCB disposal methods include: incineration with scrubbing, high-efficiency boilers, landfills, and EPA-approved alternative disposal methods. Each disposal method has various criteria. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations
RCRA Hazardous Waste (40 CFR 261.33): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1 lb (0.454 kg) [* per CWA, Sec. 311(b)(4) and 307(a)]

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. Minimum respiratory protection should include a combination dust-fume-mist and organic vapor cartridge or canister or air-supplied, depending upon the situation. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent all skin contact. Butyl rubber, neoprene, Teflon, and fluorocarbon rubber have break through times greater than 8 hrs. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Segregate contaminated clothing in such a manner so that there is no direct contact by laundry personnel. Implement quality assurance to ascertain the completeness of the cleaning procedures. Remove this material from your shoes and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in a closed, labelled, container in a ventilated area with appropriate air pollution control equipment. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. **Administrative Controls:** Inform employees of the adverse health effects associated with PCBs. Limit access to PCB work areas to authorized personnel. Consider preplacement and periodic medical examinations with emphasis on the skin, liver, lung, and reproductive system. Monitor PCB blood levels. Consider possible effects on the fetus. Keep medical records for the entire length of employment and for the following 30 yrs.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Polychlorinated biphenyls
DOT Hazard Class: 9
ID No.: UN2315
DOT Packing Group: II
DOT Label: CLASS 9
Special Provisions (172.102): 9, N81

Packaging Authorizations
a) Exceptions: 173.155
b) Non-bulk Packaging: 173.202
c) Bulk Packaging: 173.241

Quantity Limitations
a) Passenger Aircraft or Railcar: 100 L
b) Cargo Aircraft Only: 220 L

Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: 34

MSDS Collection References: 26, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 163, 164, 168, 169, 174, 175, 180
Prepared by: MJ Wurth, BS; Industrial Hygiene Review: PA Roy MPH, CIH; Medical Review: AC Darlington, MD

Material Safety Data Sheet

from Genium's Reference Collection
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GENIUM PUBLISHING CORP.

No. 677

1,1,2,2-TETRACHLOROETHANE

Issued: November 1988

SECTION 1. MATERIAL IDENTIFICATION

27

Material Name: 1,1,2,2-TETRACHLOROETHANE

Genium

Description (Origin/Uses): Used as a solvent primarily for cleaning and extraction procedures and as a chemical intermediate in the manufacture of trichloroethylene and tetrachloroethylene; and as an analytic reagent by textile manufacturers in polymer characterization tests.

Other Designations: Acetylene Tetrachloride; *sym*-Tetrachloroethane; $CHCl_2CHCl_2$; CAS No. 0079-34-5

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

HMIS			
H	2	R	1
F	0	I	4
R	0	S	–
PPG*		K	–

*See sect. 8

SECTION 2. INGREDIENTS AND HAZARDS

	%	EXPOSURE LIMITS
1,1,2,2-Tetrachloroethane, CAS No. 0079-34-5	Ca 100	**OSHA PEL (Skin*)** 8-Hr TWA: 1 ppm, 7 mg/m³ **ACGIH TLV (Skin*), 1988-89** TLV-TWA: 1 ppm, 7 mg/m³ **Toxicity Data**** Human, Oral, TD_{Lo}: 30 mg/kg Human, Inhalation, TC_{Lo}: 1000 mg/m³ (30 Mins) Rat, Oral, LD_{50}: 800 mg/kg

*This material can be absorbed through intact skin, which contributes to overall exposure.
**See NIOSH, *RTECS* (KI8575000), for additional data with references to reproductive, tumorigenic, and irritative effects.

SECTION 3. PHYSICAL DATA

Boiling Point: 295°F (146°C)
Melting Point: -47°F (-44°C)
% Volatile by Volume: Ca 100
Vapor Pressure: 6 Torrs at 77°F (25°C)*
Molecular Weight: 168 Grams/Mole
Solubility in Water (%): Insoluble
Specific Gravity (H_2O = 1): 1.58658 at 77°F (25°C)

Appearance and Odor: A colorless, nonflammable, heavy, mobile liquid; sweetish, suffocating, characteristic chloroform odor. The odor recognition threshold is reported to be less than 3 ppm.

*At 77°F (25°C) the concentration of 1,1,2,2-tetrachloroethane in saturated air is approximately 7900 ppm.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point*	Autoignition Temperature*	LEL*	UEL*

Extinguishing Media: *1,1,2,2-Tetrachloroethane does not burn. Use extinguishing agents that will put out the surrounding fire. **Unusual Fire or Explosion Hazards:** None reported. **Special Fire-fighting Procedures:** Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode to protect against the effects of the nearby fire.

