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FINAL

REMEDIAL INVESTIGATION/FEASIBILITY STUDY
WORK PLAN
OPERABLE UNIT NO. 6 (SITES 36, 43, 44, 54, and 86)

MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

CONTRACT TASK ORDER 0246

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PREFACE

These Remedial Investigation/Feasibility Study Project Plans consist of a Work Plan, Field Sampling and Analysis Plan, Quality Assurance Project Plan, and a Health and Safety Plan. In accordance with discussions between the Navy/Marine Corps, USEPA Region IV, and the North Carolina DEHNR, the format of the Project Plans has been condensed to eliminate repetitive information (e.g., discussing site background information in both the Work Plan and Field Sampling and Analysis Plan, presenting identical site maps in both documents, discussing the objectives in each document, etc.). The Project Plans reflect the necessary information suggested in USEPA Guidance (OSWER Directive No. 9355.3-01).

The Work Plan focuses on the scope of work and rationale (i.e., the "what" and "why" aspects of the project). The Field Sampling and Analysis Plan focuses on how the field scope of work will be implemented. The Quality Assurance Project Plan addresses the quality assurance/quality control aspects of the field and analytical programs.

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ARARs	applicable or relevant and appropriate requirements
AST	aboveground storage tank
AWQC	ambient water quality criteria
bgs	below ground surface
bls	below land surface
BOD	biological oxygen demand
BRA	baseline risk assessment
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CLEJ	Camp Lejeune
CLP	Contract Laboratory Program
COD	chemical oxygen demand
DOD	Department of the Defense
DON	Department of the Navy
DQO	Data Quality Objective
EMD	Environmental Management Division (Camp Lejeune)
ESE	Environmental Science and Engineering, Inc.
°F	degrees Fahrenheit
FFA	Federal Facilities Agreement
FFM	Fleet Marine Force
FMF	Fleet Marine Force Atlantic
FFSG	Force Service Support Group
FSAP	Field Sampling and Analysis Plan
ft	feet
ft/ft	foot per foot
FWSV	Freshwater Screening Values
gpm	gallons per minute
GSRA	Greater Sandy Run Area
HEAST	Health Effects Assessment Summary Tables
HI	hazard index
HPIA	Hadnot Point Industrial Area
HQ	hazard quotient
IAS	Initial Assessment Study
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
LANTDIV	Naval Facilities Engineering Command, Atlantic Division
MAG	Marine Air Ground
MCAS	Marine Corps Air Station
MCB	Marine Corps Base
MCL	maximum contaminant level

mgd	millon gallons per day
mg/L	milligram per liter
msl	mean sea level
NACIP	Navy Assessment and Control of Installation Pollutants
NC DEHNR	North Carolina Department of Environment, Health, and Natural Resources
NCP	National Oil and Hazardous Substances Contingency Plan
NCWQS	North Carolina Water Quality Standard
NEESA	Naval Energy and Environmental Support Activity
NOAA	National Oceanic Atmosphere Administration
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NREA	Natural Resources and Environmental Affairs
OU	operable unit
PA	preliminary assessment
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
POL	petroleum, oil, and lubricant
POTW	publicly owned treatment works
ppb	parts per billion
ppm	parts per million
PRAP	Proposed Remedial Action Plan
PRGs	Preliminary Remediation Goals
QA/QC	quality assurance/quality control
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RfD	reference dose
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SI	site inspection
SMCL	Secondary Maximum Contaminant Level
SQC	Sediment Quality Criteria
SSV	Sediment Screening Value
STP	sewage treatment plan
TAL	Target Analyte List
TBC	To be Considered
TCE	trichloroethylene
TCL	Target Compound List
TCLP	Toxicity Characteristics Leaching Procedure
TDS	total dissolved solids
TPH	total petroleum hydrocarbon
TSS	total suspended solids

μg/L	micrograms per liter
μg/kg	micrograms per kilogram
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WAR	Water and Air Research, Inc.
WOE	weight-of-evidence

1.0 INTRODUCTION

Marine Corps Base (MCB) Camp Lejeune was placed on the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (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 (NC DEHNR), and the United States Department of the Navy (DON) entered into a Federal Facilities Agreement (FFA) for MCB, Camp Lejeune. The primary purpose of the FFA was to ensure that environmental impacts associated with past and present activities at the MCB are thoroughly investigated, and that appropriate CERCLA and Resource Conservation Recovery Act (RCRA) responses are developed and implemented as necessary to protect the public health and welfare, and the environment (MCB, Camp Lejeune FFA, 1989).

The scope of the FFA included the implementation of a Remedial Investigation/Feasibility Study (RI/FS) at thirteen Operable Units (OUs) and twenty-seven sites across MCB, Camp Lejeune. RIs will be implemented at these OUs to determine the nature and extent of the threat to the public health and welfare and 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 FSs. 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 of 1986 (SARA) and applicable State law (FFA, 1989).

This RI/FS Work Plan addresses OU No. 6 which consists of Site 36 (Camp Geiger Area Dump Near Sewage Treatment Plant), Site 43 (Agan Street Dump), Site 44 (Jones Street Dump), Site 54 (Crash Crew Fire Training Burn Pit), and Site 86 (Tank Area AS419 - AS421 at Marine Corps Air Station).

1.1 Objective of RI/FS Work Plan

The objective of this RI/FS Work Plan is to identify the tasks required to implement an RI/FS for OU No. 6 at MCB, Camp Lejeune. The various studies or investigations required to collect appropriate data are described in this Work Plan. In addition, the Work Plan documents describe the scope and objectives of the individual RI/FS activities. It serves as a tool for assigning responsibilities and establishing the project schedule and cost. The preparation and contents of the RI/FS Work Plan are based on the scoping process, which is described below.

1.2 RI/FS Scoping

Scoping is the initial planning stage of the RI/FS. The result or outcome of the scoping process is documented in the RI/FS Work Plan. Scoping begins once the background information is reviewed and evaluated, and consists of the following activities:

- Preliminary assessment of human health and environmental risks, based on existing information.
- Identifying any potential interim actions which may need to be undertaken early in the program to mitigate potential threats to the public health and environment.
- Identifying potential contaminant migration pathways.
- Identifying contaminants of potential concern.

- Identifying Federal and State Applicable or Relevant and Appropriate Requirements (ARARs).

- Define the optimum sequence of investigation activities.

- Identifying the sampling strategies for the collection of data.

- Determining the type, amount, and data quality objectives (DQOs) to assess human health and environmental risks, and to effectively evaluate feasible technologies/alternatives.

- Identifying potential technologies/alternatives for mitigating site problems.

- Identifying the remedial alternatives suitable to site conditions.

The background information available to initiate the RI/FS process included a number of existing environmental assessment reports, which are identified in Section 7.0 (References), and information collected during planning visits at each site.

As part of the scoping process, project meetings were conducted with the Atlantic Division, Naval Facilities Engineering Command (LANTDIV), MCB, Camp Lejeune Environmental Management Division (EMD), USEPA Region IV, and the NC DEHNR to discuss the proposed RI/FS scope of work for each site, and to obtain technical and administrative input from LANTDIV.

1.3 RI/FS Work Plan Format

The following elements are presented in this RI/FS Work Plan.

- Section 2.0 - Background and Setting
- Section 3.0 - RI/FS Data Quality and Sampling Objectives
- Section 4.0 - RI/FS Tasks
- Section 5.0 - Project Management and Staffing
- Section 6.0 - Project Schedule
- Section 7.0 - References

Section 2.0 discusses site-specific background information and the setting of each site. The purpose of this section is to define the physical and known environmental characteristics of each site. This section focuses on identifying potential and/or confirmed contaminant migration pathways, identifying potential (or known) impacts to public health and environment, listing Federal or State ARARs, and evaluating potential remedial technologies/alternatives for mitigating site problems.

Section 3.0 defines site-specific RI/FS data quality and sampling objectives. Data or information deemed necessary to identify migration pathways, assess environmental and human health risks, or evaluate feasibility or remedial actions are presented in this section. This data may consist of chemical analyses, hydrogeologic information, or engineering analyses. The collection methods for obtaining this information are also identified and described in general terms [more detailed descriptions of the field investigation methods are documented in the Field Sampling and Analysis Plan (FSAP)].

Section 4.0 identifies and describes the tasks and field investigation activities that will be implemented to complete the RI/FS at the sites in terms of meeting the site-specific objectives. These tasks generally follow the description of tasks identified in USEPA's RI/FS Guidance Document (OSWER Directive 955.3-01).

Section 5.0 discusses project staffing for implementing the RI/FS. The RI/FS schedule is provided in Section 6.0. References used in developing the RI/FS Work Plan are provided in Section 7.0.

2.0 BACKGROUND AND SETTING

The purpose of this section is to summarize and evaluate existing information pertaining to MCB, Camp Lejeune, OU No. 6. The analysis of existing information will provide an understanding of the nature and extent of contamination which will assist in the design of RI tasks. The current understanding of the physical setting of the sites, the history of the sites, and the existing information related to previous environmental investigative activities are described herein.

This section specifically addresses the location and setting of the sites, historical events associated with past usage or disposal activities, topography and surface drainage, regional geology and hydrogeology, site-specific geology and hydrogeology, surface water hydrology, climatology, natural resources and ecological features, and land use.

Additional background information is presented in the following documents:

- Initial Assessment Study (IAS) of Marine Corps Base Camp Lejeune, North Carolina (Water and Air Research, 1983)
- Final Site Summary Report, Marine Corps Base, Camp Lejeune (Environmental Science and Engineering, Inc. 1990)
- Hydrogeology of Aquifers in Cretaceous and Younger Rocks in the Vicinity of Onslow and Southern Jones Counties, North Carolina (U.S. Geological Survey, 1990)
- Continuous Seismic Reflection Profiling of Hydrogeologic Features Beneath New River, Camp Lejeune, North Carolina (U.S. Geological Survey, 1990)
- Assessment of Hydrologic and Hydrogeologic Data at Camp Lejeune Marine Corps Base, North Carolina (U.S. Geological Survey, 1989)
- Site Summary Inspection, Site 43 - Agan Street Dump, Marine Corps Air Station New River, Jacksonville, North Carolina (Baker Environmental, Inc., 1993)
- Site Summary Inspection, Site 44 - Jones Street Dump, Marine Corps Air Station New River, Jacksonville, North Carolina (Baker Environmental, Inc., 1993)
- Site Assessment Report, Tanks AS419-AS421, Marine Corps Air Station New River, Jacksonville, North Carolina (O'Brien and Gere, 1992)
- Technical Memorandum No. 2; Results of Field Investigation, Marine Corps Base, Camp Lejeune, North Carolina (Dewberry and Davis, 1991)

2.1 MCB, Camp Lejeune, North Carolina

This section provides an overview of the physical features associated with MCB, Camp Lejeune, North Carolina (which also includes Camp Geiger and Marine Corps Air Station [MCAS], New River).

2.1.1 Location and Setting

MCB, Camp Lejeune is located within the Coastal Plain Physiographic Province. It is located in Onslow County, North Carolina, approximately 45 miles south of New Bern and 47 miles north of Wilmington. The facility covers approximately 236 square miles. This includes the recent acquisition of approximately 64 square miles west of the facility within the Greater Sandy Run Area (GSRA) of the county. The military reservation 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 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 2-1.

The GSRA is located in the southeast portion of Onslow County, North Carolina, near the Pender-Onslow County border. The GSRA is approximately 31 miles northeast of Wilmington, North Carolina; 15 miles south of Jacksonville, North Carolina; and 5 miles northwest of the Atlantic Ocean. The GSRA is located south and west of MCB, Camp Lejeune, sharing a common boundary along Route 17 between Dixon and Verona.

The following overview of the Complex was taken from the document "Master Plan, Camp Lejeune Complex, North Carolina." The Complex consists of 12 identifiable developed areas. Of the developed areas, Hadnot Point comprises the most concentrated area of development. This area includes the organizational offices for the Host Activity and for the Headquarters, 26 Marine Amphibious Unit, as well as the Headquarters and regimental areas for the 2nd Division of the Marine Crops, 2nd Marine Amphibious Force, 6th Marine Amphibious Brigade, 22nd Marine Amphibious Unit, 24th Marine Amphibious Unit, the Central Exchange & Commissary and the Naval Dental Clinic Headquarters. Directly north of Hadnot Point are the family housing areas concentrated throughout the wooded areas of the central Complex and along the shores of the New River. Also located in this north central area are major personnel support land uses, including the newly-constructed Naval Hospital, school sites, recreational areas, as well as additional family housing areas (quarters developments, Midway Park and Tarawa Terrace I and II).

Camp Geiger and MCAS, New River are considered as a single urban area possessing two separate missions and supported by two unrelated groups of personnel. MCAS, New River encompasses 2,772 acres and is located in the northwestern section of the Complex and lies approximately five miles south of Jacksonville. The MCAS includes air support activities, troop housing and personnel support facilities, all of which immediately surround the aircraft operations and maintenance areas.

Camp Geiger, located directly north of MCAS, New River, contains a mixture of troop housing, personnel support and training uses. Currently, the area is utilized by a number of groups which have no direct relationship to one another. The majority of the land surrounding this area is comprised of buffer zones and unbuildable marshland.

MCB, Camp Lejeune contains five other areas of concentrated development, all of which are much smaller in size and population than either Hadnot Point, MCAS, New River, or the Camp Geiger area. The oldest of these is the Montford Point area, which is bounded by the New River to the south and west and by Route 24 on the north. New development in Montford Point has been limited, with most of the facilities for troop housing, maintenance, supply and personnel support having been converted from their intended uses. A majority of the Base training schools requiring classroom instruction are located here and use surrounding undeveloped areas for training operations when required. The French Creek area located directly south of Hadnot Point is occupied by the 2nd Force Service Support Group (2nd FSSG). Its activities are directed toward providing combat service and technical support as required by Headquarters, II Marine Amphibious Force. Expansion of the French Creek Complex is constrained by the Ordnance Storage Depot explosives safety arc on the south and by the regimental area of Hadnot Point. Onslow Beach, located along the Onslow Bay, east of the New River Inlet, presents assets for amphibious training as well as recreational use. Courthouse Bay is located on one of a series of small bays which are formed by the New River. This area is used for maintenance, storage and training associated with amphibious vehicles and heavy engineering equipment. The Engineering School, also located here, conducts training activities in the large open area located to the southeast of the Courthouse Bay. Another concentrated area of development is the Rifle Range. This area is located on the southwest side of the New River, is singular in purpose and has only a small number of assigned personnel. It was constructed in the early stages of Base development and is used solely for rifle qualification training. The small group of barracks, located at the Rifle Range, are used for two-week periods by troops assigned to range training.

2.1.2 History and Mission

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 36 is located in the Camp Geiger area; Sites 43, 44, 54, and 86 are located within MCAS, New River.

The MCB organization functions as the host command to the two Fleet Marine Force Atlantic (FMFLANT) tenant activities -- Headquarters of the II Marine Amphibious Division and the 2nd FSSG. The MCB host organization mission is to provide housing, training facilities, logistical support and certain administrative support for tenant units and for other units assigned to MCB, Camp Lejeune and to conduct specialized schools and other training maneuvers, as directed.

The mission of the 6th Marine Amphibious Brigade is to provide the Command element for a brigade-size Marine Air Ground Task Force (MAGTF) with the primary mission of preparing to join up with LantCom MPS equipment and to conduct subsequent combat operations.

The mission of the 2nd Marine Division is to execute amphibious assault operations, and other operations as may be directed, which are supported by Marine aviation and force service support units. With the aircraft wing, the Marine division provides combined arms for service with the Fleet in the seizure or defense of advanced naval bases and for the conduct of land operations essential to the prosecution of a naval campaign.

The mission of the 2nd FSSG is to command, administer and train assigned units in order to provide combat service and technical support as required by Headquarters FMFLANT and its subordinate command in accomplishment of the overall FMFLANT mission.

2.1.3 Previous Investigations

In response to the passage of CERCLA, the DON initiated the Navy Assessment and Control of Installation Pollutants (NACIP) program to identify, investigate, and clean up past hazardous waste disposal sites at Navy installations. The NACIP investigations were conducted by the Navy Energy and Environmental Support Activity (NEESA) and consisted of Initial Assessment Studies (IAS) and Confirmation Studies. IAS are similar to the USEPA's Preliminary Assessments/Site Investigations (PAs/SIs). Confirmation Studies are similar to USEPA's RI/FS. When SARA was passed in 1986, the DON dissolved the NACIP in favor of the Installation Restoration Program (IRP), which adopted USEPA Superfund terminology and procedures.

The IAS for MCB, Camp Lejeune was conducted by Water and Air Research, Inc., (WAR) in 1983. The IAS identified a number of sites at MCB, Camp Lejeune as potential sources of contamination, including the sites discussed in this RI/FS Work Plan. Based on historical records, aerial photographs, field inspections, and personnel interviews, the IAS identified 76 sites at MCB, Camp Lejeune as potential sources of contamination. Of these 76 sites, 27 sites warranted further investigation to assess potential long-term impacts based on contamination characteristics, migration pathways, and pollutant receptors.

Baker (1991; Sites 43 and 44) and Environmental Science and Engineering, Inc. (ESE, 1990; Sites 36 and 54) prepared Site Inspection Reports, and O'Brien and Gere (1992; Site 86) prepared a Site Assessment Report for the DON, LANTDIV, and MCB, Camp Lejeune.

2.1.4 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 MCB, Camp Lejeune is between 20 and 40 feet above msl.

Drainage at MCB, 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 MCB, Camp Lejeune is in broad, flat interstream areas. Drainage is poor in these areas (WAR, 1983).

The U.S. Army Corps of Engineers has mapped the limits of 100-year floodplain at MCB, Camp Lejeune at 7.0 feet above msl in the upper reaches of the New River (WAR, 1983); this increases downstream to 11 feet above msl near the coastal area (WAR, 1983).

2.1.5 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. 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 (ESE, 1991). Table 2-1 presents a generalized stratigraphic column for this area. Figure 2-2 shows the locations of the cross-sections within MCB, Camp Lejeune and Figure 2-3 depicts cross-sectional views of the lithologies.

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 (i.e., surficial, water-bearing layer), 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 semiconfining units which separate the aquifers and impede the flow of groundwater between aquifers. A generalized hydrogeologic cross-section illustrating the relationship between the aquifers in this area is presented in Figures 2-2 and 2-3.

2.1.6 Regional Hydrogeology

The following summary of regional hydrogeology which was originally presented in a report published by the USGS (Harned et al., 1989).

The surficial water table aquifer is comprised of a series of sediments, primarily sand and clay, which commonly extend to depths of 50 to 100 feet. The thickness of the surficial aquifer in the vicinity of MCAS, New River is less than 40 feet. This aquifer is not used for water supply at MCB, Camp Lejeune because of its low production rate.

The principal water-supply aquifer for MCB, Camp Lejeune is found in the series of sand and limestone beds that occur between 50 and 300 feet below land surface. This series of sediments generally is referred to as the Castle Hayne Formation, associated with the Castle Hayne aquifer. This aquifer is about 150 to 350 feet thick in the area and is the most productive aquifer in North Carolina.

Clay layers occur in both of the aquifers. The layers, however, are thin and discontinuous in most of the area, and no continuous clay layer separates the surficial aquifer from the Castle Hayne aquifer. The clay layers range from 5 to 30 feet thick and comprise between 15 and 24 percent of the combined thickness of the two aquifers. The clay layers appear to be thicker and more continuous in the northwestern part, particularly in the area of the MCAS. It is inferred from their generally thin and discontinuous nature that considerable leakage of groundwater occurs across and around the clay layers, particularly in the upper part of the Castle Hayne aquifer.

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

The aquifers that lie below the Castle Hayne lie in 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 MCB Camp Lejeune area and are not used.

Rainfall in the MCB Camp Lejeune area 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, groundwater 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.

The water table varies seasonally. The water table receives more recharge in the winter than in the summer when much of the water 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.

In confined aquifers, water is under excess hydraulic (i.e., head) pressure and the level to which it rises in a tightly cased well is called the potentiometric surface. The hydraulic head in a confined or semiconfined aquifer, such as the Castle Hayne, shows a different pattern of variation over time than that in an unconfined aquifer. Some seasonal variation also is common in the water levels of the Castle Hayne aquifer, but the changes tend to be slower and over a smaller range than for water table wells.

2.1.7 Surface Water Hydrology

The following summary of surface water hydrology was originally presented in the IAS report (WAR, 1983).

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 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 into the Atlantic Ocean through the New River Inlet. Several small coastal creeks drain the area of MCB, Camp Lejeune not associated with 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. The New River, the Intracoastal Waterway, and the Atlantic Ocean meet the New River Inlet.

Water quality criteria for surface waters in North Carolina have been published under Title 15 of the North Carolina Administrative Code. At MCB, Camp Lejeune, the New River falls into two classifications: SC (estuarine waters not suited for body-contact sports or commercial shellfishing) and SA (estuarine waters suited for commercial shellfishing). The SC classification applies to three areas of the New River at MCB, Camp Lejeune, including the Rifle Range area; the rest of the New River at MCB, Camp Lejeune falls into the SA classification (ESE, 1991).

2.1.8 Climatology

MCB, Camp Lejeune experiences mild winters and hot and humid summers. The average yearly rainfall is greater than 50 inches, and the potential evapotranspiration in the region varies from 34 to 36 inches of rainfall equivalent per year. The winter and summer seasons usually receive the most precipitation. Temperature ranges are reported to be 33 to 53 degrees Fahrenheit (°F) in the winter (i.e., January) and 71 to 88°F in the summer (i.e., July). Winds are generally south-southwesterly in the summer, and north-northwesterly in the winter (WAR, 1983).

2.1.9 Natural Resources and Ecological Features

The following summary of natural resources and ecological features was obtained from the IAS Report (WAR, 1983).

The Camp Lejeune Complex is predominantly tree-covered with large amounts of softwood including shortleaf, longleaf, pond, and pines (primarily loblolly), and substantial stands of hardwood species. Approximately 60,000 of the 112,000 acres of MCB, 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.

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.

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 (WAR, 1983). 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. Both recreational and commercial fishing are practiced in the waterways of the New River and its tributaries.

Wetland ecosystems at MCB, Camp Lejeune can be categorized into five habitat types: (1) pond pine or pocosin; (2) sweet gum, water oak, cypress, and tupelo; (3) sweet bay, swamp black gum, and red maple; (4) tidal marshes; and, (5) 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 MCB, 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. Deer, 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 MCB, 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 MCB, 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 ecologically sensitive coastal barrier dunes. The coastal beaches provides 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).

None of the three sites under investigation are within or in close proximity (i.e., one-half mile) to either a natural area or a protected area. Protected areas have only been established for the red-cockaded woodpecker.

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

2.1.10 Land Use and Demographics

MCB, Camp Lejeune presently covers an area of approximately 170 square miles. Military and civilian population is approximately 60,000. During World War II, MCB, 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 land 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.

The following information was extracted from the document "Master Plan, Camp Lejeune Complex, North Carolina." The existing land use patterns in the various geographic areas within the Marine Corps Base are described in this section and listed, per geographic area, on Table 2-2. The areas described below are depicted on Figure 2-1. In addition, the number of acres comprising each land use category has been estimated and provided on the table. The following is a summary of the land use area for Camp Geiger and MCAS, New River areas.

2.1.10.1 Camp Geiger

Camp Geiger, located directly north of MCAS, New River, contains a mixture of troop housing, personnel support and training facilities. Currently, the area is utilized by a number of group which have no direct relationship to one another. The majority of the land surrounding this area is comprised of buffer zones and unbuildable marshland. Site 36 is situated within the Camp Geiger area.

A mixture of old and new facilities exists at Camp Geiger, the result of which is a patchwork of land use areas arranged in a north to south configuration. The evolution of the approximately 216 acres of development has resulted in uses that are not interrelated, physically or functionally.

Supply and storage facilities, which are concentrated along the eastern edge of the developed area and in the central portion, covers about 50 acres of land. Maintenance buildings, which cover about 19 acres, are located adjacent to the supply/storage areas. Combined, supply/storage and maintenance areas account for nearly 32 percent of the developed land in Camp Geiger.

No family housing exists at Camp Geiger. Troop housing (situated on 54 acres) is located in three areas, interspersed with community and commercial facilities. Training facilities tend to be conveniently accessible by foot from troop housing although less accessible from community areas, such as the dining facilities. The 16 acres of recreational facilities are scarce in terms of number and inconvenient in terms of access.

To comprehensively evaluate existing land use in this area it is important to examine the relationship of Camp Geiger to its neighbor to the south; the MCAS, New River. Recent commercial and community development at the Curtis Road Triangle serves effectively to pull the orientation of Camp Geiger southward.

2.1.10.2 MCAS, New River

MCAS, New River encompasses 2,772 acres and is located in the northwestern section of the complex and lies approximately five miles south of Jacksonville. MCAS, New River includes air support activities, troop housing and personnel support facilities, all of which immediately surround the aircraft operations and maintenance. It is primarily a helicopter base with an increasing contingent of fixed-wing aircraft. Its present mission is to maintain and operate facilities and provide services and material to support operations of Marine Air Groups (MAG) 26 and 29, the two tenant commands which have similar missions and tasks. MCAS also supports other activities and units as designated by the Commandant of the Marine Corps in coordination with the Chief of Naval Operations. Sites 43, 44, 54, and 86 are situated within the MCAS, New River area.

2.1.10.3 Base-Wide

Present military population of MCB, Camp Lejeune is approximately 40,928 active duty personnel. The military dependent community is in excess of 32,081. About 36,086 of these personnel and dependents reside in base housing units. The remaining personnel and dependents live off base and have had dramatic effects on the surrounding area. An additional 4,412 civilian employees perform facilities management and support functions. The population of Onslow County has grown from 17,739 in 1940, prior to the formation of the base, to its present population of 121,350.

2.1.11 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 (Harned, et al., 1989).

The water supply wells are all located within the boundaries of MCB, Camp Lejeune. The average water supply well at the base has a depth of 162 feet, a casing diameter of eight inches, and yields 174 gpm (Harned, et al., 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 gpm in municipal and industrial wells in the MCB, Camp Lejeune area. The water retrieved is typically a hard, calcium bicarbonate type (Harned, et al., 1989).

The following is a summary of the supply wells within a one-half mile radius of Sites 36, 43, 44, 54, and 86:

- Site 36 - Camp Geiger Area Dump Near Sewage Treatment Plant
  - No supply wells are located within a one-half mile radius of this site.
- Site 43 - Agan Street Dump
  - No supply wells are located within a one-half mile radius of this site.
- Site 44 - Jones Street Dump
  - No supply wells are located within a one-half mile radius of this site.
- Site 54 - Crash Crew Fire Training Burn Pit
  - MCAS-5009
- Site 86 - Tank Areas AS419-AS421 at Marine Corps Air Station
  - MCAS-131
  - MCAS-203
  - MCAS-106

2.2 Site 36 - Camp Geiger Area Dump Near Sewage Treatment Plant

This section addresses the setting, site topography and drainage features, site history, and site geology and hydrology for Site 36.

2.2.1 Site Location and Setting

The Camp Geiger Area Dump (Site 36) is located east of the Camp Geiger Sewage Treatment Plant (STP), downstream of Site 35 on the Camp Geiger portion of MCB, Camp Lejeune. The site, identified by the IAS, is approximately 1.5 acres in size and is heavily wooded and vegetated. The area was identified as the Former Dump Area. Based on review of aerial photographs recently obtained and observations noted during the site visit, however, the site actually encompasses an area of approximately 16 acres. The site boundary, based on these new findings, extends south to an unnamed tributary of Brinson Creek, north of the Former Dump Area, east to a dirt road, and west to Brinson Creek. Figure 2-4 depicts a site plan for the Site 36 area.

The following provides a brief description of Site 36 field observations which were noted during the site visit from March 16 through 18, 1994. Figure 2-4 depicts the locations of the features noted during the site visit.

- The open field area was littered with piles of tree debris.
- A former berm was identified northeast of the open field area.
- On top of the berm area, the surface is flat and heavily vegetated. No stressed areas were identified.
- The southern portion of the berm is approximately 8 to 15 feet high. The northern extent is between 2 to 6 feet high.
- Buried wire and broken debris (glass, metal) were identified in the middle of the dirt road near the northern portion of the berm area.
- A dismantled former structure was noted in aerial photographs near the edge of Brinson Creek. The structure is gone, but the concrete foundation was noted. General litter was observed throughout.
- A small pile of yellow spiractor sand (i.e., filter sand) was noted along the main access road.
- All five existing monitoring wells were located during the site visit (the location of 36GW01 was inaccurately located on existing figures).
- Another area of concern identified from the aerial photographs was noted to be southwest of the Form Dump Area. During the site visit, a formerly cleared area was identified. It had stressed vegetation. North of this area, a few buried drums were noted along with several mounds of construction debris. Portions of this area were swampy.
- 55-gallon drums and 5-gallon pails were identified south of the area where the unnamed tributary crosses the main access road. The material in the drums could not be identified. However, material in the pails were identified as "alkaline material" and "lubrication oil."

2.2.2 Site Topography and Drainage

The natural topography at Site 36 is relatively flat. Ground surface elevations are between 2 to 15 feet above grade (ESE, 1990). In general, the ground surface is higher within the central and northern portions of the site and gently slope south toward the unnamed tributary. Manmade soil bermed areas are located near the western and southern portions of the site which rise to approximately 8 to 15 feet above grade.

Drainage at the site is influenced by two surface water bodies. Surface water runoff within the southern portion of the site appears to drain into the unnamed tributary which flows east into Brinson Creek. The area adjacent to the tributary was noted to be swampy. Brinson Creek appears to influence surface water drainage primarily within the northern portion of the site. This creek eventually flows into the New River.

2.2.3 Site History

Site 36 was used for the disposal of municipal wastes and mixed industrial wastes including garbage, trash, waste oils, solvents, and hydraulic fluids from the air station from the late 1940s to the late 1950s. Approximately 10,000 to 15,000 gallons of solvents and oils may have been disposed at Site 36. Most of the material was first burned and then buried, however, some unburned material was buried. Disposal records state that all waste solvents and oils were burned at the site (ESE, 1990).

2.2.4 Site Geology and Hydrogeology

According to information obtained during the WAR (1984) and ESE (1986 and 1987) investigations, the site is underlain primarily by silty sand, with layers of silty clayey sand, clay, and coarse sand. Groundwater was encountered within the silty sand at depths ranging from 4.23 to 5.02 feet below ground surface (bgs). Shallow groundwater flow direction at the site was determined to be toward the east in the direction of Brinson Creek.

2.2.5 Summary of Previous Investigations

A SI was performed in 1984 by WAR. Additional investigations of the site occurred in 1986 and 1987 by ESE. Figure 2-5 presents the locations of the sampling points for all media (groundwater, surface water, and sediments) investigated during the SIs and analytical results. Note that only those concentrations which exceeded state and/or federal standards are presented on the figure.

2.2.5.1 Groundwater

Five shallow groundwater monitoring wells (20 to 25 feet in depth with 15-foot long screen lengths) were installed at Site 36, four in 1984 and one in 1986. Based on the figure presented in the ESE 1990 report, it appears that the screens on the monitoring wells were installed below the water table. Well 36GW01 was placed on the southern side of the disposal area (disposal area identified on the figure as "Former Dump Area"). Wells 36GW02 and 36GW03 were placed on the east and northeast sides of the disposal area between the disposal area and Brinson Creek. Well 36GW04 was installed as an upgradient well approximately 300 feet to the west (upgradient) of the disposal area. Well 36GW05 was placed to the west of the site as an additional upgradient monitoring point. The samples from these monitoring wells were analyzed for the following target compounds:

- Cadmium (total)
- Chromium (total)
- Hexavalent chromium (1986/87 only) (total)
- Lead (total)
- Volatile organic compounds (VOC)
- Oil and grease (O&G)
- Total phenol
- Ethylene dibromide (EDB) (1986/87 only)
- Xylenes (1986/87 only)
- Methyl ethyl ketone (MEK) (1986/87 only)
- Methyl isobutyl ketone (MIBK) (1986/87 only)

Cadmium, chromium, lead, and phenols were detected in all four monitoring wells in July 1984. The detected concentrations in all four monitoring wells were similar, including well 36GW04, the upgradient well. The concentrations of cadmium, chromium, and lead in all four wells exceeded North Carolina Water Quality Standards (NCWQS) and/or Federal Maximum Contaminant Levels (MCLs). Well 36GW04 was the only well that indicated detectable levels of VOCs. Low levels of trans-1,2-dichloroethene (2.0 μg/L)

2.2.5.2 Surface Water

Four surface water samples were collected in 1986: two from Brinson Creek, one upstream and one downstream, and two from the unnamed creek (one upstream and one downstream). These samples were analyzed for the same target compounds as the groundwater. Detectable levels of trans-1,2-dichloroethane (2.5 µg/L), lead (39 µg/L), and total phenols (4 µg/L) were detected in the unnamed creek upstream sample (36SW03). This small stream passes through the southern portion of the filled area. Lead (33.1 µg/L) was also detected in the upstream sample 36SW01 from Brinson Creek at a concentration which is above the state freshwater standard of 25 µg/L.

2.2.5.3 Sediment

Four sediment samples were collected in 1986 at the same locations as surface water samples. The sediment sample were analyzed for the following parameters:

- Cadmium
- Lead
- Total Phenols
- Hexavalent Chromium
- Chromium
- O&G
- EDB

Chromium, lead, O&G, and phenols were detected in all four sediment samples. Cadmium was detected in one sample (36SE04). Table 2-4 presents the analytical results for sediment.

2.3 Site 43 - Agan Street Dump

This section addresses the setting, site topography and drainage features, site history, and site geology and hydrogeology for Site 43. The information presented in this section was obtained from the 1983 WAR IAS and the 1991 Baker SI.

2.3.1 Site Location and Setting

Site 43 is located at MCAS, New River to the southeast of the Camp Geiger area (see Figure 2-1). The site is located about one mile north of the main entrance to MCAS, New River and one mile west of the runway. It is a level area approximately 11 acres in size. Site 43 is located off of Agan Street and adjacent to an abandoned sewage disposal facility. To the immediate north of the site is Edwards Creek. Straw Horn Creek, which discharges into Edwards Creek, borders the site to the east and south. Edwards Creek discharges into the New River approximately one-half mile north of the site. Marshes are present in and around most of the site. Much of the area is heavily overgrown and wooded with various narrow dirt roads present throughout the site.

The following provides a brief description of Site 43 field observations which were noted during the site visit from March 16 through 18, 1994. Figure 2-6 depicts the locations of the features noted during the site visit.

- The three existing monitoring wells had been vandalized and need ~~to be~~ replaced.
- The area immediately south of the access road was extremely swampy - could not enter.
- Standing water was observed along both sides of the access road along the southern and eastern portions of the site.
- The area between the access roads was flat and vegetated with pine trees. No visible area of concern was identified.
- The areas south-southeast of well 43GW02 contained numerous soil mounds. Drums were also identified in one area.

- The three existing monitoring wells had been vandalized and need to be replaced.
- The area immediately south of the access road was extremely swampy - could not enter.
- Standing water was observed along both sides of the access road along the southern and eastern portions of the site.
- The area between the access roads was flat and vegetated with pine trees. No visible area of concern was identified.
- The areas south-southeast of well 43GW02 contained numerous soil mounds. Drums were also identified in one area.
- The area east of well 43GW03 was swampy.
- The area north of well 43GW03 contained concrete debris, and a small area of buried 5-gallon containers.
- The area north and west of well 43GW01 contained soil mounds and construction rubble. A red-cockaded woodpecker (an endangered species) was identified in this area near Edwards Creek.

2.3.2 Site Topography and Drainage

Site 43 is a relatively flat area bounded on the north by Edwards Creek and on the south and east by Straw Horn Creek. Site elevation ranges from 0 to 6 feet above msl. The site is bounded on the north, east, and south by wooded marsh and swamp areas. The local high elevation is 15 feet above msl to the west of the site, with elevations continuously decreasing to Edwards and Straw Horn Creeks.

Stormwater runoff from the site generally drains radially (i.e., away from the site), towards Edwards and Straw Horn Creeks. The area was partially flooded during the field investigation due to frequent periods of heavy precipitation. Due to low elevation, the creeks and adjacent marshes are likely influenced by the tide.

2.3.3 Site History

Boards, trash, fiberglass and sewage treatment plant (STP) sludge reportedly were disposed on the ground surface. The years of operation are unknown (Halliburton/NUS, 1991). It is reported that minor quantities of solid wastes and possibly petroleum, oil, and lubricants (POL) wastes may also have been disposed on site. However, the type and quantity of the wastes are not known.

2.3.4 Site Geology and Hydrogeology

Five soil borings and three monitoring wells were installed at Site 43 during the Baker investigation. The maximum depth of drilling was 12 feet bgs. The soils encountered generally consists of one foot of humic material underlain by gray to brown, medium-grained sand. The humic material may be a result of frequent flooding in the area. The estimated density, calculated from the hammer blows during drilling, ranged from very loose to medium dense, with the majority of the samples falling in the medium dense range. No debris was encountered in any of the soil samples.

Groundwater was encountered during drilling operations at depths ranging from 0.9 to 6.0 feet bgs. Based upon topographic conditions and static water levels, shallow groundwater flow emanates radially from the site in the direction of the Edwards and Straw Horn Creeks.

2.3.5 Summary of Previous Site Investigations

An IAS was conducted in 1983 by WAR. The IAS concluded that only construction debris was burned on site and no hazardous waste activities occurred.

A SI was conducted in 1991 by Baker Environmental; sampling and chemical analysis was performed on soil, groundwater, surface water and sediments. Following is a summary of the contaminants that were detected in the media sampled. Figure 2-7 shows the sampling locations and presents the results of the Baker investigation.

2.3.5.1 Soil

Polynuclear aromatic hydrocarbons (PAHs) were detected in one surface soil sample (less than 2 parts per million [ppm] total PAH) at location 43GW01. PAHs may be present in this area of the site since two downgradient sediment samples also exhibited low levels of PAHs. No other area of the site exhibited similar organic soil contamination. None of the chemicals detected exceeded USEPA Region III risk-based concentrations (RBCs), however various inorganic contaminants such as barium, copper, manganese, nickel, and calcium exceeded twice the base-specific background levels in one or more samples. No inorganic level exceeded regional background values. Table 2-5 presents the organic soil analytical results and a comparison to risk-based concentrations. Table 2-6 presents the inorganic soil analytical results and comparison to twice the background concentrations.

2.3.5.2 Groundwater

Groundwater was not contaminated with PAHs even at the location where PAHs were observed in soil. This is likely due to the "immobile" nature of PAHs. The only organic contaminant present in groundwater is carbon disulfide. This contaminant was not detected in any other medium. Beryllium, cadmium, chromium, lead, iron, manganese, and nickel (all total metals) were detected in concentrations which exceeded either Federal MCLs and/or NCWQS. Table 2-7 presents the groundwater analytical results.

2.3.5.3 Surface Water

Copper, iron, lead, manganese, and zinc were detected in surface water above state and/or federal standards. Based on these standards, aquatic life could potentially be adversely impacted. Benzoic acid (a semivolatile organic compound) was the only organic contaminant detected in the surface water samples. There is no state water quality standard, federal Ambient Water Quality Criteria (AWQC), or Freshwater Water Quality Screening Value (FWSV) for benzoic acid. Table 2-8 presents the surface water analytical results.

2.3.5.4 Sediments

PAHs may have migrated via surface runoff into Edwards Creek and the low-lying marsh areas. PAHs were detected at the confluence of Edwards Creek and Straw Horn Creek, just downgradient from the soil sample location where PAHs were detected at the surface. Along with the occurrences of PAHs at two of the five sediment sampling locations, the pesticides 4,4-DDE and 4,4-DDD were present in low concentrations (less than 580 micrograms per kilogram [μg/kg]) at three locations. No pesticides were detected in soil, groundwater, or surface water. The pesticides may be associated with historical mosquito control practices. (Low pesticide levels have been detected in most streams and creeks throughout MCB, Camp Lejeune.)

Sediment screening values for the protection of biota were exceeded by lead and zinc levels in sediment. The concentrations of these contaminants fall in the range as potentially causing "possible" adverse effects on biota. The pesticides detected in the sediment were at levels where adverse effects on biota are "probable." Table 2-9 presents the sediment analytical results.

2.4 Site 44 - Jones Street Dump

This section addresses the setting, site topography and drainage features, site history, and site geology and hydrogeology for Site 44. The information presented in this section was obtained from the 1983 WAR IAS and the 1991 Baker SI.

2.4.1 Site Location and Setting

The Jones Street Dump site is located at MCAS, New River. MCAS is situated west of the New River in the northwestern section of MCB, Camp Lejeune (see Figure 2-1). The site is located behind Jones Street in a base-housing area of MCAS, just to the south of the Camp Geiger Area. It is less than one-quarter mile north of the housing area, and is approximately five acres in size. The center of the site is a level open field covered by weeds and small trees, and is bordered by base residential housing on the south and west and mature forest (deciduous and coniferous) on the north and east.

The following provides a brief description of Site 44 field observations which were noted during the site visit from March 16 through 18, 1994. Figure 2-8 depicts the locations of the features noted during the site visit.

- The formerly cleared area now contains young pine trees and grass (not typical woods vegetation).
- Northeast of the cleared area, a stagnant area was noted near Edwards Creek.
- General litter was evident throughout the site.
- The backyards to several houses are immediately adjacent to the site; yielding easy access to the site.
- The area south and southwest of well 44GW02 appeared to have several areas of ponded water - swampy.
- A vehicle engine (Honda) was disposed in a drainage ditch in the southeast portion of the site.
- The eastern portion of the site was very swampy.

2.4.2 Site Topography and Drainage

Ground surface around Site 44 slopes gently from approximately 15 feet above msl to Edwards Creek where the ground surface elevation is approximately 5 feet above msl. Stormwater runoff appears to drain north to Edwards Creek. Edwards Creek and a holding pond west of the site are the only surface waters near Site 44. Due to the sloping of the local surface contours, stormwater runoff would tend to drain to Edwards Creek and not towards the holding pond. Edwards Creek runs east and north to eventually drain into the New River approximately 6,000 feet from Site 44. The 100-year floodplain boundary is approximately 4 feet msl at Site 44. Therefore, portions of the site near Edwards Creek are within the floodplain.

2.4.3 Site History

The dump was reportedly in operation in the 1950s, and received mainly debris, cloth, boards, and paint cans. It is reported that minor quantities of potentially hazardous materials (possibly POL wastes) may also have been disposed of on site. However, the type and quantity of the wastes are not known.

2.4.4 Site Geology and Hydrogeology

Six soil borings and three shallow monitoring wells were drilled and installed during the Baker investigation. The maximum depth drilled was 15 feet. The subsurface soils encountered consisted primarily of fine sands and clays with the top foot of material being humic matter. The consistency of the clay soils encountered ranged from medium stiff to stiff. The sand encountered ranged from loose to medium dense. Debris was found in some of the samples obtained during drilling including metal, cement, and wood chips (44GW03); brick, wood, and plastic chips (44SB06); and a black soil that had an odor similar to motor oil (44GW01).

During the advancement of test borings and monitoring well boreholes, water was encountered at depths ranging from approximately 3.3 feet to 8.4 feet bgs. The estimated groundwater flow direction beneath the site is to the northeast toward Edwards Creek.

2.4.5 Previous Investigations and Findings

An IAS was conducted in 1983 by WAR. The IAS concluded that construction debris and minor quantities of potentially hazardous waste were disposed of at the dump.

A SI was conducted in 1991 by Baker Environmental; sampling and chemical analysis was performed on soil, groundwater, surface water, and sediments. The following is a summary of the contaminants that were detected in the media sampled. Figure 2-9 shows the sampling locations and presents the results of the Baker investigation.

2.4.5.1 Soil

The soil at Site 44 exhibited primarily inorganic contamination. Lead, chromium, manganese, and other heavy metals were detected above twice the average base-specific background levels. Only copper exceeded regional background levels. Nonmetallic inorganics such as arsenic were also present above twice the average base-specific background levels. The primary organic contaminants detected on site included low levels of PAHs and the pesticide 4,4-DDD in one subsurface sample and low levels of the pesticide 4,4-DDE in one surface soil sample. No one group of organics was highly distributed in site soils. Table 2-10 presents the organic soil analytical results and a comparison to risk-based concentrations. Table 2-11 presents the inorganic analytical results and a comparison to base-specific background concentrations.

2.4.5.2 Groundwater

Various inorganic compounds were detected in groundwater above state groundwater protection standards and federal drinking water standards. Shallow groundwater is not utilized as a potable water supply. Water supply wells located within a one-half mile radius of the site obtain water from the deeper portion of the Castle Hayne aquifer at depths greater than 160 feet. Four of the five supply wells within a one-half mile radius of the site are operational; however, one supply well (MCAS-106) has been shut down due to trichloroethylene (TCE) contamination. The TCE contamination is not believed to be associated with past disposal practices at the site since: (1) TCE was not detected at Site 44; (2) the well is located approximately one-quarter mile from the site; and (3) the well is located near Site 86 (Tank Area AS-419-AS421 at MCAS) and Site 54 (Crash Crew Fire Training Burn Area), which have documented solvent usage.

Low levels of PAHs (153 μg/kg of total PAHs) were detected in monitoring well 44GW03. The PAHs could be due to suspended soil particles in the sample. It is uncertain whether "dissolved" PAHs are in groundwater since the duplicate of this sample did not contain PAH constituents. Low levels of toluene and ethylbenzene (below state or federal standards) were detected in monitoring well 44GW01. Table 2-12 presents the groundwater analytical results.

2.4.5.3 Surface Water and Sediment

Surface water samples collected from Edwards Creek exhibited low levels of inorganic contamination including arsenic, chromium, iron, lead, copper, and zinc. Sediment samples exhibited slightly elevated levels of copper, lead, and zinc. Trace levels of pesticides and semivolatile constituents were also detected in sediments. Tables 2-13 and 2-14 present the analytical data for surface water and sediment, respectively.

2.5 Site 54 - Crash Crew Fire Training Burn Pit

This section addresses the setting, site topography and drainage features, site history, and site geology and hydrogeology for Site 54. The information presented in this section was obtained from the 1983 WAR IAS and the 1986 and 1987 ESE SI.

2.5.1 Site Location and Setting

Site 54 is an approximately 1.5 acre site within MCAS, New River (Figure 2-1). It is located adjacent to the southwest end of Runway 5-23 near Building 3614. The burn pit is located in the center of the site. To the northwest of a pit is an aboveground storage tank which is reported to contain No. 2 fuel oil. An oil/water separator, which is used to temporarily store spent fuel, is located southeast of the pit. Further, a drainage ditch is located south of the pit and extends away toward existing well 54GW03.

The following provides a brief description of Site 54 field observations which were noted during the site visit from March 16 through 18, 1994. Figure 2-10 depicts the locations of the features noted during the site visit.

- Fuel odor very evident while standing north of the burn pit.
- Fuel sheen on the standing water in the burn pit.
- A concrete bermed area was noted northwest of the burn pit. Rusted rings on the concrete seem to indicate that this area may be used for container storage.
- A concrete bermed area was noted east of the burn pit. The bermed area contained some burnt debris. The condition of the concrete berm (curb) is deteriorating.
- A new grass area was identified southwest of the burn pit. This had a rectangular patch of bright green grass. Very noticeable.
- A stressed area - rectangular - was identified adjacent to the new grass area. This may have been used as a burn area.
- The area of the site along Perimeter Road was found to have broken glass, and metal debris scattered into the ground. A small spill area (2 feet by 4 feet) was also identified in this area.

2.5.2 Site Topography and Drainage

The topography around Site 54 is somewhat variable. Ground surface elevations range from 25 feet above msl near the center of the site to 5 feet above msl to the west. The ground surface slopes away from the central portion (burn pit area) to the south, southeast, southwest. In general, the ground surface is essentially flat near the central portion and northward.

Surface water drainage at the site is influenced by drainage ditches which extend away from the central portion of the site toward the south. The ditches originate just south of the burn pit and appear to channelize surface water runoff (during heavy precipitation) from the pit. During the site visit, however, surface water was not noted in the ditches.

2.5.3 Site History

This area is believed to have been used since the mid-1950s for crash crew training. It is still actively used for training. Fuels (principally JP-type and possibly leaded fuels) and waste fuels were used in the training exercises. Originally the training was conducted on the ground surface. Later a burn pit was used, which was lined with asphalt around 1975.

2.5.4 Site Geology and Hydrogeology

According to information obtained during the WAR and ESE investigations, the site is underlain primarily by silty sand and silty gravelly sand, with discontinuous layers of coarse sand and clay. Groundwater was encountered within the silty sand and coarse sand units at depths ranging from 0.8 to 10 feet bgs. A moderate groundwater gradient of 0.037 was calculated. The direction of shallow groundwater flow was determined to be toward the south.

2.5.5 Summary of Previous Site Investigations

An IAS was conducted in 1983 by WAR and a SI was conducted in 1986 and 1987 by ESE. The following is a summary of the contaminants that were detected in the media sampled during both investigations. Figure 2-11 shows the sampling locations and presents the results of the ESE investigation.

2.5.5.1 Soils

During the 1984 investigation, nine soil borings were hand augered in the vicinity of the burn pit area. The results of the soil boring investigation indicated that contamination by waste POL underlies the site to the east and southeast of the burn pit. This was evidenced by a fuel odor detected during augering in these areas. In addition, during periods of high rainfall, quantities of waste POL have been observed to seep from the ground into the drainage ditches.

2.5.5.2 Groundwater

One shallow monitoring well was installed during the initial site investigation in 1984. Groundwater samples from the shallow well (54GW01) and Supply Well 5009 were collected and analyzed for: cadmium, chromium, lead, O&G, VOCs, and total phenols. The July 1984 results indicated that chromium, O&G, and phenols were detected in well 54GW01, but only phenols were detected in the Supply well 5009. No VOCs were detected in either of the 1984 samples.

Two additional shallow monitoring wells (54GW02 and 54GW03) were installed during the 1986 investigation, one upgradient and one downgradient of 54GW01. Samples were collected from these two new wells and the existing shallow well and analyzed for the following chemicals:

- Cadmium (total)
- Chromium (total)
- Hexavalent Chromium (total)
- Lead (total)
- O&G
- VOCs
- Total Phenols
- Xylenes
- Methyl ethyl ketone
- Methyl isobutyl ketone
- Ethylene dibromide

Table 2-15 presents the analytical results from the 1984, 1986, and 1987 sampling efforts.

The 1986 and 1987 results indicate that the samples collected from upgradient well 54GW02 contained both total chromium and hexavalent chromium. The sample collected in 1987 also detected lead (27 $\mu g/L$). At least one of the samples collected from downgradient monitoring well 54GW03 also contained levels of chromium and hexavalent chromium. O&G was documented in each of the samples collected with concentrations ranging from 1000 to 3000 $\mu g/L$. The groundwater sample collected from well 54GW01 contained the same compounds as in the 1984 sampling effort, chromium, O&G and phenols. None of the groundwater samples collected during the 1986/87 sampling investigation contained VOCs.

2.5.5.3 Surface Water/Sediment

Three surface water and sediment locations along the drainage ditch southeast and southwest of the pit were sampled during the 1986 sampling effort (Figure 2-11). The surface water samples were analyzed for the same compounds as the groundwater. Sediment samples were analyzed for cadmium, chromium, hexavalent chromium, lead, O&G, total phenols, and ethylene dibromide.

Total phenols were detected at a concentration of 3.0 $\mu g/L$ surface water sample 54SW1 (collected from the ditch along the southeast side of the site).

Analytical results for the three sediment samples were presented in Table 2-16. All three of the samples contained chromium, O&G, and total phenols. The two upstream samples also contained lead. None of the samples contained VOCs.

2.6 Site 86 - Tanks AS419-AS421 at Marine Corps Air Station

This section addresses the setting, site topography and drainage features, site history, and site geology and hydrogeology for Site 86. The information presented in this section was obtained from the 1990 Dewberry and Davis tank closure report, and the 1992 O'Brien and Gere site assessment.

2.6.1 Site Location and Setting

Site 86 is located at MCAS, New River, North Carolina (see Figure 2-1). The site is located on the southwest corner of Foster Street and Campbell Street. Two hundred feet to the south is the MCAS fire station (Building AS502). Approximately 800 feet beyond the fire station, to the south, lies the Air Station's taxiway. To the west lie large machinery buildings, aircraft hangers and the Base commissary building. Across Foster Street, to the east, is an area under construction with plans to build a new aircraft hanger. Farther to the east (approximately 4,000 feet), the nearest surface water body is the New River. To the north of the site are administrative buildings.

The following provides a brief description of Site 86 field observations which were noted during the site visit from March 16 through 18, 1994. Figure 2-12 depicts the locations of the features noted during the site visit.

- The location of the former ASTs are not easily identifiable due to re-vegetation.
- A fenced-in transformer area is located at the northeast corner of the site.
- Overhead steam pipelines perimeter 3 sides of the site.
- Only one area of stressed vegetation was noted. This was a small rectangular area east of the former tank locations.

2.6.2 Site Topography and Drainage

The topography at Site 86 is relatively flat with a ground surface elevation at approximately 15 feet above msl. The ground surface is slightly sloped to the south. Surface water runoff at the northern portion of the site flows into storm water drains located along Campbell Street. Within the southern portion of the site, surface water runoff appears to flow to the south based on ground surface topography.

2.6.3 Site History

Three 25,000 gallon aboveground storage tanks (ASTs) (AS419, AS420, and AS421) were installed in 1954 for storage of #6 fuel oil and used for such until 1979. From 1979 until 1988 the tanks were reportedly used for waste oil storage. The tanks were emptied in 1988, and are believed to have been removed in 1992.

2.6.4 Site Geology and Hydrogeology

According to information obtained from the O'Brien and Gere site assessment study, Site 86 is underlain (upper 30 feet of sediments) by silty sand, silty clay, and sandy clay. At a depth of approximately 26 feet bgs, a calcareous, fossiliferous, very compacted gravelly sand was reported. Groundwater was encountered at approximately 6 to 8 feet bgs within the sandy clay soil.

Site hydrogeologic conditions were evaluated by monitoring groundwater levels and conducting in-situ permeability tests. Surficial [measured within the shallow wells (15 feet in depth) groundwater was determined to flow in a radial pattern skewing away from the former tank area to the east; deeper groundwater [measured within the deep wells (30 feet in depth)] was determined to flow to the northeast. An average hydraulic conductivity, evaluated for soils within the upper 30 feet, was calculated to be 6.6 gallons/day/squared feet (gpd/ft^2).

2.6.5 *Summary of Previous Site Investigations*

Preliminary site investigations were conducted in November 1990 by Dewberry and Davis. This investigation included soil borings in the area of the tanks as shown on Figure 2-13. Eleven soil samples were analyzed for total petroleum hydrocarbons (TPH). Results from two soil samples are as follows:

- Sample NRSB-5, near the valves on the west sides of the tanks, 1-2 feet below grade. 211 ppm diesel, 7000 ppm total TPH.
- Sample NRSB-7, near the valves on the east sides of the tanks, 0.5-2 feet below grade. 70 ppm diesel, 4 feet was 200 ppm total TPH.

Results of the other nine soil boring samples were below the detection limit of 10 ppm. Soil samples analyzed for VOCs (34 priority pollutants; USEPA Method 8010/8020) yielded 0.006 ppm chloroform, 0.03 ppm methylene chloride, 0.035 ppm 1,1,1-trichloroethane, and 0.061 ppm 1,1,2-trichlorotrifluoroethane. Dewberry & Davis concluded that, based on the locations and concentrations of the detected compounds, the results are likely related to localized surface spills.

The tanks were surrounded by an earthen berm. Ground cover at Site 86 is grassy. The surrounding area cover consists of buildings and pavement. The tanks were connected by piping and a hose to a small building which likely served as a pump house. A storm water drainage ditch runs around the outside of the site. Steam lines are located overhead around the perimeter of the site.

In 1992, a site assessment was conducted by O'Brien and Gere. The following is a summary of the contaminants that were detected in the media sampled. Figure 2-13 shows the sampling locations and presents the results of the O'Brien and Gere investigation.

2.6.4.1 Soil

Two soil samples from each of the four soil borings (located "over" the former AST area) and two soil samples from each of the seven deep monitoring wells were selected for laboratory analyses of TPH. Deep soil samples were collected at the water table (14-16 depth), and shallow samples were collected five feet above the water table (9-11 depth). Five deep soil samples (GW01, GW04, GW06, GW08, and GW12) were analyzed for flashpoint and pH. Two deep soil samples (GW02 and GW06) were selected for full-scan toxicity characteristic leaching procedure (TCLP) analyses.

The pH results ranged form 4.8 to 7.6; flashpoint tests were negative; the TCLP results were below USEPA regulatory criteria for this procedure.

Soil TPH results were below the North Carolina action level of 10 mg/kg for 21 of the 22 samples. The TPH concentration from boring 86SB02, at a depth of 4 to 6 feet, was 125 mg/kg.

Positively detected concentrations ranged from 1.13 to 4.06 mg/kg. One sample (86SB02, 4-6) yielded results exceeding the North Carolina criterion of 10 mg/kg. Results of the sample from 86SB02 at 8 to 10 feet were below the detection limit.

2.6.4.2 Groundwater

Eight organic compounds were detected in the groundwater samples:

benzene	trichloroethylene
toluene	perchloroethylene
1,1-dichloroethane	chloroethane
1,2-dichloroethylene	1,1,1-trichloroethane

Of these, benzene, trichloroethylene (TCE) and perchloroethylene (PCE) were detected above their corresponding NCWQS in one or more samples. Toluene and 1,1,1-trichloroethane were detected below the NCWQS. 1,1-dichloroethane, 1,2-dichloroethylene, and chloroethane do not have groundwater standards established by North Carolina. Table 2-17 summarizes the groundwater analytical results.

SECTION 2.0
TABLES

TABLE 2-1

GEOLOGIC AND HYDROGEOLOGIC UNITS IN THE
COASTAL PLAIN OF NORTH CAROLINA
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MCB CAMP LEJEUNE, NORTH CAROLINA

GEOLOGIC UNITS			HYDROGEOLOGIC UNITS
System	Series	Formation	Aquifer and Confining Unit
Quaternary	Holocene/Pleistocene	Undifferentiated	Surficial Aquifer
Tertiary	Pliocene	Yorktown Formation[1]	Yorktown Confining Unit
			Yorktown Aquifer
	Miocene	Eastover Formation[1]	
		Pungo River Formation[1]	Pungo River Confining Unit
			Pungo River Aquifer
		Belgrade Formation[2]	Castle Hayne Confining Unit
	Oligocene	River Bend Formation	Castle Hayne Aquifer
	Eocene	Castle Hayne Formation	
			Beaufort Confining Unit[3]
	Palocene	Beaufort Formation	Beaufort Aquifer
			Peedee Confining Unit
Cretaceous	Upper Cretaceous	Peedee Formation	Peedee Aquifer
		Black Creek and Middendorf Formations	Black Creek Confining Unit
			Black Creek Aquifer
			Upper Cape Fear Confining Unit
		Cape Fear Formation	Upper Cape Fear Aquifer
			Lower Cape Fear Confining Unit
			Lower Cape Fear Aquifer
	Lower Cretaceous[1]	Unnamed Deposits[1]	Lower Cretaceous Confining Unit
			Lower Cretaceous Aquifer[1]
Pre-Cretaceous Basement Rocks		--	--

(1) Geologic and hydrologic units probably not present beneath Camp Lejeune.
(2) Constitutes part of the surficial aquifer and Castle Hayne confining unit in the study area.
(3) Estimated to be confined to deposits of Paleocene age in the study area.
Source: USGS, 1989.

TABLE 2-2

LAND UTILIZATION: DEVELOPED AREAS ACRES/LAND USE (PERCENT)
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MCB, CAMP LEJEUNE, NORTH CAROLINA

Geographic Area	Oper.	Training (Instruc.)	Maint.	Supply/ Storage	Medical	Admin.	Family Housing	Troop Housing	CM	CO	Recreat.	Utility	Total
Hadnot Point	31 (2.9)	15 (1.4)	154 (14.3)	157 (14.4)	10 (0.9)	122 (11.3)	22 (2.0)	196 (18.1)	115 (10.7)	36 (3.3)	182 (16.9)	40 (3.7)	1,080 (100)
Paradise Point	1 (0)		3 (0.4)	1 (0)			343 (34)	19 (1.9)	31 (3.1)		610 (60.4)	2 (0.2)	1,010 (100)
Berkeley Manor/ Watkins Village							406 (80)		41 (8.1)	1 (0.2)	57 (11.2)	2 (0.5)	507 (100)
Midway Park		1 (0.4)		2 (0.7)		2 (0.7)	248 (92.2)		8 (3.0)	3 (1.1)	4 (1.5)	1 (0.4)	269 (100)
Tarawa Terrace I and II			3 (0.5)			1 (0.3)	428 (77.4)		55 (9.9)	11 (2.0)	47 (8.5)	8 (1.4)	553 (100)
Knox Trailer							57 (100)						57 (100)
French Creek	8 (1.4)	1 (0.2)	74 (12.7)	266 (45.6)	3 (0.5)	7 (1.2)		122 (20.9)	22 (3.8)	6 (1.0)	74 (12.7)		583 (100)
Courthouse Bay		73 (28.6)	28 (10.9)	14 (5.5)		12 (4.7)	12 (4.7)	43 (16.9)	15 (5.9)	4 (1.6)	43 (16.9)	11 (4.3)	255 (100)
Onslow Beach	6 (9.8)	1 (1.6)	3 (4.8)	2 (3.2)	1 (1.6)	2 (3.2)		2 (3.2)	12 (19.3)		25 (40.3)	8 (13.0)	62 (100)
Rifle Range		1 (1.3)	1 (1.3)	7 (8.8)	1 (1.3)	5 (6.3)	7 (8.8)	30 (37.5)	5 (6.3)	1 (1.3)	9 (11.3)	13 (16.3)	80 (100)
Camp Geiger	4 (1.9)	15 (6.9)	19 (8.8)	50 (23.1)		23 (10.6)		54 (25.0)	27 (12.5)	2 (1.0)	16 (7.4)	6 (2.8)	216 (100)
Montford Point	6 (2.6)	48 (20.5)	2 (0.9)	4 (1.7)	2 (0.9)	9 (3.9)		82 (35.2)	20 (8.6)	1 (0.4)	49 (21.0)	10 (4.3)	233 (100)
Base-Wide Misc.	1 (0.8)			87 (68.0)		3 (2.3)			19 (14.8)			18 (14.1)	128 (100)
TOTAL	**57 (1.1)**	**155 (3.1)**	**287 (5.7)**	**590 (11.7)**	**17 (0.38)**	**186 (3.7)**	**1,523 (30.2)**	**548 (10.8)**	**370 (7.4)**	**65 (1.3)**	**1,116 (22.2)**	**119 (2.4)**	**5,033 (100)**

TABLE 2-3
GROUNDWATER ANALYTICAL RESULTS
SITE 36 - CAMP GEIGER DUMP AREA NEAR SEWAGE TREATMENT PLANT
SITE SUMMARY REPORT, 1990
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MCB, CAMP LEJEUNE, NORTH CAROLINA

Sample Number:	Standards		36GW1	36GW1	36GW1	36GW2	36GW2	36GW2	36GW3	36GW3	36GW3
Date Sampled:	NCWQS (1)	MCL (2)	7/31/84	7/31/84	12/9/86	7/31/84	7/31/84	12/9/89	7/31/84	7/31/84	12/9/86
Parameter: Units (ug/L)											
trans-1,2-Dichloroethene	70	100	< 0.7	< 0.7	< 1.6	< 0.7	< 0.7	< 1.6	< 0.7	< 0.7	< 1.6
Methylene Chloride	5	5	< 0.6	< 0.7	< 2.8	< 0.6	< 0.7	< 2.8	< 0.6	< 0.7	< 2.8
1,1,2,2-Tetrachloroethane	--	--	< 0.5	< 0.5	< 4.1	< 0.5	< 0.5	< 4.1	< 0.5	< 0.5	< 4.1
Cadmium	5	5	12	8	3	14	19	4	7	NA	< 2.9
Chromium	50	100	480	510	130	420	680	142	280	NA	12
Lead	15	15 (3)	324	265	45	249	346	73	104	NA	29
Phenols	--	--	3	2	4	2	6	7	3	3	3
Oil & Grease	--	--	< 900	< 1000	2000	< 900	< 900	2000	< 1000	< 1000	< 1000

NOTES:
ug/L - Microgram per liter.
(--) - Standard not available.
Shading indicates that chemical exceeded standard and/or criteria.
(1) NCWQS - North Carolina Water Quality Standards for groundwater.
(2) National Primary Drinking Water Regulations, Primary Maximum Contaminant Levels (MCLs).
(3) The MCL is an Action Level.
Source: ESE, Site Summary Report, Final. September, 1990.

TABLE 2-3 (continued)
GROUNDWATER ANALYTICAL RESULTS
SITE 36 - CAMP GEIGER DUMP AREA NEAR SEWAGE TREATMENT PLANT
SITE SUMMARY REPORT, 1990
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MCB, CAMP LEJEUNE, NORTH CAROLINA

Sample Number:	Standards		36GW4	36GW4	36GW4	36GW5	36GW5
Date Sampled:	NCWQS (1)	MCL (2)	7/31/84	7/31/84	12/9/86	12/9/86	3/5/87
Parameter: Units (ug/L)							
trans-1,2-Dichloroethene	70	100	2	1.2	< 1.6	< 1.6	< 1.6
Methylene Chloride	5	5	< 0.7	7	< 2.8	< 2.8	< 2.8
1,1,2,2-Tetrachloroethane	--	--	4	3	< 4.1	< 4.1	< 4.1
Cadmium	5	5	9	NA	< 2.9	< 2.9	< 3.5
Chromium	50	100	510	NA	103	18.2	51
Lead	15	15 (3)	217	NA	< 27	< 27	< 27
Phenols	--	--	2	1	< 2	< 2	< 2
Oil & Grease	--	--	< 900	< 900	2000	1000	1000

NOTES:

ug/L - Microgram per liter.

(--) - Standard not available.

Shading indicates that chemical exceeded standard and/or criteria.

(1) NCWQS - North Carolina Water Quality Standards for groundwater.

(2) National Primary Drinking Water Regulations, Primary Maximum Contaminant Levels (MCLs).

(3) The MCL is an Action Level.

Source: ESE, Site Summary Report, Final. September, 1990.

TABLE 2-4
SEDIMENT ANALYTICAL RESULTS
SITE 36 - CAMP GEIGER DUMP AREA NEAR SEWAGE TREATMENT PLANT
SITE SUMMARY REPORT, 1990
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MCB, CAMP LEJEUNE, NORTH CAROLINA

Sample Number:	36SE1	36SE2	36SE3	36SE4	NOAA SSV (1)	
Date Sampled:	12/9/86	12/10/86	12/10/86	12/10/86	ER-L (2)	ER-M (3)
Paramenter: Units (mg/kg)						
Cadmium	< 0.879	< 1.94	< 0.59	0.722	5	9
Chromium	8.49	14.2	5.29	5.44	80	145
Lead	77.5	42.5	15.3	10.7	35	110
Oil & Grease	1480	2410	1200	185	--	--
Phenols	2030	1950	1080	464	--	--

Notes:
mg/kg - Milligram per kilogram.
(--) - Value is not available.
Shading indicates that chemical exceeded standard and/or criteria
(1) NOAA SSV - National Oceanic and Atmospheric Administration Sediment Screening Values (USEPA Region IV, 1992).
(2) ER-L - Effects range - low, if contaminant concentrations fall below the ER-L adverse aquatic effects are considered unlikely.
(3) ER-M - Effects range - median, if contaminant concentrations fall above the ER-M adverse aquatic effects are considered probable.
If the value falls between ER-L and ER-M adverse aquatic effects are considered possible.
Source: ESE, Site Summary Report, Final. September, 1990.

TABLE 2-5
SOIL ANALYTICAL RESULTS/COMPARISON TO RISK-BASED CONCENTRATIONS
SITE 43 - AGAN STREET DUMP
SITE INSPECTION, 1991
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MCB, CAMP LEJEUNE, NORTH CAROLINA

Sample Number	RBCs (1)		43SB0100		43SB0103		43SB0200		43SB0200DU
Sample Depth (feet)	Residential	Industrial	0-2		3-5		0-2		0-2
Parameter: Units (ug/kg)									
Semi-volatiles:									
Phenanthrene	NA	NA	380	U	490	U	350	U	350
Di-n-butylphthalate	7,800,000	100,000,000	380	U	490	U	350	U	350
Fluoranthene	3,100,000	4,100,000	380	U	490	U	350	U	350
Pyrene	2,300,000	31,000,000	380	U	490	U	350	U	350
Benzo(a)anthracene	16,000	39,000	380	U	490	U	350	U	350
Chrysene	16,000,000	39,000,000	380	U	490	U	350	U	350
bis(2-Ethylhexyl)phthalate	85,000	200,000	380	U	490	U	350	U	350
Benzo(b)fluoranthene	16,000	39,000	380	U	490	U	350	U	350
Benzo(k)fluoranthene	16,000	39,000	380	U	490	U	350	U	350
Benzo(a)pyrene	1,600	3,900	380	U	490	U	350	U	350
Indeno(1,2,3-cd)pyrene	1,600	3,900	380	U	490	U	350	U	350
Benzo(g,h,i)perylene	NA	NA	380	U	490	U	350	U	350

NOTES:

ug/kg - Microgram per kilogram.

U - Not detected above the Contract Required Quantitation Limit (CRQL).

DUP - Duplicate.

NA - Value not available.

(1) RBCs - Risk-based Concentrations, Smith, 1993.

(2) Shading indicates that chemical exceeded RBC (none exceeded).

Source: Baker Environmental, Inc., Site Inspection Report, 1991.

TABLE 2-5 (continued)
SOIL ANALYTICAL RESULTS/COMPARISON TO RISK-BASED CONCENTRATIONS
SITE 43 - AGAN STREET DUMP
SITE INSPECTION, 1991
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MCB, CAMP LEJEUNE, NORTH CAROLINA

Sample Number	RBCs (1)			43SB0204		43SB0300		43SB0400	
Sample Depth (feet)	Residential	Industrial		4-6		0-2		0-2	
Parameter: Units (ug/kg)									
Semi-volatiles:									
Phenanthrene	NA	NA	U	400	U	400	U	380	U
Di-n-butylphthalate	7,800,000	100,000,000	U	400	U	400	U	380	U
Fluoranthene	3,100,000	4,100,000	U	400	U	400	U	380	U
Pyrene	2,300,000	31,000,000	U	400	U	400	U	380	U
Benzo(a)anthracene	16,000	39,000	U	400	U	400	U	380	U
Chrysene	16,000,000	39,000,000	U	400	U	400	U	380	U
bis(2-Ethylhexyl)phthalate	85,000	200,000	U	400	U	400	U	380	U
Benzo(b)fluoranthene	16,000	39,000	U	400	U	400	U	380	U
Benzo(k)fluoranthene	16,000	39,000	U	400	U	400	U	380	U
Benzo(a)pyrene	1,600	3,900	U	400	U	400	U	380	U
Indeno(1,2,3-cd)pyrene	1,600	3,900	U	400	U	400	U	380	U
Benzo(g,h,i)perylene	NA	NA	U	400	U	400	U	380	U

NOTES:

ug/kg - Microgram per kilogram.

