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Final

Remedial Investigation/ Feasibility Study

Sampling and Analysis Plan for Operable Unit No. 10 (Site 35)

Marine Corps Base
Camp Lejeune, North Carolina

Prepared For:

**Department of the Navy
Atlantic Division
Naval Facilities
Engineering Command**

Norfolk, Virginia

Under the

LANTDIV CLEAN Program

**Comprehensive Long-Term
Environmental Action Navy**

Baker
Baker Environmental, Inc

FOSTER WHEELI
FOSTER WHEELER ENVIRESPONSE, INC.

WESTON
MANAGERS DESIGNERS/CONSULTANTS

01128

SECTION I

FINAL

REMEDIAL INVESTIGATION/ FEASIBILITY STUDY FIELD SAMPLING AND ANALYSIS PLAN FOR OPERABLE UNIT NO. 10 (SITE 35)

MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

CONTRACT TASK ORDER 0160

Prepared For:

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

Under:

LANTDIV CLEAN Program
Contract N62470-89-D-4814

Prepared by:

BAKER ENVIRONMENTAL, INC.
Coraopolis, Pennsylvania

DECEMBER 1993

TABLE OF CONTENTS

Page

TABLE OF CONTENTS
(CONTENTS)

Page

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

LIST OF ACRONYMS AND ABBREVIATIONS

ARARs	Applicable or Relevant and Appropriate Requirements
AST	aboveground storage tanks
ATEC	ATEC Associates, Inc.
AWQC	Ambient Water Quality Criteria
Baker	Baker Environmental, Inc.
bgs	below ground surface
BOD	biological oxygen demand
BRA	Baseline Risk Assessment
BTEX	benzene, toluene, ethylbenzene, and total xylenes
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLEAN	Comprehensive Long-Term Environmental Action Navy
CLP	Contract Laboratory Program
COD	chemical oxygen demand
COPC	contaminants of potential concern
CRP	Community Relations Plan
CS	Confirmation Study
CSA	Comprehensive Site Assessment
1,2-DCE	1,2-Dichloroethene
DoN	Department of the Navy
DQOs	data quality objectives
EDB	ethylene dibromide
EPA	United States Environmental Protection Agency
ESE	Environmental Science and Engineering, Inc.
FSAP	Field Sampling and Analysis Plan
FFA	Federal Facilities Agreement
FFS	Focused Feasibility Study
FS	Feasibility Study
GC	gas chromatograph
IAS	Initial Assessment Study
LANTDIV	Atlantic Division, Naval Facilities Engineering Command
LAW	Law Engineering, Inc.
MCB	Marine Corps Base
MCL	Maximum Contaminant Level
msl	mean sea level
MTBE	methyl tertiary butyl ether
NCDEHNR	North Carolina Department of Environment, Health and Natural Resources
NCWQS	North Carolina Water Quality Standard

NPL	National Priorities List
OU	Operable Unit
ppb	parts per billion
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RA	Risk Assessment
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
SARA	Superfund Amendments and Reauthorization Act
SVOCs	Semivolatile Organic Compounds
TAL	Target Analyte List
TCE	trichloroethylene
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TDS	total dissolved solids
TSS	total suspended solids
TOC	total organic carbon
TPH	total petroleum hydrocarbons
TRC	Technical Review Committee
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UST	underground storage tank
VOCs	volatile organic compounds
WAR	Water and Air Research, Inc.

1.0 INTRODUCTION

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

The scope of the FFA included the implementation of a Remedial Investigation/Feasibility Study (RI/FS) at 23 sites throughout MCB, Camp Lejeune. Remedial investigations will be implemented at these sites to determine fully the nature and extent of the threat to the public health and welfare, or to the environment caused by the release and threatened release of hazardous substances, pollutants, contaminants or constituents at the site and to establish requirements for the performance of feasibility studies. Feasibility studies will be conducted to identify, evaluate, and select alternatives for the appropriate CERCLA responses to prevent, mitigate, or abate the release or threatened release of hazardous substances, pollutants, contaminants, or constituents at the site in accordance with CERCLA/Superfund Amendments and Reauthorization Act (SARA) and applicable state law (FFA, 1989).

This Field Sampling and Analysis Plan (FSAP) describes the proposed RI field activities that are to be conducted at Operable Unit No. 10: Site 35 - Camp Geiger Area Fuel Farm at MCB, Camp Lejeune.

The primary purpose of the FSAP is to provide guidance for all field activities by describing in detail the sampling and data collection methods to be used to implement the various field tasks identified in the RI/FS Work Plan for Operable Unit No. 10 (Baker, 1993). The guidance also helps to ensure that sampling and data collection activities are carried out in accordance with EPA Region IV and Navy Energy and Environmental Support Activity (NEESA) practices so that data obtained during the field investigation are of sufficient quantity and quality to evaluate the nature and magnitude of contamination in various media, estimate human health and environmental risks, and to evaluate potential technologies for remediation of contaminated media.

The remaining portion of this section presents the background and setting of each of the sites. Section 2.0 identifies the Data Quality Objectives (DQOs) for each of the field sampling programs described in the RI/FS Work Plan. The media, number and types of samples, and the frequency of sampling are discussed in Section 3.0 (Sampling Locations and Frequency). Section 4.0 (Sample Designation) describes the sample numbering scheme to be followed for identifying and tracking the samples. The investigative procedures (e.g., drilling, groundwater sampling, decontamination, etc.) are presented in Section 5.0 (Investigative Procedures). Sample handling and analysis is described in Section 6.0 (Sample Handling and Analysis). Section 7.0 (Site Management) focuses on the organization and responsibilities of personnel associated with the field sampling events.

In addition, background documents associated with Operable Unit No. 10 have been summarized in the RI/FS Work Plan that is associated with this document.

1.1 Site Description and Setting

This section briefly describes the description and setting of Operable Unit No. 10. A more detailed description is provided in Section 2.0 in the RI/FS Work Plan associated with this document.

1.1.1 Marine Corps Base, Camp Lejeune

This section provides an overview of the physical features associated with MCB, Camp Lejeune.

1.1.1.1 Location and Setting

MCB, Camp Lejeune is located within the Coastal Plain Physiographic Province in Onslow County, North Carolina. The facility covers approximately 170 square miles and is bisected by the New River, which flows in a southeasterly direction and forms a large estuary before entering the Atlantic Ocean.

The eastern border of MCB, Camp Lejeune is the Atlantic Ocean shoreline. The western and northwestern boundaries are U.S. Route 17 and State Route 24, respectively. The City of Jacksonville, North Carolina, borders MCB, Camp Lejeune to the north. MCB, Camp Lejeune is depicted in Figure 1-1.

1.1.1.2 History

Construction of MCB, Camp Lejeune began in 1941 with the objective of developing the "Worlds Most Complete Amphibious Training Base." Construction of the Base started at Hadnot Point, where the major functions of the Base are centered. Development at the Camp Lejeune complex is primarily in five geographical locations under the jurisdiction of the Base Command. These areas include Camp Geiger, Montford Point, Courthouse Bay, Mainside, and the Rifle Range Area. Site 35 is located in the Camp Geiger Area in the northwest quadrant of the Base.

1.1.1.3 Topography and Surface Drainage

The generally flat topography of MCB, Camp Lejeune is typical of the seaward portions of the North Carolina Coastal Plain. Elevations on the Base vary from sea level to 72 feet above mean sea level (msl); however, the elevation of most of Camp Lejeune is between 20 and 40 feet above msl.

Drainage at Camp Lejeune is generally toward the New River, except in areas near the coast which drain through the Intracoastal Waterway. In developed areas, natural drainage has been altered by asphalt cover, storm sewers, and drainage ditches. Approximately 70 percent of Camp Lejeune is in broad, flat interstream areas. Drainage is poor in these areas and the soils are often wet (Water and Air Research, 1983).

The U.S. Army Corps of Engineers has mapped the limits of 100-year floodplain at Camp Lejeune at 7.0 feet above msl in the upper reaches of the New River (Water and Air Research, 1983); this increases downstream to 11 feet above msl near the coastal area (Water and Air Research, 1983). Site 35 does not lie within the 100-year floodplain of the New River.

1.1.1.4 Regional Geology

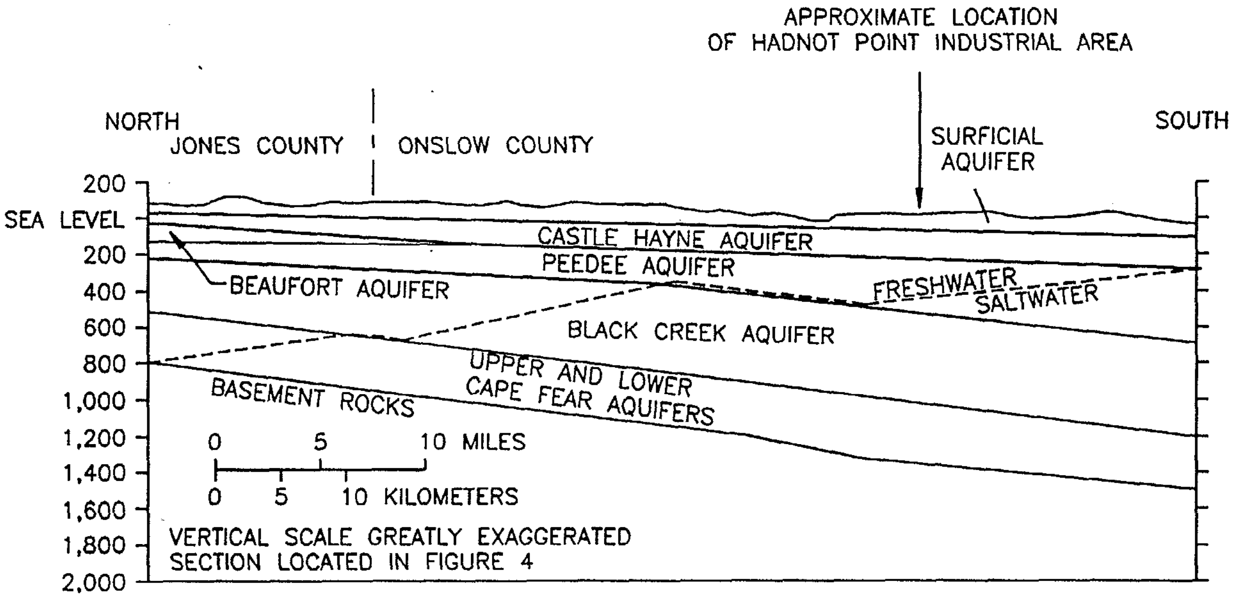
MCB, Camp Lejeune is located in the Atlantic Coastal Plain physiographic province. The sediments of the Atlantic Coastal Plain consist of interbedded sands, clays, calcareous clays, shell beds, sandstone, and limestone. These sediments lay in interfingering beds and lenses that gently dip and thicken to the southeast (ESE, 1991). These sediments were deposited in marine or near-marine environments and range in age from early Cretaceous to Quaternary time and overlie igneous and metamorphic basement rocks of pre-Cretaceous age. Table 1-1 presents a generalized stratigraphic column for this area (ESE, 1991).

1.1.1.5 Regional Hydrogeology

United States Geological Survey (USGS) studies at MCB Camp Lejeune indicate that the Base is underlain by seven sand and limestone aquifers separated by confining units of silt and clay. These include the water table (surficial), Castle Hayne, Beaufort, Peedee, Black Creek, and upper and lower Cape Fear aquifers. The combined thickness of these sediments is approximately 1,500 feet. Less permeable clay and silt beds function as confining units or semi-confining units which separate the aquifers and impede the flow of groundwater between aquifers. A generalized hydrogeologic cross-section of this area is presented in Figure 1-2 which illustrates the relationship between the aquifers in this area (ESE, 1992).

The surficial aquifer is a series of sediments, primarily sand and clay, which commonly extend to depths of 50 to 100 feet. No laterally extensive clay confining units have been encountered in this interval during previous subsurface investigations. This unit is not used for water supply in this part of the Base. In some areas, the surficial aquifer is reported to contain water contaminated by waste disposal practices, particularly in the northern and north-central developed areas of the Base (USGS, 1989).

The principal water-supply aquifer for the Base is the series of sand and limestone beds that occur between 50 and 300 feet below land surface. This series of sediments generally is known as the Castle Hayne aquifer. The Castle Hayne aquifer is about 150 to 350 feet thick in the area and is the most productive aquifer in North Carolina (USGS, 1989). Previous investigations in this area indicate that the Castle Hayne aquifer (defined as deeper than 50 to 100 feet) and the surficial aquifer (defined as less than 50 to 100 feet) are in hydraulic communication.



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Baker

Baker Environmental, Inc.

FIGURE 1-2
GENERALIZED HYDROGEOLOGIC CROSS-SECTION JONES AND ONSLOW COUNTIES, NORTH CAROLINA
REMEDIAL INVESTIGATION CTO-0160

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

SOURCE: HARNED, et. al., 1989

Onslow County and Camp Lejeune lie in an area where the Castle Hayne aquifer contains freshwater, although the proximity of saltwater in deeper layers just below this aquifer and in the New River estuary is of concern in managing water withdrawals from the aquifer since overpumping of the deeper parts of the aquifer could cause saltwater intrusion. The aquifer presently contains water having less than 250 mg/L (milligrams per liter) chloride throughout the area of the Base (USGS, 1989).

The aquifers that lie below the Castle Hayne consist of a thick sequence of sand and clay. Although some of these aquifers are used for water supply elsewhere in the Coastal Plain, they contain saltwater in the Camp Lejeune area (USGS, 1989).

Rainfall that occurs in the Camp Lejeune area (and does not exit the site as surface runoff) enters the ground in recharge areas, infiltrates the soil, and moves downward until it reaches the water table, which is the top of the saturated zone. In the saturated zone, ground water flows in the direction of lower hydraulic head, moving through the system to discharge areas like the New River and its tributaries or the ocean (USGS, 1989).

Water levels in wells tapping the surficial aquifer vary seasonally. The surficial aquifer receives more recharge in the winter than in the summer when much of the precipitation evaporates or is transpired by plants before it can reach the water table. Therefore, the water table generally is highest in the winter months and lowest in summer or early fall (USGS, 1989).

1.1.1.6 Surface Water Hydrology

The dominant surface water feature at MCB Camp Lejeune is the New River. It receives drainage from most of the base. The New River is short, with a course of approximately 50 miles on the central coastal plain of North Carolina. Over most of its course, the New River is confined to a relatively narrow channel entrenched in the Eocene and Oligocene limestones. South of Jacksonville, the river widens dramatically as it flows across less resistant sands, clays, and marls. At MCB Camp Lejeune, the New River flows in a southerly direction and empties into the Atlantic Ocean through the New River Inlet. Several small coastal creeks drain the area of MCB Camp Lejeune that is not drained by the New River and its tributaries. These creeks flow into the Intracoastal Waterway, which is connected to the Atlantic Ocean by Bear Inlet, Brown's Inlet, and the New River Inlet. (WAR, 1983).

1.1.1.7 Climatology

MCB Camp Lejeune is located within the Coastal Plain physiographic division of North Carolina. Coastal Plain elevations range from 200 feet above msl at the western boundary to generally 30 feet or less in areas of tidal influence to the east. The tidal portion of the Coastal Plain, where Camp Lejeune is situated, is generally flat and swampy.

Although coastal North Carolina lacks distinct wet and dry seasons, there is some seasonal variation in average precipitation. July tends to receive the most precipitation and rainfall amounts during summer are generally the greatest. Daily showers during the summer are not uncommon, nor are periods of one or two weeks without rain. Convective showers and thunderstorms contribute to the variability of precipitation during the summer months. October tends to receive the least amount of precipitation, on average. Throughout the winter and spring months precipitation occurs primarily in the form of migratory low pressure storms. Camp Lejeune's average yearly rainfall is approximately 52 inches.

Coastal Plain temperatures are moderated by the proximity of the Atlantic Ocean. The ocean effectively reduces the average daily fluctuation of temperature. Lying 50 miles offshore at its nearest point, the Gulf Stream tends to have little direct effect on coastal temperatures. The southern reaches of the cold Labrador Current offsets any warming effect the Gulf Stream might otherwise provide.

Camp Lejeune experiences hot and humid summers; however, ocean breezes frequently produce a cooling effect. The winter months tend to be mild, with occasional brief cold spells. Average daily temperatures range from 38° F to 58° F in January and 72° F to 86° F in July. The average relative humidity, between 75 and 85 percent, does not vary greatly from season to season.

Observations of sky conditions indicate yearly averages of approximately 112 days clear, 105 partly cloudy, and 148 cloudy. Measurable amounts of rainfall occur 120 days per year, on the average. Prevailing winds are generally from the south-southwest 10 months of the year, and from the north-northwest during September and October. The average wind speed for MCAS New River is 6.9 m.p.h.

1.1.1.8 Natural Resources and Ecological Features

The Camp Lejeune complex is predominantly tree-covered, with large amounts of softwood (shortleaf, longleaf, pond, and primarily loblolly pines) and substantial stands of hardwood species. Approximately 60,000 of the 112,000 acres of Camp Lejeune are under forestry management. Timber producing areas are under even-aged management with the exception of those areas along streams and swamps. These areas are managed to provide both wildlife habitat and erosion control. Forest management provides wood production, increased wildlife populations, enhancement of natural beauty, soil protection, prevention of stream pollution, and protection of endangered species (WAR, 1983).

Upland game species including black bear, whitetail deer, gray squirrel, fox squirrel, quail, turkey, and migratory waterfowl are abundant and are considered in the wildlife management programs (WAR, 1983).

Aquatic ecosystems on MCB Camp Lejeune consist of small lakes, the New River estuary, numerous tributaries, creeks, and part of the Intracoastal Waterway. A wide variety of freshwater and saltwater fish species exist here. Freshwater ponds are under management to produce optimum yields and ensure continued harvest of desirable fish species. Freshwater fish in the streams and ponds include largemouth bass, redbreast sunfish, bluegill, chain pickerel, yellow perch, and catfish. Reptiles include alligators, turtles, and snakes (including venomous) (WAR, 1983).

Wetland ecosystems at MCB Camp Lejeune can be categorized into five habitat types: pond pine or pocosin; sweet gum/water oak/cypress and tupelo; sweet bay/swamp black gum and red maple; tidal marshes; and coastal beaches. Pocosins provide excellent habitat for bear and deer because these areas are seldom disturbed by humans. The presence of pocosin type habitat at Camp Lejeune is primarily responsible for the continued existence of black bear in the area. Many of the pocosins are overgrown with brush and pine species that would not be profitable to harvest. Sweet gum/water oak/cypress and tupelo habitat is found in the rich, moist bottomlands along streams and rivers. This habitat extends to the marine shorelines. Dear, bear, turkey, and waterfowl are commonly found in this type of habitat. Sweet bay/swamp black gum and red maple habitat exist in the floodplain areas of Camp Lejeune. Fauna including waterfowl, mink, otter, raccoon, deer, bear, and gray squirrel frequent this habitat. The tidal marsh at the mouth of the New River is one of the few remaining North Carolina coastal areas relatively free from filling or other manmade changes. This habitat, which consists of marsh and aquatic plants such as algae, cattails, saltgrass, cordgrass, bulrush, and spikerush, provides wildlife with food and cover. Migratory waterfowl, alligators, raccoons, and river otter exist in this habitat. Coastal beaches along the intracoastal waterway and along the outer banks of Camp Lejeune are used for recreation and to house a small military command unit. Basic assault training maneuvers are also conducted along these beaches. Training regulations presently restrict activities that would impact ecological sensitive coastal barrier dunes. The coastal beaches provide habitat for many shorebirds (WAR, 1983).

The Natural Resources and Environmental Affairs (NREA) Division of MCB Camp Lejeune, the U.S. Fish and Wildlife Service, and the North Carolina Wildlife Resource Commission have entered into an agreement for the protection of endangered and threatened species that might inhabit MCB Camp Lejeune. Habitats are maintained at MCB Camp Lejeune for the preservation and protection of rare and endangered species through the base's forest and wildlife management programs. Full protection is provided to such species and critical habitat is designated in management plans to prevent or mitigate adverse effects of base activities. Special emphasis is placed on habitat and sightings of alligators, osprey, bald eagles, cougars, dusky seaside sparrows, and red-cockaded woodpeckers (WAR, 1983).

Within 15 miles of Camp Lejeune are three publicly owned forests: Croatan National Forest; Hofmann Forest; and Camp Davis Forest. The remaining land surrounding Camp Lejeune is primarily used for agriculture. Typical crops include soybeans, small grains, and tobacco (WAR, 1983).

1.1.1.9 Land Use

Camp Lejeune presently covers an area of approximately 170 square miles. Military and civilian population is approximately 60,000. During World War II, Camp Lejeune was used as a training area to prepare Marines for combat. This has been a continuing function of the facility during the Korean and Vietnam conflicts, and the recent Gulf War (i.e., Desert Storm). Toward the end of World War II, the camp was designated as a home base for the Second Marine Division. Since that time, Fleet Marine Force (FMF) units also have been stationed here as tenant commands.

1.1.1.10 Water Supply

MCB Camp Lejeune water is supplied entirely from groundwater. Groundwater is obtained from approximately 90 water supply wells and treated. There are eight water treatment plants with a total capacity of 15.821 million gallons per day (MGD). Groundwater usage is estimated at over 7 MGD (USGS, 1989).

The water supply wells are all located within the boundaries of the Base. The average water supply well at the base has a depth of 162 feet, a casing diameter of 8 inches, and yields 174 gpm (USGS, 1989).

All of the water supply wells utilize the Castle Hayne aquifer. The Castle Hayne aquifer is a highly permeable, semiconfined aquifer that is capable of yielding several hundred to 1,000 gallons per minute in municipal and industrial wells in the Camp Lejeune area. The water retrieved is typically a hard, calcium bicarbonate type.

1.1.2 Site 35 - Camp Geiger Area Fuel Farm

This section addresses the background and setting of Site 35. In addition, a summary of previous investigations is presented.

1.1.2.1 Site Location and Setting

Camp Geiger is located at the extreme northwest corner of MCB, Camp Lejeune, Onslow County. The main entrance to Camp Geiger is off U.S. Route 17, approximately 3.5 miles southeast of the City of Jacksonville, North Carolina. Site 35, the Camp Geiger Area Fuel Farm refers primarily to five, 15,000-gallon aboveground storage tanks (ASTs), a pump house, and a fuel unloading pad situated within Camp Geiger just north of the intersection of Fourth and "G" Streets. Previous environmental investigations at the site identified underground fuel distribution piping that connect the ASTs to existing and former underground storage tanks (USTs) and expanded the area referred to as Site 35. To date, the Site 35 study area has been roughly bounded on the west by D Street, on the north by Second Street, on the east by Brinson Creek, and on the south by Fourth Street and Building No. TC-474 (see Figure 1-3).

The ASTs at Site 35 are used to dispense gasoline, diesel and kerosene to government vehicles and to supply USTs in use at Camp Geiger and the nearby New River Marine Corps Air

Station. The ASTs are supplied by commercial carrier trucks which deliver product to fill ports located on the fuel unloading pad at the southern end of the facility. Six, short-run (120 feet maximum), underground fuel lines are currently utilized to distribute the product from the unloading pad to the ASTs. Product is dispensed from the ASTs via trucks and underground piping.

The site is underlain by layers of silty sand with interbedded layers of clayey sand, coarse sand and gravel. Investigations performed to date have provided subsurface stratigraphic data to a depth of 44.5 feet. Shallow groundwater is encountered at 8 to 10 feet bgs. Surface topography is characterized as generally flat with a gentle slope to the northeast toward Brinson Creek.

1.1.2.2 Site History

Construction of Camp Geiger was completed in 1945, four years after construction of MCB, Camp Lejeune was initiated. Available drawings date Site 35 back to at least July 1941. Originally, the ASTs were used for the storage of No. 6 fuel oil, but, were later converted (date unknown) for storage of other petroleum products including unleaded gasoline, diesel fuel, and kerosene. The ASTs currently in use at the site are reported to be the original tanks.

Formerly, the ASTs at Site 35 supplied a gasoline filling station which was located on the northeast corner of the intersection of "F" and Fourth Streets. A leak in the underground line from the ASTs to the dispensing island was reportedly responsible for the loss of roughly 30 gallons per day of gasoline over an unspecified period (Law, 1992). The leaking line was subsequently sealed and replaced.

Reports of a Mogas release in an underground distribution line near one of the ASTs date back to 1957-58 (ESE, 1990). Apparently, the leak occurred as the result of damage to a dispensing pump. At that time the Camp Lejeune Fire Department estimated that thousands of gallons of fuel were released although records of the incident have since been destroyed. The fuel migrated to the east and northeast into Brinson Creek. Interceptor trenches were excavated and the captured fuel was ignited and burned as was the product which discharged into Brinson Creek.

Another abandoned underground distribution line extended from the ASTs to the former Mess Hall Heating Plant, located adjacent to "D" Street, between Third and Fourth Streets. The underground line dispensed No. 6 Fuel Oil to an UST which fueled the Mess Hall boiler. The

Mess Hall, located across "D" Street to the west, is believed to have been demolished along with its Heating Plant in the 1960's.

1.1.2.3 Site Geology and Hydrogeology

The following information has been excerpted from Comprehensive Site Assessment (CSA) Report (Law, 1992). Selected portions of this report are included in Appendix A of the Work Plan for reference.

The soil and stratigraphic borings drilled to date have penetrated three distinctive units. The first unit is a fine- to medium-grained, unconsolidated sand. The thickness of this unit ranges from 15 to 30 feet. Law Engineering selected two samples of this unit to be analyzed for grain-size distribution, including samples from MW-23, collected from a depth of 8.5 to 10.5 feet, and from MW-24, collected from a depth of 13.5 to 15.5 feet. These analyses revealed that the samples generally contain 96 percent sand and 4 percent silt and clay.

The second unit is an oolitic, fossiliferous limestone which ranges in thickness from 6.5 to 20 feet. The fossils consist of fragments of mollusks; the matrix consists of fine-grained sand, fine-grained phosphate grains and lime mud. Under the Folk classification (Blatt et al, 1972), this unit is a biosparite.

The third unit is an unconsolidated, dark gray to black silty, clayey sand. Because this unit may be a confining unit separating the surficial and Castle Hayne aquifers, Law Engineering did not attempt to completely penetrate this clayey sand, and therefore, the thickness is not known. This unit was sampled in SB-1, SB-2, SB-3 and MW-19 and where it was observed to be up to 4 feet thick in SB-2. Grain-size analysis of a sample from this unit revealed that the sample contained 79 percent fine sand, 9 percent silt and 12 percent clay.

This clayey sand is probably the same described by Harned, et al (1989) as one of the confining units occurring in the surficial aquifer and the Castle Hayne. Baker's experience at Camp Lejeune sites east of the New River is that this unit is not a confining unit in that area because it is thin and discontinuous. This report noted, however, that the unit appears to be thicker and more continuous in the northwestern part of Camp Lejeune, where the Site 35 is located. Law Engineering believes that this clayey sand acts as a confining unit in the study area due to its relatively high percentage of silt and clay. It is believed that this unit separates the surficial aquifer from the underlying Castle Hayne aquifer.

Groundwater in the surficial aquifer generally flows cross the project site to the east, towards Brinson Creek. As indicated by comparing water level elevations recorded on September 3, 1991 between "shallow" and "deep" screened intervals, ground water in the surficial aquifer generally moves laterally across the project site with no significant vertical gradient.

The rate or average linear velocity of groundwater movement across the project site is a function of the hydraulic conductivity (K) of the aquifer medium, the effective porosity (n) of the aquifer medium and the hydraulic gradient (dh/dl) that exists in the surficial aquifer. The hydraulic conductivity of the unconsolidated sands within the surficial aquifer was calculated to be approximately 28 feet/day. Law calculated a range of average, linear velocities of between 0.99 feet/day ($n=25$ percent) and 1.66 feet/day ($n = 15$ percent) using values for effective porosity of 15 percent to 25 percent for fine sand, as estimated by Walton (1984).

1.1.2.4 Results of Previous Investigations

Previous investigations performed at Site 35 include the following:

- Initial Assessment Study (IAS) by Water and Air Research, Inc. (WAR), dated 1983;
- Confirmation Study (CS) by Engineering Science and Environmental, Inc. (ESE), dated 1990;
- Focused Feasibility Study (FSS) by NUS Corporation (NUS), dated 1990;
- Comprehensive Site Assessment (CSA) by Law Engineering, Inc. (LAW), dated 1992; and,
- Addendum to the CSA by Law, dated 1993.

The locations of various data points (i.e., monitoring wells,soil borings, etc.) from previous investigations are depicted in Figure 1-4.