SECTION 5. REACTIVITY DATA

Stability/Polymerization: 1,1,2,2-Tetrachloroethane is stable in closed containers during routine operations at room temperature. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Hazardous reactions between 1,1,2,2-tetrachloroethane and 2,4-dinitrophenyl disulfide, nitrogen tetroxide, chemically active metals such as potassium; and strong caustics such as potassium hydroxide, sodium, sodium-potassium alloy, hot iron, aluminum, and zinc in the presence of steam are reported. **Conditions to Avoid:** Prevent exposure to the incompatible chemicals listed above. Contact with water causes appreciable hydrolysis that will degrade and decompose this liquid. **Hazardous Products of Decomposition:** Thermal-oxidative degradation of 1,1,2,2-tetrachloroethane can produce highly toxic gases such as carbon monoxide (CO) and oxides of chlorine (ClO_x).

SECTION 6. HEALTH HAZARD INFORMATION

Carcinogenicity: NIOSH lists 1,1,2,2-tetrachloroethane as a carcinogen.
Summary of Risks: 1,1,2,2-Tetrachloroethane is absorbed through intact skin in significant amounts; one human fatality has been attributed to this route of exposure. This liquid is considered to be one of the most toxic of the common chlorinated hydrocarbons, particularly with respect to the liver. Severely acute exposure causes depression of the central nervous system (CNS), which can cause death within 12 hours. **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Target Organs:** Skin, eyes, respiratory system, CNS, gastrointestinal system, liver, and kidneys. **Primary Entry:** Inhalation, skin contact/absorption. **Acute Effects:** The initial symptoms of exposure are lacrimation, salivation, and irritation of the nose and throat; continued exposure can lead to nausea, vomiting, and narcosis. Also, low blood pressure and cardiac rhythm abnormalities; respiratory depression; nausea, vomiting, burns of the esophagus, and diarrhea; and anesthesia with dizziness leading to loss of consciousness and coma; plus possible transient liver and kidney changes. **Chronic Effects:** The two sets of manifestations are (1) malaise, drowsiness, decreased appetite, then nausea and retching, a bad taste in the throat, constipation, headache, pale stools, jaundice, and dark urine, as well as mental confusion, stupor, and coma; and (2) hand

SECTION 6. HEALTH HAZARD INFORMATION, cont.

tremors, sensation of deafness, numbness in hands and feet, a decrease in reflexes, headache, and nausea. FIRST AID: Eyes. Immediately flush eyes, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 minutes. Skin. Rinse the affected areas with flooding amounts of water, then wash it with soap and water. **Inhalation.** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have qualified medical personnel administer oxygen as required. Keep the exposed person warm and at rest until medical help is available. **Ingestion.** Unlikely. Should this type of exposure occur, give the exposed person 3 glasses of water to drink and induce vomiting, then repeat this procedure. **Get medical help (in plant, paramedic, community) for all exposures.** Seek prompt medical assistance for further treatment, observation, and support after first aid. **Note to Physician:** Workers exposed to this liquid should be evaluated with a full battery of tests for the liver, kidneys, and CNS systems, as well as the blood.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, evacuate unnecessary personnel, and provide adequate ventilation. Cleanup personnel must be properly clothed and equipped to protect the skin and eyes against any contact with the liquid as well as inhalation of its vapor (see sect. 8). Vacuum the spilled 1,1,2,2-tetrachloroethane and pump it into suitable containers for disposal. **Waste Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000 Subpart Z).
EPA Designations (40 CFR 302.4)
RCRA Waste, No. U209
CERCLA Hazardous Substance, Reportable Quantity: 1 lb (0.454 kg), per the Clean Water Act (CWA), § 307 (a); and the Resource Conservation and Recovery Act (RCRA), § 3001.

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing of this liquid is possible, wear a full face shield. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Use a NIOSH-approved respirator per Genium reference 88 for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (spills or cleaning reactor vessels and storage tanks), wear an SCBA. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, gauntlets, etc., to prevent skin contact with this liquid. **Ventilation:** Install and operate general and local ventilation systems powerful enough to maintain airborne levels of this material below the OSHA PEL standard cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of the contaminant into the general work area by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from your shoes and equipment. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material and before eating, drinking, smoking, using the toilet, or applying cosmetics. Keep it off your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Do not inhale 1,1,2,2-tetrachloroethane vapor.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store 1,1,2,2-tetrachloroethane in closed, airtight containers in a cool, dry, well-ventilated area away from incompatible chemicals (see sect. 5). **Special Handling/Storage:** Provide storage areas with adequate ventilation to prevent concentrations of the vapor from building up beyond the occupational exposure limits cited in section 2.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Tetrachloroethane
DOT Hazard Class: ORM-A
ID No. UN1702
DOT Packaging Requirements: 49 CFR 173.620
DOT Packaging Exceptions: 49 CFR 173.505

IMO Shipping Name: 1,1,2,2-Tetrachloroethane
IMO Hazard Class: 6.1
IMO Label: Poison
IMDG Packaging Group: II

References: 1, 38, 84-94, 100, 116, 117, 120, 122.