U - Not detected above the Contract Required Quantitation Limit (CRQL).

DUP - Duplicate.

NA - Value not available.

(1) RBCs - Risk-based Concentrations, Smith, 1993.

(2) Shading indicates that chemical exceeded RBC (none exceeded).

Source: Baker Environmental, Inc., Site Inspection Report, 1991.

TABLE 2-5 (continued)
SOIL ANALYTICAL RESULTS/COMPARISON TO RISK-BASED CONCENTRATIONS
SITE 43 - AGAN STREET DUMP
SITE INSPECTION, 1991
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MCB, CAMP LEJEUNE, NORTH CAROLINA

Sample Number	RBCs (1)		43SB0403		43SB0500		43SB0506		43MW0100
Sample Depth (feet)	Residential	Industrial	3-5		0-2		6-8		0-2
Parameter: Units (ug/kg)									
Semi-volatiles:									
Phenanthrene	NA	NA	440	U	350	U	380	U	57
Di-n-butylphthalate	7,800,000	100,000,000	440	U	350	U	380	U	89
Fluoranthene	3,100,000	4,100,000	440	U	350	U	380	U	230
Pyrene	2,300,000	31,000,000	440	U	350	U	380	U	210
Benzo(a)anthracene	16,000	39,000	440	U	350	U	380	U	110
Chrysene	16,000,000	39,000,000	440	U	350	U	380	U	160
bis(2-Ethylhexyl)phthalate	85,000	200,000	440	U	350	U	380	U	200
Benzo(b)fluoranthene	16,000	39,000	440	U	350	U	380	U	300
Benzo(k)fluoranthene	16,000	39,000	440	U	350	U	380	U	300
Benzo(a)pyrene	1,600	3,900	440	U	350	U	380	U	110
Indeno(1,2,3-cd)pyrene	1,600	3,900	440	U	350	U	380	U	64
Benzo(g,h,i)perylene	NA	NA	440	U	350	U	380	U	80

NOTES:
ug/kg - Microgram per kilogram.
U - Not detected above the Contract Required Quantitation Limit (CRQL).
DUP - Duplicate.
NA - Value not available.
(1) RBCs - Risk-based Concentrations, Smith, 1993.
(2) Shading indicates that chemical exceeded RBC (none exceeded).
Source: Baker Environmental, Inc., Site Inspection Report, 1991.

TABLE 2-5 (continued)
SOIL ANALYTICAL RESULTS/COMPARISON TO RISK-BASED CONCENTRATIONS
SITE 43 - AGAN STREET DUMP
SITE INSPECTION, 1991
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MCB, CAMP LEJEUNE, NORTH CAROLINA

Sample Number	RBCs (1)			43MW0100DUP		43MW0200		43MW0202	
Sample Depth (feet)	Residential	Industrial		0-2		0-2		2-4	
Parameter: Units (ug/kg)									
Semi-volatiles:									
Phenanthrene	NA	NA	J	370	U	360	U	410	U
Di-n-butylphthalate	7,800,000	100,000,000	J	40	J	360	U	410	U
Fluoranthene	3,100,000	4,100,000	J	110	J	360	U	410	U
Pyrene	2,300,000	31,000,000	J	94	J	360	U	410	U
Benzo(a)anthracene	16,000	39,000	J	55	J	360	U	410	U
Chrysene	16,000,000	39,000,000		73	J	360	U	410	U
bis(2-Ethylhexyl)phthalate	85,000	200,000	J	100	J	49	J	54	J
Benzo(b)fluoranthene	16,000	39,000	J	160	J	360	U	410	U
Benzo(k)fluoranthene	16,000	39,000	J	160	J	360	U	410	U
Benzo(a)pyrene	1,600	3,900	J	56	J	360	U	410	U
Indeno(1,2,3-cd)pyrene	1,600	3,900	J	370	U	360	U	410	U
Benzo(g,h,i)perylene	NA	NA	J	42	J	360	U	410	U

NOTES:

ug/kg - Microgram per kilogram.

U - Not detected above the Contract Required Quantitation Limit (CRQL).

DUP - Duplicate.

NA - Value not available.

(1) RBCs - Risk-based Concentrations, Smith, 1993.

(2) Shading indicates that chemical exceeded RBC (none exceeded).

Source: Baker Environmental, Inc., <u>Site Inspection Report</u>, 1991.

TABLE 2-5 (continued)
SOIL ANALYTICAL RESULTS/COMPARISON TO RISK-BASED CONCENTRATIONS
SITE 43 - AGAN STREET DUMP
SITE INSPECTION, 1991
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MCB, CAMP LEJEUNE, NORTH CAROLINA

Sample Number	RBCs (1)		43MW0300	
Sample Depth (feet)	Residential	Industrial	0-2	
Parameter: Units (ug/kg)				
Semi-volatiles:				
Phenanthrene	NA	NA	390	U
Di-n-butylphthalate	7,800,000	100,000,000	390	U
Fluoranthene	3,100,000	4,100,000	390	U
Pyrene	2,300,000	31,000,000	390	U
Benzo(a)anthracene	16,000	39,000	390	U
Chrysene	16,000,000	39,000,000	390	U
bis(2-Ethylhexyl)phthalate	85,000	200,000	72	J
Benzo(b)fluoranthene	16,000	39,000	390	U
Benzo(k)fluoranthene	16,000	39,000	390	U
Benzo(a)pyrene	1,600	3,900	390	U
Indeno(1,2,3-cd)pyrene	1,600	3,900	390	U
Benzo(g,h,i)perylene	NA	NA	390	U

NOTES:
ug/kg - Microgram per kilogram.
U - Not detected above the Contract Required Quantitation Limit (CRQL).
DUP - Duplicate.
NA - Value not available.
(1) RBCs - Risk-based Concentrations, Smith, 1993.
(2) Shading indicates that chemical exceeded RBC (none exceeded).
Source: Baker Environmental, Inc., Site Inspection Report, 1991.

TABLE 2-6
SOIL ANALYTICAL RESULTS/COMPARISON TO BACKGROUND CONCENTRATIONS
SITE 43 - AGAN STREET DUMP
SITE INSPECTION, 1991
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MCB, CAMP LEJEUNE, NORTH CAROLINA

Sample Number	USGS (1)	Base-Specific	43SB0100		43SB0103		43SB0200		43SB0200DUP		43SB0204	
Sample Depth (feet)		Background (2)	0-2		3-5		0-2		0-2		4-6	
Parameter: Units (mg/kg)												
Inorganics:												
Aluminum	66000	10780	1630		4710		4020		5640		2590	
Barium	554	28	3.5	U	77.6		7.2	U	10.6	U	6.1	U
Calcium	24000	634	245	U	510		149	U	218	U	64.4	U
Chromium	53	13.8	2.5		9.7		4.3	J	5.9	J	3.6	J
Copper	25	4.2	2.9		2.0		0.98		1.1		1.1	
Iron	25000	10140	763		1600		3050		4790		738	
Lead	20	26	4.6		2.1		3.6		5.3		4.0	
Magnesium	9200	452	70.6		250		115	U	180	U	71.1	U
Manganese	560	10.8	3.3	U	23.5		7.1	U	6.3	U	3.0	U
Nickel	20	ND	1.0	U	2.7	U	1.9	U	1.9	U	2.2	U
Potassium	--	600	126		350		223	U	225	U	264	U
Thallium	--	ND	0.47	U	0.58	U	0.43	U	0.42	U	0.5	U
Vanadium	--	19.4	2.3		7.3		6.9		9.6		2.9	
Zinc	54	8.8	4.8		8.4		4.0		5.4	U	5.4	U

NOTES:
mg/kg - Milligram per kilogram.
U - Not detected above the Contract Required Quantitation Limit (CRQL).
J - Estimated value, reported value may not be accurate or precise.
ND - Not detected.
(--) - Value not given.
DUP - Duplicate.
Shading indicates that chemical exceeded twice the base-specific background.
(1) These values are the background level of the constituents found in the cultivated and uncultivated soils in the eastern U.S. (Shacklette, 1984).
(2) Twice the regional base-specific background average of three samples (Halliburton/NUS, 1991).
Source: Baker Environmental, Inc., Site Inspection Report, 1991.

TABLE 2-6 (continued)
SOIL ANALYTICAL RESULTS/COMPARISON TO BACKGROUND CONCENTRATIONS
SITE 43 - AGAN STREET DUMP
SITE INSPECTION, 1991
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MCB, CAMP LEJEUNE, NORTH CAROLINA

Sample Number Sample Depth (feet)	USGS (1)	Base-Specific Background (2)	43SB0300 0-2		43SB0400 0-2		43SB0403 3-5		43SB0500 0-2		43SB0506 6-8	
Parameter: Units (mg/kg)												
Inorganics:												
Aluminum	66000	10780	658	J	2310	J	621	J	5280		489	
Barium	554	28	2.2		4.9		2.3		8.4	U	1.7	U
Calcium	24000	634	27.7	U	69.8	U	63.7	U	61.8	U	20.9	U
Chromium	53	13.8	2.2		4.0		1.2		5.7		1.9	
Copper	25	4.2	1.2		0.91	U	2.3		5.4		2.2	
Iron	25000	10140	419		894		263		2400		272	
Lead	20	26	1.6		4.5		1.8		2.7		1.3	
Magnesium	9200	452	29.5		90.6		34.5		142		23.4	
Manganese	560	10.8	2.0		5.4		2.2		17.4		1.8	U
Nickel	20	ND	2.2	U	2.1	U	2.4	U	2.0	U	2.0	U
Potassium	--	600	255	U	244	U	286	U	235	U	241	U
Thallium	--	ND	0.49	U	0.47	U	0.52	U	0.44	U	0.45	U
Vanadium	--	19.4	1.4		3.7		1.2		6.6		0.95	
Zinc	54	8.8	3.1		3.0		3.1		8.0		6.5	

NOTES:
mg/kg - Milligram per kilogram.
U - Not detected above the Contract Required Quantitation Limit (CRQL).
J - Estimated value, reported value may not be accurate or precise.
ND - Not detected.
(--) - Value not given.
DUP - Duplicate.
Shading indicates that chemical exceeded twice the base-specific background.
(1) These values are the background level of the constituents found in the cultivated and uncultivated soils in the eastern U.S. (Shacklette, 1984).
(2) Twice the regional base-specific background average of three samples (Halliburton/NUS, 1991).
Source: Baker Environmental, Inc., Site Inspection Report, 1991.

TABLE 2-6 (continued)
SOIL ANALYTICAL RESULTS/COMPARISON TO BACKGROUND CONCENTRATIONS
SITE 43 - AGAN STREET DUMP
SITE INSPECTION, 1991
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MCB, CAMP LEJEUNE, NORTH CAROLINA

Sample Number Sample Depth (feet)	USGS (1)	Base-Specific Background (2)	43MW0100 0-2		43MW0100DUP 0-2		43MW0200 0-2		43MW0202 2-4		43MW0300 0-2	
Parameter: Units (mg/kg)												
Inorganics:												
Aluminum	66000	10780	3810		3720		2880		4550		4460	
Barium	554	28	11.8	U	10.2	U	5.7	U	9.0	U	9.5	U
Calcium	24000	634	6720		5460		93.3		68.6	U	618	
Chromium	53	13.8	8.3		6.6		3.6		6.7		6.8	
Copper	25	4.2	3.4		1.6		2.5		0.97	U	1.1	
Iron	25000	10140	2190		1800		1530		1340		2140	
Lead	20	26	9.8		12.0		3.7		6.1		7.8	J
Magnesium	9200	452	270		224		95.0		176		177	
Manganese	560	10.8	31.2		17.7		7.9		8.2		7.4	
Nickel	20	ND	7.6		2.1	U	2.2		7.3		3.0	
Potassium	--	600	242	U	245	U	237	U	258	U	244	U
Thallium	--	ND	0.45	U	0.46	U	0.44	U	0.49	U	0.47	U
Vanadium	--	19.4	7.2		7.1		4.4		5.8		6.7	
Zinc	54	8.8	20.1		8.3		3.6		3.0		3.5	

NOTES:

mg/kg - Milligram per kilogram.

U - Not detected above the Contract Required Quantitation Limit (CRQL).

J - Estimated value, reported value may not be accurate or precise.

ND - Not detected.

(--) - Value not given.

DUP - Duplicate.

Shading indicates that chemical exceeded twice the base-specific background.

(1) These values are the background level of the constituents found in the cultivated and uncultivated soils in the eastern U.S. (Shacklette, 1984).

(2) Twice the regional base-specific background average of three samples (Halliburton/NUS, 1991).

Source: Baker Environmental, Inc., Site Inspection Report, 1991.

TABLE 2-7
GROUNDWATER ANALYTICAL RESULTS
SITE 43 - AGAN STREET DUMP
SITE INSPECTION, 1991
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MCB, CAMP LEJEUNE, NORTH CAROLINA

									Standards and Criteria		
Sample Number	43GW011		43GW021		43GW031		43GW031DUP		NCWQS	MCLs(2)	Health Advisories (3)
Parameter: Units (ug/L)											
Volatiles:											
Carbon Disulfide	7		5	U	5	U	5	U			
Inorganics:											
Aluminum	124000		177000		66000		78300		--	50-200 (5)	--
Arsenic	25.0	U	23.4		5.0	U	5.0	U	50	50	2 (3)
Barium	689		745		220		233		--	2000	2000
Beryllium	3.1		4.2		1.5		1.7		--	4	0.8 (3)
Cadmium	4.0	U	6.9		4.0	U	4.0	U	5	5	5
Calcium	91900		10300		22300		20800		--	--	--
Chromium	177		249		161		181		50	100	100
Cobalt	6.7		27.7		6.0	U	6.0	U	--	--	--
Copper	64.2		67.8		104		94.8		1000	1,300 (4)	--
Iron	[illegible]		105000		126000		134000		300	300 (5)	--
Lead	16.5		28.8		27.7		42.3		15	15 (4)	--
Magnesium	9720		11800		6800		7400		--	--	--
Manganese	220		297		72.6		74.1		50	50 (5)	--
Mercury	0.20	U	0.20	U	0.24		0.20	U	1.1	2	2
Nickel	33.8		143		20.5		29.4		100	100	100
Potassium	8210		10900		5190		6010		--	--	--
Sodium	9160		14600		22100		17900		--	--	--
Vanadium	165		233		122		140		--	--	--
Zinc	192	J	661	J	214	J	300	J	2100	5,000 (5)	2100

NOTES:

ug/L - Microgram per liter.

U - Not detected above Contract Required Quantitation Limits.

J - Estimated value, reported value may not be accurate or precise.

DUP - Duplicate.

(--) - Standard or criteria not available.

Shading indicates that chemical exceeded standard and/or criteria.

(1) North Carolina Water Quality Standards for Groundwater (NCAC, 1993)

(2) National Primary Drinking Water Regulations, Primary Maximum Contaminant Levels (MCLs)

(3) Health Advisories (USEPA, 1993), values represent lifetime exposures, except for arsenic and beryllium which represents 10-04 lifetime risk.

(4) The standard is an action level (July 17, 1992).

(5) National Secondary Drinking Water Regulation, Secondary Maximum Contaminant Levels (SMCLs).

Source: Baker Environmental, Inc., Site Inspection Report, 1991.

TABLE 2-8
SURFACE WATER ANALYTICAL RESULTS
SITE 43 - AGAN STREET DUMP
SITE INSPECTION, 1991
REMEDIAL INVESTIGATION/FEASIBILITY PROJECT PLANS - CTO-0246
MCB, CAMP LEJEUNE, NORTH CAROLINA

Sample Number	43SW01		43SW02		43SW03		43SW04		43SW05		Standards and Criteria: NCWQS (1)	Standards and Criteria: Ambient Water Quality Criteria (2)	Standards and Criteria: Freshwater Water Screening Value (3)
Parameter: Units (ug/L)													
Semi-volatiles:													
Benzoic Acid	50	U	2	J	50	U	50	U	50	U	--	--	--
Inorganics:													
Aluminum	769		803		948		435		529		--		87
Barium	14.4		87.6		11.0		24.6		19.5		1,000	--	--
Calcium	24,700		48,000		23,100		29,900		4,410		--	--	--
Copper	9.8		7.9		11.3		7.0		4	U	7	12	6.54
Iron	3800		15700		1120		3080		603		1,000	1,000	1,000
Lead	2.9	J	7.0	J	21.1		2.8	J	2	U	25	3.2	1.32
Magnesium	1,630		42,300		1,190		2,270		865		--	--	--
Manganese	153		42.6		45.8		23.8		33.1		200	--	--
Nickel	9	U	9	U	9	U	9.2		9	U	88	160	87.71
Potassium	1,250		13,000	J	1,070	U	1,650		1,070	U	--	--	--
Sodium	7,290		401,000		2930		14,100		2,910		--	--	--
Vanadium	4.7		3.8		4.4		3	U	3	U	--	--	--
Zinc	32.1	U	29.6	U	54.3		53.0		18.7	U	50	110	58.91

NOTES:
ug/L - Microgram per liter.
U - Not detected above Contract Required Quantitation Limits.
J - Estimated value, reported value may not be accurate or precise.
(--) - Standard or criteria not available.
Shading indicates that chemical exceeded standard and/or criteria.
(1) North Carolina Surface Water Standards for freshwater (NCAC, 1993).
(2) Federal Ambient Water Quality Standards, chronic freshwater (USEPA, 1991)
(3) FWSV - Freshwater Water Quality Screening Value (USEPA Region IV, 1993)

Source: Baker Environmental, Inc., Site Inspection Report, 1991.

SURFWT43.XLS / 9/15/94

TABLE 2-9
SEDIMENT SAMPLE ANALYTICAL RESULTS
SITE 43 - AGAN STREET DUMP
SITE INSPECTION, 1991
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MCB, CAMP LEJEUNE, NORTH CAROLINA

											NOAA SSV (1)	
Sample Number	43SD01		43SD02		43SD03		43SD04		43SD05		ER-L (2)	ER-M (3)
Parameter: Units												
Semi-volatiles: ug/kg												
2-Methylphenol	810	J	1300	U	390	U	850	U	560	U		
4-Methylphenol	810	J	1300	U	390	U	850	U	64	J		
Benzoic Acid	7600	J	3000	J	1900	U	4100	U	2700	U		
Di-n-butylphthalate	210	J	170	J	59	J	850	U	61	J		
Pyrene	150	J	1300	U	390	U	850	U	560	U	350	2200
Butylbenzylphthalate	1400	U	1300	U	55	J	850	U	560	U		
bis(2-Ethylhexyl)phthalate	1400	U	1300	U	390	U	1600	J	150	J		
Benzo(b)fluoranthene	290	J	1300	U	66	J	850	U	560	U	4000 (4)	35000 (4)
Benzo(k)fluoranthene	290	J	1300	U	66	J	850	U	560	U	4000 (4)	35000 (4)
Pesticides/PCBs: ug/kg												
4,4'-DDE	270		580		19	U	21	U	140	U	2	15
4,4'-DDD	500		310		19	U	21	U	180		2	20
4,4'-DDT	220		63	U	19	U	21	U	140	U	1	7
Inorganics: mg/kg												
Aluminum	6720	J	4510	J	1850		1520		1970		--	--
Barium	25.5	J	32.6	J	5.2	U	11.3	U	9.7	U	--	--
Calcium	9170	J	3330	J	7550		6880		4400		--	--
Chromium	6.9	J	5.0	J	3.6		4.2		2.9		80	145
Copper	13.2	J	9.2	J	1.9		3.6		2.6		70	390
Iron	6930	J	2850	J	787		1720		1290		--	--
Lead	28.3	J	56.0	J	7.4		28.2		8.5		35	110
Magnesium	831	J	1300	J	185		170		259		--	--
Manganese	92.1	J	8.9	J	6.7		6.5		6.8		--	--
Nickel	33.4	J	6.9	U	3.7		3.5		3.1	U	30	50
Sodium	549	U	2930	J	130	U	179	U	345	U		
Vanadium	18.6	J	12.9	J	3.6		5.0		4.0		--	--
Zinc	77.0	J	26.9	J	11.6		96.2		10.5		120	270

NOTES:
ug/L - Microgram per liter.
mg/kg - Milligram per kilogram.
U - Not detected above Contract Required Quantitation Limits.
J - Estimated value, reported value may not be accurate or precise.
--) - Value is not available.
ıading indicates that chemical exceeded NOAA SSV.
(1) NOAA SSV - National Oceanic and Atmospheric Administration Sediment Screening Values (USEPA Region IV, 1992).
(2) ER-L - Effects range - low, if contaminant concentrations fall below the ER-L adverse aquatic effects are considered unlikely.
(3) ER-M - Effects range - median, if contaminant concentrations fall above the ER-M adverse aquatic effects are considered probable.
If the value falls between ER-L and ER-M adverse aquatic effects are considered possible.

Source: Baker Environmental, Inc., Site Inspection Report, 1991.

TABLE 2-10
SOIL ANALYTICAL RESULTS/COMPARISON TO RISK-BASED CONCENTRATIONS
SITE 44 - JONES STREET DUMP
SITE INSPECTION, 1991
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MCB, CAMP LEJEUNE, NORTH CAROLINA

Sample Number	RBCs (1)		44MW0100		44MW0100DUP		44MW0106		44MW0200	
Sample Depth (feet)	Residential	Industrial	0-2		0-2		6-8		0-2	
Parameter: Units (ug/kg)										
Volatiles:										
Chloromethane	92,000	220,000	11	U	11	U	1600	U	11	U
Methylene Chloride	160,000	380,000	21	U	34	U	1100	U	37	U
Carbon Disulfide	7,800,000	100,000,000	6	U	6	U	800	U	6	U
Semivolatiles:										
Benzoic Acid	310,000,000	1,000,000,000	1300	U	1800	U	2100	U	1800	U
2-Methylnaphthalene	--	--	370	U	380	U	420	U	370	U
Acenaphthylene	--	--	370	U	380	U	420	U	370	U
Acenaphthene	4,700,000	61,000,000	370	U	380	U	420	U	370	U
Dibenzofuran	--	--	370	U	380	U	420	U	370	U
Fluorene	3,100,000	41,000,000	370	U	380	U	420	U	370	U
Phenanthrene	--	--	370	U	380	U	420	U	370	U
Fluoranthene	3,100,000	41,000,000	370	U	380	U	420	U	370	U
Pyrene	2,300,000	31,000,000	370	U	380	U	76	J	370	U
Naphthalene	3,100,000	41,000,000	370	U	380	U	420	U	370	U
Pesticides/PCBs:										
4-4'-DDE	35,000	84,000	18	U	18	U	20	U	18	U
4-4'-DDD	5,000	12,000	18	U	18	U	20	U	18	U

NOTES:

ug/kg - Microgram per kilogram

U - Not detected above the Contract Required Quantitation Limit (CRQL)

J - Estimated value, reported value may not be accurate or precise.

(--) - RBC not available.

DUP - Duplicate.

Shading indicates that chemical exceeded RBC (none exceeded).

RBC - Risk-based Concentrations (Smith, 1992)

Source: Baker Environmental, Inc., Site Inspection Report, 1991.

TABLE 2-10 (continued)
SOIL ANALYTICAL RESULTS/COMPARISON TO RISK-BASED CONCENTRATIONS
SITE 44 - JONES STREET DUMP
SITE INSPECTION, 1991
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MCB, CAMP LEJEUNE, NORTH CAROLINA

Sample Number	RBCs (1)		44MW02035		44MW0300		44MW0306		44SB0100	
Sample Depth (feet)	Residential	Industrial	3.5-5.5		0-2		6-8		0-2	
Parameter: Units (ug/kg)										
Volatiles:										
Chloromethane	92,000	220,000	12	U	12	U	1	J	14	U
Methylene Chloride	160,000	380,000	31	U	34	U	20	U	41	U
Carbon Disulfide	7,800,000	100,000,000	6	U	6	U	6	U	7	U
Semivolatiles:										
Benzoic Acid	310,000,000	1,000,000,000	1900	U	2200	U	2100	U	2200	U
2-Methylnaphthalene	--	--	390	U	440	U	170	J	450	U
Acenaphthylene	--	--	390	U	440	U	120	J	450	U
Acenaphthene	4,700,000	61,000,000	390	U	440	U	120	J	450	U
Dibenzofuran	--	--	390	U	440	U	100	J	450	U
Fluorene	3,100,000	41,000,000	390	U	440	U	100	J	450	U
Phenanthrene	--	--	390	U	440	U	320	J	450	U
Fluoranthene	3,100,000	41,000,000	390	U	440	U	160	J	450	U
Pyrene	2,300,000	31,000,000	390	U	440	U	100	J	450	U
Naphthalene	3,100,000	41,000,000	390	U	440	U	1100		450	U
Pesticides/PCBs:										
4-4'-DDE	35,000	84,000	19	U	20	U	21	U	22	U
4-4'-DDD	5,000	12,000	19	U	20	U	48		22	U

NOTES:
ug/kg - Microgram per kilogram
U - Not detected above the Contract Required Quantitation Limit (CRQL)
J - Estimated value, reported value may not be accurate or precise.
(--) - RBC not available.
DUP - Duplicate.
Shading indicates that chemical exceeded RBC (none exceeded).
RBC - Risk-based Concentrations (Smith, 1992)
Source: Baker Environmental, Inc., Site Inspection Report, 1991.

TABLE 2-10 (continued)
SOIL ANALYTICAL RESULTS/COMPARISON TO RISK-BASED CONCENTRATIONS
SITE 44 - JONES STREET DUMP
SITE INSPECTION, 1991
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MCB, CAMP LEJEUNE, NORTH CAROLINA

Sample Number	RBCs (1)		44SB0102		44SB0200		44SB0200D		44SB0206	
Sample Depth (feet)	Residential	Industrial	2-4		0-2		0-2		6-8	
Parameter: Units (ug/kg)										
Volatiles:										
Chloromethane	92,000	220,000	12	U	11	U	12	U	12	U
Methylene Chloride	160,000	380,000	39	U	30	U	35	U	32	U
Carbon Disulfide	*7,800,000*	*100,000,000*	*6*	U	*6*	U	*6*	U	*6*	U
Semivolatiles:										
Benzoic Acid	310,000,000	1,000,000,000	42	J	39	J	64	J	1900	U
2-Methylnaphthalene	--	--	410	U	370	U	400	U	390	U
Acenaphthylene	--	--	410	U	370	U	400	U	390	U
Acenaphthene	4,700,000	61,000,000	410	U	370	U	400	U	390	U
Dibenzofuran	--	--	410	U	370	U	400	U	390	U
Fluorene	3,100,000	41,000,000	410	U	370	U	400	U	390	U
Phenanthrene	--	--	410	U	370	U	400	U	390	U
Fluoranthene	3,100,000	41,000,000	410	U	370	U	400	U	390	U
Pyrene	2,300,000	31,000,000	410	U	370	U	400	U	390	U
Naphthalene	3,100,000	41,000,000	410	U	370	U	400	U	390	U
Pesticides/PCBs:										
4-4'-DDE	35,000	84,000	20	U	30		39		19	U
4-4'-DDD	5,000	12,000	20	U	18	U	19	U	19	U

NOTES:

ug/kg - Microgram per kilogram

U - Not detected above the Contract Required Quantitation Limit (CRQL)

J - Estimated value, reported value may not be accurate or precise.

(--) - RBC not available.

DUP - Duplicate.

Shading indicates that chemical exceeded RBC (none exceeded).

RBC - Risk-based Concentrations (Smith, 1992)

Source: Baker Environmental, Inc., Site Inspection Report, 1991.

TABLE 2-10 (continued)
SOIL ANALYTICAL RESULTS/COMPARISON TO RISK-BASED CONCENTRATIONS
SITE 44 - JONES STREET DUMP
SITE INSPECTION, 1991
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MCB, CAMP LEJEUNE, NORTH CAROLINA

Sample Number	RBCs (1)		44SB0300		44SB0306		44SB0400		44SB0406	
Sample Depth (feet)	Residential	Industrial	0-2		6-8		0-2		6-8	
Parameter: Units (ug/kg)										
Volatiles:										
Chloromethane	92,000	220,000	11	U	11	U	14	U	12	U
Methylene Chloride	160,000	380,000	21	U	24	U	45	U	41	U
Carbon Disulfide	7,800,000	100,000,000	6	U	6	U	2	J	6	U
Semivolatiles:										
Benzoic Acid	310,000,000	1,000,000,000	160	J	67	J	2100	U	2000	U
2-Methylnaphthalene	--	--	370	U	370	U	440	U	410	U
Acenaphthylene	--	--	370	U	370	U	440	U	410	U
Acenaphthene	4,700,000	61,000,000	370	U	370	U	440	U	410	U
Dibenzofuran	--	--	370	U	370	U	440	U	410	U
Fluorene	3,100,000	41,000,000	370	U	370	U	440	U	410	U
Phenanthrene	--	--	370	U	370	U	440	U	410	U
Fluoranthene	3,100,000	41,000,000	370	U	370	U	440	U	410	U
Pyrene	2,300,000	31,000,000	370	U	370	U	440	U	410	U
Naphthalene	3,100,000	41,000,000	370	U	370	U	440	U	410	U
Pesticides/PCBs:										
4-4'-DDE	35,000	84,000	18	U	18	U	22	U	20	U
4-4'-DDD	5,000	12,000	18	U	18	U	22	U	20	U

NOTES:

ug/kg - Microgram per kilogram

U - Not detected above the Contract Required Quantitation Limit (CRQL)

J - Estimated value, reported value may not be accurate or precise.

(--) - RBC not available.

DUP - Duplicate.

Shading indicates that chemical exceeded RBC (none exceeded).

RBC - Risk-based Concentrations (Smith, 1992)

Source: Baker Environmental, Inc., Site Inspection Report, 1991.

TABLE 2-10 (continued)
SOIL ANALYTICAL RESULTS/COMPARISON TO RISK-BASED CONCENTRATIONS
SITE 44 - JONES STREET DUMP
SITE INSPECTION, 1991
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MCB, CAMP LEJEUNE, NORTH CAROLINA

Sample Number	RBCs (1)		44SB0500		44SB0507		44SB0600		44SB0608	
Sample Depth (feet)	Residential	Industrial	0-2		7-9		0-2		8-10	
Parameter: Units (ug/kg)										
Volatiles:										
Chloromethane	92,000	220,000	11	U	12	U	11	U	12	U
Methylene Chloride	160,000	380,000	16		14	U	25	U	20	U
Carbon Disulfide	7,800,000	100,000,000	6	U	6	U	6	U	6	U
Semivolatiles:										
Benzoic Acid	310,000,000	1,000,000,000	1800	U	1900	U	1800	R	2000	U
2-Methylnaphthalene	--	--	370	U	400	U	370	R	410	U
Acenaphthylene	--	--	370	U	400	U	370	R	410	U
Acenaphthene	4,700,000	61,000,000	370	U	400	U	370	R	410	U
Dibenzofuran	--	--	370	U	400	U	370	R	410	U
Fluorene	3,100,000	41,000,000	370	U	400	U	370	R	410	U
Phenanthrene	--	--	370	U	400	U	370	R	410	U
Fluoranthene	3,100,000	41,000,000	370	U	400	U	370	R	410	U
Pyrene	2,300,000	31,000,000	370	U	400	U	370	R	410	U
Naphthalene	3,100,000	41,000,000	370	U	400	U	370	R	410	U
Pesticides/PCBs:										
4-4'-DDE	35,000	84,000	18	U	19	U	18	U	20	U
4-4'-DDD	5,000	12,000	18	U	19	U	18	U	20	U

NOTES:

ug/kg - Microgram per kilogram

U - Not detected above the Contract Required Quantitation Limit (CRQL)

J - Estimated value, reported value may not be accurate or precise.

(--) - RBC not available.

DUP - Duplicate.

Shading indicates that chemical exceeded RBC (none exceeded).

RBC - Risk-based Concentrations (Smith, 1992)

Source: Baker Environmental, Inc., Site Inspection Report, 1991.

TABLE 2-11
SOIL ANALYTICAL RESULTS/COMPARISON TO BACKGROUND CONCENTRATIONS
SITE 44 - JONES STREET DUMP
SITE INSPECTION, 1991
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MCB, CAMP LEJEUNE, NORTH CAROLINA

Sample Number Sample Depth (feet)	USGS Background (1)	Base-Specific Background (2)	44MW0100 0-2		44MW0100DUP 0-2		44MW0106 6-8		44MW0200 0-2	
Parameter: Units (mg/kg)										
Inorganics:										
Aluminum	66000	10780	9480	J	11100	J	7050	J	9570	J
Arsenic	--	3.8	2.0		2.3	J	1.7		3.2	J
Barium	554	28	14.8		16.7		17.9		11.9	
Calcium	2400	634	7500		11600		[illegible]		87.2	
Chromium	53	13.8	13.0	J	13.9	J	10.0	J	15.5	J
Copper	25	4.2	111	J	44.0	J	25.4	J	27.7	J
Iron	25000	10140	7550	J	7800	J	5570	J	11500	J
Lead	20	26	7.5		7.0		10.7		7.2	
Magnesium	9200	452	461		590		367		371	
Manganese	560	10.8	11.2		12.9		20.4		7.3	
Nickel	20	NA	13.9		8.2		5.4		3.9	
Potassium	--	600	342		424		362		454	
Selenium	--	1.04	0.87	U	0.91	U	1	U	0.89	
Vanadium	--	19.4	18.0		20.5		14.7		22.9	
Zinc	54	8.8	7.4		8.0		34.9		5.5	

NOTES:
mg/kg - Milligram per kilogram
U - Not detected above the Contract Required Quantitation Limit (CRQL)
J - Estimated value, reported value may not be accurate or precise.
DUP - Duplicate.
Shading indicates that chemical exceeded twice the base-specific background concentration
(--) - Value not given.
(1) These values are the regional soil background level averages of the constituents found in the cultivated and uncultivated soils in the eastern U.S. (Shacklette, 1984).
(2) Twice the base-specific soil background concentration, average of three samples (Halliburton/NUS, 1991).
Source: Baker Environmental, Inc., Site Inspection Report, 1991.

TABLE 2-11 (continued)
SOIL ANALYTICAL RESULTS/COMPARISON TO BACKGROUND CONCENTRATIONS
SITE 44 - JONES STREET DUMP
SITE INSPECTION, 1991
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MCB, CAMP LEJEUNE, NORTH CAROLINA

Sample Number Sample Depth (feet)	USGS Background (1)	Base-Specific Background (2)	44MW02035 3.5-5.5		44MW0300 0-2		44MW0306 6-8		44SB0100 0-2	
Parameter: Units (mg/kg)										
Inorganics:										
Aluminum	66000	10780	4050	J	11000	J	6610	J	13100	J
Arsenic	--	3.8	1.2	U	10.2		3.0		3.9	
Barium	554	28	6.1		18.3		22.9		16.0	
Calcium	2400	634	54.1	U	7270		5660		142	
Chromium	53	13.8	5.6	J	17.4	J	12.6	J	26.2	J
Copper	25	4.2	6.2	J	62.2	J	127	J	27.6	J
Iron	25000	10140	1660	J	13700	J	8350	J	20500	J
Lead	20	26	5.5		9.7		44.6		12.0	
Magnesium	9200	452	129		490		454		510	
Manganese	560	10.8	3.5		8.4		31.3		10.7	
Nickel	20	NA	3.1		10.3		8.7		4.8	
Potassium	--	600	252	U	454		481		757	
Selenium	--	1.04	0.94	U	1	U	1	U	1.1	U
Vanadium	--	19.4	5.0		27.4		16.0		39.2	
Zinc	54	8.8	3.2		7.0		44.9		10.1	

NOTES:
mg/kg - Milligram per kilogram
U - Not detected above the Contract Required Quantitation Limit (CRQL)
J - Estimated value, reported value may not be accurate or precise.
DUP - Duplicate.
Shading indicates that chemical exceeded twice the base-specific background concentration
(--) - Value not given.
(1) These values are the regional soil background level averages of the constituents found in the cultivated and uncultivated soils in the eastern U.S. (Shacklette, 1984).
(2) Twice the base-specific soil background concentration, average of three samples (Halliburton/NUS, 1991).
Source: Baker Environmental, Inc., Site Inspection Report, 1991.

TABLE 2-11 (continued)
SOIL ANALYTICAL RESULTS/COMPARISON TO BACKGROUND CONCENTRATIONS
SITE 44 - JONES STREET DUMP
SITE INSPECTION, 1991
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MCB, CAMP LEJEUNE, NORTH CAROLINA

Sample Number	USGS	Base-Specific	44SB0102		44SB0200		44SB0200DUP		44SB0206	
Sample Depth (feet)	Background (1)	Background (2)	2-4		0-2		0-2		6-8	
Parameter: Units (mg/kg)										
Inorganics:										
Aluminum	66000	10780	3930	J	8870	J	10800	J	8780	J
Arsenic	--	3.8	1.2	U	1.7		1.6		1.2	U
Barium	554	28	7.4		16.1		18.6		14.1	
Calcium	2400	634	36.3	U	12200		3930		77.6	
Chromium	53	13.8	5.3	J	11.1	J	12.7	J	9.3	J
Copper	25	4.2	2.3	J	2.8	J	2.7	J	1.5	J
Iron	25000	10140	4640	J	8140	J	8160	J	3850	J
Lead	20	26	9.8		13.0		9.4		9.6	
Magnesium	9200	452	128		414		384		270	
Manganese	560	10.8	4.0		9.3		8.1		5.2	
Nickel	20	NA	2.2	U	2.9		2.5		3.4	
Potassium	--	600	261	U	313		304		364	
Selenium	--	1.04	0.96	U	0.88	U	1.1		0.94	U
Vanadium	--	19.4	9.0		22.1		19.1		14.1	
Zinc	54	8.8	2.8		7.1		6.3		3.5	

NOTES:
mg/kg - Milligram per kilogram
U - Not detected above the Contract Required Quantitation Limit (CRQL)
J - Estimated value, reported value may not be accurate or precise.
DUP - Duplicate.
Shading indicates that chemical exceeded twice the base-specific background concentration
(--) - Value not given.
(1) These values are the regional soil background level averages of the constituents found in the cultivated and uncultivated soils in the eastern U.S. (Shacklette, 1984).
(2) Twice the base-specific soil background concentration, average of three samples (Halliburton/NUS, 1991).
Source: Baker Environmental, Inc., Site Inspection Report, 1991.

TABLE 2-11 (continued)
SOIL ANALYTICAL RESULTS/COMPARISON TO BACKGROUND CONCENTRATIONS
SITE 44 - JONES STREET DUMP
SITE INSPECTION, 1991
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MCB, CAMP LEJEUNE, NORTH CAROLINA

Sample Number Sample Depth (feet)	USGS Background (1)	Base-Specific Background (2)	44SB0300 0-2		44SB0306 6-8		44SB0400 0-2		44SB0406 6-8	
Parameter: Units (mg/kg)										
Inorganics:										
Aluminum	66000	10780	7110	J	4070	J	12000	J	5250	
Arsenic	--	3.8	4.1		1.1	U	4.9		1.2	U
Barium	554	28	12.8		7.3		13.4		12.8	B
Calcium	2400	634	4180		763		1600		56.5	U
Chromium	53	13.8	10	J	4.9	J	19.1	J	7.9	
Copper	25	4.2	2.0	J	1.9	J	2.6	J	1.4	U
Iron	25000	10140	7340	J	2090	J	16100	J	2650	
Lead	20	26	7.3		6.3		12.5		6.1	
Magnesium	9200	452	293		129		503		231	J
Manganese	560	10.8	5.8		4.1		9.2		9.4	
Nickel	20	NA	2.0		6.1		6.9		2.2	U
Potassium	--	600	267		237	U	536		276	J
Selenium	--	1.04	1.1		0.88	U	1	U	0.98	U
Vanadium	--	19.4	14.7		7.0		28.2		8.6	U
Zinc	54	8.8	4.0		3.4		7.4		4.0	J

NOTES:
mg/kg - Milligram per kilogram
U - Not detected above the Contract Required Quantitation Limit (CRQL)
J - Estimated value, reported value may not be accurate or precise.
DUP - Duplicate.
Shading indicates that chemical exceeded twice the base-specific background concentration
(--) - Value not given.
(1) These values are the regional soil background level averages of the constituents found in the cultivated and uncultivated soils in the eastern U.S. (Shacklette, 1984).
(2) Twice the base-specific soil background concentration, average of three samples (Halliburton/NUS, 1991).
Source: Baker Environmental, Inc., Site Inspection Report, 1991.

TABLE 2-11 (continued)
SOIL ANALYTICAL RESULTS/COMPARISON TO BACKGROUND CONCENTRATIONS
SITE 44 - JONES STREET DUMP
SITE INSPECTION, 1991
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MCB, CAMP LEJEUNE, NORTH CAROLINA

Sample Number	USGS	Base-Specific	44SB0500		44SB0507		44SB0600		44SB0608	
Sample Depth (feet)	Background (1)	Background (2)	0-2		7-9		0-2		8-10	
Parameter: Units (mg/kg)										
Inorganics:										
Aluminum	66000	10780	13500		2140		13400		1310	
Arsenic	--	3.8	3.9		1.2	U	2.7		1.2	U
Barium	554	28	20.2		6.1	U	19.3		3.3	U
Calcium	2400	634	9080		96.6	U	3550		167	U
Chromium	53	13.8	17.9		4.6		16.8		3.0	
Copper	25	4.2	2.8		4.5		5.1		2.5	
Iron	25000	10140	15500		1300		8750		869	
Lead	20	26	8.8		4.5		7.9		1.9	
Magnesium	9200	452	594		102		576		71.9	
Manganese	560	10.8	12.7		5.1	U	16.8		3.1	U
Nickel	20	NA	2.2	U	2.1	U	2.1	U	2.2	U
Potassium	--	600	493		250	U	617		264	U
Selenium	--	1.04	0.98	U	0.95	U	0.92	U	0.99	U
Vanadium	--	19.4	27.9		4.3		22.5		2.3	
Zinc	54	8.8	10.1		5.6		13.6		5.8	

NOTES:
mg/kg - Milligram per kilogram
U - Not detected above the Contract Required Quantitation Limit (CRQL)
J - Estimated value, reported value may not be accurate or precise.
DUP - Duplicate.
Shading indicates that chemical exceeded twice the base-specific background concentration
(--) - Value not given.
(1) These values are the regional soil background level averages of the constituents found in the cultivated and uncultivated soils in the eastern U.S. (Shacklette, 1984).
(2) Twice the base-specific soil background concentration, average of three samples (Halliburton/NUS, 1991).
Source: Baker Environmental, Inc., Site Inspection Report, 1991.

TABLE 2-12
GROUNDWATER ANALYTICAL RESULTS
SITE 44 - JONES STREET DUMP
SITE INSPECTION, 1991
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MCB, CAMP LEJEUNE, NORTH CAROLINA

Sample Number	44GW011		44GW021		44GW031		44GW031DUP		Standards and Criteria: NCWQSs (1)	MCLs (2)	Health Advisories (3)
Parameter: Units (ug/L)											
Volatiles:											
Carbon Disulfide	6		5	U	5	U	2	J	--	--	--
Toluene	3	J	5	U	5	U	5	U	1000	1000	1000
Ethylbenzene	2	J	5	U	5	U	5	U	29	700	700
Semivolatiles:											
2-Methylnaphthalene	10	U	10	U	10	U	14		--	--	--
Acenaphthene	10	U	10	U	10	U	16		--	--	--
Dibenzofuran	10	U	10	U	10	U	8	J	--	--	--
Phenanthrene	10	U	10	U	10	U	24		--	--	--
Anthracene	10	U	10	U	10	U	3	J	--	--	--
Fluoroanthene	10	U	10	U	10	U	14		--	--	--
Pyrene	10	U	10	U	10	U	9	J	--	--	--
Benzo(a)anthracene	10	U	10	U	10	U	3	J	--	--	--
Naphthalene	10	U	10	U	10	U	62		--	--	--
Inorganics:											
Aluminum	537000		73000		183000		144000		--	50 to 200 (5)	--
Arsenic	570	R	5.0	U	13.0		10.5	J	50	50	2 (3)
Barium	3180		315		1250		1210		2000	2000	2000
Beryllium	36.6		1.4		3.0		2.5		--	4	0.8 (3)
Cadmium	32.0		4.0	U	4.0	U	5.2		5	5	5
Calcium	191000		2430		197000		201000		--	--	--
Chromium	895		126		221		176		50	100	100
Cobalt	93.2		6.0	U	8.0		7.5		--	--	--
Copper	313		28.6		86.6		78.6		1000	1300 (4)	--
Iron	662000		150000		147000		134000		300	300 (5)	--
Lead	508	R	15.8		481		427		15	15 (4)	--
Magnesium	35700		3640		24100		22800		--	--	--
Manganese	1730		88.0		653		641		50	50 (5)	--
Mercury	1.1		0.20	U	0.20	U	0.20	U	1.1	2	2
Nickel	486		21.9		42.8		45.6		100	100	100
Potassium	32500		4540		22300		20900		--	--	--
Sodium	7500		4060		12600		13400		--	--	--
Thallium	2.7		2.0	U	2.0	U	2.0	U	--	2	0.4
Vanadium	759		184		311		266		--	--	--
Zinc	2800	J	87.3	J	1160	J	1110	J	2100	5000 (5)	2000

NOTES:
ug/L - Microgram per liter.
U - Not detected above the Contract Required Quantitation Limit (CRQL).
R - Unreliable result, chemical may or may not be present in the sample.
J - Estimated value, reported value may not be accurate or precise.
(--) - Standard or advisory not set.
DUP - Duplicate.
Shading indicates that chemical exceeded standard and/or criteria, or advisory.
(1) North Carolina Water Quality Standards for groundwater.
(2) National Primary Drinking Water Regulations, Primary Maximum Contaminant Levels (MCLs).
(3) Health Advisories (USEPA, 1993), values represent lifetime exposures, except for arsenic and beryllium which represent 10-04 lifetime risk.
(4) The standard is an action level (July, 1992).
(5) National Secondary Drinking Water Regulation, Secondary Maximum Contaminant Levels (SMCLs).
Source: Baker Environmental, Inc., Site Inspection Report, 1991.

TABLE 2-13
SURFACE WATER ANALYTICAL RESULTS
SITE 44 - JONES STREET DUMP
SITE INSPECTION, 1991
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MCB, CAMP LEJEUNE, NORTH CAROLINA

Sample Number	44SW01		44SW02		Standards and Criteria: State Water Quality Standards (1)	Ambient Water Quality Criteria (2q)	Freshwater Water Screening Values (3)
Parameter: Units (ug/L)							
Volatiles:							
Carbon Disulfide	18		5	U	--	--	--
1,1,2-Trichloroethane	5	U	3	J	--	9400	940
Inorganics:							
Aluminum	6930		2860		--	--	87
Arsenic	9.3		5	U	50	--	190
Barium	75.5		41.7		1000	--	--
Calcium	60100		44500		--	--	--
Chromium	13.3		4	U	50 (4)	11 (4)	11 (4)
Copper	24.0		11.1		7	12	6.54
Iron	24500		8780		1000	1000	1000
Lead	44.1		17.7		25	3.2	1.32
Magnesium	11000		7870		--	--	--
Manganese	104		84.6		50	--	--
Nickel	9.6		9	U	25	160	87.71
Potassium	3350		2690		--	--	--
Sodium	85600		60100		--	--	--
Vanadium	34.1		10.1		--	--	--
Zinc	153		83.0		50	110	58.91

NOTES:
ug/L - Microgram per liter.
U - Not detected above Contract Required Quantitation Limits.
J - Estimated value, reported value may not be accurate or precise.
(--) - Standard or criteria not available.
Shading indicates that chemical exceeded standard and/or criteria.
(1) North Carolina Surface Water Regulations for freshwater aquatic life is more stringent standard to support additional uses (NCAC, 1991).
(2) Federal Ambient Water Quality Standards, chronic freshwater (USEPA, 1991)
(3) FWSV - Freshwater Water Quality Screening Value (USEPA Region IV, 1993)
(4) State standard is for total chromium, AWQC and FWSV is for Chromium VI.
Source: Baker Environmental, Inc., Site Inspection Report, 1991.

TABLE 2-14
SEDIMENT SAMPLE ANALYTICAL RESULTS
SITE 44 - JONES STREET DUMP
SITE INSPECTION, 1991
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MCB, CAMP LEJEUNE, NORTH CAROLINA

					NOAA SSV (1)	
Sample Number	44SD01		44SD02		ER-L (2)	ER-M (3)
Parameter: Units						
Semivolatiles: ug/kg						
4-Methylphenol	140	J	1500	U	--	--
Benzoic Acid	1800	J	1000	J	--	--
2-Methylnaphthalene	110	J	1500	U	0.065	0.67
Di-n-butylphthalate	140	J	170	J	--	--
Butyl Benzyl Phthalate	1100	U	280	J	--	--
bis(2-Ethylhexyl)phthalate	220	J	290	J	--	--
Pesticides/PCBs: ug/kg						
4,4'-DDE	1000	J	660	J	0.002	0.015
4,4'-DDD	1000	J	250	J	0.002	0.02
Inorganics: mg/kg						
Aluminum	15700	J	10900	J	--	--
Arsenic	5.3	J	4.5	U	33	85
Barium	51.7	J	38.6	J	--	--
Calcium	9600	J	10700	J	--	--
Chromium	26.7	J	23.5	J	80	145
Copper	79.5	J	79.1	J	70	390
Iron	11300	J	10200	J	--	--
Lead	143	J	144	J	35	110
Magnesium	1410	J	1880	J	--	--
Manganese	37.5	J	78.8	J	--	--
Nickel	28.9	J	26.9	J	30	50
Potassium	799	J	960	U	--	--
Sodium	897	U	1640	U	--	--
Vanadium	49.4	J	42.8	J	--	--
Zinc	168	J	149	J	120	270

NOTES:
ug/kg - Microgram per kilogram.
mg/kg - Milligram per kilogram.
U - Not detected above the Contract Required Quantitation Limit (CRQL).
J - Estimated value, reported value may not be accurate or precise.
(--) - Value is not available.
Shading indicates that chemical exceeded NOAA SSV.
(1) NOAA SSV - National Oceanic and Atmospheric Administration Sediment Screening Values (USEPA Region IV, 1992).
(2) ER -L - Effects range - low, if contaminant concentrations fall below the ER-L adverse aquatic effects are considered unlikely.
(3) ER-M - Effects range - median, if contaminant concentrations fall above the ER-M adverse aquatic effects are considered probable. If the value falls between ER-L and ER-M adverse aquatic effects are considered possible.
Source: Baker Environmental, Inc., Site Inspection Report, 1991.

TABLE 2-15
GROUNDWATER ANALYTICAL RESULTS
SITE 54 - CRASH CREW FIRE TRAINING BURN PIT
SITE SUMMARY REPORT, 1990
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MCB, CAMP LEJEUNE, NORTH CAROLINA

Sample Number Sample Date	54GW1 7/16/84	54GW1 12/11/86	Supply Well 5009 7/16/84	54GW2 12/10/86	54GW2 3/5/87	54GW3 12/10/86	54GW3 3/5/87	Standard NCWQS (1)	 MCL (2)
Parameter: Units (ug/L)									
Chromium	60	10.7	< 8	67.9	28	23.9	32	50	100
Chromium (+6)	NA	< 10	NA	14.6	45.9	< 10	12.1	--	--
Lead	< 40	< 27	< 40	< 27	27	< 27	< 27	15 (3)	15 (3)
Oil & Grease	1000	3000	<900	< 300	1000	2000	2000	--	--
Phenols	3	4	2	< 2	< 2	6	< 2	--	--

Notes:
ug/L - microgram per liter
NA - Not analyzed.
(--) - Standard not available.
Shading indicates that chemical exceeded standard.
(1) NCWQS - North Carolina Water Quality Standards for groundwater
(2) MCL - Maximum Contaminant Level
(3) At the time of the investigation the NCWQS and MCL for lead in groundwater were 50 ug/L.
the analytical methods chosen for analysis of the samples were greater than the current NCWQS and MCL for lead (15 ug/L).
Source: ESE, Site Summary Report, Final. September, 1990.

TABLE 2-16
SEDIMENT ANALYTICAL RESULTS
SITE 54 - CRASH CREW FIRE TRAINING BURN PIT
SITE SUMMARY REPORT, 1990
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MCB, CAMP LEJEUNE, NORTH CAROLINA

Sample Number: Date Sampled:	54SE1 12/10/86	54SE2 12/10/86	54SE3 12/10/86
Parameter: Units (mg/kg)			
Chromium	19.3	6.45	6.48
Lead	28.2	9.36	<6.73
Oil & Grease	998	884	1560
Phenols	0.443	0.334	2.01

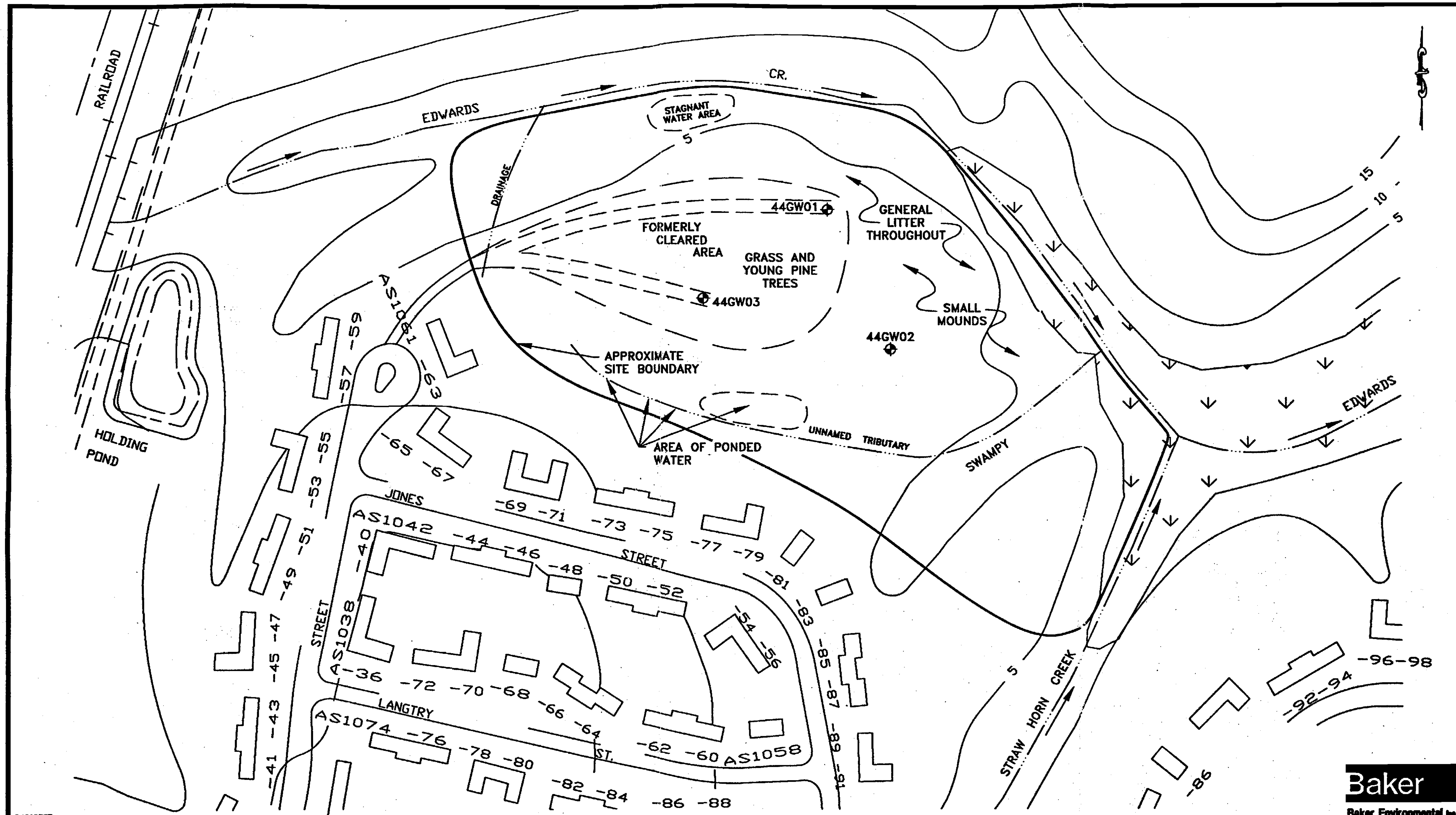
NOTES:
mg/kg - Milligram per kilogram
Source: ESE, Site Summary Report, Final. September, 1990.

TABLE 2-17
GROUNDWATER ANALYTICAL RESULTS
SITE 86 - TANKS AS419, AS420, AND AS421
SITE SUMMARY REPORT, 1990
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MCB, CAMP LEJEUNE, NORTH CAROLINA

	Standards									
Sample Number	NCWQSs (1)	MCLs (2)	86GW02	86GW03*	86GW04	86GW06	86GW08	86GW10	86GW12	H9 **
Parameter: Units (ug/L)										
Benzene	1	5	ND	ND	6	1	ND	ND	ND	ND
Toluene	1000	1000	350	ND	ND	ND	2	ND	1	ND
1,1-Dichloroethane	700	5	ND	ND	ND	ND	ND	750	ND	ND
1,2-Dichloroethylene	--	70 ***	ND	ND	94	ND	ND	76	ND	ND
Trichloroethylene	2.8	5	ND	ND	280	4	ND	77	1	ND
Perchloroethylene	0.7	5	ND	4	ND	ND	ND	210	4	ND
Chloroethane	--	--	ND	ND	ND	ND	ND	12	ND	ND
1,1,1-Tetrachloroethane	200	200	ND	ND	ND	ND	ND	ND	ND	2

Notes:
ug/L - microgram per liter
* - Shallow well, all other wells with positive detections were deep wells.
** - H - Hydropunch
*** - Value is for cis-1,2-dichloroethylene
ND - Not detected
(--) - Standard or criteria not available
(1) NCWQS - North Carolina Water Quality Standards for groundwater
(2) MCL - Maximum Contaminant Level
MCL is for cis-1,2-dichloroethene
Source: ESE, Site Summary Report, Final. September, 1990.

SECTION 2.0
FIGURES



LEGEND

44GW01 EXISTING SHALLOW MONITORING WELL LOCATION

SOURCE: LANTDIV, FEB. 1992

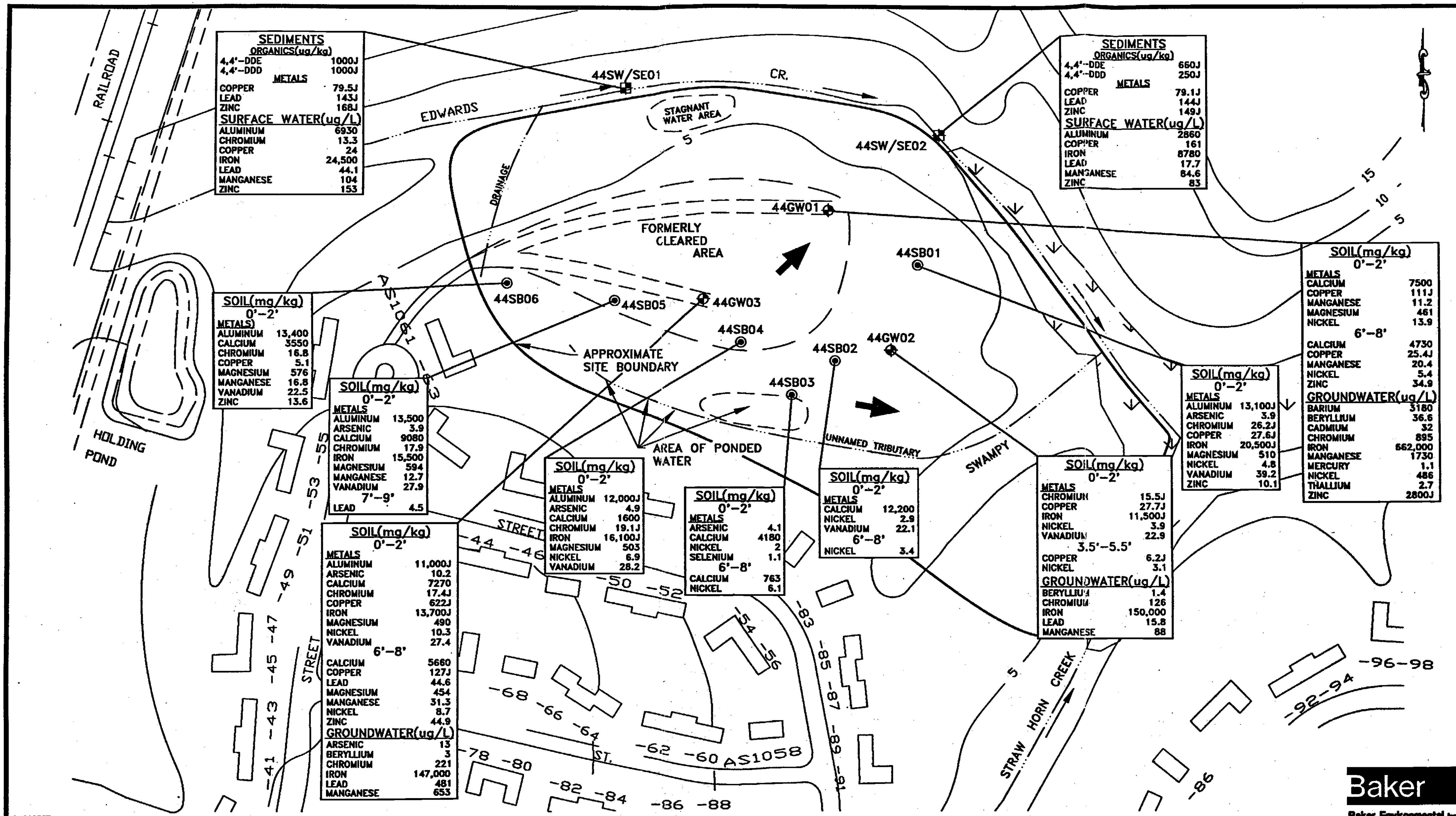
150 0 75 150 300

1 inch = 150 ft.

FIGURE 2-8
SITE PLAN
SITE 44: JONES STREET DUMP
CTO-0246

MARINE CORPS AIR STATION, NEW RIVER
JACKSONVILLE, NORTH CAROLINA

015672B12



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Baker Environmental, Inc.

LEGEND

- 44GW01 — EXISTING SHALLOW MONITORING WELL LOCATION
- 44SB01 — PREVIOUS SOIL BORING LOCATION
- 44SW/SE01 — PREVIOUS SURFACE WATER/SEDIMENT SAMPLE STATION
- → APPROXIMATE GROUNDWATER FLOW DIRECTION

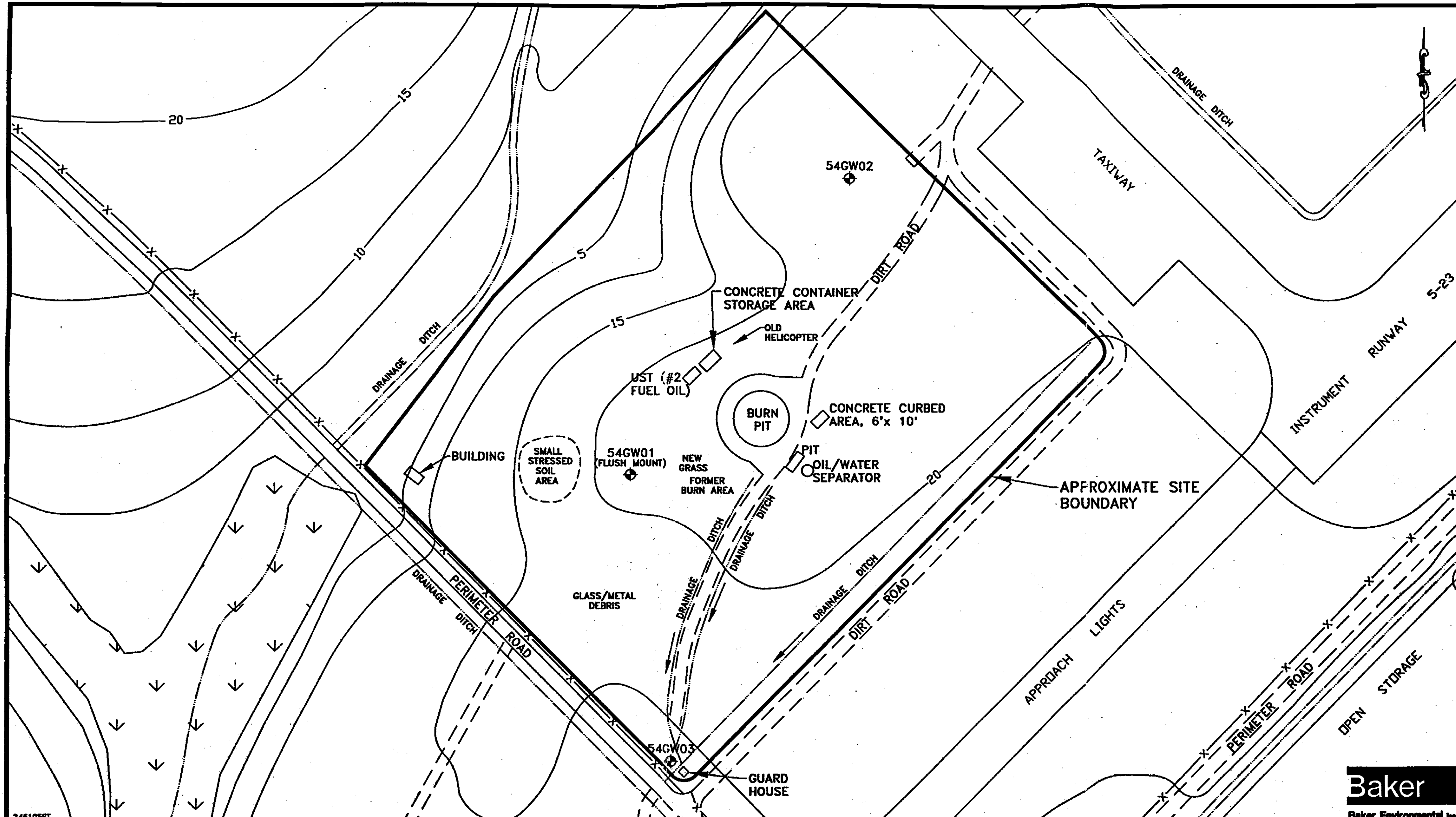
NOTES:
- -ALL RESULTS PRESENTED IN ug/L(water) OR mg/kg(soil).
- -ONLY THOSE CONCENTRATIONS WHICH EXCEED STATE/FEDERAL STANDARDS, OR RISK-BASED/BASE BACKGROUND ARE SHOWN.

SOURCE: LANTDIV, FEB. 1992

150 0 75 150 300

1 inch = 150 ft.

FIGURE 2-9
PREVIOUS INVESTIGATION SAMPLE LOCATIONS AND RESULTS
SITE 44: JONES STREET DUMP
CTO-0246
MARINE CORPS AIR STATION, NEW RIVER
JACKSONVILLE, NORTH CAROLINA



LEGEND

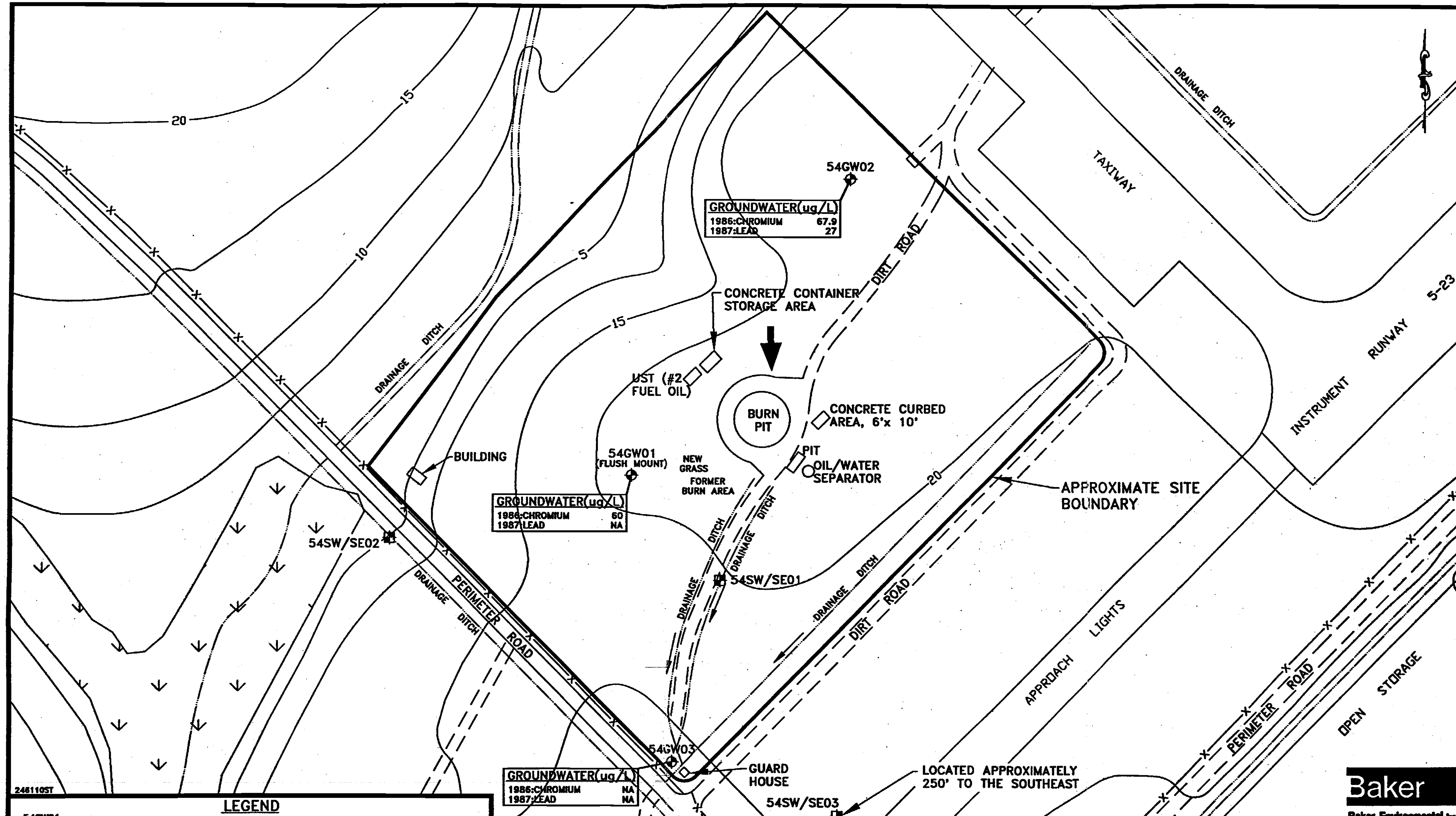
54GW01 EXISTING SHALLOW MONITORING WELL LOCATION

SOURCE: LANTDIV, FEB. 1992

150 0 75 150 300

1 inch = 150 ft.

