United States
Environmental Protection
Agency

Office of
Emergency and
Remedial Response

EPA/ROD/R04-93/162
September 1993

EPA

Superfund Record of Decision:

USMC Camp Lejeune (Operable Unit ~~1~~ 2), NC

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO. EPA/ROD/R04-93/162	2	3. Recipient's Accession No.

4. Title and Subtitle
SUPERFUND RECORD OF DECISION
USMC Camp Lejeune Military Reservation (Operable Unit 4), NC
Second Remedial Action

5. Report Date 09/10/93

6.

7. Author(s)

8. Performing Organization Rept. No.

9. Performing Organization Name and Address

10. Project Task/Work Unit No.

11. Contract(C) or Grant(G) No.
(C)
(G)

12. Sponsoring Organization Name and Address
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

13. Type of Report & Period Covered 800/800

14.

15. Supplementary Notes
PB94-964015

16. Abstract (Limit: 200 words)

The 4-acre USMC Camp Lejeune Military Reservation (Operable Unit 4) site is part of a 170-square mile Marine Corps Training Base located approximately 15 miles southeast of Jacksonville, Onslow County, North Carolina. The site borders the New River to the east and an intermittent tributary to the north, and contains three classifications of wetland areas, and various protected species, such as the American alligator. The site, known as site 48, was identified as part of the Department of Defense's Installation Restoration Program (IRP). From 1956 to late 1966, site 48 reportedly was used for the disposal of approximately 1 gallon of mercury per year that had been drained from radar unit delay lines. OU4 was first identified in 1983 during an Initial Assessment Study (IAS) conducted at Camp Lejeune. In 1984, a subsequent investigation indicated the presence of low levels of mercury in soil and sediment. However, mercury was not detected during a 1991 onsite investigation. Those metals that were detected in onsite surface water were considered to be representative of background conditions. In 1992 and 1993, a detailed site investigation revealed low levels of organic and inorganic contaminants in onsite environmental media; however, mercury was not detected. An additional assessment indicated that onsite conditions do

(See Attached Page)

17. Document Analysis **a. Descriptors**
Record of Decision - USMC Camp Lejeune Military Reservation (Operable Unit 4), NC
Second Remedial Action
Contaminated Medium: None
Key Contaminants: None

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report) None	21. No. of Pages 28
	20. Security Class (This Page) None	22. Price

(See ANSI-Z39.18) *See Instructions on Reverse*

OPTIONAL FORM 272 (4-77)
(Formerly NTIS-35)
Department of Commerce

Abstract (Continued)

not pose a threat to human health and the environment. In addition, the levels of the contaminants detected were lower than their respective Federal and State standards. A 1992 ROD addressed contaminated ground water at USMC Camp Lejeune Military, as OU1. This ROD addresses the contamination in the environmental media, as OU4. Future RODs will address environmental contamination at the 10 remaining OUs at Camp Lejeune. EPA has determined that, based on the results of the health assessment, the site does not pose a current or potential threat to human health and the environment; therefore, there are no contaminants of concern affecting this site.

The selected remedial action for this site is no further action. EPA and the State have determined that the contaminants at the site do not pose any current or potential future risks to human health or the environment and, therefore, no remediation is needed. There are no present worth or O&M costs associated with this no action remedy.

PERFORMANCE STANDARDS OR GOALS:

Not applicable.

FINAL

RECORD OF DECISION FOR OPERABLE UNIT NO. 2 (SITES 6, 9, and 82)

MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

CONTRACT TASK ORDER 0133

Prepared For:

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

Under the:

LANTDIV CLEAN Program
Contract N62470-89-D-4814

Prepared By:

BAKER ENVIRONMENTAL, INC.
Coraopolis, Pennsylvania

SEPTEMBER 24, 1993

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

IN REPLY REFER TO:
6286
BEMD
10 NOV 1993

lec. EPA
NOV 2.9 1993

Ms. Gena Townsend, Project Manager
United States Environmental Protection Agency
Region IV
Attention: Camp Lejeune Remedial
345 Courtland Street
Atlanta, Georgia 30365

Dear Ms. Townsend:

On September 10, 1993, Brigadier General L. H. Livingston, Commanding General, Marine Corps Base, Camp Lejeune, signed the Record of Decision for Operable Unit #3 (Site #48). The Record of Decision for Operable Unit #2 (Sites #6, #9, and #82) was signed on September 24, 1993.

These records of decision are enclosed for your review. We appreciate your agency's concurrence and we will now proceed with the appropriate remedial designs.

If you have any questions or comments, please contact Mr. Neal Paul, Director, Installation Restoration Division, Environmental Management Department, at telephone (919) 451-5063/5068.

Sincerely,

ROBERT L. WARREN
Assistant Chief of Staff
Environmental Management Department
By direction of
the Commanding General

Encl:
(1) Record of Decision for Operable Unit No. 2
(2) Record of Decision for Operable Unit No. 3

Copy to:
COMLANTNAVFACENGCOM Code 1823 (Linda Berry)
HQMC LFL (John Burleson)

0.4.3

Statutory Determinations

This remedial action is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost-effective. In addition, this remedial action utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable and satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element. Because this remedy will result in hazardous substances remaining on site (in terms of contaminated groundwater) above health-based levels, the five-year review will be necessary for this remedial action.

Signature (Commanding General, MCB Camp Lejeune)

Sept 93
Date

addresses the principal threats remaining at the operable unit by treating contaminated groundwater and soils.

The principal threats include the potential ingestion of contaminated groundwater originating from Site 82, and the potential exposure to contaminated soil from limited areas throughout the operable unit. The primary goals of the selected remedy are: (1) to prevent current or future exposure to the contaminated groundwater and contaminated soils, (2) to remediate groundwater contamination for future potential use of the aquifer, and (3) to treat or remove contaminated soils from designated areas of concern.

The major components of the selected remedy for this operable unit include:

- Collecting contaminated groundwater in both the shallow and deep portions of the aquifer through a series of extraction wells installed within the plume areas with the highest contaminant levels.

- Treating the extracted groundwater for organics and inorganics removal via a treatment train which may consist of, but not be limited to, filtration, neutralization, precipitation, air stripping, and activated carbon adsorption.

- Discharging the treated groundwater to Wallace Creek.

- Restricting the use on nearby water supply wells which are currently inactive/closed, and restricting the installation of any new water supply wells within the operable unit area.

- Implementing a long-term groundwater monitoring program to monitor the effectiveness of the groundwater remedy and to monitor nearby supply wells that are currently active.

- Implementing in situ treatment via volatilization (or vapor extraction) of approximately 16,500 cubic yards of volatile organic compound (VOC) contaminated soils.

- Excavating approximately 2,500 cubic yards of soil primarily contaminated with polychlorinated biphenyls (PCBs) and pesticides for off-site disposal (nonhazardous).

TABLE OF CONTENTS

		Page
ACRONYMS AND ABBREVIATIONS		iv
DECLARATION		vi
1.0	SITE LOCATION AND DESCRIPTION	1
2.0	SITE HISTORY AND ENFORCEMENT ACTIVITIES	6
	Site History	6
	Previous Investigations	7
3.0	HIGHLIGHTS OF COMMUNITY PARTICIPATION	10
4.0	SCOPE AND ROLE OF THE OPERABLE UNIT	10
5.0	SITE CHARACTERISTICS	11
	Site 6	12
	Site 82	14
	Wallace Creek	14
	Bear Head Creek	15
6.0	SUMMARY OF SITE RISKS	15
	Human Health Risk Assessment	16
	Ecological Risk Assessment	18
7.0	DESCRIPTION OF ALTERNATIVES	22
	Groundwater RAAs	23
	Soil RAAs	30
8.0	SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES	35
	Groundwater RAA Comparative Analysis	35
	Soil RAA Comparative Analysis	43
9.0	SELECTED REMEDY	46
	Remedy Description	46
	Estimated Costs	47
	Remediation Goals	50
10.0	STATUTORY DETERMINATIONS	50
	Protection of Human Health and the Environment	54
	Compliance With Applicable or Relevant and Appropriate Requirements	54
	Cost-Effectiveness	54
	Utilization of Permanent Solutions and Alternative Treatment Technologies	55
	Preference for Treatment as a Principal Element	55
11.0	RESPONSIVENESS SUMMARY	55
	Overview	55
	Background on Community Involvement	56
	Summary of Comments Received During the Public Comment Period and Agency Responses	57
	Remaining Concerns	59

LIST OF TABLES

Number		Page
1	Organic Compounds Detected within Operable Unit No. 2	9
2	Summary of Potential COCs Evaluated in the Human Health Risk Assessment	17
3	Summary of Site Risks	19
4	Summary of Potential COCs Evaluated in the Ecological Risk Assessment	21
5	Glossary of Evaluation Criteria	27
6	Applicable On-Site Treatment Technologies for the Soil AOCs	33
7	Summary of Detailed Analysis - Groundwater RAAs	36
8	Summary of Detailed Analysis - Soil RAAs	38
9	Estimated Cost of Selected Remedy for Operable Unit No. 2	51
10	Remediation Goals for Contaminants of Concern	52
11	Effluent Levels for Groundwater Contaminants of Concern	53

LIST OF FIGURES

Number		Page
1	Location Map, Operable Unit No. 2, Sites 6, 9 and 82	2
2	General Arrangement Map, Sites 6, 9 and 82	3
3	General Arrangement Map, Site 9	5
4	Approximate Location of Groundwater Contamination	24
5	Approximate Location of Soil Areas of Concern	25
6	Selected Groundwater RAA: Intensive Groundwater Extraction and Treatment (RAA No. 4)	48
7	Selected Soil RAA: On-Site Treatment and Off-Site Disposal (RAA No. 7)	49

LIST OF ACRONYMS AND ABBREVIATIONS

AOC	area of concern
ARAR	applicable or relevant and appropriate requirement
AST	aboveground storage tank
Baker	Baker Environmental, Inc.
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
COC	contaminant of concern
cy	cubic yard
DoN	Department of the Navy
FDA	U.S. Food and Drug Administration
FFA	Federal Facilities Agreement
FS	Feasibility Study
gpm	gallons per minute
HI	hazard index
HQ	hazard quotient
IAS	Initial Assessment Study
ICR	incremental cancer risk
IRP	Installation Restoration Program
MBI	Macroinvertebrates Biotic Index
MCB	Marine Corps Base
MCL	Maximum Contaminant Level
NC DEHNR	North Carolina Department of Environment, Health, and Natural Resources
NCP	National Contingency Plan
NPL	National Priorities List
NPW	net present worth
O&M	operation and maintenance
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PRAP	Proposed Remedial Action Plan

QI	quotient index
RAA	remedial action alternative
RI	Remedial Investigation
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SVOC	semivolatile organic compound
TCE	trichloroethene
TCLP	Toxicity Characteristics Leaching Procedure
TRV	terrestrial reference values
TSCA	Toxic Substance Control Act
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound

DECLARATION

Site Name and Location

Operable Unit No. 2 (Sites 6, 9, and 82)
Marine Corps Base
Camp Lejeune, North Carolina

Statement of Basis and Purpose

This decision document presents the selected remedy for Operable Unit No. 2 (Sites 6, 9, and 82) at Marine Corps Base (MCB) Camp Lejeune, North Carolina which was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), and, to the extent practicable, the National Contingency Plan (NCP). This decision is based on the Administrative Record for the operable unit.

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

Assessment of the Sites

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

Description of Selected Remedy

The selected remedy for Operable Unit No. 2 is the final action to be conducted at the three sites. A Time Critical Removal Action will be implemented at the operable unit for the removal of surficial and buried drums and containers identified during the remedial investigation. These drums and containers are potential sources of soil and/or groundwater contamination. This removal action is currently in the design stage. Implementation is planned prior to the end of this year. The selected remedial action included in this ROD

addresses the principal threats remaining at the operable unit by treating contaminated groundwater and soils.

The principal threats include the potential ingestion of contaminated groundwater originating from Site 82, and the potential exposure to contaminated soil from limited areas throughout the operable unit. The primary goals of the selected remedy are: (1) to prevent current or future exposure to the contaminated groundwater and contaminated soils, (2) to remediate groundwater contamination for future potential use of the aquifer, and (3) to treat or remove contaminated soils from designated areas of concern.

The major components of the selected remedy for this operable unit include:

- Collecting contaminated groundwater in both the shallow and deep portions of the aquifer through a series of extraction wells installed within the plume areas with the highest contaminant levels.

- Treating the extracted groundwater for organics and inorganics removal via a treatment train which may consist of, but not be limited to, filtration, neutralization, precipitation, air stripping, and activated carbon adsorption.

- Discharging the treated groundwater to Wallace Creek.

- Restricting the use on nearby water supply wells which are currently inactive/closed, and restricting the installation of any new water supply wells within the operable unit area.

- Implementing a long-term groundwater monitoring program to monitor the effectiveness of the groundwater remedy and to monitor nearby supply wells that are currently active.

- Implementing in situ treatment via volatilization (or vapor extraction) of approximately 16,500 cubic yards of volatile organic compound (VOC) contaminated soils.

- Excavating approximately 2,500 cubic yards of soil primarily contaminated with polychlorinated biphenyls (PCBs) and pesticides for off-site disposal (nonhazardous).

Statutory Determinations

This remedial action is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost-effective. In addition, this remedial action utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable and satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element. Because this remedy will result in hazardous substances remaining on site (in terms of contaminated groundwater) above health-based levels, the five-year review will be necessary for this remedial action.

Signature (Commanding General, MCB Camp Lejeune) Date

1.0 SITE LOCATION AND DESCRIPTION

Marine Corps Base, Camp Lejeune is a training base for the U.S. Marine Corps, located in Onslow County, North Carolina. The Base covers approximately 170 square miles and includes 14 miles of coastline. MCB Camp Lejeune is bounded to the southeast by the Atlantic Ocean, to the northeast by State Route 24, and to the west by U.S. Route 17. The town of Jacksonville, North Carolina is located north of the Base.

The study area, Operable Unit No. 2, is one of 13 operable units within MCB Camp Lejeune. An "operable unit" (as defined by the NCP) is a discrete action that comprises an incremental step toward comprehensively addressing site problems. The cleanup of a site can be divided into a number of operable units, depending on the complexity of the problems associated with the site. Operable units may address geographical portions of a site, specific site problems, or initial phases of an action. With respect to MCB Camp Lejeune, operable units were developed to combine one or more individual sites where Installation Restoration Program (IRP) activities are or will be implemented.

Operable Unit No. 2, which covers an area of approximately 210 acres, is comprised of three IRP sites: Sites 6, 9, and 82. Operable Unit No. 2 is located approximately two miles east of the New River and two miles south of State Route 24 (see Figure 1). As shown on Figure 2, 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.

Within Site 6, there are four main areas of concern: Open Storage Lot 201; Open Storage Lot 203; a ravine; and the wooded areas which surround these storage lots (see Figure 2). Open Storage Lot 201 is a fenced lot located in the southcentral portion of Site 6. This lot is currently used to store military equipment and vehicles, lumber, hydraulic oils and lubricants, non-PCB transformers, and other supplies. Lot 201 is approximately 25 acres in size.