Prepared by: PJ Igoe, BS
Industrial Hygiene Review: DJ Wilson, CIH
Medical Review: W Silverman, MD

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Material Safety Data Sheets Collection:

Sheet No. 317
Toluene

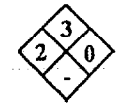
Issued: 8/79 Revision: E, 9/92

Section 1. Material Identification 39

Toluene ($C_6H_5CH_3$) Description: Derived from petroleum i.e., dehydrogenation of cycloparaffin fractions followed by the aromatization of saturated aromatic hydrocarbons or by fractional distillation of coal-tar light oil and purified by rectification. Used widely as a solvent (replacing benzene in many cases) for oils, resins, adhesives, natural rubber, coal tar, asphalt, pitch, acetyl celluloses, cellulose paints and varnishes; a diluent for photogravure inks, raw material for organic synthesis (benzoyl & benzilidene chlorides, saccharine, TNT, toluene diisocyanate, and many dyestuffs), in aviation and high octane automobile gasoline, as a nonclinical thermometer liquid and suspension solution for navigational instruments.

R 1
I 3
S 2*
K 3
* Skin absorption

NFPA



HMIS
H 2- Chronic effects
F 3
R 0
PPE-Sec. 8

Other Designations: CAS No. 108-88-3, Methacide, methylbenzene, methylbenzol, phenylmethane, toluol, Tolu-sol.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(73) for a suppliers list.

Cautions: Toluene is an eye, skin, and respiratory tract irritant becoming narcotic at high centrations. Liver and kidney damage has occurred. Pregnant women chronically exposed to toluene have shown teratogenic effects. Toluene is highly flammable.

Section 2. Ingredients and Occupational Exposure Limits

Toluene, < 100%; may contain a small amount of benzene (~ 1%), xylene, and nonaromatic hydrocarbons.

1991 OSHA PELs
8-hr TWA: 100 ppm (375 mg/m³)
15-min STEL: 150 ppm (560 mg/m³)

1990 IDLH Level
2000 ppm

1990 NIOSH RELs
TWA: 100 ppm (375 mg/m³)
STEL: 150 ppm (560 mg/m³)

1992-93 ACGIH TLV (Skin)
TWA: 50 ppm (188 mg/m³)

1990 DFG (Germany) MAK*
TWA: 100 ppm (380 mg/m³)
Half-life: 2 hr to end of shift
Category II: Substances with systemic effects
Peak Exposure Limit: 500 ppm, 30 min average value, 2/shift

1985-86 Toxicity Data†
Man, inhalation, TC_{Lo}: 100 ppm caused hallucinations, and changes in motor activity and changes in psychophysiological tests.
Human, oral, LD_{Lo}: 50 mg/kg; toxic effects not yet reviewed
Human, eye: 300 ppm caused irritation.
Rat, oral, LD_{50}: 5000 mg/kg
Rat, liver: 30 µmol/L caused DNA damage.

* Available information suggests damage to the developing fetus is probable.
†See NIOSH, *RTECS* (XS5250000), for additional irritation, mutation, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 232 °F (110.6 °C)
Melting Point: -139 °F (-95 °C)
Molecular Weight: 92.15
Density: 0.866 at 68 °F (20/4 °C)
Surface Tension: 29 dyne/cm at 68 °F (20 °C)
Viscosity: 0.59 cP at 68 °F (20 °C)
Refraction Index: 1.4967 at 20 °C/D

Water Solubility: Very slightly soluble, 0.6 mg/L at 68 °F (20 °C)
Other Solubilities: Soluble in acetone, alcohol, ether, benzene, chloroform, glacial acetic acid, petroleum ether, and carbon disulfide.
Vapor Pressure: 22 mm Hg at 68 °F (20 °C); 36.7 mm Hg at 86 °F (30 °C)
Saturated Vapor Density (Air = 0.075 lb/ft³ or 1.2 kg/m³): 0.0797 lb/ft³ or 1.2755 kg/m³
Odor Threshold (range of all referenced values): 0.021 to 69 ppm

Appearance and Odor: Colorless liquid with a sickly sweet odor.

Section 4. Fire and Explosion Data

Flash Point: 40 °F (4.4 °C) CC	Autoignition Temperature: 896 °F (480 °C)	LEL: 1.27% v/v	UEL: 7.0% v/v