FIGURE 2-10
SITE PLAN
SITE 54: CRASH CREW FIRE TRAINING BURN PIT
CTO-0246
MARINE CORPS AIR STATION, NEW RIVER
JACKSONVILLE, NORTH CAROLINA



LEGEND

54GW01 EXISTING SHALLOW MONITORING WELL LOCATION

54SW/SE01 PREVIOUS SURFACE WATER/SEDIMENT SAMPLE STATION

→ APPROXIMATE GROUNDWATER FLOW DIRECTION

NA NOT APPLICABLE

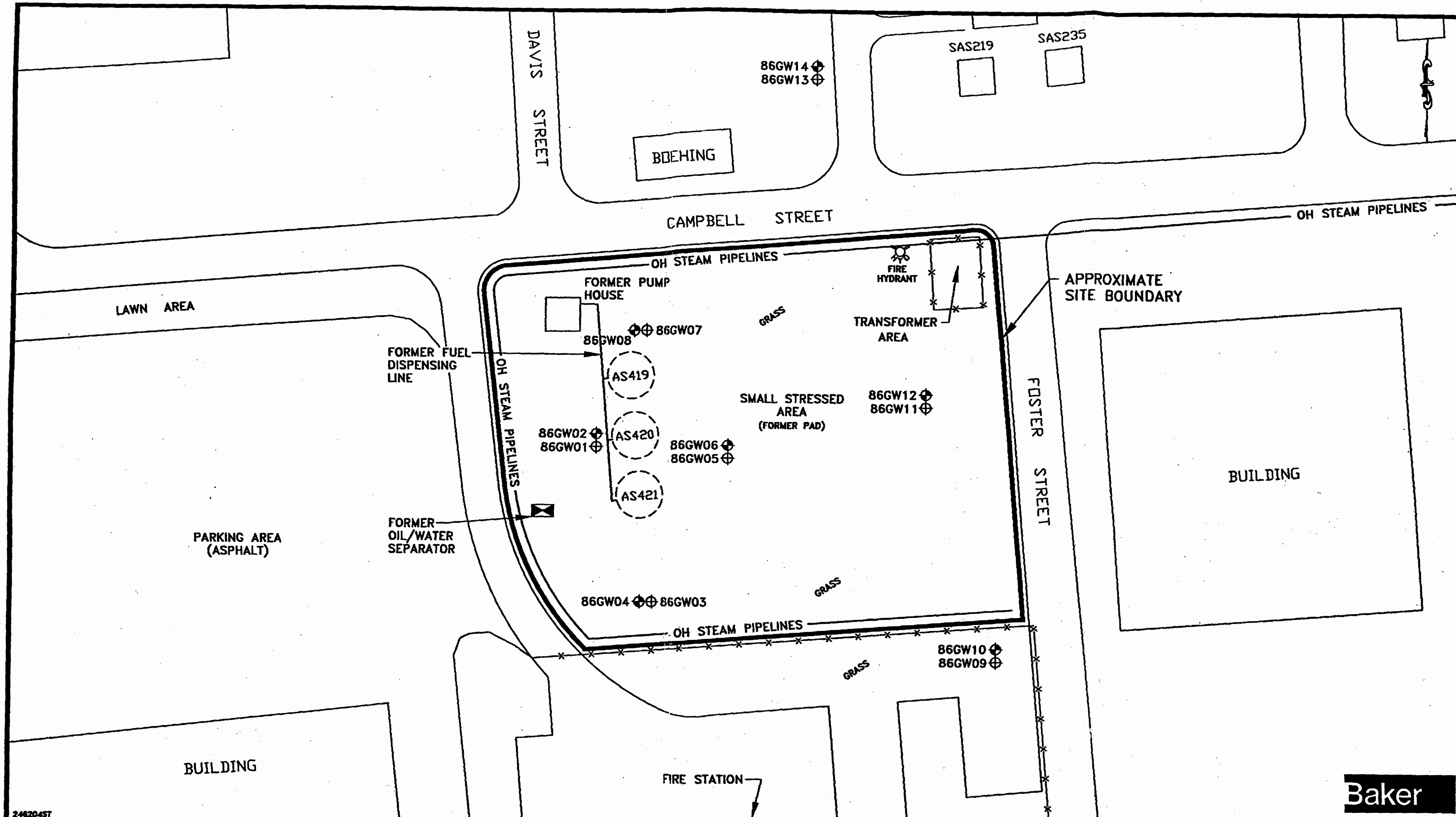
NOTES:
- ALL RESULTS PRESENTED IN ug/L.
- ONLY THOSE CONCENTRATIONS WHICH EXCEED STATE OR FEDERAL STANDARDS ARE SHOWN.
- NO SURFACE WATER/SEDIMENT CONCENTRATIONS EXCEEDED STANDARDS OR CRITERIA.

SOURCE: LANTDIV, FEB. 1992

150 0 75 150 300

1 inch = 150 ft.

FIGURE 2-11
PREVIOUS INVESTIGATION SAMPLE LOCATIONS AND RESULTS
SITE 54: CRASH CREW FIRE TRAINING BURN PIT
CTO-0246
MARINE CORPS AIR STATION, NEW RIVER
JACKSONVILLE, NORTH CAROLINA



LEGEND

86GW01 EXISTING SHALLOW MONITORING WELL LOCATION

86GW02 EXISTING INTERMEDIATE MONITORING WELL LOCATION

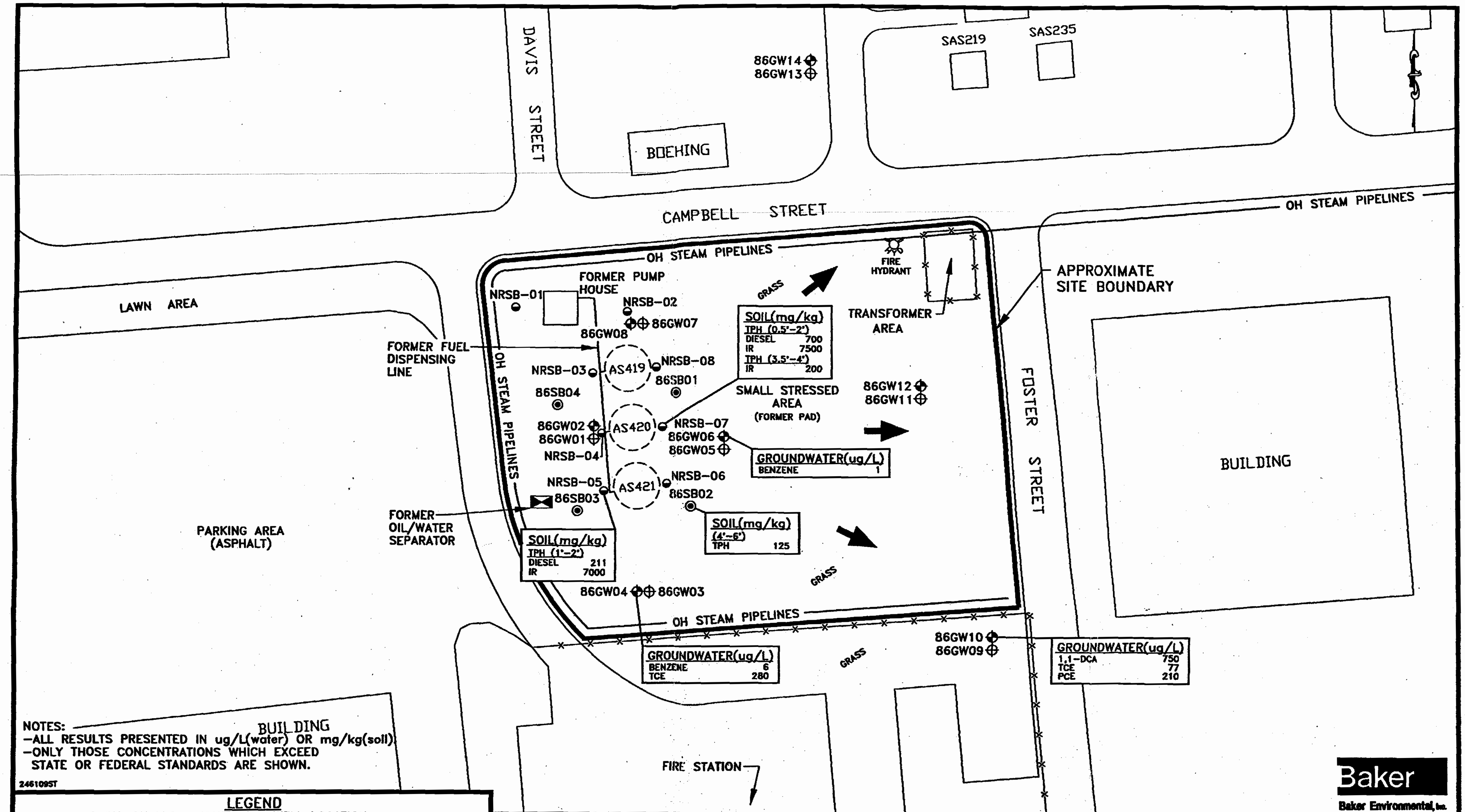
AS421 FORMER AST LOCATION

SOURCE: LANTDIV, FEB. 1992

50 0 25 50 100

1 inch = 50 ft.

FIGURE 2-12
SITE PLAN
SITE 86: TANK AREA AS419 – AS421 AT MARINE CORPS AIR STATION
CTO-0246
MARINE CORPS AIR STATION, NEW RIVER
JACKSONVILLE, NORTH CAROLINA



NOTES:
-ALL RESULTS PRESENTED IN ug/L(water) OR mg/kg(soil)
-ONLY THOSE CONCENTRATIONS WHICH EXCEED STATE OR FEDERAL STANDARDS ARE SHOWN.

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LEGEND

- 86GW01 EXISTING SHALLOW MONITORING WELL LOCATION (O'BRIEN AND GERE, 1992)
- 86GW02 EXISTING INTERMEDIATE MONITORING WELL LOCATION (O'BRIEN AND GERE, 1992)
- 86SB01 PREVIOUS SOIL BORING LOCATION (O'BRIEN AND GERE, 1992)
- NRSB-01 PREVIOUS SOIL BORING LOCATION (DEWBERRY AND DAVIS, 1990)
- APPROXIMATE GROUNDWATER FLOW DIRECTION (SHALLOW)
- AS421 FORMER AST LOCATION

SOURCE: LANTDIV, FEB. 1992

50 0 25 50 100

1 inch = 50 ft.

FIGURE 2-13
PREVIOUS INVESTIGATION SAMPLE STATIONS AND RESULTS
SITE 86: TANK AREA AS419 - AS421 AT MARINE CORPS AIR STATION
CTO-0246

MARINE CORPS AIR STATION, NEW RIVER
JACKSONVILLE, NORTH CAROLINA

3.0 DATA QUALITY AND SAMPLING OBJECTIVES

The purpose of this section is to define the site-specific RI/FS data quality and sampling objectives in order to fulfill the overall goals of characterizing the problems at each site, assessing potential impacts to the public health and environment, and identifying feasible remedial alternatives for remediating the sites, if necessary. The site-specific RI/FS objectives presented in this section have been identified based on review and evaluation of existing background information.

3.1 Data Quality Objectives

Data Quality Objectives (DQOs) are qualitative and quantitative statements that ensure data of known and appropriate quality are obtained during the RI/FS. The DQOs associated with each field sampling and analysis program are discussed and presented in this section. The DQOs were developed using the following three stages:

- Stage 1 - Identify decision types
- Stage 2 - Identify data uses/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 and the development of objectives for field 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 the design of a data collection program to meet the requirements identified in Stage 2.

3.1.1 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 current site conditions, evaluate existing data, and assess the adequacy of the data. This was documented in Section 2.0 of this Work Plan. From this review and evaluation, RI/FS objectives have been developed to (1) assess the nature of the threat posed by the release or potential release of hazardous substances; (2) characterize the site with respect to the environmental setting; and (3) evaluating potential remedial alternatives. These objectives are presented in Section 3.2.

3.1.2 Stage 2 - Identification of Data Uses/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. With respect to the RI/FS objectives, data will be required to address specific environmental media at each site. Data uses for each environmental media are presented in Section 3.1.2.1. Site-specific data needs are discussed in Section 3.1.2.2.

3.1.2.1 Data Uses for Environmental Media

RI/FS data uses can be described in general purpose categories. These categories include the following:

- Site Characterization - Data are used to determine the nature and extent of contamination at a site. Site characterization data are generated through the sampling and analysis of waste sources and environmental media.

- Health and Safety - Data are typically used to establish the level of protection needed for investigators or workers at a site, and if there should be an immediate concern for the population living within the site vicinity.

- Risk Assessment - Data are used to evaluate the threat posed by a site to public health and the environment. Risk assessment data are generated through the sampling and analysis of environmental and biological media, particularly where the potential for human or ecological exposure is great (e.g., sediments, surface soil, potable groundwater supplies).

- Evaluation of Alternatives - Data are used to evaluate various remedial technologies. Engineering data are collected in support of remedial alternative evaluation and to develop cost estimates for remediating the site. This may involve conducting bench or pilot-scale studies to determine the effectiveness or implementability of the technology.

- Engineering Design of Alternatives - Data collected during the RI/FS can be used for engineering purposes to develop a preliminary data base in reference to the performance of various remedial technologies. Data types collected during the RI/FS which are applicable to the RD process include waste characterization and preliminary volume estimates (these estimates can be further defined during the remedial design/remedial action via additional field verification sampling).

The above discussion of data uses was extracted from the document entitled Data Quality Objectives for Remedial Response Activities: Development Process (OSWER Directive 9355.0-7B). It has been presented in this Work Plan to provide the user with an understanding of the rationale for determining the site-specific RI/FS objectives as well as the rationale for the proposed sampling and analytical program for each site investigation.

With respect to the above data uses, an understanding of the site background, site history, and contaminant migration and exposure pathways are required in order to define the data needs (or data limitations). This "background" information was presented in Section 2.0 for each site. The site-specific data needs are presented in Section 3.1.2.2. RI/FS objectives, which have been formed to meet the data needs, are presented in Section 3.2.

3.1.2.2 Site-Specific Data Needs

Site 36 - Camp Geiger Dump Area Near Sewage Treatment Plant

- The potential impact to human health and the environment due to the reported disposal of municipal wastes and mixed industrial wastes based on soil, groundwater, surface water/sediment, fish, and benthic organism data.

- The nature of the contaminants which have potentially impacted soil, groundwater, surface water, sediments, fish, and benthic organisms.

- The horizontal and vertical extent of potentially contaminated soil within the Formerly Cleared Area, the Open Field Area, the Former Dump Area, and the remaining areas of the site.

- The horizontal and vertical extent of potentially contaminated groundwater within the Formerly Cleared Area, the Open Field Area, the Former Dump Area, and the remaining areas of the site.

- The site-specific control/background concentrations for soil, groundwater, surface water, and sediment.

- The presence or absence of potential hazardous substances in surface and/or buried drums.

- The environmental impacts associated with releases of potentially hazardous substances from drums.

- The presence or absence of site-related contaminants in sediments and/or surface water in Brinson Creek and the unnamed tributary.

- The risks to human health and the environment associated with current or future surface water and groundwater use or exposure.

- The risk to human health and the environment associated with the exposure to sediments in Brinson Creek and the unnamed tributary.

- The presence or absence of site-related contaminants in surface and subsurface soil to conduct a human health and ecological risk assessment.

- The effects of natural discharge from shallow and deep groundwater on local surface water.

- The presence or absence of buried material or waste.

- The hydrogeologic and geologic characteristics of the shallow and deep groundwater/soil.

- The effect of tidal changes, if any, on local surface water and groundwater.

- The hydrologic characteristics of Brinson Creek and the unnamed tributary.

Site 43 - Agan Street Dump

- The potential impact to human health and the environment due to the reported disposal of construction debris, sewage treatment plant sludge, and possibly petroleum wastes based on soil, groundwater, surface water, and sediment data.

- The nature of the contaminants which have potentially impacted soil, groundwater, surface water, and sediments.

- The horizontal and vertical extent of potentially contaminated soil within the Mounded Soil Area, in the vicinities of well 43GW01 and the Debris/Paint Can Areas, and the remaining site area.

- The horizontal and vertical extent of potentially contaminated groundwater at the site.

- The site-specific control/background concentrations for soil, groundwater, surface water, and sediment.

- The presence or absence of site-related contaminants in sediments and/or surface water in Edwards Creek and Straw Horn Creek.

- The risks to human health and the environment associated with current or future surface water and groundwater use or exposure.

- The risk to human health and the environment associated with the exposure to sediments in Edwards Creek and Straw Horn Creek.

- The presence or absence of site-related contaminants in surface and subsurface soil to conduct a human health and ecological risk assessment.

- The effects of natural discharge from shallow and deep groundwater on local surface water.

- The presence or absence of buried material or waste.

- The hydrogeologic and geologic characteristics of the shallow and deep groundwater/soil.

- The hydrologic characteristics of Edwards Creek and Straw Horn Creek.

Site 44 - Jones Street Dump

- The potential impact to human health and the environment due to the reported disposal of construction debris and possibly petroleum wastes based on soil, groundwater, surface water, and sediment data.

- The nature of the contaminants which have potentially impacted soil, groundwater, surface water, and sediments.

- The horizontal and vertical extent of potentially contaminated soil in the vicinity of well 44GW03 and the remaining site area.

- The horizontal and vertical extent of potentially contaminated groundwater at the site.

- The site-specific control/background concentrations for soil, groundwater, surface water, and sediment.

- The presence or absence of site-related contaminants in sediments and/or surface water in Edwards Creek, Straw Horn Creek, and the unnamed tributary.

- The risks to human health and the environment associated with current or future surface water and groundwater use or exposure.

- The risk to human health and the environment associated with the exposure to sediments in Edwards Creek, Straw Horn Creek, and the unnamed tributary.

- The presence or absence of site-related contaminants in surface and subsurface soil to conduct a human health and ecological risk assessment.

- The effects of natural discharge from shallow and deep groundwater on local surface water.

- The presence or absence of buried material or waste.

- The hydrogeologic and geologic characteristics of the shallow and deep groundwater/soil.

- The hydrologic characteristics of Edwards Creek and Straw Horn Creek.

Site 54 - Crash Crew Fire Training Burn Pit

- The potential impact to human health and the environment due to release of petroleum/solvent wastes based on soil and groundwater data.

- The nature of the contaminants which have potentially impacted soil and groundwater.

- The horizontal and vertical extent of potentially contaminated soil in the vicinity of the Former/Current Burn Pit Areas and Small Oil Spill Area.

- The horizontal of potentially contaminated shallow groundwater at the site.

- The site-specific control/background concentrations for soil and groundwater.

- The presence or absence of site-related contaminants in drainage ditches.

- The risks to human health and the environment associated with current or future groundwater use or exposure.

- The presence or absence of site-related contaminants in surface and subsurface soil to conduct a human health and ecological risk assessment.

- The effects of natural discharge from shallow groundwater on local surface water.

- The hydrogeologic and geologic characteristics of the shallow groundwater/soil.

- The effect of site drainage ditches on surface water runoff.

Site 86 - Tanks AS419 through AS421 at Marine Corps Air Station

- The potential impact to human health and the environment due to release of petroleum/solvent wastes based on soil and groundwater data.

- The nature of the contaminants which have potentially impacted soil and groundwater.

- The horizontal and vertical extent of potentially contaminated soil in the vicinity of the Former Aboveground Storage Tank Area.

- The horizontal and vertical extent of potentially contaminated shallow and deep groundwater at the site.

- The site-specific control/background concentrations for soil and groundwater.

- The risks to human health and the environment associated with current or future groundwater use or exposure.

- The presence or absence of site-related contaminants in surface and subsurface soil to conduct a human health and ecological risk assessments.

- The hydrogeologic and geologic characteristics of the shallow groundwater/soil.

The type and quality of data required to meet the criteria listed above are presented in Section 4.0. 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 subsequent investigations. Level III data quality is appropriate for risk assessments, site characterization, and evaluating treatment alternatives. Level II data quality is appropriate for field screening (i.e., ENSYS Screening). Level I data is appropriate for field measurements such as static water level, specific conductance, and pH. The analytical methods also differ with respect to the end use of the data. For this RI/FS, USEPA methods and Contract Laboratory Program (CLP) methods will be used when applicable.

3.1.3 Stage 3 - Design Data Collection Program

The data collection programs for Sites 36, 43, 44, 54, and 86 have been designed to meet the objectives outlined in the following sections. Section 4.0 of the RI/FS Work Plan provides a general description of the various sampling programs for the four sites. Sections 3.0 through 5.0 of this FSAP provide the specific details of these sampling programs.

3.2 Study Objectives

For each site-specific study objectives, the criteria necessary to meet each objective along with a general description of the study or investigation required to obtain the information in Table 3-1.

SECTION 3.0
TABLES

TABLE 3-1

REMEDIAL INVESTIGATION/FEASIBILITY STUBY OBJECTIVES FOR OPERABLE UNIT NO. 6
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Medium or Area of Concern	RI/FS Objective	Criteria for Meeting Objective	Proposed Investigation/Study
1. Site 36 - Soil	1a. Assess the extent of soil contamination at the Formerly Cleared Area, Open Field Area, Former Dump Area, and Drum Disposal Area.	Characterize contaminant levels in surface and subsurface soils at the Formerly Cleared Area, Open Field Area, Former Dump Area, and Drum Disposal Area.	Soil Investigation
	1b. Assess human health and ecological risks associated with exposure to surface soils at the site.	Characterize contaminant levels in surface and subsurface soils at the site.	Soil Investigation Risk Assessment
	1c. Determine whether organic or inorganic contamination from soils is migrating to groundwater.	Characterize groundwater quality in the former dump area.	Groundwater Investigation
	1d. Determine the physical and chemical nature of buried debris and/or waste.	Characterize the physical and chemical nature of the buried debris and/or waste.	Test Pit Investigation
	1e. Evaluate treatment alternatives.	Characterize areas of concern above action levels. Evaluate effectiveness and implementability of technology.	Soil Investigation Feasibility Study Bench or Pilot Scale Testing
2. Site 36 - Groundwater	2a. Assess health risks posed by potential future usage of the shallow and deep groundwater.	Evaluate groundwater quality and compare to ARARs and health-based action levels.	Groundwater Investigation Risk Assessment
	2b. Assess the extent of shallow and deep groundwater contamination.	Determine the horizontal extent of shallow groundwater contamination; determine the horizontal and vertical extent of deep groundwater contamination.	Groundwater Investigation
	2c. Define hydrogeologic characteristics for fate and transport evaluation and remedial technology evaluation, if required.	Estimate hydrogeologic characteristics of the shallow and deep aquifers (flow direction, transmissivity, permeability, etc.).	Groundwater Investigation

TABLE 3-1 (Continued)

REMEDIAL INVESTIGATION/FEASIBILITY STUDY OBJECTIVES FOR OPERABLE UNIT NO. 6
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Medium or Area of Concern	RI/FS Objective	Criteria for Meeting Objective	Proposed Investigation/Study
3. Site 36 - Sediment	3a. Assess human health and ecological risks associated with exposure to sediments in the unnamed tributary and Brinson Creek.	Characterize nature and extent of contamination in sediment.	Sediment Investigation in the unnamed tributary and Brinson Creek Risk Assessment
	3b. Assess potential ecological impacts posed by contaminated sediments in the unnamed tributary and Brinson Creek.	Qualitatively evaluate stress to benthic and fish communities.	Evaluation of Surface Water and Sediment Investigation
	3c. Determine extent of sediment contamination for purposes of identifying areas potentially requiring remediation.	Identify extent of sediment contamination where contaminant levels exceed risk-based action levels or USEPA Region IV TBCs for sediment.	Sediment Investigation in the unnamed tributary and Brinson Creek Risk Assessment
4. Site 36 - Surface Water	4a. Assess the presence or absence of surface water contamination in the unnamed tributary and Brinson Creek.	Determine surface water quality in the unnamed tributary and Brinson Creek.	Surface Water Investigation
5. Waste	6a. Determine the nature of drum/container waste material.	Characterize the nature of the waste.	Drum/Container Sampling Investigation
	6b. Evaluate disposal options for wastes.	Evaluate chemical data for comparison with disposal criteria.	Drum/Container Sampling Investigation

TABLE 3-1 (Continued)

REMEDIAL INVESTIGATION/FEASIBILITY STUDY OBJECTIVES FOR OPERABLE UNIT NO. 6
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Medium or Area of Concern	RI/FS Objective	Criteria for Meeting Objective	Proposed Investigation/Study
1. Site 43 - Soil	1a. Assess the extent of soil contamination in the Mounded Soil Area, adjacent to existing well 43GW01, and Debris/Paint Can Disposal Area.	Characterize contaminant levels in surface and subsurface soils at the Mounded Soil Area, adjacent to existing well 43GW01, and Debris/Paint Can Disposal Area.	Soil Investigation
	1b. Assess human health and ecological risks associated with exposure to surface soils at the site.	Characterize contaminant levels in surface soils at the study area.	Soil Investigation Risk Assessment
	1c. Determine whether contamination from soils is migrating to groundwater.	Characterize subsurface soil and leaching potential. Characterize shallow groundwater.	Soil Investigation Groundwater Investigation
	1d. Evaluate treatment alternatives.	Characterize areas of concern above action levels. Evaluate effectiveness and implementability of technologies.	Soil Investigation Feasibility Study Bench or Pilot-Scale Testing
	1e. Determine the physical and chemical nature of buried debris and/or waste.	Characterize the physical and chemical nature of buried debris and/or waste.	Test Pit Investigation
2. Site 43 - Groundwater	2a. Assess health risks posed by potential future usage of the shallow and deep groundwater.	Evaluate groundwater quality and compare to groundwater criteria and risk-based action levels.	Groundwater Investigation Risk Assessment
	2b. Assess nature and extent of shallow and deep groundwater contamination.	Characterize shallow and deep groundwater quality.	Groundwater Investigation
	2c. Define hydrogeologic characteristics for fate and transport evaluation and remedial technology evaluation, if required.	Estimate hydrogeologic characteristics of the shallow and deep aquifers (flow direction, transmissivity, permeability, etc.).	Groundwater Investigation

TABLE 3-1 (Continued)

REMEDIAL INVESTIGATION/FEASIBILITY STUDY OBJECTIVES FOR OPERABLE UNIT NO. 6
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Medium or Area of Concern	RI/FS Objective	Criteria for Meeting Objective	Proposed Investigation/Study
3. Site 43 - Sediment	3a. Assess human health and ecological risks associated with exposure to sediments in Edwards Creek and Straw Horn Creek.	Characterize nature and extent of contamination in sediment.	Sediment Investigation in Edwards Creek and Straw Horn Creek Risk Assessment
	3b. Assess potential ecological impacts posed by contaminated sediments in Edwards Creek and Straw Horn Creek.	Qualitatively evaluate stress to benthic and fish communities.	Evaluation of Surface Water and Sediment Investigation Evaluation of Bioassay Results
	3c. Determine extent of sediment contamination for purposes of identifying areas of concern.	Identify extent of sediment contamination where contaminant levels exceed risk-based action levels or USEPA Region IV criteria.	Sediment Investigation in Edwards Creek and Straw Horn Creek Risk Assessment
4. Site 43 - Surface Water	4a. Assess the presence or absence of surface water contamination in Edwards Creek and Straw Horn Creek.	Determine surface water quality in Edwards Creek and Straw Horn Creek.	Surface Water Investigation
	4b. Assess potential ecological impacts posed by contaminated surface water in Edwards Creek and Straw Horn Creek.	Determine surface water quality in Edwards Creek and Straw Horn Creek.	Evaluation of Surface Water and Sediment Investigation Evaluation of Bioassay Results

TABLE 3-1 (Continued)

REMEDIAL INVESTIGATION/FEASIBILITY STUDY OBJECTIVES FOR OPERABLE UNIT NO. 6
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Medium or Area of Concern	RI/FS Objective	Criteria for Meeting Objective	Proposed Investigation/Study
1. Site 44 - Soil	1a. Assess the extent of soil contamination in the area adjacent to existing well 44GW03 and other areas at the site.	Characterize contaminant levels in surface and subsurface soils at the site.	Soil Investigation
	1b. Assess human health and ecological risks associated with exposure to surface soils at the site.	Characterize contaminant levels in surface soils at the study area.	Soil Investigation Risk Assessment
	1c. Determine whether contamination from soils is migrating to groundwater.	Characterize subsurface soil and leaching potential. Characterize shallow groundwater.	Soil Investigation Groundwater Investigation
	1d. Determine the physical and chemical nature of buried debris and/or waste.	Characterize the physical and chemical nature of buried debris and/or waste.	Test Pit Investigation
	1e. Evaluate treatment alternatives.	Characterize areas of concern where contaminant concentrations in soil are above action levels. Evaluate effectiveness and implementability of technologies.	Soil Investigation Feasibility Study Bench or Pilot-Scale Testing
2. Site 44 - Groundwater	2a. Assess health risks posed by potential future usage of the shallow and deep groundwater.	Evaluate groundwater quality and compare to groundwater criteria and risk-based action levels.	Groundwater Investigation Risk Assessment
	2b. Assess nature and extent of shallow and deep groundwater contamination.	Characterize shallow and deep groundwater quality.	Groundwater Investigation
	2c. Define hydrogeologic characteristics for fate and transport evaluation and remedial technology evaluation, if required.	Estimate hydrogeologic characteristics of the shallow and deep aquifers (flow direction, transmissivity, permeability, etc.).	Groundwater Investigation

TABLE 3-1 (Continued)

REMEDIAL INVESTIGATION/FEASIBILITY STUDY OBJECTIVES FOR OPERABLE UNIT NO. 6
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Medium or Area of Concern	RI/FS Objective	Criteria for Meeting Objective	Proposed Investigation/Study
3. Site 44 - Sediment	3a. Assess human health and ecological risks associated with exposure to sediments in Edwards Creek, Straw Horn Creek, and unnamed tributaries.	Characterize nature and extent of contamination in sediment.	Sediment Investigation in Edwards Creek, Straw Horn Creek, and unnamed tributaries Risk Assessment
	3b. Assess potential ecological impacts posed by contaminated sediments in Edwards Creek, Straw Horn Creek, and unnamed tributaries.	Qualitatively evaluate stress to benthic and fish communities.	Evaluation of Surface Water and Sediment Investigation
	3c. Determine extent of sediment contamination for purposes of identifying areas of concern.	Identify extent of sediment contamination where contaminant levels exceed risk-based action levels or USEPA Region IV criteria.	Sediment Investigation in Edwards Creek, Straw Horn Creek, and unnamed tributaries Risk Assessment
4. Site 44 - Surface Water	4a. Assess the presence or absence of surface water contamination in Edwards Creek, Straw Horn Creek, and unnamed tributaries.	Determine surface water quality in Edwards Creek, Straw Horn Creek, and unnamed tributaries.	Surface Water Investigation
	4b. Assess potential ecological impacts posed by contaminated surface water in Edwards Creek, Straw Horn Creek, and unnamed tributaries.	Determine surface water quality in Edwards Creek, Straw Horn Creek, and unnamed tributaries.	Evaluation of Surface Water and Sediment Investigation Evaluation of Bioassay Results

TABLE 3-1 (Continued)

REMEDIAL INVESTIGATION/FEASIBILITY STUDY OBJECTIVES FOR OPERABLE UNIT NO. 6
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Medium or Area of Concern	RI/FS Objective	Criteria for Meeting Objective	Proposed Investigation/Study
1. Site 54 - Soil	1a. Assess the extent of soil contamination in the Former and Existing Burn Dump Areas, and Stressed Spill Area.	Characterize contaminant levels in surface and subsurface soils at the Former and Existing Burn Dump Areas, and Stressed Spill Area.	Soil Investigation
	1b. Assess human health and ecological risks associated with exposure to surface soils at the site.	Characterize contaminant levels in surface soils at the study area.	Soil Investigation Risk Assessment
	1c. Determine whether contamination from soils is migrating to groundwater.	Characterize subsurface soil and leaching potential. Characterize shallow groundwater.	Soil Investigation Groundwater Investigation
	1d. Evaluate treatment alternatives.	Characterize areas of concern which exhibit contaminant concentrations above action levels. Evaluate effectiveness and implementability of technologies.	Soil Investigation Feasibility Study Bench or Pilot-Scale Testing
2. Site 54 - Groundwater	2a. Assess health risks posed by potential future usage of the shallow groundwater.	Evaluate groundwater quality and compare to groundwater criteria and risk-based action levels.	Groundwater Investigation Risk Assessment
	2b. Assess nature and extent of shallow groundwater contamination.	Characterize shallow groundwater quality.	Groundwater Investigation
	2c. Define hydrogeologic characteristics for fate and transport evaluation and remedial technology evaluation, if required.	Estimate hydrogeologic characteristics of the shallow aquifer (flow direction, transmissivity, permeability, etc.).	Groundwater Investigation
3. Site 54 - Drainage Ditches	3a. Assess human health and ecological risks associated with exposure to soils and surface water runoff from drainage ditches.	Characterize nature and extent of contamination in soil and surface water runoff.	Drainage Ditch Investigation
	3b. Determine extent of soil and water contamination for purposes of identifying areas of concern.	Identify extent of contamination where contaminant levels exceed risk-based action levels or USEPA Region IV criteria.	Drainage Ditch Investigation

TABLE 3-1 (Continued)

REMEDIAL INVESTIGATION/FEASIBILITY STUDY OBJECTIVES FOR OPERABLE UNIT NO. 6
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Medium or Area of Concern	RI/FS Objective	Criteria for Meeting Objective	Proposed Investigation/Study
1. Site 86 - Soil	1a. Assess the extent of soil contamination in the areas of ASTs AS420 and AS421.	Characterize contaminant levels in surface and subsurface soils in the areas of ASTs AS420 and AS421.	Soil Investigation
	1b. Assess human health and ecological risks associated with exposure to surface soils at the site.	Characterize contaminant levels in surface soils at the study area.	Soil Investigation Risk Assessment
	1c. Determine whether contamination from soils is migrating to groundwater.	Characterize subsurface soil and leaching potential. Characterize shallow groundwater.	Soil Investigation Groundwater Investigation
	1d. Evaluate treatment alternatives.	Characterize areas of concern which exhibit contaminant concentrations above action levels. Evaluate effectiveness and implementability of technologies.	Soil Investigation Feasibility Study Bench or Pilot-Scale Testing
2. Site 86 - Groundwater	2a. Assess health risks posed by potential future usage of the shallow and deep groundwater.	Evaluate groundwater quality and compare to groundwater criteria and risk-based action levels.	Groundwater Investigation Risk Assessment
	2b. Assess nature and extent of shallow and deep groundwater contamination.	Characterize shallow and deep groundwater quality.	Groundwater Investigation
	2c. Define hydrogeologic characteristics for fate and transport evaluation and remedial technology evaluation, if required.	Estimate hydrogeologic characteristics of the shallow and deep aquifers (flow direction, transmissivity, permeability, etc.).	Groundwater Investigation

4.0 REMEDIAL INVESTIGATION/FEASIBILITY STUDY TASKS

This section identifies the tasks and field investigations required to complete RI/FS activities at all of the sites.

4.1 Task 1 - Project Management

Project Management activities involve such activities as daily technical support and guidance, budget and schedule review and tracking, preparation and review of invoices, personnel resources planning and allocation, preparation of monthly progress reports, and communication with LANTDIV and the Activity.

4.2 Task 2 - Subcontract Procurement

Task 2 involves the procurement of services such as drilling, IDW removal, surveying, laboratory analysis, data validation, and data management. Procurement of these services will be performed in accordance with the Navy Clean Contract Procurement Manual.

4.3 Task 3 - Record Search and Literature Review

Task 3 will involve conducting record searches and literature reviews of site-related information. This task also involves conducting interviews with Base or government personnel. Information gathered during this task will be used for preparing the RI and FS reports.

4.4 Task 4 - Field Investigations

The field investigations will be conducted under Task 4. An overview of the field investigations to be conducted at each of the five sites is presented in the following subsections. Specific details with respect to the sampling procedures, locations and number of samples, and analytical methods are provided in the Field Sampling and Analysis Plan (FSAP) and the Quality Assurance Project Plan (QAPP). The field investigations described below will provide data to meet the overall RI/FS objectives presented in Section 3.0 of this RI/FS Work Plan. Table 4-1 summarizes the sampling and analytical requirements, as well as the data quality levels.

4.4.1 Site 36 - Camp Geiger Dump Area Near Sewage Treatment Plant

The following investigations and support activities will be conducted at Site 36.

Surveying

Surveying tasks will be completed in three phases. Phase I will include a land survey which will identify surface features such as streams, mounds, and the site boundary. During the Phase II survey, the location of the proposed soil borings and monitoring wells will be surveyed to establish their horizontal control. The horizontal and vertical control for all site monitoring wells, staff gauges, surface water/sediment stations, and test pit trenches will be established during the Phase III survey.

Soil Investigation

A soil investigation will be conducted to confirm the absence or presence of contaminants and to evaluate the extent of contaminants in the soils. The investigation to be conducted at Site 36 will focus on five main areas: (1) the Formerly Cleared Area; (2) the Open Field Area; (3) the Former Dump Area; (4) the Drum Disposal Areas; and (5) the remaining site area. These areas were identified as potential areas of concern (AOCs) based on observations made during the site visit and review of historical photographs. Note that soil samples were not collected for analysis during previous investigations. The following field program will be implemented for this investigation.

- A projected total number of 34 soil borings will be advanced throughout the five areas identified. Surface (0 to 12 inches) and subsurface (just above the water table) will be collected from each soil boring. A third sample from each boring may also be collected from each boring if evidence of contamination (i.e., visual or via screening instruments) is noted or if the borings exceed 10 feet in depth. All samples will be analyzed for full TCL organics (i.e., volatiles, semivolatiles, pesticides, and PCBs) and TAL metals in accordance with Contract Laboratory Program (CLP) methods (Data Quality Objectives [DQO] Level III).

- Soil samples (surface and subsurface as described above) will also be collected for analysis during the installation of five of the nine proposed groundwater monitoring wells. Samples will be analyzed for full TCL organics and TAL metals in accordance with CLP methods (DQO Level III).

- Two upgradient sample locations (west of the site) will be selected in an area believed to be unimpacted by previous disposal activities. Samples will be analyzed for full TCL organics and TAL metals in accordance with CLP methods (DQO Level III).

- Borings were advanced, via a hand auger, in the immediate vicinity of the drum/container disposal areas during pre-investigation sampling activities conducted in June 1994. A total of nine surface and eight subsurface soil samples were collected from four locations. Samples were analyzed for full TCL organics and TAL metals in accordance with CLP methods (DQO Level III). Analytical data indicated that two of the four areas will require additional sampling to further evaluate the extent of contamination. The two areas are located along the unnamed tributary.

- Two composite soil samples will be collected for testing of grain size characteristics. The samples will be obtained from the surface to the water table.

Note that select soil samples will be subject to an accelerated laboratory turnaround time (seven days) to determine if additional sampling is necessary to delineate the extent of contamination. If contaminants are detected in these samples, additional samples will be collected to further characterize the extent of contamination. The criteria to be used for determining if additional samples will be collected is discussed in the FSAP.

Test Pit Investigation

Shallow test pits will be trenched in areas where surface and/or subsurface debris is identified. The number and locations of the trenches will be determined in the field based on the results of the soil investigation and on a site reconnaissance which will identify areas which exhibit surface debris. Samples may be collected from each trenched area and analyzed for full TCL organics and TAL metals. Furthermore, samples may also be analyzed for full toxicity characteristic leachate procedure (TCLP), and RCRA hazardous waste characteristics (ignitability, corrosivity, and reactivity), if buried waste is encountered. The determination for sample analysis will be based on visual indications (i.e., stained soils) of contamination and/or instrumentation monitoring (i.e., PID or FID). During the investigation, the area in the vicinity of the test pits will be surveyed for buried metallic objects using an all-metals detector and/or magnetometer.

Groundwater Investigation

A groundwater investigation will be conducted to further evaluate surficial and deep groundwater quality. The groundwater investigation will focus on areas not previously studied and on AOCs identified from the initial study. The following field program will be implemented for this investigation.

- One round of groundwater samples will be collected from the five existing shallow wells, nine newly installed wells (six shallow and three deep), and two temporary wells. Groundwater samples will be analyzed for full TCL organics and TAL metals (total and dissolved) in accordance with CLP methods (DQO Level III). In addition, six samples (three from shallow wells and three from deep wells) will be analyzed for total dissolved solids (TDS) and total suspended solids (TSS).

- A minimum of two rounds of static water levels will be measured in all site monitoring wells.

- Water levels will be monitored over a two day period in a shallow and deep well cluster to evaluate the potential affect of tidal influence of site groundwater.

Drum/Container Waste Samples

As mentioned in the Draft Work Plans, drums/containers (5-gallon pails) were identified on the surface and partially buried during the site visit in March 1994. Because these drums/containers serve as potential sources of contamination, Baker proposed (Draft Work Plan) to sample the drums/containers in June 1994 prior to conducting the RI. During the June sampling event, however, Baker noted that most of the drums/containers were removed from the site. Consequently, samples were only collected from several small containers. Based on visual observations and analytical data, the substances within the containers were determined to be weathered paint. No additional sampling will be required, however, the containers will be removed from the site to prevent potential releases from the containers.

Surface Water and Sediment Investigation

Surface water and sediment investigations have already been conducted at Site 36 for this RI. These investigations were performed in April 1994 as part of an RI conducted at Site 35 which is located approximately 1/4-mile northwest of Site 36. The reason these investigations were conducted concurrently with Site 35 is that both sites are situated within the Brinson Creek water shed. Conducting both investigations concurrently will provide information on the entire water shed area (i.e., ecological impacts). The following investigation activities were conducted at the site.

- Four surface water/sediment stations were sampled within the unnamed tributary. Sediment samples were collected from the bank of the tributary at depths of 0 to 6 inches and 6 to 12 inches. Surface water samples were obtained at mid-stream for each station. All surface water and sediment samples were analyzed for full TCL organics and TAL metals in accordance with CLP methods (DQO Level III).

- Three surface water/sediment stations were sampled within Brinson Creek. Sediment samples were collected from the bank of the tributary at depths of 0 to 6 inches and 6 to 12 inches. Surface water samples were obtained at mid-stream for each station. All surface water and sediment samples were analyzed for full TCL organics and TAL metals in accordance with CLP methods (DQO Level III).

- Measurements of pH, temperature, specific conductance, and dissolved oxygen were obtained at each sample station.

Stream levels will also be monitored during the RI (March 1995). Staff gauges will be installed in Brinson Creek and the unnamed tributary to assist in determining groundwater flow patterns at the site. Moreover, stream levels will be monitored over a two to three day period with automatic data loggers to evaluate the potential affect of tidal influences on the streams.

Ecologic/Aquatic Investigation

An ecologic/aquatic investigation has already been conducted at Site 36 for this RI. This investigation was also performed in April 1994 as part of an RI conducted at Site 35. The following investigation activities were conducted at the site.

- Three fish/crab/benthic macroinvertebrate organism sample stations were established within Brinson Creek. Fish (tissue) and crab samples were analyzed for full TCL organics and TAL metals in accordance with CLP methods (DQO Level III). Benthic samples will be subject to genus/species taxonomic evaluation.

4.4.2 Site 43 - Agan Street Dump

The following investigations and support activities will be conducted at Site 43.

Surveying

Surveying tasks will be completed in three phases of work as described above for Site 36.

Soil Investigation

A soil investigation will be conducted to confirm the absence or presence of contaminants and to evaluate the extent of contaminants in the shallow soils. The investigation to be conducted at Site 43 will focus on four main areas: (1) the Mounded Soil Area; (2) the area adjacent to existing well 43GW01; (3) the Debris/Paint Can Disposal Area; and (4) and the remaining site area. These areas were identified as potential AOCs based on observations made during the site visit and on the results from the SI conducted by Baker. The following field program will be implemented for this investigation.

- A projected total number of 20 soil borings will be advanced within the four AOCs. Surface and subsurface (just above the water table and possibly a third mid-depth sample) will be collected from each soil boring. Approximately 20 percent of the samples will be analyzed for full TCL organics and TAL metals. Samples obtained from the remaining borings will be analyzed for TCL semivolatiles (SVOCs) and TAL metals. The reason for focusing the analyses on SVOCs and metals is that these were the contaminants of concern identified during the initial investigation. All samples will be analyzed in accordance with CLP methods (DQO Level III).

- Soil samples (surface and subsurface as described above) will also be collected for analysis during the installation of two of the three proposed groundwater monitoring wells. Samples will be analyzed for full TCL organics and TAL metals in accordance with CLP methods (DQO Level III).

- Two upgradient sample locations (west of the site) will be selected in an area believed to be unimpacted by previous disposal activities. Samples will be analyzed for full TCL organics and TAL metals in accordance with CLP methods (DQO Level III).

- Two composite soil samples will be collected for grain size characteristics. The samples will be obtained from the surface to the top of the water table.

Note that select soil samples will be subject to an accelerated laboratory turnaround time (seven days) to determine if additional sampling is necessary to delineate the extent of contamination. If contaminants are detected in these samples, additional samples will be collected to further assess the extent of contamination. The criteria to be used for determining if additional samples will be collected is discussed in the FSAP.

Groundwater Investigation

A groundwater investigation will be conducted to further evaluate surficial and deep groundwater quality. The groundwater investigation will focus on areas not previously studied and on areas of concern identified from the initial study. The following field program will be implemented for this investigation.

- One round of groundwater samples will be collected during the RI field program. The three existing wells, noted during the site visit to be vandalized (i.e., well caps broken off), were sampled in early June 1994 to determine if substances were disposed in the wells. Analytical data from the June sampling event indicated that groundwater quality was not impacted by suspected vandalism. Accordingly, the wells will not be abandoned and replaced during the RI as described in the Draft Work Plan.

- Groundwater samples collected from the existing wells and the three newly installed wells (one shallow and two deep) will be analyzed for full TCL organics and TAL metals (total and dissolved); samples collected from the temporary wells will be analyzed for TCL volatiles, semivolatiles, pesticides, and TAL metals (total and dissolved). All samples will be analyzed in the accordance with CLP methods (DQO Level III). In addition, four samples (two from shallow wells and two from deep wells) will be analyzed for TSS and TDS.

- A minimum of two rounds of static water levels will be measured in all site monitoring wells.

Surface Water and Sediment Investigations

Surface water and sediment investigations will be conducted to further evaluate environmental impacts on near by waterways. The locations sample stations are based on the results of the initial investigation. The following field program will be implemented for this investigation.

- Two sample stations (one station will be established upgradient from the site) will be established within Edwards Creek.

- Four sample stations will be established within Straw Horn Creek.

- Sediment samples were collected from the bank of the tributary at depths of 0 to 6 inches and 6 to 12 inches. Surface water samples were obtained at mid-stream for each station. All surface water and sediment samples were analyzed for full TCL organics and TAL metals in accordance with CLP methods (DQO Level III). Two surface water samples will be analyzed for hardness and four sediment samples will be tested for grain size characteristics.

- Surface water and sediment samples will also be subject to bioassay tests. These tests are being performed because the initial investigation indicated contaminant levels which exceeded state and/or federal surface water and sediment criteria.

- Staff gauges will be installed in both Edwards Creek and Straw Horn Creek to assist in determining groundwater flow patterns at the site.

Test Pit Investigation

Shallow test pits will be trenched in areas where surface and/or subsurface debris is identified. The exact number and locations of the trenches will be determined in the field based on the results of the soil investigation and on a site reconnaissance which will identify areas which exhibit surface debris. Samples may be collected from each trenched area and subject to analysis for the same parameters discussed for Site 36. During the investigation, the area in the vicinity of the test pits will be surveyed for buried metallic objects using an all-metals detector and/or magnetometer.

4.4.3 Site 44 - Jones Street Dump

The following investigations and support activities will be conducted at Site 44.

Surveying

Surveying tasks will be completed in three phases of work as described above.

Soil Investigation

A soil investigation will be conducted to confirm the absence or presence of contaminants and to evaluate the extent of contaminants in the shallow soils. The investigation to be conducted at Site 44 will focus on two main areas: (1) the area adjacent to existing well 43GW03; and (2) the remaining site area. These areas were identified as potential AOCs based on observations made during the site visit and on the results from the SI conducted by Baker. The following field program will be implemented for this investigation.

- A projected total number of 10 soil borings will be advanced within these areas. Surface and subsurface (just above the water table and possibly a third mid-depth sample) samples will be collected from each soil boring. Approximately 20 percent of the samples will be analyzed for full TCL organics and TAL metals; the remaining samples will be analyzed for TCL volatiles, semivolatiles, pesticides, and TAL metals. The reasons that PCBs will not be analyzed in all samples are that there is not history of site usage or disposal, and they were not detected during the initial investigation. All samples will be analyzed in accordance with CLP methods (DQO Level III).

- Soil samples (surface and subsurface as described above) will also be collected during the installation of three of the proposed groundwater monitoring wells. Samples will be analyzed for full TCL organics and TAL metals in accordance with CLP methods (DQO Level III).

- One upgradient sample location (west of the site) will be selected in an area believed to be unimpacted by previous disposal activities. Samples will be analyzed for full TCL organics and TAL metals in accordance with CLP methods (DQO Level III).

- Two composite soil samples will be collected for grain size characteristics. The samples will be obtained from the surface to the top of the water table.

<u>Groundwater Investigation</u>

A groundwater investigation will be conducted to further evaluate surficial and deep groundwater quality. The groundwater investigation will focus on areas not previously studied and on areas of concern identified from the initial study. The following field program will be implemented for this investigation.

- One round of groundwater samples will be collected from the three existing shallow wells, three newly installed wells (two shallow and one deep), and one temporary well. Groundwater samples collected from the newly installed wells will be analyzed for full TCL organics and TAL metals (total and dissolved); samples collected the existing wells and temporary well will be analyzed for TCL volatiles, semivolatiles, pesticides, and metals (total and dissolved). All samples will be analyzed in accordance with CLP methods (DQO Level III). In addition, four samples (two from shallow wells and two from deep wells) will be analyzed for TSS and TDS.

- A minimum of two rounds of static water levels will be measured in all site monitoring wells.

<u>Surface Water and Sediment Investigations</u>

Surface water and sediment investigations will be conducted to further evaluate environmental impacts on near by waterways. The locations of the proposed sample stations are based on the results of the initial investigation. The following field program will be implemented for this investigation.

- Six sample stations (including one upgradient sample station) will be established within Edwards Creek.

- One sample station will be established within Straw Horn Creek.

- One sample station will be established within an unnamed tributary.

- Sediment samples will be collected from the bank of the tributary at depths of 0 to 6 inches and 6 to 12 inches. Surface water samples were obtained at mid-stream for each station. All surface water and sediment samples were analyzed for full TCL organics and TAL metals in accordance with CLP methods (DQO Level III). Two surface water samples will be analyzed for hardness and four sediment samples will be tested for grain size characteristics.

- Surface water and sediment samples will also be subject to bioassay tests. These tests are being performed because the initial investigation indicated contaminant levels which exceeded state and/or federal surface water and sediment criteria.

- Staff gauges will be installed in both Edwards Creek and Straw Horn Creek to assist in determining groundwater flow patterns at the site.

<u>Test Pit Investigation</u>

Shallow test pits will be trenched in areas where surface and/or subsurface debris is identified. The exact number and locations of the trenches will be determined in the field based on the results of the soil investigation and on a site reconnaissance which will identify areas which exhibit surface debris. Samples may be collected from each trenched area and subject to analysis for the same parameters discussed for Site 36. During the investigation, the area in the vicinity of the test pits will be surveyed for buried metallic objects using an all-metals detector and/or magnetometer.

4.4.4 Site 54 - Crash Crew Fire Training Burn Pit

The following investigations and support activities will be conducted at Site 54.

Surveying

Surveying tasks will be completed in three phases of work as described above.

Soil Investigation

A soil investigation will be conducted to confirm the absence or presence of contaminants and to evaluate the extent of contaminants in the shallow soils. The investigation to be conducted at Site 54 will focus on two main areas: (1) the Former Burn Pit Area/Concrete Container Storage Area/Fuel Oil UST Area; and (2) Stressed Soil Area. These areas were identified as potential AOCs based on observations made during the site visit and the results of previous investigations. The following field program will be implemented for this investigation.

- A sampling grid (approximately 25 to 50-foot spacings) will be established within the two areas of concern identified above. A projected total number of 18 soil borings will be advanced to approximately 18 inches. Each sample (representing the upper 18 inches of soil) will be subject to analysis in the field using the Ensys, Inc. test kit for petroleum fuel sensitivities (ENSYS PAHs and ENSYS Petro). Samples will be collected and analyzed until the extent of soil contamination (less than 10 ppm) is defined.

- Confirmatory samples (surface and subsurface as described previously) will be collected around the perimeter of the extent of contamination as identified by the field test kit.

- Twenty percent of the confirmatory samples will be analyzed for full TCL organics, TAL metals, and total petroleum hydrocarbons (TPH). The remainder of the samples will be analyzed for TCL volatiles, semivolatiles, PCBs, and metals. The reasons pesticides will not be analyzed in all samples are that there is no history of site usage or disposal, and they were not detected during the initial investigation. In addition, one composite sample will be analyzed for physical and chemical engineering parameters. All samples will be analyzed in accordance with CLP methods (DQO Level III).

- Two upgradient sample locations (north of the site) will be selected in an area believed to be unimpacted by previous disposal activities. Samples will be analyzed for full TCL organics and TAL metals in accordance with CLP methods (DQO Level III).

Groundwater Investigation

A groundwater investigation will be conducted to further evaluate groundwater quality. The groundwater investigation will focus on areas not previously studied and on areas of concern identified from the initial study. The following field program will be implemented for this investigation.

- One round of groundwater samples will be collected from the three existing shallow wells, one newly installed well, and three temporary wells. Groundwater samples collected from the existing and newly installed wells will be analyzed for TCL volatiles, semivolatiles, PCBs, and TAL metals (total and dissolved); samples collected from the temporary wells will be analyzed for TCL volatiles and semivolatiles. All samples will be analyzed in accordance with CLP methods (DQO Level III). In addition, one groundwater sample will be analyzed for engineering parameters (e.g., TSS and TDS).

- A minimum of two rounds of static water levels will be measured in all site monitoring wells.

<u>Drainage Ditch Investigation</u>

The two drainage ditches, which extend away from the burn pit area, will be investigated to determine if contaminants are being channelized off site. The investigation will include the following.

- Two water (if noted during time of sampling) and soil samples will be obtained from each ditch. Samples will be analyzed for TCL volatiles, semivolatiles, PCBs, and TAL metals (total only for water samples).
- Water and soil samples may also be obtained at the location where the drainage ditches discharge into a downgradient surface water body.

4.4.5 Site 86 - Tanks AS419 - AS421 at Marine Corps Air Station

The following investigations and support activities will be conducted at Site 86.

<u>Surveying</u>

Surveying tasks will be completed in three phases of work as described above.

<u>Soil Investigation</u>

A soil investigation will be conducted to confirm the absence or presence of contaminants and to evaluate the extent of contaminants in the shallow soils. The investigation to be conducted at Site 86 will focus on areas around former ASTs AS420 and AS421. These areas were identified during the previous investigations as being impacted by TPH. The following field program will be implemented for this investigation.

- A projected total number of nine soil borings will be advanced in the vicinity of former ASTs 420 and 421. Surface and subsurface samples (just above the water table and possibly a third mid-depth sample) will be collected.
- Twenty percent of the samples will be analyzed for full TCL organics, TAL metals, and TPH. The remaining samples will be analyzed for TCL volatiles, semivolatiles, PCBs, and TAL metals. In addition, one composite sample will be analyzed for physical and chemical engineering parameters. The reason for focusing the analyses on volatiles and semivolatiles is that these were the contaminants of concern identified during the initial investigation. All samples will be analyzed in accordance with CLP methods (DQO Level III).
- Soil samples (surface and subsurface as described above) will also be collected for analysis during the installation of four of the eight proposed groundwater monitoring wells. Samples will be analyzed for TCL volatiles, semivolatiles, and metals in accordance with CLP methods (DQO Level III).

- One upgradient sample location (north of the site) will be selected in an area believed to be unimpacted by previous disposal activities. Samples will be analyzed for TCL volatiles, semivolatiles, and metals in accordance with CLP methods (DQO Level III).

Note that selected soil samples will be subject to an accelerated laboratory turnaround time (seven days) to determine if additional sampling is necessary to delineate the extent of contamination. If contaminants are detected in these samples, additional samples will be collected to further characterize the extent of contamination. The criteria to be used for determining if additional samples will be collected is discussed in the FSAP.

Groundwater Investigation

A groundwater investigation will be conducted to further evaluate groundwater quality. The groundwater investigation will focus on areas not previously studied and on areas of concern identified from the initial study. The following field program will be implemented for this investigation.

- One round of groundwater samples will be collected from the 14 existing wells (seven shallow and seven intermediate), and eight newly installed wells (three intermediate and four deep. Groundwater samples collected from 20 percent of the wells will be analyzed for full TCL organics and TAL metals (total and dissolved). The remainder of the wells will be analyzed for TCL volatiles, semivolatiles, and TAL metals (total and dissolved). All samples will be analyzed in accordance with CLP methods (DQO Level III). Additionally, two groundwater samples (one shallow and one deep) will be analyzed for engineering parameters (e.g., TDS and TSS).

- Selected groundwater samples (volatiles only) collected from wells located east, south, and west of the site will be analyzed on an accelerated laboratory turnaround time (seven day) to determine if additional wells are required to fully evaluate the extent of contamination.

- A minimum of two rounds of static water levels will be measured in all site monitoring wells.

4.4.6 Management of Investigation Derived Waste

Investigation derived waste (IDW) will be generated during the field program at Operable Unit No. 6. IDW to be generated will include soil and mud cuttings, development and purge groundwater, spent decontamination fluids, and personal protective equipment (PPE) and clothing (PPC). Specific details regarding IDW handling, sampling, and disposal are provided in the FSAP.

4.5 Task 5 - Sample Analysis and Validation

This task involves efforts relating to the following post-field sampling activities:

- Sample Management
- Laboratory Analysis
- Data Validation

Sample management activities involve coordination with laboratories; tracking of samples submitted for analysis; tracking of analyses received; and tracking of information related to samples submitted and received from a third party validator. Sample management also involves resolving technical or administrative problems (e.g., reanalysis, resubmission of information).

Laboratory analysis begins when the samples are shipped from the field and received by the laboratory. Validation begins when the "raw" laboratory data is received by the validator from Baker. Baker will first receive the data from the laboratory, log it into a database for tracking purposes, and then forward it to the validator. A validation report will be expected within three weeks following receipt of laboratory data packages by the validator. CLP data will be validated per the CLP criteria as outlined in the following documents:

- USEPA, Hazardous Site Control Division, Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses, 1991.
- USEPA, Hazardous Site Evaluation Division, Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses, 1988.

All other data will be validated in accordance with the method of analysis using the National Functional Guidelines as a reference.

4.6 Task 6 - Data Evaluation

This task involves efforts related to the data once it is received from the laboratory and is validated. It also involves the evaluation of any field-generated data including: water level measurements, in-situ permeability tests, test boring logs, test pit logs, and other field notes. Efforts under this task will include the tabulation of validated data and field data, generation of test boring logs and monitoring well construction logs, generation of geologic cross-section diagrams, and the generation of other diagrams associated with field notes or data received from the laboratory (e.g., sampling location maps).

4.7 Task 7 - Risk Assessment

This section of the Work Plan will serve as the guideline for the baseline risk assessments (BRAs) to be conducted for MCB, Camp Lejeune during the RI.

Baseline risk assessments evaluate the potential human health and/or ecological impacts that would occur in the absence of any remedial action. The risk assessment will provide the basis for determining whether or not remedial action is necessary and the justification for performing remedial actions.

The risk assessments will be performed in accordance with USEPA guidelines. The primary documents that will be utilized include:

- Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part A), USEPA 1989.
- Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals), USEPA 1991.
- Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part C, Risk Evaluation of Remedial Alternatives), USEPA 1991.
- Risk Assessment Guidance for Superfund: Volume II, Environmental Evaluation Manual, USEPA 1989.
- Supplemental Guidance to RAGS: Standard Default Values, USEPA 1991a.
- Supplemental Guidance to RAGS: Calculating the Concentration Term, USEPA 1992.

- Superfund Exposure Assessment Manual, USEPA 1988.
- Exposure Factors Handbook, USEPA 1989b.
- Guidance for Data Usability in Risk Assessment, USEPA 1990.
- Supplemental USEPA Region IV Risk Assessment Guidance, USEPA Region IV, 1991.

USEPA Region IV will be consulted for Federal guidance, and the NC DEHNR will be consulted for guidance in the State of North Carolina.

The technical components of the BRA are contaminant identification, exposure assessment, toxicity assessment, and risk characterization. The objectives of the risk assessment process can be accomplished by:

- Characterizing the toxicity and levels of contaminants in relevant media (e.g., groundwater, surface water, soil, sediment, air, and biota).
- Characterizing the environmental fate and transport mechanisms within specific environmental media.
- Identifying potential current and future human and/or environmental receptors.
- Identifying potential exposure routes and the extent of the actual or expected exposure.
- Defining the extent of the expected impact or threat.
- Identifying the levels of uncertainty associated with the above items.

As outlined in the Scope of Work, a separate BRA will be performed at MCB, Camp Lejeune for OU No. 6. The BRAs will utilize all available data to date that has been properly validated in accordance with USEPA guidelines plus all data to be collected from additional sampling during this RI.

4.7.1 Human Health Evaluation Process

4.7.1.1 Site Location and Characterization

A background section will be presented at the beginning of each risk assessment to provide an overview of the characteristics of each site. This section will provide a site location, a general site description, and the site-specific chemicals as discussed in past reports. The physical characteristics of the site and the geographical areas of concern will be discussed. This site description will help to characterize the exposure setting.

4.7.1.2 Data Summary

Decisions regarding data use may influence the resultant risk assessment, therefore, careful consideration must be given to the treatment of those data. For purposes of risk evaluation, the sites at MCB, Camp Lejeune may be partitioned into operable units, sites, and areas of concern for which chemical concentrations will be characterized and risks will be evaluated. Sites will be grouped into operable units if they are close to one another, have similar contamination, and/or may impact the same potential receptors. In selecting data to include in the risk assessment, the objective is to characterize, as accurately as possible, the distribution and concentration of chemicals in each operable unit.

Data summary tables will be developed for each medium sampled (e.g., surface water, sediment, groundwater, soil). Each data summary table will indicate the frequency of detection, observed range of concentrations, average background concentrations (inorganics), and the upper 95 percent confidence limit (UCL) value of the means for each contaminant detected in each medium. The selection of arithmetic or geometric means will depend on whether the sample data are normally or log-normally distributed. Additionally, for contaminant concentrations determined to be "ND," one-half of the Quantitation Limit for organics and one-half of the detection limit for inorganics will be used to estimate the 95 percent UCL.

4.7.1.3 Identifying Chemicals of Potential Concern

The criteria to be used in selecting the Contaminants of Potential Concern (COPCs) from the constituents detected during the sampling and analytical phase of the investigation are: historical information, prevalence, mobility, persistence, toxicity, comparison of the Applicable, Relevant, and Appropriate Requirements (ARARs), comparison to blank data or base-specific naturally occurring levels (i.e., background), and comparison to anthropogenic levels. The criteria chosen to establish the COPC are derived from the USEPA's Risk Assessment Guidance for Superfund (USEPA, 1989).

All of the available sample data will undergo review upon initiation of the risk assessment. Common laboratory contaminants such as acetone, methylene chloride, phthalate esters, toluene, and methyl ethyl ketone will be addressed only if concentrations are 10 times greater than the corresponding blanks. In addition, chemicals that are not common laboratory contaminants will be evaluated if they are greater than five times the laboratory blank. The number of chemicals analyzed in the risk assessment will be a subset of the total number of chemicals detected at a site based on the elimination criteria discussed previously.

Tables will be prepared that list chemical concentrations for all media by site. Data will be further grouped according to organic and inorganic species within each table.

4.7.1.4 Exposure Assessment

The objectives of the exposure assessment at MCB, Camp Lejeune will be to characterize the exposure setting, identify exposure pathways, and quantify the exposure. When characterizing the exposure setting, the potentially exposed populations will be described. The exposure pathway will identify the source and the mechanism of medium for the released chemical (e.g., groundwater), the point of potential human contact with the contaminated medium, and the exposure route(s) (e.g., ingestion). The magnitude, frequency, and duration for each exposure pathway identified will be quantified during this process.

The identification of potential exposure pathways at the four sites will include the activities described in the subsections that follow.

Analysis of the Probable Fate and Transport of Site- Specific Chemicals

The environmental fate and transport of the chemicals of concern at the site, the physical/chemical and environmental fate properties of the chemicals will be reviewed. Some of these properties include volatility, photolysis, hydrolysis, oxidation, reduction, biodegradation, accumulation, persistence, and migration potential. This information will assist in predicting potential current and future exposures. It will also help in determining those media that are currently receiving site-related chemicals or may receive site-related chemicals in the future. Sources that may be consulted in obtaining this information include computer databases (e.g., AQUIRE, ENVIROFATE), as well as the open literature.

The evaluation of fate and transport may be necessary where the potential for changes in future chemical characteristics is likely and for those media where site-specific data on the chemical distribution is lacking.

Identification of Potentially Exposed Human Populations

Human populations, that may be potentially exposed to chemicals at the MCB, Camp Lejeune, include base personnel and their families, base visitors, and on-site workers and recreational fishermen/women. The Base Master Plan will be consulted to confirm or modify these potential exposures. Nonworking residents who might be exposed to site-specific chemicals could include spouses and/or children of base personnel and resident workers. Resident and nonresident workers could be exposed to chemicals as they carry out activities at any of the sites located at MCB, Camp Lejeune. The list of potential receptors and pathways to be evaluated will be refined during discussions with regulators prior to performing the BRA.

Identification of Potential Exposure Scenarios Under Current and Future Land Uses

The exposure scenarios will be finalized after consulting with the Base Master Plan, USEPA and the State of North Carolina. Generally, current and future exposure pathways will be considered preliminarily as follows:

- Site 36
  - Soil Pathway
    - -- Direct ingestion (current/future base personnel, future construction workers)
    - -- Inhalation of dust (current/future base personnel, future construction workers)
    - -- Dermal contact (current/future base personnel, future construction workers)
  - Groundwater Pathway
    - -- Direct ingestion (none)
    - -- Inhalation (future construction workers)
    - -- Dermal contact (future construction workers)
  - Surface Water
    - -- Ingestion (current/future base personnel, current/future recreational users)
    - -- Dermal contact (current/future base personnel, current/future recreational users)
  - Sediment
    - -- Ingestion (current/future base personnel, current/future recreational users)
    - -- Dermal contact (current/future base personnel, current/future recreational users)
- Site 43
  - Soil Pathway
    - -- Direct ingestion (current/future base personnel, current/future residents, future construction workers)
    - -- Inhalation of dust (current/future base personnel, current/future residents, future construction workers)
    - -- Dermal contact (current/future base personnel, current/future residents, future construction workers)

- Groundwater Pathway
  - Direct ingestion (none)
  - Inhalation (future construction workers)
  - Dermal contact (future construction workers)

- Surface Water
  - Ingestion (current/future base personnel, current/future residents)
  - Dermal contact (current/future base personnel, current/future residents)

- Sediment
  - Ingestion (current/future base personnel, current/future residents)
  - Dermal contact (current/future base personnel, current/future residents)

- Site 44

  - Soil Pathway
    - Direct ingestion (current/future base personnel, current/future residents, future construction workers)
    - Inhalation of dust (current/future base personnel, current/future residents, future construction workers)
    - Dermal contact (current/future base personnel, current/future residents, future construction workers)

  - Groundwater Pathway
    - Direct ingestion (none)
    - Inhalation (future construction workers)
    - Dermal contact (future construction workers)

  - Surface Water
    - Ingestion (current/future base personnel, current/future residents)
    - Dermal contact (current/future base personnel, current/future residents)

  - Sediment
    - Ingestion (current/future base personnel, current/future residents)
    - Dermal contact (current/future base personnel, current/future residents)

- Site 54

  - Soil Pathway
    - Direct ingestion (current/future base personnel, future construction workers)
    - Inhalation of dust (current/future base personnel, future construction workers)
    - Dermal contact (current/future base personnel, future construction workers)

  - Groundwater Pathway
    - Direct ingestion (none)
    - Inhalation (future construction workers)
    - Dermal contact (future construction workers)

- Surface Water (Drainage Ditches)
  - -- Ingestion (current/future base personnel, current/future residents)
  - -- Dermal contact (current/future base personnel, current/future residents)

- Sediment (Drainage Ditches)
  - -- Ingestion (current/future base personnel, current/future residents)
  - -- Dermal contact (current/future base personnel, current/future residents)

- Site 86

  - Soil Pathway
    - -- Direct ingestion (current/future base personnel, future construction workers)
    - -- Inhalation of dust (current/future base personnel, future construction workers)
    - -- Dermal contact (current/future base personnel, future construction workers)

  - Groundwater Pathway
    - -- Direct ingestion (none)
    - -- Inhalation (future construction workers)
    - -- Dermal contact (future construction workers)

Exposure Point Concentrations

After the potential exposure points and potential receptors have been defined, exposure point concentrations must be calculated. The chemical concentrations at these contact points are critical in determining intake and, consequently, risk to the receptor. The data from site investigations will be used to estimate exposure point concentrations.

The means and the upper 95 percent upper confidence limits of the means will be used throughout the risk assessment. If the data are log-normally distributed, the means will be based on the geometric mean rather than the arithmetic mean. In cases where maximum concentrations are exceeded by upper 95 percent confidence limit, the maximum concentrations will be used.