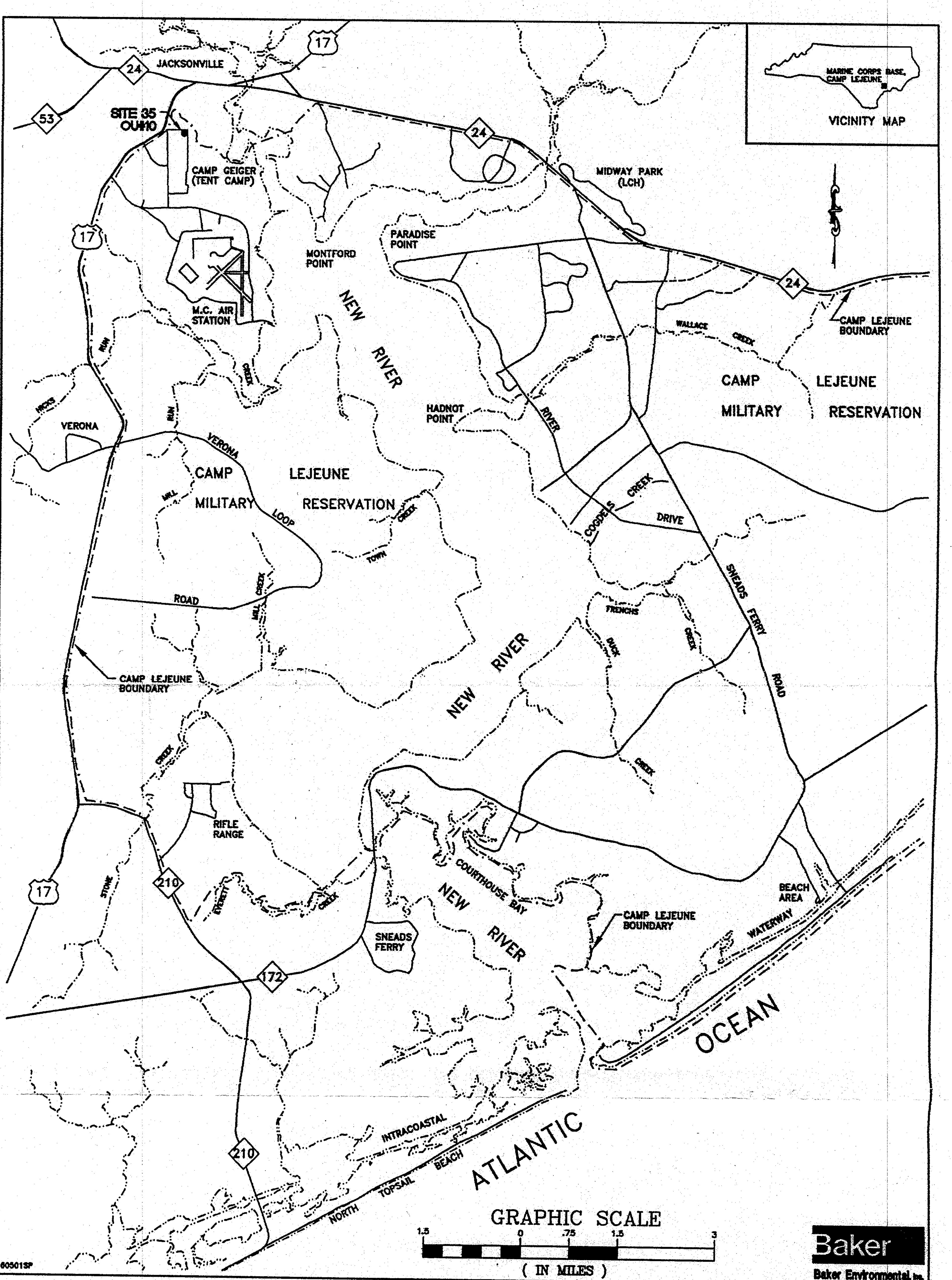
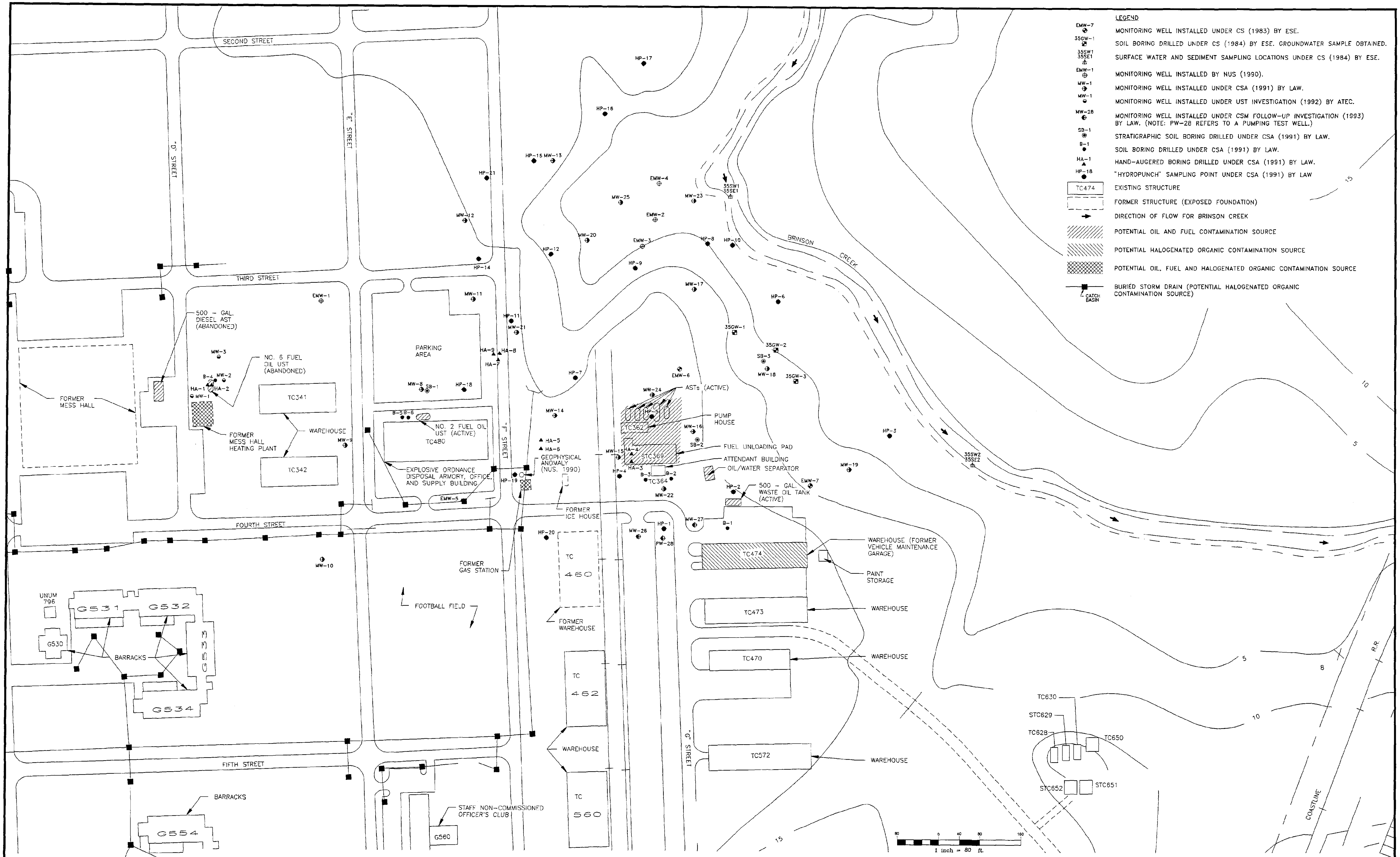


FIGURE 1-1
CAMP LEJEUNE AND SITE 35
LOCATION MAP

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

01128F012



LEGEND

DATE OCTOBER 1993
SCALE 1" = 80'
DRAWN WJH/REL
REVIEWED DLB
S.O.# 19160-43-SRN
CADD# 160515SP

NORTH

REMEDIAL INVESTIGATION/FEASIBILITY STUDY CTO-0160
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

BAKER ENVIRONMENTAL, Inc.
Coraopolis, Pennsylvania

Baker
Baker Environmental, Inc.

EXISTING MONITORING WELLS AND SAMPLING LOCATIONS
SITE 35 - CAMP GEIGER AREA FUEL FARM

SCALE 1" = 80'
DATE OCTOBER 1993

FIGURE No.
1-4

The results of the investigations performed to date identify areas of elevated petroleum hydrocarbon constituents in both soil and groundwater at Site 35. The petroleum hydrocarbons encountered in these media are the result of past operations and uncontrolled releases of oil and fuel at the site. In addition to petroleum hydrocarbons, elevated levels of halogenated organics were encountered in shallow groundwater samples at the site. The origin of these contaminants has not been determined to date. Soil samples from Site 35 were not analyzed for halogenated organic constituents under any of the previous investigation. The extent of contaminated soil and groundwater based on data obtained to date was identified in the CSA (Law, 1992). This data is attached to the RI/FS Work Plan for Site 35 (Baker, 1993) in Appendix B.

1.2 Evaluation of Existing Information

This section describes the types and volume of known wastes and impacted media at Site 35, potential migration and exposure pathways, preliminary public health and environmental impacts, preliminary ARARs (Applicable or Relevant and Appropriate Requirements) applicable to the site, potential remedial technologies, and data limitations.

1.2.1 Types and Volumes of Waste and Impacted Media Present

Information available from previous investigations indicates that Site 35 has been impacted by past releases of oils and fuels associated with the site and by halogenated organic compounds from a source(s) that has yet to be determined. No records are available to document quantities; however, a release of thousands of gallons of gasoline was reported in the late 1950s. More recently, there was a report that a buried fuel line released 30 gallons per day over an unspecified period of time.

Based on the results of the investigations performed to date it is estimated that 35,000 to 60,000 cubic yards of oil and fuel impacted soil are present at the site.

Shallow groundwater plumes impacted with halogenated and non-halogenated compounds are known to extend over an area of approximately 16 acres. The source of the halogenated organic groundwater contamination has yet to be determined. Additional investigation is needed to define the vertical and horizontal extent of halogenated organic contamination in shallow groundwater and attempt a source delineation. The source of the non-halogenated organic shallow groundwater contamination has been determined to be past site operations at the fuel farm. The horizontal extent of the non-halogenated organic shallow groundwater contamination has been adequately defined via the results of previous investigation. Additional data is required to define the vertical extent of this contamination.

1.2.2 Potential Migration and Exposure Pathways

Based on the evaluation of existing conditions at Site 35, the following potential contaminant migration and exposure pathways have been identified.

Transport Pathways

- Overland surface soil runoff to drainage ditches.
- Leaching of contaminants in subsurface soil to groundwater.
- Groundwater discharge to nearby drainage ditches/springs or streams (unnamed tributaries to Brinson Creek, Brinson Creek, and the New River).
- Groundwater infiltration from shallow aquifer to deep aquifer.

Exposure Pathways

- Current military personnel and civilian base employees traversing through the area could be exposed to surface soil, sediments, and standing water.
- Future human residential exposure by incidental soil ingestion.
- Future human residential dermal exposure by direct contact with soil.
- Future potential use of shallow and deep groundwater (shallow impacted groundwater in this area is not currently used as a potable water supply).
- Wildlife (deer, mammals), fish and fowl exposure to surface and subsurface soil and surface water. (Note: Hunting is prohibited in this area.)

- Benthic and pelagic populations on the unnamed tributaries and the New River could be exposed to contaminants.

1.2.3 Preliminary Public Health and Environmental Health Impacts

A preliminary risk evaluation of Site 35 has concluded that there may be potential human and ecological risk to receptors due to the contamination detected at this site. Military personnel and civilian contractors have been identified as the probable human receptors. The non-human population of receptors includes, but is not limited to, small mammals such as raccoon and fox, deer, birds, reptiles, and aquatic organisms, such as fish.

1.2.4 Present Database Limitations

The purpose of this section is to define data limitations with respect to either characterizing the site, assessing human health and environmental risks, or evaluating potential feasible technologies. Site-specific RI/FS objectives and sampling strategies for resolving these data deficiencies are subsequently identified in Sections 4.0 and 5.0 of this RI/FS Work Plan.

1.2.4.1 Site Characterization

A review of the data obtained under previous investigations indicates the presence of data gaps which do not afford a full characterization of the nature and extent of contamination at the site. The data gaps include lack of definition of the vertical and horizontal extent of halogenated organic contamination in groundwater, and identification of the possible source(s) of this contamination, and definition of the vertical extent of non-halogenated organic groundwater contamination. Existing monitoring wells and sampling locations, the information from which have led to a present site understanding, are depicted on Figure 1-4. Other data gaps include those associated with site soil, surface water, and sediment. The data gaps for each media are discussed below.

Groundwater

Additional groundwater data is required in the vicinity of monitoring wells MW-10 (near the southwest corner of Fourth and "E" Streets) and monitoring wells EM-7 and MW-19 (located southeast of the ASTs and northeast of Building TC474) to identify the extent of previously identified halogenated organic contamination. In the case of MW-10, where elevated levels of

TCE were reported (Law 1992), there is no data available to assess whether a plume extends to the east, south, or west. Similarly, the extent of the TCE plume was not identified south, east, or north of wells EM-7 and MW-19. No data is available to assess the vertical limits of the TCE plume since elevated levels of TCE were identified at several of the deepest wells (i.e., base of well screens set as deep as 35 feet bgs) previously installed including wells MW-10, MW-19, and EM-7.

Additional data is required in the vicinity of monitoring wells MW-2 (at former Mess Hall Heating Plant), MW-21 and MW-25 to assess the vertical extent of non-halogenated organic shallow groundwater contamination. BTEX compounds were detected in samples obtained from the deepest wells previously installed at these locations. In general, sufficient data has been obtained to date to characterize the horizontal extent of the non-halogenated organic contamination in the shallow groundwater.

Groundwater Contamination Sources

Additional soil and groundwater data is required to identify and assess the source of the halogenated organic groundwater contamination. Possible sources include: Building TC474 where vehicle maintenance was performed as late as 1988; the former Mess Hall Heating Plant where solvents may have been used for maintenance; the storm drain conduit system along Fourth Street that may have served as a conveyance system for solvents generated at an unknown off-site location; and any of the past or present buildings whose complete histories of use are not known, but, could have included the handling and storage of solvents.

Soil

The horizontal extent of oil and fuel impacted soils has, for the most part, been sufficiently defined under previous investigations performed at the site. Additional data is required along the drainage channels that extend from "F" Street and the ASTs to Brinson Creek. This data will be obtained under the Interim RI/FS the focus of which will be the oil and fuel impacted soils at this site. The project plans for the Interim RI/FS are being prepared separately under this Contract Task Order.

No soil samples obtained to date at Site 35 have been analyzed for halogenated organic compounds. As a consequence, there is no data pertaining to the possible presence of these compounds at areas where these compounds have been identified in shallow groundwater.

Additional soil sampling is required to identify the presence, if any, and extent of halogenated organic compounds in vadose zone soil in the vicinity of the shallow groundwater identified as impacted with these contaminants under previous investigations. This data will be obtained under the Interim RI/FS at areas where contaminated groundwater and soil was identified under previous investigations. Additional soil samples obtained in areas not investigated to date will be analyzed for halogenated organic compounds.

Surface Water and Sediment

To date only two surface water and sediment samples have been obtained from Brinson Creek. These samples were analyzed for lead, EDB, and oil and grease. Laboratory results of the surface water samples indicated no detections while lead and oil and grease were detected in sediment samples. Additional surface water and sediment samples are needed along Brinson Creek at locations upgradient, downgradient, and adjacent to Site 35, to support the baseline risk assessment.

1.2.4.2 Risk Assessment

No previous investigation performed to date has included the performance of a quantitative baseline human health and ecological risk assessment (RA). The chemical characteristics of surface soil, surface water, and sediment samples obtained from throughout Site 35 are the principal data needed to support the baseline human health RA. Additional sampling of selected existing groundwater wells is also needed to provide analytical results for full TAL organics and TCL inorganic parameters across the site. Fish and benthic samples are needed from various locations along Brinson Creek for use in the ecological RA.

1.2.4.3 Engineering

Engineering data is used to support the evaluation of remedial alternatives under the FS. Typically, this data refers to the engineering characteristics of subsurface soils such as particle size distribution or the hydraulic characteristics of the subsurface aquifer (pump test data). This type of data has been provided in previous reports (Law, 1992 and 1993) prepared for Site 35.

Additional engineering data required includes information used directly in the design of groundwater treatment systems such as, but not limited to, BOD (biological oxygen demand), COD (chemical oxygen demand), TSS (total suspended solids), TDS (total dissolved solids), and TOC (total organic carbon).

2.0 DATA QUALITY OBJECTIVES

Data Quality Objectives (DQOs) are qualitative and quantitative statements that ensure that data of known and appropriate quality are obtained during the RI and FS and will support remedial decisions (EPA, 1987). DQOs associated with each field collection program are discussed and presented in this Section. DQOs were developed using the following three stage process:

- Stage 1 - Identify decision types
- Stage 2 - Identify data needs
- Stage 3 - Design data collection program

Stage 1 of the DQO process takes place during the scoping of the RI/FS. This stage involves the evaluation of existing information, development of a conceptual model for the site to identify contaminant transport and exposure pathways, and the development of objectives for further data collection efforts.

Stage 2 of the DQO process involves definition of the quality and quantity of data that will be required to meet the objectives established in Stage 1.

Stage 3 involves design of a data collection program to meet the requirements identified in Stage 2.

The remaining portions of this Section document the establishment of DQOs for the RI/FS at Operable Unit No. 10.

2.1 Stage 1 - Identification of Decision Types

As part of the Stage 1 DQO process, available information from previous site investigations and other sources (e.g., USGS) were reviewed in order to describe the current site conditions, evaluate existing data, and assess the adequacy of the data. This review has been documented in Section 2.0 of the RI/FS Work Plan and summarized in Sections 1.1, and 1.2 of this FSAP. From this review and evaluation, a conceptual site model was developed for Site 35 by identifying the potential sources of contamination, the contaminant migration pathways, and potential receptors. A conceptual site model for Site 35 is presented in Table 2-1. Based on the conceptual contaminant transport/migration model for this site, specific RI/FS objectives have

TA[illegible]E 2-1

CONCEPTUAL SITE MODEL AND RI/FS OBJECTIVES FOR OPERABLE UNIT NO. 10
MCB CAMP LEJEUNE, NORTH CAROLINA

Site	Medium or Area of Concern	Potential Exposure and Migration Pathways	Site-Specific RI/FS Objectives
35	Soil Camp Geiger Fuel Farm	● Surface soil runoff from Site 35 to Brinson Creek	● Assess the horizontal extent of surface soil contamination near the fuel farm area
		● Direct contact with surface soils by humans and animals	● Assess the level and nature of contamination in surface soils at and near the fuel farm area
		● Direct contact with subsurface soils by burrowing animals	● Assess the level and nature of contamination in subsurface soils at and near the fuel farm area
		● Migration/leaching of contaminants in the fuel farm area to the soil	● Assess the vertical extent of soil contamination within the fuel farm area ● Identify physical properties of soil
	Groundwater Camp Geiger Fuel Farm	● Human exposure from future potential groundwater ingestion or dermal contact	● Assess the nature and extent of shallow aquifer contamination
		● Migration/Leaching of contaminants in the fuel farm area to the groundwater	● Assess the nature and extent of shallow aquifer contamination
		● Vertical groundwater migration to the deep aquifer (1)	● Evaluate groundwater quality in the deep aquifer (1) ● Identify physical properties of the aquifers and their physical relationship between one another
		● Off-site groundwater migration	● Evaluate off-site groundwater quality in the shallow aquifer
	Surface Water/Sediment Camp Geiger Fuel Farm	● Migration/Leaching of contaminants from the fuel farm to the surface water	● Determine the nature and extent of contamination in surface water/sediment in Brinson Creek
		● Groundwater discharge to surface water (Brinson Creek)	● Assess groundwater quality near the fuel farm area ● Assess the level and nature of contamination in surface water/sediment
		● Terrestrial wildlife - dermal exposure to contaminants in surface water and sediment	● Assess the level and nature of contamination in sediment and surface water
		● Direct contact with surface water/sediment by humans and animals	● Assess the level and nature of contamination in surface water/sediment near this portion of Site 35
		● Human exposure to VOCs due to volatilization from surface water	● Characterize surface water quality

Note: (1) The "Deep Aquifer" refers to the substratum below the clay layer identified in borings SB-1, SB-2, and SB-3 (Law, 1992) at depths ranging from 35 to 43 feet bgs. This clay layer may represent the confining aquitard that separates the shallow water table aquifer from the regionally significant Castle-Hayne Formation (see Work Plan Section 5.3.4).

been developed to (1) determine the nature and extent of the threat posed by the release or potential release of hazardous substances, (2) assess human health and environmental risks, and (3) identify and evaluate remedial alternatives. The identification of these objectives, which are also presented in Table 2-1, is the first step toward the development of a program for collection of sufficient data for decision making.

The following section identifies the data requirements to meet the site-specific RI/FS objectives.

2.2 Stage 2 - Identification of Data Needs

In Stage 2 of the DQO process, the data quality and quantity required to support the RI/FS objectives developed during Stage 1 are identified. Data collected during the RI/FS for Site 35 will be used for: human ecological risk assessment; site characterization; screening and evaluating alternatives; and remedial design. With respect to the RI/FS objectives identified in the previous section, data will be required to address the following:

Soil

- The extent of surface and subsurface soil contamination within reported disposal areas.
- The extent of surface soil contamination due to surface runoff.
- The physical properties of the soil to evaluate migration potentials and remedial technologies.
- The chemical properties of soil to assess potential human health and environmental risks, and to evaluate remedial technologies.
- The chemical properties associated with disposal and treatment requirements.

Groundwater

- The extent and nature of on site and off-site groundwater contamination in shallow and/or deep aquifers.

- The physical properties of the aquifers and their physical relationship.

- The flow direction and discharge patterns of the aquifers.

- The chemical properties to assess potential human health risks.

- The chemical properties to evaluate compliance with State and Federal drinking water standards.

- The chemical/physical properties that may affect the treatability of the groundwater.

Sediments

- The extent and nature of sediment contamination in drainage areas potentially impacted by site runoff, groundwater discharge, or tidal effects.

- The chemical properties to assess human health and environmental risks due to exposure.

- Evaluate physical/chemical stress to fish or benthic aquatic communities.

Surface Water

- The extent and nature of surface water potentially impacted by site runoff, groundwater discharge, or tidal effects.

- The chemical properties to assess human health and environmental risks.

AST Fuel Farm Area

- The extent of subsurface soil contamination at suspected source areas.
- The chemical/physical properties to assess disposal and treatment requirements.

Halogenated Organic Source Area

- The extent of subsurface soil contamination at suspected source areas.
- The chemical/physical properties to assess disposal and treatment requirements.

The type of data and the quality of data to meet the criteria listed above are summarized on Table 2-2. The data quality levels differ with respect to the end use of the data. Level IV data quality are generally required in risk assessments, characterizing the nature and extent of contamination, and to support the record of decision (ROD). Level III data quality is appropriate for evaluating treatment alternatives. Level II data quality is appropriate for field screening (i.e., geophysical investigations, soil gas). Level I data is appropriate for field measurements such as dissolved oxygen, temperature, specific conductance, and pH.

The analytical method also differs with respect to the end use of the data. For purposes of assessing health risks and to compare contaminant levels against Federal or State standards, it will be necessary to obtain lower detection levels for selected parameters such as volatile organics. For this RI/FS, Environmental Protection Agency (EPA) methods and Contract Laboratory Program (CLP) protocols will be used when applicable.

The quantity of samples collected is based on obtaining a representative measure to characterize the nature and extent of contamination, assess human health and environmental risks, and develop and evaluate remedial alternatives. For the various field investigations for Operable Unit No. 10, the number and location of samples was determined based on best engineering estimates, visual evaluation of the sites, and a review and evaluation of background information.

2.3 Stage 3 - Design Data Collection Program

The data collection programs for Operable Unit No. 10 have been designed to meet the objectives identified in Table 2-1. Section 5.3 of the RI/FS Work Plan provides a general description of the various sampling programs for Site 35. Sections 3.0 through 5.0 of this FSAP provide the specific details of these sampling programs.

TABLE 2-2

SUMMARY OF DATA TYPES AND DATA QUALITY LEVELS OPERABLE UNIT NO. 10, MCB CAMP LEJEUNE, NORTH CAROLINA

Medium	Sampling Criteria/Purpose	Data Types	Data Quality Level
Soil	• Assess extent of surface and subsurface soil contamination within reported impacted areas	TCL VOAs and SVOAs	IV
		TAL Inorganics (Metals)	IV
	• Assess extent of surface soil contamination due to surface runoff	TCL VOAs and SVOAs	IV
		TAL Inorganics (Metals)	IV
	• Identify physical properties of soil to evaluate migration potentials and remedial technologies	Atterburg Limits	III
		Grain Size	III
		Constant Head permeability	III
		TOC	III
		Microbial Enumeration	III
		Phosphorous	III
		Nitrogen	III
	• Identify chemical properties of soil to assess potential human health and environmental risks, and to evaluate remedial technologies	TCL VOAs and SVOAs	IV
		TAL Inorganics (Metals)	IV
		TPH	II
	• Identify chemical properties associated with disposal and treatment requirements	Total TCLP	III
		Reactivity	III
		Corrosivity	III
		Ignitability	III
Groundwater	• Assess extent and nature of onsite and offsite groundwater contamination in shallow and/or deep aquifers	Volatiles (EPA 601/602)	IV
		TCL SVOAs	IV
		TAL Inorganics (Metals)	IV
	• Identify physical properties of the aquifers and their physical relationship between one another	Surface Features (lithologic samples)	II
		Water Level Elevations (static)	II
		Hydraulic Conductivity(1)	II
		Transmissivity(1)	II

* Note: (1) Existing information will be reviewed (USGS publications)

TABLE 2-2 (Continued)

SUMMARY OF DATA TYPES AND DATA QUALITY LEVELS OPERABLE UNIT NO. 10, MCB CAMP LEJEUNE, NORTH CAROLINA

Medium	Sampling Criteria/Purpose	Data Types	Data Quality Level
Groundwater (continued)	• Identify flow direction and discharge patterns of the aquifers	Surface Features (lithologic samples) Water Level Elevations (static and pumping) Hydraulic Conductivity Transmissivity	II II II II
	• Identify chemical properties to assess potential human health risks	Volatiles (EPA 601/602) TCL SVOAS TAL Inorganics (Metals)	IV IV IV
	• Identify chemical properties to evaluate compliance with State or Federal drinking water standards	Volatiles (EPA 601/602) TAL Inorganics (Metals)	IV IV
	• Identify chemical/physical properties that may affect treatment	Total Suspended Solids Biological Oxygen Demand Chemical Oxygen Demand Total Dissolved Solids Temperature Specific Conductance pH Microbial Enumeration Phosphorous Nitrogen TOC Alkalinity	III III III III I I I III III III III III
Sediment	• Assess extent and nature of sediment contamination in surface water bodies potentially impacted by site runoff, groundwater discharge, or tidal effects	TCL Organics TAL Inorganics (Metals)	IV IV
	• Identify chemical properties to assess human health and environmental risks due to exposure	TCL Organics TAL Inorganics (Metals)	IV IV

TABLE 2-2 (Continued)

SUMMARY OF DATA TYPES AND DATA QUALITY LEVELS OPERABLE UNIT NO. 10, MCB CAMP LEJEUNE, NORTH CAROLINA

Medium	Sampling Criteria/Purpose	Data Types	Data Quality Level
Surface Water	• Assess extent and nature of surface water potentially impacted by site runoff, groundwater discharge, or tidal effects	TCL Organics TAL Inorganics (Metals)	IV IV
	• Identify chemical properties to assess human health and environmental risks	TCL Organics TAL Inorganics (Metals)	IV IV
	• Identify physical/chemical properties to assess potential impacts to aquatic life	Dissolved Oxygen Specific Conductance Temperature pH	I I I I
Waste	• Assess extent of subsurface soil contamination at former disposal areas	TCL Organics TAL Inorganics (Metals)	IV IV
	• Identify chemical/physical properties to assess disposal and treatment requirements	Total TCLP Reactivity Ignitability Corrosivity	III III III III

Notes:

TCL - Target Compound List
TAL - Target Analyte List
TOC - Total Organic Carbon
TCLP - Toxicity Characteristic Leaching Procedure

3.0 SAMPLING LOCATIONS AND FREQUENCY

This section identifies each sample matrix to be collected and the constituents to be analyzed under this RI/FS. The media from which samples will be obtained include soil, groundwater, surface water, sediment, benthics and fish. (Note: Table 6-1 provides a summary of the sampling and analyses to be conducted at Site 35 under this RI/FS.)

3.1 Soil and Groundwater Sample Screening

The effort to determine the source, nature and extent of halogenated organic groundwater contamination will be initiated via soil gas and groundwater sample screening. In this case screening refers to the utilization of soil gas and drive-point (e.g., tradenames Hydropunch or Geoprobe) groundwater sampling techniques. These techniques can be calibrated to provide approximate results regarding the presence or absence of a variety of chemical compounds. Both techniques are restricted primarily to the measurement of VOAs.

Soil gas and groundwater samples will both be obtained by driving a small diameter stainless steel rod into the unsaturated and saturated zones, respectively. Groundwater samples will be obtained in the saturated zone at or near the shallow groundwater surface. Soil gas samples will be obtained in the unsaturated zone just above the groundwater surface. Collected soil gas and groundwater samples will be analyzed on site using a portable gas chromatograph (GC). Benzene and TCE will be used as the indicator compounds for analysis. Sampling procedures for each technique are detailed in Section 5.0.

The purpose of screening using these techniques is to provide data to afford the optimal placement of soil borings/monitoring wells from which additional soil and groundwater samples can be obtained and shipped off site for analysis. These techniques are referred to as "screening" methods because the level of QA/QC is significantly less than that applied to standard laboratory analytical methods. Therefore, the results provided by screening are considered approximate only and subject to laboratory verification. Soil gas analysis shall be performed by an experienced chemist under controlled conditions (i.e., mobile laboratory) in accordance with Data Quality Level II.

The focus of the soil and groundwater sample screening will be the areas in the vicinity of: 1) monitoring well MW-10 and the storm drain conduit along Fourth Street; 2) monitoring wells EMW-7 and MW-19, and Building TC-474; and 3) the area surrounding the former Mess

Hall Hearing Plant. A total of 55 locations will be sampled from the three areas combined, as shown on Figure 3-1 and as discussed below.