Open Storage Lot 203 is a fenced lot situated in the northern portion of Site 6, bordering Site 82 to the south. Based on a review of historical aerial photographs, it appears that the fenced boundaries of this lot have changed since the lot was in operation. Currently, the fenced portion of Lot 203 is approximately 41 acres in size. In the past, the storage lot was reportedly used for the disposal of various chemicals including PCBs, cleaning solvents, electrolytes from used batteries, and waste oils. Storage Lot 203 is no longer used as an active

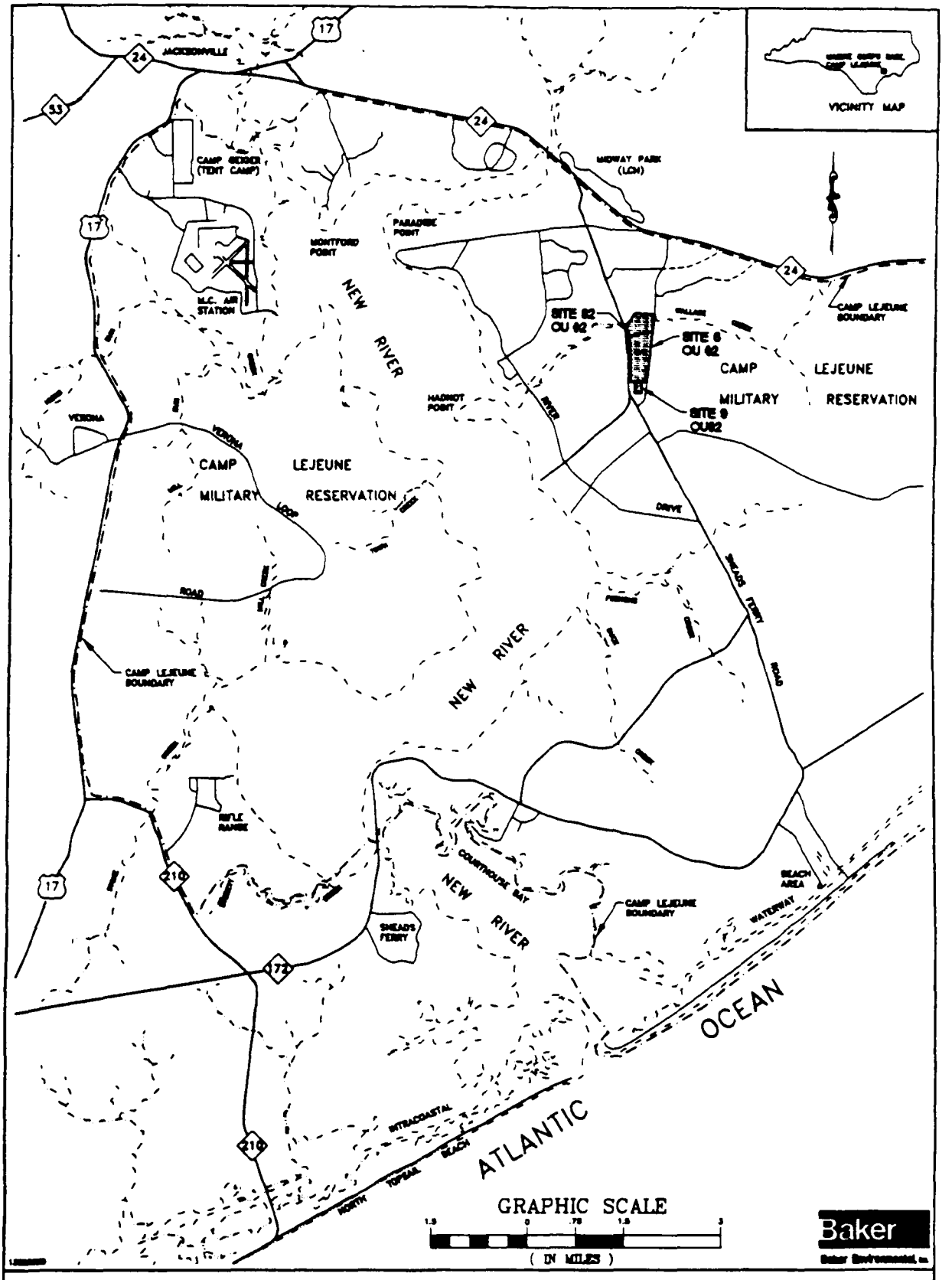
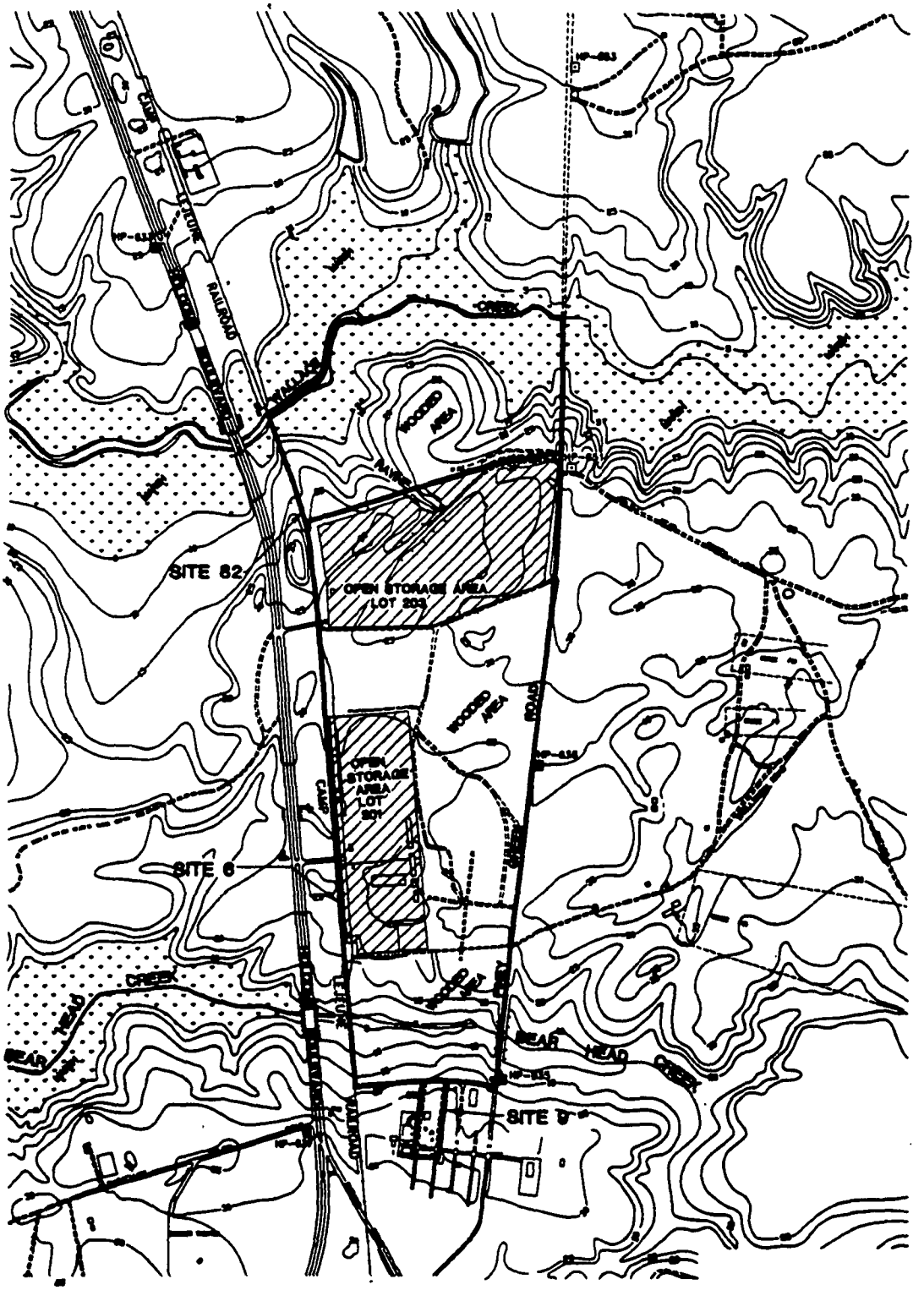


FIGURE 1
LOCATION MAP
OPERABLE UNIT No.2, SITES 6, 9 and 82
RECORD OF DECISION CTO-0133

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



LEGEND

- APPROXIMATE SITE BOUNDARIES
- OPEN STORAGE AREA
- UNPAVED ROAD
- ACTIVE WATER SUPPLY WELL
- INACTIVE WATER SUPPLY WELL

SOURCE: LANTDIV, FEBRUARY 1992

FIGURE 2
GENERAL ARRANGEMENT MAP
SITES 6, 9 and 82
RECORD OF DECISION CTO-0133

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

storage area. The lot still contains randomly stored scrap materials from former activities such as rubber rafts, shredded tires, communication wire, wooden pallets, metal debris, barbed wire fencing, and spent ammunition casings. Empty storage tanks were also identified on the lot. They were labeled as diesel fuel, gasoline, and kerosene. A large number of 55-gallon drums have been identified within Lot 203. The majority of the drums, if labeled, were identified as containing lubricants, petroleum products, or corrosives.

The ravine is located in the northwest section of Site 6 (along the northern boundary of Lot 203) and bisects Site 82. The upper portion of the ravine was, at one time, used as a disposal area. The presence of battery packs, drums, fencing, tires, wire cables, respirator cartridges, empty drums, commercial ovens, commodes, and other surficial debris is evidence of past disposal practices.

Woods and open fields surround both Storage Lots 201 and 203 and make up the remaining area of Site 6. These areas are randomly littered with debris including spent ammunition casings, and empty or rusted drums.

Site 9 is the "Fire Fighting Training Pit at Piney Green Road". The site covers an area of approximately 2.6 acres. Site 9 is bounded by Holcomb Boulevard on the west, Bear Head Creek approximately 500 feet to the north, Piney Green Road on the east and Sneads Ferry Road on the south. Site 6 also borders Site 9 to the north. Figure 2 shows the general location of Site 9. Locally, the site is bounded by unnamed streets leading to various storage buildings in the vicinity. Site 9 consists of an asphalt-lined fire training pit, an oil/water separator, four aboveground storage tanks (ASTs), three propane tanks, and a fire tower (smoke house). Figure 3 identifies the general arrangement of Site 9. The fire training pit, located in the southern area of the site, is used to conduct training exercises for extinguishing fires caused by flammable liquids. The oil/water separator is located next to the fire training pit to collect water used in the training exercises and storm water that falls into the pit. The recovered product collected in the oil/water separator is disposed of off site. Two of the ASTs at Site 9 are 2500-gallon steel tanks labeled "DO NOT USE". These tanks are not currently in use. Two additional ASTs located within a concrete containment area are currently in use. These tanks are constructed of steel and have a capacity of 500 gallons each.

Site 82, the Piney Green Road VOC Site, is located directly north and adjacent to Site 6 and encompasses approximately 30 acres (see Figure 2). The site is predominantly covered by

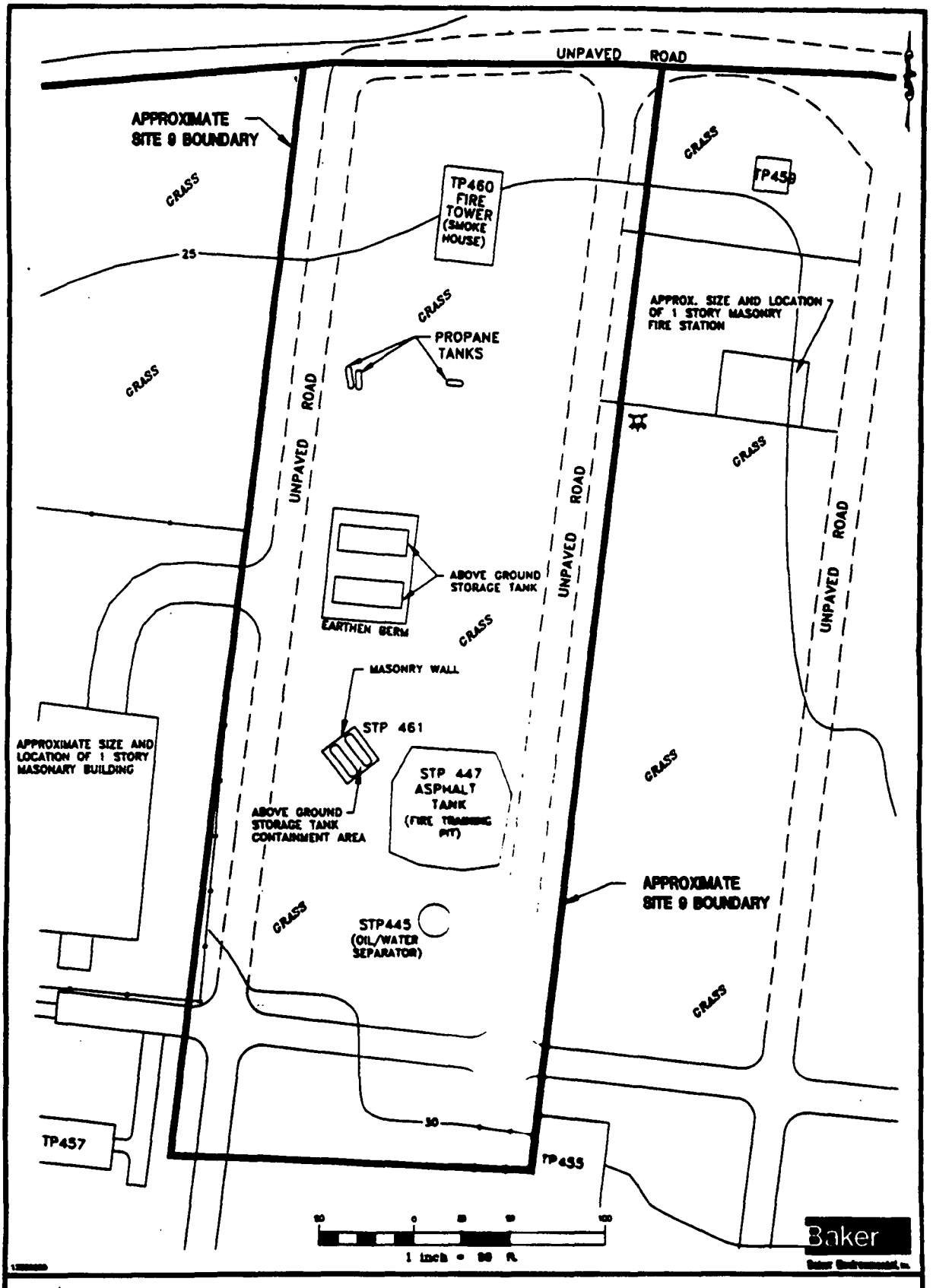


FIGURE 3
GENERAL ARRANGEMENT MAP
SITE 9
RECORD OF DECISION CTO-0133
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

SOURCE: LANTDIV, FEBRUARY 1992

woodlands and is randomly littered with debris such as communication wire, spent ammunition casings, and empty or rusted drums.

2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

This section of the ROD provides background information on each of the three sites' history and enforcement actions taken to date. Specifically, the land use history of each of the sites and the previous investigations which have been conducted are briefly discussed below.

Site History

Site 6 has a history of various uses, including the disposal and storage of wastes and supplies. 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 previously served as a waste disposal and storage area from as early as the 1940s to the late 1980s. Reports detailing disposal activities within Lot 203 are vague; there is little indication as to the types and quantities of material disposed of throughout the lot, with the exception of pesticides. 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.

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. 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.

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. No known documentation of the quantity or the location of the disposal of VOCs.

Previous Investigations

Several of the areas within Operable Unit No. 2 have been investigated for potential contamination due to Marine Corps operations and activities. A brief summary of these investigations in chronological order is presented below.

In 1983 an Initial Assessment Study (IAS) was conducted at MCB Camp Lejeune which identified a number of areas within the facility, including Sites 6 and 9, as potential sources of contamination. As a result of this study, the DoN began to contract environmental consulting firms to further investigate these sites.

During 1984 through 1987, a Confirmation Study was conducted at Operable Unit 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 National Priorities List (NPL). The DoN, the USEPA, and the North Carolina Department of Environment, Health, and Natural Resources (NC DEHNR) entered into a Federal Facilities Agreement on February 13, 1991.

In June 1991, a site investigation was conducted at Site 82. 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. Organic contamination was detected in all of the media sampled.

A Site Assessment Report was prepared 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. conducted a Remedial Investigation (RI) field program at Operable Unit No. 2 to characterize potential environmental impacts and threats to human health resulting from previous storage, operational, and disposal activities. Investigation activities commenced on August 21, 1992, and continued through November 10, 1992. The field program consisted of a preliminary site survey; an unexploded ordnance survey; a geophysical survey; a soil investigation including drilling and sampling; a groundwater investigation including monitoring well installation (shallow and deep wells) and sampling; drum waste sampling; test pit investigation; a surface water and sediment investigation; and an aquatic and ecological survey. A second phase of the investigation, focused on the groundwater contamination identified at Site 82, was conducted in early 1993 and completed by April 1993. The results of the RI are summarized below.

Levels of organic contamination including PCBs, pesticides, VOCs, and semivolatile organic compounds (SVOCs) were present throughout Operable Unit No. 2 in the various media (i.e., soil, groundwater, surface water, and sediments). Pesticides, PCBs, VOCs, and SVOCs appeared to be the predominant contaminants of concern (COCs) in soils (mostly in surface soils) and sediments. VOCs appeared to be the COCs in groundwater in both the surficial (less than 25 feet in depth) and deep (greater than 100 feet in depth) portions of the groundwater aquifer. In addition, VOCs appeared to be the COCs in the surface water. Several areas were identified within Operable Unit No. 2 which exhibited significant levels of organic contamination. These areas are located within Lot 201 (PCBs, pesticides, VOCs, and SVOCs [northeastern corner of Lot]), the ravine area (PCBs, pesticides, and SVOCs), Site 82 (VOCs and SVOCs), and Wallace Creek (VOCs). Table 1 presents a listing of the organic compounds detected within Operable Unit No. 2.

Inorganic contaminants were also present throughout Operable Unit No. 2 in the various media. The predominant inorganic COCs appeared to be barium, cadmium, chromium, lead, manganese, and zinc. These contaminants were identified in soils above background levels (i.e., compared to normal background levels for Camp Lejeune soils). In some cases, the inorganic contaminants identified in groundwater were detected above the Federal drinking water standards and/or the North Carolina Water Quality Standards. Additionally, several of these contaminants were detected above ambient water quality guidelines.