Exposure doses will be estimated for each exposure scenario from chemical concentrations at the point of contact by applying factors that account for contact frequency, contact duration, average body weight, and other route-specific factors such as breathing rate (e.g., inhalation). These factors will be incorporated into exposure algorithms that convert the environmental concentrations into exposure doses. Intakes will be reported in milligrams of chemical taken in by the receptor (i.e., ingested, inhaled, etc.) per kilogram body weight per day (mg/kg-day). Intakes for potentially exposed populations will be calculated separately for the appropriate exposure routes and chemicals.

4.7.1.5 Toxicity Assessment

Toxicity values (i.e., numerical values derived from dose-response toxicity data for individual compounds) will be used in conjunction with the intake determinations to characterize risk. Toxicity values may be taken or derived from the following sources (note that the most up-to-date toxicity information obtained from IRIS and/or HEAST will be used in the exposure assessments):

- Integrated Risk Information System (IRIS) - The principal toxicology database, which provides updated information from USEPA on cancer slope factors, reference doses, and other standards and criteria for numerous chemicals.

- Health Effects Assessment Summary Tables (HEAST) - A tabular summary of noncarcinogenic and carcinogenic information contained in IRIS.

For some chemicals, toxicity values (i.e., reference doses) may have to be derived if the principal references previously mentioned do not contain the required information. These derivations will be provided in the risk assessment for review by USEPA Region IV. The toxicity assessment will include a brief description of the studies on which selected toxicity values were based, the uncertainty factors used to calculate noncarcinogenic reference doses (RfDs), the USEPA weight-of-evidence (WOE) classification for carcinogens, and their respective slope factors.

4.7.1.6 Risk Characterization

Risk characterization involves the integration of exposure doses and toxicity information to quantitatively estimate the risk of adverse health effects. Quantitative risk estimates based on the reasonable maximum exposures to the site contaminants will be calculated based on available information. For each exposure scenario, the potential risk for each chemical will be based on intakes from all appropriate exposure routes. Carcinogenic risk and noncarcinogenic hazard indices are assumed to be additive across all exposure pathways and across all of the chemicals of concern for each exposure scenario. Potential carcinogenic risks will be evaluated separately from potential noncarcinogenic effects, as discussed in the following subsections.

Carcinogenic Risk

For the potential carcinogens that are present at the site, the carcinogenic slope factor (q_1*) will be used to estimate cancer risks at low dose levels. Risk will be directly related to intake at low levels of exposure. Expressed as an equation, the model for a particular exposure route is:

$$\text{Excess lifetime cancer risk} = \text{Estimated dose x carcinogenic slope factor; or CDI x } q_1^*$$

Where: CDI = Chronic daily intake

This equation is valid only for risk less than 10^{-2} (1 in 100) because of the assumption of low dose linearity. For sites where this model estimates carcinogenic risks of 10^{-2} or higher, an alternative model will be used to estimate cancer risks as shown in the following equation:

$$\text{Excess lifetime cancer risk} = 1 - \exp(-\text{CDI x } q_1^*)$$

Where: exp = the exponential

For quantitative estimation of risk, it will be assumed that cancer risks from various exposure routes are additive. Since there are no mathematical models that adequately describe antagonism or synergism, these issues will be discussed in narrative fashion in the uncertainty analysis.

Noncarcinogenic Risk

To assess noncarcinogenic risk, estimated daily intakes will be compared with reference doses RfD for each chemical of concern. The potential hazard for individual chemicals will be presented as a hazard quotient

(HQ). A hazard quotient for a particular chemical through a given exposure route is the ratio of the estimated daily intake and the applicable RfD, as shown in the following equation:

$$HQ = EDI/RfD$$

Where:
- HQ = Hazard quotient
- EDI = Estimated daily intake or exposure (mg/kg-day)
- RfD = Reference dose (mg/kg-day)

To account for the additivity of noncarcinogenic risk following exposure to numerous chemicals through a variety of exposure routes, a hazard index (HI), which is the sum of all the hazard quotients, will be calculated. Ratios greater than one, or unity, indicate the potential for adverse effects to occur. Ratios less than one indicate that adverse effects are unlikely. This procedure assumes that the risks from exposure to multiple chemicals are additive, an assumption that is probably valid for compounds that have the same target organ or cause the same toxic effect. In some cases when the HI exceeds unity it may be appropriate to segregate effects (as expressed by the HI) by target organ since those effects would not be additive. As previously mentioned, where information is available about the antagonism or synergism of chemical mixtures, it will be appropriately discussed in the uncertainty analysis.

4.7.1.7 Uncertainty Analysis

There is uncertainty associated with any risk assessment. The exposure modeling can produce very divergent results unless standardized assumptions are used and the possible variation in others are clearly understood. Similarly, toxicological assumptions, such as extrapolating from chronic animal studies to human populations, also introduce a great deal of uncertainty into the risk assessment. Uncertainty in a risk assessment may arise from many sources including:

- Environmental chemistry sampling and analysis.
- Misidentification or failure to be all-inclusive in chemical identification.
- Choice of models and input parameters in exposure assessment and fate and transport modeling.
- Choice of models or evaluation of toxicological data in dose-response quantification.
- Assumptions concerning exposure scenarios and population distributions.

The variation of any factor used in the calculation of the exposure concentration will have an impact on the total carcinogenic and noncarcinogenic risk. The uncertainty analysis will qualitatively discuss non-site and site-specific factors that may product uncertainty in the risk assessment. These factors may include key modeling assumptions, exposure factors, assumptions inherent in the development of toxicological end points, and spatio-temporal variance in sampling.

This section discusses the Preliminary Remediation Goals (PRGs) (ARAR-based and/or risk-based) which are determined using information on media and chemicals of potential concern, the most appropriate future land use, potential exposure pathways, toxicity information, and potential ARARs. The development of PRGs will assist in the initiation of remedial alternatives and in the selection of analytical limits of detection. Risk-based PRGs established at this time are initial, and do not establish that clean up to meet these goals is warranted. Therefore, a risk-based PRG will be considered a final remediation level only after appropriate analysis in the RI/FS and ROD.

The initial step in developing PRGs is to identify media of potential concern. Important media at these sites include groundwater, soil, surface water, and sediment. Chemicals of potential concern includes any chemical reasonably expected to be at the sites. These chemicals may have been previously detected at the site, may be presented based on site history, or may be present as degradation products. Identifying future land use for the site is used to determine risk-based PRGs. In general, residential land use should be used as a conservative estimation for the PRGs. Chemical-specific ARARs are evaluated as PRGs because they are often readily available and provide preliminary indication about the goals that a remedial action may have to attain. For groundwater SDWA maximum contaminant levels (MCLs), state drinking water standards, and Federal Water Quality Criteria (FWQC) are common ARARs.

FWQCs and state water quality standards (WQS) are common ARARs for surface water. Sediment Screening Values (SSVs) developed by National Oceanic and Atmospheric Administration (NOAA) can be used as ARARs for the evaluation of biological effects for aquatic organisms. In general, chemical-specific ARARs are not available for soil, however, some states have promulgated soil standards (e.g., PCB clean-up levels) that may be criteria appropriate to use as PRGs. Risk-based PRGs will be obtained from USEPA, Region III, Risk-Based Concentration Table (USEPA, 1994). The risk-based PRGs will be reviewed and modified after the completion of the baseline risk assessment. This modification will involve adding or subtracting chemicals of concern, media, pathways or revising individual chemical-specific goals. Tables 4-2 through 4-6 provide PRGs for each media at Sites 36, 43, 44, 54, and 86, respectively.

4.7.2 Ecological Risk Assessment

The overall purpose of an ecological risk assessment is to evaluate the likelihood that adverse ecological effects would occur or are occurring as a result of exposure to one or more physical or chemical stressors. This assessment will evaluate the potential effects of contaminants on sensitive or critical habitats or environments and protected species. The assessment will also employ a phased approach to determine potential adverse effects of contamination on the terrestrial and aquatic receptors (e.g., flora and fauna) on or adjacent to each site at MCB, Camp Lejeune. Phase I will consist of a comparison of analytical results for soils, surface water, or sediments to available ecological standards or criteria. The Phase I approach will provide a conservative evaluation of the potential ecological effects associated with site contamination. If contaminant concentrations in environmental media exceed appropriate standards or criteria, additional phases of evaluation may be necessary to fully characterize potential ecological effects at a site.

The risk assessment methodologies will be consistent with those outlined in the Framework for Ecological Risk Assessment (USEPA, 1992b). In addition, information found in the following documents will also be consulted.

- Risk Assessment Guidance for Superfund, Volume II, Environmental Evaluation Manual (USEPA, 1989e)
- Ecological Assessment of Hazardous Waste Sites: A Field and Laboratory Reference (USEPA, 1989a)

The following sections describe the general technical approach that will be used to evaluate the likelihood that adverse ecological effects could occur as a result of exposure to one or more physical or chemical stressors. The ecological risk assessment will consist of five components. These are: problem formulation; characterization of exposure; characterization of ecological effects; risk characterization; and uncertainty analysis.

4.7.2.1 Problem Formulation

Problem formulation is the first step of an ecological assessment and requires an understanding of site habitats, potential receptors, and potential endpoints. Problem formulation will be based on historical information and on the findings of the site visit conducted for each site. Data needs and regulatory issues will also be considered. The components of the problem formulation phase consist of stressor characteristics, ecosystems potentially at risk, ecological effects, endpoint selection, and a conceptual model.

The selection of chemical stressors or COPCs will be based on frequency of detection, background comparison, persistence of the contaminant, bioaccumulation potential, and the toxicity of the contaminant. Because of the differential toxicity of some contaminants to ecological verses human receptors, the COPCs for ecological receptors may differ from those selected for the human health risk assessment. Physical stressors including temperature and hydrologic changes and habitat alteration will also be taken into consideration.

Based on the site visit and historical information, ecological receptors will be identified, and the stressor-ecosystem-receptor relationship will be used to develop exposure scenarios in the characterization of exposure phase. Properties of the ecosystem that may be considered in the problem formulation phase include the abiotic environment (e.g., climatic conditions and soil or sediment properties), ecosystem structure (e.g., abundance and trophic level relationships), and ecosystem function (e.g., energy source, energy utilization, and nutrient processing). In addition, types and patterns of historical disturbances may be used to predict ecological receptor-stressor responses. Spatial and temporal distribution may also be used to define the natural variability in the ecosystem. The potential for indirect effects (e.g., reduction in prey availability or habitat utilization) will also be considered in the selection of ecosystem components.

Ecological effects data will be compiled for the physical and chemical stressors identified. Most of these data are available in the literature. Application of laboratory-based tests to field situations and to the interpretation of field observations that may be influenced by natural variability or non-site stressors that are not the focus of the ecological risk assessment will also be considered. The information compiled will be used to select ecological endpoints or characteristics of an ecological component that may be affected by exposure to a stressor.

A conceptual model of the site will then be developed. This conceptual model will consist of a series of working hypotheses regarding how the stressor might affect ecological components of the ecosystem potentially at risk.

4.7.2.2 Characterization of Exposure

The interaction of the stressor with the ecological component will be evaluated in the characterization of exposure. A quantitative evaluation of exposure will be developed that estimates the magnitude and spatial and temporal distributions of exposure for the various ecological components selected during the problem formulation and serve as input to the risk characterization.

4.7.2.3 Characterization of Ecological Effects

The relationship between the stressors and the assessment and measurement endpoints identified during problem formulation will be quantified and summarized in a stressor-response profile. The stressor-response profile will be used as input to the risk characterization. Scientific literature and regulatory guidelines will be reviewed for media-specific and/or species specific toxicity data. On-line databases will be accessed, such as AQUIRE and PHYTOTOX, to obtain current stressor-response data. Toxicity values will be from the most closely related species, where possible. If necessary, laboratory and in-field exposure response studies including acute and chronic toxicity tests of exposure to individual or multiple stressors may be used to supplement the available toxicological databases. Field studies and biosurveys may also be used to establish whether adverse ecological effects have occurred at the site.

4.7.2.4 Risk Characterization

Risk characterization is the final phase of the ecological risk assessment and integrates the results of the exposure and ecological effects analyses. The likelihood of adverse effects occurring as a result of exposure to a stressor will be evaluated.

Individual endpoints may be evaluated by using single effects (e.g, media-specific and/or species specific toxicity data) and exposure values (e.g., dose units or exposure point concentrations) and comparing them using the quotient method for both media exposure and uptake exposure.

For exposure point concentrations that were monitored or modeled in the Characterization of Exposure, water criteria from either the state or from the USEPA will be compared using the quotient method to the ambient surface water concentrations. Likewise, sediment screening values from NOAA will be compared to measured sediment concentrations. These screening values will evaluate the potential for chemical constituents in both the surface water and sediments to cause adverse biological effects. Toxicity values from the literature that represent the toxicological effects on plants and/or invertebrates inhabiting soils will be compared to surface soil concentrations.

For dose unit exposure, terrestrial reference values, developed from No-Observed-Adverse-Effect-Levels (NOAELs) or Lowest-Observed-Adverse-Effect-Levels (LOAELs), will be compared to an estimate of total exposure to soils, surface water, and vegetation via calculation of a CDI. The exposure parameters used in the CDI equation will represent feeding rates, incidental soil ingestion rates, drinking water rates, body weights, and home range input for selected terrestrial receptors known to inhabit the areas of concern.

Population and community endpoints will be assessed by considering species representation by trophic group, taxa, or habitat. Site-specific field studies and biosurveys, if conducted, on and adjacent to the areas of concern may be compared to either historical population and community endpoint information or project-specific field studies and biosurveys.

The ecological significance of the risks characterized at the site will be discussed considering the types and magnitudes of the effects and their spatial and temporal patterns. Ecologically significant risks will be defined as those potential adverse risks or impacts to ecological integrity that affect populations, communities, and ecosystems, rather than individuals (i.e. measured impacts to individuals does not necessarily indicate impacts to the ecosystem).

4.7.2.5 Uncertainty Analysis

The ecological assessment is subject to a wide variety of uncertainties. Virtually every step in the risk assessment process involves numerous assumptions that contribute to the total uncertainty in the ultimate evaluation of risk. Assumptions are made in the exposure assessment regarding potential for exposure and exposure point locations. An effort is made to use assumptions that are conservative, yet realistic. The interpretation and application of ecological effects data is probably the greatest source of uncertainty in the ecological risk assessment. The uncertainty analysis will attempt to address the factors that affect the results of the ecological risk assessment.

4.7.2.6 Data Gaps

Incomplete exposure data gap pathways will be identified and recommendations for addressing same will be provided.

4.7.2.7 Uncertainty Analysis

An ecological risk assessment, like a human health risk assessment, is subject to a wide variety of uncertainties. Virtually every step in the risk assessment process involves numerous assumptions that contribute to the total uncertainty in the ultimate evaluation of risk. Assumptions are made in the exposure assessment regarding potential for exposure and exposure point locations. An effort is made to use assumptions that are conservative, yet realistic. The interpretation and application of toxicological data in the toxicity assessment is probably the greatest source of uncertainty in the ecological risk assessment. The uncertainty analysis will attempt to address the factors that affect the results of the ecological risk assessment.

4.8 Task 8 - Remedial Investigation Report

This task is intended to cover all work efforts related to the preparation of the document providing the findings once the data have been evaluated under Tasks 5 and 6. The task covers the preparation of a Preliminary Draft, Draft, Draft Final, and Final RI Report. This task ends when the Final RI report is submitted.

4.9 Task 9 - Remedial Alternatives Screening

This task includes the efforts necessary to select the alternatives that appear feasible and require full evaluation. The task begins during data evaluation when sufficient data are available to initiate the screening of potential technologies. For reporting and tracking purposes, the task is defined as complete when a final set of alternatives is chosen for detailed evaluation.

4.10 Task 10 - Remedial Alternatives Evaluation

This task involves the detailed analysis and comparison of alternatives using the following criteria:

- Threshold Criteria:
  - Overall Protection of Human Health and the Environment
  - Compliance With ARARs

- Primary Balancing Criteria:
  - Long-Term Effectiveness and Permanence
  - Reduction of Toxicity, Mobility, and Volume Through Treatment
  - Short-Term Effectiveness
  - Implementability
  - Cost

- Modifying Criteria:
  - State and USEPA Acceptance
  - Community Acceptance

4.11 Task 11 - Feasibility Study Report

This task is comprised of reporting the findings of the Feasibility Study. The task covers the preparation of a Preliminary Draft, Draft, Draft Final, and Final FS report. This task ends when the Final FS report is submitted.

4.12 <u>Task 12 - Post RI/FS Support</u>

This task involves the technical and administrative support to LANTDIV to prepare a Draft, Draft Final, and Final Responsiveness Summary, Proposed Remedial Action Plan (PRAP), and Record of Decision (ROD). A PRAP and ROD will be prepared for the OU. These reports will be prepared using USEPA applicable guidance documents.

4.13 <u>Task 13 - Meetings</u>

This task involves providing technical support to LANTDIV during the RI/FS. It is anticipated that the following meetings will be required:

- Meeting between Baker and LANTDIV/EMD to discuss the RI/FS conclusions following submission of the Preliminary Draft RI/FS Report.
- A remedial project management (RPM) meeting with LANTDIV/EMD, USEPA Region IV, and the North Carolina DEHNR.
- A technical review committee (TRC) meeting to present the findings of the RI/FS.

The meetings will be attended by the Baker Activity Coordinator, Project Manager, and Project Engineer or Risk Assessment Specialist. It is presumed that all meetings will be conducted at MCB, Camp Lejeune, North Carolina.

SECTION 4.0
TABLES

TABLE 4-1

SUMMARY OF SAMPLING, ANALYTICAL, AND DATA QUALITY OBJECTIVES
SITES 36, 43, 44, 54, AND 86
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples[1]	Analysis	Data Quality Level
Site 36 - Camp Geiger Area Dump Near Sewage Treatment Plant Note: Surface water, sediment, fish, benthic, and waste samples were collected during the pre-investigation field activities. Accordingly, these investigations are not presented on this table.	Soil - Formerly Cleared Area	14 borings/2 samples per boring	TCL Organics[3] TAL Metals[4]	III III
	Soil - Open Field Area	6 borings/2 samples per boring	TCL Organics TAL Metals	III III
	Soil - Former Dump Area	6 borings/2 samples per boring	TCL Organics TAL Metals	III III
	Soil - Remaining Site Area	8 borings/2 samples per boring	TCL Organics TAL Metals	III III
		2 borings/1 composite sample per boring	Atterberg Limits Grain Size Distribution	II II
	Soil - Drum Container Areas	2 areas/3 borings per area/2 samples per boring	TCL Organics TAL Metals	III III
	Soil - Well Borings[2]	5 borings/2 samples per boring	TCL Organics TAL Metals	III III
	Soil - Trenches	3 to 5 trenches/2 areas/1 optional sample per trench	TCL Organics TAL Metals TCLP/RCRA (Optional)	III III III
	Soil - Upgradient	2 borings/2 samples per boring	TCL Organics TAL Metals	III III

TABLE 4-1 (Continued)

SUMMARY OF SAMPLING, ANALYTICAL, AND DATA QUALITY OBJECTIVES
SITES 36, 43, 44, 54, AND 86
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples[1]	Analysis	Data Quality Level
Site 36 - Camp Geiger Area Dump Near Sewage Treatment Plant (Continued)	Groundwater - One round of sampling	5 existing shallow monitoring wells 6 new shallow monitoring wells 3 new deep monitoring wells 2 temporary wells	TCL Organics TAL Metals (total/dissolved)	III III
		3 shallow monitoring wells 3 deep monitoring wells	TDS TSS	II II
Site 43 - Agan Street Dump	Soil - Mounded Area	1 boring/2 samples per boring	TCL Organics TAL Metals	III III
		4 borings/2 samples per boring	TCL Semivolatiles TAL Metals	III III
	Soil - Near Well 43GW01	1 boring/2 samples per boring	TCL Organics TAL Metals	III III
		2 borings/2 samples per boring	TCL Semivolatiles TAL Metals	III III
	Soil - Concrete Debris/ Paint Can Area	1 boring/2 samples per boring	TCL Organics TAL Metals	III III
		4 borings/2 samples per boring	TCL Semivolatiles TAL Metals	III III
	Soil - Remaining Site Area	2 borings/2 samples per boring	TCL Organics TAL Metals	III III
		5 borings/2 samples per boring	TCL Semivolatiles TAL Metals	III III
		2 borings/1 composite sample per boring	Atterberg Limits Grain Size Distribution	II II

TABLE 4-1 (Continued)

SUMMARY OF SAMPLING, ANALYTICAL, AND DATA QUALITY OBJECTIVES
SITES 36, 43, 44, 54, AND 86
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples[1]	Analysis	Data Quality Level
Site 43 - Agan Street Dump (Continued)	Soil - Well Borings[2]	2 borings/2 samples per boring	TCL Organics TAL Metals	III III
	Soil - Trenches	3 to 5 trenches/2 areas/1 optional sample per trench	TCLP/RCRA (Optional) TCL Organics TAL Metals	III III III
	Soil - Upgradient	2 borings/2 samples per boring	TCL Organics TAL Metals	III III
	Groundwater - One round of sampling	3 existing shallow monitoring wells 1 new shallow monitoring well 2 new deep monitoring wells 4 temporary wells	TCL Organics (temporary wells will not be analyzed for PCBs) TAL Metals (total/dissolved)	III III
		2 shallow monitoring wells 2 deep monitoring wells	TSS TDS	II II
	Surface Water - Edwards Creek	2 stations	TCL Organics TAL Metals Bioassay Hardness	III III III II
	Sediment - Edwards Creek	2 stations/2 samples per station	TCL Organics TAL Metals Bioassay Grain Size Distribution TOC	III III III II II
	Surface Water - Straw Horn Creek	4 stations	TCL Organics TAL Metals Bioassay Hardness	III III III II

TABLE 4-1 (Continued)

SUMMARY OF SAMPLING, ANALYTICAL, AND DATA QUALITY OBJECTIVES
SITES 36, 43, 44, 54, AND 86
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples[1]	Analysis	Data Quality Level
Site 43 - Agan Street Dump (Continued)	Sediment - Straw Horn Creek	4 stations/2 samples per station	TCL Organics TAL Metals Bioassay Grain Size Distribution TOC	III III III II II
Site 44 - Jones Street Dump	Soil - Near Well 44GW03	2 borings/2 samples per boring	TCL Organics TAL Metals	III III
		2 borings/2 samples per boring	TCL Volatiles/ Semivolatiles/Pesticides TAL Metals	III III
	Soil - Remaining Site Area	2 borings/2 samples per boring	TCL Organics TAL Metals	III III
		4 borings/2 samples per boring	TCL Volatiles/ Semivolatiles/Pesticides TAL Metals	III III
		2 borings/1 composite sample per boring	Atterberg Limits Grain Size Distribution	II II
	Soil - Well Borings	3 borings/2 samples per boring	TCL Organics TAL Metals	III III
	Soil - Trenches	3 to 5 trenches/2 areas/1 optional sample per trench	TCLP/RCRA (Optional) TCL Organics TAL Metals	III III III
	Soil - Upgradient	1 boring/2 samples per boring	TCL Organics TAL Metals	III III

TABLE 4-1 (Continued)

SUMMARY OF SAMPLING, ANALYTICAL, AND DATA QUALITY OBJECTIVES
SITES 36, 43, 44, 54, AND 86
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples[1]	Analysis	Data Quality Level
Site 44 - Jones Street Dump (Continued)	Groundwater - One round of sampling	3 existing shallow monitoring wells 2 new shallow monitoring wells 1 new deep monitoring well 1 temporary well	TCL Organics (existing wells and temporary wells will not be analyzed for PCBs) TAL Metals (total/dissolved)	III III
		2 shallow monitoring wells 2 deep monitoring wells	TDS TSS	II II
	Surface Water - Edwards Creek	6 stations	TCL Organics TAL Metals Hardness	III III II
	Sediment - Edwards Creek	6 stations/2 samples per station	TCL Organics TAL Metals Grain Size Distribution TOC	III III II II
	Surface Water - Straw Horn Creek	1 station	TCL Organics TAL Metals Hardness	III III II
	Sediment - Straw Horn Creek	1 stations/2 samples per station	TCL Organics TAL Metals Grain Size Distribution TOC	III III II II
	Surface Water - Unnamed Tributary	1 station	TCL Organics TAL Metals Hardness	III III II

TABLE 4-1 (Continued)

SUMMARY OF SAMPLING, ANALYTICAL, AND DATA QUALITY OBJECTIVES
SITES 36, 43, 44, 54, AND 86
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples[1]	Analysis	Data Quality Level
Site 54 - Crash Crew Fire Training Burn Pit	Soil - Burn Pit Area	14 borings/1 sample per boring	ENSYS PAH ENSYS Petro Soil	II II
	Soil - Stressed Soil Area	4 borings/1 sample per boring	ENSYS PAH ENSYS Petro Soil	II II
	Soil - Burn Pit Area/ Stressed Soil Area	Confirmatory borings/2 samples per boring	20%: TCL Organics TAL Metals TPH[6] Remainder: TCL Volatiles/ Semivolatiles/ PCBs TAL Metals	III III III III III
		2 borings/1 composite sample	Engineering Parameters[5]	II
	Soil - Upgradient	2 borings/2 samples per boring	TCL Organics TAL Metals	III III
	Groundwater - One round of sampling	3 existing shallow monitoring wells 1 new shallow monitoring well 3 temporary wells	TCL Organics (samples from existing and newly installed wells will not be analyzed for pesticides; samples from temporary wells will only be analyzed for VOCs and SVOCs) TAL Metals (total/dissolved)	III III
		1 sample (54GW04)	Engineering Parameters	II
	Ditch Water Samples	2 stations	TCL Organics (without pesticides) TAL Metals	III III

TABLE 4-1 (Continued)

SUMMARY OF SAMPLING, ANALYTICAL, AND DATA QUALITY OBJECTIVES
SITES 36, 43, 44, 54, AND 86
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples[1]	Analysis	Data Quality Level
Site 54 - Crash Crew Fire Training Burn Pit (Continued)	Ditch Soil Samples	2 stations/2 samples per boring	TCL Organics (without pesticides) TAL Metals	III III
Site 86 - Tank Area AS419-AS421	Soil - Former AST Area	9 borings/2 samples per boring	20%: TCL Organics TAL Metals TPH[6] Remainder: TCL Volatiles TAL Metals	III III III III III
		1 boring/1 composite sample from boring	Engineering Parameters[5]	II
	Soil - Well Borings[2]	4 borings/2 samples per boring	TCL Volatiles TCL Semivolatiles TAL Metals TPH	III III III III
	Soil - Upgradient	1 boring/2 samples per boring	TCL Organics (without pesticides) TAL Metals	III III
	Groundwater	7 existing shallow monitoring wells 7 existing intermediate monitoring wells 5 new deep monitoring wells 3 new intermediate monitoring wells	20%: TCL Organics TAL Metals (total and dissolved) Remainder: TCL Volatiles/ Semivolatiles TAL Metals (total and dissolved)	III III III III
		1 shallow (86GW05) 1 deep (86GW18DW)	Engineering Parameters[5]	II

TABLE 4-1 (Continued)

SUMMARY OF SAMPLING, ANALYTICAL, AND DATA QUALITY OBJECTIVES
SITES 36, 43, 44, 54, AND 86
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples[1]	Analysis	Data Quality Level
Investigation Derived Waste	Development/ Purge Water	5 to 10 samples	RCRA Hazardous Waste TCL Organics TAL Metals	III III III
	Soil/Mud Cuttings	5 samples (1 composite from each site)	RCRA Hazardous Waste TCLP TCL PCBs	III III III

(1) Baseline number of samples do not include QA/QC samples.

(2) Note that soil samples will not be collected from each well boring for laboratory analysis. Refer to figures in FSAP for well locations where samples will be submitted.

(3) TCL Organics: volatile organics, semivolatile organics, pesticides/PCBs

(4) TAL Metals:

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		

(5) Engineering Parameters:

Soil:	Water:	
Atterberg Limits	Microbial Count	Total Dissolved Solids (TDS)
Grain Size Distribution	Biological Oxygen Demand (BOD_5)	Total Suspended Solids (TSS)
Total Organic Carbon (TOC)	Chemical Oxygen Demand (COD)	
Redox Potential (Eh)	Nitrogen (NH_4)	
Microbial Enumeration	Alkalinity	

(6) TPH to include low/medium and high boiling point petroleum products.

TABLE 4-2

PRELIMINARY REMEDIATION GOALS
SITE 36 - CAMP GEIGER DUMP NEAR SEWAGE TREATMENT PLANT
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Medium	Contaminant of Concern	Preliminary Remediation Goal	Unit	Basis of Goal
Groundwater	Trans-1,2-dichloroethene	70	μg/L	NCWQS[1]
	1,1,2,2-Tetrachloroethane	0.41	μg/L	Risk Ingestion[2]
	Cadmium	5	μg/L	MCL[3]/NCWQS
	Chromium	50	μg/L	NCWQS
	Lead	15	μg/L	MCL[3,4]/NCWQS
Soil	Cadmium	39,000	μg/kg	Risk-Soil Ingestion
	Chromium	78,000	mg/kg	Risk-Soil Ingestion

Notes: (1) NCWQS - North Carolina Water Quality Standard
(2) Region III Risk-Based Concentration
(3) MCL - Maximum Contaminant Level
(4) MCL is an action level

μg/L - microgram per liter
μg/kg - microgram per kilogram
mg/kg - milligram per kilogram

TABLE 4-3

PRELIMINARY REMEDIATION GOALS
SITE 43 - AGAN STREET DUMP
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Medium	Contaminant of Concern	Preliminary Remediation Goal	Unit	Basis of Goal
Groundwater	Beryllium	4	μg/L	MCL[1]
	Cadmium	5	μg/L	NCWQS[2]/MCL
	Chromium	50	μg/L	NCWQS
	Lead	15	μg/L	MCL[3]/NCWQS
	Manganese	50	μg/L	NCWQS/MCL
	Nickel	100	μg/L	MCL
Soil	Barium	5,500	mg/kg	Risk-Soil Ingestion[4]
	Beryllium	150	μg/kg	Risk-Soil Ingestion
	Cadmium	39,000	μg/kg	Risk-Soil Ingestion
	Chromium	78,000	mg/kg	Risk-Soil Ingestion
	Manganese	390	mg/kg	Risk-Soil Ingestion
	Nickel	78,000	mg/kg	Risk-Soil Ingestion
	Zinc	23,000	mg/kg	Risk-Soil Ingestion
Surface Water	Copper	7	μg/L	NCWQS[5]
	Lead	25	μg/L	NCWQS

Notes:
(1) MCL - Maximum Contaminant Level
(2) NCWQS - North Carolina Water Quality Standard
(3) MCL is an action level
(4) Region III Risk-Based Concentration
(5) North Carolina Surface Water Standards for Freshwater (NCAC, 1993).

μg/L - microgram per liter
μg/kg - microgram per kilogram
mg/kg - milligram per kilogram

TABLE 4-4

PRELIMINARY REMEDIATION GOALS
SITE 44 - JONES STREET DUMP
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Medium	Contaminant of Concern	Preliminary Remediation Goal	Unit	Basis of Goal
Groundwater	Toluene	1,000	μg/L	NCWQS[1]/MCL[2]
	Ethylbenzene	29	μg/L	NCWQS
	Arsenic	50	μg/L	NCWQS
	Barium	1,000	μg/L	NCWQS
	Beryllium	4	μg/L	MCL
	Cadmium	5	μg/L	NCWQS
	Chromium	1,000	μg/L	MCL
	Lead	15	μg/L	MCL[3]/NCWQS
	Manganese	50	μg/L	NCWQS
	Mercury	1.1	μg/L	NCWQS
	Nickel	100	μg/L	NCWQS/MCL
	Thallium	2	μg/L	MCL
	Zinc	2,100	μg/L	NCWQS
Soil	4,4-DDD	2,700	μg/kg	Risk-Soil Ingestion[4]
	4,4-DDE	1,900	μg/kg	Risk-Soil Ingestion
	Arsenic	23	mg/kg	Risk-Soil Ingestion
	Chromium	78,000	mg/kg	Risk-Soil Ingestion
	Copper	2,900	mg/kg	Risk-Soil Ingestion
	Manganese	390	mg/kg	Risk-Soil Ingestion
	Nickel	7,800	mg/kg	Risk-Soil Ingestion
	Vanadium	550	mg/kg	Risk-Soil Ingestion
	Zinc	23,000	mg/kg	Risk-Soil Ingestion
Surface Water	Chromium	50	μg/L	NCWQS[5]
	Copper	7	μg/L	NCWQS
	Lead	50	μg/L	NCWQS
	Manganese	50	μg/L	NCWQS
	Zinc	50	μg/L	NCWQS

Notes: (1) NCWQS - North Carolina Water Quality Standard
(2) MCL - Maximum Contaminant Level
(3) MCL is an action level
(4) Region III Risk-Based Concentration
(5) North Carolina Surface Water Standards for Freshwater (NCAC, 1993).

μg/L - microgram per liter
μg/kg - microgram per kilogram
mg/kg - milligram per kilogram

TABLE 4-5

PRELIMINARY REMEDIATION GOALS
SITE 54 - CRASH CREW FIRE TRAINING BURN PIT
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Medium	Contaminant of Concern	Preliminary Remediation Goal	Unit	Basis of Goal
Groundwater	Benzene	1	μg/L	NCWQS[1]
	Toluene	6	μg/L	NCWQS/MCL[2]
	Ethylbenzene	29	μg/L	NCWQS
	Xylenes	400	μg/L	NCWQS
	Chromium	1,000	μg/L	MCL
	Lead	15	μg/L	MCL[4]/NCWQS
Soil	TCE	12	mg/kg	Risk-Soil Ingestion[3]
	Anthracene	23,000	mg/kg	Risk-Soil Ingestion
	Benzo(a)anthracene	0.87	mg/kg	Risk-Soil Ingestion
	Benzo(b)fluoranthene	0.87	mg/kg	Risk-Soil Ingestion
	Benzo(a)pyrene	0.088	mg/kg	Risk-Soil Ingestion
	Naphthalene	3,100	mg/kg	Risk-Soil Ingestion
	Pyrene	2,300	mg/kg	Risk-Soil Ingestion
	Benzene	22	mg/kg	Risk-Soil Ingestion
	Toluene	16,000	mg/kg	Risk-Soil Ingestion
	Ethylbenzene	7,800	mg/kg	Risk-Soil Ingestion
	Xylenes	160,000	mg/kg	Risk-Soil Ingestion
	Chromium	78,000	mg/kg	Risk-Soil Ingestion

Notes: (1) NCWQS - North Carolina Water Quality Standard
(2) MCL - Maximum Contaminant Level
(3) Region III Risk-Based Concentration
(4) MCL is an action level

μg/L - microgram per liter
μg/kg - microgram per kilogram
mg/kg - milligram per kilogram

TABLE 4-6

PRELIMINARY REMEDIATION GOALS
SITE 86 - TANK AREA AS419 - AS421 AT MARINE CORPS AIR STATION
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Medium	Contaminant of Concern	Preliminary Remediation Goal	Unit	Basis of Goal
Groundwater	Benzene	1	μg/L	NCWQS[(1)]
	Toluene	1,000	μg/L	NCWQS/MCL[(2)]
	1,1-Dichloroethane	5	μg/L	MCL
	TCE	2.8	μg/L	NCWQS
	PCE	0.7	μg/L	NCWQS
	1,1,1-Tetrachloroethane	200	μg/L	NCWQS/MCL
Soil	TCE	12	mg/kg	Risk-Soil Ingestion[(3)]
	Anthracene	23,000	mg/kg	Risk-Soil Ingestion
	Benzo(a)anthracene	0.87	mg/kg	Risk-Soil Ingestion
	Benzo(b)fluoranthene	0.87	mg/kg	Risk-Soil Ingestion
	Benzo(a)pyrene	0.088	mg/kg	Risk-Soil Ingestion
	Naphthalene	3,100	mg/kg	Risk-Soil Ingestion
	Pyrene	2,300	mg/kg	Risk-Soil Ingestion
	Benzene	22	mg/kg	Risk-Soil Ingestion
	Toluene	16,000	mg/kg	Risk-Soil Ingestion
	Ethylbenzene	7,800	mg/kg	Risk-Soil Ingestion
	Xylenes	160,000	mg/kg	Risk-Soil Ingestion
	Chromium	78,000	mg/kg	Risk-Soil Ingestion

Notes: (1) NCWQS - North Carolina Water Quality Standard
(2) MCL - Maximum Contaminant Level
(3) Region III Risk-Based Concentration
μg/L - microgram per liter
μg/kg - microgram per kilogram
mg/kg - milligram per kilogram

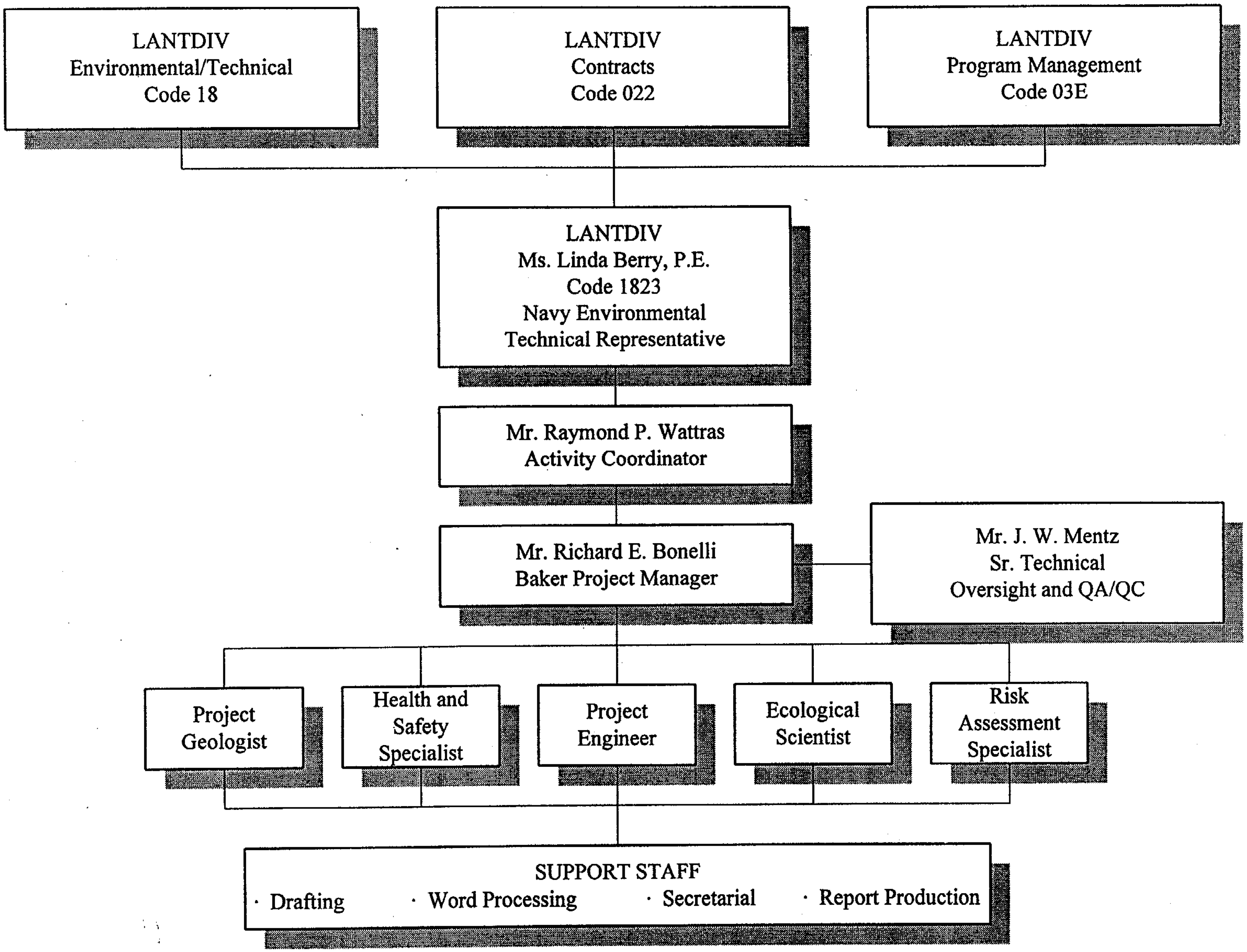
5.0 PROJECT MANAGEMENT AND STAFFING

The Baker Project Team will be managed by Mr. Richard E. Bonelli. The primary responsibilities of the Project Manager will be to monitor the technical performance, cost, and schedule, and to maintain close communication with the Navy Technical Representative, Ms. Linda Berry, P.E. The Project Manager will report to Mr. Raymond P. Wattras (Activity Coordinator). Mr. John W. Mentz will be responsible for overall quality assurance/quality control.

The Project Team will consist of a Risk Assessment Specialist, Project Engineer, Project Geologist, Health and Safety Specialist, Ecological Scientist, and technical support staff as shown in Figure 5-1.

FIGURE 5-1

PROJECT ORGANIZATION



6.0 SCHEDULE

The proposed schedule for this project has been prepared in accordance with the FFA, and is presented as Figure 6-1. The projected start up of the RI/FS field investigation (February 4, 1995) is based on finalization of the RI/FS Project Plans on or before February 4, 1995, as noted in the Fiscal Year 1994 Site Management Plan (FY94 SMP) for MCB, Camp Lejeune, North Carolina. The FY94 SMP is based on the requirements established in the Federal Facilities Agreement and between the Navy/Marine Corps, USEPA Region IV, and the NC DEHNR.

Figure 6 - 1

Study Site Management Schedule - Remedial Investigation/Feasibility Study Project Plans CTO-0246
Marine Corps Base, Camp Lejeune, North Carolina

Activity	Days	Start	Finish
Notice to Proceed	0ed	2/4/95	2/4/95
Mobilization/Subcontractor Procurement	30ed	2/4/95	3/6/95
Field Investigation	65ed	3/6/95	5/10/95
Sample Analysis/Validation	119ed	3/8/95	7/5/95
Data Evaluation	87ed	5/10/95	8/5/95
Risk Assessment	40ed	8/7/95	9/16/95
Preliminary Draft RI Report	42ed	8/5/95	9/16/95
Comment Period	28ed	9/16/95	10/14/95
Draft RI	28ed	10/14/95	11/11/95
Comment Period	60ed	11/11/95	1/10/96
Draft Final RI Report	60ed	1/10/96	3/10/96
Comment Period	30ed	3/10/96	4/9/96
Final RI	30ed	4/9/96	5/9/96
Preliminary Draft FS/PRAP	72ed	8/5/95	10/16/95
Comment Period	28ed	10/16/95	11/13/95
Draft FS/PRAP	28ed	11/13/95	12/11/95
Comment Period	60ed	12/11/95	2/9/96
Draft Final FS/PRAP	60ed	2/9/96	4/9/96
Comment Period	30ed	4/9/96	5/9/96
Final FS/PRAP	30ed	5/9/96	6/8/96
Public Comment Period	30ed	6/8/96	7/8/96
ROD	244ed	12/18/95	8/18/96
Preliminary Draft ROD	28ed	12/18/95	1/15/96

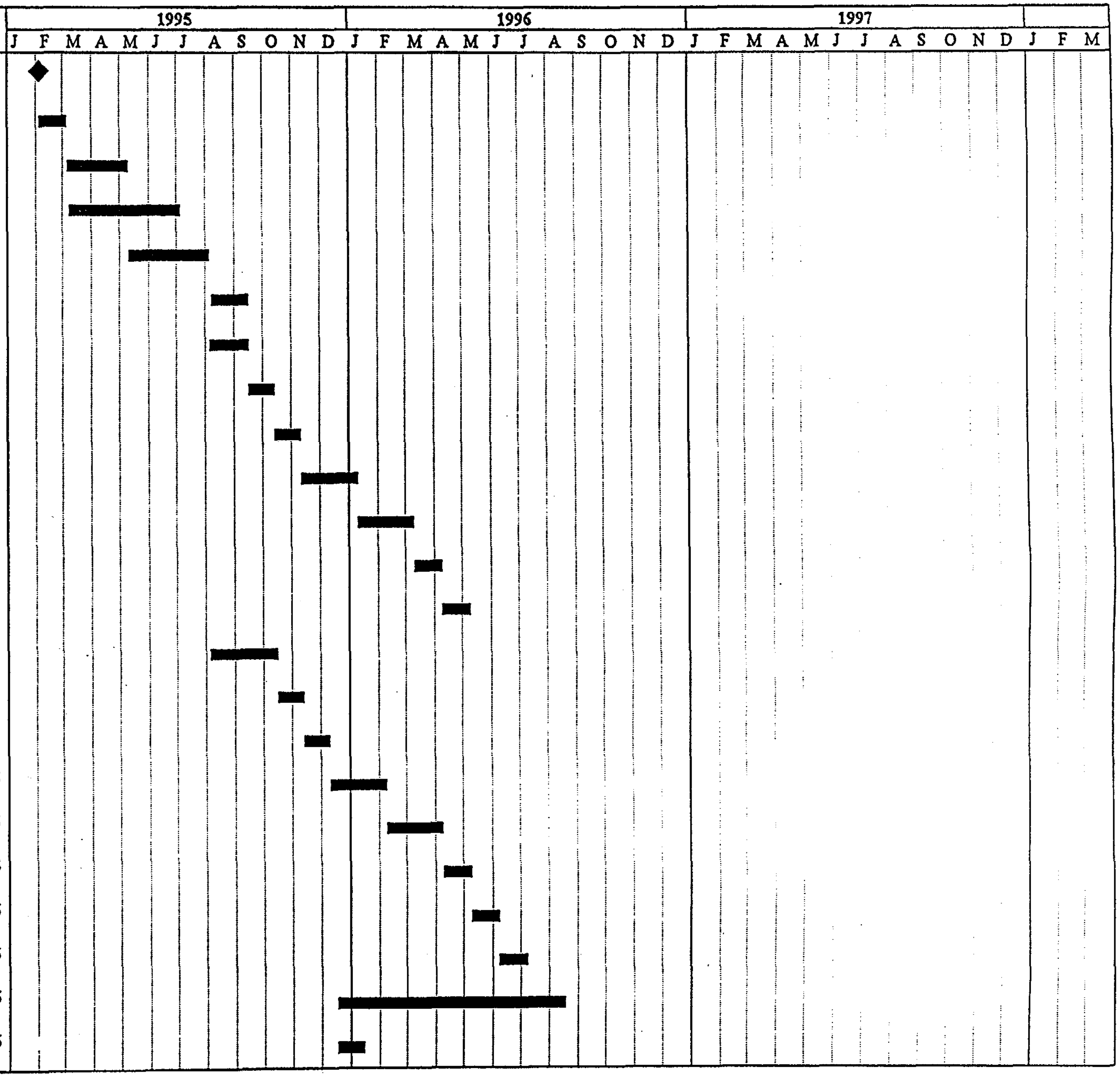
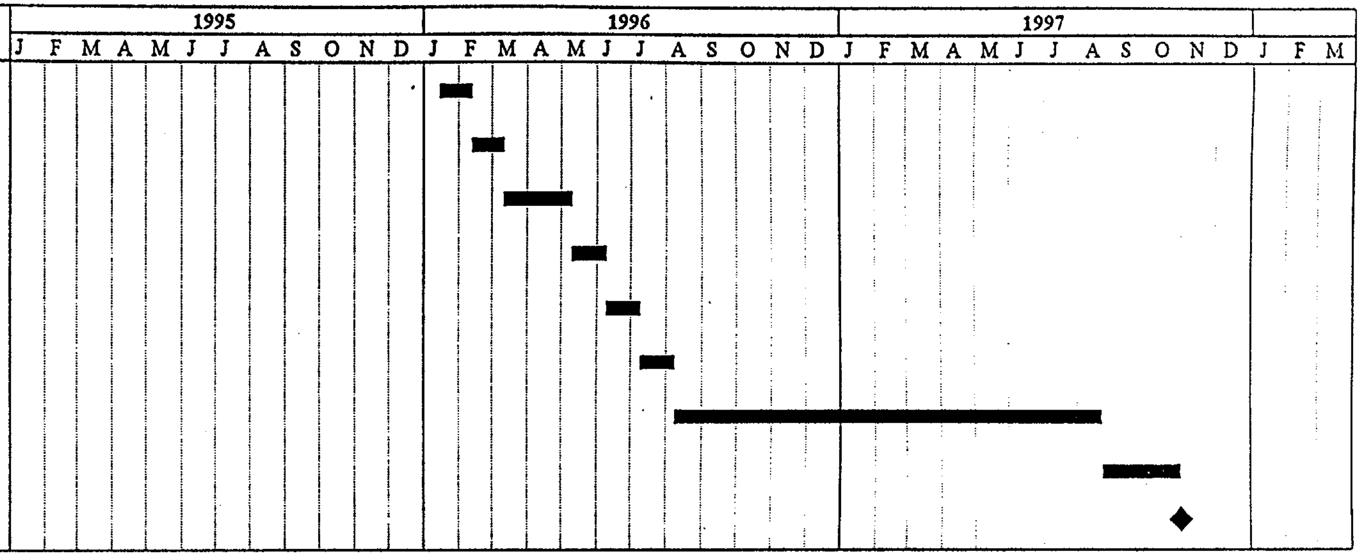


Figure 6 - 1 (continued)

Study Site Management Schedule - Remedial Investigation/Feasibility Study Project Plans CTO-0246
Marine Corps Base, Camp Lejeune, North Carolina

Activity	Days	Start	Finish
Comment Period	28ed	1/15/96	2/12/96
Draft ROD	28ed	2/12/96	3/11/96
Comment Period	60ed	3/11/96	5/10/96
Draft Final ROD	30ed	5/10/96	6/9/96
Comment Period	30ed	6/9/96	7/9/96
Final ROD	30ed	7/9/96	8/8/96
Remedial Design	380ed	8/8/96	8/23/97
Procure RA Contractor	70ed	8/23/97	11/1/97
Initiate Remedial Action	0ed	11/1/97	11/1/97



7.0 REFERENCES

Baker Environmental, Inc. 1994. Interoffice Memorandum. Site Visits, CTO-0233.

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

DON, 1988. Master Plan, Camp Lejeune Complex, North Carolina. COMNAVFACENGCOM, April 8, 1988.

ESE, 1990. Site Summary Report. Final. Marine Corps Base, Camp Lejeune, North Carolina.

U.S. Environmental Protection Agency (USEPA), 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. (WAR). 1983. Initial Assessment Study of Marine Corps Base, Camp Lejeune, North Carolina. Prepared for Naval Energy and Environmental Support Activity.

Halliburton/NUS, 1991. Preliminary Draft Site Inspection Report for Site 80 Paradise Point Golf Course. Marine Corps Base, Camp Lejeune, North Carolina.

Halliburton/NUS, 1991. Preliminary Draft Site Inspection Report for Site 3 Old Creosote Plant. Marine Corps Base, Camp Lejeune, North Carolina.

Halliburton/NUS, 1991. Preliminary Draft Site Inspection Report for Site 7 Tarawa Terrace Dump, 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.

Scudder, L. L. 1982. Memorandum from Environmental Law Counsel to Assistant Chief of Staff, Facilities. Office of the Staff Judge Advocate, MCB Camp Lejeune, North Carolina, October 6, 1982.

USDOA, 1984. Soil Survey, Camp Lejeune, North Carolina. Prepare by Soil Conservation Service in Cooperation with the U.S. Marine Corps. December 1984.

FINAL

REMEDIAL INVESTIGATION/FEASIBILITY STUDY

FIELD SAMPLING AND ANALYSIS PLAN FOR OPERABLE UNIT NO. 6 (SITES 36, 43, 44, 54, AND 86)

MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

CONTRACT TASK ORDER 0246

DECEMBER 2, 1994

Prepared for:

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1.0 SITE BACKGROUND

A description of the history and setting of Marine Corps Air Station (MCAS), New River, Marine Corps Base (MCB), Camp Lejeune, and the five study sites (Sites 36, 43, 44, 54, and 86) is contained in Section 2.0 of the Remedial Investigation/Feasibility Study (RI/FS) Work Plan.

2.0 SAMPLING OBJECTIVES

The sampling and data quality objectives (DQOs) for field investigations at Sites 36, 43, 44, 54, and 86 are summarized in Section 3.0 of the RI/FS Work Plan.

3.0 SAMPLING LOCATIONS AND FREQUENCY

3.1 Site 36 - Camp Geiger Dump Near Sewage Treatment Plant

The following investigations and support activities will be conducted at Site 36:

- Surveying
- Soil Investigation (including trench excavations)
- Groundwater Investigation
- Surface Water and Sediment Investigation
- Drum/Container Waste Sampling
- Aquatic Investigation

Each activity and investigation is described in the following subsections.

3.1.1 Surveying

The site survey will involve the surveying of the current site features including roads, surface water bodies (unnamed tributary), and any significant features which were noted during the site visit (e.g., bermed areas, cleared area).

Prior to commencing the field program, the locations of the proposed soil borings and monitoring wells will be established. Each proposed soil boring/monitoring well location will be marked with a stake to allow the field teams to identify the drilling locations. Ground surface elevation and the horizontal control of each proposed drilling location will be established.

Following the completion of the field program, all existing and newly installed monitoring wells, staff gauges, and the trench excavations will be surveyed. A reference point on the top of the PVC riser, and the ground elevation will be surveyed for each monitoring well. The vertical elevation and horizontal control for the staff gauges, and the horizontal control of the trench excavations will also be established.

Survey points will include a latitude coordinate, a longitude coordinate, and an elevation expressed in feet of mean sea level. The vertical accuracy of the survey will be within 0.01 feet and the horizontal accuracy will be within 0.1 foot. All survey points will be referenced to the North Carolina State Plane Coordinate System (NCSPCS).

3.1.2 Soil Investigation

A soil investigation will be conducted at Site 36 to confirm the absence or presence of contaminants associated with the previous disposal activities. The investigation will focus on the five areas identified in the Work Plan. The following subsections describe the tasks proposed for the field program.

3.1.2.1 Sampling Locations

A projected number of 34 soil borings (not including borings near drum/container areas) will be drilled within the site boundary to depths ranging from 4 to 8 feet (estimated range of depth to water table) to characterize the shallow stratigraphy at the site and to collect samples for laboratory analysis. The proposed drilling locations are identified on Figure 3-1. Two samples from each boring will be submitted for laboratory analysis. These samples will be collected from the surface (0 to 12 inches) and just above the groundwater water table. It is estimated that the water table is within 8 feet of the ground surface. A mid-depth sample may also be collected from these borings based on field observations and/or monitoring instrument readings, or if the boring is deeper than 10 feet.

Soil samples will also be collected for laboratory analysis at five monitoring well borings. The monitoring well borings from which samples will be submitted for analysis are indicated on Figure 3-1. A minimum of two soil samples will be collected from each of the selected well locations. The samples to be submitted for laboratory analysis will be collected from the surface and just above the water table.

Hand auger borings will be drilled at two of the drum/container areas located along the unnamed tributary. The borings will be drilled in the immediate vicinity of the drums and containers. A projected number of three borings will be drilled per area. Two samples, including a surface and subsurface sample (between 1 and 5 feet below ground surface), will be submitted from each boring for laboratory analysis.

Two upgradient borings will also be drilled west of the site. The borings are located in an area not believed to have been impacted by previous disposal activities; however, buried concrete debris may exist in the area, and may complicate drilling activities. One surface and one subsurface (just above the water table) sample will be submitted for analysis.

Three to five trenches will be excavated within the boundary of the Formerly Cleared Area and the Former Dump Area to investigate the existence of any remaining trash or debris. Trenches may also be excavated in other areas identified during the field program which exhibited surface debris or at areas where debris was noted in the split-spoon samples. The trenches will be approximately 10 to 20 feet in length and to a depth of 10 feet or to the top of the water table (which ever is encountered first). No soil samples are scheduled to be collected from the trenches for laboratory analysis; however, if potential contamination (e.g., elevated PID or OVA readings) are detected during the excavation of the trench, then one sample will be collected and submitted for laboratory analysis. During the investigation, the area in the vicinity of the test pits will be surveyed for buried metallic objects using an all-metals detector and/or magnetometer.

Section 5.1 discusses the procedures for the collection and preparation of soil samples to be collected during drilling and trenching activities.

3.1.2.2 <u>Analytical Requirements</u>

All soil samples will be analyzed for full Target Compound List (TCL) organics and Target Analyte List (TAL) metals in accordance with Contract Laboratory Program (CLP) methods. Samples obtained from trenches, if collected, will undergo analysis for TCL organics and TAL metals. In addition, samples may also be submitted for analysis of full toxic characteristic leachate procedure (TCLP), and RCRA hazardous waste characteristics (corrosivity, reactivity, and ignitability) if waste debris is noted within the trench. In addition, two borings will be advanced to collect composite samples for testing of Atterberg limits and grain size distribution.

Samples collected from 17 borings will undergo 7-day analysis. The locations of these borings are shown on Figure 3-1. Additional borings may be required, based on the 7-day analysis, to further evaluate the extent of soil contamination. The 7-day data will be compared to base background concentrations (metals) and USEPA Region III screening values to determine if additional samples will be required. The 7-day soil analysis will also be used to determine the locations of the engineering sample borings.

3.1.3 Groundwater Investigation

A groundwater investigation will be conducted to characterize the groundwater quality and evaluate the hydrogeologic characteristics of the surficial and deep aquifers at Site 36. For this investigation six shallow (36GW06 through 36GW11) and three deep (36GW06DW, 36GW07DW, and 36GW11DW) permanent monitoring wells, and two temporary (36TW01 and 36TW02) monitoring wells are proposed. The proposed wells will be installed west (upgradient [36GW06/36GW06DW]) and north of the site, and within the site boundary near suspected disposal areas. The locations of the proposed wells are shown on Figure 3-2.

The shallow wells (Type II well construction) will be installed to depths ranging from approximately 17 to 21 feet below ground surface. The well screens (15-feet in length) will be installed approximately 13 feet below the water table. The deep wells (Type III well construction) will be installed 10 to 15 feet below where the first semi-confining (i.e., lower hydraulic conductivity layer) unit is encountered. Based on recent stratigraphic information obtained by Baker during the Site 35 investigation (located approximately 1/4 mile northwest), the depth of the semi-confining unit is between 35 and 40 feet. Well construction details for the proposed shallow Type II and deep Type III monitoring wells are illustrated on Figures 5-1 and 5-2 in Section 5.0. Well installation and development procedures, and well construction materials are discussed in Section 5.2.

3.1.3.1 Sampling and Analysis

One round of groundwater samples will be collected from the five existing, nine newly installed permanent, and two temporary monitoring wells. Samples will be collected approximately one week following the development of newly installed and existing wells. All samples will be analyzed for full TCL organics and TAL metals (total and dissolved) in accordance with CLP methods. In addition, all monitoring wells will be sampled for TSS and TDS. Specific details on the procedures for the collection and preparation of groundwater samples are presented in Section 5.3.

3.1.3.2 Water Level Measurements

A minimum of two rounds of groundwater and surface water level measurements will be obtained from all site monitoring wells and staff gauges. Measurements will be obtained within a four hour period. In addition, the water levels in one shallow and one deep well will be monitored for a 24 to 48-hour period to evaluate the affects of tidal changes (Brinson Creek) on groundwater levels at the site.

3.1.4 Surface Water and Sediment Investigations

A surface water and sediment investigation was conducted in April 1994 by Baker at Site 36. The Site 36 investigations were conducted concurrently with the Site 35 investigations (located approximately 1/4 mile northwest) to provide regional aquatic and ecologic information for the Brinson Creek watershed. Data collected from both sites will be utilized for the ecological risk assessment.

The locations of the sampling stations are presented on Figure 3-3. Three surface water and sediment stations were established at Brinson Creek (36SW/SD05 through 36SW/SD07) and four stations were established at the unnamed tributary (36SW/SD01 through 36SW/SD04) of Brinson Creek. One upgradient sample station was established north of Site 35 on Brinson Creek (not shown) and 36SW/SD01 will serve as an upgradient sample station for the unnamed tributary. One surface water and two sediment samples were collected from each sampling station. Sediments were collected from depths of 0 to 6 inches and 6 to 12 inches. Specific details on the procedures for collecting and preparing surface water and sediment samples are presented in Sections 5.4 and 5.5, respectively.

All surface water and sediment samples were analyzed for full TCL organics and TAL metals in accordance with CLP methods. Surface water samples were also analyzed for hardness. The 0 to 6-inch sediment sample was analyzed for grain size characteristics and both samples (0 to 6 and 6 to 12 inches) were analyzed for total organic carbon (TOC).

Surface water elevations will be obtained from Brinson Creek and the unnamed tributary during the RI field program to be conducted in early February 1995. Staff gauges will be installed in Brinson Creek (two to three) and the unnamed tributary (two to three) to measure surface water levels which will be correlated with groundwater level measurements from monitoring wells. A minimum of two rounds of staff gauge readings will be obtained. In addition, surface water in Brinson Creek will be monitored with automatic data loggers for a 24 to 48-hour period to measure tidal changes, if any, of the creek.

3.1.5 Drum/Container Waste Sampling

Waste samples were collected in June 1994 as part of the pre-investigation activities. Results of the waste sampling were discussed in the Work Plan.

3.1.6 Aquatic Investigation

An aquatic investigation was conducted by Baker in April 1994. The investigation was conducted concurrently with the Site 35 investigation as discussed in Section 3.1.4. Three sample stations were established at Brinson Creek (adjacent to Site 36) for the collection of benthic macroinvertebrates, fish, and crabs. The sample stations are illustrated on Figure 3-3.

Ecological stresses to the aquatic community posed by water or sediment quality will be assessed by calculating faunal densities, species richness, and species diversity for benthic macroinvertebrates at each sampling station. Population statistics will be determined for fish at each sampling station. Fish samples were submitted for analysis of whole body parts and fillets. All fish and crab samples were submitted for analysis of full TCL organics and TAL metals. Specific details on benthic macroinvertebrate, fish, and crab sampling and preparation are presented in Section 5.7.

3.2 Site 43 - Agan Street Dump

The following investigations and support activities will be conducted at Site 43:

- Surveying
- Soil Investigation (including trench excavations)
- Groundwater Investigation
- Surface Water and Sediment Investigation

Each activity and investigation is described in the following subsections.

3.2.1 Surveying

The site survey will involve the surveying of the current site features including roads, surface water bodies (Edwards Creek), and any significant features which were noted during the site visit (e.g., mounded areas). Pre-investigation (i.e., locating boring and well positions) and post-investigation (i.e., elevation of wells and staff gauges) surveying activities similar to those described for Site 36 will also be performed.

3.2.2 Soil Investigation

A soil investigation will be conducted at Site 43 to confirm the presence or absence of contaminants associated with the previous disposal activities. The investigation will focus on the three areas identified in the Work Plan. The following subsections describe the tasks proposed for the field program.

3.2.2.1 Sampling Locations

A projected number of 20 soil borings will be drilled within the site boundary to depths ranging from 3 to 8 feet (estimated range of depth to water table) to characterize the shallow stratigraphy at the site and to collect samples for laboratory analysis. The proposed drilling locations are identified on Figure 3-4. Two samples from each boring will be submitted for laboratory analysis. These samples will be collected from the surface (0 to 12 inches) and just above the groundwater water table. It is estimated that the water table is within 8 feet of the ground surface. A mid-depth sample may also be collected from these borings based on field observations and/or monitoring instrument readings, or if the boring is deeper than 10 feet.

Soil samples will also be collected for laboratory analysis at two monitoring well borings. The monitoring well borings from which samples will be submitted for analysis are indicated on Figure 3-4. A minimum of two soil samples will be collected from each of the well locations. The samples to be submitted for laboratory analysis will be collected from the surface and just above the water table.

Two upgradient borings will also be drilled west of the site. The borings will be located in an area not believed to have been impacted by previous disposal practices. One surface and one subsurface (just above the water table) sample will be submitted for analysis.

Three to five trenches will be excavated near the mounded soil area and north of existing well 43GW01 to investigate the existence of any remaining trash or debris. Trenches may also be excavated in other areas identified during the field program which exhibited surface debris or at areas where debris was noted in the split-spoon samples. The trenches will be approximately 10 to 20 feet in length and to a depth of 10 feet or to the top of the water table (which ever is encountered first). No soil samples are scheduled to be collected from the trenches for laboratory analysis; however, if potential contamination (e.g., elevated PID or OVA readings) are detected during the excavation of the trench, then one sample will be collected and submitted for laboratory analysis. During the investigation, the area in the vicinity of the test pits will be surveyed for buried metallic objects using an all-metals detector and/or magnetometer.

Section 5.1 discusses the procedures for the collection and preparation of soil samples to be collected during drilling and trenching activities.

3.2.2.2 Analytical Requirements

Soil samples will be analyzed for either full TCL organics and TAL metals (select borings/monitoring well borings and upgradient samples) or TCL semivolatiles and TAL metals (CLP methods). Sample locations targeted for full TCL organics and TAL metals, or TCL semivolatiles and TAL metals analysis are depicted on Figure 3-4. Samples obtained from trenches, if collected, will undergo analysis for TCL organics and TAL metals. In addition, samples may also be submitted for analysis of full TCLP and RCRA hazardous waste characteristics if waste debris is noted within the trench. In addition, two borings will be advanced to collect composite engineering samples for testing of Atterberg limits and grain size distribution.

Samples collected from seven borings will undergo 7-day analysis. The locations of these borings are shown on Figure 3-4. Additional borings may be required, based on the 7-day analysis, to further evaluate the extent of soil contamination. The 7-day data will be compared to base background concentrations (metals) and USEPA Region III screening values to determine if additional samples will be required. The 7-day soil analysis will also be used to determine the locations of the engineering sample borings.

3.2.3 Groundwater Investigation

A groundwater investigation will be conducted to characterize groundwater quality and evaluate the hydrogeologic characteristics of the surficial and deep aquifers at Site 43. As discussed in the Work Plan, the three existing wells were noted during the site visit to be vandalized (i.e., well caps broken-off). Subsequently, the three wells were sampled in early June 1994 (prior to conducting the RI field program) to determine if groundwater quality is impacted by the disposal of wastes in the wells. Results from the

June sampling indicated that the groundwater quality was not impacted by vandalism and, therefore, the wells will not be abandoned as mentioned in the Draft FSAP.

One shallow (43GW04) and two deep (43GW01DW and 43GW04DW) permanent monitoring wells, and four temporary (43TW01 through 43TW04) monitoring wells are proposed. One shallow/deep well cluster (43GW04/43GW04DW) will be installed upgradient of the site. The other deep well, 43GW01DW, will be installed on site adjacent to existing shallow well 43GW01. The four temporary wells will be installed along the bank of Straw Horn Creek. The locations of the proposed wells are shown on Figure 3-5.

The shallow well (Type II well construction) will be installed to depths ranging from approximately 17 to 21 feet below ground surface. The well screens (15-feet in length) will be installed approximately 13 feet below the water table. The deep wells (Type III well construction) will be installed 10 to 15 feet below where the first semi-confining unit is encountered. Based on regional stratigraphic information obtained a USGS publication (Harned, et al., 1989), the depth of the semi-confining unit is between 30 and 50 feet. Well construction details for the proposed shallow Type II and deep Type III monitoring wells are illustrated on Figures 5-1 and 5-2 and in Section 5.0. Well installation procedures and development, and well construction materials are discussed in Section 5.2.

3.2.3.1 Sampling and Analysis

One round of groundwater samples will be collected from all existing and newly installed monitoring wells. The samples obtained from the newly installed wells will be collected approximately one week following the development of newly installed and existing wells. Groundwater samples collected from the three existing wells and three newly installed wells will be analyzed for full TCL organics and TAL metals (total and dissolved). Samples obtained from the temporary wells will be analyzed for TCL volatiles, semivolatiles, pesticides, and TAL metals (total and dissolved). All groundwater samples will analyzed in accordance with CLP methods. In addition, samples collected from all monitoring wells will be analyzed for TSS and TDS. Specific details on the procedures for the collection and preparation of groundwater samples are presented in Section 5.3.

3.2.3.2 Water Level Measurements

A minimum of two rounds of groundwater and surface water level measurements will be obtained from all site monitoring wells and staff gauges. Measurements will be obtained within a four hour period.

3.2.4 Surface Water and Sediment Investigations

A surface water and sediment investigation will be conducted to determine the environmental impacts to Edwards Creek and Straw Horn Creek from previous disposal activities. Two surface water/sediment stations (43SW/SD05 and 43SW/SD06) are proposed at Edwards Creek and four surface water/sediment stations (43SW/SD01 through 43SW/SD04) are proposed at Straw Horn Creek. The locations of the proposed sampling stations are presented on Figure 3-6. Note that station 43SW/SD06 will serve as a upgradient sample location.

One surface water and two sediment samples will be collected from each sampling station. Sediments will be collected from depths of 0 to 6 inches and 6 to 12 inches. Specific details on the procedures for collecting and preparing surface water and sediment samples are presented in Sections 5.4 and 5.5, respectively.

All surface water and sediment samples will be analyzed for full TCL organics and TAL metals (total and dissolved for surface water) in accordance with CLP methods. Surface water samples also will be analyzed for hardness. The 0 to 6-inch sediment sample will be analyzed for grain size characteristics, and both samples (0 to 6 inches and 6 to 12 inches) will be analyzed for TOC. In addition, surface water and sediment samples will also undergo bioassay testing.

Surface water elevations will be determined for both Edwards Creek and Straw Horn Creek. Staff gauges (two in each) will be installed to measure surface water levels which will be correlated with groundwater level measurements from monitoring wells. A minimum of two rounds of staff gauge readings will be obtained.

3.3 Site 44 - Jones Street Dump

The following investigations and support activities will be conducted at Site 44:

- Surveying
- Soil Investigation (including trench excavations)
- Groundwater Investigation
- Surface Water and Sediment Investigation

Each activity and investigation is described in the following subsections.

3.3.1 Surveying

The site survey will involve the surveying of the current site features including roads, surface water bodies (Edwards Creek, unnamed tributary), and any significant features which were noted during the site visit. Pre-investigation (i.e., locating boring and well positions) and post-investigation (i.e., elevation of wells and staff gauges) surveying activities similar to those described for Site 36 will also be performed.

3.3.2 Soil Investigation

A soil investigation will be conducted at Site 44 to confirm the presence or absence of contaminants associated with the previous disposal activities. The investigation will focus on the two areas identified in the Work Plan. The following subsections describe the tasks proposed for the field program.

3.3.2.1 Sampling Locations

A projected number of 10 soil borings will be drilled within the site boundary to depths ranging from 6 to 9 feet (estimated depth to water table) to characterize the shallow stratigraphy at the site and to collect samples for laboratory analysis. The proposed drilling locations are identified on Figure 3-7. Two samples from each boring will be submitted for laboratory analysis. These samples will be collected from the surface (0 to 12 inches) and just above the groundwater water table. It is estimated that the water table is within 10 feet of the ground surface. A mid-depth sample may also be collected from these borings based on field observations and/or monitoring instrument readings, or if the water table is deeper than 10 feet.