The largest area of soil gas and groundwater sample screening sampling points (35-SG-13 through 35-SG-34) is located south of Fourth Street from Building G533 extending east to Building TC-460, including the storm drain conduit along Fourth Street, and north of Fourth Street in the vicinity of the former gas station (see Figure 3-1, sample locations 13 through 34). The concentration of sampling points south of Fourth Street was deemed necessary because, unlike the area north of Fourth Street, very little data was obtained under previous investigations. Previous sampling in this area indicated elevated concentrations of halogenated organic compounds, including TCE, in groundwater samples collected from MW-10, MW-14, and EMW-3 (see Figure 1-4 for existing monitoring well locations). The soil gas and groundwater screening in this area is designed to delineate the horizontal extent of this contamination south of Fourth Street as well as the source, if possible. Additional sample locations may be selected in this area based on the results of the initial sampling.

The second largest concentration of sampling points will be used to identify the presence and concentration, if any, of contaminants of concern in soil and groundwater in the vicinity of Building TC-474, monitoring wells EMW-7 and MW-19, and Brinson Creek. Building TC-474 is a warehouse and former auto maintenance facility that is suspected of being the potential source of halogenated organic contamination detected in monitoring wells EMW-7 and MW-19. The initial soil gas and groundwater sampling grid for this area will consist of 21 sampling locations (35 through 55) spaced as shown on Figure 3-1. Additional sample locations may be selected in this area based on the results of the initial sampling.

The third sampling grid will be placed in the vicinity of the former Mess Hall Heating Plant because halogenated solvents may have been used at this facility as part of routine maintenance. Elevated concentrations of non-halogenated organic compounds were detected in soil samples collected from boring B-4, adjacent to the abandoned No. 6 fuel oil UST. The initial sampling grid for this area will consist of 12 sampling locations (1 through 12) spaced as shown on Figure 3-1. Additional sample locations may be selected in this area based on the results of the initial sampling.

As indicated above, additional soil gas and groundwater screening samples will be obtained based on the results of the initial sampling until the limits of the impacted areas can be determined.

The results of the soil and groundwater screening will be mapped and used as the basis for placement of soil boring and monitoring wells, as discussed in the following sections.

3.2 Soil Investigation

Soil sampling at Site 35 will be comprised of two elements including: surface soil sampling across the site to provide data to support the baseline risk assessment; and subsurface soil sampling at soil boring and shallow groundwater monitoring well locations determined via soil gas and groundwater field screening and at deep groundwater monitoring well locations. Each of these elements is discussed below:

3.2.1 Surface Soil Sampling

A total of 14 surface soil samples (SS-1 through SS-14), including two background samples (SS-1 and SS-2) will be obtained from the locations depicted on Figure 3-2. Surface soil samples are defined as those obtained from the interval between the ground surface and 12 inches below the ground surface (bgs). The sampling locations were selected based on the limits of soil and groundwater contamination established via the results of previous investigations (Law, 1992 and ATEC, 1993). Background samples SS-1 and SS-2 are located topographically upslope and hydrogeologically upgradient of previously identified contamination. The area of contamination nearest to the background sample locations is associated with the former Mess Hall Heating Plant situated roughly 150 feet and 350 feet southeast of SS-1 and SS-2, respectively.

The remaining surface soil samples are located within areas where contaminated groundwater and/or soils have been identified. Surface soil samples SS-3 and SS-4 are situated in the area of the former Mess Hall Heating Plant where elevated petroleum hydrocarbons were detected in subsurface soil and shallow groundwater (Law, 1992 and ATEC, 1993).

Surface soil samples SS-5 and SS-6 are located at the southwest corner of Fourth and "E" Streets where elevated levels of halogenated organics were detected at a monitoring well (MW-10) installed in 1991 by Law.

Surface soil samples SS-7 and SS-8 are located north of Fourth Street. SS-7 is situated between "F" Street and the parking lot for building TC480 while SS-8 is situated near monitoring well MW-25. The locations of these surface soil samples are within an area where elevated petroleum hydrocarbons were previously detected in subsurface soil and shallow groundwater samples (Law, 1992).

Surface soil samples SS-9 and SS-10 are located north of Fourth Street and between "F" Street and the Fuel Farm (TC362 and STC369). The results of previous shallow groundwater sampling and analysis in this area identified elevated levels of halogenated organics (Law, 1992).

Surface soil samples SS-11 and SS-12 are situated in the vicinity of the Fuel Farm (TC362 and STC369) located north of the corner of Fourth and "G" Streets. Elevated levels of petroleum hydrocarbons were detected in shallow groundwater samples previously obtained from this area. Past reported leaks from underground lines in this area make them the primary suspected source of contamination.

Soil samples SS-13 and SS-14 are located east of "G" Street. Sample SS-13 is situated in an area where elevated levels of halogenated organics were detected previously in shallow groundwater samples (MW-19 and EMW-7). Sample SS-14 is situated adjacent to the east wall of building TC474 which previously served as a vehicle maintenance facility and is a suspected source of the groundwater contamination in this area.

Additional samples may be obtained based on the results of soil gas and groundwater sample screening which is being conducted as a tool to aid in defining the limits of the halogenated organic contamination previously detected in shallow groundwater. The locations of these samples, if required, will be established in the field. It is assumed that approximately five additional surface soil samples (SS-15 through SS-19) will be needed. These additional five surface soil samples will be obtained from five of the 13 subsurface soil borings (B-7 through B-19) to be drilled under this RI/FS as described in the following subsection.

3.2.2 Subsurface Soil Sampling

Subsurface soil samples will be obtained from 28 soil borings drilled under this RI/FS. This includes 13 soil borings drilled exclusively for the purpose of obtaining subsurface soil data and 15 soil borings to be completed as monitoring wells. [Note: seven additional soil borings

(PSB-29 through PSB-35) are to be drilled under the Interim Remedial Action RI/FS to provide subsurface soil data at areas where petroleum-based contamination was identified in soil and/or groundwater under a previous investigation. The detailed rationale for these borings is provided in the Interim Remedial Action RI/FS Project Plan (Baker, 1993)]. It has been assumed that 13 additional soil borings (B-7 through B-19: Borings B-1 through B-6 were installed by Law in 1991), five additional two-well cluster shallow groundwater monitoring locations (MW-29A,B through MW-33A,B: monitoring wells MW-1 through MW-27 and pumping well PW-28 were installed by Law in 1991 and 1992) and five deep groundwater monitoring wells (GWD-1 through GWD-5) will be included under this RI/FS. Only the deep well locations are depicted on Figure 3-2 because the soil boring and shallow monitoring well cluster locations will be determined by the results of the soil gas and groundwater sample screening.

The locations of the 13 soil borings and five two-well cluster shallow groundwater monitoring well locations will be determined based on the results of the soil gas and groundwater sample screening. Sample screening results indicative of both the presence and absence of contamination will be used. That is, it is anticipated that several borings and wells will be positioned in areas where positive soil gas and/or groundwater sampling results are obtained to confirm the presence or absence of contamination in these areas. Several borings and wells will also be positioned in areas where no positive soil gas and/or groundwater sampling results are obtained to confirm the presence or absence of contamination and establish the perimeter of the unimpacted area.

Each subsurface soil boring will be drilled to the top of the shallow groundwater surface (assumed to be 8 to 10 feet bgs based on measurements from existing wells) and sampled at continuous 2-foot intervals via split-spoon using ASTM Method 1586-84. One subsurface sample for laboratory analysis will be obtained from each of the 13 soil borings that will not be completed as monitoring wells. Upon opening the split-spoon sampler, each soil sample will be field screened for volatile organic emissions via photoionization detector (PID) or organic vapor analyzer (OVA). The soil sample exhibiting the highest PID or OVA reading will be selected for laboratory analysis. The field geologist can exercise discretion and substitute a visually contaminated sample for the sample exhibiting the highest PID or OVA reading. Five of the 13 soil borings will be selected to provide surface soil (0 to 12 inches bgs) samples for laboratory analysis. The selection of the borings to provide these samples will be at the discretion of the field geologist.

Additional subsurface soil samples will be collected at each of the five shallow and five deep groundwater monitoring well locations. These subsurface soil samples will be obtained from the unsaturated soil interval located immediately above the static groundwater surface. The rationale for obtaining these samples is that it can provide a correlation between soil contamination and groundwater contamination and is likely to be, along with the sample exhibiting the highest PID or OVA reading, the most contaminated sample in the borehole.

Additional soil borings and shallow groundwater monitoring wells may be required based on the results of the soil gas and groundwater sample screening.

3.2.3 Soil Analysis

All surface soil samples obtained under this RI/FS will be analyzed for TCL VOAs and SVOAs, and TAL Metals. The data from these samples will be used to support the baseline risk assessment.

Subsurface soil samples obtained from soil borings to be completed as deep groundwater monitoring wells (GWD-1 through GWD-5) will be analyzed for TCL VOAs and SVOAs, and TAL metals. The data from these samples, which will be obtained from areas of previously identified contamination and from areas not previously investigated, will be used to support the baseline risk assessment and to provide additional data pertaining to the presence or absence and vertical extent of soil contamination.

Subsurface soil samples obtained from soil borings (B-7 through B-19) and shallow monitoring well borings (MW-29A,B through MW-33A,B) designed to delineate the nature and extent of the previously identified halogenated organic groundwater contamination will be analyzed only for TCL VOAs.

One undisturbed subsurface soil sample (ASTM D1587-83) will be obtained from the background deep groundwater monitoring well boring GWD-1 and analyzed for engineering parameters including particle size distribution (ASTM D422-63), Atterberg Limits (ASTM D4943-89), and constant head permeability (ASTM D2435-68). The soil sample will be obtained from the interval corresponding with the underlying clay layer that may be representative of a confining aquitard. It is preferred that the sample be obtained from the background well to ensure an unimpacted sample is sent to the geotechnical laboratory. The performance of the above physical analyses will aid in the classification of the material which, in turn, will afford an empirical estimate of the hydraulic conductivity of this zone that may be compared to the results of the permeability test.

One subsurface soil sample will be obtained from deep groundwater monitoring well boring GWD-3 and analyzed for RCRA hazardous characteristics (i.e., full TCLP, corrosivity, ignitability, reactivity). This well is located in an area where halogenated organic contamination was previously detected in shallow groundwater. In addition, subsurface soil samples will be collected for the evaluation of other engineering parameters including TOC, phosphorous, nitrogen, and microbial enumeration.

3.3 Groundwater Investigation

The groundwater investigation to be conducted under this RI/FS will include the installation of both shallow and deep groundwater monitoring wells. The rationale for the installation of these wells is presented below.

3.3.1 Shallow Groundwater Wells

Five two-well cluster shallow groundwater monitoring well locations (MW-29A,B through MW-29A,B: MW-1 through -27 and pumping well PW-28 were installed by Law in 1991 and 1992) will be installed under this RI/FS to define the horizontal extent of the halogenated organic contamination identified in groundwater samples obtained under previous studies (Law, 1992). Specifically, the extent of this contamination has not been defined south of Fourth Street where elevated levels were encountered at monitoring well MW-10 or in the vicinity of building TC474 where nearby wells MW-19 and EMW-7 exhibited elevated levels of TCE.

The locations of the shallow monitoring well clusters will be determined based on the results of soil gas and groundwater sample screening. Several of the well clusters will be positioned to confirm the presence or absence of shallow groundwater contamination at areas where positive screening results were obtained. Conversely, a couple of the shallow wells will be positioned in areas where no positive screening results were obtained so as to delineate the limits of the shallow groundwater contamination.

Five two-well shallow groundwater monitoring clusters (MW-29A,B through MW-33A,B: MW-1 through -27 and pumping well PW-28 were installed by Law in 1991 and 1992) will be installed under this RI/FS to define the horizontal extent of the halogenated organic contamination identified in groundwater samples obtained under previous studies (Law, 1992). Specifically, the extent of this contamination has not been defined south of Fourth Street where elevated levels were encountered at monitoring well MW-10 or in the vicinity of building TC474 where nearby wells MW-19 and EMW-7 exhibited elevated levels of TCE.

The locations of the shallow monitoring well clusters will be determined in the field based on the results of soil gas and groundwater sample screening. Several of the well clusters will be positioned to confirm the presence or absence of shallow groundwater contamination at areas where positive screening results were obtained. Conversely, a couple of the shallow well clusters will be positioned in areas where negative screening results were obtained so as to delineate the limits of the shallow groundwater contamination.

At each shallow monitoring well cluster location, two 2-inch diameter, schedule 40 PVC wells will be installed. The purpose of the two-well cluster concept is to provide the means for obtaining groundwater data at the shallow groundwater surface and immediately above the underlying confining layer. These intervals are monitored by existing double-nested shallow wells previously installed by Law. According to the results of previous investigations conducted by Law, the shallow groundwater surface can be expected to be encountered across the topographically flatter portions of the site at 8 to 10 feet bgs. Data provided by Law indicates the top of the confining layer is located from 35 to 43 feet bgs.

Each well in the two-well clusters will be provided with either an "A" or "B" designation (e.g., MW-29A and MW-29B). The "A" will identify the well screened at the groundwater surface, whereas "B" will identify the well screened at the top of the underlying confining layer. Each well will be constructed with 2-inch diameter, schedule 40 PVC casings and No. 10 slot, 2-inch diameter PVC screens. The groundwater surface monitoring well screened interval will be 10 feet long while a 5-foot long screen will be set in the deeper shallow groundwater well drilled to just above the confining layer. Detailed well construction information and well installation procedures are provided in Section 5.0

Additional wells may be required based on the results of the soil gas and groundwater field screening.

3.3.2 Deep Groundwater Wells

Five deep groundwater wells (GWD-1 through GWD-5) are to be installed under this RI/FS below the clay layer identified in borings SB-1, SB-2, and SB-3 (Law, 1992) at depths ranging from 35 to 43 feet bgs. This clay layer may represent the confining aquitard that separates the shallow water table aquifer from the regionally significant Castle Hayne formation. The proposed locations are shown on Figure 3-2. The deep well screens will be set immediately below the clay layer. In effect, the screens for these deep wells would be set only a few feet deeper than the deeper shallow groundwater monitoring wells and would be separated only by the underlying clay confining layer.

The purpose of the deep wells is to provide data to define the vertical extent of contamination in areas where analytical results of shallow groundwater samples obtained under previous investigations have identified elevated levels of organic contaminants. One of the five deep wells (GWD-1) will be installed in an area suspected to not have been impacted (i.e., at the northwest corner of the intersection of Third and "D" Streets) to provide background data. Two of the remaining four deep wells (GWD-3 and GWD-5) are located adjacent to existing double-nested wells MW-10 and MW-19 previously installed by law. Elevated levels of halogenated organics were detected in the lower portions of these double-nested wells that are screened from 25.5 feet to 29.5 feet and from 22.5 feet to 24.5 feet, respectively. The other two deep wells (GWD-2 and GWD-4) are located near wells MW-2 at the former Mess Hall Heating Plant and MW-25 located north of the Fuel Farm (buildings TC362 and STC369). Both of these wells are located in areas where elevated levels of petroleum hydrocarbons were identified in previous studies (ATEC, 1993 and Law, 1992).

The deep wells will be constructed of 2-inch diameter, schedule 40, PVC casings. Well screens will be 5 feet in length and will be constructed of No. 10 slotted PVC. It is assumed that all of the deep wells will be constructed with stick-up (2 to 3 feet) steel casings, locking caps, and protective bollards. Detailed well construction information and well installation procedures are provided in Section 5.0.

3.3.3 Groundwater Sampling and Analysis

One round of groundwater samples will be collected from each well installed under this RI/FS. This will result in 10 samples from newly installed shallow monitoring wells and five samples from the deep wells.

Samples from four of the five shallow groundwater cluster wells (MW-29A,B through MW-32A,B) will be analyzed for VOAs via EPA Method 601/602 including MTBE (methyl tertiary butyl ether)as these wells will be installed to provide data regarding the source and extent of the previously identified halogenated organic shallow groundwater contamination. In addition, the samples from well MW-33A and MW-33B will be analyzed for full-scan TCL organics and TAL inorganics.

Samples from four of the five newly-installed deep groundwater monitoring wells (GWD-1 through GWD-4) will be analyzed for VOAs via EPA Method 601/602 including MTBE, TCL SVOAs, and TAL Metals. A sample from well GWD-5 will be analyzed for full-scan TCL organics and TAL inorganics. This data will be used to support the baseline risk assessment and to provide information regarding the vertical extent of groundwater contamination.

In addition to the groundwater samples obtained from the newly installed shallow and deep monitoring wells, a single round of 21 groundwater samples will be obtained from a selected number (12) of existing shallow groundwater monitoring wells to provide comparative data and for use in the baseline risk assessment. The existing wells to be sampled include shallow double-nested wells MW-2, -9, -10, -14, -16, -19, -21, -22, and -25, and single shallow wells EMW-3, -5, and -7. The selection of these 12 wells was based on the results of previous investigations (Law, 1992 and ATEC, 1993). Six of the wells (MW-10, -14, and -19, and EMW-3, -5, and 7) were identified as the only wells exhibiting elevated levels of the halogenated organic compound TCE (trichloroethylene). The remaining six wells (MW-2, -9, -16, -21, -22, and -25) include wells where elevated levels of petroleum hydrocarbons were detected. All of the selected shallow wells are double-nested wells except for EMW-3, -5, and -7 which are single wells.

Each of the 21 samples obtained under this RI/FS from the 12 existing groundwater wells identified above will be analyzed for VOAs via EPA Method 601/602 including MTBE, TCL SVOAs, and TAL metals as this data will be used to support the baseline risk assessment. In addition, the sample obtained from double-nested well MW-21 will be analyzed for full-scan TCL organics and TAL inorganics in lieu of the above methods and for various engineering parameters including microbial enumeration, TOC, BOD, COD, TSS, TDS, ammonia nitrogen, total phosphorous and alkalinity.

3.3.4 Water Level Measurements

Static water level measurements (minimum two rounds) will be collected from each existing and newly installed monitoring well during the groundwater investigation. Water level measurements shall be collected from all of the wells within a four hour period, if possible. This data will be used to evaluate groundwater flow direction.

3.4 Surface Water/Sediment Investigation

Surface water and sediment investigations will be conducted along Brinson Creek to assess possible impacts from Site 35 and to support the baseline risk assessment. Six sampling stations will be established along Brinson Creek including one upstream and five adjacent/downstream locations between the site and the New River. The locations are depicted and described on Figure 3-2. The exact sampling locations are to be determined in the field and are to correspond roughly with aquatic/ecological survey sampling locations. One surface water and two sediment samples (near bank: 0 to 6 inches and 6 to 12 inches below the sediment surfaces) will be obtained from each location. The surface water and sediment samples will be analyzed for TCL organics and TAL metals.

3.5 Aquatic/Ecological Survey

Aquatic/ecological surveys will be conducted in Brinson Creek to evaluate the potential ecological impacts from past activities at Site 35. The surveys will include the collection of benthic macroinvertebrate and fish samples to assess environmental stresses posed by Site 35. To assess ecological stresses to the aquatic community posed by stream quality, faunal densities, species richness, and species diversity will be determined for benthic macroinvertebrates at each sampling station. Fish samples will be collected for each of the population statistics and subsequent laboratory analysis of whole body parts and fillets. Crab samples will be collected for subsequent analysis of edible body parts. Each fish sample for chemical analysis will represent different trophic levels, if possible, as follows: top carnivores, forage fish, and bottom feeders. All fish and crab analytical samples will be analyzed for TCL organics and TAL metals.

Benthic macroinvertebrates and fish samples will be collected from three 500-foot stretches (i.e., sampling locations) along Brinson Creek; upgradient of Site 35; roughly adjacent to

Site 35; and downgradient of Site 35 (see Figure 3-2). The stations will be located to roughly correspond to the surface water/sediment sampling locations.

Benthic macroinvertebrates will be collected with a Standard Ponar. Fish will be collected utilizing electroshocking procedures, seining, or gill nets and/or other fish collecting techniques.

Specific sampling procedures are detailed in Section 5.0.

3.6 QA/QC Samples

QA/QC requirements for this investigation are presented in the Quality Assurance Project Plan (QAPP) which is Section II of this SAP. The following QA/QC samples will be collected at each of the three sites during field sampling activities:

- Trip Blanks

  Trip blanks are defined as samples which originate from analyte-free water taken from the laboratory to the sampling site and returned to the laboratory with the volatile organic analysis (VOA) samples. One trip blank should accompany each cooler containing samples for volatile organics analysis Trip blanks shall only be analyzed for volatile organics.

- Equipment Rinsates

  Equipment rinsates are the final analyte-free water rinse from equipment decontamination procedures. Equipment rinsate blanks will be collected daily during each sampling event. Initially, samples from every other day should be analyzed. If analytes pertinent to the project are found in the rinsate, the remaining samples must be analyzed. The results from the blanks will be used to evaluate the decontamination methods. This comparison is made during data validation and the rinsates are analyzed for the same parameters as the related samples.

  One equipment rinsate will be collected per day of field sampling.

- Field Blanks

  Field blanks consist of the source water used in equipment decontamination procedures. At a minimum, one field blank for each event, each source of water and one drilling fluid sample per event must be collected and analyzed for the same parameters as the related samples. Information regarding the type and source of other well construction material (i.e., filter pack, grout, bentonite, etc.) must be recorded in the field logbook.

  Two field blanks (ambient condition blanks) will be prepared at the commencement of each sampling event. The field blanks will be prepared by pouring organic-free water brought to the field in sealed containers (used for decontamination purposes) into one set of sample bottles and deionized water directly into an additional set of sample bottles.

- Field Duplicates

  Field duplicates for soil samples are collected, homogenized, and split. All samples except VOAs are homogenized and split. Volatiles are not mixed, but select segments of soil are taken from the length of the core and placed in 40-ml. glass vials. The duplicates for water samples should be collected simultaneously. The water samples will not be composited.

  Field duplicates will be collected at a frequency of 10 percent.

- Matrix Spike/Matrix Spike Duplicates (MS/MSD)

  MS/MSDs are not field sampling activities, they are laboratory derived.

  MS/MSD samples are collected to evaluate the matrix effect of the sample upon the analytical methodology. A matrix spike and matrix spike duplicate must be performed for each group of samples of a similar matrix.

  MS/MSD samples will be collected at a frequency of 5 percent.

4.0 SAMPLE DESIGNATION

All samples collected during this investigation, including QA/QC samples, will be designated with a unique number. The number will serve to identify the investigation, the site, the area within the site, the sample media, sampling location, the depth (soil) or round (groundwater) of sample, and QA/QC qualifiers.

The sample designation format is as follows:

Site # - Media - Location - Depth/Round (QA/QC)

An explanation of each of these identifiers is given below.

Site #	This investigation includes Site 35.
Media	SB = Soil Boring (soil sample from a boring) GW = Groundwater MW = Groundwater EMW = Groundwater SW = Surface Water SD = Sediment WT = Waste
Location	The location numbers identify the sampling location. This would include station number for soil location or monitoring well number for groundwater. Each grid station will be identified with a unique identification number.
Depth/Round	Depth indicators will be used for soil samples. The number will refer to the depth of the top of the sampled interval. For example: 00 = top of sample at ground surface 01 = top of sample is 1 foot below surface 07 = top of sample is 7 feet below surface Round indicator will be used for groundwater samples (round one and round two). For example:
QA/QC	(FB) = Field Blank (D) = Duplicate Sample (TB) = Trip Blank (ER) = Equipment Rinsate

Under this sample designation format the sample number 35-GW3-01D refers to:

35-GW-3-01D	Site 35
35-GW-3-01D	Groundwater sample
35-GW-3-01D	Monitoring well #3
35-GW-3-01D	Round 1
35-GW-3-01D	Duplicate (QA/QC) sample

This sample designation format will be followed throughout the project. Required deviations to this format in response to field conditions will be documented.

5.0 INVESTIGATIVE PROCEDURES

The investigative procedures to be used for Operable Unit (OU) No. 10 (Site 35) will be discussed in the following sections. This includes: soil sample collection, monitoring well installation (both shallow and deep), staff gauge installation, groundwater sample collection, surface water sample collection, sediment sample collection, fish/benthic sample collection, decontamination procedures, surveying, handling of site investigation generated wastes, and water level measurements. Note that all of these procedures will follow the field methods described in the USEPA, Region IV, Environmental Services Division (ESD), Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual (ECBSOPQAM), February 1, 1991. Additional guidance from other sources such as the American Society for Testing Materials (ASTM) may be used, but if the ASTM and ESD methods are in conflict, the ESD procedure will be used.

5.1 Soil Sample Collection

Surface and subsurface soil samples will be collected throughout OU No. 10. The majority of the soil samples will be collected from borings advanced by a drilling rig and during the installation of monitoring wells. Soil samples may also be collected from borings advanced by hand auger or power auger.

5.1.1 Soil Borings Advanced by Hand Auger

Hand augering is the most common manual method used to collect subsurface samples. Typically, 4-inch diameter bucket augers with cutting heads are pushed and twisted into the ground and removed as the buckets are filled. The auger holes are advanced one bucket at a time. The practical depth of investigation using a hand auger is related to the material being sampled. In this investigation, hand augers will be used to collect discrete grab samples of soil from the 0 to 12-inch intervals.

The bucket auger will be decontaminated between samples as outlined in Section 5.7.

5.1.2 Soil Borings and Monitoring Well Boreholes

Soil samples from soil borings advanced by a drilling rig will be collected using a split-spoon sampler. A split-spoon sampler is a steel tube, split in half lengthwise, with the halves held together by threaded collars at either end of the tube. This device can be driven into unconsolidated materials using a drive weight connected to the drilling rig. A standard split-spoon sampler (used for performing Standard Penetration Tests) is two inches outer diameter (O.D.) and 1-3/8 inches inner diameter (I.D.). This standard spoon is available in two common lengths providing either 20-inch or 26-inch internal longitudinal clearance for obtaining 18-inch or 24-inch long samples, respectively. Split spoons capable of obtaining 24-inch long samples will be utilized during this investigation.

Split-spoon samples will be collected continuously from the ground surface to the ground water table in each soil boring. Soil borings that will be converted into shallow monitoring wells (monitoring well boreholes) will be advanced to the desired depth past the water table. The physical characteristics of the samples will be described by the site geologist. The soil in the sampler will be classified according to the Unified Soil Classification System (USCS). Soil sample descriptions will be recorded in the field geologist's notebook.

Selected split-spoon samples will be submitted to the laboratory for analysis. In general, soil samples will be collected at 2-foot intervals to the top of the water table. Surface soil samples will not be collected using a split-spoon sampler because a sufficient quantity of sample cannot be retained from 0 to 6 inches using this sampling device. Hence, surface samples will be collected using a stainless-steel spoon, hand auger, or by advancing the augers and retaining the cuttings. For borings only, split-spoon samples will be collected from approximately one foot bgs to the top of the water table; for borings advanced for monitoring well installation, split spoon samples will be collected from ground surface (no surface samples will be collected) to the bottom of the borehole.

The following procedures for collecting soil samples in split-spoons will be used:

1. The surface sample will be collected by driving the split-spoon with blows from a 140-pound hammer falling 30 inches in accordance with ASTM D1586-84, Standard Penetration Test. Only the top 6 inches will be submitted to the laboratory for analyses.

2. Advance the borehole to the desired depth using hollow stem auger drilling techniques. The split-spoon will be lowered into the borehole inside the hollow stem auger (this will ensure that undisturbed material will be sampled).

3. Drive the split-spoon using procedures outlined in 1 above.

4. Repeat this operation until the borehole has been advanced to the selected depth.

5. Record in the field logbook the number of blows required to effect each six inches of penetration or fraction thereof. The first six inches is considered to be a seating drive. The sum of the number of blows required for the second and third six inches of penetration is termed the penetration resistance, N. If the sampler is driven less than 18 inches, the penetration resistance is that for the last one foot of penetration. (If less than one foot is penetrated, the logs shall state the number of blows and the fraction of one foot penetrated.) In cases where samples are driven 24 inches, the sum of second and third 6-inch increments will be used to calculate the penetration resistance. (Refusal of the SPT will be noted as 50 blows over an interval equal to or less than 6 inches; the interval driven will be noted with the blow count.)

6. Bring the sampler to the surface and remove both ends and one half of the split-spoon such that the soil recovered rests in the remaining half of the barrel. Describe the recovery (length), composition, structure, consistency, color, condition, etc., of the recovered soil; then put into sample jars. Record the level of volatile emissions of each sample via PID or OVA in the field logbook.

7. Split-spoon samplers shall be decontaminated after each use and prior to the initial use at a site according to procedures outlined in Section 5.6.

The following procedures are to be used for soil samples submitted to the laboratory:

1. After sample collection, remove the soil from the split-spoon sampler. Prior to filling laboratory containers, the soil sample should be mixed thoroughly as possible to ensure that the sample is as representative as possible of the sample interval. Soil samples for volatile organic compounds should <u>not</u> be mixed. Further, sample containers for volatile organic compounds analyses should be filled completely without head space remaining in the container to minimize volatilization.

2. Record all pertinent sampling information such as soil description, sample depth, PID or OVA reading, sample number, sample location, and time of sample collection in the

field logbook. In addition, label, tag, and number the sample bottle(s) as outlined in Section 6.0.

3. Pack the samples for shipping. Attach seal to the shipping package. Chain-of-Custody Forms and Sample Request Forms will be properly filled out and enclosed or attached (Section 6.0).

4. Decontaminate the split-spoon sample as described in Section 5.6. Replace disposable latex gloves between sample stations to prevent cross-contamination of samples.

5.2 Monitoring Well Installation and Well Development

5.2.1 Well Installation

Shallow and deep monitoring wells will be installed to monitor the water-bearing zones located above and below a previously identified clay encountered 35 to 40 feet bgs. Shallow wells will be installed in two-well clusters that include a groundwater surface well with a 10-foot long well screen set to span the interval from two feet above the groundwater surface to eight below the groundwater surface and a deeper well with a five-foot long well screen set just above the underlying clay layer. The deep wells will be drilled and installed before the shallow wells to provide stratigraphic data regarding the location and thickness of the underlying clay layer. The deep wells will be constructed with five-foot long well screens, the tops of which will be set immediately below the base of the clay layer.