Based on the results of the various environmental investigations conducted at Operable Unit No. 2 during the RI, several areas of concern were identified. Various drums, containers, and aboveground storage tanks were noted throughout Sites 6 and 82. All surficial

TABLE 1

ORGANIC COMPOUNDS DETECTED WITHIN OPERABLE UNIT NO. 2
RECORD OF DECISION CTO-0133
MCB CAMP LEJEUNE, NORTH CAROLINA

PCBs

Aroclor-1248
Aroclor-1254
Aroclor-1260

Pesticides

4,4'-DDD
4,4'-DDE
4,4'-DDT
Alpha Chlordane
Dieldren
Endrin
Endosulfan II
Gamma Chlordane

Volatile Organic Compounds

1,1-Dichloroethene
1,2-Dichloroethane
1,1,2,2-Tetrachloroethene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
Benzene
Bromomethane
Chlorobenzene
Chloromethane
Ethylbenzene
Tetrachloroethene
Toluene
Total Xylenes
Trans-1,2-Dichloroethene
Trichloroethene
Vinyl Chloride

Semivolatile Organic Compounds

1,2-Dichlorobenzene
1,4-Dichlorobenzene
2-Methyl naphthalene
4-Methylphenol
Acenaphthylene
Anthracene
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b)fluoranthene
Benzo(g,h,i)perylene
Benzo(k)fluoranthene
Carbazole
Chrysene
Dibenzo(a,h)anthracene
Dibenzofuran
Dibenzofuran
Fluoranthene
Fluorene
Fluorene
Ideno(1,2,3-cd)pyrene
Naphthalene
Pentachlorophenol
Phenanthrane
Phenol
Pyrene

drums/containers and known buried drums will be removed from Operable Unit No. 2 through a Time Critical Removal Action which will be conducted prior to implementing any remedial alternative at the operable unit. Over 220 drums, 5 aboveground tanks, numerous small containers, and visually contaminated soils around these drums/containers will be removed during this action.

3.0 HIGHLIGHTS OF COMMUNITY PARTICIPATION

The Final Remedial Investigation (RI) and Feasibility Study (FS) Reports and the Final Proposed Remedial Action Plan (PRAP) for Operable Unit No. 2 at MCB Camp Lejeune, North Carolina were released to the public on August 23, 1993. These documents were made available to the public at information repositories maintained at the Onslow County Public Library and at the MCB Camp Lejeune Central Library. The notice of availability of the PRAP and RI/FS documents was published in the "Jacksonville Daily News" during the period August 18-24, 1993. A public comment period was held from August 24, 1993 to September 24, 1993. In addition, a public meeting was held on August 24, 1993. At this meeting, representatives from DoN/Marine Corps discussed the remedial action alternatives (RAAs) currently under consideration and addressed community concerns. Response to the comments received during the comment period is included in the Responsiveness Summary, which is part of this ROD.

This decision document presents the selected RAAs for Operable Unit No. 2 at MCB Camp Lejeune, North Carolina, chosen in accordance with CERCLA, as amended by SARA, and, to the extent practicable, the NCP. The selected decision for Operable Unit No. 2 is based on the Administrative Record.

4.0 SCOPE AND ROLE OF THE OPERABLE UNIT

The selected remedy for Operable Unit No. 2 is the final action to be conducted at the three sites. A Time Critical Removal Action will be implemented at the operable unit for the removal of surficial and buried drums/containers and aboveground storage tanks identified within the operable unit which may pose a threat to human health and/or the environment. These drums and containers are potential sources of soil and/or groundwater contamination. This removal action is currently in the design stage and will be initiated prior to the implementation of groundwater or soil remedial actions.

The selected remedial action authorized by this ROD addresses contaminated groundwater (shallow and deep) originating from Site 82 and contaminated soils throughout the operable unit. The groundwater poses a potential threat to human health and the environment because of the risks from future possible ingestion, and discharge (i.e., migration) into Wallace Creek. The contaminated soils pose a threat to human health and the environment because of the risks from exposure with the soils. The goals of the selected remedy are: (1) to prevent current or future exposure to the contaminated groundwater and contaminated soils, (2) to remediate groundwater contamination for future potential use of the aquifer, and (3) to treat or remove contaminated soils from areas of concern.

Surface water and sediment will not be addressed under this action for the following reasons:

- The overall risk to human health posed by either Wallace Creek or Bear Head Creek is low.

- The remediation of contaminated groundwater and soil at Operable Unit No. 2 will mitigate further contamination of Wallace Creek and Bear Head Creek.

- Direct treatment of surface water or sediment in either creek may result in a greater risk to the environment.

Based on studies conducted at each creek, there does not appear to be a significant impact to the benthic or fish communities. Since low levels of PCBs were detected in a few of the fish samples collected from Wallace Creek, additional studies (sampling and analysis of fish/clam tissue) are planned for Wallace Creek and Bear Head Creek to determine if there may be a bioaccumulation problem. It is not known if the PCBs are related directly to the operable unit.

5.0 SITE CHARACTERISTICS

This section of the ROD presents an overview of the nature and extent of contamination at Operable Unit No. 2 with respect to known or suspected sources of contamination, types of contamination, and affected media. Based on the results of the RI, there are several potential sources of contamination throughout Sites 6 and 82. No potential sources of contamination were identified at Site 9. The nature and extent of the contamination identified at Site 6,

Site 82 and the two nearby surface water bodies, Wallace Creek and Bear Head Creek, are itemized below.

Site 6

- The northeast corner of Lot 201 at the former pesticide storage area is contaminated with elevated 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 elevated levels of PCB (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 elevated levels of PCBs were detected in subsurface soil samples. In addition to PCBs, elevated levels of 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. No 55-gallon drums were uncovered in any of the test pit excavations. 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.

- 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.

- Groundwater quality at Lot 203 has not been significantly impacted by former disposal and storage practices. Trace levels of trichloroethene (TCE) were detected in well 6GW15, which is 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 well 6GW23.

Well 6GW23 is located in the south central portion of Lot 203. The source of VOC contamination in well 6GW23 is unknown. 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, chlorobenzene, phenol) were encountered in two wells.

- The presence of elevated 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, no elevated 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 82

- Shallow and deep 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 majority of the plume is located in the eastern half of Site 82; it also extends north of Wallace Creek and south into Lot 203. The plume appears to discharge 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 essentially defined. The horizontal extent of off-site contamination west of Site 82 (beyond well 6GW37D), however, has not been fully evaluated. Moreover, the vertical extent has been evaluated to a depth of 230 feet. It is unknown at this time whether contamination extends below 230 feet. A clay layer is present at approximately 230 feet which may impede the vertical migration of contamination.

- A large quantity of drums and debris were observed on the surface and subsurface just near monitoring wells 6GW1S and 6GW1D. 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.

- 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 the U.S. Food and Drug Administration (FDA) levels for "safe" consumption. As previously mentioned, additional fish studies are planned for Wallace Creek.

Bear Head Creek

- Sediment quality in Bear Head 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 was not 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 Bear Head Creek appears to be healthy, based on population statistics and observations. None of the fish collected at Bear Head Creek exhibited lesions or other abnormalities that would represent adverse conditions.

- The fish community in Bear Head Creek had elevated levels of pesticides, PCBs, and zinc in tissue. Additional fish studies are planned for Bear Head Creek.

6.0 SUMMARY OF SITE RISKS

As part of the RI, a Human Health Risk Assessment (Section 6.0 of the RI Report) and an Ecological Risk Assessment (under separate cover) were conducted to evaluate the current or future potential risks to human health and the environment resulting from the presence of contaminants identified at Operable Unit No. 2. A summary of the key findings from both of these studies is presented below.

Human Health Risk Assessment

The risk assessment was conducted for several environmental media including soil, groundwater, surface water, sediments, and biota. Potential contaminants of concern (COCs) for each of these media were selected based on prevalence, mobility, persistence, and toxicity. Table 2 lists the potential COCs which were identified and assessed for each media. For soil, the potential COCs included pesticides, PCBs, PAHs, and inorganics. For groundwater, the potential COCs included VOCs, phenol, and inorganics. Surface water COCs included VOCs and inorganics. Sediment COCs included VOCs, PAHs, pesticides, PCBs, and inorganics. The potential COCs for biota included pesticides, PCBs, and a few inorganics.

The exposure routes evaluated in the risk assessment included ingestion, dermal contact, and particulate inhalation of surface soils; future potential ingestion and dermal contact of groundwater; ingestion and dermal contact of surface water and sediments; and ingestion of aquatic biota. Several exposed populations were evaluated in the risk assessment with respect to both current and future potential scenarios for the operable unit. For surface soil and groundwater, civilian personnel and future on-site residents (adults and children) were retained as potentially exposed populations. Adults and adolescents were retained for surface water and sediment exposures. For aquatic biota, adults were evaluated as the potentially exposed population.

As part of the risk assessment, incremental cancer risks (ICRs) and hazard indices (HIs) were calculated for each of the exposure routes and potentially exposed populations. An ICR refers to the cancer risk that is over and above the background cancer risk in unexposed individuals. ICRs are determined by multiplying the intake level with the cancer potency factor. The risks are probabilities which are typically expressed in scientific notation (e.g., $1x10^{-6}$ or 1E-6). For example, an ICR of 1E-4 means that one additional person out of ten thousand may be at risk of developing cancer due to excessive exposure at the site if no actions are conducted. Potential concern for noncarcinogenic effects of a single contaminant in a single medium is expressed as the hazard quotient (HQ). By adding the HQs for all contaminants within a medium or across all media to which a given population may reasonably be exposed, the HI can be generated. The HI provides a useful reference point for gauging the potential significance of multiple contaminant exposures within a single medium or across media. Therefore, the HI refers to noncarcinogenic effects and is a ratio of the level of exposure to an acceptable level for all COCs. A HI greater than or equal to unity (i.e., 1.0) indicates that there may be a concern for noncarcinogenic health effects.

TABLE 2

SUMMARY OF POTENTIAL COCs EVALUATED IN THE HUMAN HEALTH RISK ASSESSMENT RECORD OF DECISION - CTO-0133 MCB CAMP LEJEUNE, NORTH CAROLINA

Contaminant	Soil	Groundwater	Surface Water	Sediment	Biota
Bromodichloromethane		X			
1,2-Dichloroethane		X			
1,1-Dichloroethene		X			
1,1,2-Trichloroethane		X			
Chlorobenzene		X			
T-1,2-Dichloroethene		X	X	X	
Tetrachloroethene		X	X		
Ethylbenzene		X			
Total Xylenes		X		X	
1,1,2,2-Tetrachloroethane		X			
1,1,1-Trichloroethane		X			
Trichloroethene		X	X		
Vinyl Chloride		X	X		
Toluene			X	X	
1,4-Dichlorobenzene	X				
Chrysene	X			X	
Acenaphthene	X				
Phenanthrene	X				
Anthracene	X				
Fluoranthene	X			X	
Pyrene	X			X	
Benzo(a)anthracene	X			X	
Benzo(b)fluoranthene	X			X	
Benzo(k)fluoranthene	X				
Benzo(a)pyrene	X			X	
Indeno(1,2,3-cd)pyrene	X				
Dibenz(a,h)anthracene	X				
Phenol		X			
4,4'-DDD	X			X	X
4,4'-DDE	X			X	X
4,4'-DDT	X			X	X
Dieldrin	X			X	
Endrin	X				X
PCB-1260	X			X	X
Antimony		X			
Arsenic	X	X	X	X	
Barium	X	X	X	X	
Beryllium		X	X	X	X
Cadmium	X		X	X	X
Chromium	X	X	X	X	
Copper		X	X	X	
Lead		X	X	X	
Manganese	X	X	X	X	
Mercury		X	X		
Nickel		X	X	X	
Vanadium	X	X	X	X	
Zinc	X	X	X	X	X

With respect to Operable Unit No. 2, all of the exposure routes/exposure populations evaluated had ICRs within the USEPA's target risk range of 10E-4 to 10E-6 except for groundwater and biota. USEPA considers the target risk range to be safe and protective of public health. Groundwater at Operable Unit No. 2 had calculated ICRs of 1.71E-4, 2.17E-4, and 3.87E-4 for future on-site residential children, civilian base employees, and future on-site residential adults, respectively. The individual risks from vinyl chloride, arsenic, and beryllium were estimated to contribute 80 percent to the total risk for all of the receptors. With respect to biota, adults who ingest fish obtained from Wallace Creek displayed an ICR value of 1.79E-3, which exceeds the USEPA's target risk range. Approximately 98 percent of this ICR value is due to the presence of PCB-1260 detected in one stripped mullet fillet. (Note: The stripped mullet is a migratory fish; therefore, the presence of PCB may not be due to contamination at Operable Unit No. 2.) The level of PCB-1260 detected in fish sample is below the FDA level for "unsafe" consumption. Additional studies along Wallace Creek will be conducted to better evaluate bioaccumulation of organic and inorganic contaminants.

The calculated HIs for all of the media combined ranged from 0.034 to 3.15. The individual HIs were below 1.0 except for groundwater which had HIs of 0.9, 1.31, and 3.0 for base personnel, future on-site residential adults, and future on-site residential children, respectively. Table 3 presents a summary of the site risks in terms of ICRs and HIs for each medium.

It is important to note that actual or threatened releases of hazardous substance from Operable Unit No. 2, if not addressed by the preferred alternative or one of the other active measures considered, may present a current or potential threat to public health, welfare, or the environment.

Ecological Risk Assessment

An Ecological Risk Assessment was conducted at Operable Unit No. 2 in conjunction with the RI. The objectives of this risk assessment were to determine if past reported disposal activities are adversely impacting the ecological integrity of Wallace Creek, Bear Head Creek, or the ravine; and to evaluate the potential effects on sensitive environments at the operable unit such as wetlands, protected species, and fish nursery areas.

TABLE 3

SUMMARY OF SITE RISKS
RECORD OF DECISION CTO-0133
MCB CAMP LEJEUNE, NORTH CAROLINA

Receptors	Surface Soils (1)		Groundwaters		Surface Waters (2)		Sediments (2)		Biota		Total (5)	
	ICR (3)	HI (4)	ICR	HI	ICR	HI	ICR	HI	ICR	HI	ICR	HI
Base Personnel	1.35E-5 [6]	0.02 [2]	2.17E-04 [94]	0.9 [98]	NA	NA	NA	NA	NA	NA	2.31E-4	0.92
Future Child Resident	1.99E-5 [10]	0.15 [5]	1.7E-4 [90]	3.0 [95]	NA	NA	NA	NA	NA	NA	1.91E-4	3.15
Future Adolescent Resident	NA	NA	NA	NA	2.7E-7 [6]	0.004 [12]	3.95E-6 [94]	0.03 [88]	NA	NA	4.12E-6	0.034
Future Adult Resident	2.54E-5 [1.15]	0.02 [0.22]	3.87E-4 [17.50]	1.31 [14.41]	6.77E-7 [0.03]	0.00 [0.0]	8.26E-6 [0.37]	0.02 [0.22]	1.79E-3 [80.95]	7.74 [85.15]	2.21E-3	9.09

Notes: (1) - Risk results associated with potential exposure to Wooded and Ravine Area surface soils
(2) - Risk results associated with potential exposure to Wallace Creek surface water and sediments
(3) - ICR = Incremental Lifetime Cancer Risk
(4) - HI = Hazard Index
(5) - Total = Surface Soils + Groundwaters + Surface Waters + Sediments + Biota

[ ] = Approximate percent contribution to the total ICR or HI value

The Ecological Risk Assessment was conducted for several environmental media including soil, surface water, sediments, and fish and crab. Table 4 lists the potential COCs which were identified and assessed in this risk assessment for each media. For soil, the potential COCs included a few VOCs, PAHs, pesticides, PCBs, and inorganics. For groundwater, the potential COCs included VOCs, phenol, and inorganics. Surface water COCs included VOCs and inorganics. Sediment COCs included VOCs, PAHs, pesticides, PCBs, and inorganics. The potential COCs for the fish and crab tissues included a few VOCs, pesticides, PCBs, and a few inorganics.

The exposure routes evaluated in the risk assessment included ingestion and dermal contact of soil, surface water, sediment, and groundwater. Several exposed populations were evaluated in the Ecological Risk Assessment. For surface water and groundwater, fish, crab, benthic macroinvertebrates, birds, and other aquatic and terrestrial life were evaluated as potentially exposed populations. Bottom feeding fish, benthic macroinvertebrates, aquatic vegetation, and other aquatic life were evaluated with respect to sediment exposure. For soil, terrestrial species were evaluated as the potentially exposed population.