Soil samples will also be collected for laboratory analysis at three monitoring well borings. The monitoring well borings from which samples will be submitted for analysis are indicated on Figure 3-7. A minimum of two soil samples will be collected from each of the selected well locations. The samples will be collected from the surface and just above the water table.

One upgradient boring will be drilled west of the site. The boring will be located in an area not believed to have been impacted by previous disposal practices. One surface and one subsurface (just above the water table) sample will be submitted for analysis.

Three to five trenches will be excavated near the Formerly Cleared Area and north of existing well 44GW02 to investigate the existence of any remaining trash or debris. Trenches may also be excavated in other areas identified during the field program which exhibited surface debris or at areas where debris was noted in the split-spoon samples. The trenches will be approximately 10 to 20 feet in length and to a depth of 10 feet or to the top of the water table (which ever is encountered first). No soil samples are scheduled to be collected from the trenches for laboratory analysis; however, if potential contamination (e.g., elevated PID or OVA readings) are detected during the excavation of the trench, then one sample will be collected and submitted for laboratory analysis. During the investigation, the area in the vicinity of the test pits will be surveyed for buried metallic objects using an all-metals detector and/or magnetometer.

Section 5.1 discusses the procedures for the collection and preparation of soil samples to be collected during drilling and trenching activities.

3.3.2.2 Analytical Requirements

Soil samples will be analyzed for either full TCL organics and TAL metals (select borings/monitoring well borings and upgradient samples) or TCL volatiles, semivolatiles, pesticides, and TAL metals (CLP methods). Sample locations targeted for full TCL organic and TAL metal analysis, or TCL volatiles, semivolatiles, pesticides, and TAL metals analysis are depicted on Figure 3-7. Samples obtained from trenches, if collected, will undergo analysis for TCL organics and TAL metals. In addition, samples may also be submitted for analysis of full TCLP and RCRA hazardous waste characteristics if waste debris is noted within the trench. In addition, two borings will advanced to collect composite samples for testing of Atterberg limits and grain size distribution.

Samples collected from four borings will undergo 7-day analysis. The locations of these borings are shown on Figure 3-7. Additional borings may be required, based on the 7-day analysis, to further evaluate the extent of soil contamination. The 7-day data will be compared to base background concentrations (metals) and USEPA Region III screening values to determine if additional samples will be required. The 7-day soil analysis will also be used to determine the locations of the engineering sample borings.

3.3.3 Groundwater Investigation

A groundwater investigation will be conducted to characterize groundwater quality and evaluate the hydrogeologic characteristics of the surficial and deep aquifers at Site 44. For this investigation two shallow (44GW04 and 44GW05) and one deep (44GW01DW) permanent monitoring wells, and one temporary (44TW01) monitoring well are proposed. The two shallow wells will be installed within the northern and southern areas of the site and the deep well will be installed adjacent to existing shallow well 44GW01. Shallow/deep well cluster 43GW04/43GW04DW, to be installed as part of the Site 43 investigation, will also serve as upgradient wells for Site 44. The locations of the wells are shown on Figure 3-8.

The shallow wells (Type II well construction) will be installed to depths ranging from approximately 19 to 22 feet below ground surface. The well screens (15-feet in length) will be installed approximately 13 feet below the water table. The deep well (Type III well construction) will be installed 10 to 15 feet below where the first semi-confining unit is encountered. Based on regional stratigraphic information obtained from a USGS publication (Harned, et al., 1989), the depth of the semi-confining unit is between 30 and 50 feet. Well construction details for the proposed shallow Type II and deep Type III monitoring wells are illustrated on Figures 5-1 and 5-2 in Section 5.0. Well installation and development procedures, and well construction materials are discussed in Section 5.2.

3.3.3.1 Sampling and Analysis

One round of groundwater samples will be collected from all existing and newly installed monitoring wells approximately one week after each well (newly installed and existing) has been developed. Groundwater samples collected from the three newly installed wells will be analyzed for full TCL organics and TAL metals (total and dissolved); samples collected from the temporary wells and the existing wells will be analyzed for TCL volatiles, semivolatiles, pesticides, and TAL metals (total and dissolved). In addition, samples collected from all monitoring wells will be analyzed for TSS and TDS. All groundwater samples will analyzed in accordance with CLP methods. Specific details on the procedures for the collection and preparation of groundwater samples are presented in Section 5.3.

3.3.3.2 Water Level Measurements

A minimum of two rounds of groundwater and surface water level measurements will be obtained from all site monitoring wells and staff gauges. Measurements will be obtained within a four hour period.

3.3.4 Surface Water and Sediment Investigations

A surface water and sediment investigation will be conducted to determine the environmental impacts to Edwards Creek, Straw Horn Creek, and the unnamed tributary of Edwards Creek from previous disposal activities. Six surface water/sediment stations (44SW/SD01 and 44SW/SD06) are proposed at Edwards Creek, one surface water/sediment station (44SW/SD08) is proposed at Straw Horn Creek, and one surface water/sediment station (44SW/SD07) is proposed at the unnamed tributary of Edwards Creek. The locations of the proposed sampling stations are presented on Figure 3-9. Note that station 44SW/SD01 will serve as a upgradient sample location.

One surface water and two sediment samples will be collected from each sampling station. Sediments will be collected from depths of 0 to 6 inches and 6 to 12 inches. Specific details on the procedures for collecting and preparing surface water and sediment samples are presented in Sections 5.4 and 5.5, respectively.

All surface water and sediment samples will be analyzed for full TCL organics and TAL metals (total and dissolved for surface water) in accordance with CLP methods. Surface water samples will also be analyzed for hardness. The 0 to 6-inch sediment sample will be analyzed for grain size characteristics, and both samples (0 to 6 and 6 to 12 inches) will be analyzed for TOC. In addition, surface water and sediment samples will also undergo bioassay testing.

Surface water elevations will be determined for both Edwards Creek and Straw Horn Creek. Staff gauges (two in each) will be installed to measure surface water levels which will be correlated with groundwater level measurements from monitoring wells. A minimum of two rounds of staff gauge readings will be obtained.

3.4 Site 54 - Crash Crew Fire Training Burn Pit

The following investigations and support activities will be conducted at Site 54:

- Surveying
- Soil Investigation
- Groundwater Investigation

Each activity and investigation is described in the following subsections.

3.4.1 Surveying

The site survey will involve the surveying of the current site features including roads, surface water bodies (drainage ditches), and any significant features which were noted during the site visit (stressed soil area). Pre-investigation (i.e., locating boring and well positions) and post-investigation (i.e., elevation of wells) surveying activities similar to those described for Site 36 will also be performed.

3.4.2 Soil Investigation

A soil investigation will be conducted at Site 54 to confirm the presence or absence of contaminants associated with the burn pit operations. The investigation will focus on the two areas identified in the Work Plan. The following subsections describe the tasks proposed for the field program.

3.4.2.1 Sampling Locations

A projected number of 18 soil borings will be initially drilled as part of the soil investigation. The proposed drilling locations are identified on Figure 3-10. Samples will be collected initially for field screening analysis. Two areas, including the area in the immediate vicinity of the burn pit and the stressed soil area, have been identified for field screening analysis. Samples will be collected with a hand auger from the first 18 inches below ground surface. Each sample will be subject to analysis with the Ensys, Inc. field test kit for petroleum fuel sensitivities. Samples will be collected from each area until the extent of soil contamination (less than 10 ppm) is defined. The extent of soil contamination, as defined by the Ensys testing, will be marked with survey stakes.

Following the field screening analysis, confirmatory samples will be collected for laboratory analysis. Five to eight borings will be advanced per area, via a drill rig, for the confirmatory sampling. Two samples from each boring will be submitted for laboratory analysis. These samples will be collected from the surface (0 to 12 inches) and just above the groundwater water table. It is estimated that the water table is within 10 feet of the ground surface. A mid-depth sample may also be collected from these borings based on field observations and/or monitoring instrument readings, or if the water table is deeper than 10 feet.

Two upgradient borings will be drilled north of the site. The borings are located in areas not believed to have been impacted by previous disposal practices. One surface and one subsurface (just above the water table) sample will be submitted for analysis.

Section 5.1 discusses the procedures for the collection and preparation of soil samples to be collected during drilling and trenching activities.

3.4.2.2 Analytical Requirements

Twenty percent of the confirmatory samples will be analyzed for full TCL organics, TAL metals, and TPH, and the remainder of the samples TCL volatiles, semivolatiles, PCBs, and TAL metals (CLP methods). In addition, two borings will be advanced to collect samples for testing of select engineering parameters (chemical and physical properties) including Atterberg limits, grain size distribution, TOC, redox potential (Eh), and microbial enumeration. The locations of the engineering parameter borings will be determined in the field based on the results of Ensys analysis.

3.4.3 Groundwater Investigation

A groundwater investigation will be conducted to characterize groundwater quality and evaluate the hydrogeologic characteristics of the surficial aquifer at Site 54. For this investigation one shallow (54GW04) permanent monitoring well, and three temporary (54TW01, 54TW02, and 54TW03) monitoring wells are proposed. The shallow permanent well will be installed southeast of the oil/water separator and the temporary wells will be installed around the burn pit. The location of the proposed wells are shown on Figure 3-11.

The shallow well (Type II well construction) will be installed at approximately 18 to 23 feet below ground surface. The well screen (15 feet in length) will be installed approximately 13 feet below the water table. Well construction details for the proposed shallow Type II monitoring well is illustrated on Figure 5-1. Well installation and development procedures, and well construction materials are discussed in Section 5.2.

3.4.3.1 Sampling and Analysis

One round of groundwater samples will be collected from all existing and newly installed monitoring wells approximately one week after each well (newly installed and existing) has been developed. Groundwater samples collected from the existing and newly installed well will be analyzed for TCL volatiles, semivolatiles, PCBs, and TAL metals (total and dissolved). Samples collected from the temporary wells will be analyzed for TCL volatiles and semivolatiles. All groundwater samples will be analyzed in accordance with CLP methods. In addition, samples collected from one well (54GW04) will be analyzed for engineering/general chemistry parameters including microbial enumeration, biological oxygen demand (BOD_5), chemical oxygen demand (COD), nitrogen (NH_4), and alkalinity; samples collected from all wells will also be analyzed for TDS and TSS. Specific details on the procedures for the collection and preparation of groundwater samples are presented in Section 5.3.

3.4.3.2 Water Level Measurements

A minimum of two rounds of water level measurements will be obtained from all site monitoring wells. Measurements will be obtained within a four hour period.

3.4.4 Drainage Ditch Samples

Samples will be collected from within the two surface drainage ditches located south of the burn pit as shown on Figure 3-12. Water (if present) and soil/sediment samples (54DD01 through 54DD04) will be obtained from the two ditches. In addition, samples may also be collected at the point where the ditches discharge into a surface water feature (south of the site). This sample station will be determined in the field based on the amount of surface water flow from the ditches.

One water and two soil/sediment samples will be collected from each sampling station. Soil/sediments will be collected from the surface (ground surface to 12 inches) and just above the water table (soil) or from 6 to 12 inches (sediment). They will be obtained using the same procedures described for other soil or sediment acquisition, depending on the amount of water in the ditches during the time of sampling. Water samples will be obtained using the procedures described for surface water acquisition. Water and soil/sediment samples will be analyzed for TCL volatiles, semivolatiles, PCBs, and TAL metals in accordance with CLP methods.

3.5 Site 86 - Tank Area AS419 - AS421 at the Marine Corps Air Station

The following investigations and support activities will be conducted at Site 86:

- Surveying
- Soil Investigation
- Groundwater Investigation

Each activity and investigation is described in the following subsections.

3.5.1 Surveying

The site survey will involve the surveying of the current site features including roads, aboveground structures, and any significant features which were noted during the site visit. Pre-investigation (i.e., locating boring and well positions) and post-investigation (i.e., elevation of wells) surveying activities similar to those described for Site 36 will also be performed.

3.5.2 Soil Investigation

A soil investigation will be conducted at Site 86 to confirm the presence or absence of contaminants associated with the former ASTs. The investigation will focus on the areas where former ASTs AS420 and AS421 were located. The following subsections describe the tasks proposed for the field program.

3.5.2.1 Sampling Locations

A projected number of nine soil borings will be drilled in the vicinity of former ASTs AS420 and AS421 to depths ranging from 6 to 8 feet (estimated range of depth to water table) to characterize the shallow stratigraphy at the site and to collect samples for laboratory analysis. The proposed drilling locations are identified on Figure 3-13. Two samples from each boring will be submitted for laboratory analysis. These samples will be collected from the surface (0 to 12 inches) and just above the groundwater water table. A mid-depth sample may also be collected from these borings based on field observations and/or monitoring instrument readings, or if the water table is deeper than 10 feet.

Soil samples will also be collected for laboratory analysis at four monitoring well borings. The monitoring well borings from which samples will be submitted for analysis are indicated on Figure 3-13. A minimum of two soil samples will be collected from each of the selected well locations. The samples will be collected from the surface and just above the water table.

One upgradient boring will be drilled north of the site. The boring will be located in an area not believed to have been impacted by the former ASTs. One surface and one subsurface (just above the water table) sample will be submitted for analysis.

Section 5.1 discusses the procedures for the collection and preparation of soil samples to be collected during drilling and trenching activities.

3.5.2.2 Analytical Requirements

Twenty percent of the soil samples will be analyzed for full TCL organics, TAL metals, and TPH. The remainder of the samples will be analyzed for TCL volatiles, semivolatiles, PCBs, and TAL metals (CLP methods). Sample locations targeted for full TCL organics, TAL metals, and TPH analysis are depicted on Figure 3-13. In addition, one boring will be advanced to collect samples for testing of select engineering parameters (chemical and physical properties) including Atterberg limits, grain size distribution, TOC, Eh, and microbial enumeration.

Samples collected from select borings will be undergo 7-day analysis. The locations of these borings are shown on Figure 3-13. Additional borings may be required, based on the 7-day analysis, to further evaluate the extent of soil contamination. The 7-day data will be compared to base background concentrations (metals) and USEPA Region III screening values to determine if additional samples will be required. The 7-day soil analysis will also be used to determine the locations of the engineering sample borings.

3.5.3 Groundwater Investigation

A groundwater investigation will be conducted to characterize groundwater quality and evaluate the hydrogeologic characteristics of the surficial and deep aquifers at Site 86. For this investigation three intermediate (86GW15IW, 86GW16IW, and 86GW17IW) and five deep (86GW15DW through 86GW19DW) monitoring wells are proposed. The three intermediate/deep well clusters will be installed east, southeast, and west (upgradient [86GW17IW/86GW17DW]) of the site and two deep wells will be installed adjacent to existing shallow wells 86GW04 and 86GW10. The location of the proposed wells are shown on Figure 3-14.

The intermediate wells (Type II well construction) will be installed at approximately 30 to 40 feet below ground surface at a depth just above the first semi-confining unit. The deep wells (Type III well construction) will be installed 10 to 15 feet below where the first semi-confining unit. Based on regional stratigraphic information obtained from a USGS publication (Harned, et al., 1989), the depth of the semi-confining unit is between 40 and 50 feet. Well construction details for the proposed shallow Type II and deep Type III monitoring wells are illustrated on Figures 5-1, 5-2, and in Section 5.0. Well installation and development procedures, and well construction materials are discussed in Section 5.2.

3.5.3.1 Sampling and Analysis

One round of groundwater samples will be collected from all existing and newly installed monitoring wells approximately one week after each well (newly installed and existing) has been developed. Twenty percent of the groundwater samples (86GW03, 86GW05, 86GW06, 86GW10, and 86GW13) will be analyzed for full TCL organics and TAL metals (total and dissolved). Samples collected from the remaining wells will be analyzed for TCL volatiles, semivolatiles, and TAL metals (total and dissolved). TCL volatile samples collected from monitoring wells 86GW15IW, 86GW15DW, 86GW17DW, 86GW17IW, 86GW18DW, and 86GW19DW will be subject to 7-day analysis to determine in the field if additional wells are required. All groundwater samples will analyzed in accordance with CLP methods. In addition, samples collected from one shallow (86GW05) well and one deep well (86GW18DW) will be analyzed for engineering/general chemistry parameters including microbial enumeration, BOD_5, COD, NH_4, and alkalinity; samples collected from all wells will be analyzed for TDS and TSS. Specific details on the procedures for the collection and preparation of groundwater samples are presented in Section 5.3.

3.5.3.2 Water Level Measurements

A minimum of two rounds of groundwater level measurements will be obtained from all site monitoring wells. Measurements will be obtained within a four hour period.

3.6 QA/QC Samples

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

- Trip Blanks

  Trip blanks are defined as samples which originate from the 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 organic analysis. The blanks should only be analyzed for volatile organics.

- Equipment Rinsates

  Equipment rinsates are the final analyte-free water rinse from equipment decontamination procedures. Equipment rinsates 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 rinsates, the remaining samples must be analyzed. The results from the rinsates 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 source of water must be collected and analyzed for the same parameters as the related samples.

  Two field blanks (ambient condition blanks) will be prepared at the commencement of each sampling event. The field blanks will be prepared by pouring potable water (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 4-ounce glass jars. 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/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.

3.7 Investigation Derived Waste

Investigation derived wastes (IDW) will be generated during the field program at OU No. 6. The IDW to be generated will include soil and mud cuttings, purge and development groundwater, spent decontamination fluid, and personal protective equipment (PPE) and clothing (PPC). Tables 3-1 and 3-2 summarize the estimated IDW quantities, the contaminants of concern for each IDW media, and the proposed management of each IDW per site. The following describes the procedures for IDW management for OU No. 6.

3.7.1 Soil IDW Management

Soil cuttings (and drilling mud) generated during soil boring and monitoring well installations, and spoil generated from trench excavations will be managed in one of three ways as shown on Table 3-2. Soil cuttings and spoil obtained from soil borings and excavations will be backfilled into the boreholes or trenches upon completion. Soil cuttings obtained during shallow (or intermediate) well installation (with the exception of Site 86) will be spread on the ground surface near the borehole. Lastly, soil and mud cuttings obtained during deep well installation will be temporarily containerized in roll-off boxes, sampled, and disposed either on site (if determined to be nonhazardous) or off site (if determined to be hazardous). One composite soil sample will be collected from each roll-off box and analyzed for full TCLP, TCL PCBs, and RCRA hazardous waste characteristics.

3.7.2 Groundwater IDW Management

Groundwater generated during well development and purging activities will be managed in one of two ways as described on Table 3-2. Groundwater obtained during purging of existing site wells (with the exception of Sites 43 and 86) will be discharged to the ground surface near the monitoring well. For all newly installed monitoring wells (and temporary), and existing wells at Sites 43 and 86, the development and purge groundwater will be temporarily containerized in tanks, sampled, and analyzed for TCL organic, TAL metals, and RCRA hazardous waste characteristics. Hazardous groundwater will be transported and disposed off site and nonhazardous groundwater will be discharged on the ground surface. All groundwater generated at Site 86, however, will be transported off site and disposed of as either hazardous or nonhazardous. Note that groundwater exhibiting visual indications of contamination will be containerized in the tanks and subject to analysis.

3.7.3 Decontamination IDW Management

Spent decontamination fluids will be containerized temporarily in drums at each site, sampled, and analyzed for TCL organic, TAL metals, and RCRA hazardous waste characteristics. Upon receipt of analytical data, the fluids will be either discharged on the ground surface (nonhazardous) or transported off site for disposal (hazardous).

3.7.4 PPE and PPC IDW Management

PPE (e.g., spent respirator cartridges) and PPC (e.g., tyvex) will be double bagged, labeled, and disposed of as solid waste in a on site refuse container. If the PPE or PPC is exposed to potentially hazardous substances or excessively contaminated soil or groundwater, they will be placed in a drum and disposed of in a solid waste landfill.

SECTION 3.0
TABLES

TABLE 3-1

ESTIMATED INVESTIGATION DERIVED WASTE QUANTITIES GENERATED DURING VARIOUS SITE ACTIVITIES AT OPERABLE UNIT NO. 6 REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246 MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Site	Activity	Media	Estimated Quantity
36	Soil Boring/Monitoring Well Installation	Soil/Mud Cuttings	40 yd^3
	Trenching	Soil	14 yd^3
	Well Development	Groundwater	2,000 gallons
	Well Purging	Groundwater	1,000 gallons
	Decontamination	Liquids	200 gallons
43	Soil Boring/Monitoring Well Installation	Soil/Mud Cuttings	20 yd^3
	Trenching	Soil	14 yd^3
	Well Development	Groundwater	1,300 gallons
	Well Purging	Groundwater	500 gallons
	Decontamination	Liquids	200 gallons
44	Soil Boring/Monitoring Well Installation	Soil/Mud Cuttings	8 yd^3
	Trenching	Soil	14 yd^3
	Well Development	Groundwater	650 gallons
	Well Purging	Groundwater	200 gallons
	Decontamination	Liquids	200 gallons
54	Soil Boring/Monitoring Well Installation	Soil Cuttings	5 yd^3
	Well Development	Groundwater	150 gallons
	Well Purging	Groundwater	200 gallons
	Decontamination	Liquids	200 gallons
86	Soil Boring/Monitoring Well Installation	Soil/Mud Cuttings	20 yd^3
	Well Development	Groundwater	2,300 gallons
	Well Purging	Groundwater	1,200 gallons
	Decontamination	Liquids	200 gallons

TABLE 3-2

INVESTIGATION DERIVED WASTE MANAGEMENT FOR OPERABLE UNIT NO. 6
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Site	Media	Activity	Estimated Quantity	Contaminants of Concern	Management Option
36	Soil/Mud Cuttings	Soil borings/trenching	19 yd^3	Unknown	Backfill cuttings into borehole/trench.
		Shallow well installation	10 yd^3	Unknown	Spread cuttings on ground surface near borehole.
		Deep well installation	25 yd^3	Unknown	Containerize cuttings/mud in roll-off box for temporary storage; collect composite sample from roll-off box for analytical testing; nonhazardous soil to be spread on ground surface on site; hazardous soil to be transported off site for disposal.
	Groundwater	Shallow existing wells - purging	300 gallons	Metals	Discharge to the ground surface near monitoring well.
		Shallow/deep new wells - development and purging	2,700 gallons	Metals	Containerize water in tanks for temporary storage; collect one sample from each tank for analytical testing; nonhazardous groundwater to be discharged to the ground surface; hazardous groundwater to be transported off site for disposal.
	Decontamination Fluids	Decontamination	200 gallons	Acetone	Containerize fluids in drums for temporary storage; collect one composite sample from drums for analytical testing; noncontaminated water to be discharged to the ground surface; contaminated water to be transported off site for disposal.
43	Soil/Mud Cuttings	Soil borings/trenching	2 yd^3	Metals/PAHs	Backfill cuttings into borehole/trench.
		Shallow well installation	5 yd^3	Metals/PAHs	Spread cuttings on ground surface near borehole.
		Deep well installation	13 yd^3	Metals/PAHs	Containerize cuttings/mud in roll-off box for temporary storage; collect composite sample from roll-off box for analytical testing; nonhazardous soil to be spread on ground surface on site; hazardous soil to be transported off site for disposal.
	Groundwater	All site wells - development and purging	1,800 gallons	Metals	Containerize water in tanks for temporary storage; collect one sample from each tank for analytical testing; nonhazardous groundwater to be discharged to the ground surface; hazardous groundwater to be transported off site for disposal.
	Decontamination Fluids	Decontamination	200 gallons	Acetone	Containerize fluids in drums for temporary storage; collect one composite sample from drums for analytical testing; noncontaminated water to be discharged to the ground surface; contaminated water to be transported off site for disposal.

TABLE 3-2 (CONTINUED)

INVESTIGATION DERIVED WASTE MANAGEMENT FOR OPERABLE UNIT NO. 6
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

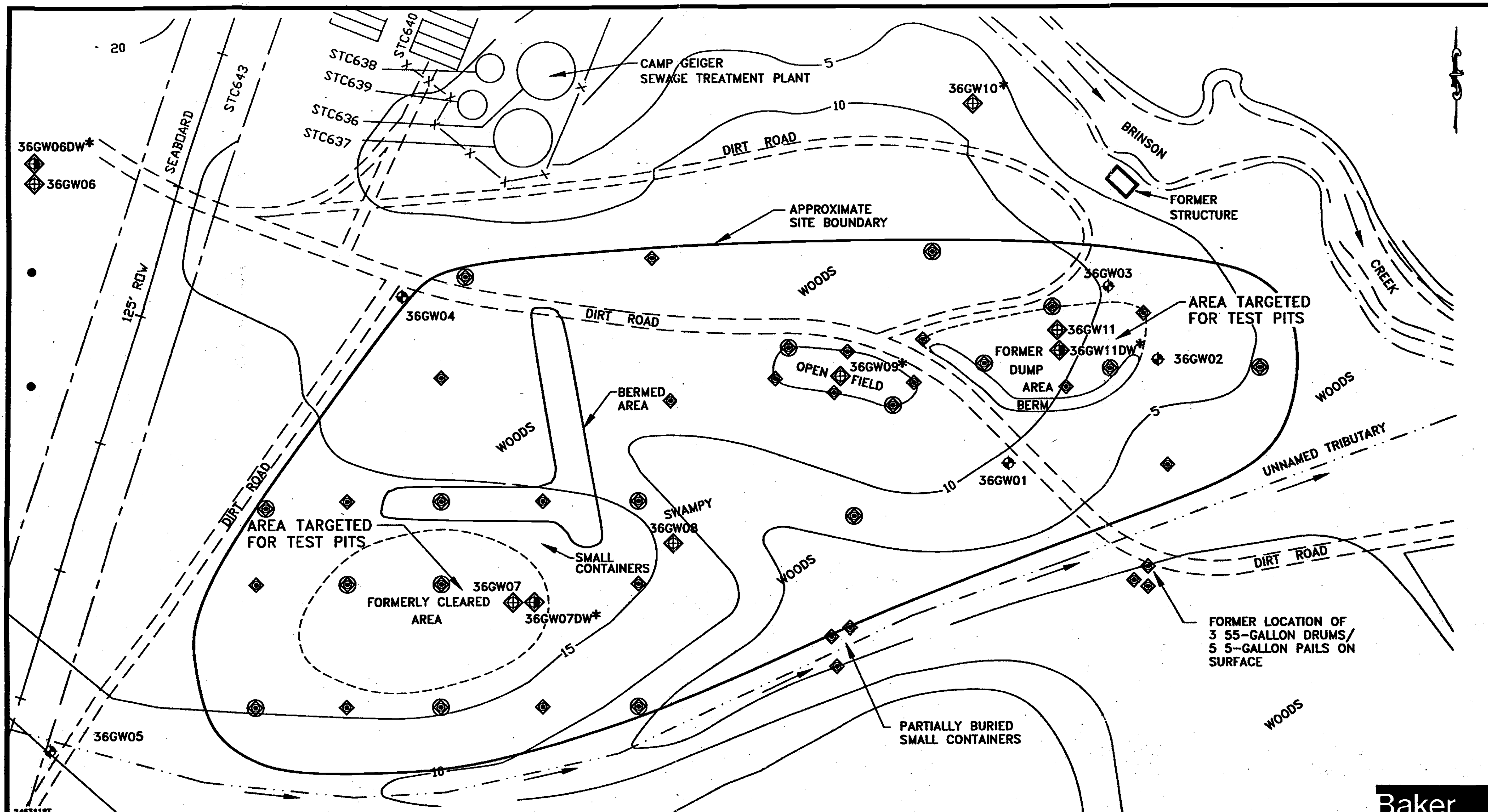
Site	Media	Activity	Estimated Quantity	Contaminants of Concern	Management Option
44	Soil/Mud Cuttings	Soil borings/trenching	15 yd^3	Pesticides/ PAHs/Metals	Backfill cuttings into borehole/trench.
		Shallow well installation	2 yd^3	Pesticides/ PAHs/Metals	Spread cuttings on ground surface near borehole.
		Deep well installation	5 yd^3	Pesticides/ PAHs/Metals	Containerize cuttings/mud in roll-off box for temporary storage; collect composite sample from roll-off box for analytical testing; nonhazardous soil to be spread on ground surface on site; hazardous soil to be transported off site for disposal.
	Groundwater	Shallow existing wells - purging	75 gallons	Metals	Discharge to the ground surface near monitoring well.
		Shallow/deep new wells - development and purging	775 gallons	Metals	Containerize water in tanks for temporary storage; collect one sample from each tank for analytical testing; nonhazardous groundwater to be discharged to the ground surface; hazardous groundwater to be transported off site for disposal.
	Decontamination Fluids	Decontamination	200 gallons	Acetone	Containerize fluids in drums for temporary storage; collect one composite sample from drums for analytical testing; noncontaminated water to be discharged to the ground surface; contaminated water to be transported off site for disposal.
54	Soil Cuttings	Soil borings	3 yd^3	Volatiles/ Semivolatiles/ Metals	Backfill cuttings into borehole/trench.
		Shallow well installation	2 yd^3	Volatiles/ Semivolatiles/ Metals	Spread cuttings on ground surface near borehole.
	Groundwater	Shallow existing wells - purging	200 gallons	Volatiles/ Semivolatiles/ Metals	Discharge to the ground surface near monitoring well.
		Shallow new wells - development and purging	150 gallons	Volatiles/ Semivolatiles/ Metals	Containerize water in tanks for temporary storage; collect one sample from each tank for analytical testing; nonhazardous groundwater to be discharged to the ground surface; hazardous groundwater to be transported off site for disposal.
	Decontamination Fluids	Decontamination	200 gallons	Acetone	Containerize fluids in drums for temporary storage; collect one composite sample from drums for analytical testing; noncontaminated water to be discharged to the ground surface; contaminated water to be transported off site for disposal.

TABLE 3-2 (CONTINUED)

INVESTIGATION DERIVED WASTE MANAGEMENT FOR OPERABLE UNIT NO. 6
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Site	Media	Activity	Estimated Quantity	Contaminants of Concern	Management Option
86	Soil/Mud Cuttings	Soil borings	2 yd^3	Volatiles/ Semivolatiles/ Metals	Backfill cuttings into borehole/trench.
		Intermediate Well Installation	5 yd^3	Volatiles/ Semivolatiles/ Metals	Containerize cuttings/mud in roll-off box for temporary storage; collect composite sample from roll-off box for analytical testing; nonhazardous soil to be spread on ground surface on site; hazardous soil to be transported off site for disposal.
		Deep well installation	13 yd^3	Volatiles/ Semivolatiles/ Metals	Containerize cuttings/mud in roll-off box for temporary storage; collect composite sample from roll-off box for analytical testing; nonhazardous soil to be spread on ground surface on site; hazardous soil to be transported off site for disposal.
	Groundwater	All site wells - development and purging	3,500 gallons	Volatiles/ Metals	Containerize water in tanks for temporary storage; collect one sample from each tank for analytical testing; nonhazardous groundwater to be discharged to the ground surface; hazardous groundwater to be transported off site for disposal.
	Decontamination Fluids	Decontamination	200 gallons	Acetone	Containerize fluids in drums for temporary storage; collect one composite sample from drums for analytical testing; noncontaminated water to be discharged to the ground surface; contaminated water to be transported off site for disposal.

SECTION 3.0
FIGURES



LEGEND

- 36GW01 EXISTING SHALLOW MONITORING WELL LOCATION
- 36GW06 PROPOSED SHALLOW MONITORING WELL LOCATION
- 36GW06DW PROPOSED DEEP MONITORING WELL LOCATION
- PROPOSED SOIL BORING LOCATION
- PROPOSED SOIL BORING LOCATION (7-DAY TURNAROUND)
- PROPOSED UPGRADIENT SOIL BORING LOCATION
- * DENOTES SAMPLE COLLECTION FOR LABORATORY ANALYSIS FROM WELL BORING

SOURCE: LANTDIV, FEB. 1992

150 0 75 150 300

1 inch = 150 ft.

FIGURE 3-1
PROPOSED SAMPLE LOCATIONS FOR SOIL INVESTIGATION
SITE 36:CAMP GEIGER AREA DUMP
NEAR SEWAGE TREATMENT PLANT
CTO-0246

MARINE CORPS AIR STATION, NEW RIVER
JACKSONVILLE, NORTH CAROLINA

015672B22

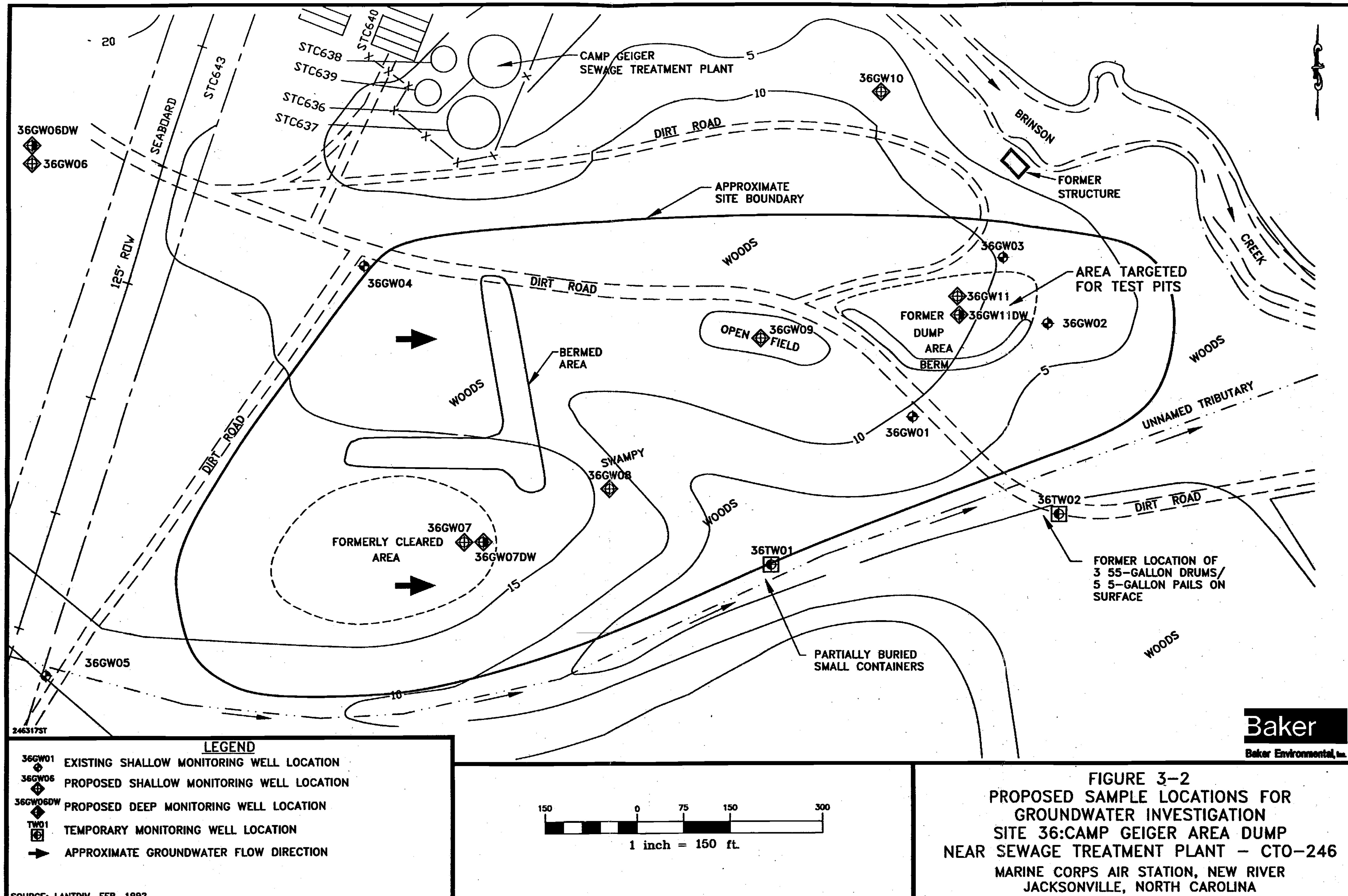
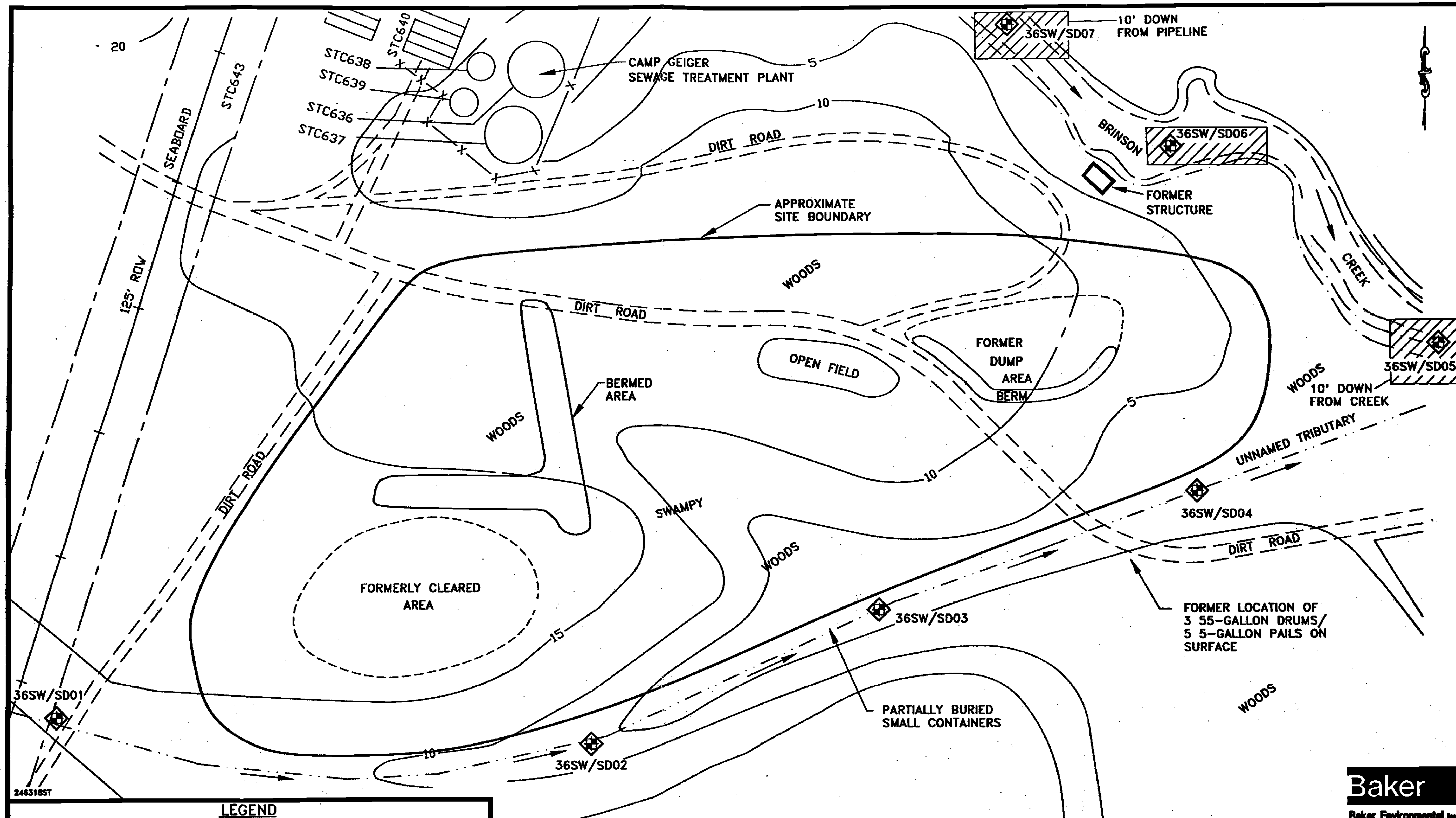


FIGURE 3-2
PROPOSED SAMPLE LOCATIONS FOR GROUNDWATER INVESTIGATION
SITE 36:CAMP GEIGER AREA DUMP
NEAR SEWAGE TREATMENT PLANT – CTO-246
MARINE CORPS AIR STATION, NEW RIVER
JACKSONVILLE, NORTH CAROLINA



LEGEND

36SW/SD01 PROPOSED SURFACE WATER/SEDIMENT SAMPLE STATION

PROPOSED FISH/CRAB/BENTHIC SAMPLE STATION

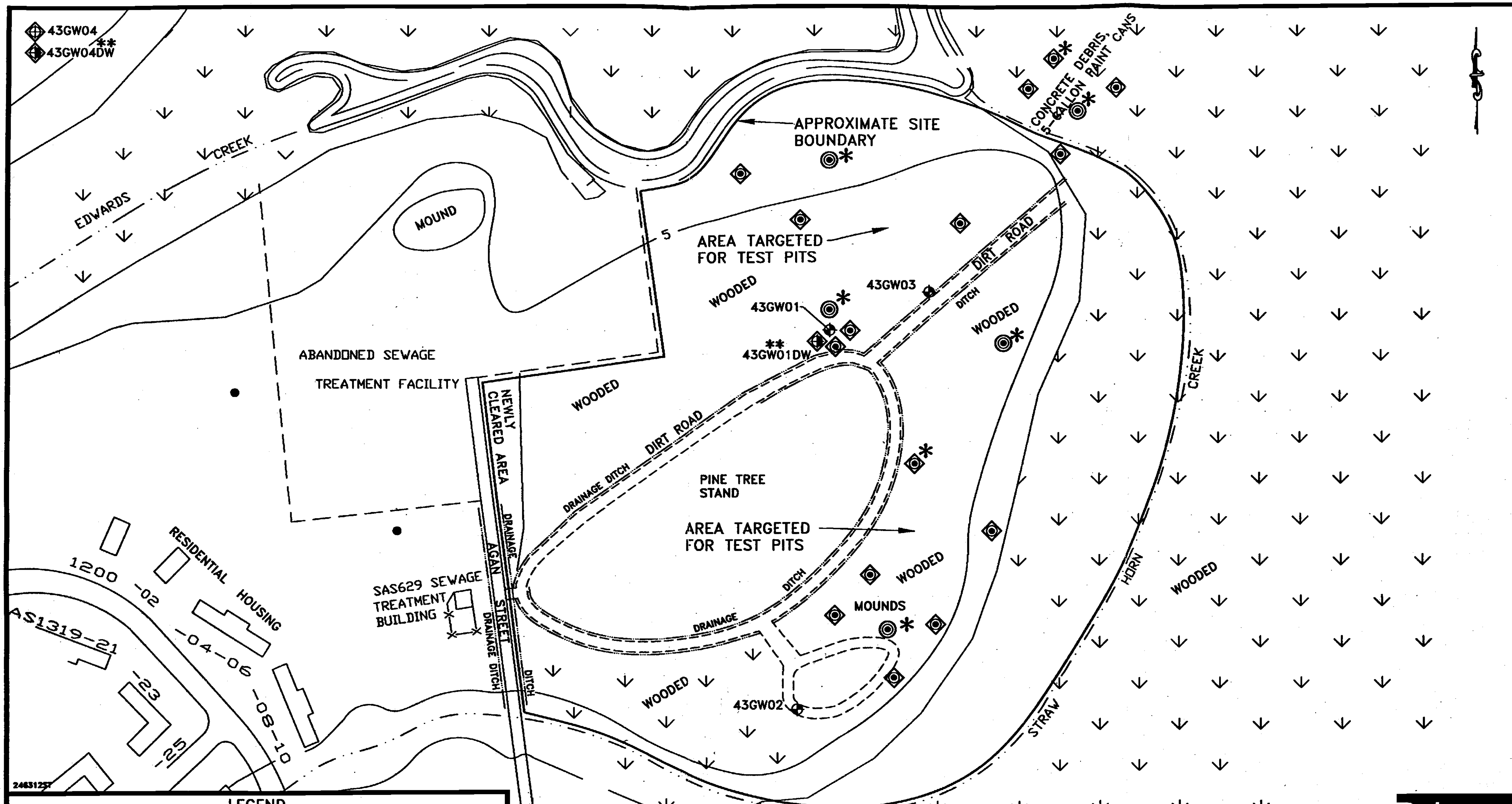
NOTE: SAMPLES WERE COLLECTED IN APRIL, 1994.

SOURCE: LANTDIV, FEB. 1992

150 0 75 150 300

1 inch = 150 ft.

FIGURE 3-3
PROPOSED SAMPLE LOCATIONS FOR SURFACE WATER/SEDIMENT AND AQUATIC INVESTIGATIONS
SITE 36:CAMP GEIGER AREA DUMP
NEAR SEWAGE TREATMENT PLANT – CTO-0246
MARINE CORPS AIR STATION, NEW RIVER
JACKSONVILLE, NORTH CAROLINA



LEGEND

- 43GW01 EXISTING SHALLOW MONITORING WELL LOCATION
- 43GW04 PROPOSED SHALLOW MONITORING WELL LOCATION
- 43GW01DW PROPOSED DEEP MONITORING WELL LOCATION
- PROPOSED SOIL BORING LOCATION (TCL SEMIVOLATILE/ TAL METALS ANALYSIS)
- PROPOSED SOIL BORING LOCATION (FULL TCL ORGANICS/TAL METALS ANALYSIS)
- PROPOSED UPGRADIENT SOIL BORING LOCATION(FULL TCL ORGANICS/TAL METALS ANALYSIS)
- * DENOTES 7-DAY TURNAROUND ANALYSIS
- ** DENOTES SAMPLE COLLECTION FOR LABORATORY ANALYSIS FROM WELL BORING

SOURCE: LANTDIV, FEB. 1992

150 0 75 150 300

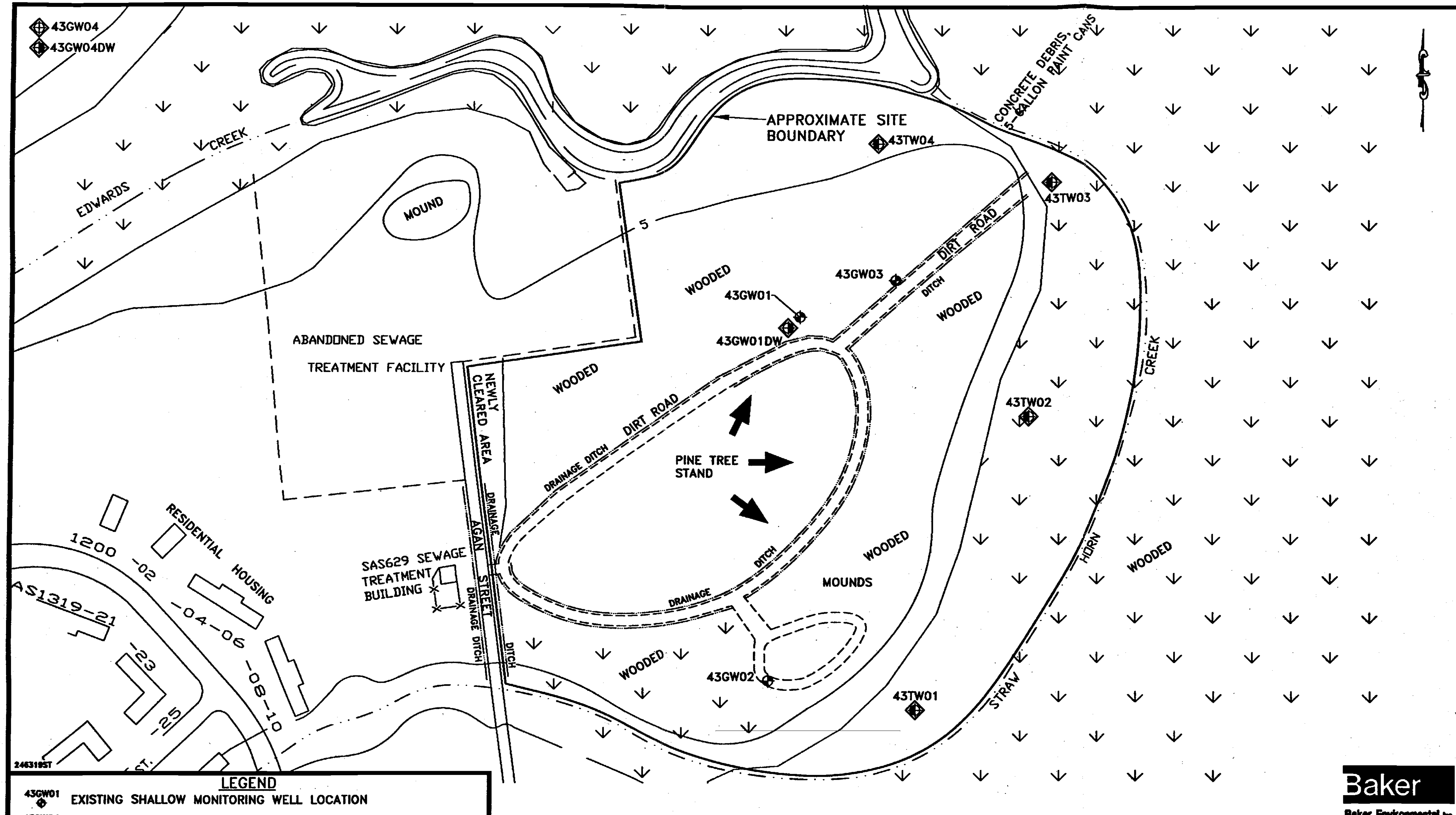
1 inch = 150 ft.

Baker

Baker Environmental, Inc.

FIGURE 3-4
PROPOSED SAMPLE LOCATIONS FOR SOIL INVESTIGATION
SITE 43: AGAN STREET DUMP
CTO-0246

MARINE CORPS AIR STATION, NEW RIVER
JACKSONVILLE, NORTH CAROLINA



LEGEND

- 43GW01 EXISTING SHALLOW MONITORING WELL LOCATION
- 43GW04 PROPOSED SHALLOW MONITORING WELL LOCATION
- 43GW01DW PROPOSED DEEP MONITORING WELL LOCATION
- 43TW01 PROPOSED TEMPORARY MONITORING WELL LOCATION
- APPROXIMATE GROUNDWATER FLOW DIRECTION

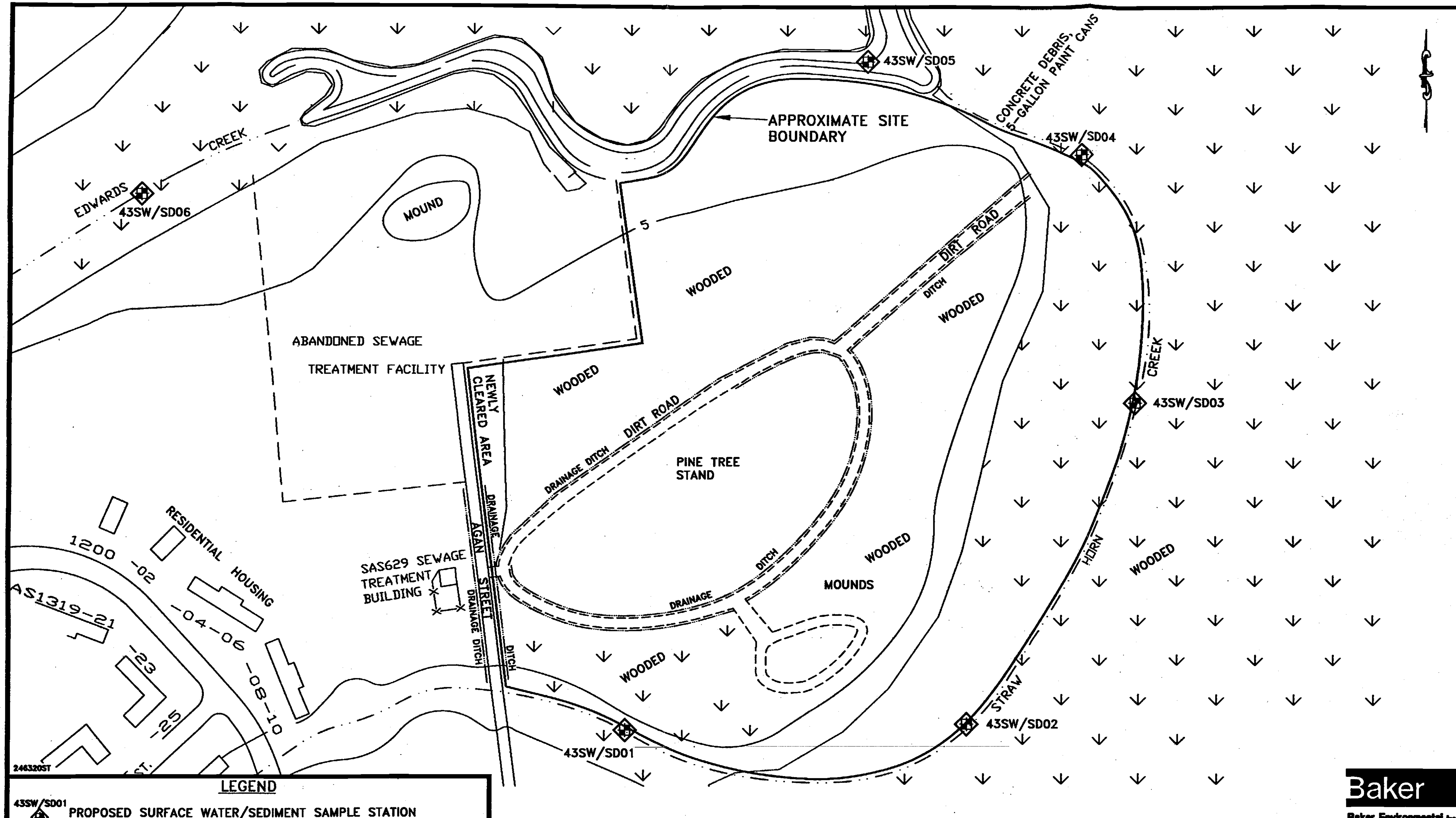
SOURCE: LANTDIV, FEB. 1992

150 0 75 150 300

1 inch = 150 ft.

FIGURE 3-5
PROPOSED SAMPLE LOCATIONS FOR GROUNDWATER INVESTIGATION
SITE 43: AGAN STREET DUMP
CTO-0246

MARINE CORPS AIR STATION, NEW RIVER
JACKSONVILLE, NORTH CAROLINA



Baker
Baker Environmental, Inc.

LEGEND

43SW/SD01 PROPOSED SURFACE WATER/SEDIMENT SAMPLE STATION

NOTE:
BIOASSAY SAMPLES WILL BE COLLECTED AT EACH SURFACE WATER/ SEDIMENT STATION.

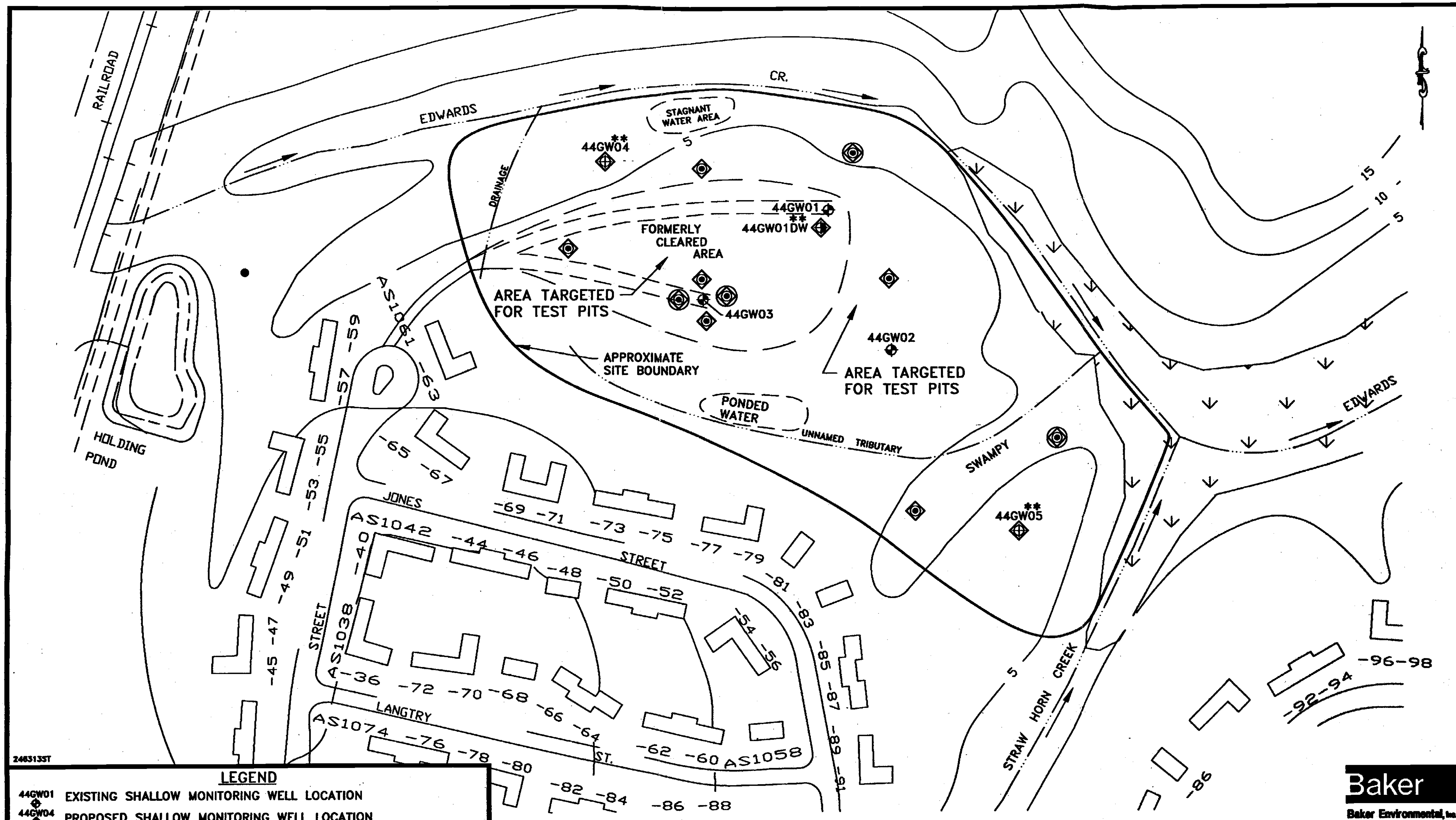
SOURCE: LANTDIV, FEB. 1992

150 0 75 150 300

1 inch = 150 ft.

FIGURE 3-6
PROPOSED SAMPLE LOCATIONS FOR SURFACE WATER AND SEDIMENT INVESTIGATIONS
SITE 43: AGAN STREET DUMP
CTO-0246

MARINE CORPS AIR STATION, NEW RIVER
JACKSONVILLE, NORTH CAROLINA



LEGEND

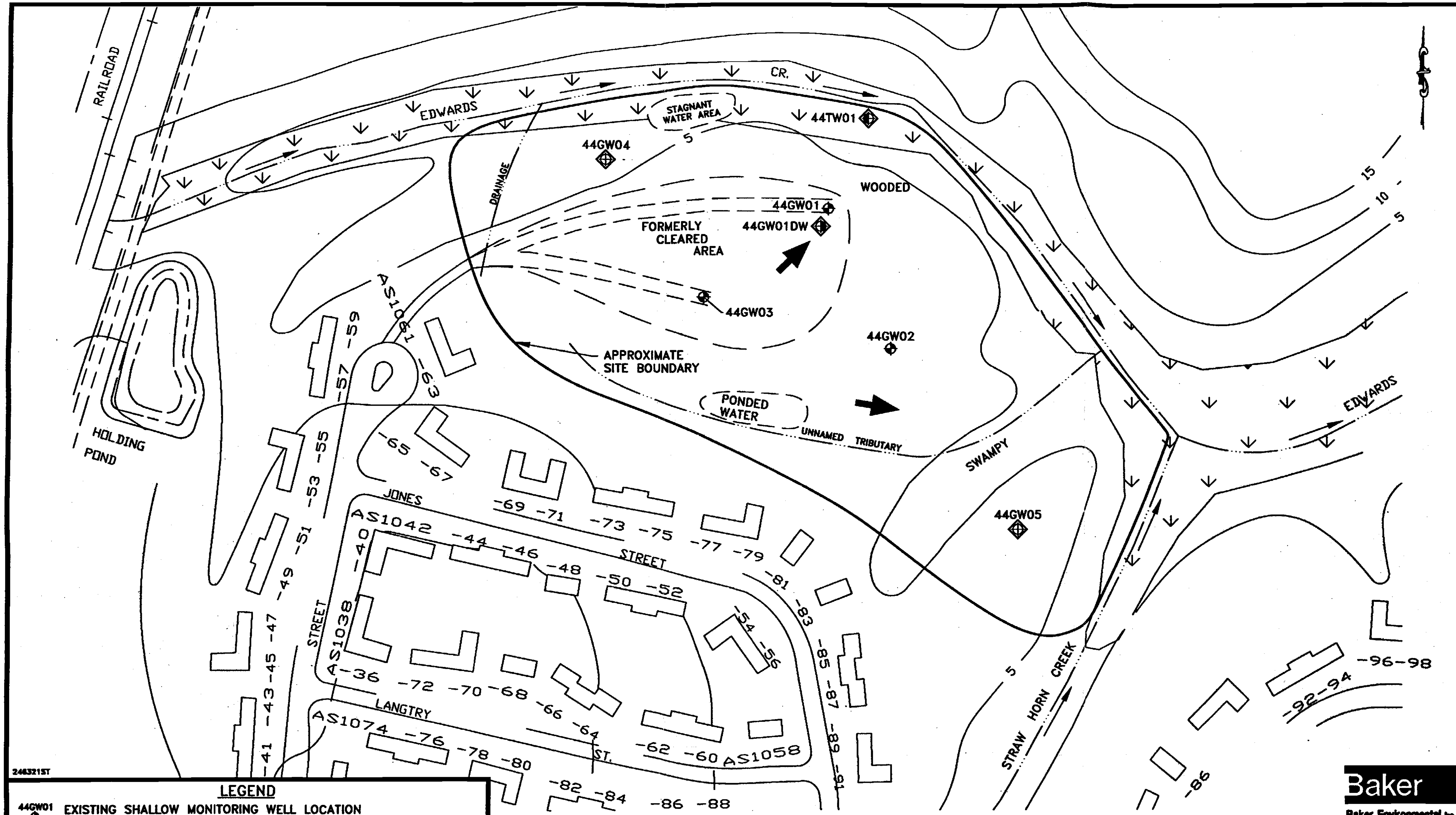
- 44GW01 EXISTING SHALLOW MONITORING WELL LOCATION
- 44GW04 PROPOSED SHALLOW MONITORING WELL LOCATION
- 44GW01DW PROPOSED DEEP MONITORING WELL LOCATION
- PROPOSED SOIL BORING LOCATION [TCL ORGANICS (WITHOUT PCBs)TAL METALS]
- PROPOSED SOIL BORING LOCATION (7-DAY TURNAROUND FULL TCL ORGANICS/TAL METALS ANALYSIS)
- PROPOSED UPGRADIENT SOIL BORING LOCATION (FULL TCL ORGANICS/TAL METALS ANALYSIS)
- ** DENOTES SAMPLE COLLECTION FOR LABORATORY ANALYSIS FROM WELL BORING.

SOURCE: LANTDIV, FEB. 1992

150 0 75 150 300

1 inch = 150 ft.

FIGURE 3-7
PROPOSED SAMPLE LOCATIONS FOR SOIL INVESTIGATIONS
SITE 44: JONES STREET DUMP
CTO-0246
MARINE CORPS AIR STATION, NEW RIVER
JACKSONVILLE, NORTH CAROLINA



LEGEND

44GW01 EXISTING SHALLOW MONITORING WELL LOCATION (TCL ORGANICS WITHOUT PCBs/TAL METALS)

44GW04 PROPOSED SHALLOW MONITORING WELL LOCATION (FULL TCL ORGANICS/TAL METALS)

44GW01DW PROPOSED DEEP MONITORING WELL LOCATION (FULL TCL ORGANICS/TAL METALS)

44TW01 PROPOSED TEMPORARY MONITORING WELL LOCATION (TCL ORGANICS WITHOUT PCBs/TAL METALS)

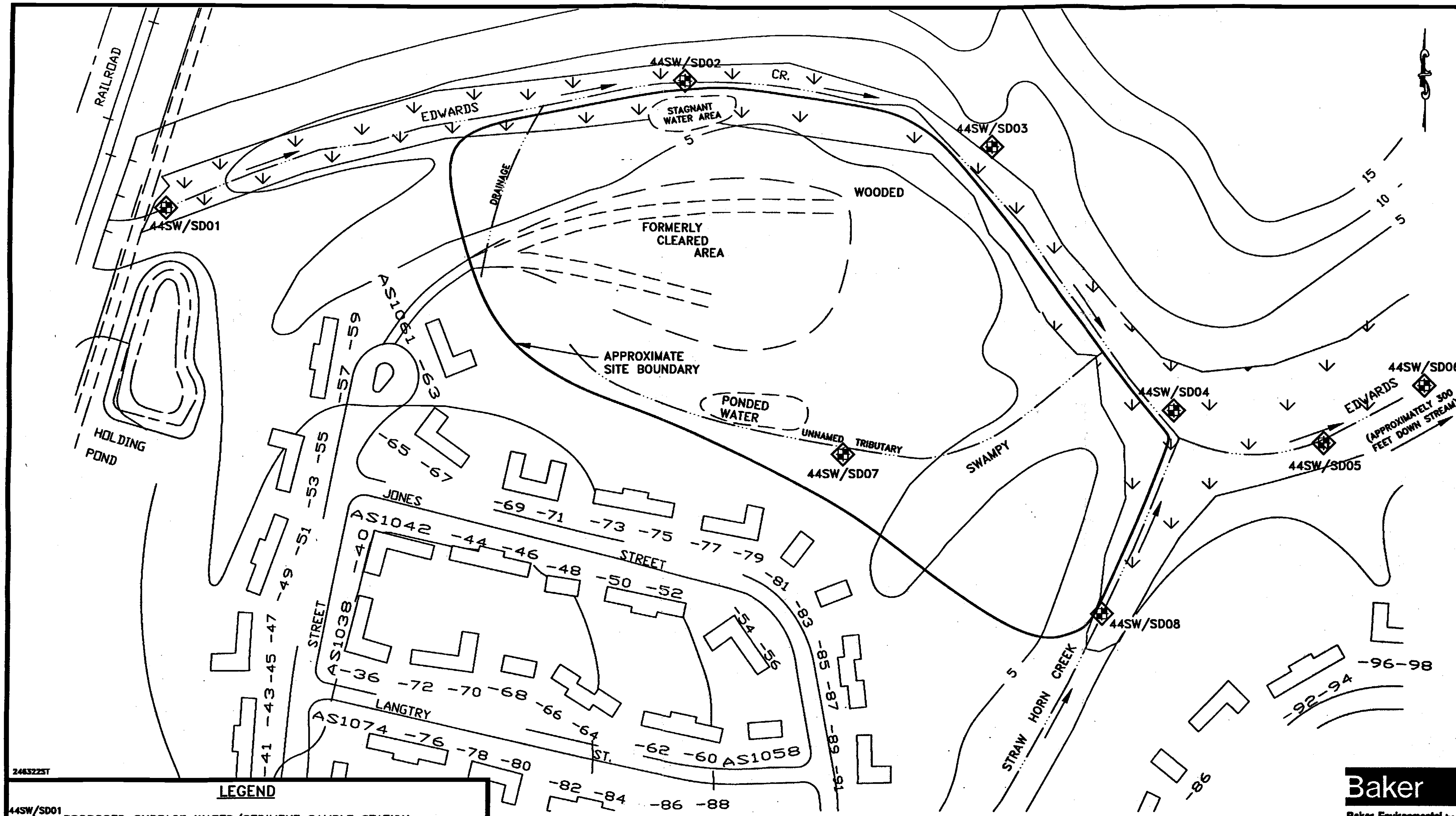
APPROXIMATE GROUNDWATER FLOW DIRECTION

SOURCE: LANTDIV, FEB. 1992

150 0 75 150 300

1 inch = 150 ft.

FIGURE 3-8
PROPOSED SAMPLE LOCATIONS FOR GROUNDWATER INVESTIGATION
SITE 44: JONES STREET DUMP
CTO-0246
MARINE CORPS AIR STATION, NEW RIVER
JACKSONVILLE, NORTH CAROLINA



LEGEND

44SW/SD01 PROPOSED SURFACE WATER/SEDIMENT SAMPLE STATION

NOTE:
-BIOASSAY SAMPLES WILL BE COLLECTED AT EACH SURFACE WATER/ SEDIMENT STATION.

SOURCE: LANTDIV, FEB. 1992

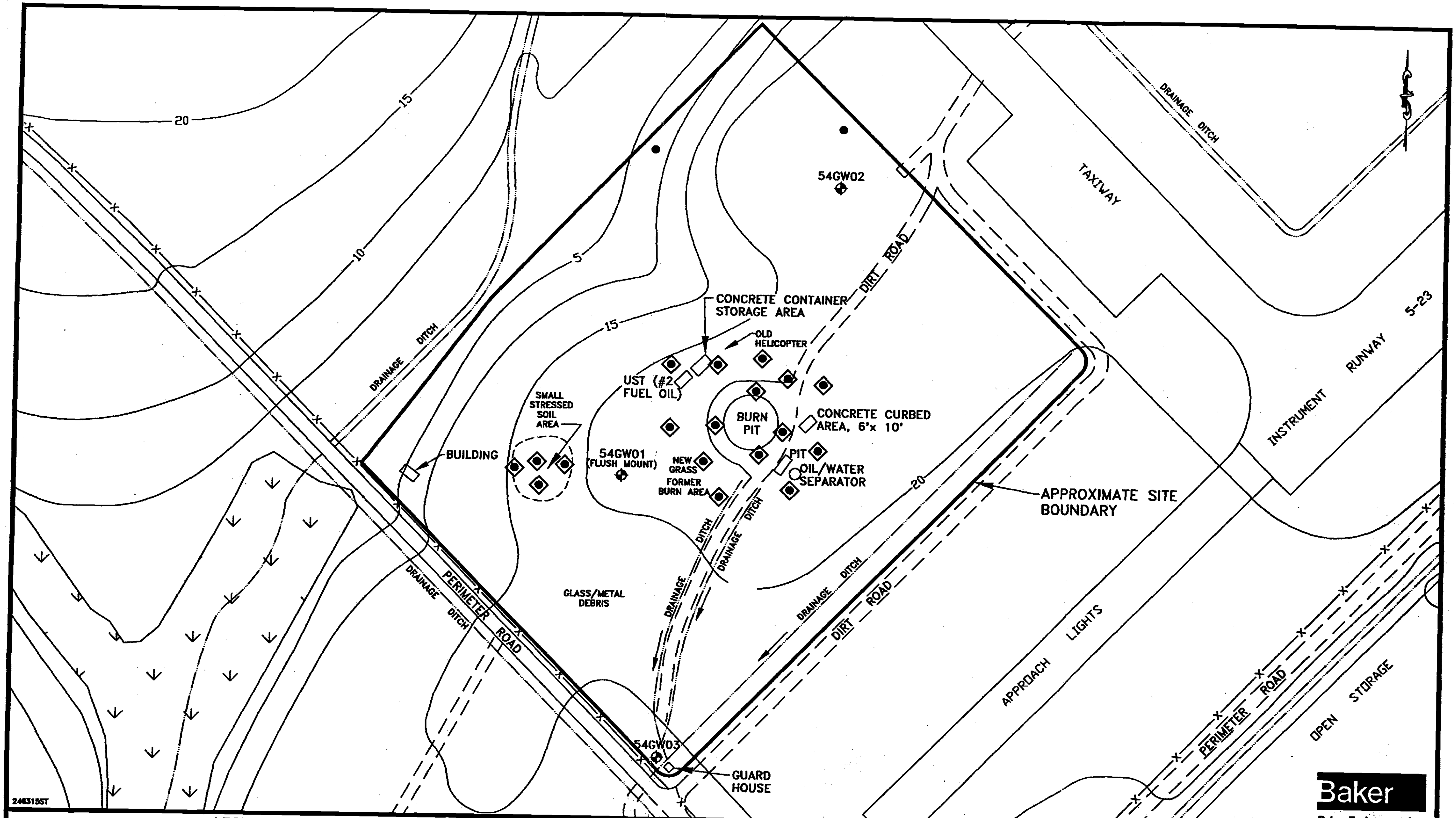
150 0 75 150 300

1 inch = 150 ft.