Extinguishing Media: Toluene is a Class 1B flammable liquid. To fight fire, use dry chemical carbon dioxide, or 'alcohol-resistant' foam. Water spray may be ineffective as toluene floats on water and may actually spread fire. **Unusual Fire or Explosion Hazards:** Concentrated vapors are heavier than air and may travel to an ignition source and flash back. Container may explode in heat of fire. Toluenes' burning rate = 5.7 mm/min and its flame speed = 37 cm/sec. Vapor poses an explosion hazard indoors, outdoors, and in sewers. May accumulate static electricity. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighter's protective clothing provides only limited protection. Apply cooling water to sides of tanks until well after fire is out. Stay away from ends of tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holders; if impossible, withdraw from fire and let burn. Withdraw immediately if you hear a rising sound from venting safety device or notice any tank discoloration due to fire because a BLEVE (boiling liquid expanding vapor explosion) may be imminent. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Toluene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization can't occur. **Chemical Incompatibilities:** Strong oxidizers, concentrated nitric acid, nitric acid + sulfuric acid, dinitrogen tetroxide, silver perchlorate, bromine trifluoride, tetranitromethane, and 1,3-dichloro-5,5-dimethyl-2,4-imidazolididione. **Conditions to Avoid:** Contact with heat, ignition sources, or incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of toluene can produce carbon dioxide, and acrid, irritating smoke.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,(164) NTP,(169) and OSHA(164) do not list toluene as a carcinogen. **Summary of Risks:** Toluene is irritating to the eyes, nose, and respiratory tract. Inhalation of high concentrations produces a narcotic effect sometimes leading to coma as well as liver and kidney damage. 93% of inhaled toluene is retained in the body of which 80% is metabolized to benzoic acid, then to hippuric acid and excreted in urine. The remainder is metabolized to *o*-cresol and excreted or exhaled unchanged. Toluene metabolism is inhibited by alcohol ingestion and is synergistic with benzene, asphalt fumes, or chlorinated hydrocarbons (i.e. perchloroethylene). Toluene is readily absorbed through the skin at 14 to 23 mg/cm²/hr. Toluene is absorbed quicker during exercise than at rest and appears to be retained longer in obese versus thin victims; presumably due to its lipid solubility. There is inconsistent data on toluene's ability to damage bone marrow; chronic poisoning has resulted in anemia and leucopenia with biopsy showing bone marrow hypo-plasia. These reports are few and some authorities argue that the effects may have been due to benzene contaminants. Chronic inhalation during pregnancy has been associated with teratogenic effects on the fetus including microcephaly, CNS dysfunction, attentional deficits, developmental delay + language impairment, growth retardation, and physical defects including a small midface, short palpebral fissures, with deep-set eyes, low-set ears, flat nasal bridge with a small nose, micrognathia, and blunt fingertips. There is some evidence that toluene causes an autoimmune illness in which the body produces antibodies that cause inflammation of its own kidney.

Continue on next page

Section 6. Health Hazard Data

Medical Conditions Aggravated by Long-Term Exposure: Alcoholism and CNS, kidney, skin, or liver disease. **Target Organs:** CNS, liver, kidney, skin. **Primary Entry Routes:** Inhalation, skin contact/absorption. **Acute Effects:** Vapor inhalation causes respiratory tract irritation, fatigue, giddiness, confusion, dizziness, headache, dilated pupils, watering eyes, nervousness, insomnia, parasthesis, and vertigo progressing to narcotic coma. Death may result from cardiac arrest due to ventricular fibrillation with catecholamines loss. Liquid splashed in the eye causes conjunctival irritation, transient corneal damage and possible burns. Prolonged skin contact leads to drying and fissured dermatitis. Ingestion causes GI tract irritation and symptoms associated with inhalation. **Chronic Effects:** Symptoms include mucous membrane irritation, headache, vertigo, nausea, appetite loss and alcohol intolerance. Repeated heavy exposure may result in encephalopathies (cerebellar ataxia and cognitive dysfunction), liver enlargement, and kidney dystrophy (wasting away). Symptoms usually appear at workdays end, worsen at weeks end and decrease or disappear over the weekend. **FIRST AID** Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult an ophthalmologist immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water to dilute. *Do not* induce vomiting because of danger of aspiration into the lungs. Gastric lavage may be indicated if large amounts are swallowed; potential toxicity needs to be weighed against aspiration risk when deciding for or against gastric lavage. **Note to Physicians:** Monitor cardiac function. If indicated, use epinephrine and other catecholamines carefully, because of the possibility of a lowered myocardial threshold to the arrhythmogenic effects of such substances. Obtain CBC, electrolytes, and urinalysis. Monitor arterial blood gases. If toluene has > 0.02% (200 ppm) benzene, evaluate for potential benzene toxicity. BEI: hippuric acid in urine, sample at shift end (2.5 g/g creatinine); Toluene in venous blood, sample at shift end (1.0 mg/L).