Significant findings from the Ecological Risk Assessment are summarized below. Based on the concentrations of several inorganics detected in the surface water and several organics and inorganics detected in the sediment samples collected from Wallace Creek, Bear Head Creek and the ravine, the potential risk for aquatic life in the creeks to be adversely affected by chronic toxicity from the COCs may be moderate to high, provided that the exposure concentration evaluated represents long-term conditions. However, based on studies conducted to date, there does not appear to be any impact on the fish or benthic communities due to site contamination.

With respect to soil quality, the effects on terrestrial life from pesticides, PCBs, PAHs, and several of the inorganics could not be addressed in the Ecological Risk Assessment because of lack of available toxicological information. The surface soil concentrations of inorganics such as arsenic, chromium, copper, and/or zinc detected within Sites 6 and 82 exceeded published toxicological values and potentially may cause adverse effects to terrestrial life.

With respect to fish, the fish community at Wallace Creek and Bear Head Creek appeared healthy, and the population statistics did not indicate that the environment was impacted by the COCs from Operable Unit No. 2. In addition, no anomalies such as lesions, or bacterial or viral infections were observed on any fish. Fish tissue samples collected from Wallace and

TABLE 4

SUMMARY OF POTENTIAL COCs EVALUATED IN THE ECOLOGICAL RISK ASSESSMENT RECORD OF DECISION - CTO-0133 MCB CAMP LEJEUNE, NORTH CAROLINA

Contaminant	Soil	Surface Water	Sediment	Fish and Crab
Bromodichloromethane				
1,2-Dichloroethane		X	X	
1,1-Dichloroethene				
1,1,2-Trichloroethane				
Chlorobenzene				
T-1,2-Dichloroethene				
Tetrachloroethene	X	X	X	
Benzene			X	X
Ethylbenzene			X	
Total Xylenes			X	
1,1,2,2-Tetrachloroethane				
1,1,1-Trichloroethane	X			
Trichloroethene		X	X	X
Vinyl Chloride		X		
Toluene		X	X	X
Carbon Disulfide			X	
1,4-Dichlorobenzene	X			
Chrysene	X		X	
Acenaphthene				
Phenanthrene			X	
Anthracene	X			
Fluoranthene	X		X	
Pyrene	X		X	
Benzo(a)anthracene	X		X	
Benzo(b)fluoranthene	X		X	
Benzo(k)fluoranthene	X		X	
Benzo(a)pyrene	X		X	
Indeno(1,2,3-cd)pyrene	X			
Dibenz(a,h)anthracene	X			
Phenol	X		X	X
4,4'-DDD	X		X	X
4,4'-DDE	X		X	X
4,4'-DDT	X		X	X
Dieldrin	X		X	
Endrin	X		X	
PCB-1260	X		X	X
Aluminum		X	X	
Antimony				
Arsenic	X	X	X	
Barium	X	X	X	
Beryllium			X	
Cadmium	X	X	X	X
Chromium	X	X	X	
Copper	X	X	X	
Iron		X	X	
Lead	X	X	X	
Manganese		X	X	
Mercury	X	X	X	
Nickel	X	X	X	
Selenium			X	X
Silver		X	X	X
Vanadium		X	X	
Zinc	X	X	X	X

Bear Head Creeks had elevated concentrations of pesticides, PCBs, TCE, and/or zinc. The risk assessment preliminarily concluded that due to the nature of these COCs, they may be attributed to Operable Unit No. 2; however, further studies are required to verify this conclusion.

With respect to benthic macroinvertebrates, the Macroinvertebrates Biotic Index (MBI) ranged from good/fair (6.46) in the upper reaches of Wallace Creek to poor (9.8) in the lower reaches. The MBI was poor (7.06 to 7.51) in Bear Head Creek. The risk assessment concluded that the adverse habitat in both of these creeks may be created by factors not associated with COCs from Operable Unit No. 2 (e.g., the presence of a salt wedge and low dissolved oxygen).

With respect to terrestrial receptors, such as white-tailed deer, cottontail rabbit and quail, estimates of potential risk were made by comparing total exposure of the COCs to the terrestrial reference values (TRVs) using the Quotient Index (QI) method. A QI value less than 1.0 indicates a low likelihood of adverse effects. For the COCs that had available TRVs, the QI did not exceed 1.0 for any of the terrestrial receptors evaluated.

It is important to note that actual or threatened releases of hazardous substance from Operable Unit No. 2, if not addressed by the preferred alternative or one of the other active measures considered, may present a current or potential threat to public health, welfare, or the environment.

7.0 DESCRIPTION OF ALTERNATIVES

Several Remedial Action Alternatives (RAAs) have been developed to address the contaminated groundwater and/or soils at various areas of concern (AOCs) within Operable Unit No. 2. The AOCs were identified based on a comparison of the media-specific contaminant concentrations detected at the operable unit to the media-specific remediation goals developed in the FS. The AOCs identified for Operable Unit No. 2 include:

- VOC-contaminated groundwater plume (shallow and deep) originating from Site 82.
- Four small areas of groundwater contamination south and west of Open Storage Lot 203.
- Source of groundwater VOC contamination at Site 82 (referred to as Soil AOC1).

- Upper portion of the ravine at Site 6 with elevated levels of PAHs, PCBs, and metals in soil and sediment (Soil AOC2). This may be a source of contamination to Wallace Creek.

- Northcentral portion of Lot 203 with elevated levels of PCBs in soil (Soil AOC3).

- Northwestern portion of Lot 203 with elevated levels of PCBs in soil (Soil AOC4).

- Northeast corner of Lot 201 with elevated levels of pesticides in soil (Soil AOC5).

- Wooded area east of Lot 201 and adjacent to Piney Green Road with elevated levels of PCBs in soil (Soil AOC6).

Figures 4 and 5 show the general location of the above-mentioned AOCs for groundwater and soil, respectively.

No AOCs were identified within Site 9. In addition, drums and containers which have been identified at the sites are being removed from Operable Unit No. 2 through a Time Critical Removal Action. This removal action is currently in the design stage and will be conducted prior to implementing any RAA.

Based on the AOCs identified above, five groundwater RAAs and seven soil RAAs have been and evaluated. A brief overview of each of the RAAs per media is included below. All costs and implementation times are estimated.

Groundwater RAAs

The Groundwater RAAs listed below were developed and evaluated for Operable Unit No. 2.

- RAA No. 1 No Action
- RAA No. 2 Limited Action
- RAA No. 3 Containment
- RAA No. 4 Intensive Groundwater Extraction and Treatment
- RAA No. 5 Groundwater Extraction and Treatment

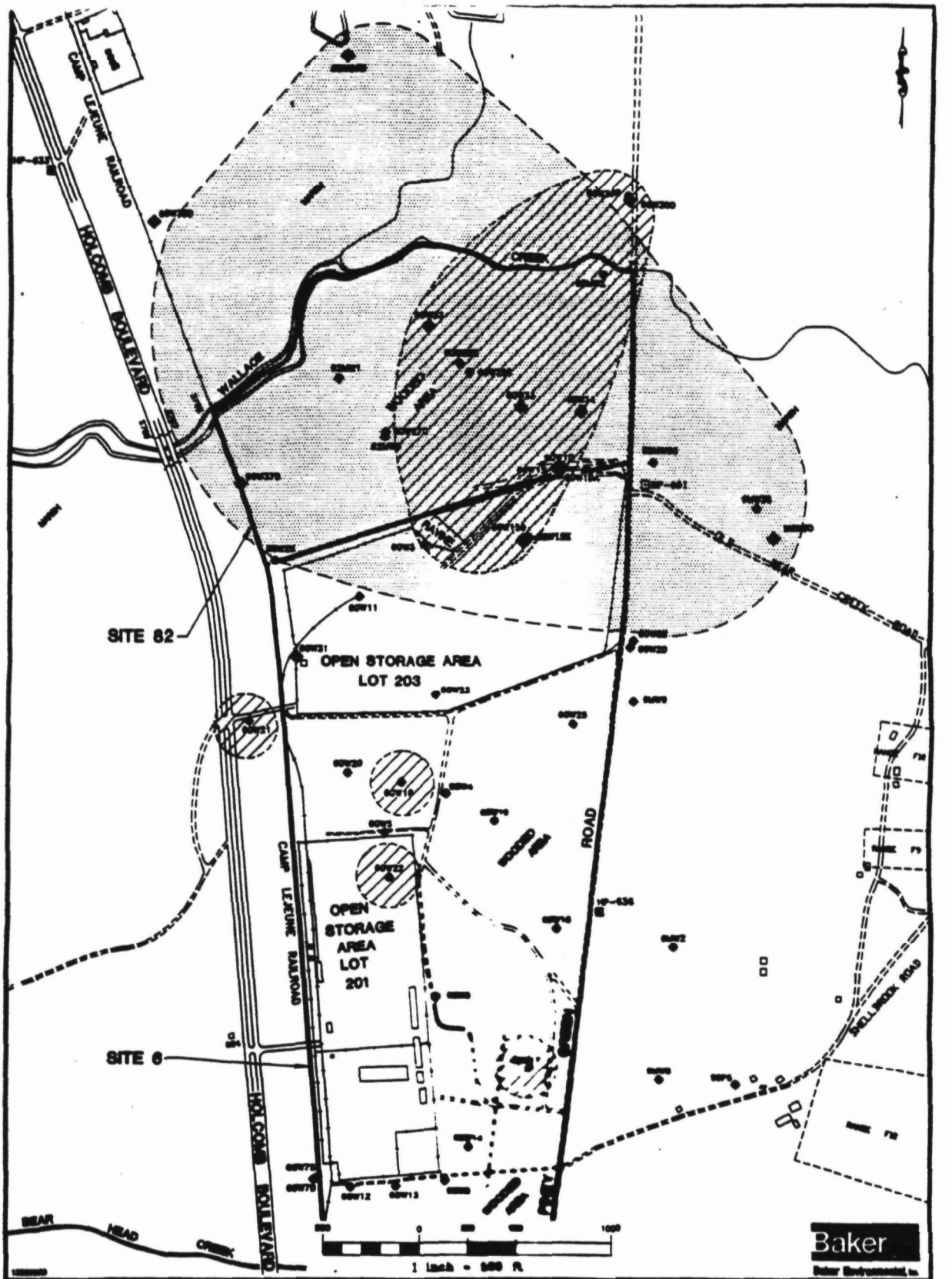


FIGURE 4
APPROXIMATE LOCATION OF
GROUNDWATER CONTAMINATION
RECORD OF DECISION CTO-0133

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

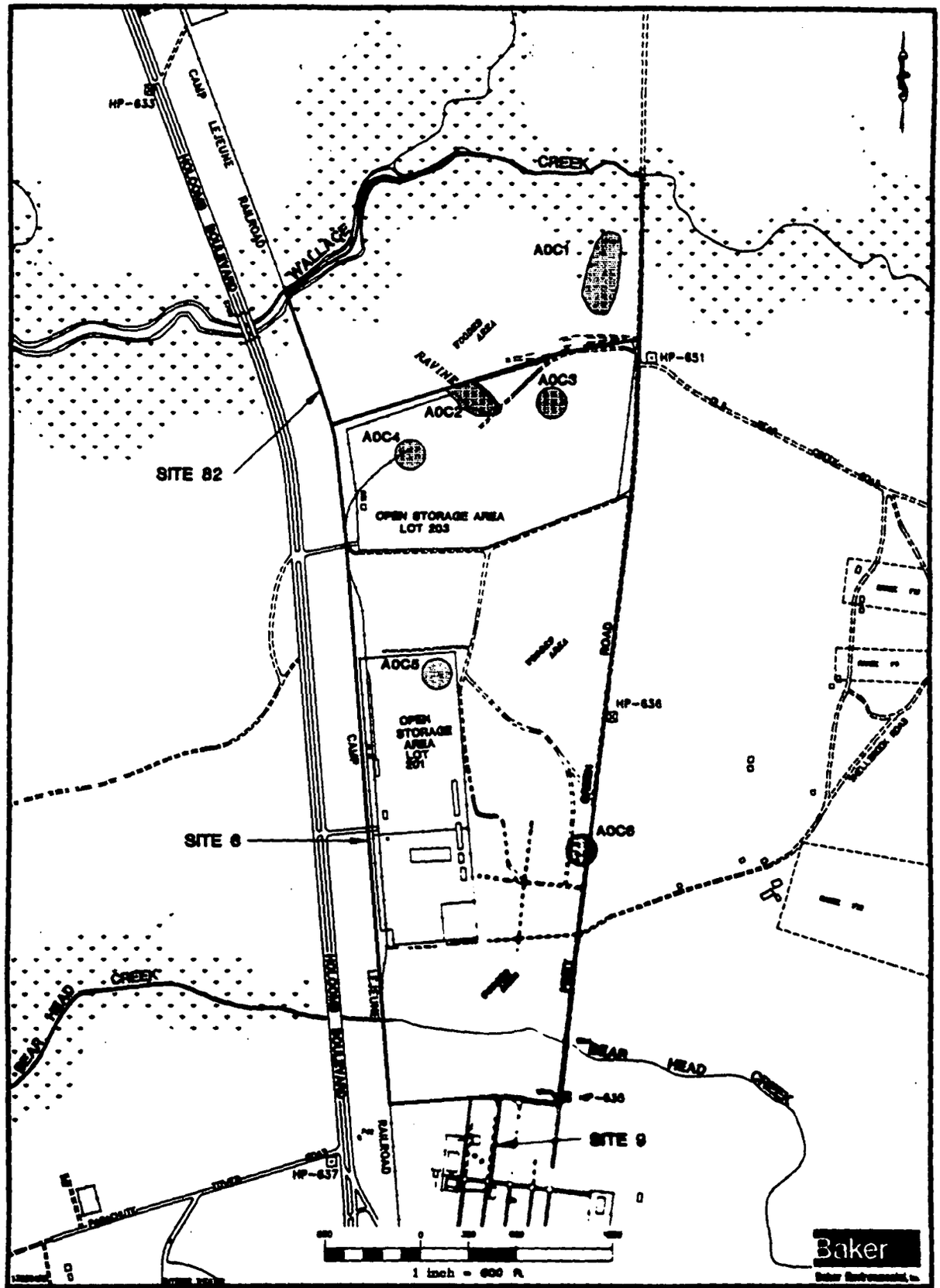


FIGURE 5
APPROXIMATE LOCATION OF
SOIL AREAS OF CONCERN
RECORD OF DECISION CTO-0133

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

Except for the "No Action" RAA, all of the Groundwater RAAs have a few common components. RAAs 2 through 5 will include institutional controls such as a long-term groundwater monitoring, aquifer-use restrictions, and deed restrictions. The monitoring activities will be conducted to gauge the effectiveness of the selected remedy and to monitor the nearby supply wells currently active. Deed restrictions will be placed on the operable unit to prohibit the installation of any new water supply wells. Aquifer-use restrictions will be implemented to control the use of existing potable water supply wells that are contaminated. RAAs 3 through 5 include the extraction and on-site treatment of contaminated groundwater followed by discharge to Wallace Creek.

A concise description of how each groundwater alternative will address the contamination at the operable unit as well as the estimated cost and timeframe to implement the alternative follows.

- **RAA No. 1: No Action**

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

  The No Action RAA is required under CERCLA to be evaluated through the nine point evaluation criteria summarized on Table 5. This RAA provides a baseline for comparison of other RAAs. Under this RAA, no further action at the operable unit will be implemented to prevent exposure to groundwater contamination.

  Potential health risks will remain and no chemical-specific applicable or relevant and appropriate requirements (ARARs) will be met. As the contaminant plumes migrates further off site, potential risks may increase if supply wells are impacted.

- **RAA No. 2: Limited Action**

  Capital Cost: $0
  Annual O&M Costs: $40,000
  NPW: $600,000
  Months to Implement: 3

  RAA No. 2 will include the three institutional controls that are common with RAA Nos. 2 through 5, as previously mentioned. The long-term monitoring program will consist of semiannual sampling and analysis of the groundwater from 21 existing

TABLE 5
GLOSSARY OF EVALUATION CRITERIA

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

- **Compliance with ARARs** - addresses whether or not an alternative will meet all of the applicable or relevant and appropriate requirements (ARARs) or other Federal and State environmental statutes and/or provide grounds for invoking a waiver.

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

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

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

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

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

- **USEPA/State Acceptance** - Evaluates the technical and administrative issues and concerns the USEPA and State have regarding each of the alternatives. This criterion is addressed in the ROD once comments on the RI/FS report and PRAP have been received.

- **Community Acceptance** - Evaluates the issues and concerns the public may have regarding each of the alternatives. This criterion is addressed in the ROD once the comments on the RI/FS report and the PRAP have been received.

monitoring wells and 3 operational water supply wells. Aquifer-use restrictions will be placed on Supply Wells 637 and 651 which are both currently inactive. Deed restrictions will be implemented which will restrict the installation of any new water supply wells within the vicinity of Operable Unit No. 2.