Procedures for the installation and construction of shallow, groundwater surface monitoring wells are presented below:

- Activity personnel will approve all monitoring well locations. These locations will be free of underground or overhead utility lines.

- A borehole will be advanced by a drilling rig using hollow stem augers. Initially, the boreholes will be advanced with 3-1/4 inch I.D. augers. After the borehole has been advanced to its final depth, the borehole will be overdrilled with 10-1/4 inch I.D. augers (for well installation only).

- Soil (split spoon) samples will be collected continuously during borehole advancement. Samples will be collected according to the procedures outlined in Section 5.1.2.

- Upon completion of the borehole to the desired depth, monitoring well construction materials will be installed (inside the hollow stem augers).

- PVC is the material selected for monitoring well construction. It was selected on the basis of its low cost, ease of use and flexibility. EPA Region IV requires justification of using PVC. Appendix A is a project-specific justification for use of PVC (based on existing groundwater quality information) presented in the EPA Region IV required format.

- Ten feet of 2-inch I.D., Schedule 40, #10 slot (0.010-inch) screen with a bottom cap. The top of the well screen will be connected to a threaded, flush-joint, PVC riser. The screen will extend two to three above the seasonal high static groundwater table surface. The riser will extend to approximately six inches below the ground surface.

- The annular space around the screen will be backfilled with a well-graded medium to coarse sand (No. 1 or No. 2 Silica Sand) as the hollow-stem augers are being withdrawn from the borehole. Sand shall be placed from the bottom of the boring to approximately two feet above the top of the screened interval. A lesser distance above the top of the screened interval may be packed with sand if the well is very shallow to allow for placement of sealing materials.

- A sodium bentonite seal at least 24-inch thick, unless shallow groundwater conditions are encountered, will be placed above the sand pack. The bentonite shall be allowed to hydrate for at least 2 hours before further completion of the well.

- The depth intervals of all backfill materials shall be measured with a weighted measuring tape to the nearest 0.1 foot and recorded in the field logbook.

- The monitoring wells will be completed at the surface. The aboveground section of the PVC riser pipe will be protected by installation of a 4-inch diameter, 5-foot long steel casing (with locking cap and lock) into the cement grout. The bottom of the surface casing will be placed at a minimum of 2-1/2, but not more than 3-1/2 feet below the ground surface, as space permits. For very shallow wells, a steel casing of less than

5 feet in length may be used, as space permits. The protective steel casing shall not fully penetrate the bentonite seal.

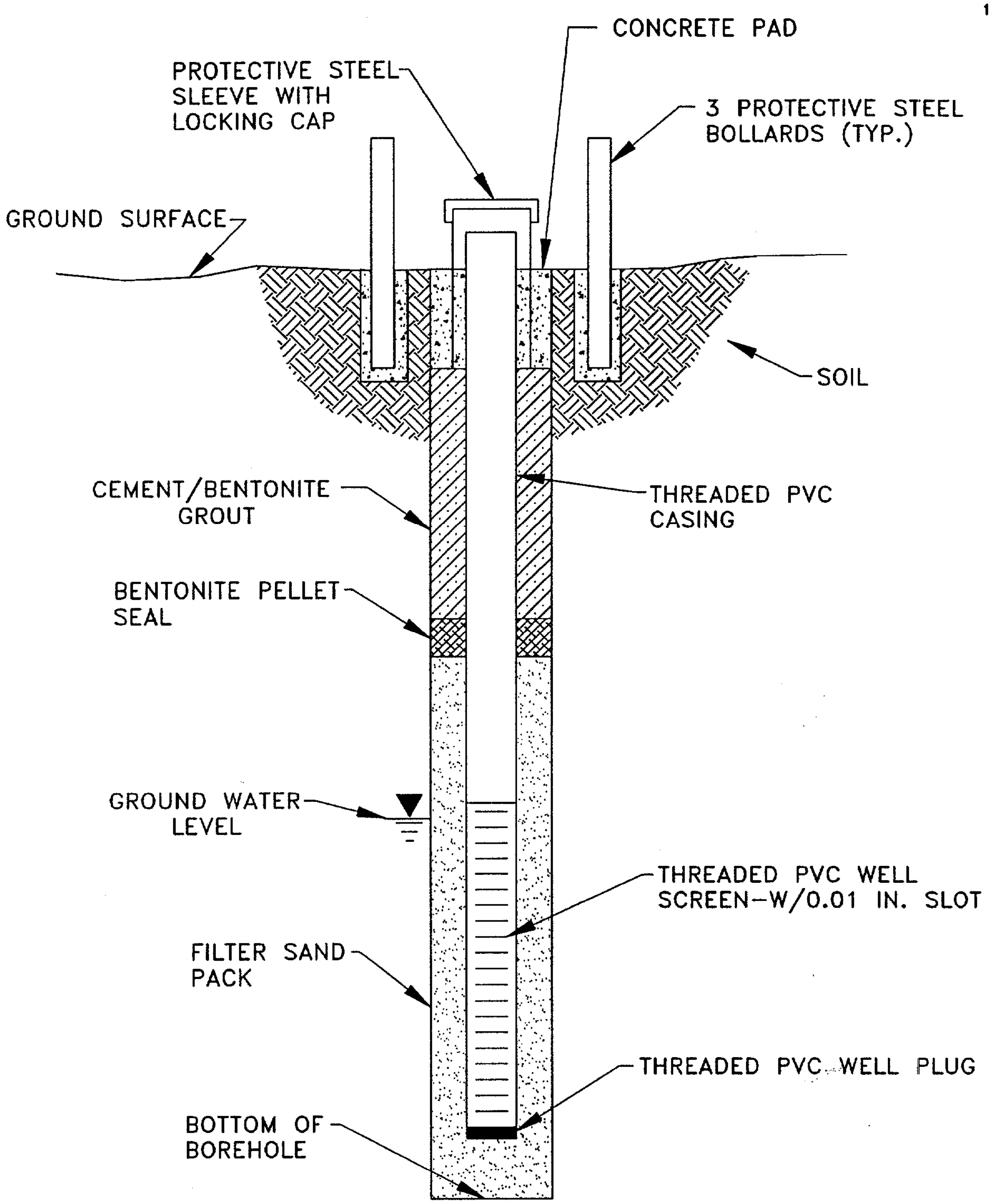
- The top of each well will be protected with the installation of four, 3-inch diameter, 5-foot long steel pipes which will be installed around the outside of the concrete apron. The steel pipes shall be embedded to a minimum depth of 2.5 feet in 3,000 psi concrete. Each pipe shall also be filled with concrete. A concrete pad shall be placed at the same time the pipes are installed. The pad will be a minimum of 4-feet by 4-feet by 6-inches, extending two feet below the ground surface in the annular space and set two inches into the ground elsewhere. The protective casing and steel pipes will be painted with day-glo yellow paint, or equivalent.

- If necessary, in high-traffic areas, the monitoring well shall be completed at the surface using a "flush" man-hole type cover. If the well is installed through a paved or concrete surface, the annular space shall be grouted to a depth of at least 2.5-feet and the well shall be finished with a concrete collar. If the well has not been installed through a paved or concrete surface, the well shall be completed by construction of a concrete pad, a minimum of 4-feet by 6-inches, extending two feet below the ground surface in the annular space and set two inches into the ground elsewhere. If water table conditions prevent having a 24-inch bentonite seal and the concrete pad as specified, the concrete pad depth should be decreased. Two weep holes will be drilled into opposite sides of the protective casing just above the concrete pad. The concrete shall be crowned to meet the finished grade of the surrounding pavement, as required. If appropriate, the vault around the buried wellhead will have a water drain to the surrounding soil and a watertight cover.

- All wells will have a locking cap connected to the protective casing. Each well will be tagged which will contain general well construction information and marked as "Test Well - Not For Consumptive Use."

Figure 5-1 is a typical above grade shallow (Type I) groundwater monitoring well.

Procedures for the installation and construction of shallow monitoring wells with screens set below the groundwater surface and above the confining clay layer are presented below:



N.T.S.

Baker

Baker Environmental, Inc.

FIGURE 5-1
TYPICAL ABOVE GRADE SHALLOW (TYPE I) GROUNDWATER
MONITORING WELL CONSTRUCTION DIAGRAM
SITE 35

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

- Activity personnel will approve all monitoring well locations. These locations will be installed free of underground or overhead utility lines.

- A borehole will be advanced initially using hollow stem augers to just below the water table (so that samples can be collected for laboratory analysis). The augers will be nominal 3/4-inch I.D. Continuous 2-foot split-spoon samples will be collected while the borehole is advanced. Samples will be collected according to the procedures outlined in Section 5.1.2. After advancing the borehole to the desired depth, the borehole will be overdrilled with 6-1/4 inch I.D. augers, prior to well installation.

- Split-spoon samples will be collected continuously during borehole advancement until the underlying layer is encountered. The expected depth of the underlying clay layer will be based primarily on data obtained from previous investigations and the well logs for deep wells GWD-1 through GWD-5 which will have already been completed. Samples will be collected according to the procedures outlined in Section 5.1.2.

- PVC is the material selected for monitoring well construction. It was selected on the basis of its low cost, ease of use and flexibility. EPA Region IV requires justification of using PVC. Appendix A is a projected-specific justification for use of PVC (based on existing groundwater quality information) presented in the EPA Region IV required format.

- Five feet of 2-inch I.D., Schedule 40, # 10 slot (0.010 inch) screen with a bottom cap will be installed. The base of the well screen will be set immediately above the top of the underlying clay layer.

- The annular space around the screen will be backfilled with a well-graded medium to coarse sand as (No. 1 or No. 2 silica sand) as the hollow-stem augers are being withdrawn from the borehole. Sand shall be placed from the bottom of the boring to approximately two feet above the top of the screened interval. A lesser distance above the top of the screened interval may be packed with sand if the well is very shallow to allow for placement of sealing materials. Monitoring wells greater than 50 feet deep shall have the sand pack installed via tremie method.

- A sodium bentonite seal (typically bentonite pellets) at least 24-inch thick, unless shallow groundwater conditions are encountered, will be placed above the sand pack.

The bentonite shall be allowed to hydrate for at least 2 hours before further completion of the well.

- The annular space above the bentonite seal will be backfilled with a cement-bentonite grout consisting of either two parts sand per one part of cement and water, or three to four percent bentonite powder (by dry weight) and seven gallons of potable water per 94 pound bag of portland cement. The bentonite seal shall be installed using a tremie pipe, if applicable depths are anticipated (i.e., greater than 25 feet).

- The depth intervals of all backfill materials shall be measured with a weighted measuring tape to the nearest 0.1 foot and recorded in the field logbook.

- The monitoring wells will be completed at the surface. The aboveground section of the PVC riser pipe will be protected by installation of a 4-inch diameter, 5-foot long steel casing (with locking cap and lock) into the cement grout. The bottom of the surface casing will be placed at a minimum of 2-1/2, but not more than 3-1/2 feet below the ground surface, as space permits. For very shallow wells, a steel casing of less than 5 feet in length may be used, as space permits. The protective steel casing shall not fully penetrate the bentonite seal.

- The top of each well will be protected with the installation of four, 3-inch diameter, 5 foot long steel pipes which will be installed around the concrete apron. The steel pipes shall be embedded to a minimum depth of 2.5 feet in 3,000 psi concrete. Each pipe shall also be filled with concrete. A concrete pad shall be placed at the same time the pipes are installed. The pad will be a minimum of 4-feet by 4-feet by 6-inches, extending two feet below the ground surface in the annular space and set two inches into the ground elsewhere. The finished pad shall be sloped so that the drainage will flow away from the protective casing and off the pad. The protective casing and steel pipes will be painted with day-glo yellow paint, or equivalent.

- If necessary, in high-traffic areas, the monitoring well shall be completed at the surface using a "flush" man-hole type cover. If the well is installed through a paved or concrete surface, the annular space shall be grouted to a depth of at least 2.5 feet and the well shall be finished with a concrete collar. If the well has not been installed through a paved or concrete surface, the well shall be completed by construction of a concrete pad, a minimum of 4-feet by 6-inches, extending two feet below the ground surface in the annular space and set two inches into the ground elsewhere. If water table conditions prevent having a 24-inch bentonite seal and the concrete pad as specified, the concrete pad depth should be decreased. Two weep holes will be drilled into opposite sides of the protective casing just above the concrete pad. The concrete shall be crowned to meet the finished grade of the surrounding pavement, as required. If appropriate, the vault around the buried wellhead will have a water drain to the surrounding soil and a watertight cover.

- All wells will have a locking cap connected to the protective casing. Each well will be tagged which will contain general well construction information and marked as "Test Well - Not for Consumptive Use."

Figure 5-2 is a typical above grade shallow (Type II) groundwater monitoring well construction diagram.

Procedures for the installation and construction of deep wells are presented below. In general, the borehole will be advanced and samples collected as described above. Additionally, well materials are the same as those described above.

- If a clay layer (i.e., layer which exhibits a low enough hydraulic conductivity which may impede the vertical migration of contamination) is encountered during borehole advancement, split-spoon samples will be collected at continuous intervals to determine the thickness of the layer.

- If the clay layer is determined to have low enough hydraulic conductivity (based on visual observations) and is at least two feet thick, then the well will be completed as a deep well (also commonly referred to as a double-cased well).

- Once it is determined that the clay layer meets the criteria mentioned above, the clay will be cased-off. Eight-inch steel casing will be installed at least one foot into the clay layer. The casing will then be grouted in place. The grout shall consist of a cement-bentonite mixture consisting of either two parts sand per one part of cement and water, or three to four percent bentonite powder (by dry weight) and seven gallons of potable water per 94 pound bag of portland cement.

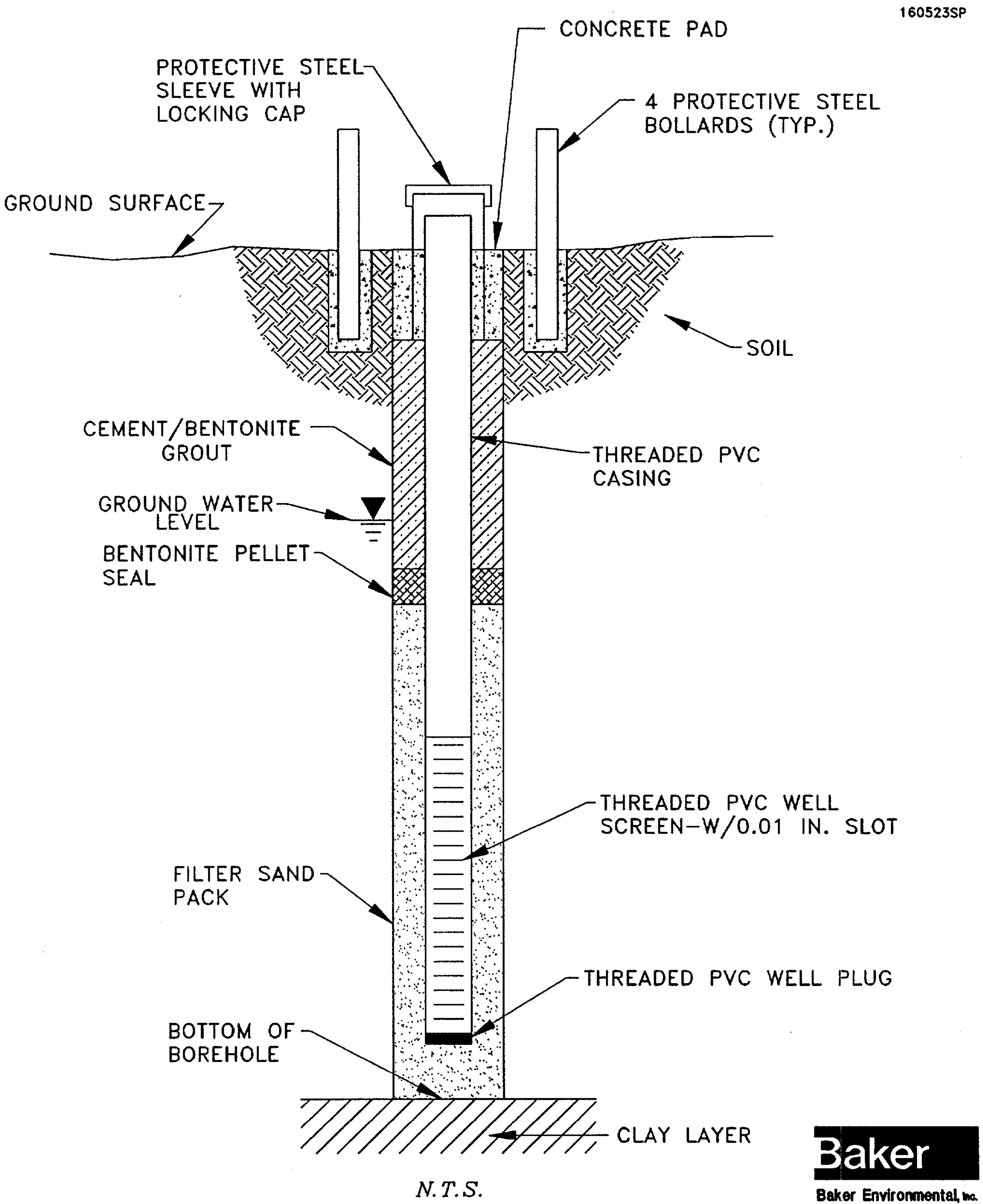


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FIGURE 5–2
TYPICAL ABOVE GRADE SHALLOW (TYPE II) GROUNDWATER MONITORING WELL CONSTRUCTION DIAGRAM
SITE 35

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

- The grout will be allowed to set-up for a minimum of 24-hours before the borehole is further advanced.

- Upon completion of the borehole to the desired depth, monitoring well construction materials will be installed as described above.

Figure 5-3 is a typical above grade deep monitoring well construction diagram.

All monitoring wells will be developed as specified in the ECBSOPQAM. The purposes of well development is to stabilize and increase the permeability of the filter pack around the well screen, to restore the permeability of the formation which may have been reduced by the drilling operations, and to remove fine-grained materials that may have entered the well or filter pack during installation. The selection of the well development method typically is based on drilling methods, well construction and installation details, and the characteristics of the formation.

Well development shall not be initiated until a minimum of 48 hours has elapsed subsequent well completion. This time period will allow the cement grout to set. Shallow wells typically are developed using bailers or low-yield pumping in combination with surging using a surge block. Deep monitoring wells are developed using compressed air (equipped with an air filter) in combination with surging. Selection of a development device will be dependent on conditions encountered during monitoring well installation.

All wells shall be developed until well water runs relatively clear of fine-grained materials. Note that the water in some wells does not clear with continued development. Typical limits placed on well development may include any one of the following:

- Clarity of water based on visual determination

- A maximum time period (typically one hour for shallow wells)

- A maximum well volume (typically three to five well volumes)

- Stability of specific conductance and temperature measurements (typically less than 10 percent change between three successive measurements)

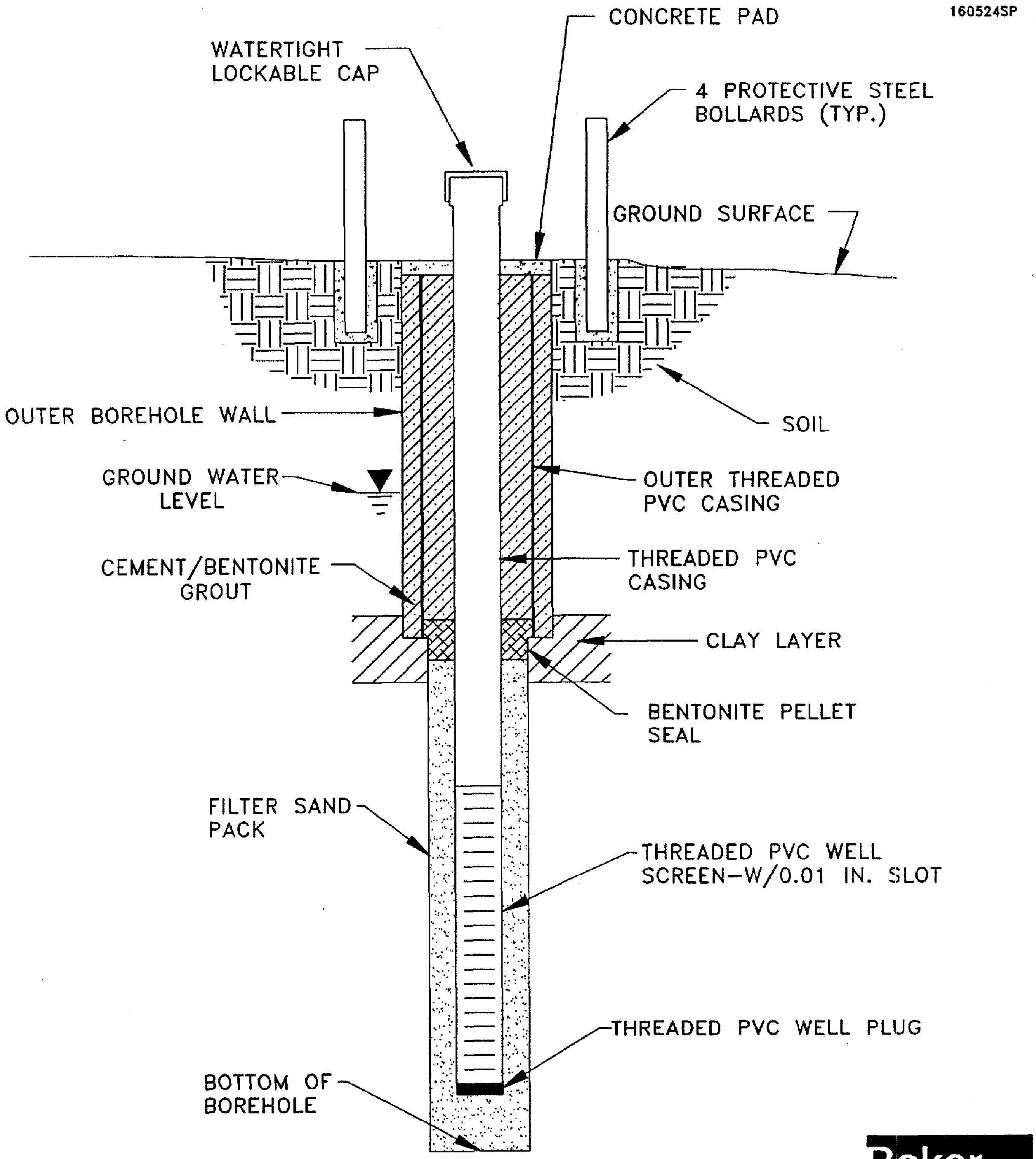

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FIGURE 5-3
TYPICAL ABOVE GRADE DEEP GROUNDWATER MONITORING WELL CONSTRUCTION DIAGRAM
SITE 35

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

- Clarity based on turbidity measurements [typically less than 50 Net Turbidity Units (NTU)]

A record of the well development shall be completed to document the development process.

Usually, a minimum period of one to two weeks should elapse between the end of initial development and the first sampling event for a well. This equilibration period allows groundwater unaffected by the installation of the well to occupy the vicinity of the screened interval.

5.3 Groundwater Sample Collection

Groundwater samples will be collected from existing and newly installed monitoring wells on site.

The collection of a groundwater sample includes the following steps:

1. First open the well cap and use volatile organic detection equipment (HNu or OVA) on the escaping gases at the well head to determine the need for respiratory protection. This task is usually performed by the Field Team Leader, Health and Safety Officer, or other designee.

2. When proper respiratory protection has been donned, sound the well for total depth and water level (decontaminated equipment) and record these data in the field logbook. Calculate the fluid volume in the well.

3. Lower purging equipment (bailer or submersible pump) into the well to a short distance below the water level and begin water removal. Purged water will be temporarily stored in DOT-approved 55-gallon drums. Final containment of purged water is addressed in Section 5.9.1.

4. Measure the rate of discharge using a bucket and stopwatch.

5. Purge a minimum of three to five well volumes before sampling. In low permeability strata (i.e., if the well is pumped to dryness), one volume will suffice. Allow the well to

recharge as necessary, but preferably to 70 percent of the static water level, and then sample.

6. Record measurements of specific conductance, temperature, and pH during purging to ensure the groundwater stabilizes. Generally, these measurements are made after three, four, and five well volumes.

7. Lower the closed top teflon bailer into the well, submerge into the groundwater, and retrieve. A teflon coated line (only the portion in contact with the water table) will be used for lowering the bailer. Pour groundwater from the bailer into the laboratory-supplied sample bottles.

8. Samples for VOC analysis will be collected first, followed by semivolatiles, PCBs, pesticides, and metals. Sample bottles will be filled in the same order for all monitoring wells.

9. Samples will be collected for total (unfiltered) and dissolved (filtered) metal analysis. Samples collected for dissolved metals analysis will be filtered in the field prior to being submitted for analysis. Filtering will be conducted using a 45-micron filter.

Sample preservation handling procedures are outlined in Section 6.0.

5.4 Surface Water Sample Collection

The following procedures will be used for the collection of surface water samples at stations located on site. At each station, samples will be collected at the approximate mid-vertical point or near the bank of the surface water body. Care will be taken to ensure that the sampler does not contact and/or stir up the sediments, while still being relatively close to the sediment-water interface.

The surface water samples will be collected by dipping the laboratory-supplied sample bottles directly into the water. Clean PVC gloves will be worn by sampling personnel at each sampling station. For those sample bottles that contain preservative (e.g., sulfuric acid), the water will be collected in a clean, decontaminated sampling container, and then slowly transferred into the appropriate laboratory-supplied sample bottle.

The water samples will be collected from near mid-stream at each station. Water samples at the furthest downstream station will be collected first, with subsequent samples taken at the next upstream station(s). Sediment samples will be collected after the water samples to minimize sediment disturbance and suspension.

All sample containers not containing preservative will be rinsed at least once with the sample water prior to final sample collection. In addition, the sampling container used to transfer the water into sample bottles containing preservatives will be rinsed once with sample water.

Care will be taken when collecting samples for analysis of volatile organics compounds (VOCs) to avoid excessive agitation that could result in loss of VOCs. VOC samples will be collected prior to the collection of the samples for analysis of the other parameters. Sample bottles (40 milliliter septum vials with screw-on caps with teflon-silicon disks) will be filled in the same order at all sampling stations. The sample bottles will be filled by pouring down the side until the container is completely filled leaving no head space. Each filled bottle will be checked for bubbles and rejected if encountered.

Temperature, pH, specific conductance, and dissolved oxygen of the surface water will be measured in the field at each sampling location (at each sampling depth), immediately following sample collection.

The sampling location will be marked by placing a wooden stake and bright colored flagging at the nearest bank or shore. The sampling location will be marked with indelible ink on the stake. In addition, the distance from the shore and the approximate location will be estimated using triangulation methods, and recorded and sketched in the field log book. If permission is granted, photographs will be taken to document the physical and biological characteristics of the sampling location.

The following information will be recorded in the field logbook:

- Project location, date and time
- Weather
- Sample location, number, and identification number
- Flow conditions (i.e., high, low, in flood, etc.)
- On site water quality measurements
- Visual description of water (i.e., clear, cloudy, muddy, etc.)

- Sketch of sampling location including boundaries of the water body, sample location (and depth), relative position with respect to the site, location of wood identifier stake
- Names of sampling personnel
- Sampling technique, procedure, and equipment used

Sample preservation and handling procedures are outlined in Section 6.0.

5.5 Sediment Sample Collection

The following procedures will be used for the collection of sediment samples at stations located on site. At each station, surface and near surface sediment samples will be collected at a depth of 0-6 inches, and 6-12 inches. These intervals of sediment will be collected using a stainless steel hand-held coring instrument. A new or decontaminated stainless steel liner tube, fitted with an eggshell catcher to prevent sample loss, will be used at each station.

The coring device will be pushed into the sediments to a minimum depth of fifteen inches, or until refusal, whichever is encountered first. The sediments in the 0 to 6-inch interval and 6 to 12-inch interval will be extruded with a decontaminated extruder into the appropriate sample containers. If less than twelve inches of sediments are obtained, the first six inches will be placed in the 0 to 6-inch container, and the remaining sediment will be placed into the 6 to 12-inch container.

The sampling procedures for using the hand-held coring instrument are outlined below:

1. Inspect and prepare the corer:

    a. Inspect the core tube and, if one is being used, the core liner. Core tube and core liner must be firmly in place, free of obstruction throughout its length. Bottom edge of core tube, or of the nose piece, should be sharp and free of nicks or dents.

    b. Check the flutter valve for ease of movement.

    c. Check the flutter valve seat to make sure it is clear of any obstruction that could prevent a tight closure.

   d. Attach a line securely to the core sampler. The line should be free of any frayed or worn sections, and sufficiently long to reach bottom.

2. Get in position for the sampling operation -- keeping in mind that, if the purpose is to obtain samples containing fauna or stratified sediments, disturbance of the bottom area to be sampled should be avoided.

3. Line up the sampler, aiming it vertically for the point where the sample is to be taken.

4. Push the core sampler, in a smooth and continuous movement, through the water and into the sediments -- increasing the thrust as necessary to obtain the penetration desired.

5. If the corer has not been completely submerged, close the flutter valve by hand and press it shut while the sample is retrieved. Warning: the flutter valve must be kept very wet if it is to seal properly.

6. Lift the core sampler clear of the water, keeping it as nearly vertical as possible, and handle the sample according to the type of core tube.