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Cleanup personnel protect against inhalation and skin/eye contact. Use water spray to cool and disperse vapors but it may not prevent ignition in closed spaces. Cellosolve, hycar absorbent materials, and fluorocarbon water can also be used for vapor suppression/containment. Take up small spill with earth, sand, vermiculite, or other absorbent, noncombustible material. Dike far ahead of large spills for later reclamation or disposal. For water spills, (10 ppm or greater) apply activated carbon at 10X the spilled amount and remove trapped material with suction hoses or use mechanical dredges/lifts to remove immobilized masses of pollutants and precipitates. Toluene can undergo fluidized bed incineration at 842 to 1796 °F (450 to 980 °C), rotary kiln incineration at 1508 to 2912 °F (820 to 1600 °C), or liquid injection incineration at 1202 to 2912 °F (650 to 1600 °C). Follow applicable OSHA regulations (29 CFR 1910.120). **Ecotoxicity Values:** Blue gill, LC_{50} = 17 mg/L/24 hr; shrimp (*Crangonfracis coron*), LC_{50} = 4.3 ppm/96 hr; fathead minnow (*Pimephales promelas*), LC_{50} = 36.2 mg/L/96 hr. **Environmental Degradation:** If released to land, toluene evaporates and undergoes microbial degradation. In water, toluene volatilizes and biodegrades with a half-life of days to several weeks. In air, toluene degrades by reaction with photochemically produced hydroxyl radicals. **Disposal:** Treat contaminated water by gravity separation of solids, followed by skimming of surface. Pass through dual media filtration and carbon absorption units (carbon ratio 1 kg to 10 kg soluble material). Return waste water from backwash to gravity separator. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33): No. U220
Extremely Hazardous Substance (40 CFR 355), TPQ: Not listed
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1000 lb (454 kg)
[* per RCRA, Sec. 3001; CWA, Sec. 311 (b)(4); CWA, Sec. 307 (a)]
Listed as a SARA Toxic Chemical (40 CFR 372.65): Not listed

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses with shatter-resistant glass and side-shields or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For < 100 ppm, use any chemical cartridge respirator with appropriate organic vapor cartridges, any supplied-air respirator (SAR), or SCBA. For < 200 ppm, use any SAR operated in continuous-flow mode, any SAR or SCBA with a full facepiece, or any air-purifying respirator with a full facepiece having a chin-style, front or back mounted organic vapor canister. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent skin contact. Polyvinyl alcohol with a breakthrough time of > 8 hr, Teflon and Viton are recommended as suitable materials for PPE. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove toluene from your shoes and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Prevent physical damage to containers. Store in a cool, dry, well-ventilated area away from ignition sources and incompatibles. Outside or detached storage is preferred. If stored inside, use a standard flammable liquids warehouse, room, or cabinet. To prevent static sparks, electrically ground and bond all equipment used with toluene. Do not use open lights in toluene areas. Install Class 1, Group D electrical equipment. Check that toluene is free of or contains < 1% benzene before use. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. **Administrative Controls:** Adopt controls for confined spaces (29 CFR 1910.146) if entering areas of unknown toluene levels (holes, wells, storage tanks). Consider preplacement and periodic medical exams of exposed workers that emphasize the CNS, liver, kidney, and skin. Include hemocytometric and thrombocyte count in cases where benzene is a contaminant of toluene. Monitor air at regular intervals to ensure effective ventilation.

Transportation Data (49 CFR 172.101)

Shipping Name: Toluene
Hazard Class: 3
ID No.: UN1294
DOT Packing Group: II
DOT Label: Flammable Liquid
Special Provisions (172.102): T1

Packaging Authorizations
a) Exceptions: 150
b) Non-bulk Packaging: 202
c) Bulk Packaging: 242

Quantity Limitations
a) Passenger Aircraft or Railcar: 5L
b) Cargo Aircraft Only: 60L

Vessel Stowage Requirements
Vessel Stowage: B
Other: --

MSDS Collection References: 26, 73, 100, 101, 103, 124, 126, 127, 132, 140, 148, 153, 159, 163, 164, 167, 169, 171, 174, 175, 176, 180.
Prepared by: M Gannon, BA; Industrial Hygiene Review: PA Roy, CIH, MPH; Medical Review: AC Darlington, MD, MPH

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Material Safety Data Sheets Collection:

Sheet No. 312
Trichloroethylene

Issued: 7/79 Revision: F, 9/92

Section 1. Material Identification

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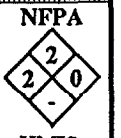
Trichloroethylene (C_2HCl_3) Description: Derived by treating tetrachloroethane with lime or other alkali in the presence of water, or by thermal decomposition of tetrachloroethane followed by steam distillation. Stabilizers such as epichlorohydrin, isobutanol, carbon tetrachloride, chloroform, benzene, or pentanol-2-triethanolamine are then added. Used as a degreasing solvent in electronics and dry cleaning, a chemical intermediate, a refrigerant and heat-exchange liquid, and a diluent in paint and adhesives; in oil, fat, and wax extraction and in aerospace operations (flushing liquid oxygen). Formerly used as a fumigant (food) and anesthetic (replaced due to its hazardous decomposition in closed-circuit apparatus).

Other Designations: CAS No. 79-01-6; acetylene trichloride; Algylen; Anamenth; Benzinol; Cecolene; Chlorylen; Dow-Tri; ethylene trichloride; Germalgene; Narcogen; Triasol; trichloroethene; TCE; 1,1,3-trichloroethylene.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(73) for a suppliers list.

R 1
I 2
S 2*
K 3
* Skin absorption

NFPA



HMIS
H 2†
F 2
R 0
PPE‡
† Chronic Effects
‡ Sec. 8

Cautions: TCE is irritating and toxic to the central nervous system (CNS). Inhalation of high concentrations have lead to death due to ventricular fibrillation. Chronic exposure may lead to heart, liver, and kidney damage. The liquid is absorbed through the skin. Although it has a relatively low flash point, TCE burns with difficulty.