Under this RAA, the institutional controls, if strictly enforced, will provide protection against risk from groundwater ingestion. Chemical-specific ARARs will not be met with implementation of this RAA.

- **RAA No. 3: Containment**

Capital Cost: $2.6 million
Annual O&M Costs: $285,000
NPW: $7.0 million
Months to Implement: 15

Under RAA No. 3, the contaminated groundwater plumes (shallow and deep) originating from Site 82 will be contained to eliminate further contaminant migration via a network of extraction wells placed along the boundaries of the two plumes. Approximately six deep extraction wells will be installed to a depth of 110 feet and pumped at a rate of 150 gallons per minute (gpm). In addition, approximately six shallow extraction wells will be installed to a depth of 35 feet and pumped at a rate of 5 gpm. The extracted groundwater will be treated on site for the removal of organic and inorganic COCs via a combination of applicable treatment options (or a treatment train), and then discharged to either the New River or via injection wells into the Beaufort Aquifer. Groundwater will be treated to meet State and/or Federal standards for the protection of aquatic life (Ambient Water Quality Criteria or North Carolina Water Quality Standards), if discharged into the New River. The treatment train may consist of, but not be limited to, filtration, neutralization, precipitation, air stripping, and activated carbon adsorption. The same institutional controls included under RAA No. 2 will also be implemented under this RAA.

The overall objective of this RAA is to reduce the potential for continued groundwater contaminant migration. Even though treatment of the extracted groundwater will be conducted, the RAA will not be designed to treat all of the groundwater from all affected plume areas. Potential risks will be reduced by implementing the institutional controls and by mitigating the migration of the contaminant plumes.

- **RAA No. 4: Intensive Groundwater Extraction and Treatment**

  Capital Cost: $1.4 million
  Annual O&M Costs: $227,000
  NPW: $4.9 million
  Months to Implement: 12

  Under RAA No. 4, the contaminated groundwater (shallow and deep) originating from Site 82 with the highest level of contamination will be extracted and treated on site. A network of extraction wells will be placed in the plume areas with the highest contaminant levels. Approximately two deep extraction wells (110 feet deep) will be installed and pumped at a rate of 150 gpm. In addition, three shallow (35 feet deep) extraction wells will be installed and pumped at a rate of 5 gpm. The extracted groundwater will be treated via a treatment train similar to the one mentioned in RAA No. 3 (with the exception of size). Groundwater will be treated to meet State and Federal standards for protection of aquatic life, and discharged to Wallace Creek. The same institutional controls included under RAA No. 2 will also be implemented under this RAA.

  The overall objective of this RAA is to focus on the worst area of groundwater contamination. The rationale for this approach is that the major source areas of the groundwater contamination can be isolated and handled more feasibly than the entire area of impacted groundwater. The cones of influence created by the extraction wells are expected to reach the downgradient boundary of the plume. Groundwater extraction and treatment will be employed until the remediation goals of the aquifer are met.

- **RAA No. 5: Groundwater Extraction and Treatment**

  Capital Cost: $3.5 million
  Annual O&M Costs: $355,000
  NPW: $8.9 million
  Months to Implement: 15-20

  Under RAA No. 5, the contaminated groundwater plumes (shallow and deep) originating from Site 82 will be remediated via extraction and on-site treatment. A network of extraction wells will be placed along the boundaries and within the two plume areas. Approximately eight deep extraction wells will be installed to a depth of 110 feet and pumped at a rate of 150 gpm. In addition, approximately twelve shallow extraction wells will be installed to a depth of 35 feet and pumped at a rate of 5 gpm.

The extracted groundwater will be treated via a treatment train similar to the one mentioned in RAA No. 3 (with the exception of size). Treated groundwater will be discharged to either the New River or via injection wells into the Beaufort Aquifer. The effluent levels will meet State or Federal standards for the protection of aquatic life. The same institutional controls included under RAA No. 2 will also be implemented under this RAA.

The overall objective of this RAA is to reduce the COCs in the groundwater to drinking water standards for Class I aquifers, and to mitigate the potential for further migration of the existing groundwater plumes. The primary difference between this alternative and RAA No. 4 is that a shorter time frame is expected for meeting the remediation goals.

Soil RAAs

The Soil RAAs listed below were developed and evaluated for Operable Unit No. 2.

- RAA No. 1 No Action
- RAA No. 2 Capping
- RAA No. 3 On-Site Treatment
- RAA No. 4 Capping and On-Site Treatment (All AOCs)
- RAA No. 5 Off-Site Treatment/Disposal
- RAA No. 6 Capping and On-Site Treatment (Limited AOCs)
- RAA No. 7 On-Site Treatment and Off-Site Disposal

A concise description of how each soil alternative will address the contamination at the operable unit as well as the estimated cost and timeframe to implement the alternative follows.

- **RAA No. 1: No Action**

  Capital Cost: $0
  Annual O&M Costs: $0
  NPW: $0
  Months to Implement: None

  The No Action RAA is required under CERCLA to be evaluated through the nine point evaluation criteria (Table 5). This RAA provides a baseline for comparison. Under

this RAA, no further action at the operable unit will be implemented to prevent exposure to contaminated soil.

Potential health risks will remain and no chemical-specific ARARs will be met.

- **RAA No. 2: Capping**

  Capital Cost: $2.8 million
  Annual O&M Costs: $40,000
  NPW: $3.4 million
  Months to Implement: 6

  Soil RAA No. 2 includes the excavation and consolidation of the soils from all of the Soil AOCs and placement under a fenced multilayered cap located within Open Storage Lot 203 (Site 6). Approximately 19,000 cubic yards (cy) of contaminated soil will be excavated and spread to a thickness of one to two feet in the designated cap area located within Lot 203. A multilayered cap, with the approximate dimensions of 400 feet wide by 700 feet long, will be placed over the compiled soils. The cap will consist of a vegetated top cover, a middle drainage layer, and a low permeability bottom layer. Long-term groundwater monitoring of six existing monitoring wells will be included under this RAA. In addition, the capped area will be fenced and deed restrictions will be enforced restricting any earth-moving activities within the capped area.

  The objectives of this RAA are to consolidate the contaminated soils into one area, to prevent the potential for direct contact with the soils, and to prevent the potential for the migration of contaminants via storm water infiltration. Even though the contaminated soils will not be removed from the site, potential risks due to exposure to the COCs in the soils will be reduced as long as the cap is maintained. This alternative does not satisfy the statutory preference for treatment.

- **RAA No. 3: On-Site Treatment**

  Capital Cost: $1.5 to $6.6 million
  Annual O&M Costs: $0 to $330,000 (up to five years)
  NPW: $1.7 to $6.6 million
  Months to Implement: 15-60 (dependent on treatment option)

  RAA No. 3 includes the excavation of up to 19,000 cy of contaminated soil and treatment on site via a combination of one or more treatment options such as land

treatment, in situ volatilization, chemical dechlorination, or incineration. Land treatment would be applicable to three of the AOCs at the operable unit. In situ volatilization would be applicable to only Soil AOC1 (contaminated with VOCs); whereas chemical dechlorination would only be applicable to the three AOCs with PCBs. Mobile incineration would be applicable to all of the AOCs. Table 6 presents a listing of the technologies that are applicable to each of the six soil AOCs. For purposes of the FS, four possible combinations of these treatment options were evaluated: (1) on-site incineration of soils from all of the AOCs, (2) land treatment of soil from AOCs 1, 2, and 5 with incineration of the soil from AOCs 3, 4 and 6, (3) in situ volatilization of the soil from AOC 1 with incineration of the remaining soil, and (4) in situ volatilization of the soil from AOC 1, land treatment of soil from AOCs 2 and 5, and chemical dechlorination of soil from AOCs 3, 4 and 6.

Under this RAA, excavation of the soils removes the sources of contamination, and treatment will reduce the toxicity of the COCs. This RAA will meet the chemical-specific ARARs and will be protective of human health and the environment.

- **RAA No. 4: Capping and On-Site Treatment (All AOCs)**

  Capital Cost: $926,000
  Annual O&M Costs: $30,000 - $80,000
  NPW: $1.6 million
  Months to Implement: 12-60 (dependent on treatment option)

  Under RAA No. 4, the soils at PCB-contaminated AOCs (800 cy) will be excavated and placed under a soil cover placed within Open Storage Lot 203; and the soil from the remaining AOCs (18,200 cy) will be treated on site by a combination, or by one of the four treatment options mentioned under RAA No. 3. The excavated PCB-contaminated soils will be spread to a thickness of one to two feet in the designated cap area located within Lot 203. A soil cover, with the approximate dimensions of 200 feet by 200 feet, will be placed over the compiled soils. The soil cover will consist of a vegetative cover and a low permeability layer. Long-term groundwater monitoring of six existing monitoring wells will be included under this RAA. In addition the capped area will be fenced and deed restrictions will be enforced restricting any earth-moving activities within the capped area.

  The principle objectives of this RAA are to consolidate the PCB-contaminated (more difficult to treat) soils in one area and to treat the other contaminated soils on site.

TABLE 6

APPLICABLE ON-SITE TREATMENT TECHNOLOGIES FOR THE SOIL AOCs RECORD OF DECISION CTO-0133 MCB CAMP LEJEUNE, NORTH CAROLINA

Technology	Soil AOCs					
	1	2	3	4	5	6
Land Treatment	X	X			X	
In Situ Volatilization	X					
Chemical Dechlorination			X	X		X
Incineration	X	X	X	X	X	X

Potential risks due to exposure to the COCs in the soils will be reduced as long as the soil cover is maintained. The statutory preference for treatment is partially satisfied under this RAA.

- **RAA No. 5: Off-Site Treatment/Disposal**

Capital Cost: $5.5 million (disposal); $20.4 million (treatment)
Annual O&M Costs: $0
NPW: $5.5 million (disposal); $20.4 million (treatment)
Months to Implement: 8-12

Soil RAA No. 5 includes the excavation of soil from all of the Soil AOCs (19,000 cy) and off-site treatment and/or disposal. The treatment/disposal facility will have to be permitted to accept low levels (i.e., less than 50 parts per million) of PCBs. Based on available information, it appears that the soils can be disposed as nonhazardous waste. A possible landfill is located in Pinewood, South Carolina, approximately 200 miles away.

Potential risks due to exposure to the soil COCs will be reduced under this RAA since the contaminants are removed from the sites. The statutory preference for treatment will be satisfied if the excavated soils are treated and not just disposed.

- **RAA No. 6: Capping and On-Site Treatment (Limited AOCs)**

Capital Cost: $710,000
Annual O&M Costs: $30,000 - $80,000
NPW: $1.4 million
Months to Implement: Up to 60 months to complete

RAA No. 6 is essentially the same as Soil RAA No. 4 except that three of the Soil AOCs (Nos. 2, 3, and 6) will not be remediated. This RAA is based on a land use scenario that Operable Unit No. 2 would only be used for open storage and not residential housing (future scenario). Based on this rationale, only Soil AOC1, AOC4 and AOC5 exhibit contaminants levels exceeding the established action levels for the protection of base personnel working at the sites, and therefore, would require remediation.

Under this RAA, soils from AOC4 and AOC5 (400 cy) will be excavated and placed under a soil cover, and soils from AOC1 (16,500 cy) will be treated on site via in situ volatilization. The same soil cover and institutional controls mentioned under soil

RAA No. 4 are included under this RAA. Potential risks due to exposure to the soil COCs will be reduced as long as the soil cover is maintained.

- **RAA No. 7: On-Site Treatment and Off-Site Disposal**

  Capital Cost: $1.3 million
  Annual O&M Costs: $50,000 for 5 years
  NPW: $1.5 million
  Months to Implement: Up to 60 months to complete

  Under RAA No. 7, the soils from Soil AOC1 (16,500 cy) will be treated on site via in situ volatilization and the soils from the remaining AOCs (2,500 cy) will be excavated and disposed off site. The soils should be able to be landfilled as nonhazardous waste since the levels of PCBs detected at the site were below 50 parts per million, and the soil is not characteristically hazardous. A possible landfill is located in Pinewood, South Carolina, approximately 200 miles from Operable Unit No. 2. The details of the in situ volatilization system will be determined during the design stage.

  The objective of this RAA is to treat the largest area and the easiest to treat Soil AOC and to dispose of the more difficult to treat Soil AOCs off site. The low levels of PCBs detected in the soils do not justify on-site treatment. Under this RAA, potential risks due to contaminated soil exposure will be reduced.

8.0 SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

A detailed analysis was performed on the groundwater and soil RAAs using the nine evaluation criteria in order to select a site remedy. Tables 7 and 8 present a summary of this detailed analysis for Groundwater RAAs and Soil RAAs, respectively. A brief summary of each alternative's strengths and weaknesses with respect to the evaluation criteria follows. A glossary of the evaluation criteria has previously been noted on Table 5.

Groundwater RAA Comparative Analysis

Overall Protection of Human Health and the Environment

RAA No. 1 (No Action) does not provide protection to human health or the environment. Under the Limited Action RAA (No. 2), institutional controls would provide protection to human health, although the potential for further migration of the contaminated groundwater

TABLE 7

SUMMARY OF DETAILED ANALYSIS - GROUNDWATER RAAs
RECORD OF DECISION - CTO-0133
MCB CAMP LEJEUNE, NORTH CAROLINA

Evaluation Criteria	RAA No. 1 No Action	RAA No. 2 Limited Action	RAA No. 3 Containment	RAA No. 4 Intensive Extraction and Groundwater Treatment	RAA No. 5 Extraction and Groundwater Treatment
OVERALL PROTECTIVENESS					
• Human Health Protection	No reduction in risk.	Institutional controls provide protection against risk from groundwater ingestion.	Migration of plume mitigated. Pump and treat provide protection against risk from groundwater ingestion.	Groundwater plumes treated. Pump and treat provide protection against risk from groundwater ingestion.	Groundwater plumes treated. Pump and treat provide protection against risk from groundwater ingestion.
• Environmental Protection	Allows continued contamination of the groundwater.	Allows continued contamination of the groundwater.	Migration of contaminated groundwater is reduced by pump and treat.	Migration of contaminated groundwater is reduced by pump and treat.	Migration of contaminated groundwater is reduced by pump and treat.
COMPLIANCE WITH ARARS					
• Chemical-Specific ARARs	Will exceed Federal and/or NC groundwater quality ARARs.	Will exceed Federal and/or NC groundwater quality ARARs.	May not meet Federal and NC groundwater quality ARARs.	Should meet Federal and NC groundwater quality ARARs in time.	Should meet Federal and NC groundwater quality ARARs in time.
• Location-Specific ARARs	Not applicable.	Not applicable.	Will meet location-specific ARARs.	Will meet location-specific ARARs.	Will meet location-specific ARARs.
• Action-Specific ARARs	Not applicable.	Not applicable.	Will meet action-specific ARARs.	Will meet action-specific ARARs.	Will meet action-specific ARARs.
LONG-TERM EFFECTIVENESS AND PERMANENCE					
• Magnitude of Residual Risk	As area of contamination increases, potential risks may increase.	Risk reduced to human health since the use of the groundwater aquifer is restricted.	Risk reduced by extracting contaminated groundwater.	Risk reduced by extracting contaminated groundwater.	Risk reduced by extracting contaminated groundwater.
• Adequacy and Reliability of Controls	Not applicable - no controls.	Reliability of institutional controls is uncertain.	Groundwater pump and treat is reliable.	Groundwater pump and treat is reliable.	Groundwater pump and treat is reliable.
• Need for 5-year Review	Review would be required to ensure adequate protection of human health and the environment is maintained.	Review would be required to ensure adequate protection of human health and the environment is maintained.	Review not needed once remediation goals are met.	Review not needed once remediation goals are met.	Review not needed once remediation goals are met.