7. Secure and identify the new sample. Unscrew the nose cone. Pull the liner out. Push out any extra sediments (greater than 12 inches). Push out the sediments within the 6 to 12 inch interval and place it in a sample jar. Push out the 0 to 6 inch sediment interval into another sample jar.

8. Seal all sample jars tightly.

9. Label all samples.

5.6 Biological and Fish Sample Collection

5.6.1 Biological Sample Collection

Biological samples collected at the stations will consist of fish and benthic macroinvertebrates. Prior to initiating the sampling event, the following sampling area description information will be recorded at each station:

- Project location, date and time
- Tide (low vs. high)
- Weather
- Sample location, number, and identification number
- Flow conditions (i.e., high, low, in flood, etc.)
- On site water quality measurements
- Visual description of water (i.e., clear, cloudy, muddy, etc.)
- Sketch of sampling location including boundaries of the water body, sample location (and depth), relative position with respect to the site, location of wood identifier stake
- Names of sampling personnel
- Sampling technique, procedure, and equipment used
- Average width, depth and velocity of the water body
- Description of substrate
- Descriptions of other "abiotic" characteristics of the reach such as pools, riffles, runs, channel shape, degree of bank erosion, and shade/sun exposure
- Description of biotic community (i.e., flora, fauna, etc.)
- Description of other "biotic" characteristics of the reach including aquatic and riparian vegetation and wetlands

After the habitat review is complete, the field team leader will define and locate the stations for biological sampling. Every attempt will be made to define stations to exclude atypical habitats such as bridges and mouths of tributaries. In addition, upstream and downstream locations will be selected to be as ecologically similar as possible in their biotic and abiotic characteristics.

Field water quality measurements will be conducted at each station, prior to collection of the samples. These measurements include temperature, pH, dissolved oxygen, specific conductivity and salinity. All instruments will be calibrated in accordance with the manufacturers' instructions prior to conducting the measurements. All measurements, including the calibration procedures, will be recorded on field data sheets.

5.6.1.1 Benthic Macroinvertebrate Sample Collection

Benthic macroinvertebrates will be collected at each station using a Standard Ponar Grab Sampler. Each station will consist of three replicate samples with one grab per replicate.

After the sediments are collected, the contents of the sample will be placed into a small tub. The sediments in the tub will be transferred to a No. 35 sieve (0.500 mm) and washed with water to remove small sediment particles. The remaining contents in the sieve will be transferred into sample jars. Approximately half of the sample jar will be filled with the sample, and 10 percent (by weight) buffered formalin will be added to fill the remainder of the jar. A 100 percent cotton paper label will be placed inside the jar, identifying the station location and replicate number. The label will be marked with a pencil. The outside of the jar will be labeled using a black permanent marker with the station location and sample number. All the sample jars will be stored in large plastic tubs until transfer to Baker Ecological Services Laboratory in Coraopolis, Pennsylvania.

5.6.1.2 Processing of Macroinvertebrate Samples

The samples will be returned to the Baker Ecological Services Laboratory for final processing. The samples will be rewashed using a No. 35 sieve (0.500 mm), to remove any remaining fine sediments, and the remaining portion of the sample will be transferred back into the sample jar containing fresh 90 percent ethanol.

The sediment sample will be sorted under a dissecting microscope. Using a pair of forceps all the remaining organisms will be removed from the sample and placed into glass vials containing 90 percent ethanol. After all the organisms in a given sample are sorted, 100 percent cotton paper labels will be placed inside the vials and/or jars, identifying the station location and replicate number. The labels will be marked with a pencil. The vials will be sealed with cotton, and placed into a sample jar containing 90 percent ethanol. The date, sorting time, and the name of the person who sorted the sample will be recorded on a log sheet.

The same sorting procedures outlined above will be repeated as a QA/QC measure, with any additional species identified, being placed into their respective vials. An environmental scientist will perform this QA/QC measure. Fifty percent of the sample will be resorted. If more than five percent of the individuals are missed during the initial sorting, then the rest of the sample will be resorted. If less than five percent of the individuals are missed during the initial sorting, then the rest of the sample will not be resorted. Any changes to this procedure will be approved by the project manager. The number of additional individuals found in the sample will be recorded. The date, sorting time, number of additional individuals found and the percent of the sample that was QA/QCed will be recorded on a log sheet. All collected individuals will be sent to the appropriate laboratory for taxonomic identification.

5.6.1.3 Analysis of Macroinvertebrates

Results of the benthic macroinvertebrate collection will be used to prepare the following descriptive statistics on a station-by-station basis: (1) a list of taxa collected; (2) a table of numbers of each taxa collected by replicate; and (3) relative pollution tolerance of the species.

The benthic macroinvertebrate communities will be examined using a mathematical expression of community structure (i.e., diversity index). Diversity data are useful because they condense a substantial amount of laboratory data into a single value. Separate values of the diversity index will be computed for sampling areas within the upstream, downstream and adjacent reaches. Analysis of the species diversity will be used to compare the community structure between the stations as well as evaluate the impact that the contaminants from the site may be having on the aquatic community.

The species collected during the aquatic surveys will be evaluated to determine their biological relevance, and pollution tolerance. Biological impairment of the benthic community may be indicated by the absence of generally pollution-sensitive macroinvertebrate species such as Ephemeroptera, Plecoptera, and Trichoptera; excess dominance by any one particular taxon; low overall taxa richness; or appreciable shifts in community composition relative to the reference condition. In addition, a Macroinvertebrate

Biotic Index, based on North Carolina Biotic Index of benthic macroinvertebrates, will be used to assess stream quality, as appropriate.

5.6.2 Fish Collection

Fish will be collected at the designated stations using a combination of the following: electrofishing, seining, gill nets, and/or other fish collecting techniques. The following paragraphs discuss the procedures that will be used for collecting the fish.

The fish sampled via electroshocking will be collected using either a boat-mounted Smith-Root, Inc. electrofisher powered by a 5,000-watt portable generator, or a Smith-Root, Inc. backpack electrofisher. The boat-mounted unit will be utilized for deeper waters, while the backpack unit will be utilized in shallow waters. Stunned fish will be collected with one-inch mesh or smaller dip nets handled by members of the field sampling team. The length of shocking time per subsection will be recorded as seconds of applied current.

At each station where haul seines are utilized, a minimum of two haul seines will be conducted. The haul seine will be deployed with one person securing the seine on the shore and another person walking out in a loop. The bottom of the net will be kept in contact with the sediment to prevent fish from swimming under the net. Other field personnel will aid in removing snags from the net and preventing fish from jumping over the net. When the person deploying the net arrives back at shore, the net will be pulled in, making sure the bottom of the net remains in the sediment. After the bag in the middle of the seine reaches the shore, the bag will be lifted and the fish will be carefully transferred into plastic tubs filled with water.

Gill nets also may be used to collect fish. The nets will be deployed either in the evening or the morning and they will be checked for fish within twelve hours after being deployed.

After each fish collection event, the fish will be placed into plastic tubs filled with water. Aerators will be placed into the tubs and the water in the tubs will be replaced periodically often to minimize fish mortality. The collected fish will be separated into different species, and then measured and counted. The small fish (less than 20 mm) will be weighed in groups of 10 or 20 because of their low individual weight; the larger fish will be weighed individually. The proportion of individuals as hybrids and the proportion of individuals with disease, tumors, fin damage, and skeletal anomalies will be recorded at each station.

Most of the fish species will be processed in the field and returned to the water body. Specimens that present taxonomic difficulties, or are too numerous for effective field processing, will be preserved in 10 percent formalin and transported to the Baker Ecological Services Laboratory for taxonomic work. At a minimum, one representative fish from each species will be preserved in 10 percent formalin as a voucher specimen.

Three different species will be collected at each station for the tissue analysis (whole-body and fillet). An attempt will be made to collect ten individuals from three different species, with each species being a representative of a different trophic level, if possible. The following are the desired trophic levels for collection: top carnivores, forage fish, and bottom feeders. However, based on Baker's experience from previous sampling at MCB Camp Lejeune, sampling variability may prevent the same species of fish from being sampled at each station, because either the preferred species will not be captured, or adequate numbers of uniform-size individuals will not be captured. Therefore, if the preferred species are not successfully collected to satisfy the above requirements, a substitute species will be collected that, if possible, exhibited a similar trophic position in the ecosystem.

Specimens submitted to the laboratory for chemical analysis will be placed into sealed plastic bags. A 100percent cotton label will be placed inside the bag, identifying the station number. A pencil will be used to mark the label. The outside of the bag also will be labeled with the station number using a black permanent marker. The bags will then be placed on ice in coolers.

5.6.2.1 Analysis of Fish Species

At each station, fish will be collected for population statistics and tissue analysis. All fish will be weighed to the nearest gram and measured to the nearest tenth of a centimeter. The total length of the fish will be measured (i.e., the distance in a straight line from the anterior-most projecting part of the head to the farthest tip of the caudal fin when its rays are squeezed together).

Results of the fish collection effort will be used to prepare the following descriptive statistics on a station by station basis: 1) a list of fishes collected, 2) a table of numbers of each species collected by station (including hybrid and pathology statistics), 3) a table of fish population estimates in numbers per unit effort, and 4) a table of fish biomass estimates in weight per unit effort.

The fish will be processed (e.g., filleted, homogenized) by the laboratory conducting the chemical analyses. If the time between sampling and preparation will be longer than 48 hours, the fish will be frozen.

At least ten individuals from each species, if available, will be composited and analyzed for whole body burdens of chemicals. In addition, fillets of at least ten individuals, if available, from each edible species will be composited and analyzed for chemical constituents. If adequate individuals from each species are not collected for both whole-body analysis and fillet analysis, only the fillets will be analyzed.

5.7 Decontamination Procedures

Equipment and materials utilized during this investigation that will require decontamination fall into two broad categories:

- Field measurement and sampling equipment: water level meters, bailers, split-spoon samplers, hand auger buckets, stainless-steel spoons, etc.
- Large machinery and equipment: drilling rigs and drilling equipment, backhoes, etc.

5.7.1 Field Measurement Sampling Equipment

5.7.1.1 Cleaning Procedures for Teflon® or Glass Field Sampling Equipment used for the Collection of Samples for Trace Organic Compounds and/or Metals Analyses

1. Equipment will be washed thoroughly with laboratory detergent and hot water using a brush to remove any particulate matter or surface film.
2. The equipment will be rinsed thoroughly with hot tap water.
3. Rinse equipment with at least a 10 percent nitric acid solution.
4. Rinse equipment thoroughly with deionized water.

6. Rinse equipment twice with solvent and allow to air dry for at least 24 hours.
7. Wrap equipment in one layer of aluminum foil. Roll edges of foil into a "tab" to allow for easy removal. Seal the foil wrapped equipment in plastic and date.
8. Rinse the Teflon® or glass sampling equipment thoroughly with tap water in the field as soon as possible after use.

When this sampling equipment is used to collect samples that contain oil, grease, or other hard to remove materials, it may be necessary to rinse the equipment several times with pesticide-grade acetone or hexane to remove the materials before proceeding with Step 1. In extreme cases, it may be necessary to steam clean the field equipment before proceeding with Step 1. If the field equipment cannot be cleaned utilizing these procedures, it should be discarded.

Small and awkward equipment such as vacuum bottle inserts and well bailers may be soaked in the nitric acid solution instead of being rinsed with it. Fresh nitric acid solution should be prepared for each cleaning session.

5.7.1.2 Cleaning Procedures for Stainless Steel or Metal Sampling Equipment used for the Collection of Samples for Trace Organic Compounds and/or Metals Analyses

1. Wash equipment thoroughly with laboratory detergent and hot water using a brush to remove any particulate matter or surface film.
2. Rinse equipment thoroughly with hot tap water.
3. Rinse equipment thoroughly with deionized water.
4. Rinse equipment twice with solvent and allow to air dry for at least 24 hours.
5. Wrap equipment in one layer of aluminum foil. Roll edges of foil into a "tab" to allow for easy removal. Seal the foil wrapped equipment in plastic and date.

6. Rinse the stainless steel or metal sampling equipment thoroughly with tap water in the field as soon as possible after use.

When this sampling equipment is used to collect samples that contain oil, grease, or other hard to remove materials, it may be necessary to rinse the equipment several times with pesticide-grade acetone or hexane to remove the materials before proceeding with Step 1. In extreme cases, when equipment is painted, badly rusted, or coated with materials that are difficult to remove, it may be necessary to steam clean, wire brush, or sandblast equipment before proceeding with Step 1. Any metal sampling equipment that cannot be cleaned using these procedures should be discarded.

5.7.1.3 Reusable Glass Composite Sample Containers

1. Wash containers thoroughly with hot tap water and laboratory detergent, using a bottle brush to remove particulate matter and surface film.
2. Rinse containers thoroughly with hot tap water.
3. Rinse containers with at least 10 percent nitric acid.
4. Rinse containers thoroughly with tap water.
5. Rinse containers thoroughly with deionized water.
6. Rinse twice with solvent and allow to air dry for at least 24 hours.
7. Cap with aluminum foil or Teflon® film.
8. After using, rinse with tap water in the field, seal with aluminum foil to keep the interior of the container wet, and return to the laboratory.

When these containers are used to collect samples that contain oil, grease, or other hard to remove materials, it may be necessary to rinse the container several times with pesticide-grade acetone before proceeding with Step 1. If these materials cannot be removed with acetone, the container should be discarded. Glass reusable composite containers used to collect samples at pesticide, herbicide, or other chemical manufacturing facilities that produce toxic or noxious compounds shall be properly disposed of (preferably at the facility) at the conclusion of sampling activities and shall not be returned for cleaning. Also, glass composite containers used to collect in-process wastewater samples at industrial facilities shall be discarded after sampling. Any bottles that have a visible film, scale, or discoloration remaining after this cleaning procedure shall also be discarded.

5.7.1.4 Plastic Reusable Composite Sample Containers

1. Proceed with the cleaning procedures as outlined in Section 5.7.1.3 but omit the solvent rinse.

Plastic reusable sample containers used to collect samples from facilities that produce toxic or noxious compounds or are used to collect in-process waste stream samples at industrial facilities will be properly disposed (preferably at the facility) of at the conclusion of the sampling activities and will not be returned for cleaning. Any plastic composite sample containers that have a visible film, scale, or other discoloration remaining after this cleaning procedure will be discarded.

5.7.1.5 Well Sounders or Tapes Used to Measure Ground Water Levels

1. Wash with laboratory detergent and tap water.
2. Rinse with tap water.
3. Rinse with deionized water.
4. Allow to air dry overnight.
5. Wrap equipment in aluminum foil (with tab for easy removal), seal in plastic, and date.

5.7.1.6 Submersible Pumps and Hoses Used to Purge Ground Water Wells

1. Using a brush, scrub the exterior of the contaminated hose and pump with soapy water.

2. Rinse the soap from the outside of pump and hose with tap water.

3. Rinse the tap water residue from the outside of pump and hose with deionized water.

4. Equipment should be placed in a polyethylene bag or wrapped with polyethylene film to prevent contamination during storage or transit.

5. The submersible pump to be used is a "Redi-Flo 2".

5.7.2 Large Machinery and Equipment

All drilling rigs, drilling and sampling equipment, backhoes, and all other associated equipment involved in the drilling and sampling activities shall be cleaned and decontaminated before entering the designated drill site. All equipment should be inspected before entering the site to ensure that there are no fluids leaking and that all gaskets and seals are intact. All drilling and associated equipment entering a site shall be clean of any contaminants that may have been transported from another hazardous waste site, thereby minimizing the potential for cross-contamination. Before site drilling activities are initiated, all drilling equipment shall be thoroughly cleaned and decontaminated at the designated cleaning/decontamination area. The following requirements and procedures are to be strictly adhered to on all drilling activities.

Any portion of the drill rig, backhoe, etc., that is over the borehole (kelly bar or mast, backhoe buckets, drilling platform, hoist or chain pulldowns, spindles, cathead, etc.) shall be steam cleaned before being brought on the site to remove all rust, soil and other material which may have come from other hazardous waste sites. The drill rig and/or other equipment associated with the drilling and sampling activities shall be inspected to insure that all oil, grease, hydraulic fluid, etc., have been removed, and all seals and gaskets are intact and there are no fluid leaks. No oils or grease shall be used to lubricate drill stem threads or any other drilling equipment being used over the borehole or in the borehole without EPA approval. If drill stems have a tendency to tighten during drilling Teflon® string can be used on the drill stem threads. The drill rig(s) shall be steam cleaned prior to drilling each borehole. In addition, all downhole sampling equipment that will come into contact with the downhole equipment and sample medium shall be cleaned and decontaminated by the following procedures.

1. Clean with tap water and laboratory grade, phosphate-free detergent, using a brush, if necessary, to remove particulate matter and surface films. Steam cleaning and/or high pressure hot water washing may be necessary to remove matter that is difficult to remove with the brush. Hollow-stem augers, drill rods, shelby tubes, etc., that are hollow or have holes that transmit water or drilling fluids, shall be cleaned on the inside and outside. The steam cleaner and/or high pressure hot water washer shall be capable of generating a pressure of at least 2500 PSI and producing hot water and/or steam (200°F plus).

2. Rinse thoroughly with tap water (potable).

   NOTE: Tap water (potable) may be applied with a pump sprayer. All other decontamination liquids (D.I. water, organic-free water, and solvents), however, must be applied with noninterferring containers. These containers shall be made of glass, Teflon®, or stainless steel. This aspect of the decontamination procedures used by the driller will be inspected by the site geologist and/or other responsible person prior to beginning of operations.

3. Rinse thoroughly with deionized water.

4. Rinse twice with solvent (pesticide grade isopropanol).

5. Rinse thoroughly with organic-free water and allow to air dry. Do not rinse with deionized or distilled water.

   Organic-free water can be processed on site by purchasing or leasing a mobile deionization-organic filtration system.

   In some cases when no organic-free water is available, it is permissible (with approval) to leave off the organic-free water rinse and allow the equipment air dry before use.

6. Wrap with aluminum foil, if appropriate, to prevent contamination if equipment is going to be stored or transported. Clean plastic can be used to wrap augers, drill stems, casings, etc., if they have been air dried.

7. All downhole augering, drilling and sampling equipment shall be sandblasted before Step #1 if painted, and/or if there is a buildup of rust, hard or caked matter, etc., that cannot be removed by steam and/or high pressure cleaning. All sandblasting shall be performed prior to arrival on site.

8. All well casing, tremie tubing, etc., that arrive on site with printing and/or writing on them shall be removed before Step #1. Emery cloth or sand paper can be used to remove the printing and/or writing. Most well material suppliers can supply materials without the printing and/or writing if specified when materials are ordered.

9. Well casing, tremie tubing, etc., that are made of plastic (PVC) shall not be solvent rinsed during the cleaning and decontamination process. Used plastic materials that cannot be cleaned are not acceptable and shall be discarded.

Cleaning and decontamination of all equipment shall occur at a designated area on the site, downgradient, and downwind from the clean equipment drying and storage area. All cleaning of drill rods, auger fights, well screen and casing, etc., will be conducted above the plastic sheeting using saw horses or other appropriate means. At the completion of the drilling activities, the pit shall be backfilled with the appropriate material designated by the Site Manager, but only after the pit has been sampled, and the waste/rinse water has been pumped into 55-gallon drums. No solvent rinsates will be placed in the pit unless prior approval is granted. All solvent rinsates shall be collected in separate containers for proper disposal.

5.8 Surveying

All surveying activities will be conducted by a qualified surveying subcontractor licensed in the State of North Carolina. Surveying activities will include the following:

- Resurveying areas at the sites which may have undergone physical changes due to recent construction activities

- Surveying sampling grid for soil investigation.

- Surveying nongrid sampling points (monitoring wells, surface water/sediment locations).

All grid intersections will be marked with a wooden stake and will be numbered by the surveyor with a unique location number.

All newly-installed monitoring wells will be surveyed. The vertical accuracy shall be surveyed to 0.01 feet and the horizontal accuracy within 0.1 foot. In addition, other sampling stations (test pit, surface water/sediment) will be surveyed for horizontal control within 1 foot accuracy. Control will be established by use of horizontal and vertical control points near the site that are tied into the North Carolina State Plane Coordinate System. If control points cannot be located, two benchmarks/monuments will be surveyed from the closest USGS (or equivalent) benchmarks. The 1929 msl datum will be used as a reference for the vertical elevation.

Surveying of surface water sampling stations may be difficult, especially in deep water. The field team will estimate all locations and mark them on a field map during sampling.

5.9 Handling of Site Investigation Generated Wastes

5.9.1 Responsibilities

LANTDIV - LANTDIV or the facility must ultimately be responsible for the final disposition of site wastes. As such, a LANTDIV representative will usually prepare and sign waste disposal manifests as the generator of the material, in the event off-site disposal is required. However, it may be the responsibility of Baker, depending on the contingency discussions during execution of the investigation to provide assistance to LANTDIV in arranging for final disposition and preparing the manifests.

Project Manager - It is the responsibility of the Project Manager to work with the LANTDIV EIC in determining the final disposition of site investigation wastes. The Project Manager will relay the results and implications of the chemical analysis of the waste or associated material, and advise on the regulatory requirements and prudent measures appropriate to the disposition of the material. The Project Manager also is responsible for ensuring that field personnel involved in site investigation waste handling are familiar with the procedures to be implemented in the field, and that all required field documentation has been completed.

Field Team Leader - The Field Team Leader is responsible for the on site supervision of the waste handling procedures during the site investigations. The Field Team Leader also is responsible for ensuring that all other field personnel are familiar with these procedures.

5.9.2 Sources of Investigation Derived Wastes (IDW)

Field investigation activities often result in the generation and handling of potentially contaminated materials that must be properly managed to protect the public and the environment, as well as to meet legal requirements. These wastes may be either hazardous or nonhazardous in nature. The nature of the waste (hazardous or nonhazardous) will determine how the wastes will be handled during the field investigation.

The sources of waste material depend on the site activities planned for a project. The following types of activities (or sources), typical of site investigations, may result in the generation of waste material which must be properly handled:

- Drilling and monitoring well construction (drill cuttings)
- Monitoring well development (development water)
- Groundwater sampling (purge water)
- Heavy equipment decontamination (decontamination fluids)
- Sampling equipment decontamination (decontamination fluids)
- Personal protective equipment (health and safety disposables)
- Mud rotary drilling (contaminated mud)

5.9.3 Designation of Potentially Hazardous and Nonhazardous IDW

Wastes generated during the field investigation can be categorized as either potentially hazardous or nonhazardous in nature. The designation of such wastes will determine how the wastes will be handled. The criteria for determining the nature of the waste, and the subsequent handling of the waste is described below for each type of investigative waste.

5.9.3.1 Drill Cuttings

Drill cuttings will be generated during the augering of test borings and monitoring well boreholes. All drill cuttings will be containerized in 55-gallon drums or in lined roll-off boxes. As the borehole is augered, and soil samples collected, the site geologist will monitor the cuttings/samples with an HNu photoionization (PID) unit for organic vapors. In addition, the site geologist will describe the soils in a field log book. Upon completion, the soil borings will be backfilled with a cement-bentonite grout.

5.9.3.2 Monitoring Well Development and Purge Water

All development and purge waters shall be containerized in tankers, or large (250-gallon) containers.

5.9.3.3 Decontamination Fluids

Equipment and personal decontamination fluids shall be containerized in 55-gallon drums. The fluids shall be collected from the decon/wash pads. If military vehicle wash racks are used to decon the heavy equipment, no collection of these wastewaters will be necessary since the decontamination waters will be treated at one of the Camp Lejeune treatment facilities (depending upon the location of the vehicle wash racks).

5.9.3.4 Personal Protective Equipment

All personal protective equipment (tyvek, gloves, and other health and safety disposables) shall be placed in the dump box, which will be provided by Camp Lejeune. Camp Lejeune will dispose of these materials when the box is full.

5.9.4 Labeling

If 55-gallon drums are used to containerize drill cuttings, the containers will be consequently numbered and labeled by the field team during the site investigation. Container labels shall be legible and of an indelible medium (waterproof marker, paint stick, or similar means). Information shall be recorded both on the container lid and its side. Container labels shall include, as a minimum:

- LANTDIV CTO (number)
- Project name
- Drum number
- Boring or well number
- Date

- Source
- Contents

If laboratory analysis reveals that containerized materials are hazardous or contain PCBs, additional labeling of containers may be required. The project management will assist LANTDIV in additional labeling procedures, if necessary, after departure of the field team from the facility. These additional labeling procedures will be based upon the identification of material present; EPA regulations applicable to labeling hazardous and PCB wastes are contained in 40 CFR Parts 261, 262 and 761.

5.9.5 Container Log

A container log shall be maintained in the site log book. The container log shall contain the same information as the container label plus any additional remarks or information. Such additional information may include the identification number of a representative laboratory sample.

5.9.6 Container Storage

Containers of site investigation wastes shall be stored in a specially designated, secure area that is managed by the Camp Lejeune Environmental Management Division until disposition is determined. All containers shall be covered with plastic sheeting to provide protection from weather.

If the laboratory analysis reveal that the containers hold hazardous or PCB waste, additionally required storage security may be implemented; in the absence of the investigation team, these will be the responsibility of LANTDIV or the facility, as confirmed by the contingency discussions.

Baker will assist LANTDIV in devising the storage requirements, which may include the drums being staged on wooden pallets or other structures to prevent contact with the ground and being staged to provide easy access. Weekly inspections by facility personnel of the temporary storage area may also be required. These inspections may assess the structural integrity of the containers and proper container labeling. Also, precipitation that may accumulate in the storage area may need to be removed. These weekly inspections by facility personnel of the temporary storage area may also be required. These inspections may assess the structural integrity of the containers and proper container labeling. Also, precipitation that may accumulate in the storage area may need to be removed. These weekly inspections and whatever precipitation removal shall be recorded in the site logbook.

5.9.7 Container Disposition

The disposition of containers of site investigation generated wastes shall be determined by LANTDIV, with the assistance of Baker, as necessary. Container disposition shall be based on quantity of materials, types of materials, and analytical results. If necessary, specific samples of contained materials may be collected identify further characteristics which may affect disposition. Typically, container disposition will not be addressed until after receipt of applicable analytical results; these results are usually not available until long after completion of the filed investigation at the facility.

5.9.8 Disposal of Contaminated Materials

Actual disposal methods for contaminated materials disturbed during a site investigation are the same as for other PCB or hazardous substances: incineration, landfilling, treatment, and so forth. The responsibility for disposal must be determined and agreed upon by all involved parties during negotiations addressing this contingency.

The usual course will be a contractor specialist retained to conduct the disposal. However, regardless of the mechanism used, all applicable Federal, state and local regulations shall be observed. EPA regulations applicable to generating, storing and transporting PCB or hazardous wastes are contained in 40 CFR Parts 262, 263 and 761.

Another consideration in selecting the method of disposal of contaminated materials is whether the disposal can be incorporated into subsequent site cleanup activities. For example, if construction of a suitable on-site disposal or treatment structure is expected, contaminated materials generated during the site investigation may be stored at the site for treatment/disposal with other site materials. In this case, the initial containment (drums or other containers) shall be evaluated for use as long-term storage. Also, other site conditions, such as drainage control, security and soil types must be considered in order to provide proper storage.

5.10 Water Level Measurements

Water level measurements will be collected from soil borings (during drilling), hydropunch locations, test pits and monitoring wells. Static water levels will be measured to the nearest 0.01 foot with a decontaminated electronic water level indicator (E-tape).

Water levels is monitoring wells will be measured from the top of the PVC casing riser. All other water level measurements will be taken from ground surface.

5.11 Soil Gas Survey

The following subsections are from the standard operating procedures provided by Tracer Research Corporation (TRC). They outline the soil gas survey and soil gas sample collection procedures.

5.11.1 Soil Gas Sampling Procedure

Probe Placement

A. A clean probe (pipe) is removed from the storage tube on top of the van.

B. The soil gas probe is placed in the jaws of hydraulic pusher/puller mechanism.

C. A sampling point is put on the bottom of the probe.

D. The hydraulic pushing mechanism is used to push the probe into the ground.

E. If the pusher mechanism will not push the probe into the ground a sufficient depth for sampling, the hydraulic hammer is used to pound the probe into the ground.

Sample Extraction

A. An adaptor is put onto the top of the soil gas probe.

B. The vacuum pump is hooked onto the adaptor.

C. The vacuum pump is turned on and used to evacuate soil gas.

D. Evacuation will be at least 30 seconds, but never more than 5 minutes for samples having evacuation pressures less than 15 inches of mercury. Evacuation times will be at least 1 minute, but no more than 5 minutes for probes reading greater than 15 inches of mercury.

E. Gauges on the vacuum pump are checked for inches of mercury.

   1. Gauge must read at least 2 inches of mercury less than maximum vacuum to be extracting sufficient soil gas to collect a valid sample.

Sample Collection

A. With vacuum pump running, a hypodermic syringe needle is inserted through the silicone rubber and down into the metal tubing of adaptor.

B. Gas samples should only contact metal surfaces and never contact potentially sorbing materials (i.e., tubing, hose, pump diaphragm).

C. The syringe is purged with soil gas then, without removing syringe needle from adapter, a 2-10 mL soil gas sample is collected.

D. The syringe and needle are removed from the adaptor and the end of the needle is capped.

E. If necessary, a second 10 mL sample is collected using the same procedure.

Deactivation of Sampling Apparatus

A. The vacuum pump is turned off and unhooked from the adaptor.

B. The adaptor is removed and stored with equipment to be cleaned.

C. Using the hydraulic puller mechanism, the probe is removed from the ground.

D. The probe is stored in the "dirty" probe tube on top of the van.

E. The probe hole is backfilled, if required.

Log Book and U.S. EPA Field Sheet Notations for Sampling

A. Time (military notation).

B. Sample number (use client's numbering system).

C. Location (approximate description - i.e., street names).

D. Sampling depth.

E. Evacuation time before sampling.

F. Inches of mercury on vacuum pump gauge.

G. Probe and adaptor numbers.

H. Number of sampling points used.

I. Observations (i.e., ground conditions, concrete, asphalt, soil appearance, surface water, odors, vegetation, etc.).

J. Backfill procedure and materials, if needed.

Other Recordkeeping

A. Client-provided data sheets are filled out, if required.

B. Sample location is marked on the site map.

Determination of Sampling Locations

A. Initial sample locations will be determined by client (perhaps after consultation with TRC personnel) prior to start of job.