Section 2. Ingredients and Occupational Exposure Limits

Trichloroethylene, < 100% [contains stabilizers (Sec. 1)].

1991 OSHA PELs
8-hr TWA: 50 ppm (270 mg/m^3)
15-min STEL: 200 ppm (1080 mg/m^3)

1990 IDLH Level
1000 ppm

1990 NIOSH REL
10-hr TWA: 25 ppm (~135 mg/m^3)

1992-93 ACGIH TLVs
TWA: 50 ppm (269 mg/m^3)
STEL: 200 ppm (1070 mg/m^3)

1990 DFG (Germany) MAK
Ceiling: 50 ppm (270 mg/m^3)
Category II: Substances with systemic effects
Half-life: 2 hr to shift length
Peak Exposure Limit: 250 ppm, 30 min average value; 2 peaks/shift

1985-86 Toxicity Data*
Human, inhalation, TC_{Lo}: 160 ppm/83 min caused hallucinations and distorted perceptions.
Human, lymphocyte: 5 mL/L caused DNA inhibition.
Rabbit, skin: 500 mg/24 hr caused severe irritation.
Rabbit, eye: 20 mg/24 hr caused moderate irritation.
Mouse, oral, TD_{Lo}: 455 mg/kg administered intermittently for 78 weeks produced liver tumors.

* See NIOSH, *RTECS* (KX4550000), for additional irritation, mutation, reproductive, tumorigenic and toxicity data.

Section 3. Physical Data

Boiling Point: 189 °F (87 °C)
Freezing Point: -121 °F (-85 °C)
Viscosity: 0.0055 Poise at 77 °F (25 °C)
Molecular Weight: 131.38
Density: 1.4649 at 20/4 °C
Refraction Index: 1.477 at 68 °F (20 °C/D)
Odor Threshold: 82 to 108 ppm (*not an effective warning*)

Vapor Pressure: 58 mm Hg at 68 °F (20 °C); 100 mm Hg at 32 °F (0 °C)
Saturated Vapor Density (Air = 0.075 lbs/ft^3; 1.2 kg/m^3): 0.0956 lbs/ft^3; 1.53 kg/m^3
Water Solubility: Very slightly soluble; 0.1% at 77 °F (25 °C)
Other Solubilities: Highly soluble in organic solvents (alcohol, acetone, ether, carbon tetrachloride, & chloroform) and lipids.
Surface Tension: 29.3 dyne/cm

Appearance and Odor: Clear, colorless (sometimes dyed blue), mobile liquid with a sweet chloroform odor.

Section 4. Fire and Explosion Data

Flash Point: 90 °F (32 °C) CC	**Autoignition Temperature:** 788 °F (420 °C)	**LEL:** 8% (25 °C); 12.5% (100 °C)	**UEL:** 10% (25 °C); 90% (100 °C)

Extinguishing Media: A Class 1C Flammable Liquid. Although it has a flash point of 90 °F, TCE burns with difficulty. For small fires, use dry chemical, carbon dioxide, water spray, or regular foam. For large fires, use water spray, fog, or regular foam. **Unusual Fire or Explosion Hazards:** Vapor/air mixtures may explode when ignited. Container may explode in heat of fire. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing provides only limited protection against TCE. Apply cooling water to sides of container until well after fire is out. Stay away from ends of tanks. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: TCE slowly decomposes in the presence of light and moisture to form corrosive hydrochloric acid. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Include alkalis (sodium hydroxide), chemically active metals (aluminum, beryllium, lithium, magnesium, sodium, potassium, and titanium), epoxides, and oxidants (nitrogen tetraoxide, perchloric acid). Contact with 1-chloro-2,3-epoxy propane or the mono and di 2,3-epoxypropyl ethers of 1,4-butanediol + 2,2-bis-4(2',3'-epoxypropoxy)-phenylpropane can, in the presence of catalytic quantities of halide ions, cause dehydrochlorination of TCE to explosive dichloroacetylene. **Conditions to Avoid:** Exposure to light, moisture, ignition sources, and incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of TCE (above 300 °C) or exposure to ultraviolet light can produce carbon dioxide (CO_2) and toxic dichloro acetylene (explosive), chlorine, hydrogen chloride, and phosgene gas.

Section 6. Health Hazard Data

Carcinogenicity: The following agencies have rated TCE's carcinogenicity: IARC (Class 3, limited animal evidence & insufficient human data), Germany MAK (Class B, justifiably suspected of having carcinogenic potential), & NIOSH (Class X, carcinogen defined with no further categorization). **Summary of Risks:** TCE vapor is irritating to the eyes, nose, and respiratory tract and inhalation of high concentrations can lead to severe CNS effects such as unconsciousness, ventricular arrythmias, and death due to cardiac arrest. Mild liver dysfunction was also seen at levels high enough to produce CNS effects. Contact with the liquid is irritating to the skin and can lead to dermatitis by defatting the skin. Chronic toxicity is observed in the victims increasing intolerance to alcohol characterized by 'degreasers flush', a transient redness of the face, trunk, and arms. The euphoric effect of TCE has led to craving, and habitual sniffing of its vapors.