TABLE 7 (Continued)

SUMMARY OF DETAILED ANALYSIS - GROUNDWATER RAAs
RECORD OF DECISION - CTO-0133
MCB CAMP LEJEUNE, NORTH CAROLINA

Evaluation Criteria	RAA No. 1 No Action	RAA No. 2 Limited Action	RAA No. 3 Containment	RAA No. 4 Intensive Extraction and Groundwater Treatment	RAA No. 5 Extraction and Groundwater Treatment
REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT					
• Treatment Process Used	None.	None.	Treatment train for metals removal, air stripping, and activated carbon.	Treatment train for metals removal, air stripping, and activated carbon.	Treatment train for metals removal, air stripping, and activated carbon.
• Amount Destroyed or Treated	None.	None.	Majority of contaminants in groundwater out edges of plumes.	Majority of contaminants in groundwater.	Majority of contaminant in groundwater plumes.
• Reduction of Toxicity, Mobility or Volume	None.	None.	Reduced volume and toxicity of contaminated groundwater.	Reduced volume and toxicity of contaminated groundwater.	Reduced volume and toxicity of contaminated groundwater.
• Residuals Remaining After Treatment	Not applicable - no treatment.	Not applicable - no treatment.	Minimal residuals after goals are met.	Minimal residuals after goals are met.	Minimal residuals after goals are met.
• Statutory Preference for Treatment	Not satisfied.	Not satisfied.	Satisfied.	Satisfied.	Satisfied.
SHORT-TERM EFFECTIVENESS					
• Community Protection	Risks to community not increased by remedy implementation.	Risks to community not increased by remedy implementation.	Minimal, if any, risks during extraction and treatment.	Minimal, if any, risks during extraction and treatment.	Minimal, if any, risks during extraction and treatment.
• Worker Protection	No significant risk to workers.	No significant risk to workers.	Protection required during treatment.	Protection required during treatment.	Protection required during treatment.
• Environmental Impacts	Continued impacts from existing conditions.	Still would be continued migration of contamination.	Aquifer drawdown during extraction could potentially reduce flow in Wallace Creek.	Aquifer drawdown during extraction not expected to be problematic in Wallace Creek.	Aquifer drawdown during extraction could potentially reduce flow in Wallace Creek.
• Time Until Action is Complete	Not applicable.	Risks from potential groundwater ingestion reduced within 3 to 6 months due to institutional controls.	Estimated 30 years.	Estimated 30 years.	Estimated 30 years.
IMPLEMENTABILITY					
• Ability to Construct and Operate	No construction or operation activities.	No construction or operation activities.	Groundwater extraction and treatment systems requires installation.	Groundwater extraction and treatment systems requires installation.	Groundwater extraction and treatment systems requires installation.
• Ability to Monitor Effectiveness	No monitoring. Failure to detect contamination will result in potential ingestion of contaminated groundwater.	Proposed monitoring will give notice of failure before significant exposure occurs.	Adequate system monitoring.	Adequate system monitoring.	Adequate system monitoring.
• Availability of Services and Capacities; Equipment	None required.	None required.	Needs groundwater treatment equipment.	Needs groundwater treatment equipment.	Needs groundwater treatment equipment.
COSTS NPW	$0	$600,000	$7.0 million	$4.9 million	$8.9 million

TABLE 8

SUMMARY OF DETAILED ANALYSIS - SOIL RAAs
RECORD OF DECISIONS - CTO-0133
MCB CAMP LEJEUNE, NORTH CAROLINA

Evaluation Criteria	RAA No. 1 No Action	RAA No. 2 Capping	RAA No. 3 On-Site Treatment	RAA No. 4 Capping and On-Site Treatment (All Areas of Concern)	RAA No. 5 Off-Site Treatment	RAA No. 6 Capping and On-Site Treatment (Limited Areas of Concern)	RAA No. 7 On-Site Treatment, Off-Site Disposal
OVERALL PROTECTIVENESS							
• Human Health Protection	No reduction in risk.	Would reduce potential for direct contact with contaminated soil.	Excavation removes source of contamination.	Reduces potential for direct contact with PCB-contaminated soil and removes other contaminated soils.	Excavation removes source of contamination.	Reduces potential for direct contact with PCB-contaminated soil and removes other contaminated soils - based on existing land use scenario.	Excavation and/or treatment removes source of contamination
• Environmental Protection	Allows contaminated soils to remain on site.	Allows contaminated soils to remain on site.	No additional environmental impacts.	No additional environmental impacts.	Contaminated soils exceeding remediation goal removed and treated.	No additional environmental impacts.	No additional environmental impacts.
COMPLIANCE WITH ARARs							
• Chemical-Specific ARARs	Will exceed ARARs.	Will exceed ARARs.	Will meet contaminant-specific ARARs.	PCB ARAR not met; other contaminant-specific ARARs met.	Will meet ARARs.	PCB ARAR not met; other contaminant-specific ARARs met (with respect to existing land use scenario).	Will meet ARARs.
• Location-Specific ARARs	Not applicable.	Will meet location-specific ARARs.	Will meet location-specific ARARs.	Will meet location-specific ARARs.	Will meet location-specific ARARs.	Will meet location-specific ARARs.	Will meet location-specific ARARs.
• Action-Specific ARARs	Not applicable.	Will meet action-specific ARARs.	Will meet action-specific ARARs.	Will meet action-specific ARARs.	Will meet action-specific ARARs.	Will meet action-specific ARARs.	Will meet action-specific ARARs.
LONG-TERM EFFECTIVENESS AND PERMANENCE							
• Magnitude of Residual Risk	Source has not been removed. Potential risks not reduced.	Contaminated soils are not removed from the site, but potential risk due to exposure to COCs are reduced as long as the cap is maintained.	Potential risk due to exposure to soil COCs removed.	Potential risks reduced as long as the cover is maintained.	Potential risk due to exposure to soil COCs removed.	Potential risks with respect to existing land use scenario reduced as long as the cap is maintained.	Potential risk due to exposure to soil COCs removed.
• Adequacy and Reliability of Controls	Not applicable - no controls.	Multilayered cap controls contaminated soil - can be a reliable option if maintained properly.	All treatment options are reliable.	Soil cover can be reliable and adequate. Treatment option reliable and adequate.	Off-site treatment is very reliable because contaminated soils are removed.	Soil cover can be reliable and adequate. Treatment option reliable and adequate.	Treatment option and off-site disposal are reliable.
• Need for 5-year Review	Review would be required to ensure adequate protection of human health and the environment is maintained.	Review would be required to ensure adequate protection of human health and the environment is maintained.	Review may not be needed since contaminated soil treated (unless treatment process lasts longer than 5 years).	Review would be required to ensure adequate protection of human health and the environment is maintained.	Review not needed since contaminated soil removed.	Review would be required to ensure adequate protection of human health and the environment is maintained.	Review may not be needed since contaminated soil treated (unless treatment process lasts longer than 5 years).

TABLE 8 (Continued)

SUMMARY OF DETAILED ANALYSIS - SOIL RAAs
RECORD OF DECISION - CTO-0133
MCB CAMP LEJEUNE, NORTH CAROLINA

Evaluation Criteria	RAA No. 1 No Action	RAA No. 2 Capping	RAA No. 3 On-Site Treatment	RAA No. 4 Capping and On-Site Treatment (All Areas of Concern)	RAA No. 5 Off-Site Treatment	RAA No. 6 Capping and On-Site Treatment (Limited Areas of Concern)	RAA No. 7 On-Site Treatment, Off-Site Disposal
REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT • Treatment Process Used	None.	None.	Combination of land treatment, in situ volatilization, chemical dechlorination, and/or incineration.	In situ volatilization, land treatment, or incineration.	Off-site treatment.	In situ volatilization, land treatment, or incineration.	In situ volatilization, off-site disposal.
• Amount Destroyed or Treated	None.	None.	Majority of soil COCs.	Majority of soil COCs with the exception of PCBs.	Majority of soil COCs.	Majority of soil COCs with the exception of PCBs.	Majority of soil COCs.
• Reduction of Toxicity, Mobility or Volume	None.	None (not through treatment).	Reduction in toxicity, mobility and volume of contaminated soil.	Reduction in toxicity, mobility and volume of non-PCB contaminated soils.	Reduction in toxicity, mobility and volume of contaminated soil.	Reduction in toxicity, mobility and volume of non-PCB contaminated soils.	Reduction in toxicity, mobility and volume of contaminated soil.
• Residuals Remaining After Treatment	Not applicable - no treatment.	Residuals are capped.	No residuals.	Only PCB-contaminated soils remain at sites.	No residuals.	PCB-contaminated soils and some other soil COCs.	No residuals.
• Statutory Preference for Treatment	Not satisfied.	Not satisfied.	Satisfied.	Satisfied for non-PCB contaminated soils, not for PCB-contaminated soils.	Satisfied.	Satisfied for non-PCB contaminated soils, not for PCB-contaminated soils (with respect to existing land use scenario).	Satisfied.
SHORT-TERM EFFECTIVENESS • Community Protection	Risks to community not increased by remedial implementation	Temporary potential risks during soil excavation and cap installation activities	Limited potential risks during soil excavation and treatment activities	Temporary potential risks during soil excavation and cap installation activities and treatment activities.	Limited potential risks during soil excavation activities.	Temporary potential risks during soil excavation and cap installation activities and treatment activities.	Limited potential risks during soil excavation and treatment activities.
• Worker Protection	No significant risks to workers	Temporary potential risks during soil excavation and cap installation activities.	Potential risks during soil excavation and treatment activities.	Temporary potential risks during soil excavation and cap installation activities and treatment activities.	Potential risks during excavation and transportation activities.	Temporary potential risks during soil excavation and cap installation activities and treatment activities.	Potential risks during soil excavation and treatment activities.
• Environmental Impacts	Continued impacts from existing conditions.	No additional environmental impacts.	Air quality and odors - but treatment system will be designed to meet standards.	Air quality and odors - but treatment system will be designed to meet standards and treatment activities.	No additional environmental impacts.	Air quality and odors - but treatment system will be designed to meet standards.	Air quality and odors - but treatment system will be designed to meet standards.
• Time Until Action is Complete	Not applicable.	Six to twelve months.	Up to five years.	Up to five years.	Six to twelve months.	Up to five years.	Up to five years.

TABLE 8 (Continued)

SUMMARY OF DETAILED ANALYSIS - SOIL RAAs
RECORD OF DECISION - CTO-0133
MCB CAMP LEJEUNE, NORTH CAROLINA

Evaluation Criteria	RAA No. 1 No Action	RAA No. 2 Capping	RAA No. 3 On-Site Treatment	RAA No. 4 Capping and On-Site Treatment (All Areas of Concern)	RAA No. 5 Off-Site Treatment	RAA No. 6 Capping and On-Site Treatment (Limited Areas of Concern)	RAA No. 7 On-Site Treatment, Off-Site Disposal
IMPLEMENTABILITY							
• Ability to Construct and Operate	No construction or operation activities.	Simple to construct and maintain. Requires materials handling procedures.	Requires soil excavation activities. Requires assembly of treatment systems.	Simple to construct and maintain. Requires materials handling procedures. Requires soil excavation activities. Requires assembly of treatment systems.	Requires soil excavation activities. No other on-site operations.	Simple to construct and maintain. Requires materials handling procedures. Requires soil excavation activities. Requires assembly of treatment systems.	Requires soil excavation activities. Requires assembly of treatment systems.
• Ability to Monitor Effectiveness	No monitoring included.	Cap maintenance and groundwater monitoring will adequately monitor effectiveness.	Adequate system monitoring.	Adequate system monitoring.	No monitoring other than confirmation soil sampling.	Adequate system monitoring.	Adequate system monitoring.
• Availability of Services and Capacities; Equipment	None required.	No special services or equipment required. Cap materials should be readily available.	May need on-site mobile incinerator.	Equipment and material should be readily available.	Needs off-site treatment services.	Equipment and material should be readily available.	Equipment and material should be readily available. Needs off-site disposal services.
COSTS NPW	$0	$3.4 million	$1.7 million to $6.6 million	$1.6 million	$5.5 million to $20 million	$1.4 million	$1.5 million

would still exist. All of the remaining Groundwater RAAs provide some protection of human health and the environment. RAA No. 3 provides protection through preventing further migration of the contaminated groundwater plume. RAA No. 4 provides protection through removing and treating the most contaminated areas of groundwater contamination. RAA No. 5 provides the quickest method of protection since both migration is prevented and also the most contaminated areas are treated. It should be noted that RAAs Nos. 4 and 5 may result in complete restoration of the plume over time; however, remediation will continue for many years due to the magnitude and complexity of the groundwater problem.

Compliance with ARARs

RAA Nos. 1 and 2 would potentially exceed Federal and State ARARs. RAA Nos. 3, 4, and 5 would potentially meet all of their respective ARARs for the treated effluent. RAA No. 3 would not meet ARARs associated with a Class I aquifer. In time, RAA Nos. 4 and 5 would meet the remediation goals for a Class I aquifer.

Low levels of VOCs and the inorganics lead, chromium, and manganese in shallow groundwater were detected at "random" locations throughout Site 6, including background wells. No source of this contamination was evident. A waiver to not meet ARARs for groundwater under Site 6 would be required on the basis that it would not be technically feasible to remediate "random" areas of groundwater contamination from an engineering perspective. These wells would be periodically monitored as part of RAA Nos. 3, 4, and 5.

Long-term Effectiveness and Permanence

RAA No. 1 would not reduce potential risks due to exposure to contaminated groundwater. Risks would be reduced under RAA Nos. 2 through 5 through the implementation of the institutional controls and/or treatment. The reliability of enforcing aquifer-use restrictions is effective. RAA Nos. 3 through 5 would provide additional long-term effectiveness and permanence because they use a form of treatment to reduce the potential hazards posed by the COCs present in the groundwater aquifer.

With respect to the adequacy and reliability of controls, the groundwater pump and treat systems included under RAA Nos. 3, 4, and 5 should be reliable and adequate. The institutional controls included under RAA Nos. 2 through 5 would be reliable and adequate if strictly enforced. RAA No. 1 does not include any type of controls.

Initially, all of the RAAs would require a 5-year review to ensure that adequate protection of human health and the environment is being maintained. RAA No. 5 would be the first RAA that would not need the 5-year review (i.e., once the remediation goals are met).

Reduction of Toxicity, Mobility, or Volume of the Contaminants Through Treatment

RAA Nos. 3, 4, and 5 include treatment such as air stripping, activated carbon adsorption, and metals removal. RAA Nos. 1 and 2 do not include any form of treatment. RAA Nos. 3, 4, and 5 would satisfy the statutory preference for treatment and would provide reduction of toxicity, mobility and/or volume of contaminants in the groundwater.

Short-term Effectiveness

Risks to community and workers are not increased with the implementation of RAA Nos. 1 and 2. Current impacts from existing conditions would continue under these two RAAs. Under RAA Nos. 3, 4, and 5, risks to the community and workers would be slightly increased due to a temporary increase in dust production and volatilization during the installation of the piping for the groundwater treatment system (during treatment operations for the workers). In addition, aquifer draw down would occur under RAA Nos. 3, 4, and 5. Discharge of the treated effluent to Wallace Creek under RAA No. 4 is not expected to increase risks to the aquatic habitat.

Implementability

No construction, operation, or administrative activities are associated with RAA No. 1. There are no construction or operation activities associated with RAA No. 2 other than groundwater sampling which is easily performed. The remaining RAAs would require operation of a groundwater pump and treatment system which can be labor intensive. In addition, these RAAs would be required to meet the substantive requirements of an NPDES permit for discharging the treated effluent. Under RAA No. 4, the treated effluent can be discharged to Wallace Creek without significant impacts to flow or ecological risks. However, due to the volume of flow anticipated under RAA Nos. 3 and 5, the treated effluent would need to be discharged to the New River or via deep injection wells.

Cost

In terms of cost-effectiveness, RAA No. 1 has the lowest estimated NPW ($0), followed by RAA No. 2 ($600,000), RAA No. 4 ($4.9 million), RAA No. 3 ($7.0 million), and RAA No. 5 ($8.9 million).

USEPA/State Acceptance

Both the USEPA and the NC DEHNR had concerns that the No Action Alternative (RAA No. 1) and the Limited Action Alternative (RAA No. 2) would not be protective since high levels of COCs would remain in the deeper portions of the aquifer (which is a potable water supply source). Both agencies were in favor of the treatment options involving restoration of the aquifer (i.e., RAA Nos. 4 and 5), but had concerns regarding the impacts to Wallace Creek due to the discharge. Under RAA No. 4, the impacts to Wallace Creek were not significant due to the lower discharge rate. Both USEPA and the North Carolina DEHNR concurred with the selected remedy.

Community Acceptance

Based on the comments received during the public meeting and public comment period, the public does not appear to be opposed to the remedy selected for Operable Unit No. 2.

Soil RAA Comparative Analysis

Overall Protection of Human Health and the Environment

Soil RAA Nos. 3 (On-Site Treatment), 5 (Off-Site Treatment/Disposal), and 7 (On-Site Treatment and Off-Site Disposal) would provide the highest level of protection to human health and the environment since the soil contaminated at levels above the remediation goals will be excavated and/or treated. RAA Nos. 4 and 6 (Capping and On-Site Treatment) would provide the next highest degree of protection to human health and the environment since some of the contaminated soils would be treated on site and the remaining soils above the remediation goals would be capped (which will prevent exposure via direct contact). RAA No. 2 (Capping) will provide the next highest degree of protection since the potential for direct contact with the contaminated soils would be reduced via the placement of a cap. RAA No. 1 (No Action) provides no protection to human health or the environment.

Compliance with ARARs

RAA Nos. 1, 2, 4, and 6 would not meet all of the chemical-specific ARARs for the soil COCs remaining at the sites. RAA Nos. 3, 5, and 7 would meet all of the chemical-specific ARARs. Action-specific and location-specific ARARs should be met by all of the RAAs evaluated.