B. Remaining sample locations may be determined by:

1. Client
    a. Entire job sampling locations set up on grid system.
    b. Client decides location of remaining sample locations based on results of initial study, or

2. Client and TRC personnel
    a. Client and TRC personnel decide location of remaining sample locations based on results of initial sample locations.

5.11.2 Analytical Procedures

Varian 3300 Gas Chromatograph

A. Equipped with Electron Capture Detectors (ECD), Flame Ionization Detectors (FID), Photo Ionization Detectors (PID) and/or Thermal Conductivity (TC) Detectors.

B. The chromatographic column used by TRC for the analysis of halocarbons is a 1/8-inch diameter packed column containing Alltech OV-101. This nicely separates most of the tri-chloro and tetra-chloro compounds that are encountered in soil gas investigations. The di-chloro compounds tend to elute ahead of the tri-chloro and tetra-chloro compounds, thus creating no interference. In the event that assurance of the identity of a compound in any particular sample is needed, it will be analyzed on a SP-1000 column after the OV-101 analysis.

Two Spectra Physics SP4270 Computing Integrators

The integrators are used to plot the chromatogram and measure the size of the chromatographic peaks. The integrators compute and record the area of each peak. The peak areas are used directly in calculation of contaminant concentration.

Chemical Standards from ChemServices, Inc. of Westchester, Pennsylvania

A. TRC uses analytical standards that are preanalyzed, of certified purities and lot numbered for quality control assurance. Each vial is marked with an expiration date. All analytical standards are the highest grade available. Certified purities are typically 99percent.

B. The Quality Assurance procedures used by ChemServices were described by the Laboratory Supervisor, Dr. Lyle Phipher:

   1. The primary measurement equipment at ChemServices, the analytical balance, is serviced by the Mettler Balance Company on an annual basis and recalibrated with NBS traceable weights.

   2. All chemicals purchased for use in making the standards are checked for purity by means of gas chromatography using a thermal conductivity detector. Their chemicals are purified as needed.

   3. The information on the purification and analysis of the standards is made available upon request for any item they ship when the item is identified by lot number. All standards and chemicals are shipped with their lot numbers printed on them. The standards used by TRC are made up in a two-step dilution of the pure chemical furnished by ChemServices.

Analytical Supplies

A. Sufficient 2 and 10 cc glass and Hamilton syringes, so that none have to be reused without first being cleaned.

B. Disposable lab supplies, where appropriate.

C. Glassware to prepare aqueous standards.

D. Miscellaneous laboratory supplies.

5.11.3 QA/QC Procedures

Standards

A. A fresh standard is prepared each day. The standards are made by serial dilution.

   1. First, a stock solution containing the standard in methanol is prepared at TRC offices in Tucson. The stock solution is prepared by pipetting the pure chemical into 250 mL of methanol in a volumetric flask at room temperature. The absolute mass is determined from the product of volume and density calculated at room temperature. Hamilton microliter syringes, with a manufacturer's stated accuracy of + of - 1 percent, are used for pipetting. Information on density is obtained from the CRC Handbook of Physics and Chemistry. Once the stock solution is prepared, typically in concentration range of 50-1000 mg/L, a working standard is prepared in water each day. The solute in the stock solution has a strong affinity to remain in methanol so there is no need to refrigerate the stock solution. Additionally, the solute tends not to biodegrade or volatilize out of the stock solution.

   2. The working standards are prepared in 40 mL VOA septum vials by diluting the appropriate µg/L quantity of the standard solution in 40 mL of water.

B. The standard water is analyzed for contamination before making the aqueous standard each day.

C. The aqueous standard is prepared in a clean vial using the same syringe each day. The syringe should only be used for that standard.

D. Final dilution of the calibration standards are made in water in a volatile organic analysis (VOA) vial having a Teflon®-coated septum cap instead of in a volumetric flask in order to have the standard in a container with no air exposure. The VOA bottle permits mixing of the standard solution and subsequent syringe sampling all day long without opening the bottle or exposing it to air. The measurement uncertainty inherent in the use of a VOA bottle instead of a volumetric flask is approximately + or - 1 percent.

E. The aqueous standard will contain the compounds of interest in the range of 5 to 100 µg/L depending on the detectability of the individual components. The standard will be analyzed at least three times at the beginning of each day to determine the mean response factor (RF) for each component. The standard will be injected again after every fifth sample to check detector response and chromatographic performance of the instrument throughout the day.

F. The RF allows conversion of peak areas into concentrations for the contaminants of interest. The RF used is changed if the standard response varies 25 percent. If the standard injections vary by more than 25 percent, the standard injections are repeated. If the mean of the two standard injections represents greater than 25 percent difference, then a third standard is injected and a new RF is calculated from the three standard injections. A new data sheet is started with the new RFs and calibration data.

$$\% \text{ difference} = \frac{\text{A area - B area}}{\text{A area}}$$

Where: A = mean peak area of standard injection from first calibration.
B = peak area of subsequent standard injection.

G. The low µg/L aqueous standards that are made fresh daily need not be refrigerated during the day because they do not change significantly in a 24-hour period. On numerous occasions the unrefrigerated 24-hour old standards have been compared with fresh standards and no difference has been measurable. If the standards were made at high ppm levels in water, the problem of volatilization would probably be more pronounced in the absence of refrigeration.

H. Primary standards are kept in the hotel room when on a project.

I. A client may provide analytical standards for additional calibration and verification.

System Blanks

A. System blanks are ambient air drawn through the probe and complete sampling apparatus (probe adaptor and 10 cc syringe) and analyzed by the same procedure as a soil gas sample. The probe is above the ground.

B. One system blank is run at the beginning of each day and compared to a concurrently sampled air analysis.

C. A system blank is run before reusing any sampling system component.

Ambient Air Samples

A. Ambient air samples are collected and analyzed a minimum of two times daily to monitor safety of the work environment and to establish site background concentrations, if any, for contaminants of interest.

B. All ambient air samples shall be documented.

Samples

A. All unknown samples will be analyzed at least twice.

B. More unknown samples will be run until reproducibility is within 25 percent, computed as follows:

$$\text{Difference} = \frac{A - B}{(A + B)/2}$$

Where: A is first measurement result.
B is second measurement result.

If the difference is greater than .25, a subsequent sample will be run until two measurements are made that have a difference of .25 or less. Those two measurements will be used in the final calculation for that sample.

C. The injection volume should be adjusted so that mass of analyte is as near as possible to that which is contained in the standard, at least within a factor of ten.

D. Whenever possible, the attenuation for unknown samples is kept constant through the day (so as to provide a visual check of integrations).

E. A water plug is used as a gas seal in µL syringes.

F. A seal is established between syringes when subsampling.

G. At very high concentrations, air dilutions are acceptable once concentration of contaminants in air have been established.

H. All sample analysis are documents.

I. Separate data sheets are used if chromatographic conditions change.

J. Everything is labeled in µg/L, mg/L, etc., parts per million (ppm) and parts per billion (ppb) notations are to be avoided.

Daily System Preparation

A. Integrators parameters are initialized.

1. Pt. evaluation
2. Attenuation
3. Peak markers
4. Auto zero
5. Baseline offset (min. 10percent of full scale)

B. The baseline is checked for drift, noise, etc.

C. System parameters are set.

1. Gas flows (Note: N_2 (nitrogen), air, H_2 (hydrogen), tank pressure)

2. Temperatures
   a. Injector
   b. Column

c. Detector

D. After last analysis of the day, conditioned septa are rotated into injection ports used during the day and replaced with fresh septa.

E. Column and injector temperatures are run up to bake out residual contamination.

F. Syringes are cleaned each day.

1. 2 and 10 cc syringes are cleaned with Alconox or equivalent detergent and brush.

2. µL syringes are cleaned daily with IPA or methanol (MeOH) and purged with N_2. Syringe Kleen is used to remove metal deposits in the barrel.

3. Syringes are baked out overnight in the oven of the gas chromatograph at a minimum temperature of 60°C.

Sample Splits

If desired, TRC's clients or any party, with the approval of TRC's client, may use sample splits to verify TRC's soil gas or groundwater sampling results.

A. Sample splits may be collected in two valve, flow-through-type, all-glass or internally electroplated, stainless steel containers for analysis within 10 days of collection.

1. Flow-through sample collection bottles should be cleaned by purging with nitrogen at 100°C for at least 30 minutes. Once clean, the bottles should be stored, filled with nitrogen at ambient pressure.

2. Sample bottles are filled by placing them in the sample stream between the probe and the vacuum pump. Five sample bottle volumes should be drawn through the container before the final sample is collected. The sample should be at ambient pressure.

B. Sample splits can be provided in 10 cc glass syringes for immediate analysis in the field by the party requesting the sample splits.

C. Splits of the aqueous standards or the methanol standards used by TRC for instrument calibration may be analyzed by the party requesting sample splits.

5.12 Drive-Point Groundwater Field Screening (Geoprobe™)

The drive-point sampling technique can sample and analyze subsurface contamination in soil gas, soil, and groundwater. During the initial phase of the investigation at Site 35 the drive-point system will be utilized to collect and analyze groundwater samples to assist in determining the extent of contamination in the surficial aquifer, as well as the direction of migration. This information will aid in determining optimum locations for the proposed thirteen soil borings and five nested wells.

One round of groundwater samples will be collected at each sampling location. The groundwater samples will be collected and analyzed by a gas chromatograph (GC) in an on-site laboratory equipped van. The on-site GC will be used to scan the groundwater samples and will be able to relay results to the field crew on a same-day basis so that field decisions can be made regarding the placement of soil borings and nested wells. EPA Method 601 (modified) will be utilized to analyze trichloroethylene based on previous analytical results.

Subsequent to collecting the groundwater samples, the probe will be removed and the hole will be backfilled to the ground surface with a cement/bentonite grout mixture. It is anticipated that the drive-point will be advanced in both asphalt and grass cover.

6.0 SAMPLE HANDLING AND ANALYSIS

6.1 Sample Program Operations

Field activities will be conducted according to the guidance of USEPA Region IV Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual (February 1, 1991).

The number of samples (including QA/QC samples), analytical method, data quality level and laboratory turnaround times are included in Table 6-1. Preservation requirements, bottle requirements and holding times are included in Section 7.0 of the QAPP which is Section II of this SAP. Collection procedures for field QA/QC samples are outlined in Section 3.3.

6.2 Chain-of-Custody

Chain-of-custody procedures will be followed to ensure a documented, traceable link between measurement results and the sample/parameter that they represent. These procedures are intended to provide a legally acceptable record of sample preparation, storage and analysis.

To track sample custody transfers before ultimate disposition, sample custody will be documented using the chain-of-custody form shown in Figure 6-1. A chain-of-custody seal is shown in Figure 6-2. A sample label is shown in Figure 6-3.

A chain-of-custody form will be completed for each container in which the samples are shipped. The shipping containers will usually be coolers. After the samples are properly packaged, the coolers will be sealed and prepared for shipment. Custody seals will be placed on the outside of the coolers to ensure that the samples are not disturbed prior to reaching the laboratory.

A field notebook will be maintained for the site.

6.3 Logbooks and Field Forms

Field notebooks will be used to record sampling activities and information. Field notebooks will be bound, field survey books. Notebooks will be copied and submitted to the field

TABLE 6-1

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITE 35
REMEDIAL INVESTIGATION CTO-0160
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples(1)	Analysis	Data Quality Level	Analytical Method	Laboratory Turnaround Time(3)	Field QA/QC Samples (9)
							Field Duplicate
Site 35	Soil - AST Fuel Tank Farm	1 boring 1 subsurface soil sample (GWD-1)(12)	Atterberg Limits Grain Size Constant Head Permeability	III III III	ASTM D4943 ASTM D422 ASTM D2434	Routine Routine Routine	NA
		1 boring 1 subsurface soil sample (GWD-3)(12)	Total TCLP Corrosivity Ignitability Reactivity TOC Total Phosphorous Microbial Enumeration Nitrogen (TKN)	III III III III III III III III	40 CFR 261 40 CFR 261 40 CFR 261 40 CFR 261 EPA 415.1 EPA 365.2 SM 907 EPA 351.3	Routine Routine Routine Routine Routine Routine Routine Routine	NA
		14 surface soil samples (SS-1 through SS-14) 5 surface soil samples from selected borings (B-7 through B-19) (2)	TCL VOAs and SVOAs TAL Metals	IV IV	4, 5 7	Routine	2
		13 subsurface soil samples from 13 soil borings (B-7 through B-19 (10)	TCL VOAs	IV	4	Routine	2
		5 subsurface soil samples from 5 deep well borings (GWD-1 through GWD-5 (11)	TCL VOAs and SVOAs TAL Metals	IV IV	4, 5 7	Routine	1
		5 subsurface soil samples from 5 shallow well cluster locations (MW-29A through MW-33A)(11)	TCL VOAs	IV	4	Routine	1
	Groundwater	11 samples from existing wells (shallow: MW-2, 9, 10, 14, 16, 19, 22, 25; EMW-3, 5, 7)	Volatiles (EPA 601/602) TCL SVOAs TAL Metals	IV IV IV	4 5 7	Routine	2
		8 samples from existing wells (intermediate: MW-2, 9, 10, 14, 16, 19, 22, 25)	Volatiles (EPA 601/602) TCL SVOAs TAL Metals	IV IV IV	4 5 7	Routine	1
		2 samples from existing well(shallow double-nested: MW-21)(14)	TCL Organics TAL Metals	IV IV	4, 5,6 7,	Routine	0

TABLE 6-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITE 35
REMEDIAL INVESTIGATION CTO-0160
MCB CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples(1)	Analysis	Data Quality Level	Analytical Method	Laboratory Turnaround Time(3)	Field QA/QC Samples (9) Field Duplicate
Site 35	Groundwater (Continued)	4 samples from newly installed shallow wells (MW-29A, 30A, 31A, 32A)	Volatiles (EPA 601/602)	IV	4	Routine	1
		4 samples from newly installed shallow wells (deep: MW-29B, 30B, 31B, 32B)	Volatiles (EPA 601/602)	IV	4	Routine	1
		2 samples from newly installed shallow well cluster MW-33A and MW-33B	TCL Organics TAL Metals	IV IV	4, 5, 6 7	Routine	0
		4 samples from newly installed deep wells (GWD-1, 2, 3, 4)	Volatiles (EPA 601/602)	IV	4	Routine	1
		1 sample from newly installed deep well GWD-5	TCL Organics TAL Metals	IV IV	4, 5, 6 7	Routine	0
		1 sample (shallow): from one existing shallow well (MW21)	BOD COD TOC TSS TDS Nitrogen (TKN) Total Phosphorous Microbial Enumeration Alkalinity	III III III III III III III III III	8 8 8 8 8 EPA 351.2 EPA 365.2 SM 907 EPA 310.1	Routine Routine Routine Routine Routine Routine Routine Routine Routine	NA
	Surface Water - Brinson Creek	6 samples	TCL Organics TAL Metals	IV IV	4, 5, 6 7	Routine	1
	Sediment - Brinson Creek	12 samples (0-6") (6-12")	TCL Organics TAL Metals	IV IV	4, 5, 6 7	Routine	1
	IDW(15) (GW)	1 sample from 5,000-gallon tanker	TCL Organics TAL Metals	IV IV	4, 5, 6 7	14 days	NA
	IDW (Soil)	1 composite sample from roll-off boxes	Total TCLP Corrosivity Ignitability Reactivity	III IV III IV	40 CFR 261 40 CFR 261 40 CFR 261 40 CFR 261	14 days	NA

TABLE 6-1 (Continued)

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAMS AT SITE 35
REMEDIAL INVESTIGATION CTO-0160
MCB CAMP LEJEUNE, NORTH CAROLINA

(1) Baseline number of samples do not include field QA/QC samples.
(2) Surface soil samples shall be obtained from the interval 0 to 12 inches bgs.
(3) Routine analytical turnaround is 28 days following receipt of sample.
(4) Purgeable Organic Compounds - EPA 8240/EPA 624 (EPA 601/602 for groundwater only)
(5) Base/Neutral Acid Extractables - EPA 3510/EPA 625
(6) Pesticides and PCBs - EPA 3510/3550/EPA 608
(7) TAL Inorganics:

Aluminum	EPA 3010/EPA 200.7	Cobalt	EPA 3010/EPA 200.7	Potassium	EPA 3010/EPA 200.7
Antimony	EPA 3010/EPA 200.7	Copper	EPA 3010/EPA 200.7	Selenium	EPA 3020/EPA 270.2
Arsenic	EPA 3020/EPA 206	Iron	EPA 3010/EPA 200.7	Silver	EPA 3010/EPA 200.7
Barium	EPA 3010/EPA 200.7	Lead	EPA 3020/EPA 239	Sodium	EPA 3010/EPA 200.7
Beryllium	EPA 3010/EPA 200.7	Magnesium	EPA 3010/EPA 200.7	Thallium	EPA 3020/EPA 279
Cadmium	EPA 3010/EPA 200.7	Manganese	EPA 3010/EPA 200.7	Vanadium	EPA 3010/EPA 200.7
Calcium	EPA 3010/EPA 200.7	Mercury	EPA 3010/EPA 245.1	Zinc	EPA 3010/EPA 200.7
Chromium	EPA 3010/EPA 200.7	Nickel	EPA 3010/EPA 200.7		

(8) BOD - Biological Oxygen Demand (SM 5210)
COD - Chemical Oxygen Demand (EPA 410.1)
TSS - Total Suspended Solids (EPA 160.2)
TDS - Total Dissolved Solids (EPA 160.1)
TOC - Total Organic Carbon (EPA 415.1)

(9) Trip Blank - 1 per cooler (VOCs only)
Equipment Rinsate - 1 per day for each matrix sampled
Matrix Spike/Matrix Spike Duplicate - 1 per 20 samples

(10) One soil sample per boring is assumed. Selected sample will have exhibited highest PID or OVA reading. The field geologist can exercise discretion and substitute a visually contaminated sample in lieu of the sample exhibiting the highest PID or OVA reading.
(11) One soil sample per boring to be obtained from the unsaturated soil interval located immediately above the static groundwater surface.
(12) This soil sample shall be obtained undisturbed via Shelby Tube (ASTM D1587-83) from the underlying clay stratum that reportedly lies roughly 35 to 40 feet bgs.
(13) This soil sample shall be obtained from somewhere within the unsaturated zone at the discretion of the field geologist.
(14) Two samples refers to one sample from each of the two screened intervals within the double-nested well.
(15) IDW = Investigation Derived Waste

FIGURE 6-1

Baker Environmental, Inc.
420 Rouser Road, AOP Building 3, Coraopolis, PA 15108

CHAIN-OF-CUSTODY RECORD

PROJECT NO.:

SITE NAME:

SAMPLERS (SIGNATURE):

STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS								REMARKS

RELINQUISHED BY (SIGNATURE):	DATE/TIME:	RECEIVED BY (SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE/TIME:	RECEIVED BY (SIGNATURE):
RELINQUISHED BY (SIGNATURE):	DATE/TIME:	RECEIVED BY (SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE/TIME:	RECEIVED BY (SIGNATURE):
RELINQUISHED BY (SIGNATURE):	DATE/TIME:	RECEIVED FOR LABORATORY BY (SIGNATURE):	DATE/TIME:	REMARKS:	

FIGURE 6-2

EXAMPLE CUSTODY SEAL

Baker _____/_____/_____ **Date** ____________________ **Signature** CUSTODY SEAL	**Baker** _____/_____/_____ **Date** ____________________ **Signature** CUSTODY SEAL

FIGURE 6-3

EXAMPLE SAMPLE LABEL

Baker

Baker Environmental Inc.
Airport Office Park, Bldg. 3
420 Rouser Road
Coraopolis, PA 15108

Project: 19026-SRN CTO No.: 0026

Sample Description: Groundwater

Date: 09/17/92 Sampler: ABC

Time: 0944

Analysis: TAL Metals (CAP) Preservation: HNO_3

Project Sample No.: CAX-GW-04

Note: Typically, sample labels are provided by the analytical laboratory and may be used instead of the above. However, samplers should make sure all pertinent information can be affixed to the label used.

sampling task leader, for filing upon completion of the assignment. The cover of each logbook will contain:

- The name of the person to whom the book is assigned
- The book number
- The project name
- Entry start date
- Entry completion date

Entries will include general sampling information so that site activities may be reconstructed. The beginning of each entry will include the date, sampling site, start time, weather conditions, field personnel present and level of personal protection. Other possible entries would be names and purpose of any visitors to the vicinity during sampling, unusual conditions which might impact the interpretation of the subsequent sampling data, or problems with the sampling equipment. All entries will be in ink with no erasures. Incorrect entries will be crossed out with a single strike and initialed.

Field forms used in association with the logbooks include: Test Pit Record (Figure 6-4), Field Test Boring Record (Figure 6-5), and Test Boring and Well Construction Record (Figure 6-6).

FIGURE 6-4

TEST PIT RECORD

Baker
Baker Environmental, Inc

PROJECT: ______________________
S.O. NO.: ______________ TEST PIT NO.: ______________
COORDINATES: EAST ______________ NORTH: ______________
SURFACE ELEVATION: ______________ WATER LEVEL: ______________
WEATHER: ______________ DATE: ______________

REMARKS: ______________________

DEFINITIONS

HNU = Photo Ionization Detector Reading
OVA = Organic Vapor Analyzer Reading
Lab Class. = USCS (ASTM D-2487) or AASHTO (ASTM D-3282)
Lab Moist. = Moisture Content (ASTM D-2216) Dry Weight Basis

Depth (Ft.)	Sample Type and No.	HNU (OVA) or ppm		Lab. Class.	Lab. Moist %	Visual Description (Principal Constituents, Gradation, Color, Moisture Content, Organic Content, Plasticity, and Other Observations)	Elevation
		Field	Head Space				
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

CONTRACTOR: ______________________ BAKER REP.: ______________________
EQUIPMENT: ______________________ TEST PIT NO.: ______________ SHEET 1 OF 1

FIGURE 6-5

Baker
Baker Environmental, Inc

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT:
S.O. NO.: BORING NO.:
COORDINATES: EAST: NORTH:
ELEVATION: SURFACE: TOP OF PVC CASING:

RIG:	SPLIT SPOON	CASING	AUGERS	CORE BARREL	DATE	PROGRESS (FT)	WEATHER	WATER DEPTH (FT)	TIME
SIZE (DIAM.)									
LENGTH									
TYPE									
HAMMER WT.									
FALL									
STICK UP									

REMARKS:

SAMPLE TYPE

S = Split Spoon	**A** = Auger
T = Shelby Tube	**W** = Wash
R = Air Rotary	**C** = Core
D = Denison	**P** = Piston

N = No Sample

WELL INFORMATION	DIAM	TYPE	TOP DEPTH (FT)	BOTTOM DEPTH (FT)

Depth (Ft.)	Sample Type and No.	Samp. Rec. Ft. & %	SPT or RQD	Lab. Class. or Pen. Rate	PID (ppm)	Visual Description	Well Installation Detail	Elevation Ft. MSL
1								
2								
3								
4								
5								
6								
7								
8								
9								
10						Match to Sheet 2		

DRILLING CO.: BAKER REP.:
DRILLER: BORING NO.: SHEET 1 OF 2

Baker
Baker Environmental, Inc

FIGURE 6-6

FIELD WELL CONSTRUCTION LOG

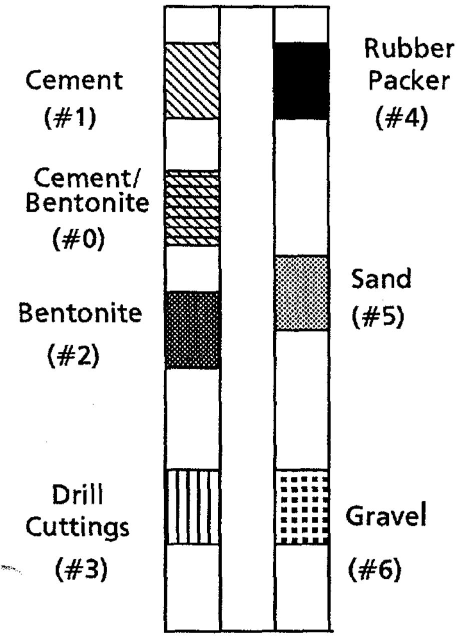
PROJECT: ____________________
S.O. NO.: ____________________ BORING NO.: ____________________
COORDINATES: EAST: ____________________ NORTH: ____________________
ELEVATION: SURFACE: ____________________ TOP OF STEEL CASING: ____________________

Well Development ____________________
____
____

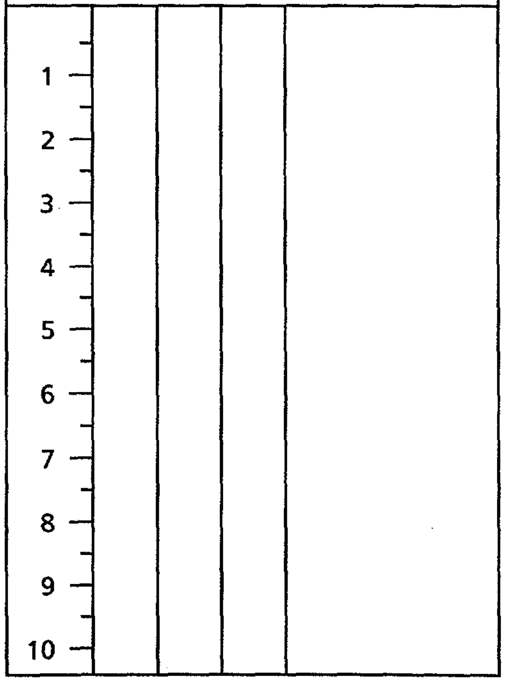
Pay Items			
Item	**Quantity**	**Unit**	**Remarks**

WELL INFORMATION	DIAM. (INCHES)	TYPE	TOP DEPTH (FT.)	BOTTOM DEPTH (FT.)
Well Casing				
Well Screen				

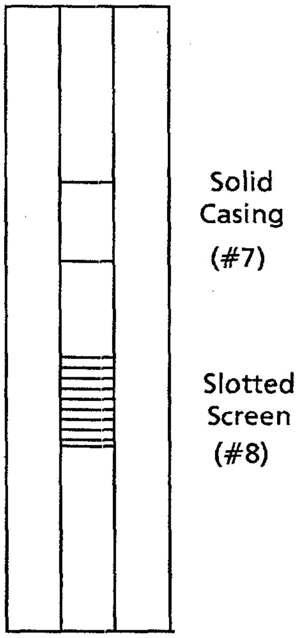
Backfill Key



Well Installation Detail



Well Key



DRILLING CO.: ____________________ BAKER REP.: ____________________
DRILLER: ____________________ BORING NO.: ____________________ SHEET ___ OF ___

7.0 SITE MANAGEMENT

This section outlines the responsibilities and reporting requirements of on-site personnel.

7.1 Field Team Responsibilities

The field portion of this project will consist of one field team. All field activities will be coordinated by a Site Manager.

The Field Team will employ one or more drilling rigs for soil boring and monitoring well installation. The rig(s) will be supervised by a Baker geologist. Two sampling technicians will be assigned to the field team.

A Site Manager (or Field Team Leader) will be assigned to manage all field activities. The Site Manager will ensure that all field activities are conducted in accordance with the project plans (the Work Plan, this Field Sampling and Analysis Plan, the Quality Assurance Project Plan, and the Health and Safety Plan).

7.2 Reporting Requirements

The Site Manager will report a summary of each day's field activities to the Project Manager or his/her designee. This may be done by telephone or telefax. The Site Manager will include, at a minimum, the following in his/her daily report:

- Baker personnel on site.
- Other personnel on site.
- Major activities of the day.
- Subcontractor quantities (e.g., drilling footages).
- Samples collected.
- Problems encountered.
- Planned activities.

The Site Manager will receive direction from the Project Manager regarding changes in scope of the investigation. This will be especially critical as the rapid-turnaround laboratory results become available since additional sample locations may be added to the program.

8.0 REFERENCES

Camp Lejeune Federal Facility Agreement (FFA). December 6, 1989.

ATEC, 1992. Underground Storage Tank Site Check, Investigation Report, Former Mess Hall Heating Plant. Marine Corps Base, Camp Lejeune, North Carolina.

ESE, 1990. Final Community Relations Plan for MCB Camp Lejeune. ESE Project No. 49-02036, September 1990.

ESE, 1992. Final Site Assessment Report for Sites 6, 48, and 69 - Characterization Study to Determine Existence and Possible Migration of Specific Chemicals In Situ. Marine Corps Base, Camp Lejeune, North Carolina.

Harned, D.A., Lloyd, O.B. Jr., and Treece, M.W. Jr., 1989. Assessment of Hydrologic and Hydrogeologic Data at Camp Lejeune Marine Corps Base, North Carolina. USGS. Water Resources Investigations Report 89-4096.

Law, 1992. Final Report, Underground Fuel Investigation, Camp Geiger Fuel Farm. Marine Corps Base, Camp Lejeune, North Carolina.

Law, 1993. Addendum to Report of Underground Fuel Investigation and Comprehensive Site Assessment. Camp Geiger Fuel Farm, Marine Corps Base, Camp Lejeune, North Carolina.