Continue on next page

Section 6. Health Hazard Data, *Continued*

TCE crosses the placental barrier and thus exposes the fetus (any effects are yet unknown). There are increased reports of menstrual disorders in women workers and decreased libido in males at exposures high enough to cause CNS effects. TCE is eliminated unchanged in expired air and as metabolites (trichloroacetic acid & trichloroethanol) in blood and urine. **Medical Conditions Aggravated by Long-Term Exposure:** Disorders of the nervous system, skin, heart, liver, and kidney. **Target Organs:** Respiratory, central & peripheral nervous, and cardiovascular (heart) systems, liver, kidney, and skin. **Primary Entry Routes:** Inhalation, skin and eye contact, and ingestion (rarely). **Acute Effects:** Vapor inhalation can cause eye, nose, and throat irritation, nausea, blurred vision, overexcitement, headache, drunkenness, memory loss, irregular heartbeat (resulting in sudden death), unconsciousness, and death due to cardiac failure. Skin contact with the liquid can cause dryness and cracking and prolonged exposure (generally if the victim is unconscious) can cause blistering. Eye contact can cause irritation and watering, with corneal epithelium injury in some cases. Ingestion of the liquid can cause lip, mouth, and gastrointestinal irritation, irregular heartbeat, nausea and vomiting, diarrhea (possibly blood-stained), drowsiness, and risk of pulmonary edema (fluid in lungs). **Chronic Effects:** Effects may persist for several weeks or months after repeated exposure. Symptoms include giddiness, irritability, headache, digestive disturbances, mental confusion, intolerance to alcohol (degreasers flush), altered color perception, loss or impairment of sense of smell, double vision, and peripheral nervous system function impairment including persistent neuritis, temporary loss of sense of touch, and paralysis of the fingers from direct contact with TCE liquid.
FIRST AID Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting. Do not give milk, as its fat content (TCE is lipid soluble) may inhance gastrointestinal absorption of TCE. **Note to Physicians:** TCE elimination seems to be triphasic with half lives at 20 min, 3 hr, and 30 hr. Some success is seen in treating patients with propranolol, atropine, and disulfiram. Monitor urine and blood (lethal level = 3 to 110 µg/mL) metabolites. BEI = 100 mg/g creatinine (trichloroacetic acid) in urine, *sample at end of workweek.* BEI = 4 mg/L (trichloroethanol) in blood, *sample at end of shift at end of the workweek.* These tests are not 100% accurate indicators of exposure; monitor TCE in expired air as a confirmatory test.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Immediately notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off all ignition sources. For small spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable container for later disposal. For large spills, flush to containment area where density stratification will form a bottom TCE layer which can be pumped and containerized. Report any release in excess of 1000 lbs. Follow applicable OSHA regulations (29 CFR 1910.120). **Ecotoxicity Values:** Bluegill sunfish, LC_{50} = 44,700 µg/L/96 hr; fathead minnow (*Pimephales promelas*), LC_{50} = 40.7 mg/L/96 hr. **Environmental Degradation:** In air, TCE is photooxidized with a half-life of 5 days and reported to form phosgene, dichloroacetyl chloride, and formyl chloride. In water it evaporates rapidly in minutes to hours. TCE rapidly evaporates and may leach since it does not absorb to sediment. **Soil Absorption/Mobility:** TCE has a Log K_{oc} of 2, indicating high soil mobility. **Disposal:** Waste TCE can be poured on dry sand and allowed to vaporize in isolated location, purified by distillation, or returned to supplier. A potential candidate for rotary kiln incineration at 1508 to 2912 °F (820 to 1600 °C) with an acid scrubber to remove halo acids. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations
CERCLA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
Listed as a RCRA Hazardous Waste (40 CFR 261.33 & 261.31): No. U228 & F002 (*spent solvent*)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 100 lb (45.4 kg) [* per RCRA, Sec. 3001, CWA Sec. 311 (b)(4), & CWA Sec. 307 (a)]

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear chemical safety goggles (cup-type or rubber framed, equipped with impact-resistant glass), per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. At any detectable concentration, wear a SCBA with a full facepiece operated in pressure demand or other positive pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets made from Viton or Neoprene to prevent skin contact. *Do not* use natural rubber or polyvinyl chloride (PVC). **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove this material from your shoes and clean personal protective equipment. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Prevent physical damage to containers. Store in steel drums, in a cool, dry, well-ventilated area away from sunlight, heat, ignition sources, and incompatibles (Sec. 5). Store large quantities in galvanized iron, black iron, or steel containers; small amounts in dark (amber) colored glass bottles. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. Design processes so that the operator is not directly exposed to the solvent or its vapor. Do not use open electric heaters, high-temperature processes, arc-welding or open flames in TCE atmospheres. **Administrative Controls:** Consider preplacement and periodic medical exams of exposed workers with emphasis on skin, respiratory, cardiac, central and peripheral nervous systems, and liver and kidney function. Employ air and biological monitoring (BEIs). Instruct employees on safe handling of TCE.