Baker

Baker Environmental, Inc.

FIGURE 3-9
PROPOSED SAMPLE LOCATIONS FOR SURFACE WATE AND SEDIMENT INVESTIGATION
SITE 44: JONES STREET DUMP
CTO-0246
MARINE CORPS AIR STATION, NEW RIVER
JACKSONVILLE, NORTH CAROLINA



LEGEND

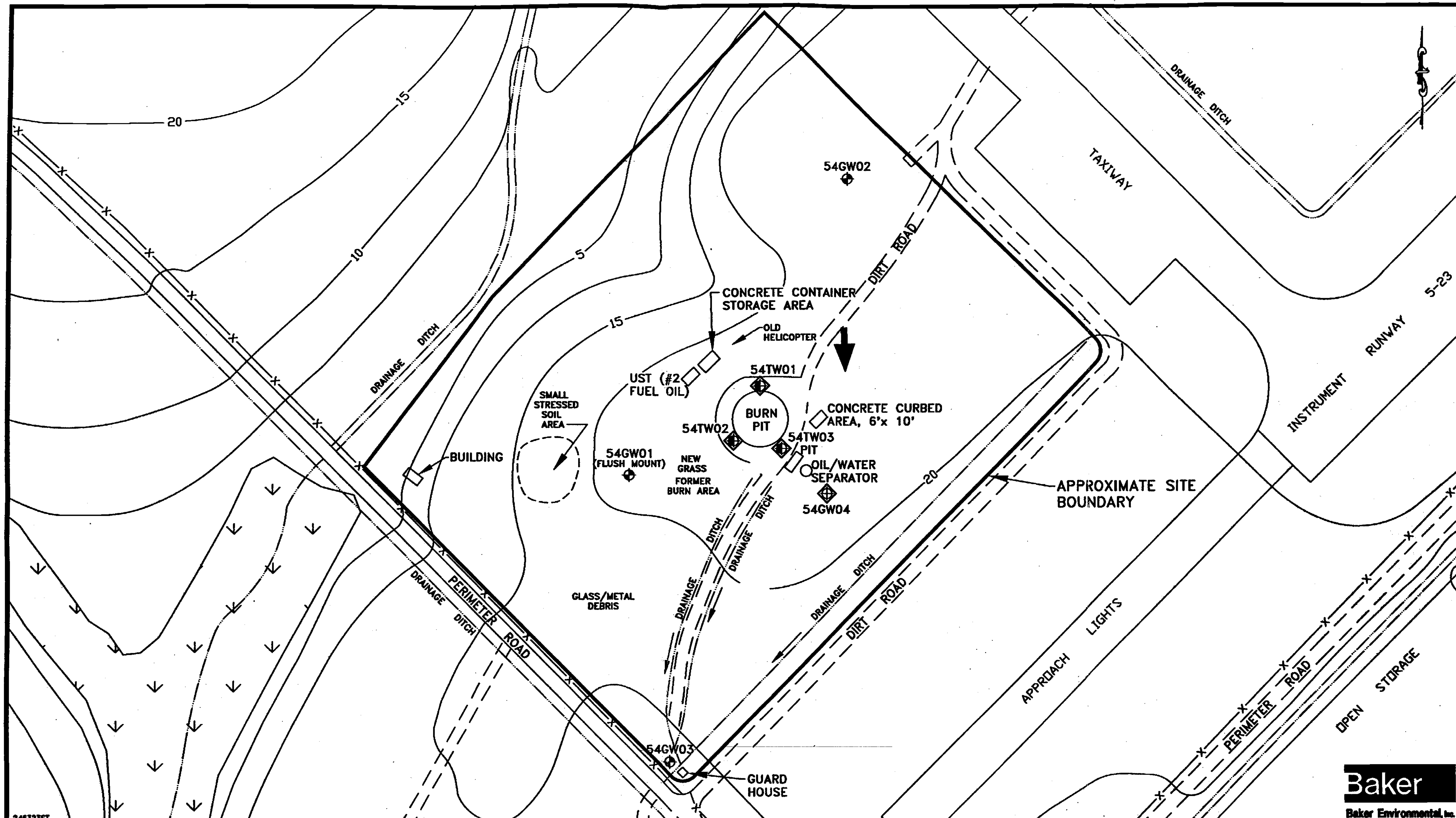
54GW01	EXISTING SHALLOW MONITORING WELL LOCATION
◈	PROPOSED SURFACE SOIL SAMPLE LOCATION (TEST KIT ANALYSIS)
●	PROPOSED UPGRADIENT SOIL BORING LOCATION

SOURCE: LANTDIV, FEB. 1992

150 0 75 150 300

1 inch = 150 ft.

FIGURE 3-10
PROPOSED SAMPLE LOCATIONS FOR SOIL INVESTIGATION
SITE 54: CRASH CREW FIRE TRAINING BURN PIT - CTO-0246
MARINE CORPS AIR STATION, NEW RIVER
JACKSONVILLE, NORTH CAROLINA



LEGEND

54GW01 EXISTING SHALLOW MONITORING WELL LOCATION

54GW04 PROPOSED SHALLOW MONITORING WELL LOCATION

54TW01 PROPOSED TEMPORARY MONITORING WELL LOCATION

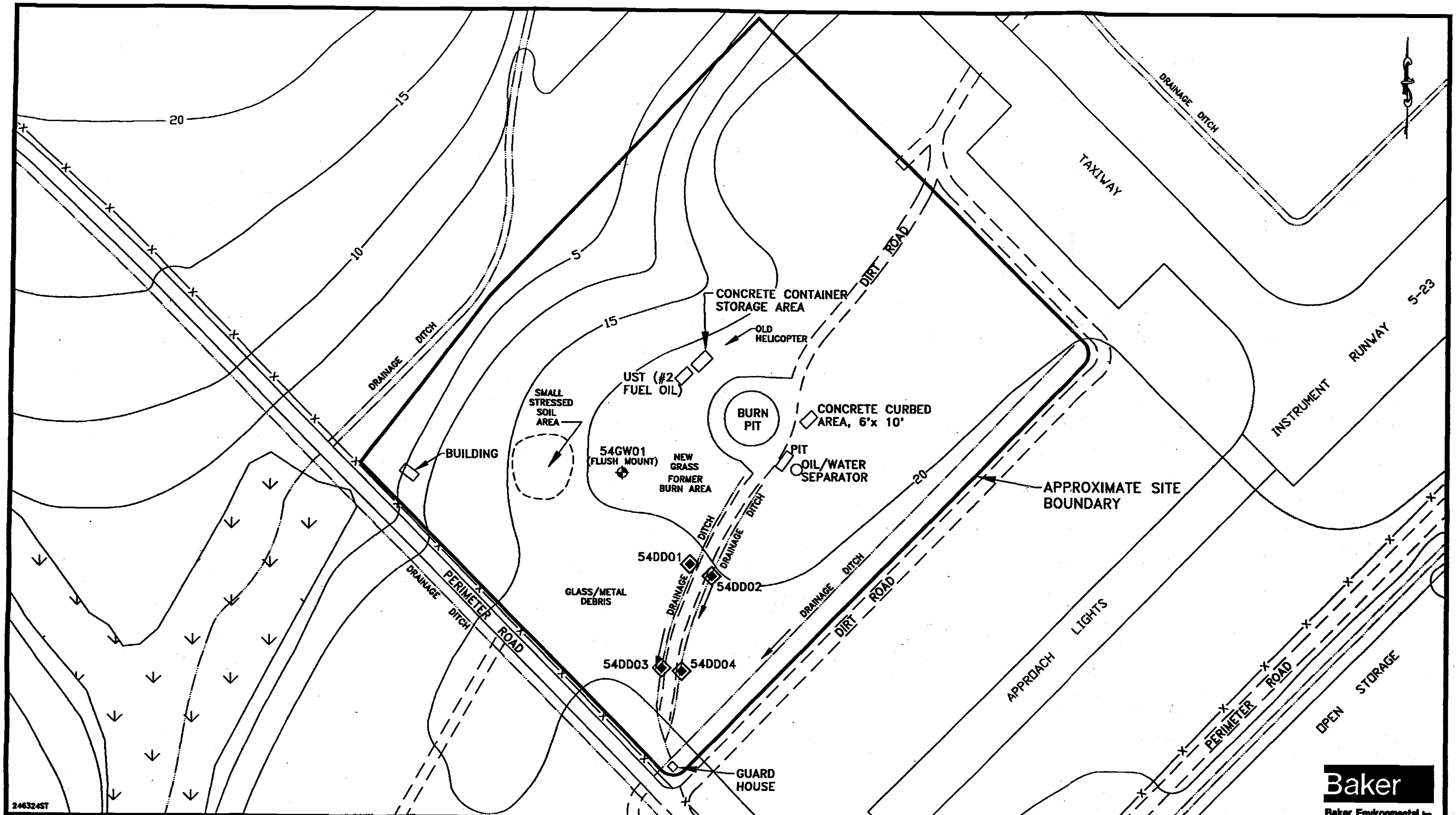
APPROXIMATE GROUNDWATER FLOW DIRECTION

SOURCE: LANTDIV, FEB. 1992

150 0 75 150 300

1 inch = 150 ft.

FIGURE 3-11
PROPOSED SAMPLE LOCATIONS FOR GROUNDWATER INVESTIGATION
SITE 54: CRASH CREW FIRE TRAINING BURN PIT – CTO-0246
MARINE CORPS AIR STATION, NEW RIVER
JACKSONVILLE, NORTH CAROLINA



LEGEND

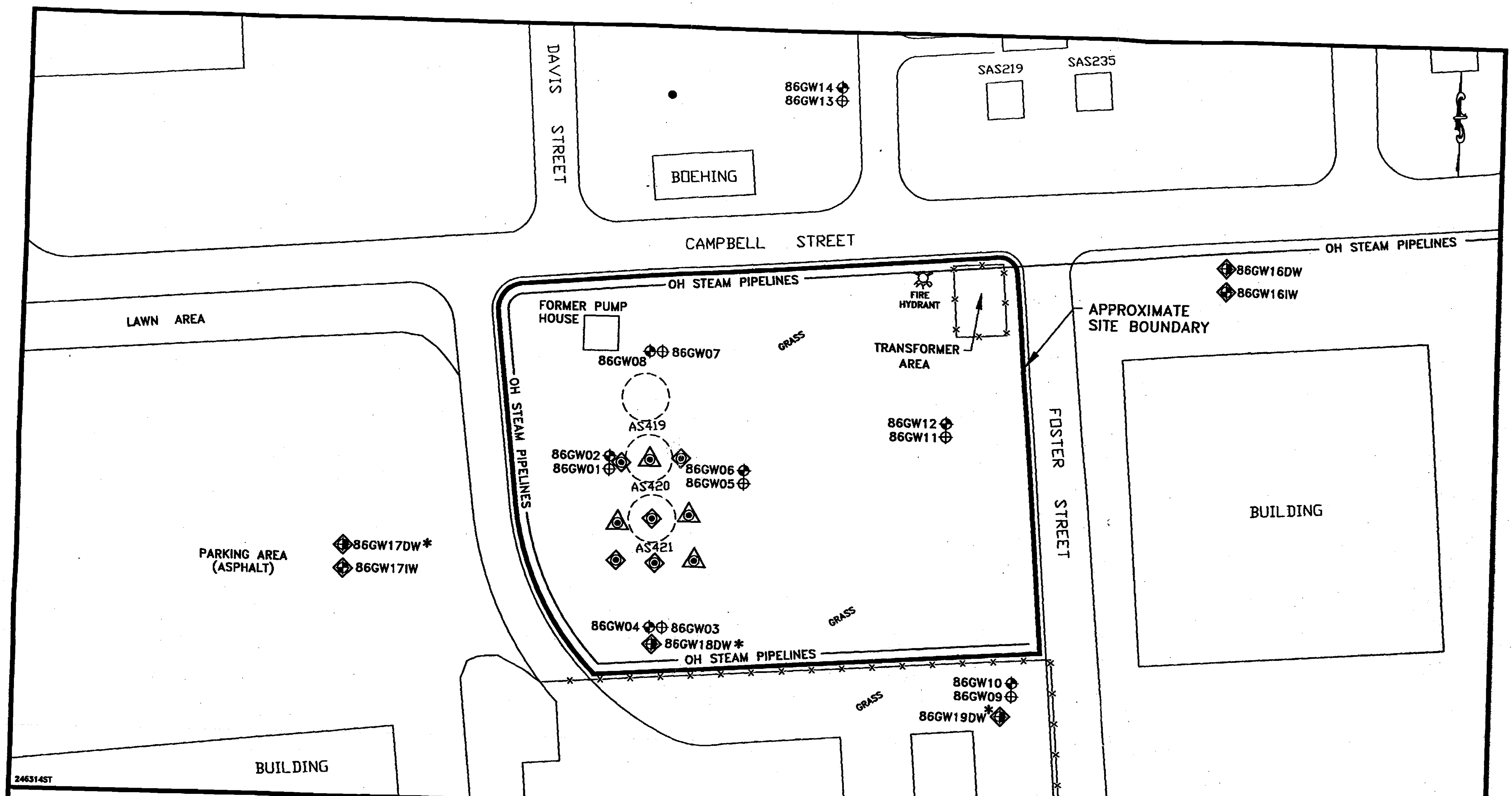
54DD01 PROPOSED DRAINAGE DITCH SAMPLE LOCATION (SOIL AND/OR WATER)

SOURCE: LANTDIV, FEB. 1992

150 0 75 150 300

1 inch = 150 ft.

FIGURE 3-12
PROPOSED DITCH SAMPLE LOCATIONS
SITE 54: CRASH CREW FIRE TRAINING BURN PIT
CTO-0246
MARINE CORPS AIR STATION, NEW RIVER
JACKSONVILLE, NORTH CAROLINA



LEGEND

- 86GW01 EXISTING SHALLOW MONITORING WELL LOCATION
- 86GW02 EXISTING INTERMEDIATE MONITORING WELL LOCATION
- 86GW15IW PROPOSED INTERMEDIATE MONITORING WELL LOCATION
- 86GW15DW PROPOSED DEEP MONITORING WELL LOCATION
- PROPOSED SOIL BORING LOCATION(ROUTINE TURNAROUND ANALYSIS)
- PROPOSED SOIL BORING LOCATION(7-DAY TURNAROUND ANALYSIS; TCL ORGANICS/TAL METALS/TPH)
- ● PROPOSED UPGRADIENT SOIL BORING LOCATION
- * DENOTES SAMPLE COLLECTION FOR LABORATORY ANALYSIS FROM MONITORING WELL BORING.

SOURCE: LANTDIV, FEB. 1992

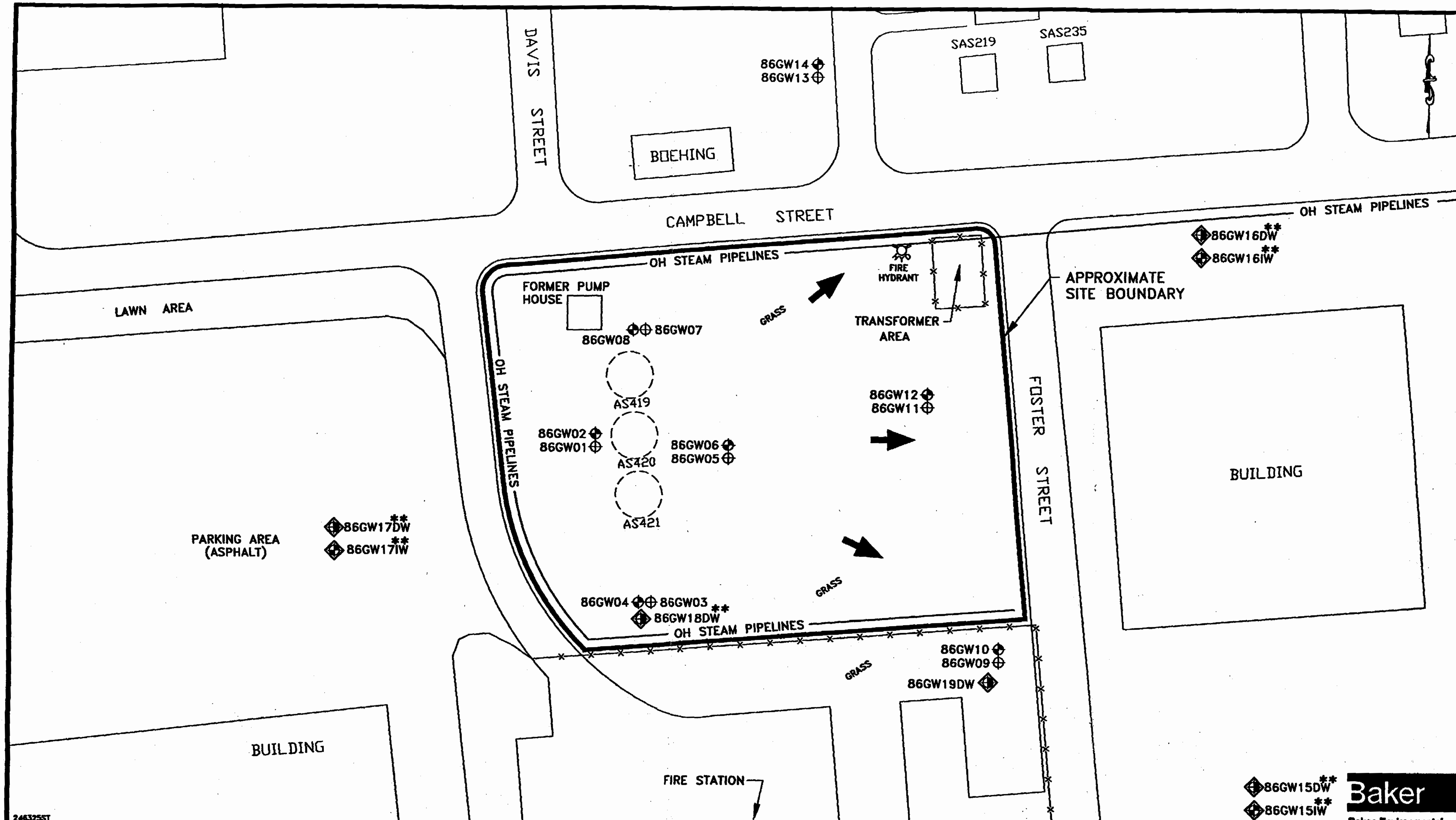
50 0 25 50 100

1 inch = 50 ft.

Baker

Baker Environmental, Inc.

FIGURE 3-13
PROPOSED SAMPLE LOCATIONS FOR SOIL INVESTIGATION
SITE 86: TANK AREA AS419 – AS421 AT MARINE CORPS AIR STATION – CTO-0246
MARINE CORPS AIR STATION, NEW RIVER
JACKSONVILLE, NORTH CAROLINA



LEGEND

86GW01 EXISTING SHALLOW MONITORING WELL LOCATION

86GW02 EXISTING INTERMEDIATE MONITORING WELL LOCATION

86GW15IW PROPOSED INTERMEDIATE MONITORING WELL LOCATION

86GW15DW PROPOSED DEEP MONITORING WELL LOCATION

** DENOTES 7-DAY LABORATORY ANALYSIS (VOLATILES ONLY)

APPROXIMATE GROUNDWATER FLOW DIRECTION (SHALLOW)

SOURCE: LANTDIV, FEB. 1992

FIGURE 3-14
PROPOSED SAMPLE LOCATIONS FOR GROUNDWATER INVESTIGATION
SITE 86: TANK AREA AS419 – AS421 AT MARINE CORPS AIR STATION – CTO-0246
MARINE CORPS AIR STATION, NEW RIVER
JACKSONVILLE, NORTH CAROLINA

4.0 SAMPLE DESIGNATION

In order to identify and accurately track the various samples, 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 # - Location - Media/Station # or QA/QC - Depth/Round

An explanation of each of these identifiers is given below.

Site#	This investigation includes Sites 36, 43, 44, 54, and 86.
Location	The location designation will refer to a surface feature or grid.
Media	SB = Soil Boring (soil sample from a boring) GW = Groundwater SW = Surface Water SD = Sediment TP = Test Pit W = Waste

Station# Each soil test boring or monitoring well will be identified with a unique identification number.

QA/QC	(FB) = Field Blank (D) = Duplicate Sample (following depth/round) (TB) = Trip Blank (ER) = Equipment Rinsate
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 = ground surface to 1 foot below ground surface 01 = top of sample is 1 foot below ground surface 02 = top of sample is 3 feet below ground surface 03 = top of sample is 5 feet below ground surface Round indicator will be used for groundwater samples (round one and round two). For example:

Under this sample designation format the sample number 36-GW06DW-01D refers to:

<u>36</u>-GW06DW-01D	Site 36
36-<u>GW</u>06DW-01D	Groundwater sample
36-GW<u>06</u>DW-01D	Monitoring well #6
36-GW06<u>DW</u>-01D	Deep well

36-GW06DW-<u>01</u>D	Round 1
36-GW06DW-01<u>D</u>	Duplicate (QA/QC) sample

The sample designation 43-SB11-00D refers to:

<u>43</u>-SB11-00D	Site 43
43-<u>SB</u>11-00D	Soil Boring
43-SB<u>11</u>-00D	Test boring #11
43-SB11-<u>00</u>D	Sample depth interval 0 to 12"
43-SB11-00<u>D</u>	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 Sites 36, 43, 44, 54, and 86 will be discussed in the following subsections. These procedures include soil sample collection, monitoring well installation (both shallow and deep), aquatic sampling (fish/crabs/benthic), groundwater sample collection, surface water sample collection, sediment sample collection, drum/container waste sample collection, decontamination procedures, surveying, handling of site investigation derived 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 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 Sites 36, 43, 44, 54, and 86. Soil samples will be collected from borings and during the installation of monitoring wells. Soil samples will also be collected from borings advanced by a hand auger. Some soil samples will be collected from test pits (task at Sites 36, 43, and 44) excavated by a backhoe. All ground penetrations will receive utility clearance from the appropriate on-base personnel. Appendix A contains Baker's standard operating procedures (SOPs) for soil sample acquisition.

5.1.1 Soil Borings Advanced by Hand Auger

Hand augering is the most common manual method used to collect subsurface samples. Four-inch diameter 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. During this investigation, hand augers will be used to collect discrete grab samples of soil from the 0 to 12-inch, and just above the water table.

When a vertical sampling interval has been established, one auger bucket is used to advance the auger hole to the first desired sampling depth. Since discrete grab samples are to be collected to characterize each depth, a new bucket will be placed on the end of the auger extension immediately prior to collecting the next sample. The top several inches of soil should be removed from the bucket to minimize the chances of cross-contamination of the sample from fall-in of material from the upper portions of the hole. The bucket auger will be decontaminated between samples as outlined in Section 5.8.

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 split-spoon sampler (used for performing Standard Penetration Tests) is two inches outer diameter (OD) 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 approximately 12 feet below the water table. Soil borings converted into deep monitoring wells at Sites 36, 43, 44, and 86 will be advanced to a depth of approximately 40 to 50 feet bgs, based on encountering the upper unit of the Castle Hayne Formation. 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. Soil samples will be collected at continuous 2-foot increments to the top of the water table. Surface soil samples will not be collected using a split-spoon sampler because a sufficient quantity of samples cannot be retained from 0 to 12 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 (if surface soil is very compacted). For borings only, split-spoon samples will be collected from approximately one foot to the top of the water table. At borings advanced for monitoring well installation where environmental samples will be collected, split spoon samples will be collected continuously from ground surface to the top of the water table; below the water table, soil samples will be collected at 5-foot intervals.

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 SOP Soil and Rock Sample Acquisition.

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. Split-spoon samples will be collected continuously until groundwater is encountered.

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.

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, in stainless steel bowls with stainless steel spoons, as thoroughly as possible to ensure that the sample is as

representative as possible of the sample interval. Soil samples for volatile organic compounds should not be mixed. Discrete soil samples from different sections of the split-spoon, representative of the soil types encountered, will be placed in the sample jar with a minimum of disturbance. 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, 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.

5.1.3 Test Pits (Sites 36, 43, and 44)

Test pits will be excavated using a backhoe. The following procedures apply to the excavation and backfilling of a typical test pit.

- The positions of the test pits shall be located in the field by the Field Team Leader or Site Manager. Utility clearance shall be obtained from Activity personnel for all test pit locations prior to excavation.

- Excavation equipment shall be thoroughly decontaminated prior to and after each test pit excavation.

- A safety zone shall be established around the test pit location prior to initiation of excavation.

- Excavation shall commence by removing lifts of no more than approximately 6 to 12 inches of soil.

- Test pit excavation will continue to a depth of 10 feet or to the water table (whichever is encountered first). If the ground is too unstable before a depth of 10 feet is reached, the test pit will be advanced as deep as possible. Note that benching of the side walls may be required during excavation of the trench.

- Soil samples may be collected during the excavation. The collected sample shall consist of visually contaminated soil or soils exhibiting elevated levels of organics from monitoring instrument readings encountered during excavation. If no suspected contaminated soil is encountered, then a sample shall not be collected. Samples will be collected from the backhoe bucket using a stainless steel trowel or spoon. Samples from the backhoe bucket will be collected from the center portion of the bucket to avoid contact. These samples will be logged, packaged, and submitted to the laboratory for analysis.

- The field inspector shall log the test pit soils and record observations and the test pit cross-section shall be sketched in the Field Logbook with notable features identified.

- Test pit depths (and water levels) may be measured using an engineers rule (six foot) or a weighted measuring tape. Depths shall be measured from the ground surface.

- Upon completion, test pits shall be immediately backfilled.

- If debris is encountered, the debris that is removed from the trench will be containerized and the excavation will be terminated (no additional debris will be removed).

- Test pit locations shall be marked with five wooden stakes; one at each corner and one in the center. The test pit number shall be recorded on the centrally located stake.

Backfilling of trenches and test pits is a normally accepted practice to reduce immediate site hazards and minimize the potential for rainwater accumulation and subsequent contaminant migration.

After inspection and completion of the appropriate test pit logs, backfill material should be returned to the pit under the direction of the field inspector. The test pit cover should be inspected and further regraded, if necessary. Where it is safe to do so, the backhoe bucket should be used to compact each one to 2-foot layer of clean backfill as it is placed, to reduce settling and compaction. Appendix B contains the SOPs for Test Pit and Trench Excavations.

5.2 Monitoring Well Installation

Shallow monitoring wells will be installed to monitor the shallow (water table) water-bearing zone. It is estimated that these wells will be installed from 15 to 30 feet. Procedures for the installation and construction of shallow monitoring wells are presented below (see Figure 5-1):

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

- A borehole will be advanced by a drilling rig using 6-1/4-inch I.D. hollow stem augers. Initially, the boreholes may be advanced with 3-1/4-inch I.D. augers, then overdrilled with 6-1/4-inch I.D. augers if the formation is loosely consolidated (for well installation only). A lean mixture of bentonite inside the augers may be needed if flowing sands are encountered. If bentonite is used, the quantity will be documented.

- Soil (split spoon) samples will be collected continuously during borehole advancement until the water table is encountered, then at 5-foot intervals thereafter until the final depth is reached. At well locations where environmental samples will not be collected, samples will be collected at 5-foot intervals (from start to finish) for classifications purposes only. 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. USEPA Region IV requires justification of using PVC. Justification criteria for use of PVC as well as casing material is provided in Appendix D.

- Fifteen feet of 2-inch I.D., Schedule 40, #10 slot (0.010-inch) screen with a bottom cap will be installed. The screen will be connected to threaded, flush-joint, PVC riser. The riser will extend 2 to 3 feet above the surface. A PVC slip-cap vented to the atmosphere, will be placed at the top of the riser.

- The annular space around the screen will be backfilled with a well-graded medium to coarse sand (No. 1 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 8 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 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 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 depicts a typical Type II shallow monitoring well construction diagram.

Procedures for the installation and construction of Type III deep wells are presented below:

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

- The borehole will be advanced until completion using mud rotary drilling. The reason mud rotary drilling will be used is because of the unconsolidated formation and drilling depths anticipated. A tricon drill bit with a O.D. of 7-7/8 inches will be used for advancing the borehole. Split-spoon samples will be collected at approximate 5 to 10-foot intervals during borehole advancement (mud rotary drilling). If a clay layer is encountered which may serve as a potential confining unit, continuous samples will be collected to determine the thickness of the layer. At that time, a decision will be made as to whether a Type-III well will be installed (described in the next section). Samples will be collected according to the procedures outlined in Section 5.1.2.

- At well locations where environmental samples will be collected, the borehole will be advanced initially using 3-1/4-inch I.D. hollow stem augers to just below the water table. 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 the environmental samples have been collected, the borehole will be further advanced using mud rotary.

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

- PVC is the material selected for monitoring well construction. It was selected on the basis of its low cost, ease of use and flexibility. USEPA Region IV requires justification of using PVC.

- Ten to twenty feet of 2-inch I.D., Schedule 40, # 10 slot (0.010-inch) screen with a bottom cap will be installed. The final determination for the length of the screen will be decided in the field based on the thickness of the upper portion of the Castle Hayne Formation.

- The annular space around the screen will be backfilled with a well-graded medium to coarse sand as (No. 1 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 (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 8 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 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 4 feet 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 depicts a typical Type III deep monitoring well construction diagram.

Procedures for the installation of temporary groundwater monitoring wells is as follows:

- The borehole for the well installation will be drilled with a 2-inch or 4-inch diameter hand auger. The total depth of the borehole will be a minimum of six (6) feet.

- Well construction materials will consist of a five (5) foot section of 2-inch I.D. PVC screen (0.01-inch slot), bottom cap, 2-inch I.D. PVC riser and filter sock. The length of PVC riser will depend on the total depth of the borehole.

- Following the completion of the borehole, the PVC screen with bottom cap will be lowered into the borehole. The PVC riser will be attached and the assembly will be lowered to the bottom of the borehole. Enough riser will be attached to allow for a minimum two (2) foot stickup above the ground riser.

- Following the one round of sampling, these wells will be pulled and the boreholes backfilled with spoil material from the drilling of the borings.

<u>Well Development</u>

All monitoring wells (existing and newly installed) 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 to well completion. This time period will allow the cement grout to set. Shallow wells (less than 25 feet in depth) will be developed using a low-yield pump in combination with surging using a surge block. Intermediate and deep monitoring wells (deeper than 25 feet in depth) will be developed using compressed air (equipped with an air filter) in combination with surging. Final selection of a development device, however, may 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 pH, specific conductance, temperature and turbidity (most critical parameter; less than 10 turbidity units should be achieved) measurements. Typically less than 10 percent change between three successive measurements are used to determine stability. If a turbidity of 10 or less is not achieved during development within a three hour period, the well will be considered "developed" (this shall be noted in the field logbook).

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

Usually, a minimum period of one week should elapse between the end of initial development (all existing and newly installed wells will be developed) 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. Details on SOPs for monitoring well installation can be found in Appendix D.

5.3 Groundwater Sample Collection

5.3.1 Groundwater Samples Collected from Monitoring Wells

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 the intake for the peristaltic pump (shallow wells under 25 feet in depth) or submersible pump [deep wells below 25 feet in depth (RediFlo-2® low yielding pumps)] into the well to a short distance below the water level (above screen, intake) and begin water removal. If the water level drops inside the well during purging, the flow rate shall be adjusted so that no net head loss occurs. A low flow (less than one gpm and less than the discharge rate substained during well development) will be maintained during purging. Purged water will be temporarily stored in DOT-approved 55-gallon drums. Final containment of purged water is addressed in Section 5.10.

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 turbidity (most critical parameter; typically less than 10 turbidity units is considered "clear"), specific conductance, temperature, and pH during purging (i.e., after each volume has been removed) to ensure the groundwater stabilizes. Less than 10 percent change between successive measurements shall be used to determine stability.

7. After it has been determined that the well has stabilized, samples will be collected directly from the peristaltic or submersible pump for all parameters. If a teflon bailer is used, lower the 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 volatiles analysis will be collected first, followed by semivolatiles, PCBs, pesticides, and metals (total and dissolved). Sample bottles will be filled in the same order for all monitoring wells.

9. 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.

Appendix E presents the SOP for groundwater sampling.

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.

The water samples will be collected from near mid-stream at each station, where applicable. 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 will be filled in the same order at all sampling stations.

Temperature, pH, and specific conductance 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.

Details on surface water sample acquisition are presented in Appendix F.

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 to 6 inches, and 6 to 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 15 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 12 inches of sediments are obtained, the first 6 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 (i.e., stainless-steel core sampler) 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 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, then push out the 0 to 6-inch sediment interval. Samples (with the exception of VOAs) will first be homogenized prior to being transferred to their containers.

8. Seal all sample jars tightly.

9. Label all samples.

Appendix F presents the SOP for sediment sampling.

5.6 Drum and Container Waste Sample Collection

The following procedures will be used for the collection of drum and container waste samples at Site 36. Currently at Site 36 there are between 15 and 20 drums/containers which have materials which will require sampling for disposal. Samples of solid and/or liquid wastes will be obtained from each drum or container. Samples will be collected for field compatibility testing and laboratory analysis. Appendix G presents a detailed summary of the drum/container sample procedures.

A general compatibility testing protocol exists in which wastes are consolidated into compatible groups. A more definitized testing protocol may be generated from reagents contained within the HAZCAT Kit. The consolidated waste streams are then sampled for final comprehensive analyses as required for disposal. This consolidation protocol is designed to segregate wastes in a manner which will minimize on-site chemical reactions, which could result in the release of potentially hazardous substances. Wastes that have specific disposal requirements are also identified before materials are mixed to avoid creating larger quantities of a problem waste material (e.g., cyanides, sulfides, PCBs). If a container has more than one phase, each phase will be tested separately. Approximately one 8-ounce jar filled with sample is sufficient for a compatibility test. The decision logic to be utilized when conducting the compatibility testing is depicted on the flow charts/decision trees which are included in Appendix S.

Following the physical/chemical testing (via the HAZCAT Kit) aliquots from containers of the same waste stream will be combined in a documented sequence. Visual observations (i.e., color, precipitation, or phase separation) and temperature measurements (to test for chemical reactions) will be made. Compatibility testing will be performed on each drum, separating and classifying various unknown containerized waste materials into compatible groups based on their physical and chemical characteristics. Incompatible waste and some of the RCRA hazardous waste characteristics (ignitability, corrosivity, and reactivity) are identified at a minimum during these tests. A controlled amount from each of the samples will be combined in a separate container, one at a time, and observed closely for any reaction. The volume bulk test should equal approximately one quart (32 ounce) to allow for sufficient volume for the lab as well as extra to submit to various disposal facilities. This methodology will eliminate resampling for disposal purposes. If a reaction occurs, the compatibility sequence is started again, omitting the sample which caused the reaction (see designed decision tree matrices for more detail). This method is continued until the volume of waste deemed compatible is sufficient to make up a bulk load for disposal.

Upon completion of compatibility testing, the information gathered from these tests will be used to further segregate the samples into smaller groupings (i.e., flammable liquid, corrosive, oxidizer, peroxide, etc.). Based on the results of the compatibility testing and following approval to bulk the wastes, drums will be bulked in the sequence designated by the field chemist with compatible drum waste. Following bulking, samples will be obtained from the bulked waste groups by representative methods. Specific analysis of these bulk composite samples will depend upon disposer criteria for analysis of wastes, as well as regulatory requirements for completing manifests and shipping papers.

Drums classified as "RCRA empty" will have less than one inch of material or residual material in the bottom. All other drums will be classified as having material and will be sampled accordingly.

Drum/container documentation will be performed concurrently with drum sampling activities. The drums/containers will be sampled in the following manner:

1. The drum/container will be opened. Sample collection will require level B protection at a minimum.

2. Liquid sample collection

    a. A clean glass tube is inserted into the opening in the drum/container.

    b. The liquid in the drum/container represents a core of the drum/container contents.

    c. The liquid in the tube is transferred repeatedly into an 8-ounce jar until it is filled.

    d. The mouth of the jar is sealed with teflon tape, and the lids are securely tightened.

    e. The outside of the jar is wiped clean.

    f. Each drum/container sample is noted on a chain-of-custody form and recorded in the appropriate drum/container log sheet and/or field log book.

    g. The samples are then sent to the laboratory for analysis.

    h. For every 20 liquid samples, if obtained, a blind duplicate should be submitted with a one sample minimum. The duplicate samples will be prepared from the drum/container by blending in a clean glass jar bottle with a sufficient quantity of sample that would allow for duplicates to be prepared.

3. Solid sample collection

    a. A decontaminated stainless steel spoon will be used to extract the sample from the drum/container.

    b. Sample jars will be filled directly from the stainless steel spoons.

5.7 Biological and Fish Sample Collection

5.7.1 Biological Sample Collection

Biological samples collected at the stations consisted of fish, crab, and benthic macroinvertebrates. Prior to initiating the sampling event, the following sampling area description information was 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.)
- Description 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 was complete, the field team leader defined and located the stations for biological sampling. Every attempt was made to define stations to exclude atypical habitats such as bridges and mouths of tributaries. In addition, upstream and downstream locations were selected to be as ecologically similar as possible in their biotic and abiotic characteristics.

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

Appendix H presents the SOP for biological and fish sample collection.

5.7.1.1 Benthic Macroinvertebrate Sample Collection

Benthic macroinvertebrates were collected at each station using a Standard Ponar Grab Sampler. At each station, three replicate samples were completed, with one grab per replicate. The benthic macroinvertebrate samples were collected in close proximity to where the sediment samples for chemical analysis were collected.

After the sediments are collected, the contents of the sample were placed into a small tub. The sediments in the tub were transferred to a No. 35 sieve (0.500 mm) and washed with water to remove small sediment particles. The remaining contents in the sieve were transferred into sample jars. Approximately half of the sample jar were filled with the sample, and 10 to 15% (by weight) buffered formalin was added to fill the remainder of the jar. A 100% cotton paper label was placed inside the jar, identifying the station location and replicate number. The label was marked with a pencil. The outside of the jar was labeled using a black permanent marker with the station location and sample number. All the sample jars were stored in large plastic tubs until transfer to Baker Ecological Services Laboratory in Coraopolis, Pennsylvania.

5.7.1.2 Processing of Macroinvertebrate Samples

The samples were returned to the Baker Ecological Services Laboratory for processing. The formalin in the jars was replaced with 708 isopropyl alcohol. The samples then were sent to AMC Environmental Services, Inc., for sorting of the benthic macroinvertebrates from the sample residue and subsequent taxonomic identification.

5.7.1.3 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.

5.7.2 Fish and Crab Collection

Fish were collected at the designated stations using a combination of the following: gill nets, hoop nets, minnow traps, and catfish traps. In addition, crabs were collected using crab pots. The following paragraphs discuss the procedures that were used for collecting the fish and crabs.

The gill nets used to collect the fish were monofilament, 50 or 100 feet in length, 6 feet deep, and had a stretch mesh size ranging from 3 to 4 inches. The nets were deployed by securing both ends across the creek. At least two yellow buoys marked with Baker Environmental, the hotel phone number, and the scientific collection permit number were attached to each net.

The gill nets were deployed either in the morning or evening, and checked the following morning or evening. Fish that were dead for an extended period of time (i.e., bloating) were not used for tissue analysis because of the potential for decomposition and leaching of contaminants from the organs into the edible portions of the fish.

Hoop nets also were used to collect fish. The hoops nets ranged in outer diameter from 2 to 3-1/2 feet and were 4-1/2 to 14 feet in length. The square mesh size was 1 to 1-1/2 inches. The nests were used with either 10-, 25- or 40-foot wings.

The hoop nets were deployed by attaching each wing to a 6-1/2-foot fence post that was driven into the sediments, with the wings forming a 45 to 90 degree angle. The back of the hoop net then was attached to a 6-1/2 fence post, and the net was stretched out to pull the wings taught. This post then was driven into the sediments to secure the nets in place. The nets were checked at least once daily because these nets typically do not kill the captured fish.

Minnow traps were deployed at each station along the right bank facing downstream. The minnow traps were baited with dog food. The traps were checked at the end of the sampling trip.

Catfish traps were deployed at each station. The catfish traps were approximately 4 to 5 feet in length and 15 inches in diameter. They were deployed by weighing the traps and setting them in the channel. They were marked with a yellow buoy for easy retrieval.

Crab pots were used to collect blue crabs at each of the stations. The crab pots were either baited with chicken necks or dead fish obtained during the fish sampling. The crab pots were checked every few days.

The collected fish were separated into different species, and then measured and counted. The small fish (less than 20 mm) were weighed in groups of 10 or 20 because of their low individual weight; the larger fish were weighed individually. The proportion of individuals as hybrids and the proportion of individuals with disease, tumors, fin damage, and skeletal anomalies were recorded at each station.

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

Specimens submitted to the laboratory for chemical analysis were wrapped in aluminum foil and placed into sealed plastic bags. A 100% cotton label was placed inside the bag, identifying the station number. A pencil was used to mark the label. The outside of the bag also was labeled with the station number using a black permanent marker. The bags were then placed in a freezer.

5.7.2.1 Analysis of Fish and Crab Species

At each station, fish were collected for population statistics and fish and crabs were collected for tissue analysis. All fish were weighed to the nearest gram and measured to the nearest tenth of a centimeter. The total length of the fish were 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 and crab were processed (e.g., filleted, homogenized) by the laboratory conducting the chemical analyses. Because the time between sampling and preparation was longer than 48 hours, the fish and crab were frozen.

5.8 Land Survey

Each of the four SI sites require survey information. Horizontal and vertical survey tolerances are addressed within the survey requirements under Section 3.0, for each of the four sites. Appendix I provides a more detailed description of survey procedures and surveyor qualifications.

5.9 Monitoring and Data Collection Equipment

Field support activities and investigations will require the use of monitoring and data collection equipment. Specific conductance, temperature, and pH readings will be recorded during groundwater and surface water sample collection. In addition, similar specific conductance and pH readings will be recorded during well development. Appendix J, On-Site Water Quality Testing, provides specific procedures for collecting conductance, temperature, and pH readings.

Additional monitoring well information may be obtained using water level meters, water-product level meters, and well depth meters. The operation and various uses of this data collection equipment is provided in Appendix K.

Health and safety monitoring and environmental media screening will be conducted using a photoionization detector (PID), flame ionization detector (FID), and a combustible gas/oxygen meters (O_2/LEL). The operation and use of the PID is described in Appendix L. The Bacharach O_2/LEL meter will also be used during the sampling program, primarily to monitor health and safety conditions. Appendix M provides a description of the Bacharach O_2/LEL meter and operating procedures.

5.10 Decontamination

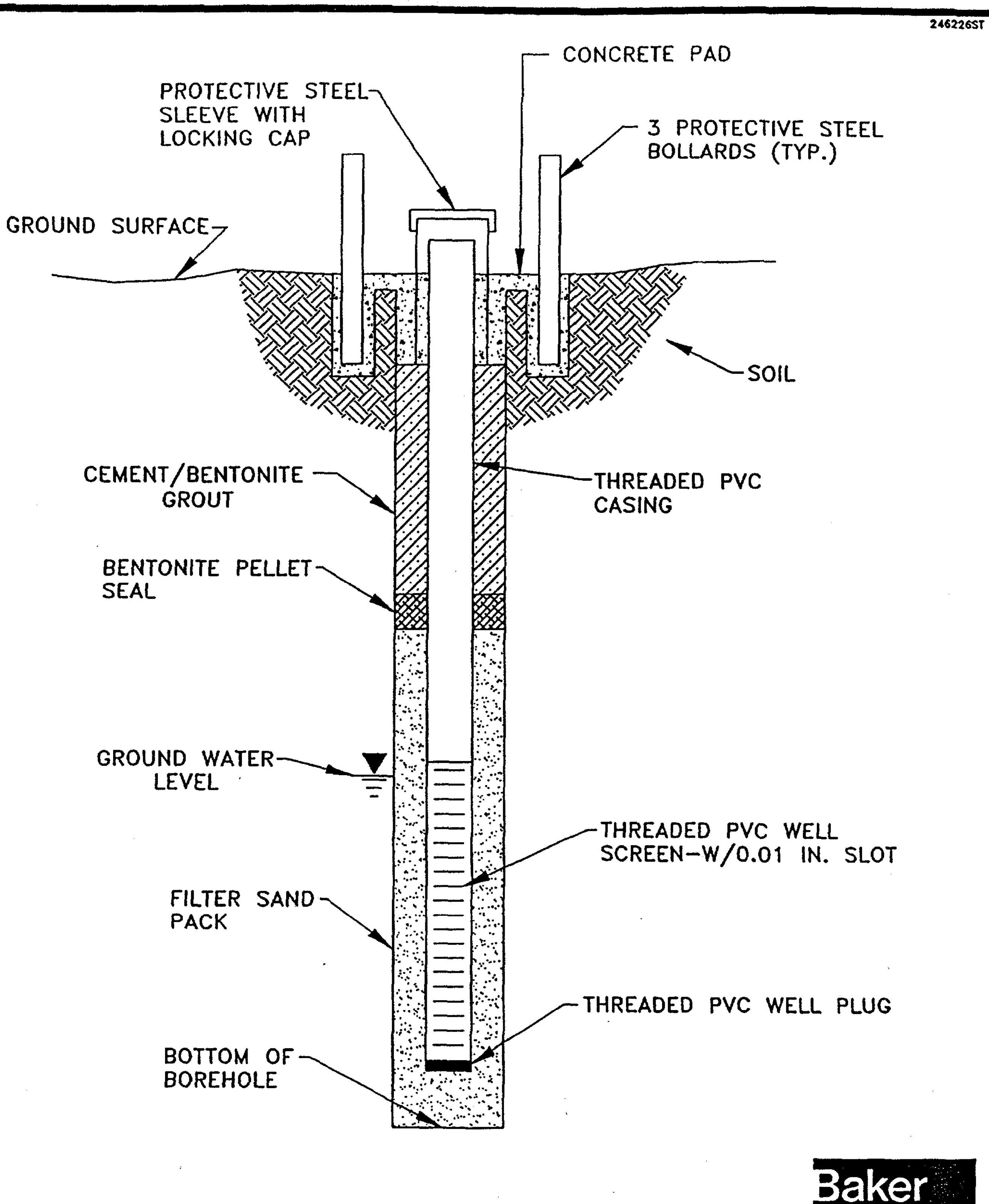
Equipment and materials that require decontamination fall into two broad categories:

1. Field measurement, sampling, and monitoring equipment (e.g. water level meters, bailers, split-spoon samplers, hand auger buckets, stainless steel spoons, etc.)

2. Machinery, equipment, and materials (e.g. drilling rigs, backhoes, drilling equipment, monitoring well materials, etc.)

Appendices N and O detail procedures for decontaminating the two categories of equipment and materials, respectively.

SECTION 5.0
FIGURES



N.T.S.

Baker
Baker Environmental, Inc.

FIGURE 5-1
TYPICAL ABOVE GRADE TYPE II GROUNDWATER MONITORING WELL CONSTRUCTION DIAGRAM
CTO-0246

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

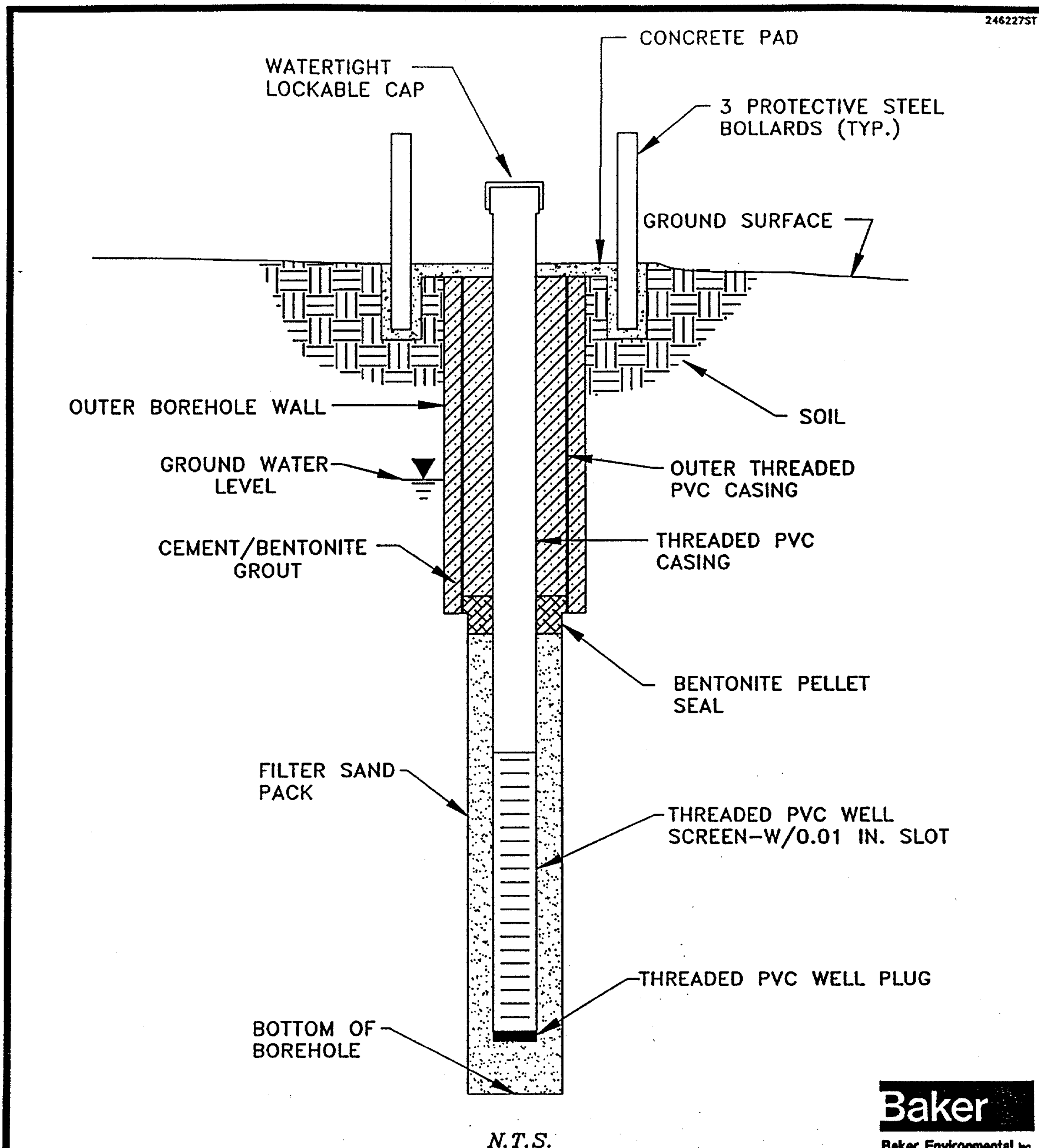


FIGURE 5-2
TYPICAL DEEP ABOVE GRADE TYPE III GROUNDWATER MONITORING WELL CONSTRUCTION DIAGRAM
CTO-0246

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

6.0 SAMPLE HANDLING AND ANALYSIS

Field activities will be conducted in accordance with the USEPA Region IV Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual (February 1, 1991).

The number of samples, analytical methods, data quality level, and laboratory turnaround times are presented in Table 6-1. Preservation requirements and sample holding times are provided in Section 7.0 of the QAPP.

6.1 Sample Preservation and Handling

Sample preservation and handling procedures will be adhered to during the field program in order to maintain sample integrity. Preservation and handling procedures are provided in Appendix P of this FSAP.

6.2 Chain-of-Custody

Chain-of-custody procedures will be followed throughout the field program to ensure a documented, traceable link between measurement results and the sample or parameter they represent. These procedures are intended to provide a legally acceptable record of sample collection, identification, preparation, storage, shipping, and analysis. Chain-of-custody procedures to be followed during the field program are contained in Appendix Q.

6.3 Field Logbook

Field logbooks will be used to record sampling activities and information. Logbooks will be copied and submitted to the field site manager for filing upon completion of the field program. Entries will include general sampling information so that site activities may be reconstructed. In addition to the field logbook, field forms (e.g. boring logs, well development records, etc) will be completed as support documentation for the field logbook. Appendix R describes the general format of the field logbook and applicable field forms.

SECTION 6.0
TABLES

TABLE 6-1

SUMMARY OF SAMPLING, ANALYTICAL, AND DATA QUALITY OBJECTIVES
SITES 36, 43, 44, 54, AND 86
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples[1]	Analysis	Data Quality Level
Site 36 - Camp Geiger Area Dump Near Sewage Treatment Plant Note: Surface water, sediment, fish, benthic, and waste samples were collected during the pre-investigation field activities. Accordingly, these investigations are not presented on this table.	Soil - Formerly Cleared Area	14 borings/2 samples per boring	TCL Organics[3] TAL Metals[4]	III III
	Soil - Open Field Area	6 borings/2 samples per boring	TCL Organics TAL Metals	III III
	Soil - Former Dump Area	6 borings/2 samples per boring	TCL Organics TAL Metals	III III
	Soil - Remaining Site Area	8 borings/2 samples per boring	TCL Organics TAL Metals	III III
		2 borings/1 composite sample per boring	Atterberg Limits Grain Size Distribution	II II
	Soil - Drum Container Areas	2 areas/3 borings per area/2 samples per boring	TCL Organics TAL Metals	III III
	Soil - Well Borings[2]	5 borings/2 samples per boring	TCL Organics TAL Metals	III III
	Soil - Trenches	3 to 5 trenches/2 areas/1 optional sample per trench	TCL Organics TAL Metals TCLP/RCRA (Optional)	III III III
	Soil - Upgradient	2 borings/2 samples per boring	TCL Organics TAL Metals	III III

TABLE 6-1 (Continued)

SUMMARY OF SAMPLING, ANALYTICAL, AND DATA QUALITY OBJECTIVES
SITES 36, 43, 44, 54, AND 86
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples[1]	Analysis	Data Quality Level
Site 36 - Camp Geiger Area Dump Near Sewage Treatment Plant (Continued)	Groundwater - One round of sampling	5 existing shallow monitoring wells 6 new shallow monitoring wells 3 new deep monitoring wells 2 temporary wells	TCL Organics TAL Metals (total/dissolved) TDS TSS	III III II II
Site 43 - Agan Street Dump	Soil - Mounded Area	1 boring/2 samples per boring	TCL Organics TAL Metals	III III
		4 borings/2 samples per boring	TCL Semivolatiles TAL Metals	III III
	Soil - Near Well 43GW01	1 boring/2 samples per boring	TCL Organics TAL Metals	III III
		2 borings/2 samples per boring	TCL Semivolatiles TAL Metals	III III
	Soil - Concrete Debris/ Paint Can Area	1 boring/2 samples per boring	TCL Organics TAL Metals	III III
		4 borings/2 samples per boring	TCL Semivolatiles TAL Metals	III III
	Soil - Remaining Site Area	2 borings/2 samples per boring	TCL Organics TAL Metals	III III
		5 borings/2 samples per boring	TCL Semivolatiles TAL Metals	III III
		2 borings/1 composite sample per boring	Atterberg Limits Grain Size Distribution	II II

TABLE 6-1 (Continued)

SUMMARY OF SAMPLING, ANALYTICAL, AND DATA QUALITY OBJECTIVES
SITES 36, 43, 44, 54, AND 86
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples[1]	Analysis	Data Quality Level
Site 43 - Agan Street Dump (Continued)	Soil - Well Borings[2]	2 borings/2 samples per boring	TCL Organics TAL Metals	III III
	Soil - Trenches	3 to 5 trenches/2 areas/1 optional sample per trench	TCLP/RCRA (Optional) TCL Organics TAL Metals	III III III
	Soil - Upgradient	2 borings/2 samples per boring	TCL Organics TAL Metals	III III
	Groundwater - One round of sampling	3 existing shallow monitoring wells 1 new shallow monitoring well 2 new deep monitoring wells 4 temporary wells	TCL Organics (temporary wells will not be analyzed for PCBs) TAL Metals (total/dissolved) TSS TDS	III III II II
	Surface Water - Edwards Creek	2 stations	TCL Organics TAL Metals (total/dissolved) Bioassay Hardness	III III III II
	Sediment - Edwards Creek	2 stations/2 samples per station	TCL Organics TAL Metals Bioassay Grain Size Distribution TOC	III III III II II
	Surface Water - Straw Horn Creek	4 stations	TCL Organics TAL Metals (total/dissolved) Bioassay Hardness	III III III II

TABLE 6-1 (Continued)

SUMMARY OF SAMPLING, ANALYTICAL, AND DATA QUALITY OBJECTIVES
SITES 36, 43, 44, 54, AND 86
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples[1]	Analysis	Data Quality Level
Site 43 - Agan Street Dump (Continued)	Sediment - Straw Horn Creek	4 stations/2 samples per station	TCL Organics TAL Metals Bioassay Grain Size Distribution TOC	III III III II II
Site 44 - Jones Street Dump	Soil - Near Well 44GW03	2 borings/2 samples per boring	TCL Organics TAL Metals	III III
		2 borings/2 samples per boring	TCL Volatiles/ Semivolatiles/Pesticides TAL Metals	III III
	Soil - Remaining Site Area	2 borings/2 samples per boring	TCL Organics TAL Metals	III III
		4 borings/2 samples per boring	TCL Volatiles/ Semivolatiles/Pesticides TAL Metals	III III
		2 borings/1 composite sample per boring	Atterberg Limits Grain Size Distribution	II II
	Soil - Well Borings	3 borings/2 samples per boring	TCL Organics TAL Metals	III III
	Soil - Trenches	3 to 5 trenches/2 areas/1 optional sample per trench	TCLP/RCRA (Optional) TCL Organics TAL Metals	III III III
	Soil - Upgradient	1 boring/2 samples per boring	TCL Organics TAL Metals	III III

TABLE 6-1 (Continued)

SUMMARY OF SAMPLING, ANALYTICAL, AND DATA QUALITY OBJECTIVES
SITES 36, 43, 44, 54, AND 86
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples[1]	Analysis	Data Quality Level
Site 44 - Jones Street Dump (Continued)	Groundwater - One round of sampling	3 existing shallow monitoring wells 2 new shallow monitoring wells 1 new deep monitoring well 1 temporary well	TCL Organics (existing wells and temporary wells will not be analyzed for PCBs) TAL Metals (total/dissolved) TDS TSS	III III II II
	Surface Water - Edwards Creek	6 stations	TCL Organics TAL Metals (total/dissolved) Hardness	III III II
	Sediment - Edwards Creek	6 stations/2 samples per station	TCL Organics TAL Metals Grain Size Distribution TOC	III III II II
	Surface Water - Straw Horn Creek	1 station	TCL Organics TAL Metals (total/dissolved) Hardness	III III II
	Sediment - Straw Horn Creek	1 stations/2 samples per station	TCL Organics TAL Metals Grain Size Distribution TOC	III III II II
	Surface Water - Unnamed Tributary	1 station	TCL Organics TAL Metals (total/dissolved) Hardness	III III II

TABLE 6-1 (Continued)

SUMMARY OF SAMPLING, ANALYTICAL, AND DATA QUALITY OBJECTIVES
SITES 36, 43, 44, 54, AND 86
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples[1]	Analysis	Data Quality Level
Site 54 - Crash Crew Fire Training Burn Pit	Soil - Burn Pit Area	14 borings/1 sample per boring	ENSYS PAH ENSYS Petro Soil	II II
	Soil - Stressed Soil Area	4 borings/1 sample per boring	ENSYS PAH ENSYS Petro Soil	II II
	Soil - Burn Pit Area/ Stressed Soil Area	Confirmatory borings/2 samples per boring	20%: TCL Organics TAL Metals TPH[6] Remainder: TCL Volatiles/ Semivolatiles/ PCBs TAL Metals	III III III III III
		2 borings/1 composite sample	Engineering Parameters[5]	II
	Soil - Upgradient	2 borings/2 samples per boring	TCL Organics TAL Metals	III III
	Groundwater - One round of sampling	3 existing shallow monitoring wells 1 new shallow monitoring well 3 temporary wells	TCL Organics (samples from existing and newly installed wells will not be analyzed for pesticides; samples from temporary wells will only be analyzed for VOCs and SVOCs) TAL Metals (total/dissolved) TSS TDS	III III II II
		1 sample (54GW04)	Engineering Parameters	II
	Ditch Water Samples	2 stations	TCL Organics (without pesticides) TAL Metals	III III

TABLE 6-1 (Continued)

SUMMARY OF SAMPLING, ANALYTICAL, AND DATA QUALITY OBJECTIVES
SITES 36, 43, 44, 54, AND 86
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples[1]	Analysis	Data Quality Level
Site 54 - Crash Crew Fire Training Burn Pit (Continued)	Ditch Soil Samples	2 stations/2 samples per boring	TCL Organics (without pesticides) TAL Metals	III III
Site 86 - Tank Area AS419-AS421	Soil - Former AST Area	9 borings/2 samples per boring	20%: TCL Organics TAL Metals TPH[6] Remainder: TCL Volatiles TAL Metals	III III III III III
		1 boring/1 composite sample from boring	Engineering Parameters[5]	II
	Soil - Well Borings[2]	4 borings/2 samples per boring	TCL Volatiles TCL Semivolatiles TAL Metals TPH	III III III III
	Soil - Upgradient	1 boring/2 samples per boring	TCL Organics (without pesticides) TAL Metals	III III
	Groundwater	7 existing shallow monitoring wells 7 existing intermediate monitoring wells 5 new deep monitoring wells 3 new intermediate monitoring wells	20%: TCL Organics TAL Metals (total and dissolved) Remainder: TCL Volatiles/ Semivolatiles TAL Metals (total and dissolved) TSS (all wells) TDS (all wells)	III III III III II II

TABLE 6-1 (Continued)

SUMMARY OF SAMPLING, ANALYTICAL, AND DATA QUALITY OBJECTIVES
SITES 36, 43, 44, 54, AND 86
REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROJECT PLANS - CTO-0246
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Study Area	Investigation	Baseline No. of Samples(1)	Analysis	Data Quality Level
Site 86 - Tank Area AS419-AS421 (Continued)	Groundwater (Continued)	1 shallow (86GW05) 1 deep (86GW18DW)	Engineering Parameters(5)	II
Investigation Derived Waste	Development/ Purge Water	5 to 10 samples	RCRA Hazardous Waste TCL Organics TAL Metals	III III III
	Soil/Mud Cuttings	5 samples (1 composite from each site)	RCRA Hazardous Waste TCLP TCL PCBs	III III III

(1) Baseline number of samples do not include QA/QC samples.

(2) Note that soil samples will not be collected from each well boring for laboratory analysis. Refer to figures in FSAP for well locations where samples will be submitted.

(3) TCL Organics: volatile organics, semivolatile organics, pesticides/PCBs

(4) TAL Metals:

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		

(5) Engineering Parameters:

Soil:
- Atterberg Limits
- Grain Size Distribution
- Total Organic Carbon (TOC)
- Redox Potential (Eh)
- Microbial Enumeration

Water:
- Microbial Count
- Biological Oxygen Demand (BOD_5)
- Chemical Oxygen Demand (COD)
- Nitrogen (NH_4)
- Alkalinity
- Total Dissolved Solids (TDS)
- Total Suspended Solids (TSS)

(6) TPH to include low/medium and high boiling point petroleum products.

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 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).

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

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. All changes in scope will be discussed and agreed upon by LANTDIV, MCB, Camp Lejeune EMD, USEPA Region IV, and the North Carolina DEHNR.

8.0 REFERENCES

U.S. Environmental Protection Agency (USEPA), 1992. Guidance for Performing Site Inspections Under CERCLA. Interim Final. Office of Emergency and Remedial Response, PB92-963375. EPA/540-R-92-021.

U.S. Department of the Navy (DON), 1992. Navy/Marine Corps Installation Restoration Manual. February 1992.

Environmental Science and Engineering, Inc. (ESE), 1990. Final Site Summary Report, Marine Corps Base Camp Lejeune, North Carolina. Prepared for Naval Facilities Engineering Command Atlantic Division. ESE Project No. 49-02036. September 1990.

U.S. Environmental Protection Agency (USEPA), 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. Interim Final. Office of Emergency and Remedial Response, OSWER Directive 9344.3-01. EPA/540/G-89-004.

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

DRAFT

REMEDIAL INVESTIGATION/FEASIBILITY STUDY HEALTH AND SAFETY PLAN

OPERABLE UNIT NO.13 (SITE 63) MCB CAMP LEJEUNE, NORTH CAROLINA

CONTRACT TASK ORDER 0304

MAY 10, 1995

Prepared For:

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

Under the:

LANTDIV CLEAN Program
Contract N62470-89-D-4814

Prepared By:

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Coraopolis, PA 15108

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1.0 INTRODUCTION

This Health and Safety Plan (HASP) has been developed by Baker Environmental, Inc. (Baker) to accompany the Project Plans for Contract Task Order 0304. The objective of the project is to conduct a remedial investigation/feasibility study (RI/FS) at Operable Unit No. 13 (Site 63) Verona Loop Dump at Marine Corps Base (MCB), Camp Lejeune, North Carolina. The purpose of this HASP is to comply with the safety and health regulations of the OSHA General Industry and Construction Standards and to define the requirements and designate protocols to be followed during RI/FS activities involving potentially contaminated soils, groundwater, surfacewater, and/or seidment.

1.1 Scope

The provisions of this HASP are applicable to Baker personnel involved with the RI/FS activities. This site-specific Health and Safety Plan (HASP) has been prepared in accordance with the U.S. Department of Labor Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations and Emergency Response (HAZWOPER)Standard, 29 CFR 1910.120 and 1925.65.

1.2 Site Description

The study area is located along Verona Road south of the Marine Corps Air Station (MCAS), New River. Site 63 is approximately three to four acres in size. Verona Loop Dump is primarily wooded with the exception of a haul road formerly used to transport debris to the dump. The site is bordered by Verona Loop Road to the south, an intermittent stream to the east, and woods to the north and west. The site is relatively flat, although the eastern portion slopes toward the stream. There are no current site structures. There are no supply wells within a one mile radius of the site.

1.3 Project Description

The work tasks that will be conducted by Baker personnel as part of this project include the following:

- Soil boring and sampling
- Monitoring well installations and sampling
- Water/Sediment sampling

1.4 References

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

- ACGIH Threshold Limit Values for Chemical Substances 1994-1995.
- OSHA Federal Regulation. 29 CFR 1910 and 1926. 1993.
- OSHA/NIOSH/EPA/USCG Occupational Health and Safety Guidance Manual for Hazardous Waste Site Activities. October 1985.

- NIOSH Pocket Guide to Chemical Hazards. June 1990.
- Genium Publishing Corp, Genium's Reference Collection, MSDSs
- EPA Standard Operating Safety Guidelines. June 1992.
- Lewis, Richard J., Sr. Hazardous Chemicals Desk Reference. 1991.

2.0 SITE ORGANIZATION AND COORDINATION

The following personnel have direct responsibility for health and safety management at the sites under investigation, are identified as follows:

- Project Manager - Mr. Matthew D. Bartman - The Baker Project Manager has the responsibility to ensure that the elements of the Work Plan are implemented in a safe and healthy manner in accordance with the HASP.

- Project Health and Safety Officer - Mr. Ronald Krivan - The PHSO is responsible for the preparation, review, and approval of the HASP.

- Site Manager - Mr. Mark DeJohn - The Site Manager is responsible for assuring that day-to-day activities are conducted in accordance with the HASP. The Site Manager has the immediate authority to suspend field activities if conditions/activities develop or exist that present an immediate health or safety risk to the employees.

- Site Health and Safety Officer - [To Be Named Prior To Mobilization] - The SHSO will be responsible for continually evaluating safety on the site and ensuring adherence to the HASP. The SHSO has authority to modify the existing HASP procedures as conditions warrant. The SHSO will also be responsible for the preparation of daily reports which include the day's events from a health and safety standpoint, for documentation of measurements taken for health and safety purposes, and for reporting accidents and other relevant health and safety issues.

Subcontractor personnel are responsible for:

- Complying with the contents of this HASP at a minimum.

- Complying with all OSHA regulations relevant to their work.

- Obtaining the appropriate training and medical surveillance requirements under 29 CFR 1910.120 and providing this documentation to the Site Manager prior to or during site mobilization.

- Having a competent safety monitor on site.

LANTDIV Representatives:

Ms. Katherine Landmann, Naval Technical Representative (NTR) (804) 322-4818

MCB Camp Lejeune Representatives:

- Mr. Neal Paul (910) 451-5068
- Mr. Tom Morris (910) 451-5068
- Mr. Walt Haven (910) 451-5068

3.0 SITE CHARACTERIZATION

This section provides information on the site history, previous investigations, and health and safety concerns for the physical and health hazards associated with this site.

3.1 Site History

Information regarding the history of Site 63 is scarce. It was reported that the area was used as a disposal site for wastes generated during military training exercises. The type of materials disposed are described only as bivouac wastes. No hazardous wastes were reported to be involved in the disposal operations. The years of operating the site as disposal grounds are unknown. The area is currently unrestricted with respect to site access and military maneuvers are still conducted in the area.

3.2 Previous Investigations

- A Site Inspection was conducted in 1991 by Baker Environmental, Inc.
- Final Site Inspection Report (Baker, January 31, 1994).