NUS, 1990. Draft Field Investigation/Focused Feasibility Study, Camp Geiger Fuel Spill Site. Camp Lejeune, North Carolina.

U.S. Environmental Protection Agency, 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. Office of Emergency and Remedial Response, OSWER Directive 9355.3-01, October 1988.

Water and Air Research, Inc., 1983. Initial Assessment Study of Marine Corps Base, Camp Lejeune, North Carolina. Prepared for Naval Energy and Environmental Support Activity.

APPENDIX A
JUSTIFICATION CRITERIA FOR USE OF PVC AS WELL CASING MATERIAL

The following is EPA Region IV minimum seven point information requirements to justify the use of PVC as an alternate casing material for groundwater monitoring wells. If requested, justification of the use of PVC should be developed by addressing each of the following items:

1. **The DQOs for the groundwater samples to be collected.**

   Level IV DQOs will be used for analyses of groundwater samples collected during this project. Analytical parameters have been selected to characterize the presence or absence of contamination and to assess any associated risks to human health or the environment.

2. **The anticipated (organic) compounds.**

	Maximum Groundwater Organic Concentrations (µg/L)
Benzene	2,300
Toluene	280
Ethylbenzene	590
Total Xylenes	1,100
MTBE	46
Trans-1,2-DCE	110
TCE	810
PCE	1.0
Vinyl chloride	6.0

The concentrations listed above represent maximums at each site. These compounds are not necessarily present in all wells at a site.

There are two primary concerns regarding sample bias associated with use of PVC well casing under these conditions. One is that organic contaminants will leach from the PVC well casing. The other is that organic contaminants that may be present in the groundwater would adsorb onto the PVC. Either of these could result in biased analytical results.

It is important to note that all stagnant water from inside the well casing is purged immediately before sample collection. The time required to do this is expected to be much less than that required for groundwater sampling bias phenomena (adsorbing/leaching) to develop.

3. **The anticipated residence time of the sample in the well and the aquifer's productivity.**

Samples collected immediately after purging (i.e "fresh" from the aquifer).

Aquifer productivity: Subsurface soil samples are mostly fine sand. Hydraulic conductivity is estimated at 0.0001 to 0.01 cm/sec. The wells should recharge (enough to sample) before any sorbing/leaching of organics can occur. Aquifer tests conducted by O'Brien and Gere (1988) provided information of the following aquifer characteristics:

transmissivity:	500 gpd/ft.
well yield:	3 gpm
saturated thickness:	19-22 ft.
radius of influence:	300-400 ft.

4. **The reasons for not using other casing materials.**

Costs associated with use of stainless steel and teflon casing materials are prohibitive, particularly in 4-inch monitoring wells. PVC strength will be sufficient for this investigation. Existing groundwater quality data indicate that leaching/sorbing of organic materials from/onto the PVC will not be extensive enough to bias future groundwater analysis. PVC is lighter and more flexible than stainless steel.

5. **Literature on the adsorption characteristics of the compounds and elements of interest.**

The following was originally presented in National Water Well Association (NWWA, 1989):

Miller (1982) conducted a study to determine if PVC exhibited any tendency to sorb potential contaminants from solution. Trichloroethene and 1,1,2-trichloroethane did not sorb to PVC. Reynolds and Gillham (1985) found that 1,1,2,2-tetrachloroethane could sorb to PVC. The sorption was slow enough that groundwater sampling bias would not be significant if well development (purging the well of stagnant water) and sampling were to take place in the same day.

6. **Whether the wall thickness of the PVC casing would require a larger annular space when compared to other well construction materials.**

   It will not. Hollow stem augers used during drilling operations will be of sufficient diameter for installation of the PVC casing.

7. **The type of PVC to be used and, if available, the manufacturers specifications, and an assurance that the PVC to be used does not leach, mask, react or otherwise interfere with the contaminants being monitored within the limits of the DQOs.**

   Baker will request the appropriate manufacturers specifications and assurances regarding this requirement. This material will be supplied to Baker by the drilling subcontractor.

References for Appendix A:

National Water Well Association, 1989, Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells, Dublin, Ohio, 398 pp.

Miller, G.D., 1982, Uptake of lead, chromium and trace level volatile organics exposed to synthetic well casings, Proceedings of the Second National Symposium on Aquifer Restoration and Ground-Water Monitoring, National Water Well Association, Dublin, Ohio, pp. 236-245.

Reynolds, G.W. and Robert W. Gillham, 1985, Absorption of halogenated organic compounds by polymer materials commonly used in ground-water monitors, Proceedings of the Second Canadian/American Conference on Hydrogeology, National Water Well Association, Dublin, Ohio, pp. 125-132.

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6. **Whether the wall thickness of the PVC casing would require a larger annular space when compared to other well construction materials.**

   It will not. Hollow stem augers used during drilling operations will be of sufficient diameter for installation of the PVC casing.

7. **The type of PVC to be used and, if available, the manufacturers specifications, and an assurance that the PVC to be used does not leach, mask, react or otherwise interfere with the contaminants being monitored within the limits of the DQOs.**

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Reynolds, G.W. and Robert W. Gillham, 1985, Absorption of halogenated organic compounds by polymer materials commonly used in ground-water monitors, Proceedings of the Second Canadian/American Conference on Hydrogeology, National Water Well Association, Dublin, Ohio, pp. 125-132.

SECTION II

DRAFT

REMEDIAL INVESTIGATION/ FEASIBILITY STUDY QUALITY ASSURANCE PROJECT PLAN FOR OPERABLE UNIT NO. 10 (SITE 35) MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

CONTRACT TASK ORDER 0160

Prepared For:

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

Under:

LANTDIV CLEAN Program
Contract N62470-89-D-4814

Prepared by:

BAKER ENVIRONMENTAL, INC.
Coraopolis, Pennsylvania

JULY 7, 1993

TABLE OF CONTENTS

TABLE OF CONTENTS
(CONTINUED)

APPENDIX

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

This Quality Assurance Project Plan (QAPP) has been developed for the field investigation of the following site at Marine Corps Base, Camp Lejeune, North Carolina:

- Site 35 - Camp Geiger Area Fuel Farm

The preparation of this QAPP, and other related project plans, is being performed under the Navy CLEAN Contract Task Order 0160. Baker Environmental, Inc., a wholly owned subsidiary of the Michael Baker Corporation, is the prime contractor for the implementation of this project.

This QAPP addresses the quality assurance and quality control steps and procedures that will be administered for the sample collection and analysis for this Remedial Investigation (RI). Detailed information regarding sample handling and analytical methods are provided in Sections 6.0 and 9.0, respectively. Sample collection procedures are provided in the Field Sampling and Analysis Plan (FSAP).

2.0 SCOPE OF QUALITY ASSURANCE PROJECT PLAN

This Quality Assurance Project Plan (QAPP) addresses sample collection and analysis to be conducted for the field investigation of Site 35 of Camp Lejeune, North Carolina. The QAPP has been developed for the Department of Navy (DoN) in accordance with U. S. Environmental Protection Agency (USEPA) guidelines. Contractors will follow QA/QC practices and procedures, including chain-of-custody procedures, while conducting all sample collection and analysis activities.

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

1. Use of a NEESA-certified analytical laboratory;
2. Use of accepted analytical methods for the samples outlined in the Field Sampling and Analysis Plan (FSAP). Analysis of samples for hazardous constituents parameters will be performed using the following documents:
    - "Statement of Work for Organic Analysis," USEPA, OLM01.6, June 1991;
    - "Statement of Work for Inorganic Analysis," USEPA, ILM02.0, March 1990;
    - "Methods for Chemical Analysis of Water and Waste," USEPA, 1979, Revised March 1983;
    - "Environmental Protection Agency Regulations on Test Procedures for Analysis of Pollutants," USEPA, 40 CFR 136;
    - "Test Methods for Evaluating Solid Waste," USEPA, November 1986, 3rd Edition; and
    - "Hazardous Waste Management System; Identification and Listing of Hazardous Waste; Toxicity Characteristics Revisions; Final Rule," USEPA, 52 FR 26886.
3. Field audit(s) during initial sampling activities to verify that sampling is being performed according to the Plan.

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

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

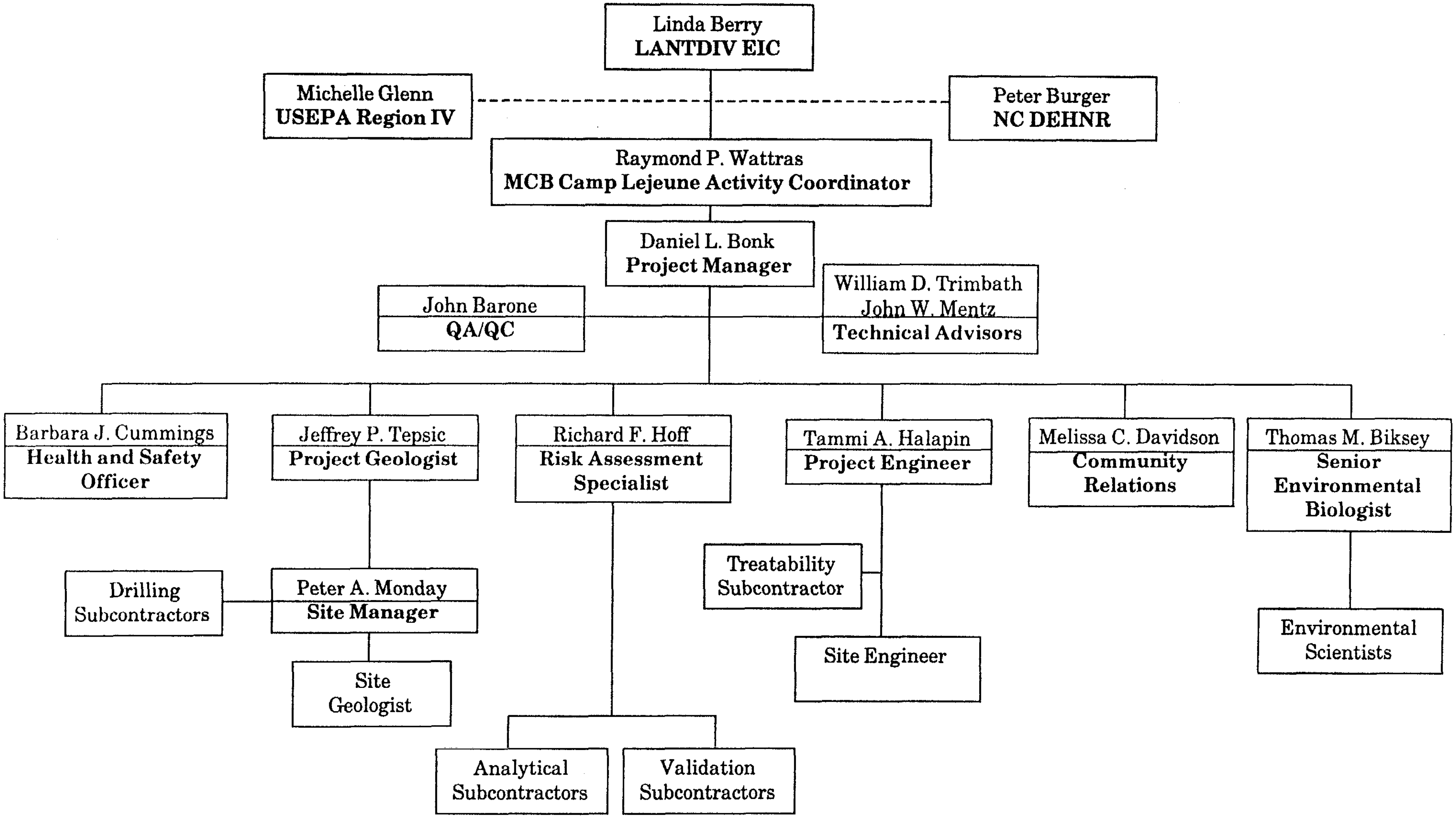
3.0 PROJECT DESCRIPTION

An introduction to the field investigation of Site 35 describing the project objectives and scope are given in Sections 4.0 and 5.0 of the RI/FS Work Plan. These sections discuss the objectives of the RI, and the various field sampling and analytical programs. A detailed description of the field investigations, including sample location and designation, sampling procedures and frequency, is presented in Sections 3.0, 4.0, and 5.0 of the FSAP.

4.0 PROJECT ORGANIZATION

Technical performance of the investigation of Site 35 at Camp Lejeune and key personnel responsible for quality assurance throughout its duration are described in Section 6.0 of the RI/FS Work Plan. The contractor will utilize subcontractors to perform laboratory analysis, data validation, drilling and monitoring well installation, ordnance clearance, and surveying. Specific subcontractors have not yet been identified. Figure 4-1 shows the project organization, lines of authority, and support personnel/organizations.

FIGURE 4-1
PROJECT ORGANIZATION
RI/FS AT OPERABLE UNIT NO. 10
SITE 35
MCB CAMP LEJEUNE, NORTH CAROLINA



5.0 QUALITY ASSURANCE OBJECTIVES FOR DATA MEASUREMENT

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

5.1 Project Quality Assurance Objectives

Project QA objectives are:

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

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

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

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

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

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

- "Statement of Work for Organic Analysis," USEPA , OLM01.6, June 1991;
- "Statement of Work for Inorganic Analysis," USEPA , ILM02.0, March 1990;
- "Methods for Chemical Analysis of Water and Waste," USEPA, 1979, Revised March 1983;
- "Environmental Protection Agency Regulations on Test Procedures for Analysis of Pollutants," USEPA, 40 CFR 136;
- "Test Methods for Evaluating Solid Waste," USEPA, November 1986, 3rd Edition;
- "Hazardous Waste Management System; Identification and Listing of Hazardous Waste; Toxicity Characteristics Revisions; Final Rule," USEPA, 52 FR 26886; and
- "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans," USEPA, (QAMS 005/80).

5.2 Data Quality Objectives

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

TABLE 5-1

DEFINITIONS OF DATA QUALITY INDICATORS

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

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

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

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

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

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

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

The data collected during the course of the site investigation will be used:

- To assess potential human health and environmental risks;
- To monitor health and safety conditions during field activities;
- To identify releases or suspected releases of hazardous waste and/or constituents;
- To characterize the wastes contained and/or managed; and,
- To screen from further investigation those areas which do not pose a threat to human health or environment.

All samples for characterizing the site, assessing human health and environmental risks, or selecting remedial alternatives will be analyzed and reported by the laboratory as Level IV data. Samples collected to evaluate process options (e.g., TOC, TSS, etc.) will be analyzed and reported by the laboratory as Level III data quality. Field parameters including temperature (aqueous only) and specific conductance will be Level I data quality. In the event treatability studies are conducted, sample analyses will be Level III or IV quality.

6.0 SAMPLING PROCEDURES

Descriptions of the procedures to be used for sampling the groundwater, surface water, sediment and soil at the site are provided in Section 5.0 of the FSAP. The number of samples, sampling locations, and sampling rationale by media also are presented in the FSAP.

7.0 SAMPLE AND DOCUMENT CUSTODY PROCEDURES

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

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

7.1 Sampling Handling

New polyethylene or glass bottles containing the proper preservatives will be provided by the laboratory for sample collection. In addition to the chemical preservatives, samples will be stored on ice at 4°C in a waterproof metal or sturdy plastic cooler, if required (see Tables 7-1 through 7-2 for summaries of containers, preservation, and holding times for water and soil/sediment respectively).

7.2 Chain-of-Custody Procedures

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

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

TABLE 7-1

SUMMARY OF CONTAINERS, PRESERVATION, AND HOLDING TIMES FOR AQUEOUS SAMPLES

Parameter	Container	Preservation	Holding Time
TCL Volatiles	Two 40-ml vials with teflon septum caps	Cool, 4°C HCl pH <2	14 days (7 days if unpreserved)
TCL Semivolatiles	1-liter amber glass bottle with teflon caps	Cool, 4°C	7 days to extraction; 40 days from extraction to analysis
TCL Pesticides/PCBs	1-liter amber glass bottle with teflon caps	Cool, 4°C	7 days to extraction; 40 days after extraction for analysis
TAL Metals	1-500 ml polyethylene bottle	HNO_3 pH<2	6 months; Mercury 28 days
TAL Cyanide	1-liter polyethylene bottle	NaOH pH>12 Cool, 4°C	14 days
TOC	1-liter polyethylene bottle	Cool to 4°C HCl or H_2SO_4 to pH<2	28 days
TSS	1-liter polyethylene bottle	Cool, 4°C	7 days
TDS	1-liter polyethylene bottle	Cool, 4°C	7 days
BOD	1-liter polyethylene bottle	Cool, 4°C	48 hours
COD	1-liter polyethylene bottle	Cool, 4°C H_2SO_4 pH <2	28 days

TCL - Target Contaminant List
TAL - Target Analyte List
TOC - Total Organic Carbon
TSS - Total Suspended Solids
TVS - Total Volatile Solids
TDS - Total Dissolved Solids
BOD - Biological Oxygen Demand
COD - Chemical Oxygen Demand

TABLE 7-2

SUMMARY OF CONTAINERS, PRESERVATION, AND HOLDING TIMES FOR SOIL AND SEDIMENT SAMPLES

Parameter	Container	Preservation	Holding Time
TCL Volatiles	Two 4-ounce wide-mouth glass jars	Cool, 4°C	10 days (7 days if unpreserved)
TCL Semivolatiles	One 8-ounce wide-mouth glass jar	Cool, 4°C	7 days to extraction; 40 days from extraction to analysis
TCL Pesticides/PCBs	One 8-ounce wide-mouth glass jar	Cool, 4°C	7 days to extraction; 40 days after extraction for analysis
TAL Metals	One 8-ounce wide-mouth glass jar	Cool, 4°C	6 months; Mercury, 28 days
TAL Cyanide	One 8-ounce wide-mouth glass jar	Cool, 4°C	14 days
Total TCLP	Two 8-ounce wide-mouth glass jar	Cool, 4°C	14 days
Chloride	One 4-ounce wide-mouth glass jar	--	28 days
Fluoride	One 4-ounce wide-mouth glass jar	None	28 days
Alkalinity	One 4-ounce wide-mouth glass jar	Cool, 4°C	14 days
TOC	One 4-ounce wide-mouth glass jar	Cool, 4°C	28 days
TPH	One-4 ounce wide-mouth glass jar	Cool, 4°C	28 days
Corrosivity	One 4-ounce wide-mouth glass jar	Cool, 4°C	NA
Ignitability	One 4-ounce wide-mouth glass jar	Cool, 4°C	NA
Reactivity	One 8-ounce wide-mouth glass jar	Cool, 4°C	NA

NOTE: Samples to be tested for TCLP should undergo minimal disturbance prior to analysis.

TCL - Target Contaminant List
TAL - Target Analyte List
TCLP - Toxicity Characteristic Leaching Procedure
TOC -Total Organic Carbon
TPH - Total Petroleum Hydrocarbons

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

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

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

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

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

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

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

The sample custody is documented using Chain-of-Custody (COC) records. Field personnel will complete a COC record, in waterproof ink, to accompany each cooler forwarded from the site to the laboratory. Chemical reagents used to preserve the samples will be recorded on the

COC record. Any errors on the COC records will not be erased; instead, a line will be drawn through the error and initialed by the person completing the form. The original copy will be placed in a sealable plastic bag and put inside the appropriate cooler, secured to the cooler's lid.

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

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

Laboratory Chain-of-Custody Procedures

Upon sample receipt the steps below are performed.

- Samples are received and unpacked in the laboratory where the staff checks for bottle integrity (loose caps, broken bottles, etc.).
- Samples are verified with incoming paperwork (packing slip, etc.) by type of bottle and stabilizer. The paperwork is either signed or initialed.
- Information concerning the sample (from the sampling record, Chain-of-Custody, and observation) is recorded along with parameters to be analyzed, date of sampling, and date the sample is received in the laboratory.
- Samples are placed in an appropriate secured storage area, e.g. refrigeration, until analysis.

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

If collected samples arrive without Chain-of-Custody or incorrect Chain-of-Custody records, the following steps are taken:

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

Primary considerations for sample storage are:

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

7.3 Document Custody Procedures

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

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

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

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

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

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

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

8.0 CALIBRATION PROCEDURES AND FREQUENCY

8.1 Field Instruments

One field instrument will be used for health and safety monitoring: the HNu System portable photoionizer. These instruments will be calibrated on site daily according to the manufacturer's instructions in addition to the factory calibration it will receive prior to the start of site sampling. The calibration standards will be recorded in the field log book. Specific procedures for the calibration of water quality instruments are given in Appendix A of this document.

A pH meter and a conductivity meter will be used to analyze groundwater and surface water samples. Procedures from "Test Methods for Evaluating Solid Waste," USEPA, SW-846, November 1986, 3rd Edition will be used to calibrate these meters. Specific procedures for the calibration of water quality instruments are given in Appendix A of this document

8.2 Laboratory Instruments

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

- "Statement of Work for Organic Analysis," USEPA, OLM01.6, June 1991;
- "Statement of Work for Inorganic Analysis," USEPA, ILM02.0, March 1990;
- "Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater," USEPA, July 1982;
- "Methods for Chemical Analysis of Water and Waste," USEPA, 1979, Revised March 1983;
- "Environmental Protection Agency Regulations on Test Procedures for Analysis of Pollutants," USEPA, 40 CFR 136;
- "Test Methods for Evaluating Solid Waste," USEPA, November 1986, 3rd Edition; and

- "Hazardous Waste Management System; Identification and Listing of Hazardous Waste; Toxicity Characteristics Revisions; Final Rule," USEPA, 52 FR 26886.

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

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

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

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

8.2.1 Method Calibration

Method calibration is performed as part of the laboratory analytical procedure (calibration curves, tuning). Calibration curves are prepared using five standards in graduated amounts across the appropriate range of analysis. New calibration curves are prepared whenever new reagents or standards are prepared or yearly, whichever is more frequent.

8.2.2 GC/MS System Calibration Procedure

This section outlines the requirements for the calibration of GC/MS systems for the determination of organic compounds. The following operations are performed in support of these requirements:

- Documentation of GC/MS mass calibration and abundance pattern;
- Documentation of GC/MS response factor stability; and
- Internal standard response and retention time monitoring.

Tuning and Mass Calibration

It is necessary to establish that a given GC/MS system meets the standard mass spectral abundance criteria prior to initiating data collection. This is accomplished through the analysis of p-bromofluorobenzene (BFB) for volatile compounds or decafluorotriphenylphosphine (DFTPP) for semivolatile compounds. The BFB or DFTPP criteria are met before any blanks, standards, or samples are analyzed.

A GC/MS system used for organic compound analysis is tuned to meet the criteria specified for BFB analysis (volatile compounds) or DFTPP (semivolatile compounds) for an injection of 50 nanograms (ng) of BFB or DFTPP. The analysis is performed separately from standard or blank analysis. These criteria are demonstrated every 12 hours of operation. Background subtraction, if required, is straight forward to eliminate column bleed or instrument background ions. Calibration documentation is in the form of a bar graph spectrum and a mass listing.

GC/MS System Calibration

After tuning criteria have been met and prior to sample analysis, the GC/MS system is initially calibrated at five concentrations utilizing the compounds to be analyzed to determine the linearity of response. Internal and surrogate standards are used with each calibration standard. Standards are analyzed under the same conditions as the samples.

- Relative Response Factor (RRF) Calculation - The USEPA specifies the internal standard to be used on a compound-by-compound basis for quantification. The relative response factor (RRF) is calculated for each compound at each concentration level.

- Continuing Calibration - A calibration check standard containing all semivolatile or volatile compounds and surrogates is run each 12 hours of analysis. A system performance check is performed. The criteria are the same as for the initial calibration system performance check. A calibration check is also performed. The percent difference is determined for each CCC.

The percent Difference for each CCC must be less than or equal to 25.0 percent. The system performance check and calibration check criteria must be met before sample analysis can be performed. The continuing calibration is recorded on the continuing calibration forms.

8.2.3 GC System Calibration Procedure

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

Three types of analyses are used to verify the calibration and evaluate instrument performance. The analyses of instrument blanks, Performance Evaluation mixtures (PEMs), and the mid-point concentration of the the individual standard mixtures A and B constitute the continuing calibration.

- It is necessary to establish resolution criteria by performing a Resolution Check Mixture where the depth of the valley of two adjacent peaks must be greater than or equal to 60.0 percent of the height of the shorter peak.

- The breakdown of DDT and Endrin in both of the PEMs must be less than 20.0 percent and the combined breakdown of DDT and Endrin must be less than 30.0 percent. All peaks in both the Performance Evaluation Mixtures must be 100 percent resolved on both columns.

- The absolute retention times of each of the single component pesticides and surrogates in both of the PEMs must be within the retention time windows determined from the three point initial calibration.

- The relative percent difference of the calculated amount and the true amount for each of the single component pesticides and surrogates in both of the PEMs must be less than or equivalent to 25.0 percent.

- At least one chromatogram between any two adjacent peaks in the midpoint concentrations of Individual Standard Mixtures A and B in the initial calibration must be greater than or equal to 90.0 percent.

8.2.4 System Calibration Procedure for GC Purgable Halocarbons and Aromatics

The system must be calibrated daily by external calibration. A minimum of three concentration levels, of each parameter, is used to prepare a calibration curve. The working calibration curve must be verified on each working day by the measurement of one or more calibration standards. If the response for any parameter varies from the predicted response by more than plus or minus ten percent, the test must be repeated using a fresh calibration standard.

The laboratory must spike and analyze a minimum of ten percent of all samples to monitor continuing laboratory performance.

Prior to analysis, the system must be demonstrated to be free from contamination, under the conditions of the analysis, by running a laboratory reagent blank.

The retention time window used to make the identification should be based upon measurements of actual retention time variations of standards over the course of the day.

If the response peak exceeds the working range of the system, prepare a dilution of the sample with reagent water and reanalyze.

8.2.5 System Calibration Procedure for Metals Analysis

This section outlines the requirements for the calibration of atomic absorption (AA) and Inductively Coupled Plasma (ICP) systems for the determination of metals. The following are performed in support of these requirements:

- Documentation of standard response; and
- Correlation coefficient monitoring.

The AA system utilized for direct aspiration technique analysis is initially calibrated with a calibration blank and five calibration standards. The standard concentrations are determined as follows. One standard is at a concentration near, but above, the MDL. The other concentrations correspond to the expected range of concentrations found in the actual samples. This five-point calibration is performed daily.

The AA system utilized for graphite furnace technique analysis is initially calibrated with a calibration blank and three calibration standards. The standard concentrations are determined as follows. One standard is at a concentration at the Contract Required Detection Limit (CRDL). The other concentrations correspond to the expected range of concentrations found in the actual samples. This three-point calibration is performed daily.

For AA systems, the calibration standards are prepared fresh each time an analysis is to be performed and discarded after use. The standards contain the same reagents at the same concentrations as will result in the samples following preparation.

The ICP system is calibrated initially with a calibration blank and one calibration standard. This calibration is performed daily. In addition, ICP systems must undergo quarterly linearity checks.

Correlation Coefficient Calculation

The data points of the blank and the five calibration standards are utilized to calculate the slope, the intercept, and the correlation coefficient of the best fit line. An acceptable correlation coefficient must be achieved before sample analysis may begin. An acceptable correlation coefficient is >0.995 for AA analyses and >0.995 for ICP analysis.

Calibration Verification

The initial calibration curve is verified on each working day by the measurement of one mid-range calibration standard. The calibration verification acceptance criterion is as follows:

- ICEP/GFAA - 90 to 110 percent of true value; and
- Cold Vapor AA - 80 to 120 percent of true value.

When measurements exceed the control limits, the analysis is terminated, the problem corrected, the instrument recalibrated, and the calibration reverified.

8.2.6 System Calibration Procedure for Inorganic Analyses

This section outlines the requirements that are used for calibration of colorimetric systems for analyses of inorganic parameters. The following are performed in support of these requirements:

- Documentation of standard response; and
- Correlation coefficient monitoring.

The system is initially calibrated with a blank and five calibration standards. Standard concentrations are one standard at a concentration near, but above, the MDL with additional concentrations corresponding to the expected range of concentrations found in actual samples. Standards contain the same reagents at the same concentrations as will be present in samples following preparation.

Correlation Coefficient Calculation

Data points of the blank and five calibration standards are utilized to calculate slope, intercept, and correlation coefficient of a best fit line. An acceptable correlation coefficient is achieved before sample analysis may begin. An acceptable correlation coefficient is >0.995 for all systems.

Calibration Verification

The initial calibration curve is verified on each working day by the measurement of two calibration standards. One standard is at a concentration near the low end of the calibration curve and one standard is at the high end of the curve. The acceptance criteria for recovery of verification standards is within 15 percent of the expected recovery for cyanide analyses and 10 percent of the expected recovery for other inorganic analyses. When measurements exceed control limits, analysis is terminated, the problem is corrected, the instrument is recalibrated, and calibration is reverified.

8.2.7 Periodic Calibration

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

- Balances are calibrated weekly with class S weights.

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

- The temperatures of the refrigerators are recorded daily.

- All liquid in glass thermometers are calibrated annually with the N.B.S. certified thermometer. Dial thermometers are calibrated quarterly.

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

The following equipment must maintain the following temperatures:

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

9.0 ANALYTICAL PROCEDURES

9.1 Field Analysis

An HNu PI-101 will be used to analyze ambient air for health and safety monitoring, as well as to screen soil during the soil sampling. The HNu PI-101 detects total organic vapor. This instrument will be operated in accordance with the manufacturer's instructions.

The pH, temperature, and specific conductivity of aqueous samples also will be measured in the field. These analyses will be obtained in accordance with "Handbook for Sampling and Sample Preservation of Water and Wastewater," September 1982, EPA/600/4-82-029.