Transportation Data (49 CFR 172.101)

Shipping Name: Trichloroethylene
Hazard Class: 6.1
ID No.: UN1710
DOT Packing Group: III
DOT Label: Keep Away From Food
DOT Special Provisions (172.102): N36, T1

Packaging Authorizations
a) Exceptions: 173.153
b) Non-bulk Packaging: 173.203
c) Bulk Packaging: 173.241

Quantity Limitations
a) Passenger Aircraft or Railcar: 60L
b) Cargo Aircraft Only: 220L

Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: 40

MSDS Collection **References:** 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 140, 148, 149, 153, 159, 163, 164, 167, 168, 171, 174, 175, 176, 180.
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** D Wilson, CIH; **Medical Review:** AC Darlington, MD

Attachment C
Emergency Procedures for Exposure to Hazardous Materials/Waste

ATTACHMENT C

EMERGENCY PROCEDURES FOR EXPOSURE TO HAZARDOUS MATERIALS/WASTE

1. Call ambulance or transport individual to hospital/clinic immediately. Don't forget to take the HASP with you; it contains information on the contaminants expected to be found on site and will assist the physician in his/her assessment of the exposure.

2. Fill in Potential Exposure Report, answering each of the questions to the best of your ability.

3. Contact our physician(s) at EMR as soon as possible. The procedure is as follows:

   a. **Call EMR at 1-800-229-3674!**

   b. Ask to speak with:

      Dr. David L. Barnes;
      Dr. Elaine Theriault; or
      Ms. T.J. Wolff, R.N.

Note: During nonbusiness hours (after 6 p.m.) call 1-800-229-3674 and follow directions for paging the aforementioned individuals.

4. Once in contact with any of these individuals, explain what has happened (they will review the information on the form with you and may ask you to fax the form to them, if possible), and allow either of them to speak with the attending physician.

5. When asked about payment (and they will ask), inform the Hospital/Clinic/Physician that this is a "work related injury" and have them contact the Benefits Coordinator at (412) 269-2744. Have invoices sent to:

   Michael Baker Jr. Inc.
   Attn: Benefits Coordinator
   Airport Office Park, Bldg. 3
   Coraopolis, PA 15108

6. Contact the Project Manager and the Project Health and Safety Officer as soon as it is feasible, but wait no longer than 24 hours.

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POTENTIAL EXPOSURE REPORT

Name: _____ Date of Exposure: _____

Social Security No.: _____ Age: _____ Sex: _____

I. Exposing Agent

Name of Product or Chemicals (if known) _____

_____

Characteristics (if the name is not known)

Solid Liquid Gas Fume Mist Vapor

II. Dose Determinants

What was individual doing? _____

How long did individual work in area before signs/symptoms developed?

_____

Was protective gear being used? If yes, what was the PPE?

_____

Was there skin contact? _____

Was the exposing agent inhaled? _____

Were other persons exposed? If yes, did they experience symptoms?

_____

III. Signs and Symptoms (check off appropriate symptoms)

Immediately with Exposure:

- ☐ Burning of eyes, nose, or throat
- ☐ Tearing
- ☐ Headache
- ☐ Cough
- ☐ Shortness of breath
- ☐ Delirium
- ☐ Chest tightness/pressure
- ☐ Nausea/vomiting
- ☐ Dizziness
- ☐ Weakness
- ☐ Heat flashes
- ☐ Other _____

Delayed Symptoms:

- ☐ Weakness
- ☐ Nausea/vomiting
- ☐ Shortness of breath
- ☐ Cough
- ☐ Loss of appetite
- ☐ Abdominal pain
- ☐ Headache
- ☐ Numbness/tingling
- ☐ Other _____

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POTENTIAL EXPOSURE REPORT

IV. Present Status of Symptoms (check off appropriate symptoms)

- ☐ Burning of eyes, nose, or throat
- ☐ Tearing
- ☐ Headache
- ☐ Cough
- ☐ Shortness of breath
- ☐ Chest tightness/pressure
- ☐ Cyanosis (bluish skin color)
- ☐ Nausea/vomiting
- ☐ Dizziness
- ☐ Weakness
- ☐ Loss of appetite
- ☐ Abdominal pain
- ☐ Numbness/tingling
- ☐ Other _____

Have symptoms (please check off appropriate response and give duration of symptoms):

Improved _____ Worsened _____ Remain Unchanged _____

V. Treatment of Symptoms (check off appropriate response)

None _____ Self-medicated _____ Physician treated _____

VI. Name _____
(Attending physician)

VII. Hospital/Clinic _____

Source: EMR, Inc.