3.2.1 Soil Investigation

Six (6) soil borings were drilled on site and advanced to the water table. Soil samples from two depths, zero to two feet below ground surface (bgs) and from just above the soil/groundwater interface, were collected from each borehole. Additionally, a total of six soil samples were taken during the drilling and installation of three groundwater monitoring wells. All soil samples were analyzed for full TCL organics and TAL metals.

Surface Soil:

- Low levels of the volatile organics toluene (2 µg/kg) and total xylenes (3 µg/kg) were detected in the subsurface soil collected from soil boring 63SB03. The subsurface sample from this boring did not exhibit either contaminant.
- Low levels of phthalates were detected in three out of nine samples.
- Low levels of pesticide constituents, 4,4'-DDD, 4,4'-DDT, and 4,4'-DDE, were detected in sample 63SB04.
- Aroclor-1254 was detected at a level of 1,000 µg/kg in sample 63SB02.
- Inorganic concentrations in surface soil appeared to be consistent with base-specific inorganic levels with the exception of lead (36.3 mg/kg) in soil boring SB0400.

Subsurface Soil:

- Low levels of phthalates were detected in several samples.

- Various inorganics were detected in subsurface-soil samples, none of which appeared to be elevated substantially above base-specific levels.

3.2.2 Groundwater Investigation

Three (3) shallow monitoring wells were installed, and one round of groundwater samples were collected. Groundwater samples were analyzed for full TCL organics and TAL metals using CLP analytical protocols.

- Low levels of benzoic acid (3 µg/L) and bis(2-ethyhexyl)phthalate (9 µg/L) were detected in groundwater collected from monitoring well 63MW02.

- Trace levels of carbon disulfide (1 µg/L) in both wells 63MW01 and 63MW02.

- Maximum concentrations of aluminum (85,300 µg/L), barium (5,410 µg/L), chromium (134 µg/L), iron (100,000 µg/L), lead (369 µg/L), and manganese (1020 µg/L) exceeded federal and/or state groundwater standards. All maximum concentrations occurred in well 63MW02.

3.2.3 Surface Water/Sediment Investigation

Two surface water and two sediment samples were collected from the intermittent stream. No organic contaminants were detected in either the surface water or sediment samples.

- Iron was the only contaminant detected above North Carolina and Federal surface water quality standards.

- Concentration levels of aluminum, arsenic, barium, beryllium, chromium, copper, iron, lead, magnesium, manganese, nickel, vanadium, and zinc were less than the effective range-median (ER-M) in both sediment samples.

3.3 Physical Hazards

The identified potential physical hazards associated with this project during the site activities include thermal stress, explosion and fire, utilities, and heavy equipment operations. The following presents a description of these potential hazards. General physical hazards that may be present during the project activities are listed in the following subsections.

3.3.1 Thermal Stress

Provisions for monitoring for thermal stress are included in Attachment A - Baker Safety SOPs.

3.3.2 Explosion and Fire

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

- Heavy equipment malfunction or re-fueling operations
- Penetration into underground utility/service lines (gas, electric, fuel)

- Ignition of trapped flammable vapors
- Vehicular accidents
- Puncturing of drums or containers during drilling operations
- Ignition of flammables or combustibles from open flames during welding or cutting

Hazard Prevention

Explosion and/or fire hazards can be prevented by grounding, approved safety cans, compressed gas cylinder safety, leak repair, vehicle maintenance, fire extinguishers, no smoking, and no incendiary or igniter devices.

Site personnel should be trained in the proper use of portable fire extinguishing equipment. Site personnel should respond to fires as follows:

- Evacuate all personnel

- Call the Fire Department

- If the fire is small or confined, attempts to fight the fire with portable fire extinguishers is authorized

- Support the Fire Department response forces as appropriate (probably will be limited to providing information regarding site activities, hazards, and missing personnel, if any)

3.3.3 Utilities

Underground utility clearance must be obtained before any intrusive activities are performed; this clearance will be provided by a representative from the Public Works Department at MCB Camp Lejeune. If underground utilities are identified in these areas, the ground above the utility lines are to be physically marked, such as, with spray paint or flags. Base representatives are to be notified at least three days prior to soil intrusive activities to acquire a utility clearance. A 24-inch minimum clearance must be used for work near underground utilities.

Energized overhead electric lines may present a risk of electrocution. OSHA standards require that equipment maintain certain distances from power lines. For lines 0 to 50 kilovolts (kV), a minimum distance of 10 feet must be maintained. Lines carrying over 50 kV require that the equipment location be at least 10 feet plus an additional 0.4 inch for each 1 kV over 50.

3.3.4 Heavy Equipment

One of the primary physical hazards associated with the site work is the use of heavy equipment, which may include the use of a drill rig for permanent monitoring wells and/or hydraulic-operated direct push equipment for temporary monitoring wells. Only operators trained, qualified, and authorized will be permitted to operate the heavy equipment.

Hazards generally associated with drilling operations include the following:

- Motor vehicle exhaust products (e.g., carbon monoxide) from the drill rig engine

- Overhead utility wires, (i.e., electrical and telephone), can be hazardous when the drill rig boom is in the upright position

- Underground pipelines and utility lines can be ruptured or damaged during active drilling operations

- Moving parts, i.e., augers, on the drill rig may catch clothing. Free or falling parts from the cat head may cause head injury

- Moving the drill rig over uneven terrain may cause the vehicle to roll over or become stuck in a rut or mud. Be aware of hazards associated with moving heavy machinery and other associated injury

- High pressure hydraulic lines and air lines used on drill rigs are hazardous when they are leaking, worn or incorrectly assembled

Hazard Prevention

- Review the contaminants suspected to be on site and perform air monitoring as required. Shut down drill rig and/or divert exhaust fumes.

- All chains, lines, and cables should be inspected daily for weak spots, frays, etc.

- Ear muffs and/or ear plugs effectively reduce noise levels.

- Personal protection including safety boots, eye protection, and hard hats will be worn at all times when working around a drill rig. Secure loose clothing. Check boom prior to approaching drill rig.

- To avoid contact with any overhead lines, the drill rig boom should be lowered prior to moving the rig. Overhead utilities should be considered "live" until determined to be otherwise.

- The rig mast should not be erected within 10 feet of an overhead electrical line until the line is deenergized, grounded, or shielded and an electrician has certified that arcing cannot occur.

- A thorough underground utilities search should be conducted before the commencement of a drilling project. Proper utility clearances must be obtained prior to intrusive work.

- All high pressure lines should be checked prior to and during use.

- The subcontracting drilling company's site supervisor is to provide, during the HASP briefing, a description of cautions to be observed when working around the drill rig.

- Hand signals will be prearranged between the operator and personnel working around the drill rig.

- Personal are to remain in the field of vision of the operator and remain clear of moving parts, especially where loose-fitting clothing can become entangled.

- Personnel working near a drill rig are to be aware of the location and operation of the emergency shut off devices.

- Establish appropriate work zone around the drill rig of a radius of at least equal to the height of the drill boom, and delineate work zone with construction warning tape.

3.3.5 Noise

Past experience during this type of heavy equipment operation has not indicated a noise level concern in conjunction with 29 CFR 1910.95 requirements. Hearing protection will be made available and employees can receive hearing protection upon request.

3.3.6 Monitoring Well Sampling

General physical hazards that may be present if permanent monitoring wells are installed and the associated sampling activities include:

- Cuts from sharp edges of the well casing.
- Biting insects inside the well casing.
- Muscle strain during well purging.

3.4 Chemical Hazards

The primary chemical hazards that may be encountered at the site are based are based on previous soil and groundwater investigations. Previous surface soil investigation detected low levels of the following compounds toluene, xylene, phthalates, 4,4'-DDD, 4,4'-DDT, 4,4'-DDE in some of the samples. PCBs were detected in one sample at a level of 1,000 µg/kg and lead was detected in another sample at 36 mg/kg. Previous groundwater investigations indicated low levels of benzoic acid and bis(2-ethylhexyl) phthalate. In addition, one monitoring well results exceeded the federal and/or state groundwater standards with the following: aluminum, barium, chromium, iron, lead, and manganese. Table 3-1 identifies chemical/physical properties of the chemicals that were detected during previous investigations. A Material Safety Data Sheet is available in Attachment B for each of the chemicals in Table 3-1.

Other chemical hazards that may be present are from the preservative chemicals that will be in some of the sample containers (such as, hydrochloric acid). An MSDS will be obtained from the laboratory and be available with the field sampling team for all sample preservatives. In addition, isopropanol will be used as part of the decontamination of the sampling equipment. An MSDS for this chemical can be located in Attachment B.

3.5 Environmental Hazards

The following paragraphs identify the potential hazards associated with flora and fauna at Site 63. If additional concerns are identified, they will be added to this HASP.

3.5.1 Hazardous Flora

Incidence of contact by individuals to poisonous/thorny plants is high, especially during surface water and sediment sampling activities; therefore, bare skin should be covered (i.e., long pants and shirt, steel toe boots, leather or cotton gloves, safety glasses, and head protection) as much as practical when working in forested or densely vegetated areas. Personnel should avoid entering an area in the direct path of known poisonous flora (i.e., poison ivy, poison oak, or poison sumac); a secondary route should be selected. Care should also be taken when walking in such areas as uneven terrain or vines may present a tripping hazard.

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

3.5.2 Hazardous Fauna

Mosquitoes and gnats pose a nuisance and physical hazard to field personnel; they distract workers, leading to accidents, and pose a physical threat by transmitting live microorganisms. Avoiding the use of perfumes and scented deodorants and donning light colored clothing is preferable. The use of Avon's "Skin So Soft" or other insect repellent is encouraged and will be provided, as needed in the Baker Field Trailer.

Poisonous snakes such as the rattlesnake, copperhead, and cottonmouth (water moccasin), all known as pit vipers, are common to the United States. Snakes typically do not attack people but will bite when provoked, angered, or accidentally injured (as when stepped on). When encountering a snake, avoid quick/jerky motions, loud noises, and retreat slowly; do not provoke the snake. If bitten, follow emergency procedures outlined in Section 8.8.3.

There is a potential to come in contact with other dangerous insects; these include fire ants, chiggers, bees, wasps, hornets, mites, fleas, spiders, and ticks.

If a tick is found buried under the skin, remove it by pulling steadily and firmly. Grasp the tick with fine-tipped tweezers, as close to the skin as possible, and pull slowly. Once the tick is removed, wash the area immediately with soap and water. Apply an antiseptic or antibiotic ointment if available. Observe the bite area periodically thereafter.

Insect bites are characterized by localized pain, potential stinger, swelling, and a possible allergic reaction. Care for an insect bite by scrapping away stingers, wash wound, cover with sterile gauze, apply a cold pack, and watch for signals of allergic reactions.

All personnel should perform "checks" on each other periodically and at the end of the work shift, especially when working in grassy or forested areas. All insect bites must be reported to the SHSO. If a spider bite by a black widow or brown recluse is suspected, follow emergency procedures in Section 8.8.4.

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

4.0 SITE CONTROL

The Site Manager is designated to control access and security on site. The Site Manager will establish site security in accordance with job locations. The following identifies the PPE level assigned to the site activities and the site control measures that accompany them. Refer to Section 6.0 for a definition of the protection level requirements.

4.1 Level D

Work Zones for activities conducted in Level D or a modified Level D protection level will be monitored by the SHSO to restrict unauthorized personnel from entering the monitoring well area during installation and sampling activities.

4.2 Level C

Although activities are expected to be conducted in Level D and modified Level D attire, if air monitoring indicates the presence of contaminants and warrant an upgrade in the level of personal protection the boundaries for the following work zones will be defined as follows:

- Work Zone - The area immediately around the work area, such as the drill rig boom radius.
- Hotline - The boundary between the Work Zone and the Contaminate Reduction Zone (CRZ).
- CRZ - The area between the Work Zone and the Support Zone (located upwind of the site investigative activities).
- Contamination Control Line - The boundary between the CRZ and the Support Zone.
- Support Zone - The outermost area next to the CRZ and upwind of the site investigative activities.

These boundaries will be demarcated using colored boundary tape, cones, or equivalent.

Unauthorized personnel will not be permitted in the work areas.

4.3 Site Access

The Site Manager is designated to coordinate overall access and security at each area under investigation. Perimeters for activities to be conducted at Site 63 will be established based on in Section 4.3, local conditions, the items listed below, and Navy Activity requirements.

- Personnel will not be permitted within the Work Zone (i.e., Exclusion Zone) or Contamination Reduction Zone without proper authorization from the SHSO.

- All personnel arriving or departing the site will be documented in the site log book.

- All activities on site must be cleared through the Site Manager and documented in the site log book.

- The on-site Command Post will be established at the Baker Field Trailer, which will be in the Support Zone and oriented upwind from all Work Zones.

4.4 Buddy System

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

4.5 Safe Work Practices

Routine safe work practices may consist of:

- Conducting operations in a manner to reduce exposure of personnel and equipment.
- Implementing appropriate decontamination procedures.
- Conducting sampling activities from an upwind location.
- Adherence to applicable safety regulations in OSHA Standards 29 CFR 1910 and 1926.
- Setting up barriers to exclude unauthorized personnel from contaminated areas.
- Minimizing the number of personnel and equipment at each area under investigation.
- Establishing work zones within each area under investigation.
- Establishing control points for ingress to and egress from work zones.

4.5.1 Heavy Equipment

The following safe work practices will be adhered to if heavy equipment operations take place.

- Hard hats will be worn at when working in a work zone with heavy equipment.

- Heavy equipment requiring an operator will not be permitted to run unattended.

- Heavy equipment will not be operated in a manner that will endanger persons or property nor will the safe operating speeds or loads be exceeded.

- Heavy equipment will be shut down and positive means taken to prevent its operation while repairs or fueling are being performed.

- Personnel, other than the operator, should not ride on equipment.

- A "spotter" will be used to help direct the heavy equipment operator.

- Personnel are to remain in the field of vision of the operator and remain clear of moving parts.

- Hand signals will be prearranged between operator and personnel working around the heavy equipment.

- Backup alarms must operate properly on the heavy equipment.

4.5.2 Drilling Operations

The following safe work practices will be adhered to if drilling operations occur.

- Hand signals will be prearranged between operator and personnel working around the drill rig.

- Personnel are to remain in the field of vision of the operator and remain clear of moving parts where protective clothing can be entangled, i.e., Tyvek caught in the auger.

- Personnel working near a drill rig are to be aware of the location and operation of the emergency shut off devices.

- Utility clearances must be secured prior to digging (see Section 3.3.3).

- The drill rig boom is to remain a minimum of 10 feet from power lines (see Section 3.3.3).

- During the HASP briefing, the supervisor of the drilling company will provide additional precautions to be observed when working around the drill rig.

4.6 Sanitation Procedures/Site Precautions

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

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

- Single service disposal cups.

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

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

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

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

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

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

- Contact lenses are <u>not permitted</u> to be worn on site.

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

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

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

- Alcoholic beverages and firearms are prohibited on site.

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

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

4.7 Dust Generation Repression

The nature of some of the chemicals that have been detected from previous investigation present a health concern from ingestion and/or inhalation, therefore, visual dust generation during soil intrusive activities is to be avoided. Although dust generation from the type of drilling that is to be conducted at Site 63 is uncommon, a water mist will be provided to repress dust generation if this situation should occur.

5.0 EXPOSURE MONITORING

The following information presents the air monitoring to be performed during the soil intrusive activities at Site 63. The air monitoring will consist of breathing zone, point source, and perimeter monitoring. Real-time organic vapor monitoring will be conducted using a HNu (PID) with a 10.2 eV probe.

5.1 Breathing Zone

The action level to upgrade from Level D to Level C will be a HNu (PID) reading in the breathing zone of greater than two ppm above the background for a period greater than or equal to 1 minute. If breathing zone readings exceed ten ppm above background continuously for five minutes or longer personnel will stop work, leave the work area, and consult the SHSO.

5.2 Point Source Monitoring

The HNu (PID) monitor will be used to monitor the point source during the soil intrusive activities. Point source monitoring is defined as monitoring performed at the source of the work activity. If point source HNu (PID) readings are detected above background, breathing zone monitoring will also be conducted.

5.3 Perimeter Monitoring

A PID will be used to monitor the perimeter of the work area to determine safe areas during a work stoppage if concentrations meet the work stoppage criteria identified in Section 5.1.

5.4 Equipment Calibration

Equipment calibration of the HNu (PID) will be completed daily before use. The calibration will be performed in accordance with the manufacturer's requirements. The calibration information will be logged on a field calibration form. These forms will be placed in the project files upon completion of the field activities.

5.5 Monitoring Documentation

As the air monitoring is performed, documentation of the results will be entered into a field log book by the individual performing the monitoring. Documentation is to include date, time, instrument result, work area, and specific location, such as, background, point source and breathing zone. This air monitoring documentation will be placed in the project files upon completion of the field activities.

6.0 PERSONAL PROTECTIVE EQUIPMENT

The Level of Protection selected is based upon the following:

- Measured concentration of a chemical substance or substances in the ambient atmosphere
- Potential for exposure to substances in air, liquids, or direct contact with material because of work activities
- Knowledge of chemicals on-site along with properties such as toxicity, route of exposure, and contaminant matrix

6.1 Levels of Protection

Job Task	Level of Protection				
	A	B	C	D+	D
General site activities (such as, Mobilization/Demobilization)					x
Soil boring and sampling				x	
Monitoring well installation				x	
Monitoring well developing, purging, and sampling				x	
Surface Water/Sediment sampling				x	

x - Level of protection for the task identified

The SHSO will upgrade the level of protection based on the results of air monitoring at worker locations, or based on his or her professional judgement according to observations of site activities.

Protective ensembles are described below:

Level D

- Work clothes
- Work gloves (as needed)
- Steel toe boots
- Safety glasses (as needed)

Modified Level D (D+)

- Work clothes
- Gloves, chemical resistant (nitrile) (during sampling activities)
- Steel toe boots
- Safety glasses
- Hard Hat (during heavy equipment activities)

Level C

- Air-purifying respirator, full-face, with organic vapor/HEPA cartridges
- Chemical-resistant clothing (such as polycoated tyvek)
- Gloves (outer), chemical resistant
- Gloves (inner), chemical resistant
- Steel toe boots
- Boot covers (outer), chemical-resistant (disposable)

CHANGES TO THE SPECIFIED LEVELS OF PROTECTION SHALL BE AT THE DIRECTION OF THE SHSO AND THE FIELD SUPERVISOR.

6.2 Reassessment of Protection Program

The Level of Protection shall be upgraded or downgraded based on changes in site conditions or findings of investigations.

7.0 DECONTAMINATION PROCEDURES

The following presents the information for personnel and equipment decontamination requirements.

7.1 Personnel Decontamination

Decontamination involves the orderly, controlled removal of contaminants. Standard decontamination sequences are presented in the table below. All site personnel should minimize contact with contaminants in order to minimize the need for extensive decontamination.

Level C	Level D & D+
1. Equipment drop	1. Equipment drop
2. Outer boot/glove wash	2. Boot/glove wash*
3. Outer boot/glove rinse	3. Boot/glove rinse*
4. Outer boot/glove removal	4. Boot/glove removal*
5. Coverall removal/disposal	5. Coverall removal*
6. Respirator removal	6. Hand/face wash
7. Inner glove removal/disposal	
8. Hand/face wash	
9. Respirator cleaning/sanitizing	

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

7.2 Equipment Decontamination

The protocols outlined in the project plans for equipment decontamination must be followed to minimize contamination extending beyond the site boundary.

8.0 EMERGENCY PROCEDURES

8.1 Scope

The activities to be conducted under this HASP are not remediation (cleanup), but investigative; therefore the potential for a "release" to air, water, or soil is low. However, other emergencies, such as fire or personal injury may occur. If so, local emergency response groups will be called in to handle the incident, as necessary.

8.2 Pre-Emergency Planning

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

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

Specific points of contact, where applicable, will be established and added to the HASP. If requested, Material Safety Data Sheets for hazardous chemicals/materials brought on site (which are maintained at the Command Post), will be provided at this time.

8.3 Emergency Coordinator

The SHSO acting as the Emergency Coordinator is responsible for field implementation of these Emergency Procedures. The Emergency Coordinator is responsible for reacting (not responding) to emergencies. As the Emergency Coordinator, specific duties include:

- Familiarizing all on-site personnel with the emergency procedures and the emergency coordinator's authority.

- Identifying the nearest telephone in the event of an emergency.

- Communicating site emergency procedures and requirements to all Baker and subcontractor personnel.

- Specifying the Site Manager as the backup/alternate Emergency Coordinator.

- Controlling activities of subcontractors and contacting the emergency response groups, as necessary.

- Anticipating, identifying, and assessing fires, explosions, chemical releases, and other emergency situations to the best of the coordinator's ability, and providing this information to the emergency group(s) responding.

- Familiarity with site personnel trained in emergency first aid and adult CPR.

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

8.4 Communications/Telephone Numbers

Internal communications will rely on direct communication (via verbal or two-way radios) between site personnel. External communications will employ a telephone located in the Baker Field Trailer, a mobile telephone for emergency use, and various telephones located throughout the Base (near the investigation areas). Telephone communication at the Command Post will be established during site mobilization.

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

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

Coordination between Baker and subcontractor personnel is the responsibility of the Site Manager. The best means for securing the lines of communication will be determined at the pre-entry briefing.

Hand signals, as outlined below, will be used in the event that radio communications fail:

Hand gripping throat (typically Level C/B activities)	Can't breathe
Grip partner's wrist or both hands around waist	Leave area immediately
Hands on top of head	Need assistance
Thumbs up	OK, I am all right, I understand
Thumbs down	I do not understand

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

8.5 Assembly Area

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

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

8.6 Emergency Hospital Route

An emergency hospital route map (Figure 8-1) and written directions to the hospital (Figure 8-2) will be posted in the Baker Field Trailer and maintained in the Baker Field Vehicle. Personnel will be informed of the location of the map and the directions to the hospital during the pre-entry briefing.

8.7 Emergency Medical Treatment

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

Emergency Medical Services

For chemical and nonchemical exposure incidents, the nearest public hospital is:

Name	Onslow County Memorial Hospital
Address	317 Western Boulevard, Jacksonville, North Carolina
On-Base Telephone No.	(*9) 577-2240
Off-Base Telephone No.	(910) 577-2240

Local ambulance service is available from:

Name	Naval Hospital (On Base) or City of Jacksonville (Off Base)
On-Base Telephone No	911
Off-Base Telephone No	(910) 455-9119 or 911

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

8.8 Injuries

If injuries are not serious or life threatening, affected personnel may be transported by other site personnel to the local medical facility, if necessary. Emergency medical response personnel will be contacted in the event of serious or multiple injuries. Medical personnel will be provided with all available information regarding the nature of the incident, chemicals involved, etc. Instances requiring treatment beyond "first aid" will be handled at appropriate facilities and reported to the Project Manager and PHSO within 24 hours.

There will be a minimum of two persons during each phase of field activities that will be trained in standard first aid and adult CPR. These personnel will also be familiar with Baker's program for potential exposure to bloodborne pathogens as outlined in the Baker Safety SOPs in Attachment A. Subcontractors will be responsible for securing proper medical attention for their employees. Baker may assist the subcontractor as necessary.

8.8.1 Physical Injury

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

8.8.2 Chemical Injury

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

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

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

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

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

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

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

8.8.3 Snakebite Injury

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

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

Provide treatment as follows:

1. Calm the victim and keep affected area still.

2. Contact ambulance if you cannot provide victim with transportation to the nearest hospital.

3. Wash the wound.

4. Keep the affected area below the level of the heart if bite is on the arm or leg.

5. Treat for shock.

6. Monitor airway, breathing, and circulation.

7. Obtain physical description of snake, if possible.

8. Provide the emergency medical responder (either the ambulance attendant or the emergency room at the hospital) with all pertinent information such as how long ago the bite occurred, the type of snake (if known), any known allergic conditions (if known), etc.

9. Inform the SHSO as soon as possible.

8.8.4 Spider Bite Injury

There are two spiders commonly found in the United States whose bite can be serious: the black widow spider and the brown recluse spider. These bites may be serious, even life-threatening. Many other spiders will bite, but they do not produce serious complications. The black widow spider measures approximately 1 inch long with its legs extended. It is glossy black in color and has a distinctive yellow-orange marking in the shape of an hourglass on its belly. On its back, however, there is no marking, and unless you happen to turn the spider over, you cannot see this mark. The danger of the black widow spider bite lies in its systemic manifestations. The venom from this spider attacks the nervous system, resulting in severe muscle cramps with boardlike rigidity of the abdominal muscles, tightness in the chest, and difficulty in breathing. Sweating, nausea, and vomiting will also occur.

The emergency treatment for the black widow spider bite is basic life support. sometimes the individual is not even aware of having been bitten, or where. Apply cold to the site of the bite if it can be identified. There is a specific antivenin for this spider bite that must be administered by a physician. It is particularly important to identify the spider, and bring it in, if you can.

The brown recluse spider is a little bit smaller than the black widow spider and is dull brown in color. It has a violin-shaped mark on its back, which can be seen when you are looking at the spider from above. The spider gets its name because it tends to live in dark areas, corners, and old unused buildings. The bite from this animal produces local rather than systemic manifestations. The venom of the brown recluse spider causes severe local tissue damage and can lead to an ulcer and gangrene. The bitten area becomes red, swollen, and tender within a few hours after the bite. A small blister forms, and several days later, this may form a large scab, covering a deep ulcer. Death is rarely reported, but these bites need local surgical treatment, and these patients should be brought to the hospital. Again, if possible, identification of the spider should be carried out.

8.9 Emergency Decontamination Procedures

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

Level D	Level D+	Level C	Level B
• Equipment drop • Tape, boot, and glove removal • Coverall removal	• Equipment drop • Tape, outer boot, and glove removal • Coverall removal/ disposal • Inner glove removal/ disposal	• Equipment drop • Tape, outer boot, and glove removal • Coverall removal/ disposal • Respirator removal • Inner glove removal/ disposal	• Equipment drop • Tape, outer boot, and glove removal • SCBA or escape tank removal • Coverall removal/ disposal • SCBA or ALR face shield removal • Inner glove removal/ disposal

* If circumstances dictate that contaminated clothing cannot be readily removed, then remove gross contamination and wrap injured personnel with clean garments/blankets to avoid contaminating other personnel or transporting equipment. All emergency personnel are to be immediately informed of the injured person's condition, potential contaminants, and provided with all pertinent chemical data.

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

8.10 Personal Protection and First Aid Equipment

PPE available for emergency response will include the following:

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

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

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

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

8.11 Notification

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

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

8.12 Hazard Assessment

The Emergency Coordinator will assess possible hazards to human health or the environment that may result from an uncontrolled situation, to the best of the individual's abilities, incorporating the following steps, as appropriate.

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

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

- Inform appropriate personnel, as identified in Section 8.11, who will determine if release of material(s) meets USEPA requirements for reportable quantities for spills under the RCRA or Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

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

8.13 Security

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

- Activities that have occurred since the incident was first reported.
- Tasks currently being performed and where.
- Rescue and response equipment used.
- Protective equipment being used.

8.14 Emergency Alerting

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

Personnel Injury in the Work Zone:

- Initiate a verbal warning or one long airhorn blast and move all unaffected site personnel to the support zone (for Level D/D+) or the CRZ (for Level C or higher).
- Send the rescue team into the Work Zone (if required) to remove the injured person to the hotline.
- Have the SHSO and/or Site Manager evaluate the nature of the injury and assure that the affected person is decontaminated according to Section 8.9.
- If required, contact an ambulance and/or the designated medical facility.

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

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

Personnel Injury in the Support Zone:

- The Site Manager and SHSO will assess the nature of the injury; if the cause of the injury or loss of the injured person does not affect the performance of other site personnel, operations may continue.
- If the injury increases the risk to others, a verbal warning or one long airhorn blast shall be sounded and all remaining site personnel will move to the command post for further instructions.
- Activities on site will stop until the added risk is mitigated.

Fire/Explosion:

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

Personal Protective Equipment Failure:

- If any site worker experiences difficulty, failure, or alteration of protective equipment that affects the protection factor, that person and his/her buddy shall immediately cease work activities, leave the Work Zone, and repair or replace the defective equipment.

- Reentry will not be permitted until the equipment has been repaired or replaced.

Other Equipment Failure:

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

8.15 Training

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

8.16 Spill Containment Procedures

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

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

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

9.0 TRAINING AND HAZARD COMMUNICATION REQUIREMENTS

Training requirements for site personnel are outlined in the following subsections.

9.1 General Worker Training

OSHA requires that personnel who will work on-site to be trained according to the requirements of 29 CFR 1910.120. Initial training must be a 40-hour course and three days of actual field experience under the direction of a trained, experienced supervisor. In addition to the initial training, personnel must attend 8-hour annual refresher courses to ensure that personnel retain the basic knowledge necessary for their safety when involved with hazardous waste site operations.

9.2 Supervisor Training

Supervisory personnel must attend 8-hour supervisory training sessions in addition to the basic 40-hour training described above. This training provides instruction in the management aspects of health and safety at hazardous waste sites. The SHSO will be qualified as a supervisor.

9.3 Site Specific Training

The SHSO will brief all individuals who will enter the site on the contents of this HASP. Each individual must certify that he or she has received the briefing, and that he or she understands the health and safety precautions to be taken by signing the Health and Safety Training Record.

9.4 Hazard Communication

In order to comply with 29 CFR 1910.1200, Hazard Communication Standard, the Baker written Hazard Communication Program will be available to site personnel upon request.

All containers of hazardous materials received on site will be inspected to ensure the following: (1) all containers will be clearly labeled as to the contents; (2) the appropriate hazard warnings will be noted; (3) the name and address of the manufacturer will be listed.

All secondary containers will be labeled with either an extra copy of the original manufacturer's label or with generic labels which have a block for identity and blocks for the hazard warnings.

Copies of MSDSs for all hazardous chemicals known or suspected to be on site will be maintained in the work area. MSDSs will be available to all employees for review during each work shift.

9.5 Recordkeeping

Training records relevant to safe operation of the site will be maintained by the SHSO for all Baker employees at the site.

10.0 MEDICAL SURVEILLANCE REQUIREMENTS

10.1 General

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

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

10.2 Site Specific

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

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

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

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

11.0 HEALTH AND SAFETY PLAN APPROVAL

This HASP for the RI/FS activities at MCB Camp Lejeune Site 63 has been reviewed by the following personnel prior to the start of field activities.

NAME	Title	
Mr. Ronald Krivan	PHSO	Signature

NAME	Title	
Mr. Matthew D. Bartman	Project Manager	Signature

12.0 DECLARATION OF HEALTH AND SAFETY PLAN REVIEW

All site personnel indicated below have reviewed and are familiar with this HASP for Site 63 RI/FS field activities.

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

TABLE 3-1
TOXICOLOGICAL PROPERTIES OF CHEMICALS
RI/FS SITE 63
MCB CAMP LEJEUNE

Chemical Compound (a)	Hazard Rating (b) H F R	Volatility (c)	Skin Absorption (d)	Carcinogen (e)	Exposure Limit (f)	STEL (g)	IDLH (h)	IP (i)
Bis(2-ethylhexyl) phthalate (DEHP)	2 1 0	0.01	No	Yes	5 mg/m^3	-	-	NA
Chromium	NA	NA	No	Yes	0.5 mg/m^3	-	-	NA
4,4-DDD	NA	NA	Yes	Yes	1 mg/m^3	-	-	-
4,4-DDE	NA	NA	Yes	Yes	1 mg/m^3	-	-	-
4,4-DDT	NA	NA	Yes	Yes	1 mg/m^3	-	-	-
Lead	NA	NA	No	Yes	0.05 mg/m^3	-	700 mg/m^3	NA
Polychlorinated Biphenyls (Aroclor-1254)	2 1 0	1 mm @ 100°F	Yes	Yes	0.5 mg/m^3	-	-	NA
Toluene	2 3 0	22	Yes	No	50 ppm	150 ppm	2,000 ppm	8.82
Xylene	2 3 0	6.72	No	No	100 ppm	150 ppm	1,000 ppm	8.56

Notes:
(a) Chemical compound of potential concern obtained from previous investigation.
(b) Hazard Rating - based upon Health (H), Fire (F), or Reactivity (R) hazard from NFPA 704 Standard Rating System (0 = no hazard, 4 = high hazard)
(c) Volatility Rating - based upon vapor pressure in mm Hg at 68° F, 20° C
(d) Skin Absorption - "Yes" indicates potential exposure through skin and mucous membranes, either by airborne or, more particularly, by direct contact - ACGIH 1994-1995
(e) Carcinogen - "Yes" indicates a compound is a confirmed or suspect human carcinogen by the IARC, NIOSH, NTP, EPA or ACGIH
(f) Exposure Limit - Based on the Time Weighted Average from the 1994-1995 TLV - Threshold Limit Value of the ACGIH or OSHA Permissible Exposure Limits (PEL), whichever is lower
(g) Short Term Exposure Limit - "STEL" denotes a 15 minute time weighted average which may not be exceeded - ACGIH 1994-1995
(h) IDLH - Immediately Dangerous to Life and Health.
(i) Ionization Potential - expressed in electron volts (eV)

TABLE 8-1

EMERGENCY TELEPHONE NUMBERS

Facility	Phone Number On-Base Phone[1]	Phone Number Off-Base Phone[2]	Contact*
Security	911 or 2555	911 or (910) 451-2555	Response Operator
Fire (MCAS)	911 or 6620	(910) 451-6220	Response Operator
Fire (Hot Work Permit)	6220 or 3004	(910) 451-7221	Area Fire Captain
Ambulance (On-Base)	911		Response Operator
Ambulance (Off Base)	(*9) 455-9119	(910) 455-9119 or 911	Response Operator
Hospital Emergency Room (On-Base)	911 or 4840, 4841, 4842	451-4840 451-4841 451-4842	Response Operator
Onslow County Hospital (Off Base)	(*9) 577-2240	(910) 577-2240	Response Operator
Emergency (One Call)	911	911	Response Operator
On-Scene Coordinator	911	(910) 451-5815	Fire Chief
Environmental Management Division (EMD)	5068	(910) 451-5068	Mr. Neal Paul Mr. Tom Morris Mr. Walt Haven
Public Works (Underground Utilities via EMD Contact)	5068	(910) 451-5068	Mr. Neal Paul
Duke Regional Poison Control Center	(*2) 1-800-672-1697	1-800-672-1697	Response Operator
National Response Center	1-800-424-8802	1-800-424-8802	Response Operator
CHEMTREC	1-800-424-9300	1-800-424-9300	Response Operator
Baker Environmental Project Manager	(*8) 1-412-269-2053	1-412-269-2053	Mr. Matthew Bartman
Baker Environmental Project Health and Safety Office	(*8) 1-412-269-2036	1-412-269-2036	Mr. Ronald Krivan

(1) The following prefixes apply when using on-base telephones:
*2 - operator assisted calls including 800 numbers
*8 - long distance calls
*9 - local calls

(2) When using the mobile phone, which is programmed for the Pittsburgh area, use the phone numbers (including area codes) for an off-base phone.

TABLE 10-1

MEDICAL SURVEILLANCE TESTING PARAMETERS*

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

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

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

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

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

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

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

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

FIGURES

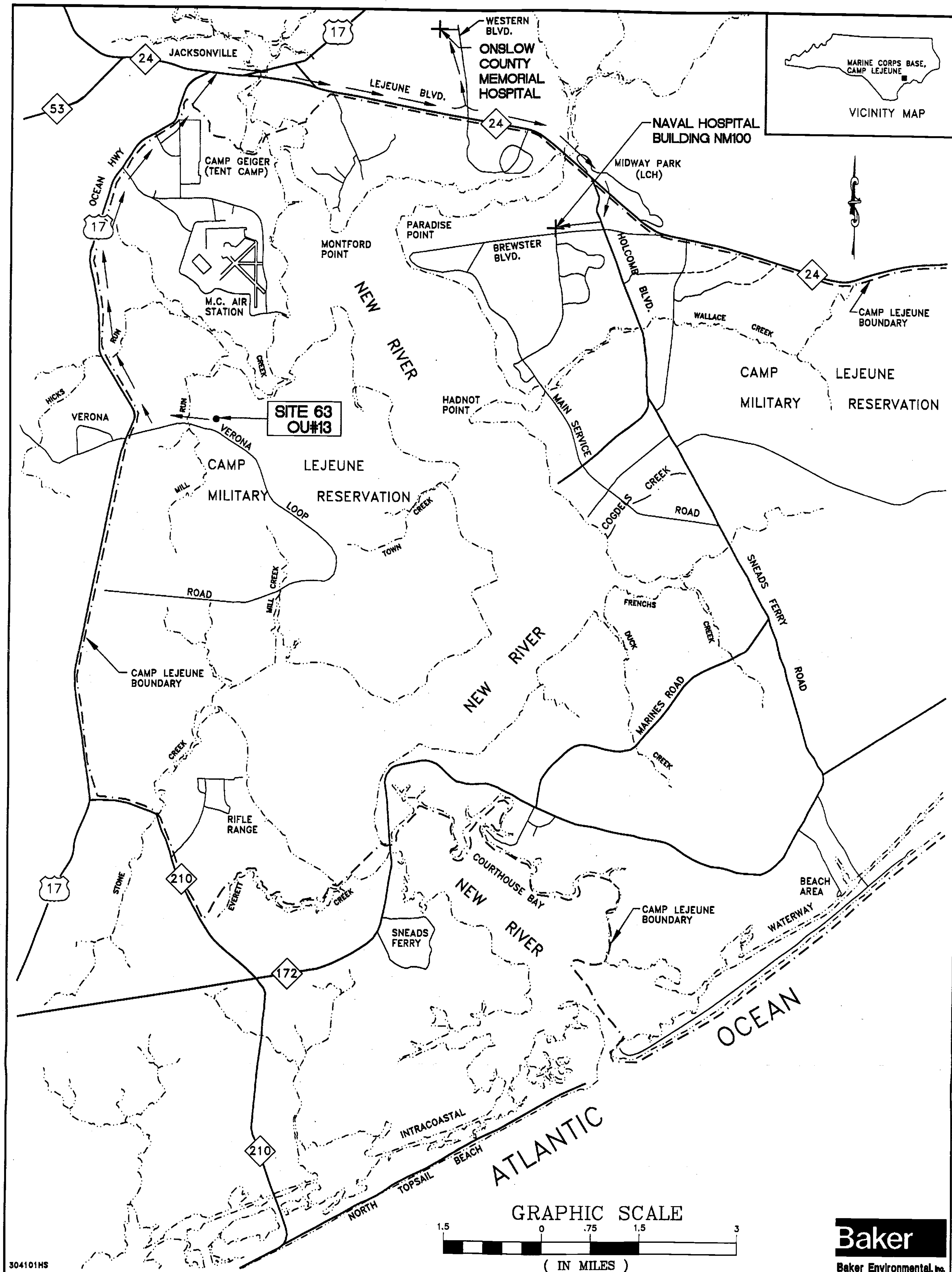

FIGURE 8-1
EMERGENCY HOSPITAL ROUTE
SITE 63 - VERONA LOOP DUMP

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

01567Z01Z

FIGURE 8-2

DIRECTIONS TO HOSPITAL FROM SITES 65 AND 73

Directions to Naval Hospital Building NM100 are as follows:

1a. From Site 63, turn right onto Verona Loop Road proceed approximately 3/4 of a mile to Ocean Highway (Route 17).

1b. Turn right onto Route 17 and proceed north.

2. Travel north on Route 17 for approximately 5-1/2 miles until intersecting with Lejeune Blvd.

3. Turn right onto Lejeune Blvd. (Route 24) and proceed east to Holcomb Blvd. through the main gate.

4. At first traffic light turn right onto Brewster Boulevard and proceed approximately 3/4 of a mile then turn right, following directions to the emergency room entrance.

Directions to Onslow County Memorial Hospital are as follows:

1. Follow directions 1-2 above.

2. Turn right onto Lejeune Blvd. (Route 24) and proceed east.

3. Continue on Route 24 east until intersecting with Western Boulevard.

4. Turn left onto Western Boulevard and proceed north until the fifth stoplight (approximately 1.5 miles).

5. Hospital is on left hand side.

6. Follow directions to emergency room entrance.

ATTACHMENT A
BAKER SAFETY STANDARD OPERATING PROCEDURES

ATTACHMENT A

BAKER ENVIRONMENTAL, INC.
SAFETY STANDARD OPERATING PROCEDURES

TABLE OF CONTENTS

*Not Applicable

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2.0 - RESPIRATORY PROTECTION PROGRAM

This Respiratory Protection Program presents the elements necessary for administering a successful program. Attached at the end of this program is a copy of the following Baker Environmental, Inc. (Baker) forms:

- Qualitative Respirator Fit Test Record
- Air-Supplying Respirator Inspection Form
- Air-Purifying Respirator Inspection Form

2.1 PURPOSE

The purpose of the Baker Respiratory Protection Program is to govern the selection and use of respiratory protection by Baker personnel. This program is also designed to meet requirements of the Occupational Safety and Health Administration (OSHA) standards 29 CFR 1910.134 and 1926.103, "Respiratory Protection."

2.2 SCOPE

This program applies to Baker SRN personnel who may be involved with potential respiratory hazards as part of their job duties. This program outlines the procedures to follow when respiratory equipment is required.

2.3 RESPONSIBILITY

Baker provides the necessary respiratory equipment to protect the safety and health of each Baker employee. The Baker SRN Project Health and Safety Officer (PHSO) and Project Manager are responsible for identifying the need for this Respiratory Protection Program at project sites. The Baker Site Health and Safety Officer (SHSO) and Site Manager are responsible for implementing and administering the Respiratory Protection Program in the field. Baker employees are to use and maintain the respiratory protection provided in accordance with training received and instructions outlined in this program.

2.4 HAZARD ASSESSMENT

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

After a task-specific assessment is completed and it is determined that there is a potential for airborne exposure concentrations to exceed the recommended limits, engineering and administrative controls should be implemented. If the exposure cannot be reduced, or it is not feasible to reduce the airborne exposure below the recommended limits, respirators will be selected by the PHSO and/or SHSO on the basis of:

- Toxicity
- Maximum expected concentration
- Oxygen levels
- Warning properties of the substance(s) involved
- Sorbent limitations
- Facepiece fit
- Mobility requirements
- Type of use (routine, escape, or emergency entry)
- Possibility of ingestion of toxic materials
- Respirator attributes

2.5 TRAINING

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

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

Employees who have attended the 40-hour training in accordance with 29 CFR 1910.120 (HAZWOPER) will be provided with the basic information necessary to comply with the OSHA training requirements and will only need to attend a supplementary session provided by qualified Baker personnel. The annual HAZWOPER 8-hour refresher will serve to reinforce these issues on an annual basis. Records of the training and fit-testing will be maintained for a minimum of 30 years following termination of employment for each employee.

2.6 TYPES OF RESPIRATORS

Baker purchases and provides, as necessary, the following respirators:

- North Brand half-face (Model 7700) and full-face (Model 7600) air-purifying respirators

- North Brand positive pressure 30-minute Self-Contained Breathing Apparatus (SCBAs) (Model 800)

- North Brand positive pressure supplied airline respirators with 5-minute escape air cylinders (Model 85500).

- MSA Ultra Twin full-face respirator (Model 480263)

- MSA Comfo II half-face respirator (Model 479529)

Only respiratory equipment certified by the appropriate approval agencies (e.g., NIOSH, MSHA) according to Title 30, Part II of the Code of Federal Regulations, will be distributed to Baker employees. All Baker employees who regularly perform tasks requiring respiratory protection will be issued their own half-face and/or full-face respirator, provided the employee can achieve a proper fit and is medically capable of wearing the equipment.

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

2.7 AIR QUALITY

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

Air cylinders shall be tested and maintained as prescribed in the Shipping Container Specification Regulations of the Department of Transportation (49 CFR Part 178). Air-line couplings shall be incompatible with outlets for other gas systems to prevent inadvertent servicing of air-line respirators with nonrespirable gases or oxygen.

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

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

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

2.8 CLEANING AND MAINTENANCE

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

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

All respirators shall be stored in a plastic bag within a cool/dry location, in a manner that will protect them against dust, sunlight, heat, extreme cold, excessive moisture, or damaging chemicals. They shall be stored to prevent distortion of rubber or other elastomer parts. Cartridges will not be stored while attached to an air-purifying respirator at anytime.

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

2.9 INSPECTIONS

At the time of cleaning, and before and after each use, respirators will be inspected. Deteriorated components will be replaced before the respirator is placed back into service, or the respirator will be replaced. Repair components must be obtained from the manufacturer of the respirator to maintain the NIOSH certification. Emergency-use respirators and self-contained breathing apparatuses (SCBAs) will be inspected after each use or at a minimum, once a month. Sample inspection forms for both air-purifying respirators and air supplying respirators are attached. These forms are required to be completed each time a respirator is inspected. However, during field projects in which a field logbook is in use, personnel may enter the appropriate information into their field logbook as an alternative to the inspection form. A list of the items to be covered during an inspection are as follows:

- Air-Purifying Respirator (full or half-face)

  - Face Piece
    - -- Clean and sanitized?
    - -- Cracks, tears or holes absent?
    - -- Proper shape and flexibility retained?
    - -- Air-purifying element holders intact?
    - -- Stored properly, free from heat, dirt, and sunlight?

  - Headstraps or Headbands
    - -- Signs of wear or tears?
    - -- Buckles function properly?

  - Respirator Interior
    - -- Foreign material under valve seat?
    - -- Cracks or tears in valves/valve bodies?
    - -- Valve covers/bodies installed properly?

- Supplied Air Respirators
  - Cylinder undamaged?
  - Facepiece and hoses undamaged?
  - Connections undamaged?
  - Apparatus complete?
  - Facemask cleaned and sanitized?
  - Hoses and connections cleaned?

Note: The date and the initials of the qualified individual performing the inspection must be entered into the field logbook.

2.10 FIT-TESTING

Each respirator wearer shall be provided with a respirator that can properly form a secure face-to-mask seal. Each wearer shall be fit-tested prior to issuance of the respirator using either an irritant smoke or odorous vapor, or other suitable test agent (see example of form at end of text). Retesting shall be performed, at a minimum, on an annual basis or if a different model respirator, other than the model the wearer was previously fit-tested for, is to be used. Air-purifying respirators fit-tested qualitatively will be assigned a protection factor of 10 (APF = 10). A copy of Baker's Fit-Test Form is attached.

Facial hair, which interferes with the normally effective face to mask seal, is prohibited. Each respirator wearer shall be required to check the seal of the respirator by negative and positive pressure checks prior to entering a harmful atmosphere.

2.11 MEDICAL SURVEILLANCE

Personnel who are or may be assigned to tasks requiring use of respirators shall participate in a medical surveillance program on an annual basis. The medical surveillance program shall include, but may not be limited to, a history of respiratory disease, work history, a physical exam, and spirometry conducted by the company's physician and at the expense of the company. Test parameters included in Baker's medical surveillance program are in each site-specific HASP.

2.12 LIMITATIONS

Wearing any respirator, alone or in conjunction with other types of protective equipment, will impose some physiological stress on the wearer. Therefore, selection of respiratory protective devices will be based on the breathing resistance, weight of the respirator, the type and amount of protection needed as well as the individual's tolerance of the given device. Additional concerns regarding the limitations of different types of PPE and the monitoring requirements for heat stress/strain will be addressed in the "Heat Stress" SOP.

2.13 SUBCONTRACTOR REQUIREMENTS

In compliance with Baker's respiratory protection program, all subcontractors under the direction of Baker personnel will be expected to comply with pertinent sections of OSHA Standards 1910.134 and 1926.103. Additionally, the subcontractor will be asked to:

- Provide documentation that their employees have been fit-tested on the air-purifying respirator the employee is expected to use.

- Provide documentation that their employees have been medically certified to wear a respirator.

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QUALITATIVE RESPIRATOR FIT TEST RECORD

TEST SUBJECT NAME ________________________________
(last) (first) (initial)

DATE ____________ SOCIAL SECURITY NUMBER ____________

SEX (M/F) ______ AGE ______ DEPARTMENT ____________

RESPIRATOR MEDICAL DATE ________ RESPIRATOR TRAINING DATE ________

SPECIAL/UNUSUAL CONDITIONS/CONSIDERATIONS:

Yes	No		Yes	No	
☐	☐	Claustrophobia	☐	☐	Scars
☐	☐	Facial hair	☐	☐	Broken or crooked nose
☐	☐	Eyeglasses	☐	☐	Extreme facial dimensions
☐	☐	Contacts	☐	☐	Wrinkles
☐	☐	Other: ____________			

RESPIRATOR SELECTION

Manufacturer/Model	Size	Style	Result
	S ___ M ___ L ___	Half ___ Full ___	Pass ___ Fail ___
	S ___ M ___ L ___	Half ___ Full ___	Pass ___ Fail ___
	S ___ M ___ L ___	Half ___ Full ___	Pass ___ Fail ___

Testing Agent	Qualitative Test	Sensitivity Check
Isoamyl Acetate	Yes: ___ No: ___	Yes: ___ No: ___
Irritant Smoke	Yes: ___ No: ___	Yes: ___ No: ___
Other: ____________	Yes: ___ No: ___	Yes: ___ No: ___

TEST EXERCISES
(Check all that apply)

Normal Breathing ____________ Talking ____________
Deep Breathing ____________ Bending ____________
Head, Side to Side ____________ Jaw Movements ____________
Head, Up and Down ____________ Rainbow Passage ____________

COMMENTS: ________________________________

Signed: ____________________
(Test Subject)

Signed: ____________________
(Technician/Instructor)

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AIR-PURIFYING RESPIRATOR INSPECTION FORM

Type (Full or Half-Face)	FACE PIECE					HEADSTRAPS OR HEADBANDS		RESPIRATOR INTERIOR			Inspected By (Initials)	Date Inspected
	Clean and Sanitized?	Cracks, Tears, or Holes?	Proper Shape and Flexibility?	Air Purifying Element Holders Operate Correctly?	Proper Storage Free From Heat, Dirt, Sunlight, etc.?	Signs of Wear or Tear?	Buckles Function Properly?	Foreign Material Under Valve Seat?	Cracks or Tears in Valves or Valve Bodies?	Valve Covers and Bodies in Good Condition and Installed Correctly?		

✓ = OK X = Not OK

Baker Environmental, Inc

AIR-SUPPLYING RESPIRATOR INSPECTION FORM

Type (SCBA or SAR)	Cylinder Condition (Damaged or Undamaged)	Cylinder (Full or MT)	Facepiece and Hoses (Damaged or Undamaged)	Connections (Damaged or Undamaged)	Apparatus Complete (Yes/No)	Cleaned and Sanitized (Yes/No)	Remarks	Inspected By (Initials)	Date Inspected

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3.0 - CARE AND CLEANING OF PERSONAL PROTECTIVE EQUIPMENT

3.1 INTRODUCTION

The following procedures cover the care and cleaning of Levels D, D+, C, and B personal protective equipment (ppe). Note: These are general procedures that apply to most situations and are not all inclusive. Procedures are subject to change at the direction of the Site Health and Safety Officer (SHSO).

3.2 INSPECTION

Proper inspection of personal protective equipment (PPE) features several sequences of inspection depending on articles of PPE and its frequency of use as follows:

- Inspection and operational testing of PPE received from the factory or distributor.
- Inspection of PPE as it is issued to workers.
- Inspection after use or training, and prior to maintenance.
- Periodic inspection of stored equipment.
- Periodic inspection when a question arises concerning the appropriateness of the selected equipment, or when problems with similar equipment arise.

The primary inspection of PPE in use for activities at the site will occur prior to immediate use, will be conducted by the user to ensure that the specific device or article has been checked out by the user, and that the user is familiar with its use.

3.2.1 Chemical Resistant Suit (Levels D+ through B)

- Determine if suit is the one specified in the Site Health and Safety Plan (HASP)

- Before donning, inspect suit for holes or tears; check to see that zippers are operable and look for signs of suit degradation.

- When wearing, avoid contact with contaminated material where possible; be aware of sharp objects that can tear suit; periodically look over suit to check for major rips or tears.

- While decontaminating, remove gross excess of material from suit; remove suit so that material does not contact inner suit; place clothing in properly labeled disposal containers.

3.2.2 Inner/Outer Gloves (Levels D+ through B)

- Determine if gloves meet the specifications in the site HASP.

- Look for rips, tears, or degradation of material. Replace as necessary or at the direction of the SHSO.

3.2.3 Chemically Resistant Boots (Levels D+ through B)

- Determine if boots meet the specifications in the site HASP.

- Nondisposable boots are to be examined on a daily basis before and after use. Disposable boots should be examined prior to donning and while in use, and disposed according to site procedures.

3.2.4 Safety (Steel Toe and/or Shank) Boots (Levels D through B)

- Examine daily for gouges, open seams, etc., anything that would lessen the integrity of the boot. Replace as boot becomes worn.

3.2.5 Hard Hats (Levels D through B)

- Should be visually inspected before donning for fit, cracks, and overall condition.

3.2.6 Safety Glasses/Goggles (Levels D through C)

- Should be visually inspected before donning for cracks, deteriorated parts, and overall condition. Replace as necessary.

3.2.7 Respirators (Levels D+ through B)

- Procedures for care of respiratory protective equipment are covered in Baker's SOP for Respiratory Protection.

3.2.8 Hearing Protection (Levels D through B)

- Disposable - Replace daily, or as material becomes worn or dirty.
- Reusable - Inspect before use, clean regularly, replace parts as necessary.

3.3 EQUIPMENT CLEANING

General procedures for cleaning of equipment are listed below. Site-specific concerns will be addressed by the SHSO prior to and during site activities. Cleaning of respiratory equipment is covered under the "Respiratory Protection Program" SOP.

3.3.1 Gross Physical Removal

Remove large amounts of contaminated soil or sediment by scraping off with a tongue depressor or other suitable instrument, then wipe off using a disposable wipe/paper towel.

3.3.2 Physical/Chemical Removal

Remove residual contamination with a soft-bristled, long-handled brush or equivalent using a nonphosphate detergent solution.

3.3.3 Rinsing/Dilution

The detergent solution and residual contaminants will be rinsed with distilled/tap water using a pressurized sprayer, a tub filled with clean wash water, or equivalent.

3.4 EQUIPMENT STORAGE

Storage of ppe is an important aspect to the daily care and cleaning therefore, the following considerations should be observed:

- Different types of ppe shall be stored in a clean and dry environment, free from elements that could damage ppe.
- PPE shall be stored and labeled so that site personnel can readily select the specified PPE.
- Contaminated, nondisposable ppe shall be decontaminated before returning to the storage area.
- Contaminated, disposable PPE shall not be returned to the storage trailer, but disposed according to the provisions identified in the Site Work Plans.

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4.0 - BLOODBORNE PATHOGENS (Safe Handling of First Aid Incidents)

4.1 PURPOSE

The purpose of the Occupational Safety and Health Administration (OSHA) Bloodborne Pathogens Standard, Title 29 CFR Part 1910.1030, is to protect workers from bloodborne pathogens such as the (HIV) and (HBV) by reducing or eliminating workers' exposure to blood and other potentially infectious materials. Although HIV and HBV are specifically mentioned by OSHA, the standard includes any bloodborne pathogen, such as Hepatitis C, malaria, and syphilis. The standard requires the employer to develop a written exposure control plan that will reduce or eliminate employee exposure, thus reducing their risk of infection.

The purpose of the Baker Environmental (Baker) exposure control plan is to minimize the possibility of transmission of bloodborne pathogens in the workplace by establishing procedures for the safe handling of first aid incidents that may expose personnel to blood or other potentially infectious materials.

4.2 SCOPE

All Baker SRN personnel who may be exposed to blood or other potentially infectious materials as part of their job duties are required to follow the guidelines set forth in this SOP. The exposure control plan shall be reviewed and updated at least annually, to reflect new or modified tasks and procedures that affect occupational exposure, and to reflect new or revised employee positions with occupational exposure.

4.3 RESPONSIBILITY

The Baker Project Health and Safety Office (PHSO) and Project Manager are responsible for implementing and administering this exposure control plan at project sites for their employees. These individuals will be assisted in the field by the Baker Site Health and Safety Officer (SHSO) who will be responsible for implementing the exposure control plan.

4.4 DEFINITIONS

Bloodborne Pathogens - Pathogenic microorganisms that may be present in human blood and has the potential to cause disease in humans. Two examples of bloodborne pathogens include, hepatitis B virus (HBV) and human immunodeficiency virus (HIV).

Contaminated - Means the presence or the reasonably anticipated presence of blood or other potentially infectious materials on an item or surface.

Decontamination - Physically or chemically removing, inactivating, or destroying bloodborne pathogens on a surface or item to the point where they are no longer capable of transmitting infectious particles, so that the surface or item is rendered safe for handling, use, or disposal.

Exposure Incident - A specific eye, mouth, other mucous membrane, non-intact skin, or parenteral contact with blood or other potentially infectious materials that result from the performance of an employee's duties.

Occupational Exposure - Reasonably anticipated skin, eye, mouth, mucous membrane, or parenteral contact with blood or other potentially infectious materials that may result from the performance of an employee's duties.

Other Potentially Infectious Materials - Includes the following human body fluids: semen, vaginal secretions, cerebrospinal fluid, synovial fluid, pleural fluid, pericardial fluid, peritoneal fluid, amniotic fluid, saliva in dental procedures, any body fluid that is visibly contaminated with blood, and all body fluids in situations where it is difficult or impossible to differentiate between body fluids; any unfixed tissue or organ (other than intact skin) from a human; and HIV-containing cell or tissue cultures, organ cultures, and HIV- or HBV-containing culture medium or other solutions; and blood, organs, or other tissues from experimental animals infected with HIV or HBV.

Parenteral - Piercing of the mucous membranes or the skin barrier through such events as needlesticks, human bites, cuts, and abrasions.

Regulated Waste - OSHA defines a regulated waste as a liquid or semi-liquid blood or other potentially infectious materials; contaminated items that would release blood or other potentially infectious materials in a liquid state if compressed; items caked with dried blood or other potentially infectious materials that are capable of release of these materials during handling; contaminated sharps; and pathological and microbiological wastes containing blood or other potentially infectious materials.

4.5 PROCEDURES FOR EXPOSURE TO BLOODBORNE PATHOGENS

The sections below will discuss the means by which Baker personnel can determine exposure potential, modes of transmission, methods of compliance, medical monitoring, and post exposure procedures.

4.5.1 Exposure Determination

The exposure determination is based upon the job classifications with occupational exposure potential, and the activities in which these exposures can occur, as follows.

Job Classifications

- Site Manager/Site Safety and Health Officer
- Environmental Scientists
- Geologists
- Other Baker Field Personnel

Exposure Activities

- Response to first aid incidents involving site personnel
- Decontamination of personnel, personal protective equipment, work surfaces, and equipment potentially exposed to blood or other potentially infectious materials

4.5.2 Modes of Virus Transmission in the Workplace

Modes of virus transmission are similar for the viruses of concern. Primarily, virus transmission occurs as the result of direct blood contact from percutaneous inoculation, contact with an open wound, non-intact skin (e.g. chapped, abraded, or dermatitis), or mucous membranes to blood, blood-contaminated body fluids, or concentrated virus. Protective measures for workers will focus on preventing exposure to blood and other body fluids that can result from an injury or sudden illness.

4.5.3 Methods of Compliance

4.5.3.1 Universal Precautions

The unpredictable and emergent nature of exposures likely to be encountered on a site may make differentiation between hazardous body fluids and those that are not hazardous very difficult. Thus, all employees will observe "Universal Precautions" to prevent contact with blood or other potentially infectious materials. These "Universal Precautions" stress that all blood or other potentially infectious materials will be treated as if they are known to be infectious.

The universal precautions will include:

(1) Cover the skin, especially open cuts, scrapes, skin rashes, or other broken skin.

(2) Don't touch objects that could be contaminated, such as blood-covered surfaces, clothing or linens.

(3) Cover mucous membranes (i.e., mouth, nose, and eyes).

(4) Prevent direct contact with sharps, such as needles, scalpels, or broken glass that could pierce or puncture your skin.

(5) Clean and decontaminate surfaces, containers, and equipment that may have been exposed to blood or other body fluids.

4.5.3.2 Standard Work Practices

Standard work practices are to be implemented at all times by all employees who may be exposed to blood or other potentially infectious materials. Work practices are defined as specific policies or procedures whose purpose is to reduce the potential for employee exposure to bloodborne pathogens. Work practices for use by site personnel are described in the balance of this section.

Personal Hygiene

All exposed employees will observe the following hygienic practices:

- During or immediately after exposure to blood or other potentially infectious materials; do not eat, drink, chew gum, chew tobacco, smoke, apply cosmetics, balms or medications, or any other activity that increases the potential for hand-to-mouth, mucous membrane, or skin contact.

- Following exposure to blood or other potentially infectious materials, personnel will wash their hands and any other exposed skin with a disinfectant soap and water after removal of chemical-protective gloves or other personal protective equipment (PPE). This will be performed before eating, urinating, defecating, applying make-up, smoking or undertaking any activity that may result in increased potential for hand to mouth, mucous membrane, or skin contact.

Personal Protective Equipment

The basic premise for wearing the appropriate PPE is that site personnel must be protected from exposure to blood and other potentially infectious materials. Appropriate PPE is available to all site personnel.

Responders to a medical emergencies will have access to the appropriate PPE. The PPE will be present in the site trailer and field vehicles. The PPE should be used in accordance with the level of exposure encountered. Minor lacerations or small amounts of blood do not merit the same extent of PPE use as required for massive arterial bleeding. Management of the patient who is not bleeding, and has no bloody body fluids, should not routinely require the use of PPE.

The following PPE will be present in each Baker Field Vehicle and/or the Baker Site Trailer.

1. Disposable chemical-protective gloves (i.e, nitrile or latex)
2. Resuscitation equipment*
3. Safety glasses, goggles, or faceshields
4. Tyvek® coveralls

* Resuscitation Equipment - Because the risk of salivary transmission of infectious disease during artificial ventilation of trauma victims, pocket mouth-to-mouth resuscitation masks will be present in the first aid kits. The pocket mouth-to-mouth resuscitation masks are designed to isolate response personnel from contact with the victims' blood and blood-contaminated saliva, respiratory secretions, and vomitus.

Decontamination procedures will follow those outlined in each site HASP.

Handling Regulated Wastes

With the exception of contaminated sharps, all other regulated wastes must be placed in closable, color-coded, labeled containers that prevent leakage of fluids. All applicable federal and state regulations must be followed for transporting and disposing of the wastes.

Training and Education

All employees with the potential for occupational exposure will receive initial training on the safe handling of first aid incidents during first aid/CPR Instruction, and subsequently during HASP briefings and annual training refreshers. See Appendix A for the Bloodborne Pathogens Training Outline.

4.5.4 Medical Monitoring

All Baker personnel will follow the guidelines established by Baker's Board Certified Health Physician in association with EMR, Inc.

4.5.5 Post-Exposure Procedures and Follow-Up management

The following subsections presents the procedures to follow when a first aid incident occurs involving the presence of blood or other potentially infectious material; specific steps need to be taken to safeguard the health of Baker site personnel.

4.5.5.1 First Aid Incident Report

If there is a reasonable cause to believe that a potential exposure to blood or other potentially infectious materials has been experienced, the employee must complete the steps listed below.

These steps are required when non-HBV vaccinated first aid responders participate and regardless of whether an actual "exposure incident" occurred.

1. Immediately notify the SHSO. The SHSO will determine whether an "exposure incident" occurred.

2. Wash area of contamination and remove contaminated clothing to ensure that no further contamination will occur.

3. All parties involved will complete the Supervisors Incident Report Form and the incident will be reported to Baker's Human Resources office.

Non-HBV vaccinated Baker employees who render first aid where blood or other potentially infectious materials are present must be seen by a designated EMR physician within 24 hours of the incident. The employee must take a copy of the Supervisors Incident Report Form and a copy of OSHA Standard 1910.1030 to the physician.

Employees who respond to first aid incidents involving the presence of blood or other potentially infectious materials where the determination was made that an "exposure incident" occurred, have 90 days following baseline blood level collection to decide if they wish to have their blood tested for HIV.

The confidential medical evaluation and follow-up will include:

1. The circumstances of the exposure.

2. If consent has been obtained testing of the source individual's blood in order to determine HIV and/or HBV infectivity. If consent is not obtained this will be documented in writing.

3. If consent has been obtained, the exposed employee's blood will be tested.

The occupational physician will provide the employer with a confidential written opinion that includes verification that the employee has been informed of the results of the evaluation and also includes a recommendation for further evaluation or treatment. A copy of this written opinion will be provided within 15 days following the medical evaluation.

4.5.5.2 "Good Samaritan" Behavior

The OSHA standard does not cover "good samaritan" behavior. However, employees who provide first aid as "good samaritans" should receive the same post incident evaluation either through an EMR designated physician or their personal physician.

4.6 REFERENCES

OSHA Title 29 CFR Part 1910.1030

U.S. Department of Labor, U.S. Department of Health and Human Services. Joint Advisory Notice: protection against occupational exposure to Hepatitis B virus and human immunodeficiency virus. Federal Register 1987; 52:41818-24.

Centers for Disease Control. Update on hepatitis B prevention. MMWR 1987; 36:353-360,366.

Centers for Disease Control. Update: Acquired immunodeficiency syndrome and human immunodeficiency virus infection among health- care workers. MMWR 1988; 37:229-34, 239.

OSHA Instruction CPL 2-2.44, February 13, 1992, Enforcement Procedures for the Occupational Exposure to Bloodborne Pathogens Standard.

Appendix A

SUGGESTED BLOODBORNE PATHOGENS TRAINING OUTLINE

I. <u>Introduction</u>

A. Purpose of the training program

B. Overview: Bloodborne Pathogen Standard 29 CFR 1910.1030
   1. Applicability to Site Personnel
   2. General requirements
   3. Overview of Baker exposure control plan

II. <u>Bloodborne Diseases</u>

A. Types

B. Modes of Transmission

III. <u>Baker Exposure Control Plan</u>

A. Purpose

B. Plan availability

C. Bloodborne pathogen hazard recognition steps
   1. Concept of universal precautions
   2. Blood and other potentially infectious materials

D. Potential exposure minimization
   1. Work practices
   2. Personal protective equipment
   3. Hygienic practices

E. Procedures for decontamination
   1. Personnel
   2. Personal protective equipment (PPE)
      a. Tasks and procedures requiring PPE
      b. Location of PPE
      c. Disposal of PPE
   3. Equipment
   4. Work surfaces

F. Medical monitoring
   1. Baker medical monitoring program
   2. Post exposure evaluation procedures
      a. First aid incident report
      b. HBV and non-HBV vaccinated responders
      c. Exposure incidents (defined)
      e. Confidential medical evaluation

G. Emergency Preparedness
   1. First aid kits
   2. Personal injury

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5.0 - HEAT STRESS

5.1 INTRODUCTION

Heat stress in the hazardous waste industry usually is a result of protective clothing decreasing natural body ventilation, although it may occur at any time work is being performed at elevated temperatures. If the body's physiological processes fail to maintain a normal body temperature because of excessive heat, a number of physiological reactions can occur, ranging from mild (such as fatigue, irritability, anxiety, and decreased concentration, dexterity, or movement) to fatal.

5.2 CAUSES AND SYMPTOMS

The following heat stress causes and symptoms are provided for buddy monitoring purposes. Site personnel must realize that monitoring the physical condition of fellow personnel in Levels D+ through B protective ensembles will be more difficult.

1. *Heat rash* results from continuous exposure to heat or humid air and chafing clothes. The condition decreases the ability to tolerate heat. Symptoms include a mild red rash.

2. *Heat cramps* are caused by heavy sweating and inadequate fluid intake. Symptoms include muscle spasms and pain in the hands, feet, and abdomen.

3. *Heat exhaustion* occurs when body organs attempt to keep the body cool, due to inadequate fluid intake and personnel not acclimated to the environment. Symptoms include pale, cool, moist skin; heavy sweating; dizziness, headaches, and vomiting.

4. *Heat stroke* is the most serious form of heat stress. It is a MEDICAL EMERGENCY. Symptoms are red, hot, <u>dry</u> skin; lack of perspiration; nausea; dizziness and confusion; strong, rapid pulse rate; and coma.

The need to seek medical attention and the urgency in seeking medical attention depends on the symptoms and the severity of the symptoms displayed by the affected individual. If *heat stroke* is noted or suspected, medical attention must be sought IMMEDIATELY. Efforts should be taken to cool the body to prevent serious injury or death.

5.3 PREVENTION

Because heat stress is one of the most common and potentially serious illnesses at hazardous waste sites, regular monitoring and other preventive measures are vital. Site workers must learn to recognize and treat the various forms of heat stress. The best approach is preventive heat stress management. In general:

- Monitor for signs of heat stress.

- Fluid intake should be increased during rest schedules to prevent dehydration. Drinking cool water (maintained at 50 to 60°F) is satisfactory when light sweating occurs and temperatures are moderate to cool; however, diluted electrolyte solutions (i.e., Gatorade, Sqwincher, or equivalent) must be used in addition to water under one or all of the following conditions: continued or heavy sweating, moderate to high ambient temperatures, or heavy work loads. The intake of coffee during working hours is discouraged.

- Acclimate workers to site work conditions by slowly increasing workloads (i.e., do not begin site work activities with extremely demanding activities).

- Use cooling devices to aid natural body ventilation. These devices, however, add weight and their use should be balanced against worker efficiency. An example of a cooling aid is a cooling vest that can be worn under clothing, but not against the skin.

- In extremely hot weather, conduct field activities in the early morning and evening.

- Ensure that adequate shelter is available to protect personnel against heat that can decrease physical efficiency and increase the probability of both heat and cold stress. If possible, set up the command post in a shaded area, and encourage breaks in shaded areas.

- In hot weather, rotate shifts of workers wearing impervious clothing.

- Good hygienic standards must be maintained by frequent changes of clothing and showering. Clothing should be permitted to dry during rest periods. Persons who notice skin problems should immediately consult the SHSO.

5.4 MONITORING

Provisions for monitoring for heat stress will be determined by the SHSO and performed as outlined below. Because the incidence of heat stress depends on a variety of factors, all workers, even those not wearing protective equipment, should be monitored.

5.4.1 Monitoring for Permeable Clothing

For workers wearing permeable clothing (e.g., standard cotton or synthetic work clothes), follow recommendations for monitoring requirements and suggested work/rest schedules in the current American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values for Heat Stress. If the actual clothing work differs from the ACGIH standard ensemble in insulation value and/or wind and vapor permeability, change the monitoring requirements and work/rest schedules accordingly.

The guidelines to follow for workers above as determined by the SHSO are as follows:

1. Increased awareness of heat stress symptoms and buddy monitoring.
2. Fluid intake discipline.
3. Self monitoring of urine output quantities to prevent dehydration.
4. Attention to work-rest intervals.
5. Calculate the Heat Exposure Threshold Limit Value (TLV) for work-rest intervals using the following steps:
   a. Determine the Wet Bulb Globe Temperature (WBGT) Index using the Quest® Heat Stress Monitor.
   b. Estimate the work load using the following guidelines:
      (1) Light work = sitting or standing to control machines, performing light hand or arm work.