Long-term Effectiveness and Permanence

The treatment RAAs (Nos. 3, 5, and 7) would have the highest level of long-term effectiveness and permanence since the soils contaminated with COCs at levels above the remediation goals will be treated. The partial capping/partial treatment RAAs (Nos. 4 and 6) would have the next highest level of effectiveness and permanence since the majority of contaminated soils will be treated. Capping of soils can have long-term effectiveness if the cap or cover is adequately designed and maintained. Capping is not considered a permanent option. Therefore, RAA No. 2 would have the next highest level of long-term effectiveness and permanence, followed by RAA No. 1 (No Action).

With respect to the adequacy and reliability of controls, RAA No. 5 (Off-Site Treatment/Disposal) would have the highest rating since only common earth moving equipment would be required at the sites. The treatment options included under RAAs 3, 4, 6, and 7 would have adequate controls. Capping included under RAA No. 2 can be a reliable control option if properly maintained. The soil cover included under RAA Nos. 4 and 6 can be a reliable control option for preventing dermal contact if properly maintained. RAA No. 1 does not include any type of controls.

RAA No. 5 would not require a 5-year review since all of the contaminated soils will be removed from the sites. RAA Nos. 3 and 7 may require a 5-year review based on the duration of the treatment process. RAA Nos. 2, 4, and 6 would require a 5-year review to ensure that adequate protection of human health and the environment is being maintained through use of the cap/cover. RAA No. 1 would require a 5-year review to ensure that the existing conditions at the sites are not deteriorating.

Reduction of Toxicity, Mobility, or Volume of the Contaminants Through Treatment

RAA No. 3 (On-Site Treatment) includes complete treatment of all soils with COCs above the remediation goals. RAA No. 5 (Off-Site Treatment/Disposal) may include complete treatment of all the excavated soils, but if applicable, this option may not include any form of treatment, only disposal (i.e., if all of the wastes are nonhazardous or if the level of contamination is below RCRA land disposal restrictions for hazardous soils). The partial treatment alternatives (RAA Nos. 4, 6, and 7) would include some form of treatment (e.g., in situ volatilization, land treatment, or incineration) for the majority of the contaminated soil. RAA Nos. 1 and 2 do not include any form of treatment.

Short-term Effectiveness

It is not expected that the implementation of any of the RAAs would cause adverse effects to human health and the environment. Workers could be exposed to contaminated soils during excavation activities which are applicable to RAA Nos. 2 through 7; installation of caps/covers which are applicable to RAA Nos. 2, 4, and 6; and operation of the treatment systems which are applicable to RAA Nos. 3, 4, 6, and 7. Implementation of appropriate worker health and safety precautions would mitigate any threat. No adverse threats to the community are anticipated. No additional environmental impacts are expected.

Implementability

All of the RAAs are technically feasible, and therefore implementable. Since no actions are associated with RAA No. 1, it would be the easiest to implement. In terms of technical implementability, the next easiest RAA to implement would be RAA No. 5 since it only requires common soil excavation and hauling activities. RAA No. 2 would be the next easiest RAA to technically implement, since it includes soil excavation and other earth moving activities (i.e., capping). The remaining RAAs (Nos. 3, 4, 6, and 7) should be relatively the same to implement. Note that RAAs 3, 4, 6, and 7 would require some type of treatability testing. In terms of administrative feasibility, RAA Nos. 5 and 7 may be more difficult to implement due to the unknown availability/capacity of an appropriate treatment/disposal facility.

Cost

In terms of cost-effectiveness, RAA No. 1 has the lowest estimated NPW ($0); followed by RAA No. 6 ($1.4 million); RAA No. 7 ($1.5 million); RAA No. 4 ($1.6 million); RAA No. 2 ($3.4 million), RAA No. 5 ($5.5 million for disposal), and RAA No. 5 ($20.4 million for treatment). The NPW for the four treatment combination options under RAA No. 3 ranged from $1.7 million to $6.6 million.

USEPA/State Acceptance

The USEPA or the NC DEHNR did not express any major concerns over any of the alternatives. They are in favor of alternatives which include some form of treatment. Both USEPA and NC DEHNR concurred with the selected remedy for the contaminated soils.

Community Acceptance

Based on the comments received during the public meeting and public comment period, the public does not appear to be opposed to the remedy selected for Operable Unit No. 2.

9.0 SELECTED REMEDY

This section of the ROD focuses on the selected remedy for Operable Unit No. 2. The major treatment components, engineering controls, and institutional controls of the remedy will be discussed along with the estimated costs to implement the remedial action. In addition, the remediation goals to be attained at the conclusion of the remedial action will be discussed.

Remedy Description

The selected remedy for Operable Unit No. 2 is a combination of Groundwater RAA No. 4 (Intensive Groundwater Extraction and Treatment) and Soil RAA No. 7 (On-Site Treatment and Off-Site Disposal). Overall, the major components of the selected remedy include:

- Collecting contaminated groundwater in both the shallow and deep portions of the aquifer through a series of extraction wells installed within the plume areas with the highest contaminant levels. Approximately two deep extraction wells will be installed

to a depth of 110 feet and pumped at a rate of 150 gpm. In addition, three shallow extraction wells will be installed to a depth of 35 feet and pumped at a rate of 5 gpm.

- Treating the extracted groundwater for organics and inorganics removal via a treatment train which may consist of, but not be limited to, filtration, neutralization, precipitation, air stripping, and activated carbon adsorption.

- Discharging the treated groundwater to Wallace Creek.

- Restricting the use on nearby water supply wells which are currently inactive/closed (Nos. 637 and 651), and restricting the installation of any new water supply wells within the operable unit area.

- Implementing a long-term groundwater monitoring program to monitor the effectiveness of the groundwater remedy and to monitor the nearby water supply wells that are currently active. Under this monitoring program, groundwater from 21 existing monitoring wells and 3 nearby supply wells (Nos. 633, 635, and 636) will be collected on a semiannual basis and analyzed for Target Compound List volatiles. Additional wells may be added to the monitoring program, if necessary.

- Implementing in situ treatment via volatilization (or vapor extraction) of approximately 16,500 cubic yards of VOC-contaminated soils.

- Excavating approximately 2,500 cubic yards of PCB and pesticide contaminated soils for off-site disposal (nonhazardous). A possible off-site landfill is located in Pinewood, South Carolina, approximately 200 miles away from the operable unit.

The proposed locations of the major components of the selected remedy are presented on Figures 6 and 7.

Estimated Costs

The estimated capital costs associated with the selected remedy is approximately $2.8 million. Annual O&M costs of approximately $227,000 are projected for the operation of the groundwater treatment system and the sampling of the monitoring wells and supply wells. This annual cost is for 30 years. The annual O&M cost projected for the operation of the in situ

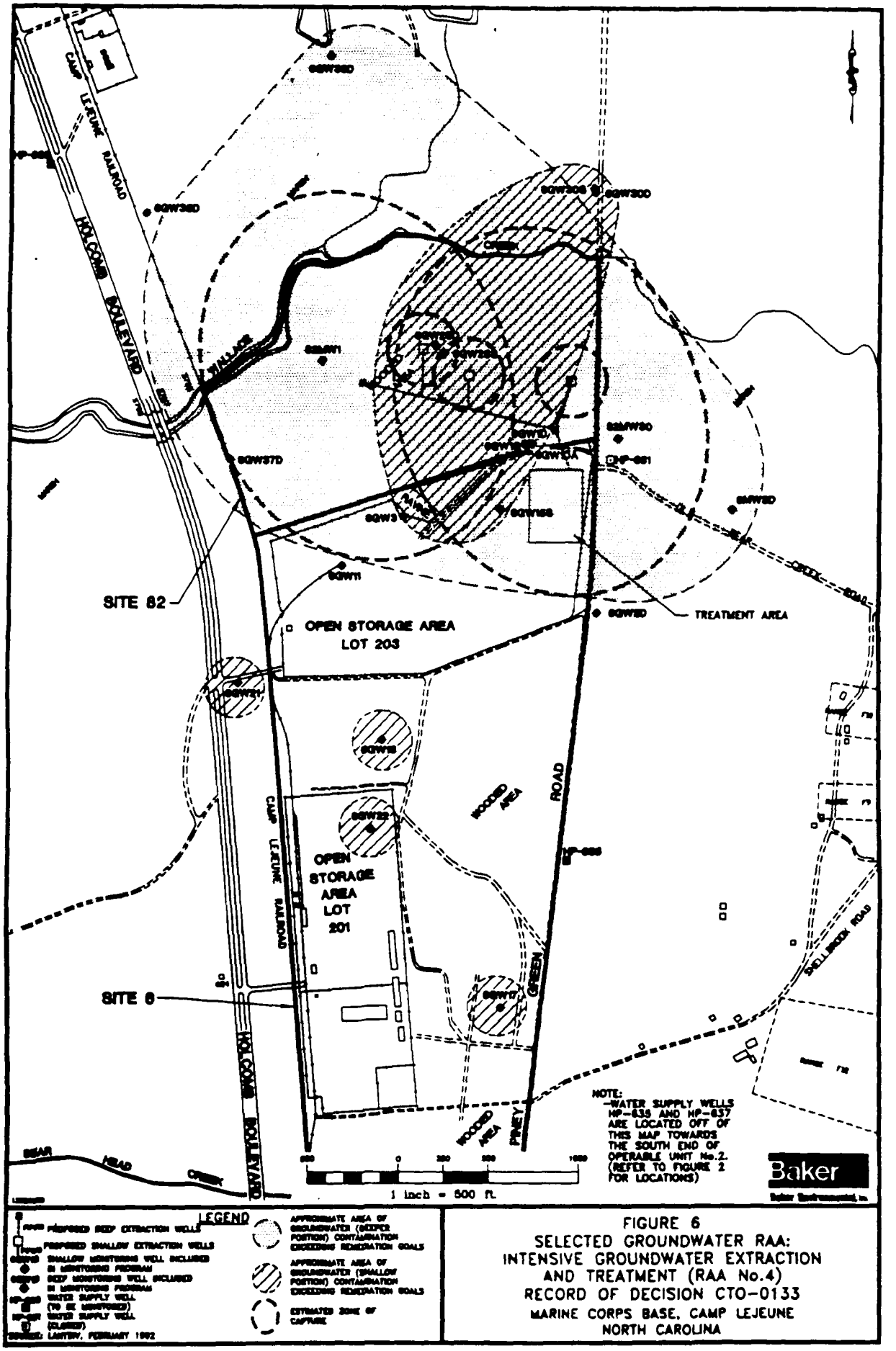


FIGURE 6
SELECTED GROUNDWATER RAA:
INTENSIVE GROUNDWATER EXTRACTION AND TREATMENT (RAA No.4)
RECORD OF DECISION CTO-0133
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

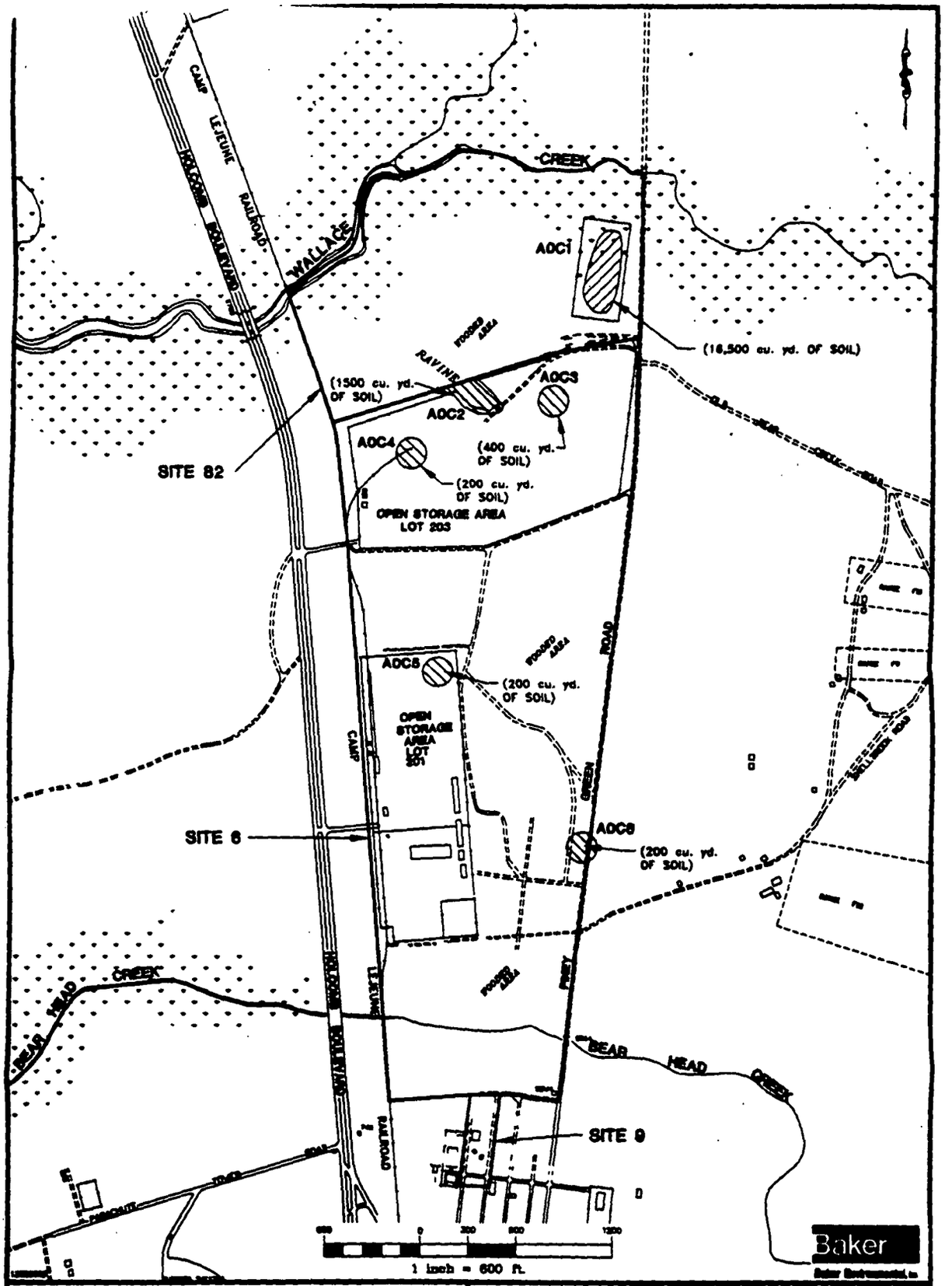


FIGURE 7
SELECTED SOIL RAA: ON-SITE TREATMENT AND OFF-SITE DISPOSAL (RAA No.7)
RECORD OF DECISION CTO-0133

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

volatilization system is approximately $50,000 for a 5 year duration. Assuming an annual percentage rate of 5 percent, these costs equate to a NPW of approximately $6.5 million. Table 9 presents a summary of this cost estimate for the major components of the selected remedy.

Remediation Goals

The selected remedy will be operated until the remediation goals developed in the FS are met. The remediation goals for the groundwater COCs and the soil COCs are listed on Table 10. Where applicable, the groundwater remediation goals were based on Federal Maximum Contaminant Levels (MCLs) and North Carolina groundwater standards. In the absence of the above-mentioned criteria, a risk-based action level (based on an ICR of 1.0E-4 and an HI of 1.0) was developed. The soil remediation goal for PCBs was based on the Toxic Substance Control Act (TSCA) guidance for non-residential use (i.e., industrial area). The other soil remediation goals were based on risk-based action levels for an ICR of 1.0E-4 and an HI of 1.0.

For groundwater, the semiannual monitoring results of the groundwater plumes will determine when the remedial action has met the remediation goals. For the soils to be treated via in situ volatilization (AOC1), the results from routine sampling of the treated soils will determine when the treatment is complete. Confirmation soil sampling results during excavation activities will be used for the remaining soils to be removed from the operable unit.

Prior to discharging the treated groundwater to Wallace Creek, effluent levels which are protective of aquatic life and/or human health will be met. The effluent criteria for the COCs are presented on Table 11. The criteria is based on the following standards: the North Carolina Ambient Water Quality Criteria for Tidal Saltwaters (Aquatic or Human Health), North Carolina Ambient Water Quality Criteria for Freshwater Classes, Federal Ambient Water Quality Criteria for Protection of Marine Life (Acute), and Federal Maximum Contaminant Level (MCL).