9.2 Laboratory Analysis

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

TABLE 9-1

METHOD PERFORMANCE LIMITS

Compound	Water CRQL(1) (µg/L)	Soil/Sediment CRQL(1) (µg/kg)	Method
Volatiles			CLP protocols SOW 1991
Chloromethane	10	10	
Bromomethane	10	10	
Vinyl Chloride	10	10	
Chloroethane	10	10	
Methylene Chloride	5	5	
Acetone	10	10	
Carbon Disulfide	5	5	
1,1-Dichloroethene	5	5	
1,1-Dichloroethane	5	5	
1,2-Dichloroethene (total)	5	5	
Chloroform	5	5	
1,2-Dichloroethane	5	5	
2-Butanone	10	10	
1,1,1-Trichloroethane	5	5	
Carbon Tetrachloride	5	5	
Bromodichloromethane	5	5	
1,2-Dichloropropane	5	5	
cis-1,3-Dichloropropene	5	5	
Trichloroethene	5	5	
Dibromochloromethane	5	5	
1,1,2-Trichloroethane	5	5	
Benzene	5	5	
trans-1,3-Dichloropropene	5	5	
Bromoform	5	5	
4-Methyl-2-pentanone	10	10	
2-Hexanone	10	10	
Tetrachloroethene	5	5	
Toluene	5	5	
1,1,2,2-Tetrachloroethane	5	5	
Chlorobenzene	5	5	
Ethyl Benzene	5	5	
Styrene	5	5	
Xylenes (total)	5	5	

(1) Contract Required Quantitation Limit, taken from "Statement of Work for Organic Analysis," USEPA Contract Laboratory Program, OLM01.6, June 1991.

TABLE 9-1 (Continued)

METHOD PERFORMANCE LIMITS

Compound	Water CRQL[1] (µg/L)	Soil/Sediment CRQL[1] (µg/kg)	Method
Semivolatiles Phenol	10	330	CLP protocols SOW 1991
bis(2-Chloroethyl) ether	10	330	
2-Chlorophenol	10	330	
1,3-Dichlorobenzene	10	330	
1,4-Dichlorobenzene	10	330	
Benzyl alcohol	10	330	
1,2-Dichlorobenzene	10	330	
2-Methylphenol	10	330	
bis(2-Chloroisopropyl)ether	10	330	
4-Methylphenol	10	330	
N-Nitroso-di-n-dipropylamine	10	330	
Hexachloroethane	10	330	
Nitrobenzene	10	330	
Isophorone	10	330	
2-Nitrophenol	10	330	
2,4-Dimethylphenol	10	330	
Benzoic acid	50	1600	
bis(2-Chloroethoxyl)methane	10	330	
2,4-Dichlorophenol	10	330	
1,2,4-Trichlorobenzene	10	330	
Naphthalene	10	330	
4-Chloroaniline	10	330	
Hexachlorobutadiene	10	330	
4-Chloro-3-methylphenol (para-chloro-meta-cresol)	10	330	
2-Methylnaphthalene	10	330	
Hexachlorocyclopentadiene	10	330	
2,4,6-Trichlorophenol	10	330	
2,4,5-Trichlorophenol	50	1600	
2-Chloronaphthalene	10	330	
2-Nitroaniline	50	1600	
Dimethylphthalate	10	330	

(1) Contract Required Quantitation Limit, taken from "Statement of Work for Organic Analysis," USEPA Contract Laboratory Program, OLM01.6, June 1991.

TABLE 9-1 (Continued)

METHOD PERFORMANCE LIMITS

Compound	Water CRQL(1) (μg/L)	Soil/Sediment CRQL(1) (μg/kg)	Method
Acenaphthylene	10	330	CLP protocols SOW 1991
2,6-Dinitrotoluene	10	330	
3-Nitroaniline	50	1600	
Acenaphthene	10	330	
2,4-Dinitrophenol	50	1600	
4-Nitrophenol	50	1600	
Dibenzofuran	10	330	
2,4-Dinitrotoluene	10	330	
Diethylphthalate	10	330	
4-Chlorophenyl-phenyl ether	10	330	
Fluorene	10	330	
4-Nitroaniline	50	1600	
4,6-Dinitro-2-methylphenol	50	1600	
N-nitrosodiphenylamine	10	330	
4-Bromophenyl-phenylether	10	330	
Hexachlorobenzene	10	330	
Pentachlorophenol	50	1600	
Phenanthrene	10	330	
Anthracene	10	330	
Di-n-butylphthalate	10	330	
Fluoranthene	10	330	
Pyrene	10	330	
Butylbenzylphthalate	10	330	
3,3'-Dichlorobenzidine	20	660	
Benzo(a)anthracene	10	330	
Chrysene	10	330	
bis(2-Ethylhexyl)phthalate	10	330	
Di-n-octylphthalate	10	330	
Benzo(b)fluoranthene	10	330	
Benzo(k)fluoranthene	10	330	
Benzo(a)pyrene	10	330	
Indeno(1,2,3-cd)pyrene	10	330	
Dibenz(a,h)anthracene	10	330	
Benzo(g,h,i)perylene	10	330	

(1) Contract Required Quantitation Limit, taken from "Statement of Work for Organic Analysis," USEPA Contract Laboratory Program, OLM01.6, June 1991.

TABLE 9-1 (Continued)

METHOD PERFORMANCE LIMITS

Compound	Water CRQL(1) (µg/L)	Soil/Sediment CRQL(1) (µg/kg)	Method
Pesticides/PCBs			
alpha-BHC	0.05	8.0	CLP protocols SOW 1991
beta-BHC	0.05	8.0	
delta-BHC	0.05	8.0	
gamma-BHC (Lindane)	0.05	8.0	
Heptachlor	0.05	8.0	
Aldrin	0.05	8.0	
Heptachlor epoxide	0.05	8.0	
Endosulfan I	0.05	8.0	
Dieldrin	0.10	16.0	
4,4'-DDE	0.10	16.0	
Endrin	0.10	16.0	
Endosulfan II	0.10	16.0	
4,4'-DDD	0.10	16.0	
Endosulfan sulfate	0.10	16.0	
4,4'-DDT	0.10	16.0	
Methoxychlor	0.5	80.0	
Endrin ketone	0.10	16.0	
alpha-Chlordane	0.5	80.0	
gamma-Chlordane	0.5	80.0	
Toxaphene	1.0	160.0	
Aroclor-1016	0.5	80.0	
Aroclor-1221	0.5	80.0	
Aroclor-1232	0.5	80.0	
Aroclor-1242	0.5	80.0	
Aroclor-1248	0.5	80.0	
Aroclor-1254	1.0	160.0	
Aroclor-1260	1.0	160.0	

(1) Contract Required Quantitation Limit, taken from "Statement of Work for Organic Analysis," USEPA Contract Laboratory Program, OLM01.6, June 1991.

TABLE 9-1 (Continued)

METHOD PERFORMANCE LIMITS

Analyte	Method Number(1)	CRDL(2) (µg/L)	Method Description
Aluminum	200.7	200	Inductively Coupled Plasma
Antimony	200.7 204.2	60	Inductively Coupled Plasma Atomic Absorption, Furnace Technique
Arsenic	200.7 206.2	10	Inductively Coupled Plasma Atomic Absorption, Furnace Technique
Barium	200.7	200	Inductively Coupled Plasma
Beryllium	200.7 210.2	5	Inductively Coupled Plasma Atomic Absorption, Furnace Technique
Cadmium	200.7 213.2	5	Inductively Coupled Plasma Atomic Absorption, Furnace Technique
Calcium	200.7 215.1	5000	Inductively Coupled Plasma Atomic Absorption, Direct Aspiration
Chromium	200.7 218.2	10	Inductively Coupled Plasma Atomic Absorption, Furnace Technique
Cobalt	200.7	50	Inductively Coupled Plasma
Copper	200.7	25	Inductively Coupled Plasma
Iron	200.7	100	Inductively Coupled Plasma
Lead	200.7 239.2	3	Inductively Coupled Plasma Atomic Absorption, Furnace Technique

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(1) Methods taken from "Statement of Work for Inorganic Analysis," USEPA Contract Laboratory Program, ILM02.0, March 1990.

(2) Contract Required Detection Limit.

(3) Extraction method for arsenic, lead, selenium, and thallium taken from USEPA Method 3020, "Test Methods for Evaluating Solid Waste," USEPA, November 1986, 3rd Edition.

(4) Extraction method for all other metals taken from USEPA Method 3010, "Test Methods for Evaluating Solid Waste," USEPA, November 1986, 3rd Edition.

TABLE 9-1 (Continued)

METHOD PERFORMANCE LIMITS

Analyte	Method Number[1]	CRDL[2] (µg/L)	Method Description
Magnesium	200.7 242.1	5000	Inductively Coupled Plasma Atomic Absorption, Direct Aspiration
Manganese	200.7	15	Inductively Coupled Plasma
Mercury	245.1 245.2 245.5	0.2	Water by manual cold vapor technique Water by automated cold vapor technique Soil/sediment by manual cold vapor technique
Nickel	200.7	40	Inductively Coupled Plasma
Potassium	200.7 258.1	5000	Inductively Coupled Plasma Atomic Absorption, Direct Aspiration
Selenium	200.7 270.2	5	Inductively Coupled Plasma Atomic Absorption, Furnace Technique
Silver	200.7 272.2	10	Inductively Coupled Plasma Atomic Absorption, Furnace Technique
Sodium	200.7 273.1	5000	Inductively Coupled Plasma Atomic Absorption, Direct Aspiration
Thallium	200.7 279.2	10	Inductively Coupled Plasma Atomic Absorption, Furnace Technique
Vanadium	200.7	50	Inductively Coupled Plasma
Zinc	200.7	20	Inductively Coupled Plasma
Cyanide	335.2	10	Titrimetric, Spectrophotometric

(1) Methods taken from "Statement of Work for Inorganic Analysis," USEPA Contract Laboratory Program, ILM02.0, March 1990.

(2) Contract Required Detection Limit.

(3) Extraction method for arsenic, lead, selenium, and thallium taken from USEPA Method 3020, "Test Methods for Evaluating Solid Waste," USEPA, November 1986, 3rd Edition.

(4) Extraction method for all other metals taken from USEPA Method 3010, "Test Methods for Evaluating Solid Waste," USEPA, November 1986, 3rd Edition.

TABLE 9-1 (Continued)

METHOD PERFORMANCE LIMITS

Parameter	Water PQL(1) (μg/L)	Soil PQL(1) (μg/kg)	Method
Pesticides Chlordane	0.14	9.4	EPA Method 8080
Endrin	0.06	4.0	
Heptachor (and its hydroxide)	0.03	2.0)	
Lindane	0.04	2.7	
Methoxychlor	1.8	120	
Toxaphene	2.4	160	
Herbicides 2,4-D	12	800	EPA Method 8150
2,4,5-TP (Silvex)	1.7	110	
Volatiles Benzene	5	10	EPA Method 8240
Carbon Tetrachloride	5	5	
Chlorobenzene	5	5	
Chloroform	5	5	
1,2-Dichloroethane	5	5	
1,1-Dichloroethylene	5	5	
Methyl ethyl ketone	N/A	N/A	
Tetrachloroethylene	5	5	
Trichloroethylene	5	5	
Vinyl Chloride	10	10	

(1) Practical Quantitation Limit taken from "Test Methods for Evaluating Solid Waste," USEPA, November 1986.

N/A - Not Applicable

Note: These methods will be used to analyze the Toxicity Characteristic Leading Procedure (TCLP) extract. The extract will be prepared using Method 1311, described in "Hazardous Waste Management System; Identification and Listing of Hazardous Waste; Toxicity Characteristics Revisions; Final Rule," USEPA, 52FR 26886.

TABLE 9-1 (Continued)

METHOD PERFORMANCE LIMITS

Parameter	Water PQL(1) (μg/L)	Soil PQL(1) (μg/kg)	Method
Semivolatiles			
o-Cresol	10	660	EPA Method 8270
m-Cresol	10	660	
p-Cresol	10	660	
Cresol	10	660	
1,4-Dichlorobenzene	10	660	
2,4-Dinitrotoluene	10	660	
Hexachlorobenzene	10	660	
Hexachlorobutadiene	10	660	
Hexachloroethane	10	660	
Nitrobenzene	10	660	
Pentachlorophenol	50	3300	
Pyridine	50	660	
2,4,5-Trichlorophenol	10	660	
2,4,6-Trichlorophenol	10	660	

(1) Practical Quantitation Limit taken from "Test Methods for Evaluating Solid Waste," USEPA, November 1986.

Note: These methods will be used to analyze the Toxicity Characteristic Leading Procedure (TCLP) extract. The extract will be prepared using Method 1311, described in "Hazardous Waste Management System; Identification and Listing of Hazardous Waste; Toxicity Characteristics Revisions; Final Rule," USEPA, 52FR 26886.

TABLE 9-1 (Continued)

METHOD PERFORMANCE LIMITS

Analyte	Water PQL[1] (µg/L)	Soil PQL[1] (mg/kg)	Method	Method Description
Metals				
Arsenic	10	30	6010 7060	Inductively Coupled Plasma Atomic Absorption, Furnace Technique
Barium	20	1	6010	Inductively Coupled Plasma
Cadmium	1	2	6010 7131	Inductively Coupled Plasma Atomic Absorption, Furnace Technique
Chromium	20	4	6010 7191	Inductively Coupled Plasma Atomic Absorption, Furnace Technique
Lead	10	2	6010 7421	Inductively Coupled Plasma Atomic Absorption, Furnace Technique
Mercury	2	0.002	7470	Water by manual cold vapor technique Water by automated cold vapor technique
Selenium	20	40	6010 7740	Inductively Coupled Plasma Atomic Absorption, Furnace Technique
Silver	2	4	6010 7760	Inductively Coupled Plasma Atomic Absorption, Furnace Technique

(1) Practical Quantitation Limit, taken from "Test Methods for Evaluating Solid Waste," USEPA, November 1986.

Note: These methods will be used to analyze the Toxicity Characteristic Leading Procedure (TCLP) extract. The extract will be prepared using Method 1311, described in "Hazardous Waste Management System; Identification and Listing of Hazardous Waste; Toxicity Characteristics Revisions; Final Rule," USEPA, 52FR 26886.

TABLE 9-1 (Continued)

METHOD PERFORMANCE LIMITS

Parameter	Water PQL	Soil PQL	Method
RCRA			
Soil pH/Corrosivity	N/A	N/A	SW 9045
Ignitability	N/A	N/A	SW 1010
Reactive Cyanide	10 mg/L(1)	10 mg/kg(1)	SW 9012
Reactive Sulfide	50 mg/L(1)	50 mg/kg	SW 9030
Engineering/FS Parameters			
Ammonium Nitrogen	N/A	N/A	EPA 350.2
Sulfate	15 mg/L(2)	15 mg/kg(2)	EPA 375.1
Chemical Oxygen Demand (COD)	N/A	N/A	EPA 410.1
Biological Oxygen Demand (BOD)	N/A	N/A	EPA 405.1
Total Suspended Solids (TSS)	N/A	N/A	EPA 160.2
Total Dissolved Solids (TDS)	N/A	N/A	EPA 160.1
Total Volatile Solids (TVS)	N/A	N/A	EPA 160.4
Total Organic Carbon (TOC)	N/A	N/A	EPA 415.1
Total Petroleum Hydrocarbons (TPH)	35 mg/L	65 mg/kg	EPA 5030/3550
Chloride	N/A	N/A	SW 9251
Alkalinity (Total)	N/A	N/A	SM 2320-B
Nitrogen, Organic (as N)	N/A	N/A	EPA 351.3
Total Fluoride	N/A	N/A	EPA 340.2
Particle Size Distribution	N/A	N/A	ASTM D422
Microbial Count	N/A	N/A	SM 907
Atterberg Limits	N/A	N/A	ASTM D-4943-89
Total Phosphorus	N/A	N/A	EPA 365.2

(1) Practical Quantitation Limit taken from "Test Methods for Evaluating Solid Waste," USEPA, November 1986.

(2) Method Detection Limit taken from "Methods for Chemical Analysis of Water and Wastes," USEPA, 1979, Revised March 1983.

N/A - Not Applicable

10.0 DATA REDUCTION, VALIDATION AND REPORTING

10.1 Field Data Procedures

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

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

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

10.2 Laboratory Data Procedures

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

Laboratory Data Validation

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

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

- Utilization of the proper equations;
- Correctness of numerical input;
- Correctness of computations; and
- Correct interpretation of raw data (chromatographs, strip charts, etc.).

The checking process is thorough enough to verify the results.

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

Analytical Reports

The items listed below are required of analytical reports.

- Data is presented in a tabular format.

- Analytical reports are approved by appropriate laboratory personnel.

- The following information is included on the report: client name and address, report date, sample date, analysis dates, number of samples, purchase order number, project number, and project type. All pages are numbered.

- The sample numbers and corresponding laboratory numbers are identified.

- The parameters analyzed, report units, and values are identified.

- Method, trip, and field blank results are reported.

- Matrix spike, matrix spike duplicate, and replicate recoveries are reported.

- Calibration summaries are reported.
- Surrogate recoveries are reported.
- Holding times and sample analysis dates are reported.
- The detection limit of the procedure is identified.
- Consistent significant figures are used.
- Referenced footnotes are used when applicable.
- A letter of transmittal accompanies the report if any anomalies are associated with the data. The letter specifies these anomalies.

11.0 INTERNAL QUALITY CONTROL CHECKS

11.1 Field Internal Quality Control Checks

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

11.2 Types of QC Samples

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

Field Duplicates

Duplicates for soil samples are collected, homogenized, and split. All samples except VOCs are homogenized, and split. Volatiles are not mixed, but select segments of the soil are taken from the length of the core and placed in 40 ml glass vials. Cores may be sealed and shipped to the laboratory for subsampling if the project deems this appropriate. The duplicate for water samples should be collected simultaneously. Field duplicates should be collected at a frequency of 10% per sample matrix for levels IV and III. All the duplicates should be sent to the primary laboratory responsible for analysis. The same samples used for field duplicates shall be split by the laboratory and used by the laboratory as the laboratory duplicate or matrix spike. This means that for the duplicate sample, there will be analyses of the normal sample, the field duplicate, and the laboratory matrix spike/duplicate.

Equipment Rinsates

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

Field Blanks

Field blanks consist of the source water used in decontamination, steam cleaning, and drilling. At a minimum, one field blank from each vent and each source of water must be collected and analyzed for the same parameters as the related samples. Organic-free deionized water is taken to the field in sealed containers and poured into the appropriate sample containers at predesignated locations. This is done to determine if any contaminants present in the area may have an affect on the sample integrity.

Trip Blank

Analysis of trip blanks is performed to monitor possible contamination during shipment and collection of samples. Trip blanks are initiated in the laboratory prior to the shipping of sample packs. A corresponding trip blank is prepared for each set of samples to be analyzed for volatile organic compounds.

Trip blank samples are prepared by adding four drops of concentrated hydrochloric acid and then filling the container with organic-free deionized water (ASTM Type II). The trip blanks accompany the samples through shipment to the sample site, sample collection, shipment to the laboratory, and storage of the samples.

If the analyses indicate contamination of the trip blank, the sample sources may be resampled. If the extent and nature of the contamination does not warrant such actions, the data will be accepted as valid.

Method Blank

Analysis of method blanks is performed to verify that method interferences caused by contamination in reagents, glassware, solvents, etc. are minimized and known.

Method blanks are initiated by the analyst prior to the preparation and/or analysis of the sample set. A method blank consists of a volume of organic-free deionized water equal to the sample volume which is carried through the entire analytical procedure. For solid samples to be analyzed by GC/MS, the method blank consists of a purified solid matrix approximately equal to the sample weight. A method blank is analyzed with each set of samples or at the very least, daily. If the analytical data of the method blank indicates excessive contamination, the source of contaminant will be determined. The samples may be re-analyzed or the data may be processed as is depending upon the nature and extent of the contamination.

Replicate Sample Analysis

Replicate sample analysis is performed to demonstrate the precision of an analysis. An interlaboratory replicate sample is initiated by the analyst prior to sample preparation and carried through the entire analytical procedure. The frequency of interlaboratory replicate analysis for each analyte is summarized in Table 11-1.

Spike Analysis

Spike analysis is performed to demonstrate the accuracy of an analysis. The analyst initiates the spike prior to sample preparation and analysis by adding a known amount of analyte(s) to a sample. The spike sample is carried through the entire analytical procedure. The frequency of spike analysis for each analyte(s) is summarized in Table 11-1.

TABLE 11-1

QC ANALYSIS FREQUENCY

Parameter	Replicate	Spike
Organic		
All analyses by GC/MS	5%	5%
All analyses by GC	5%	5%
Metals		
Liquids by flame AA or ICP	5%	5%
Solids by flame AA or ICP	5%	10%
All analyses by furnace AA	5%	10%
General Chemistry		
Cyanide	5%	5%
Nitrate	5%	5%
Sulfide	5%	5%

Surrogate Standards

Surrogate standard analysis is performed to monitor the preparation and analyses of samples. All samples and blanks analyzed by GC/MS are fortified with a surrogate spiking solution prior to extraction or purging.

Internal Standards

Internal standard analyses are performed to monitor system stability. Prior to injection or purging, internal standards are added to all blanks and samples analyzed by GC/MS (refer to Section 5.1.1.).

Matrix Spikes and Matrix Spike Duplicates

A matrix spike is an aliquot of a matrix (water or soil) fortified (spiked) with known quantities of specific compounds and subjected to the entire analytical procedure in order to indicate the appropriateness of the method for the matrix by measuring recovery. A matrix spike duplicate is a second aliquot of the same matrix as the matrix spike that is spiked in order to determine the precision of the method. A matrix spike and matrix spike duplicate will be performed at a frequency of 1 per 20 samples for organics.

11.3 Laboratory Control Limits

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

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

Method Blanks

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

- If the concentration of the method blank is less than or equal to the detection level, no correction of sample results is performed.

- If the concentration of the blank is above the detection level for any group of samples associated with a particular blank, the concentration of the sample with the least concentrated analyte must be ten times the blank concentration. Otherwise, all samples associated with the blank and less than ten times the blank concentration must be redigested (reprepared) and reanalyzed, if possible. If the affected samples cannot be reprepared and reanalyzed within method holding times, the flagged sample result and the blank result are both to be reported. The sample value is not corrected for the blank value.

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

- A method blank for volatiles analysis must contain no greater than five times the detection limit of common laboratory solvents (common laboratory solvents are: methylene chloride, acetone, toluene, 2-butanone, and chloroform).

- A method blank for semivolatiles analysis must contain no greater than five times the detection limit of common phthalate esters.

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

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

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

Surrogate Standards

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

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

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

Corrective action will include steps listed below.

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

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

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

    - Recovery of any one surrogate compounds in the volatile fraction is outside the surrogate spike recovery limits;

    - Recovery of any one surrogate compound in either semivolatile fraction is below ten percent; or

    - Recoveries of two or more surrogate compounds in either semivolatile fraction are outside surrogate spike recovery limits.

Corrective action will include the steps listed below.

- A check of: the calculations for errors; of the internal standard and surrogate spiking solutions for degradation, contamination, etc.; and of instrument performance.
- Recalculating or reanalysis the sample or extract if the above corrective action fails to solve the problem.
- Reextraction and reanalysis of the sample if none of the above are a problem.

11.4 Quality Assurance Review of Reports, Plans, and Specifications

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

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

11.5 Laboratory Quality Assurance

Field Quality Assurance

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

TABLE 11-2

QA/QC SAMPLE FREQUENCY

Type of Sample	Metal	Organic
Trip Blank (for volatiles only)	NA(1)	One per cooler or one per shipping day
Equipment Rinsate(2)	One per day	One per day
Field Blank	One per source per event(3)	
Field Duplicate(4)	10%	10%

(1) Not Applicable

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

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

(4) The duplicate must be taken from the same sample which will become the laboratory matrix spike/matrix spike duplicate for organics or for the sample used as a duplicate in inorganic analysis.

12.0 PERFORMANCE AND SYSTEM AUDITS

A field audit will be conducted during the field investigation to verify that sampling is being performed according to the plan. A report will be submitted within 30 calendar days of completion of the audit. Serious deficiencies will be reported within 24 hours of the time of discovery of the deficiency, including actions taken or to be taken to correct such deficiencies.

The following table (Table 12-1) is used for audits. At the appropriate time, the Project Manager or Program QA/QC designee will conduct field audits.

TABLE 12-1

SYSTEM AUDIT CHECKLIST - FIELD OPERATIONS

Project No. ______________________ Date ______________________

Project Name & Location ______________________ Name & Signature of Auditor ______________________

Team Members ______________________ Name & Signature of Field Team ______________________

Yes _____ No _____ 1. Is there a set of accountable field documents checked out to the Site Manager?
Comments: ______________________

Yes _____ No _____ 2. Is the transfer of field operations from the Site Manager to field participants documented in a log book?
Comments: ______________________

Yes _____ No _____ 3. Is there a written list of sampling locations and descriptions?
Comments: ______________________

Yes _____ No _____ 4. Are samples collected as stated in the project plan or as directed by the Site Manager?
Comments: ______________________

Yes _____ No _____ 5. Are samples collected in the type of container specified in the project plan or as directed by the Site Manager?
Comments: ______________________

Yes _____ No _____ 6. Are samples preserved as specified in the project plan or as directed by the Site Manager?
Comments: ______________________

TABLE 12-1
SYSTEM AUDIT CHECKLIST - FIELD OPERATIONS
PAGE TWO

Yes _____ No _____ 7. Are the number, frequency and type of samples collected as specified in the project plan or as directed by the Site Manager?
Comments: ______________________________
____
____

Yes _____ No _____ 8. Are the number, frequency and type of measurements taken as specified in the project plan or as directed by the Site Manager?
Comments: ______________________________
____
____

Yes _____ No _____ 9. Are samples identified with sample labels?
Comments: ______________________________
____
____

Yes _____ No _____ 10. Are blank and duplicate samples properly identified?
Comments: ______________________________
____
____

Yes _____ No _____ 11. Are sample and serial numbers for samples split with other organizations recorded in a log book or on a chain-of-custody record?
Comments: ______________________________
____
____

Yes _____ No _____ 12. Are samples listed on a chain-of-custody record?
Comments: ______________________________
____
____

Yes _____ No _____ 13. Is chain-of-custody documented and maintained?
Comments: ______________________________
____
____

Yes _____ No _____ 14. Are quality assurance checks performed as directed?
Comments: ______________________________
____
____

TABLE 12-1
SYSTEM AUDIT CHECKLIST - FIELD OPERATIONS
PAGE THREE

Yes ______ No ______ 15. Are photographs documented in logbooks as required?
Comments: ______________________________

Yes ______ No ______ 16. Are all documents accounted for?
Comments: ______________________________

Yes ______ No ______ 17. Have any documents been voided or destroyed?
Comments: ______________________________

13.0 PREVENTIVE MAINTENANCE

13.1 Field Maintenance

The HNu PI-101 is to be used in site characterization and will be maintained as described by the manufacturer's instructions. The pH and specific conductance meters to be used during sampling will be maintained according to Appendix A, Field Water Quality Instruments.

13.2 Laboratory Maintenance

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

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

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

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

- Special precautions are taken to avoid spillage of corrosive chemicals on or around equipment and instrumentation not only to extend the life of the item, but also to eliminate contamination.

- Where available, covers are placed on instrumentation when not in use.

- Instrument parts are cleaned as required (i.e., mirrors, probes, detector cells).

14.0 DATA MEASUREMENT ASSESSMENT PROCEDURES

14.1 Overall Project Assessment

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

14.2 Field Quality Assessment

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

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

14.3 Laboratory Data Quality Assessment

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

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

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

- Trip Blank Evaluation - Trip blank results are evaluated for high readings similar to the method blanks described above. If high trip blank readings are encountered (i.e. a value sufficient to result in a difference in sample values, if not corrected, greater than or equal to the smallest significant digit known to be valid), procedures for sample collection, shipment, and laboratory analysis are reviewed. If both the method and the trip blanks exhibit significant background contamination, the source of contamination is probably within the laboratory. Ambient air in the laboratory and reagents are checked as possible sources of contamination.

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

- Duplicate Sample Analyses - Duplicate sample analyses are used to determine the precision of the analytical method for the sample matrix. Two types of duplicate samples are analyzed for this project, field, and interlaboratory. Duplicate results are used to calculate precision as defined by the RPD. If interlaboratory duplicate values exceeds the control limit, the sample set are reanalyzed for the parameter in question. Precision limits are updated periodically following review of data.

- Reference Sample Analyses - The results of reference sample analysis are compared with true values, and the percent recovery of the reference sample is calculated. If correction is required (excessive or inadequate percent recovery), the reference sample is reanalyzed to demonstrate that the corrective action has been successful.

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

- Matrix Spike Analyses - The observed recovery of spike versus theoretical spike recovery is used to calculate accuracy as defined by the percent recovery. If the accuracy value exceeds the control limit for the given parameter, the appropriate laboratory personnel notified and corrective action is taken before the sample set is reanalyzed for the parameter in question.

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

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

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

14.4 Laboratory Data Validation

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

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

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

15.0 CORRECTIVE ACTION

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

The following personnel are responsible for detecting and reporting nonconformances:

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

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

15.1 Corrective Action

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

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

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

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

15.2 Limits of Operation

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

16.0 QUALITY ASSURANCE REPORTING PROCEDURES

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

The Project Manager will keep in contact with the Navy Engineer-in-Charge through informal, verbal reports during the project as well as through monthly progress reports.

Appendix A
Field Water Quality Instruments

APPENDIX A

FIELD WATER QUALITY INSTRUMENTS

A. Calibration and Preventive Maintenance

Activity Before Site Visit

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

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

Activity at Site

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

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

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

B. Analytical Methods

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