10.0 STATUTORY DETERMINATIONS

A selected remedy must satisfy the statutory requirements of CERCLA Section 121 which include: (1) be protective of human health and the environment, (2) comply with ARARs (or justify an ARAR waiver), (3) be cost-effective, (4) utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable;

TABLE 9

ESTIMATED COST SUMMARY FOR THE SELECTED REMEDY
RECORD OF DECISION CTO-0133
MCB CAMP LEJEUNE, NORTH CAROLINA

Cost Component	Estimated Cost
Capital Costs::	
• **Groundwater Remediation**	
Mobilization	$25,000
Extraction Well System	315,000
Treatment System	675,000
Discharge System	28,000
Demobilization	17,000
Pilot Studies	53,000
	$1,113,000
Engineering and Contingencies	$317,000
	$1,430,000
• **Soil Remediation**	
Site Preparation	$28,000
In Situ Volatilization	404,000
Off-Site Landfilling	522,000
Site Restoration	22,000
Demobilization	7,000
Pilot Studies	50,000
	$1,033,000
Engineering and Contingencies	$295,000
	$1,328,000
Operation and Maintenance Costs:	
• **Groundwater Remediation**	
System Operation	$155,000
Effluent Sampling	33,000
Groundwater Monitoring	39,000
	$227,000 (for 30 years)
• **Soil Remediation**	
In Situ Volatilization System	$50,000
	$50,000 (for 5 years)
TOTAL CAPITAL COST	$2,758,000
TOTAL OPERATION AND MAINTENANCE COSTS	$277,000 (Years 1-5) $227,000 (Years 6-30)
TOTAL NET PRESENT WORTH (Using 5% discount rate)	$6.5 million

TABLE 10

REMEDIATION GOALS FOR CONTAMINANTS OF CONCERN
RECORD OF DECISION CTO-0133
MCB CAMP LEJEUNE, NORTH CAROLINA

Media	Contaminant of Concern	Remediation Goal	Unit [1]
Groundwater	1,2-Dichloroethane	0.38	µg/L
	Trans-1,2-Dichloroethene	70	µg/L
	Ethylbenzene	29	µg/L
	Tetrachloroethene	0.7	µg/L
	Trichloroethene	2.8	µg/L
	Vinyl Chloride	0.015	µg/L
	Arsenic	50	µg/L
	Barium	1,000	µg/L
	Beryllium	4	µg/L
	Chromium	50	µg/L
	Lead	15	µg/L
	Manganese	50	µg/L
	Mercury	1.1	µg/L
	Vanadium	80	µg/L
Soil	PCBs	10,000	µg/kg
	4,4'-DDT	60,000	µg/kg
	Benzene	5.4	µg/kg
	Trichloroethene	32.2	µg/kg
	Tetrachloroethene	10.5	µg/kg
	Arsenic	23,000	µg/kg
	Cadmium	39,000	µg/kg
	Manganese	390,000	µg/kg

[1] µg/L = microgram per liter
µg/kg = microgram per kilogram

TABLE 11

EFFLUENT LEVELS FOR GROUNDWATER CONTAMINANTS OF CONCERN
RECORD OF DECISION CTO-0133
MCB CAMP LEJEUNE, NORTH CAROLINA

Groundwater Contaminant of Concern	Effluent Level	Basis
1,2-Dichloroethane	113,000	Ambient Water Quality Criteria for Protection of Marine Life (Acute)
Trans-1,2-Dichloroethene	100	Federal MCL
Ethylbenzene	430	Ambient Water Quality Criteria for Protection of Marine Life (Acute)
Tetrachloroethene	0.8	North Carolina Water Quality Standards for Freshwater Classes (WS Classes)
Trichloroethene	92.4	North Carolina Ambient Water Criteria for Tidal Saltwater (Human Health)
Vinyl Chloride	525	North Carolina Ambient Water Criteria for Tidal Saltwater (Human Health)
Arsenic	50	North Carolina Ambient Water Quality Criteria for Tidal Saltwater (Aquatic Life)
Barium	1,000	North Carolina Water Quality Standards for Freshwater Classes (WS Classes)
Beryllium	0.117	North Carolina Ambient Water Criteria for Tidal Saltwater (Human Health)
Chromium	20	North Carolina Ambient Water Quality Criteria for Tidal Saltwater (Aquatic Life)
Lead	25	North Carolina Ambient Water Quality Criteria for Tidal Saltwater (Aquatic Life)
Manganese	50	North Carolina Water Quality Standards for Freshwater Classes (WS Classes)
Mercury	0.025	North Carolina Ambient Water Quality Criteria for Tidal Saltwater (Aquatic Life)
Vanadium	NA	No standard established.

Note: All concentrations expressed in µg/L.

and (5) satisfy the preference for treatment that reduces toxicity, mobility, or volume as a principal element, or provide an explanation as to why this preference is not satisfied. The evaluation of how the selected remedy for Operable Unit No. 2 satisfies these requirements is presented below.

Protection of Human Health and the Environment

The selected remedy provides protection to human health and the environment through extraction and treatment of groundwater, implementation of groundwater related institutional controls, the in situ treatment of VOC-contaminated soils, and the excavation and removal of PCB and pesticide contaminated soils. The institutional controls, which include aquifer use restrictions, well placement restrictions, and groundwater monitoring, will reduce the potential for ingestion of contaminated groundwater. The volatilization of the VOC-contaminated soil will eliminate the threat of exposure to the most mobile contaminants from direct contact with or ingestion of the contaminated soil, as well as migration of contaminants to the water table. By removing and disposing the PCB and pesticide contaminated soils off site, the potential risks associated with exposure to these contaminants is eliminated.

Compliance With Applicable or Relevant and Appropriate Requirements

The selected remedy will either comply with all ARARs or have the appropriate waivers. Specifically, the remedy will meet (or be waived from) the Federal Drinking Water Maximum Contaminant Levels, the North Carolina Water Quality Criteria for Groundwater, Clean Water Act discharge criteria, and TSCA PCB regulations. In addition, the selected remedy will comply with the appropriate parts of the Department of Transportation Rules for Transportation, the Fish and Wildlife Coordination Act, the Federal Endangered Species Act, the Protection of Wetlands Order, and the Floodplain Management Order.

Cost-Effectiveness

The selected remedy affords overall effectiveness proportional to its costs. With respect to the groundwater-related remedial actions, the selected remedy is the most cost-effective of the "treatment" alternatives. The only Groundwater RAAs that are more cost-effective than the selected remedy are the Limited Action (i.e., institutional controls only) and the No Action RAAs. With respect to the soil-related remedial actions, the selected remedy is the most

cost-effective RAA that includes remediation of all of the Soil AOCs, with the exception of the No Action RAA.

Utilization of Permanent Solutions and Alternative Treatment Technologies

The selected remedy represents a permanent solution with respect to the principal threats posed by the groundwater and soil contamination. Therefore, this remedy utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable. The groundwater treatment system represents a permanent solution. The in situ volatilization of the VOC-contaminated soils represents both a permanent solution and an alternative treatment technology.

Preference for Treatment as a Principal Element

By treating the extracted groundwater and the VOC-contaminated soils (which accounts for the majority of the contaminated soil), the selected remedy addresses two of the principal threats posed by the operable unit through the use of treatment technologies. Therefore, the statutory preference for remedies that employ treatment as a principal element is satisfied.

11.0 RESPONSIVENESS SUMMARY

Overview

At the time of the public comment period (August 24 through September 23, 1993), the Department of Navy/Marine Corps had already selected a preferred alternative for Operable Unit No. 2 (Sites 6, 9, and 82). The preferred alternative addresses soil and groundwater contamination problems throughout Operable Unit No. 2. The preferred alternative specified in the ROD involves the following: pump and treat of contaminated shallow and deep groundwater; in situ treatment via vapor extraction of volatile organic compounds in soil (Area of Concern No. 1); and excavation and off-site disposal of pesticide- and PCB-contaminated soil at Area of Concern Nos. 2 through 6. Treatment of the groundwater would involve metals removal, air stripping, and carbon adsorption. The treated groundwater would be discharged into Wallace Creek.

Judging in part from the lack of written comments received during the public comment period, and the comments received from the audience at the public meeting of August 24, 1993, the

EPA Region IV and the NC DEHNR support the preferred alternatives for addressing soil and groundwater contamination. Members of the community who attended the public meeting on August 24, 1993 did not appear to have any opposition to the preferred soil or groundwater alternatives.

Background On Community Involvement

A record review of the MCB Camp Lejeune files indicates that the community involvement centers mainly on a social nature, including the community outreach programs and base/community clubs. The file search did not locate written Installation Restoration Program concerns of the community. A review of historic newspaper articles indicated that the community is interested in the local drinking and groundwater quality, as well as that of the New River, but that there are no expressed interests or concerns specific to the environmental sites (including Sites 6, 9, and 82). Two local environmental groups, the Stump Sound Environmental Advocates and the Southeastern Watermen's Association, have posed questions to the base and local officials in the past regarding other environmental issues. These groups were sought as interview participants for the August 1993, community relations interviews. Neither group was available for the interviews.

Community relations activities to date are summarized below:

- Conducted additional community relations interviews, February through March, 1990. A total of 41 interviews were conducted with a wide range of persons including base personnel, residents, local officials, and off-base residents;

- Prepared a Community Relations Plan, September, 1990;

- Conducted additional community relations interviews, August 1993. Nineteen persons were interviewed, representing local business, civic groups, on- and off-base residents, military and civilian interests;

- Prepared a revised Preliminary Draft Community Relations Plan, August 1993;

- Established two information repositories;

- Established the Administrative Record for all of the sites at the base;

cost-effective RAA that includes remediation of all of the Soil AOCs, with the exception of the No Action RAA.

Utilization of Permanent Solutions and Alternative Treatment Technologies

The selected remedy represents a permanent solution with respect to the principal threats posed by the groundwater and soil contamination. Therefore, this remedy utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable. The groundwater treatment system represents a permanent solution. The in situ volatilization of the VOC-contaminated soils represents both a permanent solution and an alternative treatment technology.

Preference for Treatment as a Principal Element

By treating the extracted groundwater and the VOC-contaminated soils (which accounts for the majority of the contaminated soil), the selected remedy addresses two of the principal threats posed by the operable unit through the use of treatment technologies. Therefore, the statutory preference for remedies that employ treatment as a principal element is satisfied.

11.0 RESPONSIVENESS SUMMARY

Overview

At the time of the public comment period (August 24 through September 23, 1993), the Department of Navy/Marine Corps had already selected a preferred alternative for Operable Unit No. 2 (Sites 6, 9, and 82). The preferred alternative addresses soil and groundwater contamination problems throughout Operable Unit No. 2. The preferred alternative specified in the ROD involves the following: pump and treat of contaminated shallow and deep groundwater; in situ treatment via vapor extraction of volatile organic compounds in soil (Area of Concern No. 1); and excavation and off-site disposal of pesticide- and PCB-contaminated soil at Area of Concern Nos. 2 through 6. Treatment of the groundwater would involve metals removal, air stripping, and carbon adsorption. The treated groundwater would be discharged into Wallace Creek.

Judging in part from the lack of written comments received during the public comment period, and the comments received from the audience at the public meeting of August 24, 1993, the

EPA Region IV and the NC DEHNR support the preferred alternatives for addressing soil and groundwater contamination. Members of the community who attended the public meeting on August 24, 1993 did not appear to have any opposition to the preferred soil or groundwater alternatives.

Background On Community Involvement

A record review of the MCB Camp Lejeune files indicates that the community involvement centers mainly on a social nature, including the community outreach programs and base/community clubs. The file search did not locate written Installation Restoration Program concerns of the community. A review of historic newspaper articles indicated that the community is interested in the local drinking and groundwater quality, as well as that of the New River, but that there are no expressed interests or concerns specific to the environmental sites (including Sites 6, 9, and 82). Two local environmental groups, the Stump Sound Environmental Advocates and the Southeastern Watermen's Association, have posed questions to the base and local officials in the past regarding other environmental issues. These groups were sought as interview participants for the August 1993, community relations interviews. Neither group was available for the interviews.

Community relations activities to date are summarized below:

- Conducted additional community relations interviews, February through March, 1990. A total of 41 interviews were conducted with a wide range of persons including base personnel, residents, local officials, and off-base residents;

- Prepared a Community Relations Plan, September, 1990;

- Conducted additional community relations interviews, August 1993. Nineteen persons were interviewed, representing local business, civic groups, on- and off-base residents, military and civilian interests;

- Prepared a revised Preliminary Draft Community Relations Plan, August 1993;

- Established two information repositories;

- Established the Administrative Record for all of the sites at the base;

- Released PRAP for public review in repositories, August 1993;

- Released public notice announcing public comment and document availability of the PRAP, August 18 - 24, 1993;

- Held Technical Review Committee meeting, August 24, 1993, to review PRAP and solicit comments; and

- Held public meeting on August 24, 1993 to solicit comments and provide information. Approximately 10 people attended. The public meeting transcript is available in the repositories.

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

As previously mentioned, no comments (written) were received during the public comment period. However, several questions/comments were generated at the August 24, 1993 public meeting. The public meeting was held to discuss the Department of Navy/Marine Corps' preferred alternatives. Many of the questions pertained to matters that are not related to the preferred alternatives (e.g., a member of the audience asked whether the consultant was obtaining good soil profiles of the entire base and region). These types of questions and answers will not be addressed as part of this Responsiveness Summary; however, specific answers to these questions are documented in the transcript to the public meeting. The transcript has been included in the Administrative Record. A summary of comments pertaining to the proposed alternatives and site investigations is given below.

Impacts to the Value of Wallace Creek from Treated Groundwater Discharge

(1) One member of the audience at the public meeting questioned what impact the discharge of treated groundwater would have on Wallace Creek.

Navy/Marine Corps Response: The discharge of treated groundwater into Wallace Creek should have no significant impact for several reasons: (1) the creek already receives a significant amount of groundwater discharge; (2) the effluent quality will be

protective of aquatic life; and (3) Wallace Creek is believed to be large enough (from a flow and volume standpoint) to support the additional effluent loading.

Contamination in Buried Drums at Operable Unit No. 2 and Mode of Disposal

(1) One member of the audience at the public meeting wanted clarification with respect to "threatened releases" as stated in the feasibility study report.

Navy/Marine Corps Response: The contents remaining in the buried drums, which will be remediated as part of a Time-Critical Removal Action, constitute a threatened release of contaminants to the environment. In addition, it is believed that the contents of the drums have in some cases migrated from the drums via corrosion and into subsurface soil and possibly groundwater. Therefore, the drum contents are a threat to the environment.

(2) One member of the audience asked what will the Navy/Marine Corps do with the drums once they are excavated and removed.

Navy/Marine Corps Response: Drums excavated from the former disposal areas will be overpacked (placed within a new, secure container and sealed) and taken to either a landfill for disposal, or to an incinerator, depending on the contents of the drum. If the contents are hazardous and require treatment, the drums will be incinerated, if technically feasible. If the contents are nonhazardous, the drums may be disposed of in a landfill without treatment.

Long-Term Impacts to Human Health, Animals, and Plant Life via Bioaccumulation

(1) A few members of the audience were concerned with long-term impacts to human health (e.g., liver damage or cancer) from possible exposure to site contaminants.

Navy/Marine Corps Response: This assessment was not performed as part of the remedial investigation or human health risk assessment. The risk assessment goes as far as estimating the potential or risk of acquiring carcinogenic and noncarcinogenic diseases under a no action scenario. This is known as the "baseline risk assessment." However, the baseline risk assessment does not address actual impacts (e.g., cancer rates of former workers at Storage Lot 203) to former workers or other individuals who

may have been exposed to contaminated soil or groundwater. The Agency for Toxic Substances and Disease Registry (ATSDR) is a Federal public health agency affiliated with the U.S. Department of Health and Human Services. ATSDR is performing a Public Health Assessment to evaluate whether exposure to site contaminants is resulting in impacts to human health. As part of this assessment, ATSDR will look at community-wide rates of illness, disease, and death and compare these with national and state rates.

(2) A few members of the audience asked about contaminant uptake in wildlife (other than fish) and plant life. Specifically, are animal studies being conducted to assess bioaccumulation?

Navy/Marine Corps Response: Performing ecological risk assessments is in the infancy stage as compared to performing human health risk assessments. To date, collecting animals for chemical uptake analysis is not the norm with the exception of fish and shellfish. However, this appears to be changing. Some studies are now being considered by the ecological community that include analysis of earthworms and field mice that will help assess ecological impacts. As more studies are completed, newer guidance from EPA will likely result. It is possible that future ecological investigations will put more emphasis on plant and animal uptake. At present, the ecological investigations are performed by comparing the contaminant concentrations in soil, surface water, or sediment with literature values to estimate potential impacts to aquatic or terrestrial life. As in the case of Operable Unit No. 2, fish and shellfish samples were submitted for chemical analysis to evaluate whether site contaminants are bioaccumulating.

Remaining Concerns

There were no issues or concerns with respect to the preferred alternatives that the Department of the Navy/Marine Corps were unable to address. Therefore, there are no remaining issues to resolve.