(2) Moderate work = walking about with moderated lifting and pushing.

(3) Heavy work = pick and shovel work.

c. Evaluate the calculations against the following Heat Exposure TLVs* in °C or (°F).

Work - Rest Regimen	Work Load		
	Light	Moderate	Heavy
Continuous work	30.0 (86)	26.7 (80)	25.0 (77)
75% work - 25% rest, each hour	30.6 (87)	28.0 (82)	25.9 (78)
50% work - 50% rest, each hour	31.4 (89)	29.4 (85)	27.9 (82)
25% work - 75% rest, each hour	32.2 (90)	31.1 (88)	30.0 (86)

* For unacclimated workers, the permissible heat exposure TLV should be reduced by 2.5°C.

Special Considerations

- Acclimatization - After approximately one to two weeks, workers should be acclimated to their environment.
- Fitness - Physically fit workers will adjust more readily to a change in environment.
- Medication - Some medications can predispose individuals to heat-induced illnesses.

5.4.2 Semipermeable/Impermeable Clothing Monitoring

For workers wearing semipermeable or impermeable clothing encapsulating ensembles, the ACGIH standard cannot be used. For these situations, workers should be monitored when the temperature in the work area is above 70°F (21°C).

To monitor the worker, use one or more of the following methods:

- Heart rate. Count the radial pulse during a 30-second period as early as possible in the rest period.
  - If the heart rate exceeds 110 beats per minute at the beginning of the rest period, shorten the next work cycle by one-third and keep the rest period the same.

- If the heart rate still exceeds 110 beats per minute at the next rest period, shorten the following work cycle by one-third.

- Oral temperature. Use a clinical thermometer (3 minutes under the tongue) or similar device to measure the oral temperature at the end of the work period (before drinking).

    - If oral temperature exceeds 99.6°F (37.6°C), shorten the next work cycle by one-third without changing the rest period.

    - If oral temperatures still exceeds 99.6°F (37.6°C) at the beginning of the next rest period, shorten the following work cycle by one-third.

    - Do not permit a worker to wear a semipermeable or impermeable garment when his/her oral temperature exceeds 100.6°F (38.1°C).

- Body water loss. Measure weight on a scale accurate to ±0.25 pound at the beginning and end of each work day to see if enough fluids are being taken to prevent dehydration. Weights should be taken while the employee wears similar clothing or preferably in underwear only. The body water loss should not exceed 1.5 percent total body weight loss in a work day.

Initially, the frequency of physiological monitoring depends on the air temperature adjusted for solar radiation and the level of physical work. The length of work cycle will be governed by the frequency of the required physiological monitoring.

5.5 CARING FOR HEAT-RELATED ILLNESS

To care for heat-related illness provide the following:

- Remove victim from heat.

- Loosen tight clothing.

- Apply cool, wet cloths to the skin.

- Fan the victim.
- If victim is conscious, give cool water to drink.
- Call for an ambulance or transport to hospital if heat stroke is suspected, victim refuses water, vomits, or starts to lose consciousness.

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8.0 - CUTTING AND WELDING

Cutting and welding operations are performed routinely. Personnel engaged in these operations must be highly skilled and understand the importance of using safe work practices to minimize potential exposure to fire, explosion, or health hazards. No work involving a flame or spark-producing operation is to be conducted without preparing a Hot Work Permit (attached) and following the provisions of this procedure.

8.1 SAFETY RESPONSIBILITY

Both welder and Baker personnel must work together to ensure safe cutting and welding operations.

All personnel, including subcontractors, should understand the potential hazards of the work site, required use of personal protective equipment, and other safety aspects prior to initiation of cutting and welding procedures.

Under no circumstances should work be done in front of or around the open end of piping that has not been cleaned/purged, then checked using the Oxygen/Lower Explosive Limit Meter.

8.2 EQUIPMENT

It is necessary to keep equipment in good working condition and inspect regularly for defects. Equipment shall be approved and operated as specified by the manufacturer.

8.2.1 Welding Machines

Carelessness around welding machines can lead to serious injury or death. The inspector should be particularly aware of the following:

- Never touch live metal parts with bare skin or wet clothing; electrocution can result.
- Do not attempt to refuel a welding machine while it is in operation.

- Inspect all machine connections and grounding prior to use.

- Prevent electrode holders from coming in contact with people, metal objects, fuel sources, water, or compressed gas cylinders.

- The welder should not loop or coil the electrode cable around parts of the body.

8.2.2 Compressed Gas Cylinders

- Handling and storage of cylinders should be in accordance with approved governmental practices.

- Cylinders must always be secured and oxygen cylinders must be stored at least 20 feet from combustible gas cylinders.

8.2.3 Oxygen Use

- Do not confuse oxygen with air or use it as a substitute because it supports and accelerates combustion causing flammable materials to burn violently.

- Oil or grease in the presence of oxygen may ignite or explode spontaneously.

- Ensure that regulators used in oxygen service are free of dirt, oil or grease.

- Never use oxygen to blow out or purge vessels or pipelines previously containing flammables or to dust off clothing.

8.3 FIRE AND EXPLOSION PREVENTION

8.3.1 Location of Combustibles

- Cutting and welding operations shall be conducted in a designated location free from combustibles.

- Use care when welding metal partitions or piping which are adjacent to immovable combustibles because of the possibility of ignition by conduction.

8.3.2 Fire Watch

- Fire watchers with fire extinguishers or charged hoselines shall be posted.
- These individuals should be prepared to extinguish fires in the incipient stage or sound an alarm and should have no other duties at the job site.
- The fire watch should continue for at least a half hour after completion of the cutting or welding operation.

8.3.3 Fire Extinguishers

- Welding machines must have a fire extinguisher mounted in an easily accessible location either on the machine or nearby.

8.3.4 Prohibited Areas

Cutting and welding operations shall not be conducted when any of the following conditions exist:

- The area may contain flammable vapors in excess of 10% of the L.E.L.
- Large quantities of exposed, readily ignitable materials such as bulk sulfur are stored in the area.

8.4 PERSONAL PROTECTION

The following sections present the personal protective equipment such as clothing, eye and face protection, respiratory protection, and noise protection.

8.4.1 Clothing

- To protect the skin during cutting or welding operations, wear gauntlet type gloves and protective aprons. Depending on the job, it may be necessary to also wear leggings, cape sleeves or shoulder covers, and skull caps under helmets.

- Sleeves and collars should be buttoned, pockets should be removed from the front of clothing or buttoned with a flap, and pants should be uncuffed to prevent the retention of sparks.

- To prevent patter from getting into shoes, use spats or have pants overlap shoes.

- Woolen clothing is preferred but cotton material, preferably flame retardant, is acceptable.

- Keep outer clothing free from oil or grease.

8.4.2 Eye and Face Protection

- Approved eye protection must be worn at all times by welders and their assistants to protect against flying sparks, radiant energy, ultraviolet, visible and infrared radiation.

- Helmets must be designed to protect the face, forehead, neck and ears from radiant heat.

- Where exposure to flash exists for the other personnel, a screen should be used.

8.4.3 Respiratory Protection

Adequate ventilation (natural or mechanical) is necessary in all cutting and welding operations. Respiratory protection may also be necessary to prevent unacceptable exposure levels to toxic fumes and gases. Avoid breathing the fume plume.

8.4.4 Noise Protection

Engine driven generators, plasma arc cutting, and other processes may expose personnel to excessive noise. If excessive noise cannot be controlled at the source, the use of ear plugs or muffs is required.

8.5 HOT WORK PERMIT

No employee is to begin hot work unless a Hot Work Permit has been obtained. It is the responsibility of the Site Manager to request this permit. The Hot Work Permit shall be signed by the Site Manager and Site Health and Safety Officer and explained to each affected employee.

Note: It is the responsibility of the Site Manager to see that workers comply with all safety practices of the Hot Work Permit.

The Hot Work Permit will be valid for a single work shift only. On projects requiring more than a single work shift, a new permit shall be completed at the start of each shift. The permit shall be displayed at the project site.

At the conclusion of the project, the Hot Work Permits will be forwarded to the Site Manager and placed in the project file.

ATTACHMENT B
MATERIAL SAFETY DATA SHEETS

Material Safety Data Sheet

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 182

CHROMIUM (III) OXIDE

Issued: April 1986

SECTION 1. MATERIAL IDENTIFICATION 20

MATERIAL NAME: CHROMIUM (III) OXIDE

OTHER DESIGNATIONS: Chrome Oxide, Chromic Oxide, Chromium Sesquioxide, Cr_2O_3, CAS #1308-38-9

MANUFACTURER/SUPPLIER: Available from several suppliers, including:
Ciba-Geigy Corp., Plastics, Pigments, and Additives Division, Three Skyline Drive, Hawthorne, NY 10532; Telephone: (914) 347-4700.

HMIS
H Chronic
F 0
R 0
PPE*
* See Sect. 8

Not Found

SECTION 2. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
Chromium (III) Oxide, Cr_2O_3, CAS #1308-38-9	>99	ACGIH TLV, 8-hr TWA: 0.5 mg/m^3*
		OSHA PEL, 8-hr TWA: 1 mg/m^3**

* Current (1985-86) ACGIH TLV for chromium (III) Compounds, as Cr.

** Current OSHA PEL for chromium metal and insoluble salts, as Cr.

SECTION 3. PHYSICAL DATA

Boiling Point ... 7232°F (4000°C)
Melting Point ... 4415°F (2435°C)
Specific Gravity ... 5.21
Vapor Pressure @ 25°C ... Negligible
Solubility in Water ... Insoluble
Molecular Weight ... 152

Appearance and odor: Green granules, crystals, or powder. No odor.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air	LOWER	UPPER
Not Found	Not Found	Not Found		

EXTINGUISHING MEDIA: Chromic oxide is not combustible. Use extinguishing agents that are suitable for the surrounding fire.

UNUSUAL FIRE/EXPLOSION HAZARDS: None

SPECIAL FIRE-FIGHTING PROCEDURES: Fire fighters should wear self-contained breathing apparatus and full protective gear for protection against dust, mist, or fumes that may be generated during fire-fighting activities.

SECTION 5. REACTIVITY DATA

Chromium oxide is stable under normal conditions.

Hazardous polymerization will not occur.

INCOMPATIBILITIES: Chromic oxide can react vigorously with lithium, chlorine trifluoride, oxygen difluoride, and molten alkali. An explosion may occur on contact with glycerol.

HAZARDOUS DECOMPOSITION PRODUCTS: None.

No. 182 4/86 CHROMIUM (III) OXIDE

SECTION 6. HEALTH HAZARD INFORMATION | TLV

CARCINOGENIC ASSESSMENT: The IARC and NTP list "chromium and certain chromium compounds" as suspected carcinogens. Chromic oxide is not specifically cited. Hexavalent chromium compounds are those most generally associated with carcinogenic effects.
PRIMARY ROUTES OF ENTRY: This material can enter the body if it is inhaled or swallowed. EFFECTS OF OVEREXPOSURE: Trivalent chromium compounds (such as Cr_2O_3) are considered to exhibit a low degree of toxicity. Excessive concentrations of airborne dust may irritate the nose, throat, and respiratory tract. Prolonged overexposure may result in pulmonary changes. Skin and eye contact may cause irritation.

FIRST AID: EYE CONTACT: Flush eyes, including under the eyelids, with a gentle flow of running water to remove particles. If irritation persists, seek medical attention.* SKIN CONTACT: Thoroughly wash contaminated area with mild soap and water. Seek medical attention if irritation persists.* INHALATION: Remove victim from exposure. Seek medical attention if irritation or discomfort persist or if other symptoms develop.* INGESTION: If victim is conscious, give him a large quantity of milk or water to drink. Get medical assistance.*

* GET MEDICAL ASSISTANCE = In plant, paramedic, community. Get medical help for further treatment, observation, and support after first aid, if indicated.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

CLEANUP PROCEDURES: Carefully scoop up or vacuum spilled material into a suitable container. Avoid generating dust. Cleanup personnel should wear gloves, goggles, and an approved respirator.

DISPOSAL: Reclaim material when possible. Unsalvageable waste may be disposed of in an approved landfill. Follow Federal, state, and local regulations.

Reportable spill quantity: None given in 40 CFR 117.3.

EPA Hazardous Waste Number: D0007 (EP Toxic 40 CFR 261.24). Applies to waste containing leachable chromium using EPA's extraction procedure.

SECTION 8. SPECIAL PROTECTION INFORMATION

VENTILATION: Use local exhaust ventilation to maintain airborne dust levels below the TLV. RESPIRATORS: Where airborne levels exceed the TLV, NIOSH-approved respirators with appropriate protection factors should be worn. High-efficiency particulate respirators are suitable for concentrations up to 10 mg/m^3. Respirator usage must be in accordance with OSHA requirements (29 CFR 1910.134).

OTHER PROTECTIVE EQUIPMENT: Dustproof goggles and gloves should be worn when handling this material. Protective clothing should be worn as required by the work situation to prevent prolonged or repeated skin contact.

Eyewash stations and washing facilities should be readily accessible to employees handling this material.

Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

PRECAUTIONS IN STORAGE: Store in tightly closed containers away from incompatible materials (see sect. 5). Protect containers from physical damage.

PRECAUTIONS IN HANDLING: Maintain good housekeeping procedures to prevent accumulating dust. Use procedures that minimize dust generation. Use good personal hygiene: launder contaminated clothing before reuse; wash exposed skin after handling; wash hands before eating, drinking, or smoking.

Avoid skin/eye contact and inhalation. Use with adequate ventilation. Do not ingest.

DOT Hazard Class: Not listed in hazardous materials tables (49 CFR 172.101 or 172.102).

Data Source(s) Code: 1, 2, 4, 5, 9, 12, 14, 27, 44, 58, 61, 62, 84. CV

Approvals	JD Rccco
Indust. Hygiene/Safety	DW
Medical Review	

DDT (Dichlorodiphenyltrichloroethane)
MSDS No. 155
Date of Preparation: 10/93

Section 1 - Chemical Product and Company Identification

42

Product/Chemical Name: .... DDT (Dichlorodiphenyltrichloroethane)
Chemical Formula: .... $(ClC_6H_4)_2CHCCl_3$
CAS No.: 50-29-3
Synonyms: Agritan; 2,2-bis(*p*-chlorophenyl)-1,1,1-trichloroethane; chlorophenothan; Citox; dichlorodiphenyltrichloroethane; Dicophane; diphenyltrichloroethane; Genitox; Kopsol; NCI-C00464; Neocid; Pentech; trichlorobis (4-chlorophenyl) ethane; 1,1'-(2,2,2-trichloroethylidene)bis(4-chlorobenzene), Zerdane.
Derivation: Prepared by condensing chloral or chloral hydrate with chlorobenzene in presence of sulfuric acid.
General Use: One of the most widely used contact insecticides from 1945 until its ban in 1972. Although banned in the U.S. (except for such uses as emergency health situations and for controlling body lice), it is still widely used in the tropics for control of vector-carrying diseases such as malaria, yellow fever, dengue, filariasis, louse-borne typhus, and louse-borne relapsing fever.

Section 2 - Composition / Information on Ingredients

DDT: *p'p'*DDT 70% wt + *o'p'*DDT 30% wt (technical grade)
Trace Impurities: DDD, DDE

OSHA PELs
8-hr TWA: 1 mg/m^3 (skin)

ACGIH TLVs
TWA: 1 mg/m^3

NIOSH REL
10-hr TWA: 0.5 mg/m^3
Ca*: (Limit of quantitation: 0.1 mg/m^3)

IDLH Level
Ca*

DFG (Germany) MAK (skin)
TWA: 1 mg/m^3 (total dust)
Category III: Substances with systemic effects
Onset of effect: > 2 hr.
Peak Exposure Limit: 10 mg/m^3, 30 min. average value, 1/shift

* Ca = Carcinogen

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

DDT is a white to gray, crystalline solid. Although it has been banned in the U.S. because of its persistence in the environment and potential for bioaccumulation, DDT has not produced toxicity in workers who either manufactured or used it (even over many years). However, this lack of toxicity is based on inhalation and skin absorption. If DDT is ingested, especially in large amounts, central nervous system effects will occur with possible liver damage. DDT is considered a confirmed animal carcinogen and a suspected human carcinogen.

Wilson Risk Scale

R	1
I	3
S	1*
K	2

*Skin absorption

HMIS

H	2†
F	2
R	0

†chronic effects
PPE‡
‡Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, ingestion, skin contact.
Target Organs: Central nervous system, liver, skin, peripheral nervous system.
Acute Effects
Inhalation: Inhalation does not appear to cause toxicity beyond that of minor mechanical irritation.
Eye: Exposure to 423 mg/m^3/1 hr/day for 6 days caused eye irritation.
Skin: Skin absorption may occur from some DDT solutions, but degree of absorption will depend on the solvent involved. Aqueous solutions and the powder or crystals are not easily absorbed.
Ingestion: DDT can cause a variety of central nervous system effects if ingested. Large doses generally result in vomiting, while smaller doses cause symptoms within 2 to 3 hr post-ingestion. Symptoms include tingling of the lips, tongue, and face; malaise; headache; sore throat; fatigue; tremors of the head, neck, and eyelids; apprehension; ataxia; and confusion. Convulsions and paralysis of the hands is possible in severe exposures (if vomiting does not occur). Vital signs are usually normal, but in severe poisonings, the pulse may be irregular and abnormally slow. Based on animal studies, it is expected that ventricular fibrillation and sudden death can occur at any time during acute poisoning. Recovery from acute poisoning generally occurs within 24 hr except in the most serious cases.
Carcinogenicity: DDT is considered a suspected human carcinogen by several governmental agencies. IARC-2B (possibly carcinogenic to humans, limited evidence in humans in the absence of sufficient evidence in experimental animals), NTP-2 (reasonably anticipated to be a carcinogen: limited human evidence or sufficient animal evidence), EPA-B2 (sufficient animal evidence; inadequate human evidence), and NIOSH-X (carcinogen defined without further categorization)
Medical Conditions Aggravated by Long-Term Exposure: Possibly, disorders of the central nervous system and liver.

Chronic Effects: There are conflicting reports on whether or not DDT produces chronic effects in humans. Although it is well established that chronic exposure in experimental animals produces effects including liver damage, CNS degeneration, dermatitis, weakness, convulsions, coma, and death, these effects are not confirmed in humans. Liver cancer is confirmed in animals, but has not been documented in humans. These conflicting reports appear due to the lack of documented chronic toxicity in workers and data showing that DDT and its metabolites are retained in the body fat for long time periods, thus providing a basis for the *possibility* of chronic toxicity.

Other: Solvents such as kerosine are added to DDT as a vehicle and, depending on the type involved, may be more toxic than DDT itself.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.

Skin Contact: *Quickly* remove contaminated clothing. Rinse away any loose material and wash exposed area with soap and water. For reddened or blistered skin, consult a physician. Carefully dispose of contaminated clothing because it may pose a fire hazard.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the *conscious and alert* person drink 1 to 2 glasses of water to dilute. *Do not* induce vomiting. Gastric lavage should be performed promptly.

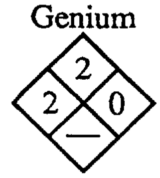
After first aid, get appropriate in-plant, paramedic, or community medical support.

Notes to Physicians: Effects may be delayed; keep under observation.

Special Precautions/Procedures: Amobarbital or pentobarbital is recommended for the relief of central neurological manifestations; tribromoethanol and paraldehyde are recommended for allaying prolonged convulsions.

Section 5 - Fire-Fighting Measures

Genium



Flash Point: DDT itself is noncombustible but is dissolved in a variety of solvents. The average quoted Flash Point is 162 °F (72.2 °C) although the specific vehicle is not identified.

Flash Point Method: CC

Autoignition Temperature: None reported

LEL: None reported

UEL: None reported

Flammability Classification: Class IIIA Combustible Liquid (varies depending on vehicle)

Extinguishing Media: For small fires, use dry chemical, water spray, or regular foam. For large fires, use water spray, fog, or regular foam.

Unusual Fire or Explosion Hazards: Container may explode in heat of fire.

Hazardous Combustion Products: Chloride fumes and carbon oxide gases.

Fire-Fighting Instructions: Do not release runoff from fire control methods to sewers or waterways. Fight fire from maximum distance. Stay away from ends of tanks.

Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural fire fighters' protective clothing is *not* effective.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Notify safety personnel, isolate area, deny entry, and stay upwind. Shut off all ignition sources. Cleanup personnel should protect against contamination.

Small Spills: For dry spills, carefully scoop up material or vacuum (with an approved filter). Damp mop any residue. For small solution spills, take up with earth, sand, vermiculite, or other absorbent material and place in suitable containers for disposal.

Large Spills

Containment: Dike far ahead of liquid spill for later reclamation or disposal. Do not release into sewers or waterways.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Use non-sparking tools to open containers. Keep dry chemical extinguishers on hand in case of fire.

Storage Requirements: Prevent physical damage to containers. Store in a cool, dry, well-ventilated area away from heat, ignition sources, and incompatibles (Sec. 10). *Do not* store in aluminum or iron containers.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: To prevent static sparks, electrically ground and bond all equipment used with and around DDT.

Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations below OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103]

Administrative Controls: Consider preplacement and periodic medical exams of exposed workers with emphasis on the liver and central nervous system.

Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For any detectable concentration, use a SCBA with a full facepiece and operated in pressure demand or other positive-pressure mode, or any supplied-air respirator with a full facepiece and operated in pressure demand or other positive-pressure mode with an auxiliary SCBA. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets made of butyl rubber to prevent prolonged or repeated skin contact. Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy.

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder before reuse. Remove this material from your shoes and clean personal protective equipment.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Solid

Appearance and Odor: White to gray crystals or powder which is odorless or has a slight aromatic odor.

Odor Threshold: 5.0725 mg/m^3

Vapor Pressure: 5.5×10^{-6} mm Hg at 68 °F (20 °C)

Formula Weight: 354.48

Specific Gravity (H_2O=1, at 4 °C): 0.98 to 0.99

Water Solubility : 0.0012 ppm

Other Solubilities (g DDT/100 mL): acetone 58, 95% alcohol 2, benzene 78, benzyl benzoate 42, carbon tetrachloride 45, chlorobenzene 74, cyclohexanone 116, dibutyl phthalate 33, o-dichlorobenzene 68, dichlorodifluoromethane 2, dioxane 100, ethyl ether 28, gasoline 10, isopropanol 3, kerosine 8 to 10, methylated naphthalenes 40 to 60, mineral oil 5, morpholine 75, peanut oil 11, pine oil 0 to 16, tetralin 61, tributyl phosphate 50, and xylene 60.

Boiling Point: 365 °F (185 °C)

Melting Point: 227 °F (108.3 °C)

Section 10 - Stability and Reactivity

Stability: DDT is stable at room temperature in closed containers under normal storage and handling conditions. It biodegrades very slowly.

Polymerization: Hazardous polymerization does not occur.

Chemical Incompatibilities: Strong oxidizers, alkaline materials, iron and aluminum salts.

Conditions to Avoid: Exposure to heat, ignition sources, and incompatibles.

Hazardous Decomposition Products: Thermal oxidative decomposition of DDT can produce carbon dioxide.

Section 11- Toxicological Information

Toxicity Data:*

Eye Effects: None reported.

Skin Effects: None reported.

Acute Oral Effects:
Human, oral, LD_{Lo}: 500 mg/kg caused convulsions, cardiac arrhythmias, and respiratory changes.
Rat, oral, LD_{50}: 87 mg/kg; details not reported

Carcinogenicity: Rat, oral, TD_{Lo}: 1225 mg/kg given for 7 continuous weeks caused liver tumors.

Mutagenicity: *E. coli:* 15 µmol/L caused DNA damage.

Teratogenicity: Rat, oral, TD_{Lo}: 112 mg/kg given to a 56 day old male caused paternal effects (spermatogenesis, testes, epididymis, sperm duct).

* See NIOSH, *RTECS* (KJ3325000), for additional toxicity data.

Section 12 - Ecological Information

Ecotoxicity: Glass shrimp (*Palaemonestes kadiakensis*), LC_{50} = 2.3 mcg/L/96 hr at 69.8 °F (21 °C); Japanese quail, 2 month old male, (*Coturnix japonica*), LD_{50} = 841 mg/kg; bluegill (*Lepomis macrochirus*), LC_{50} = 28.7 mcg/L/36 hr.

Environmental Degradation: In water, DDT will adsorb strongly to sediments, significantly bioconcentrate in fish, and will be subject to considerable evaporation with an estimated half-life of several hr to almost 50 hr from certain waters. It may biodegrade when high concentrations of required microbes (*Escherichia*, *Hydrogenomonas*, and *Saccharomyces*) are present. On land, DDT will adsorb strongly and should not appreciably leach to groundwater. It may evaporate (half-life of 100 days) and is subject to photooxidation from soil. DDT may significantly biodegrade in flooded soils or under anaerobic conditions provided high populations of the required microbes are present. Half-life ranges from 2 to >15 yr. In the air, DDT is subject to direct photooxidation and reaction with photochemically produced hydroxyl radicals (est. half-life = 2 days). Wet and dry deposition are significant mechanisms for removal from air.

Section 13 - Disposal Considerations

Disposal: DDT is a good candidate for rotary kiln or liquid injection incineration (furnace with afterburner and alkali scrubber). 60 to 80% removal of DDT from contaminated soils has been achieved in 10 min. by super critical-carbon dioxide extraction. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Container Cleaning and Disposal: Triple rinse containers. Containers in good condition should be returned to the manufacturer and those that are not reusable should be punctured and transported to a scrap metal facility for recycling, disposal, or burial in a designated landfill.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Organochlorine pesticides, solid toxic, n.o.s.
Shipping Symbols: —
Hazard Class: 6.1
ID No.: UN2761
Packing Group: III
Label: Keep Away From Food
Special Provisions (172.102): —

Packaging Authorizations
a) Exceptions: 173.153
b) Non-bulk Packaging: 173.213
c) Bulk Packaging: 173.240

Quantity Limitations
a) Passenger, Aircraft, or Railcar: 100 kg
b) Cargo Aircraft Only: 200 kg

Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: 40

Section 15 - Regulatory Information

EPA Regulations:
RCRA Hazardous Waste Number (40 CFR 261.33): U061
Listed as a RCRA Hazardous Waste Classification (40 CFR 261.33)
Listed as a CERCLA Hazardous Substance (40 CFR 302.4) per RCRA, Sec. 3001; CWA, Sec. 311 (b)(4); and CWA, Sec. 307(a)
CERCLA Reportable Quantity (RQ), 1 lb (0.454 kg)
SARA Toxic Chemical (40 CFR 372.65): Not listed
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed
OSHA Regulations:
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A)

Section 16 - Other Information

References: 73, 101, 103, 124, 126, 127, 132, 133, 136, 139, 148, 153, 167, 168, 169, 176, 180, 183

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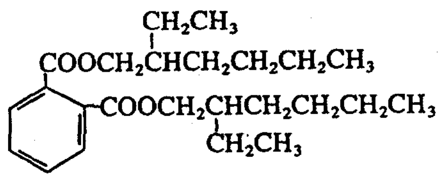
OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR
DI-2-ETHYLHEXYL PHTHALATE (DEHP)
POTENTIAL HUMAN CARCINOGEN

INTRODUCTION

This guideline summarizes pertinent information about di-2-ethylhexyl phthalate (DEHP) for workers, employers, and occupational safety and health professionals who may need such information to conduct effective occupational safety and health programs. Recommendations may be superseded by new developments in these fields; therefore, readers are advised to regard these recommendations as general guidelines.

SUBSTANCE IDENTIFICATION

- **Formula:** $C_{24}H_{38}O_4$
- **Structure:**



- **Synonyms:** DEHP; 1,2-benzenedicarboxylic acid; bis(2-ethylhexyl) ester; bis(2-ethylhexyl) phthalate; DEHP; phthalic acid; bis(2-ethylhexyl) ester; di-sec octyl phthalate
- **Identifiers:** CAS 117-81-7; RTECS TI0350000; DOT not assigned
- **Appearance and odor:** Clear to slightly colored, oily, odorless liquid

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**

1. Molecular weight: 390.54
2. Boiling point (at 760 mmHg): 386°C (727°F)
3. Specific gravity (water = 1): 0.9861
4. Vapor density (air = 1 at boiling point of DEHP): 16
5. Melting point: -50°C (-58°F)
6. Vapor pressure: At 20°C (68°F), 0.01 mmHg; at 200°C (392°F), 1.32 mmHg
7. Solubility in water, g/100 g water at 20°C (68°F): 0.005
8. Evaporation rate (butyl acetate = 1): Almost zero

- **Reactivity**

1. Incompatibilities: Contact with nitrates, strong oxidizers, strong alkalies, or strong acids may cause fire and explosion.
2. Hazardous decomposition products: Toxic vapors and gases (e.g., carbon monoxide) may be released in a fire involving DEHP.

- **Flammability**

1. Flash point: 218°C (425°F) (open cup)
2. Autoignition temperature: 390°C (735°F)
3. Flammable limits in air, % by volume: Lower, 0.3 at 245°C (474°F); Upper, Not available
4. Extinguishant: Dry chemical, foam, or carbon dioxide
5. Class IIIB Combustible Liquid (29 CFR 1910.106), Flammability Rating 1 (NFPA)

- **Warning properties**

1. Evaluation of warning properties for respirator selection: Warning properties are not considered in recommending respirators for use with carcinogens.

EXPOSURE LIMITS

The current Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for DEHP is 5 milligrams of DEHP per cubic meter of air (mg/m^3) as a time-weighted average (TWA) concentration over an 8-hour workshift. The National Institute for Occupational Safety and Health (NIOSH) recommends that DEHP be controlled and handled as a potential human carcinogen in the workplace, and the recommended exposure limit (REL) is that exposure be reduced to the lowest feasible limit. The use of DEHP in the quantitative fit testing of respirators should be discontinued and replaced with less toxic material such as refined corn oil. The American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value (TLV®) is 5 mg/m^3 as a TWA for a normal 8-hour workday and a 40-hour workweek; the ACGIH short-term exposure limit (STEL) is 10 mg/m^3 (Table 1).

Table 1.—Occupational exposure limits for di-2-ethylhexyl phthalate

	Exposure limits mg/m^3
OSHA PEL TWA	5
NIOSH REL (Ca)*	Lowest feasible limit
ACGIH TLV® TWA	5
STEL	10

* (Ca): NIOSH recommends treating as a potential human carcinogen.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health
Division of Standards Development and Technology Transfer

HEALTH HAZARD INFORMATION

• **Routes of exposure**

DEHP may cause adverse health effects following exposure via inhalation, ingestion, or dermal or eye contact.

• **Summary of toxicology**

Effects on animals: Subchronic inhalation of DEHP by rats or mice caused pulmonary irritation, swelling, and congestion of the liver and kidneys, renal cysts, bladder stones, testicular degeneration, increased liver metabolism and liver and kidney weights, and reduced weight gain, renal concentration capacity, blood hematocrit, and cholesterol and triglyceride levels. Chronic inhalation of DEHP by mice or rats produced liver cancer. Oral administration of DEHP to mice or rats on various days during fetal development caused a reduction in implantation rates, an increase in embryolethality, delayed births, and malformations of the skeletal system and the external and central nervous systems. Two-generation reproduction studies in treated rats showed a depression in placental and fetal weights and an increase in liver and kidney weights.

• **Signs and symptoms of exposure**

Short-term (acute): Exposure to DEHP can cause gastric disturbances and diarrhea. Skin sensitization and irritation of the eyes, skin, and respiratory tract can also occur.

RECOMMENDED MEDICAL PRACTICES

• **Medical surveillance program**

Workers with potential exposures to chemical hazards should be monitored in a systematic program of medical surveillance intended to prevent or control occupational injury and disease. The program should include education of employers and workers about work-related hazards, placement of workers in jobs that do not jeopardize their safety and health, earliest possible detection of adverse health effects, and referral of workers for diagnostic confirmation and treatment. The occurrence of disease (a "sentinel health event," SHE) or other work-related adverse health effects should prompt immediate evaluation of primary preventive measures (e.g., industrial hygiene monitoring, engineering controls, and personal protective equipment). A medical surveillance program is intended to supplement, not replace, such measures.

A medical surveillance program should include systematic collection and epidemiologic analysis of relevant environmental and biologic monitoring, medical screening, morbidity, and mortality data. This analysis may provide information about the relatedness of adverse health effects and occupational exposure that cannot be discerned from results in individual workers. Sensitivity, specificity, and predictive values of biologic monitoring and medical screening tests should be evaluated on an industry-wide basis prior to application in any given worker group. Intrinsic to a surveillance program is the dissemination of summary data to those who need to know, including employers, occupational health professionals, potentially exposed workers, and regulatory and public health agencies.

• **Preplacement medical evaluation**

Prior to placing a worker in a job with a potential for exposure to DEHP, the physician should evaluate and document the worker's baseline health status with thorough medical, environmental, and occupational histories, a physical examination, and physiologic and laboratory tests appropriate for the anticipated occupational risks. These should concentrate on the function and integrity of the eyes, skin, liver, kidneys, gastrointestinal tract, and reproductive and respiratory systems. Medical surveillance for respiratory disease should be conducted by using the principles and methods recommended by NIOSH and the American Thoracic Society (ATS).

A preplacement medical evaluation is recommended in order to detect and assess preexisting or concurrent conditions which may be aggravated or result in increased risk when a worker is exposed to DEHP. The examining physician should consider the probable frequency, intensity, and duration of exposure, as well as the nature and degree of the condition, in placing such a worker. Such conditions, which should not be regarded as absolute contraindications to job placement, include chronic diseases of the liver or skin. The physician should obtain baseline values for liver function tests.

• **Periodic medical screening and/or biologic monitoring**

Occupational health interviews and physical examinations should be performed at regular intervals. Additional examinations may be necessary should a worker develop symptoms that may be attributed to exposure to DEHP. The interviews, examinations, and appropriate medical screening and/or biologic monitoring tests should be directed at identifying an excessive decrease or adverse trend in the integrity and physiologic function of the eyes, skin, liver, kidneys, gastrointestinal tract, and reproductive and respiratory systems as compared to the baseline status of the individual worker or to expected values for a suitable reference population. The following tests should be used and interpreted according to standardized procedures and evaluation criteria recommended by NIOSH and ATS: standardized questionnaires and lung function tests.

• **Medical practices recommended at the time of job transfer or termination**

The medical, environmental, and occupational history interviews, the physical examination, and selected physiologic and laboratory tests which were conducted at the time of placement should be repeated at the time of job transfer or termination. Any changes in the worker's health status should be compared to those expected for a suitable reference population. Because occupational exposure to DEHP may cause diseases of prolonged induction-latency, the need for medical surveillance may extend well beyond termination of employment.

• **Sentinel health events**

Acute SHE's include contact and/or allergic dermatitis.

MONITORING AND MEASUREMENT PROCEDURES

• **Method**

Sampling and analysis may be performed by collecting DEHP vapors with cellulose membrane filters followed by elution with carbon disulfide and analysis by gas chromatography. Direct-reading devices calibrated to measure DEHP may also be used if available. A detailed sampling and analytical method for DEHP may be found in the *NIOSH Manual of Analytical Methods* (method number 5020).

PERSONAL PROTECTIVE EQUIPMENT

Chemical protective clothing (CPC) should be selected after utilizing available performance data, consulting with the manufacturer, and then evaluating the clothing under actual use conditions.

Workers should be provided with and required to use CPC, gloves, and other appropriate protective clothing necessary to prevent skin contact with DEHP.

SANITATION

Clothing which is contaminated with DEHP should be removed immediately and placed in sealed containers for storage until it can be discarded or until provision is made for the removal of DEHP from the clothing. If the clothing is to be laundered or cleaned, the person performing the operation should be informed of DEHP's hazardous properties. Reusable clothing and equipment should be checked for residual contamination before reuse or storage.

A change room with showers, washing facilities, and lockers that permit separation of street and work clothes should be provided.

Workers should be required to shower following a workshift and prior to putting on street clothes. Clean work clothes should be provided daily.

Skin that becomes contaminated with DEHP should be promptly washed with soap and water.

The storage, preparation, dispensing, or consumption of food or beverages, the storage or application of cosmetics, the storage or smoking of tobacco or other smoking materials, or the storage or use of products for chewing should be prohibited in work areas.

Workers who handle DEHP should wash their faces, hands, and forearms thoroughly with soap and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

Common operations in which exposure to DEHP may occur and control methods which may be effective in each case are listed in Table 2.

Table 2.—Operations and methods of control for di-2-ethylhexyl phthalate (DEHP)

Operations	Controls
During bulk processing and application of plasticized polyvinyl chloride, polyvinylidene chloride, and other vinyl resins	Local exhaust ventilation, personal protective equipment
During hot processing of some plasticized polystyrenes, acrylics, urethanes, polyamides, and other synthetic resins	Local exhaust ventilation, personal protective equipment
During hot compounding plasticization of chlorinated rubbers and nitrile and neoprene rubbers	Local exhaust ventilation, personal protective equipment
During the application of nitrocellulose-based adhesives	Local exhaust ventilation, personal protective equipment
During hot esterification and subsequent steps in the manufacturing of DEHP	Local exhaust ventilation, personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, remove the victim from further exposure, send for medical assistance, and initiate emergency procedures.

- **Eye exposure**

Where there is any possibility of a worker's eyes being exposed to DEHP, an eye-wash fountain should be provided within the immediate work area for emergency use.

If DEHP gets into the eyes, flush them immediately with large amounts of water for 15 minutes, lifting the lower and upper lids occasionally. Get medical attention as soon as possible. Contact lenses should not be worn when working with this chemical.

- **Skin exposure**

Where there is any possibility of a worker's body being exposed to DEHP, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.

If DEHP gets on the skin, wash it immediately with soap and water. If DEHP penetrates the clothing, remove the clothing immediately and wash the skin with soap and water. Get medical attention promptly.

- **Rescue**

If a worker has been incapacitated, move the affected worker from the hazardous exposure. Put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILLS AND LEAKS

Workers not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.

If DEHP is spilled or leaked, the following steps should be taken:

1. Remove all ignition sources.
2. Ventilate area of spill or leak.
3. For small quantities of liquids containing DEHP, absorb on paper towels and place in an appropriate container.
4. Large quantities of liquids containing DEHP may be absorbed in vermiculite, dry sand, earth, or a similar material and placed in an appropriate container.
5. Liquids containing DEHP may be collected by vacuuming with an appropriate system. If a vacuum system is used, there should be no sources of ignition in the vicinity of the spill, and flashback prevention devices should be provided.

WASTE REMOVAL AND DISPOSAL

U.S. Environmental Protection Agency, Department of Transportation, and/or state and local regulations shall be followed to assure that removal, transport, and disposal are in accordance with existing regulations.

RESPIRATORY PROTECTION

It must be stressed that the use of respirators is the least preferred method of controlling worker exposure and should not normally be used as the only means of preventing or minimizing exposure during routine operations. However, there are some exceptions for which respirators may be used to control exposure: when engineering and work practice controls are not technically feasible, when engineering controls are in the process of being installed, or during emergencies and certain maintenance operations including those requiring confined-space entry (Table 3).

In addition to respirator selection, a complete respiratory protection program should be instituted which as a minimum complies with the requirements found in the OSHA Safety and Health Standards 29 CFR 1910.134. A respiratory protection program should include as a minimum an evaluation of the worker's ability to perform the work while wearing a respirator, the regular training of personnel, fit testing, periodic environmental monitoring, maintenance, inspection, and cleaning. The implementation of an adequate respiratory protection program, including selection of the correct respirators, requires that a knowledgeable person be in charge of the program and that the program be evaluated regularly.

Only respirators that have been approved by the Mine Safety and Health Administration (MSHA, formerly Mining Enforcement and Safety Administration) and by NIOSH should be used. **Remember! Air-purifying respirators will not protect from oxygen-deficient atmospheres.**

BIBLIOGRAPHY

• American Conference of Governmental Industrial Hygienists: "Di-sec-Octyl Phthalate," *Documentation of the Threshold Limit Values and Biological Exposure Indices* (5th ed.), Cincinnati, 1986.

• American Conference of Governmental Industrial Hygienists: *TLVs® Threshold Limit Values and Biological Exposure Indices for 1987-88*, Cincinnati, 1987.

• American Lung Association of San Diego and Imperial Counties: "Taking the Occupational History," *Annals of Internal Medicine*, 99:641-651, November 1983.

• Clayton, G.D., and Clayton, F.E. (eds.): *Toxicology*, Vol. IIA of *Patty's Industrial Hygiene and Toxicology* (3rd rev. ed.), John Wiley & Sons, Inc., New York, 1981.

• *Code of Federal Regulations*, U.S. Department of Labor, Occupational Safety and Health Administration, 29 CFR 1910.106, 1910.134, 1910.1000, OSHA 2206, revised July 1, 1986.

• *Code of Federal Regulations*, U.S. Department of Transportation, 49 CFR 172.101, Transportation 49, revised October 1, 1982.

• Goldman, R.H., and Peters, J.M.: "The Occupational and Environmental Health History," *Journal of the American Medical Association*, 246:2831-2836, 1981.

• Halperin, W.E., Ratcliffe, J., Frazier, T.M., Wilson, L., Becker, S.P., and Shulte, P.A.: "Medical Screening in the Workplace: Proposed Principles," *Journal of Occupational Medicine*, 28(8): 547-552, 1986.

• Hankinson, J.L.: "Pulmonary Function Testing in the Screening of Workers: Guidelines for Instrumentation, Performance, and Interpretation," *Journal of Occupational Medicine*, 28(10):1081-1092, 1986.

• International Agency for Research on Cancer: *IARC Monographs on the Carcinogenic Risk of Chemicals to Humans, Some Industrial Chemicals and Dyestuffs*, Vol. 29, Lyon, France, 1982.

• Levy, B.S., and Wegman, D.H. (eds.): *Occupational Health: Recognizing and Preventing Work-Related Disease*, Little, Brown and Company, Boston, 1983.

• National Fire Protection Association: *National Fire Codes®* (Vol. 13), Quincy, Massachusetts, 1983.

• National Institute for Occupational Safety and Health, U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control: *NIOSH Manual of Analytical Methods* (3rd ed., Vol. 1), Eller, P.M. (ed.), DHHS (NIOSH) Publication No. 84-100, Cincinnati, 1984.

• National Institute for Occupational Safety and Health, U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control: *Registry of Toxic Effects of Chemical Substances* (Microfiche Edition), Sweet, D.V., and Lewis, R.J. (eds.), Cincinnati, April 1985.

• National Institute for Occupational Safety and Health, U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control: *1985 Supplement to NIOSH Manual of Analytical Methods*, 3rd ed., Eller, P.M. (ed)., DHHS (NIOSH) Publication No. 85-117, Cincinnati, 1985.

• Proctor, N.H., and Hughes, J.P.: *Chemical Hazards of the Workplace*, J.B. Lippincott Company, Philadelphia, 1978.

• Rom, W.N. (ed.): *Environmental and Occupational Medicine*, Little, Brown and Company, Boston, 1983.
• Rothstein, M.A.: *Medical Screening of Workers*, Bureau of National Affairs, Washington, DC, 1984.
• Rutstein, D.D., Mullan, R.J., Frazier, T.M., Halperin, W.E., Melius, J.M., and Sestito, J.P.: "Sentinel Health Events (Occupational): A Basis for Physician Recognition and Public Health Surveillance," *American Journal of Public Health*, 73:1054-1062, 1983.
• Scientific Assembly on Environmental and Occupational Health: "Evaluation of Impairment/Disability Secondary to Respiratory Disease," *American Review of Respiratory Diseases*, 126:945-951, 1982.
• Scientific Assembly on Environmental and Occupational Health: "Surveillance for Respiratory Hazards in the Occupational Setting," *American Review of Respiratory Diseases*, 126:952-956, 1982.

Table 3.—Respiratory protection for di-2-ethylhexyl phthalate (DEHP)

Condition	Minimum respiratory protection*
Any detectable concentration	Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive pressure mode
	Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode
Planned or emergency entry into environments containing unknown or any detectable concentration	Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode
	Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive pressure mode
Firefighting	Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode
Escape only	Any air-purifying full facepiece respirator with a high-efficiency particulate filter
	Any appropriate escape-type self-contained breathing apparatus

* Only NIOSH/MSHA-approved equipment should be used.

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Material Safety Data Sheets Collection:

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Automotive Gasoline, Lead-free

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Section 1. Material Identification

35

Automotive Gasoline, Lead-free, Description: A mixture of volatile hydrocarbons composed mainly of branched-chain paraffins, cycloparaffins, olefins, naphthenes, and aromatics. In general, gasoline is produced from petroleum, shale oil, Athabasca tar sands, and coal. Motor gasolines are made chiefly by cracking processes, which convert heavier petroleum fractions into more volatile fractions by thermal or catalytic decomposition. Widely used as fuel in internal combustion engines of the spark-ignited, reciprocating type. Automotive gasoline has an octane number of approximately 90. A high content of aromatic hydrocarbons and a consequent high toxicity are also associated with a high octane rating. Some gasolines sold in the US contain a minor proportion of tetraethyllead, which is added in concentrations not exceeding 3 ml per gallon to prevent engine "knock." However, methyl-tert-butyl ether (MTBE) has almost completely replaced tetraethyllead.

Other Designations: CAS No. 8006-61-9, benzin, gasoline, gasolene, motor spirits, natural gasoline, petrol.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[(73)] for a suppliers list.

R 1
I 2
S 2*
K 4
* Skin absorption

NFPA
3
1 0
-

HMIS
H 2
F 3
R 1
PPG†
† Sec. 8

Cautions: Inhalation of automotive gasoline vapors can cause intense burning in throat and lungs, central nervous system (CNS) depression, and possible fatal pulmonary edema. Gasoline is a dangerous fire and explosion hazard when exposed to heat and flames.

Section 2. Ingredients and Occupational Exposure Limits

Automotive gasoline, lead-free*

1990 OSHA PELs
8-hr TWA: 300 ppm, 900 mg/m³
15-min STEL: 500 ppm, 1500 mg/m³

1990-91 ACGIH TLVs
TWA: 300 ppm, 890 mg/m³
STEL: 500 ppm, 1480 mg/m³

1990 NIOSH REL
None established

1985-86 Toxicity Data*
Man, inhalation, TC_{Lo}: 900 ppm/1 hr; toxic effects include sense organs and special senses (conjunctiva irritation), behavioral (hallucinations, distorted perceptions), lungs, thorax, or respiration (cough)
Human, eye: 140 ppm/8 hr; toxic effects include mild irritation
Rat, inhalation, LC_{50}: 300 g/m³/5 min

* A typical modern gasoline composition is 80% paraffins, 14% aromatics, and 6% olefins. The mean benzene content is approximately 1%. Other additives include sulfur, phosphorus, and MTBE.
† See NIOSH, *RTECS* (LX3300000), for additional toxicity data.

Section 3. Physical Data

Boiling Point: Initially, 102 °F (39 °C); after 10% distilled, 140 °F (60 °C); after 50% distilled, 230 °F (110 °C); after 90% distilled, 338 °F (170 °C); final boiling point, 399 °F (204 °C)
Vapor Density (air = 1): 3.0 to 4.0
Density/Specific Gravity: 0.72 to 0.76 at 60 °F (15.6 °C)
Water Solubility: Insoluble

Appearance and Odor: A clear (gasoline may be colored with dye), mobile liquid with a characteristic odor recognizable at about 10 ppm in air.

Section 4. Fire and Explosion Data

Flash Point: -45 °F (-43 °C)	Autoignition Temperature: 536 to 853 °F (280 to 456 °C)	LEL: 1.3% v/v	UEL: 6.0% v/v

Extinguishing Media: Use dry chemical, carbon dioxide, or alcohol foam as extinguishing media. Use of water may be ineffective to extinguish fire, but use water spray to knock down vapors and to cool fire-exposed drums and tanks to prevent pressure rupture. Do not use a solid stream of water since it may spread the fuel.
Unusual Fire or Explosion Hazards: Automobile gasoline is an OSHA Class IB flammable liquid and a dangerous fire and explosion hazard when exposed to heat and flames. Vapors can flow to an ignition source and flash back. Automobile gasoline can also react violently with oxidizing agents.
Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode, and full protective clothing. When the fire is extinguished, use nonsparking tools for cleanup. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Automotive gasoline is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Automotive gasoline can react with oxidizing materials such as peroxides, nitric acid, and perchlorates.
Conditions to Avoid: Avoid heat and ignition sources.
Hazardous Products of Decomposition: Thermal oxidative decomposition of automotive gasoline can produce oxides of carbon and partially oxidized hydrocarbons.

Section 6. Health Hazard Data

Carcinogenicity: In 1990 reports, the IARC list gasoline as a possible human carcinogen (Group 2B). Although the IARC has assigned an overall evaluation to gasoline, it has not assigned an overall evaluation to specific substances within this group (inadequate human evidence).
Summary of Risks: Gasoline vapors are considered moderately poisonous. Vapor inhalation can cause central nervous system (CNS) depression 'd mucous membrane and respiratory tract irritation. Brief inhalations of high concentrations can cause a fatal pulmonary edema. Reported sponses to gasoline vapor concentrations are: 160 to 270 ppm causes eye and throat irritation in several hours; 500 to 900 ppm causes eye, nose, and throat irritation, and dizziness in 1 hr; and 2000 ppm produces mild anesthesia in 30 min. Higher concentrations are intoxicating in 4 to 10 minutes. If large areas of skin are exposed to gasoline, toxic amounts may be absorbed. Repeated or prolonged skin exposure causes dermatitis. Certain individuals may develop hypersensitivity. Ingestion can cause CNS depression. Pulmonary aspiration after ingestion can cause severe pneumonitis. In adults, ingestion of 20 to 50 g gasoline may produce severe symptoms of poisoning.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Target Organs: Skin, eye, respiratory and central nervous systems.
Primary Entry Routes: Inhalation, ingestion, skin contact.
Acute Effects: Acute inhalation produces intense nose, throat, and lung irritation; headaches; blurred vision; conjunctivitis; flushing of the face; mental confusion; staggering gait; slurred speech; and unconsciousness, sometimes with convulsions. Ingestion causes inebriation (drunkenness), vomiting, dizziness, fever, drowsiness, confusion, and cyanosis (a blue to dark purplish coloration of skin and mucous membrane caused by lack of oxygen). Aspiration causes choking, cough, shortness of breath, increased rate of respiration, excessively rapid heartbeat, fever, bronchitis, and pneumonitis. Other symptoms following acute exposure include acute hemorrhage of the pancreas, fatty degeneration of the liver and kidneys, and passive congestion of spleen.
Chronic Effects: Chronic inhalation results in appetite loss, nausea, weight loss, insomnia, and unusual sensitivity (hyperesthesia) of the distal extremities followed by motor weakness, muscular degeneration, and diminished tendon reflexes and coordination. Repeated skin exposure can cause blistering, drying, and lesions.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, *do not induce vomiting* due to aspiration hazard. Give conscious victim a mixture of 2 tablespoons of activated charcoal mixed in 8 oz of water to drink. Consult a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate all unnecessary personnel, remove heat and ignition sources, and provide maximum explosion-proof ventilation. Cleanup personnel should protect against vapor inhalation and liquid contact. Use nonsparking tools. Take up small spills with sand or other noncombustible adsorbent. Dike storage areas to control leaks and spills. Follow applicable OSHA regulations (29 CFR 1910.120).
Aquatic Toxicity: Bluegill, freshwater, LC_{50}, 8 ppm/96 hr.
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
RCRA Hazardous Waste (40 CFR 261.21): Characteristic of ignitability
CERCLA Hazardous Substance (40 CFR 302.4): Not listed
ARA Extremely Hazardous Substance (40 CFR 355): Not listed
ARA Toxic Chemical (40 CFR 372.65): Not listed
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Since contact lens use in industry is controversial, establish your own policy.
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. There are no specific NIOSH recommendations. However, for vapor concentrations not immediately dangerous to life or health, use chemical cartridge respirator equipped with organic vapor cartridge(s), or a supplied-air respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Materials such as neoprene or polyvinyl alcohol provide excellent/good resistance for protective clothing. Note: Resistance of specific materials can vary from product to product.
Ventilation: Provide general and local explosion-proof exhaust ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in closed containers in a cool, dry, well-ventilated area away from heat and ignition sources and strong oxidizing agents. Protect containers from physical damage. Avoid direct sunlight. Storage must meet requirements of OSHA Class IB liquid. Outside or detached storage preferred.
Engineering Controls: Avoid vapor inhalation and skin or eye contact. Consider a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Indoor use of this material requires explosion-proof exhaust ventilation to remove vapors. Only use gasoline as a fuel source due to its volatility and flammable/explosive nature. Practice good personal hygiene and housekeeping procedures. Wear clean work clothing daily.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Gasoline *(including casing-head and natural)*
DOT Hazard Class: Flammable liquid
ID No.: UN1203
DOT Label: Flammable liquid
DOT Packaging Exceptions: 173.118
DOT Packaging Requirements: 173.119

IMO Shipping Name: Gasoline
IMO Hazard Class: 3.1
ID No.: UN1203
IMO Label: Flammable liquid
IMDG Packaging Group: II

MSDS Collection References: 26, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 138, 140, 143, 146, 153, 159
Prepared by: M Allison, BS; Industrial Hygiene Review: DJ Wilson, CIH; Medical Review: W Silverman, MD; Edited by: JR Stuart, MS

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Material Safety Data Sheets Collection:

Sheet No. 713
Lead (Inorganic)

Issued: 8/90

Section 1. Material Identification

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Lead (Inorganic) (Pb) Description: Exists widely throughout the world in a number of ores. Its main commercial source is galena (lead sulphide). Lead mineral is separated from crude ores by blast-furnace smelting, drossing, or electrolytic refining. Lead is used mostly in manufacturing storage batteries. Other uses are in manufacturing tetraethyllead and both organic and inorganic lead compounds in ceramics, plastics, and electronic devices; in producing ammunition, solder, cable covering, sheet lead, and other metal products (brass, pipes, caulking); in metallurgy; in weights and as ballast; as a chemical intermediate for lead alkyls and pigments; as a constuction material for the tank linings, piping, and equipment used to handle the corrosive gases and liquids used in sulfuric acid manufacturing, petroleum refining, halogenation, sulfonation, extraction, and condensation; and for x-ray and atomic radiation protection.

Other Designations: CAS No. 7439-92-1, lead oxide; lead salts, inorganic; metallic lead; plumbum.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.

R 0
I 4
S -
K 0

Genium
1
3 0
-

HMIS
H 3
F 1
R 0
PPG*
* Sec. 8

Cautions: *Inorganic lead is a potent systemic poison.* Organic lead (for example, tetraethyl lead) has severe, but different, health effects. Occupational lead poisoning is due to inhalation of dust and fumes. Major affected organ systems are the nervous, blood, and reproductive systems, and kidneys. Health impairment or disease may result from a severe acute short- or long-term exposure.

Section 2. Ingredients and Occupational Exposure Limits

Lead (inorganic) fumes and dusts, as Pb, ca 100%

1989 OSHA PELs (Lead, inorganic compounds)
8-hr TWA: 50 µg/m³
Action Level TWA*: 30 µg/m³

29 CFR 1910.1025 Lead Standard
Blood Lead Level: 40 µg/100 g

1989-90 ACGIH TLV (Lead, inorganic, fumes and dusts)
TLV-TWA: 150 µg/m³

1988 NIOSH REL
10-hr TWA: <100 µg/m³

1985-86 Toxicity Data†
Human, inhalation, TC_{Lo}: 10 µg/m³ affects gastrointestinal tract and liver
Human, oral, TD_{Lo}: 450 mg/kg ingested over 6 yr affects peripheral and central nervous systems
Rat, oral, TD_{Lo}: 790 mg/kg affects multigeneration reproduction

* Action level applies to employee exposure without regard to respirator use.
† See NIOSH, *RTECS* (OF7525000), for additional mutative, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 3164 °F (1740 °C)
Melting Point: 621.3 °F (327.4 °C)
Vapor Pressure: 1.77 mm Hg at 1832 °F (1000 °C)
Viscosity: 3.2 cp at 621.3 °F (327.4 °C)
Molecular Weight: 207.20
Specific Gravity (20 °C/4 °C): 11.34
Water Solubility: Relatively insoluble in hot or cold water*

Appearance and Odor: Bluish-white, silvery, gray, very soft metal.

* Lead dissolves more easily at a low pH.

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: None reported	LEL: None reported	UEL: None reported

Extinguishing Media: Use dry chemical, carbon dioxide, water spray, or foam to extinguish fire.
Unusual Fire or Explosion Hazards: Flammable and moderately explosive in the form of dust when exposed to heat or flame.
Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective equipment. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Lead is stable at room temperature in closed containers under normal storage and handling conditions. It tarnishes on exposure to air. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Mixtures of hydrogen peroxide + trioxane explode on contact with lead. Lead is incompatible with sodium azide, zirconium, disodium acetylide, and oxidants. A violent reaction on ignition may occur with concentrated hydrogen peroxide, chlorine trifluoride, sodium acetylide (with powdered lead), ammonium nitrate (below 200 °C with powdered lead). Lead is attacked by pure water and weak organic acids in the presence of oxygen. Lead is resistant to tap water, hydrofluoric acid, brine, and solvents.
Conditions to Avoid: Rubber gloves containing lead may ignite in nitric acid.
Hazardous Products of Decomposition: Thermal oxidative decomposition of lead can produce highly toxic fumes of lead.

Section 6. Health Hazard Data

Carcinogenicity: Although the NTP and OSHA do not list lead as a carcinogen, the IARC lists it as probably carcinogenic to humans, but having (usually) no human evidence. However, the literature reports instances of lead-induced neoplasms, both benign and malignant, of the kidney and other organs in laboratory rodents. Excessive exposure to lead has resulted in neurologic disorders in infants. Experimental studies show lead has reproductive and teratogenic effects in laboratory animals. Human male and female reproductive effects are also documented.
Summary of Risks: Lead is a potent, systemic poison that affect a variety of organ systems, including the nervous system, kidneys, reproductive system, blood formation, and gastrointestinal (GI) system. The most important way lead enters the body is through inhalation, but it can also be ingested when lead dust or unwashed hands contaminate food, drink, or cigarettes. Much of ingested lead passes through feces without absorption into the body. Adults may absorb only 5 to 15% of ingested lead; children may absorb a much larger fraction. Once in the body, lead enters the bloodstream and circulates to various organs. Lead concentrates and remains in bone for many years. The amount of lead the body stores increases as exposure continues, with possibly cumulative effects. Depending on the dose entering the body, lead can be deadly within several days or affect health after many years. Very high doses can cause brain damage (encephalopathy).
Medical Conditions Aggravated by Exposure: Lead may aggravate nervous system disorders (e.g., epilepsy, neuropathies), kidney diseases, high blood pressure (hypertension), infertility, and anemia. Lead-induced anemia and its effect on blood presssure can aggravate cardiovascular disease.

Continue on next page

Section 6. Health Hazard Data, *continued*

Target Organs: Blood, central and peripheral nervous systems, kidneys, and gastrointestinal (GI) tract.
Primary Entry Routes: Inhalation, ingestion.
Acute Effects: An acute, short-term dose of lead could cause acute encephalopathy with seizures, coma, and death. However, short-term exposures of this magnitude are rare. Reversible kidney damage can occur from acute exposure, as well as anemia.
Chronic Effects: Symptoms of chronic long-term overexposure include appetite loss, nausea, metallic taste in the mouth, lead line on gingival (gum) tissue, constipation, anxiety, anemia, pallor of the face and the eye grounds, excessive tiredness, weakness, insomnia, headache, nervous irritability, fine tremors, numbness, muscle and joint pain, and colic accompanied by severe abdominal pain. Paralysis of wrist and, less often, ankle extensor muscles may occur after years of increased lead absorption. Kidney disease may also result from chronic overexposure, but few, if any, symptoms appear until severe kidney damage has occurred. Reproductive damage is characterized by decreased sex drive, impotence, and sterility in men; and decreased fertility, abnormal menstrual cycles, and miscarriages in women. Unborn children may suffer neurologic damage or developmental problems due to excessive lead exposure in pregnant women. Lead poisoning's severest result is encephalopathy manifested by severe headache, convulsions, coma, delirium, and possibly death.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Consult a physician if any health complaints develop.
Inhalation: Remove exposed person to fresh air and support breathing as needed. Consult a physician.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If large amounts of lead were ingested, induce vomiting with Ipecac syrup. Consult a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: For diagnosis, obtain blood pressure, blood lead level (PbB), zinc protoporphyrin (ZPP), complete blood count for microcytic anemia and basophilic stippling, urinalysis, and blood urea nitrogen (BUN) of creatinine. Examine peripheral motor neuropathy, pallor, and gingival lead line. Use Ca-EDTA to treat poison, but *never* chelate prophylactically. Consult an occupational physician or toxicologist.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel and evacuate all unnecessary personnel immediately. Cleanup personnel should protect against inhalation of dusts or fume and contact with skin or eyes. Avoid creating dusty conditions. Water sprays may be used in large quantities to prevent the formation of dust. Cleanup methods such as vacuuming (with an appropriate filter) or wet mopping minimizes dust dispersion. Scoop the spilled material into closed containers for disposal or reclamation. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33, Appendix II—EP Toxicity Test Procedures)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [* per Clean Water Act, Sec. 307(a)]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact. Protective clothing made of man-made fibers and lacking turn-ups, pleats, or pockets retain less dust from lead.
Ventilation: Provide general and local ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially washing hands before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in tightly closed containers in a cool, dry, well-ventilated area away from all incompatible materials, direct sunlight, and heat and ignition sources.
Engineering Controls: Educate worker about lead's hazards. Follow and inform employees of the lead standard (29 CFR 1910.1025). Avoid inhalation of lead dust and fumes and ingestion of lead. Use only with appropriate personal protective gear and adequate ventilation. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Avoid creating dusty conditions. Segregate and launder contaminated clothing. Take precautions to protect laundry personnel. Practice good personal hygiene and housekeeping procedures. For a variety of reasons, the lead concentration in workroom air may not correlate with the blood lead levels in individuals.
Other Precautions: Provide preplacement and periodic medical examinations which emphasize blood, nervous system, gastrointestinal tract, and kidneys, including a complete blood count and urinalysis. Receive a complete history including previous surgeries and hospitalization, allergies, smoking history, alcohol consumption, proprietary drug intake, and occupational and nonoccupational lead exposure. Maintain records for medical surveillance, airborne exposure monitoring, employee complaints, and physician's written opinions for at least 40 years or duration of employment plus 20 years. Measurement of blood lead level (PbB) and zinc protoporphyrin (ZPP) are useful indicators of your body's lead absorption level. Maintain worker PbBs at or below 40 µg/100 g of whole blood. To minimize adverse reproductive health effects to parents and developing fetus, maintain the PbBs of workers intending to have children below 30 µg/100 g. Elevated PbBs increase your risk of disease, and the longer you have elevated PbBs, the greater your chance of substantial permanent damage.

Transportation Data (49 CFR 172.102)
IMO Shipping Name: Lead compounds, soluble, n.o.s.
IMO Hazard Class: 6.1
ID No.: UN2291
IMO Label: St. Andrews Cross (X, Stow away from foodstuffs)
IMDG Packaging Group: III

MSDS Collection **References:** 26, 38, 73, 84, 85, 88, 89, 90, 100, 101, 103, 109, 124, 126, 132, 133, 134, 136, 138, 139, 142, 143
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Upfal, MD, MPH; **Edited by:** JR Stuart, MS

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Material Safety Data Sheets Collection:

Sheet No. 683
Polychlorinated Biphenyls (PCBs)

Issued: 11/88 Revision: A, 9/92

Section 1. Material Identification

39

Polychlorinated Biphenyls [$C_{12}H_{10-n}Cl_n$ (n=3, 4, 5)] Description: A class of nonpolar chlorinated hydrocarbons with a biphenyl nucleus (two benzene nuclei connected by a single C-C bond) in which any or all of the hydrogen atoms have been replaced by chlorine. Commercial PCBs are mixtures of chlorinated biphenyl isomers with varying degrees of chlorination. Prepared industrially by the chlorination of biphenyl with anhydrous chlorine in the presence of a catalyst such as ferric chloride or iron filings. Except for limited research and development applications, PCBs have not been produced in the US since 1977. When large quantities of PCBs were manufactured in the US, they were marketed under the tradename Aroclor (Monsanto) and were characterized by four digit numbers. The first two digits indicating biphenyls (12), triphenyls (54), or both (25, 44); the last two digits indicating the weight percent of chlorine. PCBs' thermal stability, nonflammability, and high dielectric capability made them very useful in electrical equipment. Formerly used as additives in hydraulic fluids, heat transfer systems, lubricants, cutting oils, printer's ink, fire retardants, asphalt, brake linings, automobile body sealants, plasticizers, adhesives, synthetic rubber, floor tile, wax extenders, dedusting agents, pesticide extenders, and carbonless reproducing paper. PCBs are still used in certain existing electrical capacitors and transformers that require enhanced electrical protection to avoid heating from sustained electric faults.

Other Designations: CAS No. 1336-36-3, Aroclor, Clophen, Chlorextol, chlorinated biphenyls, chlorinated diphenyl, chlorinated diphenylene, chloro biphenyl, chloro-1,1-biphenyl, Dykanol, Fenclor, Inerteen, Kaneclor, Montar, Noflamol, Phenoclor, Pyralene, Pyranol, Santotherm, Sovol, Therminol FR-1

R 1
I 4
S 3*
K 1
* Skin absorption

NFPA
1
2 0
—

HMIS
H 2‡
F 1
R 0
PPE†
† Sec. 8
‡ Chronic Effects

Cautions: PCBs are potent liver toxins that may be absorbed through skin. Potentially, chronic or delayed toxicity is significant because PCBs accumulate in fatty tissue and may reasonably be anticipated to be carcinogens. PCBs are a bioaccumulative environmental hazard. When burned, decomposition products may be more hazardous than the PCBs.

Section 2. Ingredients and Occupational Exposure Limits

PCBs, contain various levels of polychlorinated dibenzofurans and chlorinated naphthalenes as contaminants

1991 OSHA PELs, Skin
8-hr TWA (Chlorodiphenyl, 42% chlorine): 1 mg/m^3
8-hr TWA (Chlorodiphenyl, 54% chlorine): 0.5 mg/m^3

1990 DFG (Germany) MAK, Danger of Cutaneous Absorption
TWA (Chlorodiphenyl, 42% chlorine): 0.1 ppm (1 mg/m^3)
Category III: Substances with systemic effects, onset of effect > 2 hr., half-life > shift length (strongly cumulative)
Short-term Level: 1 ppm, 30 min., average value, 1 per shift
TWA (Chlorodiphenyl, 54% chlorine): 0.05 ppm (0.5 mg/m^3)
Category III: (see above)
Short-term Level: 0.5 ppm, 30 min., average value, 1 per shift

1985-86 Toxicity Data*
Rat, oral, TD: 1250 mg/kg administered intermittently for 25 weeks produced liver tumors.
Mammal, oral, TD_{Lo}: 325 mg/kg administered to female for 30 days prior to mating and from the 1st to the 36th day of gestation produced effects on newborn (stillbirth; live birth index; viability index).

1990 NIOSH REL
TWA (Chlorodiphenyl, 42% chlorine): 0.001 mg/m^3
TWA (Chlorodiphenyl, 54% chlorine): 0.001 mg/m^3

1992-93 ACGIH TLVs, Skin *
TWA (Chlorodiphenyl, 42% chlorine): 1 mg/m^3
TWA (Chlorodiphenyl, 54% chlorine): 0.5 mg/m^3

* These guidelines offer reasonably good protection against systemic intoxication, but may not guarantee that chloroacne won't occur.
† See NIOSH, *RTECS* (TQ1350000), for additional reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data*

Boiling Point: 644-707 °F (340-375 °C)
Melting Point: 42%: -2.2 °F (-19°C); 54%: 14 °F (-10 °C)
Vapor Pressure: 1 mm Hg at 100 °F (38 °C); 10^{-6} to 10^{-3} mm at 20 °C
Molecular Weight: 188.7 to 398.5
Specific Gravity: 1.3 to 1.8 at 20 °C
Water Solubility: Low solubility (0.007 to 5.9 mg/L)
Other Solubilities: Most common organic solvents, oils, and fats; slightly soluble in glycerol and glycols.

Appearance and Odor: PCBs vary from mobile oily liquids to white crystalline solids and hard non-crystalline resins, depending upon chlorine content.

* Physical and chemical properties vary widely according to degree and to the position of chlorination.

Section 4. Fire and Explosion Data

Flash Point: 286-385 °F (141-196 °C) OC*	Autoignition Temperature: 464 °F (240 °C)	LEL: None reported	UEL: None reported

Extinguishing Media: Use extinguishing media suitable to the surrounding fire. Use dry chemical, foam, carbon dioxide (CO_2), or water spray. Water spray may be ineffective. Use water spray to cool fire-exposed containers or transformers. Do not scatter PCBs with high-pressure water streams. **Unusual Fire or Explosion Hazards:** Combustion products (hydrogen chloride, phosgene, polychlorinated dibenzofurans, and furans) are more hazardous than the PCBs themselves. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Approach fire from upwind to avoid highly toxic decomposition products. Structural firefighter's protective clothing will provide *limited* protection. Do not release runoff from fire control methods to sewers or waterways. Dike for later disposal.

* Flash points shown are a range for various PCBs. Some forms do not have flash points.

Section 5. Reactivity Data

Stability/Polymerization: PCBs are very stable materials but are subject to photodechlorination when exposed to sunlight or UV (spectral region above 290 nanometers). Hazardous polymerization cannot occur. **Chemical Incompatibilities:** PCBs are chemically inert and resistant to oxidation, acids, and bases. **Conditions to Avoid:** Avoid heat and ignition sources.
Hazardous Products of Decomposition: Thermal oxidative decomposition [1112-1202 °F (600-650 °C)] of PCBs can produce highly toxic derivatives, including polychlorinated dibenzo-para-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), hydrogen chloride, phosgene and other irritants.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,[164] and NTP[169] list PCBs as an IARC probable carcinogen (overall evaluation is 2A; limited human data; sufficient animal data) and NTP anticipated carcinogen, respectively. **Summary of Risks:** PCBs are potent liver toxins that can be absorbed through unbroken skin in toxic amounts without immediate pain or irritation. PCBs have low acute toxicity, but can accumulate in fatty tissue and severe health effects may develop later. Generally, toxicity increases with a higher chlorine content; PCB-oxides are more toxic. The toxic action on the liver also increases with simultaneous exposure to other liver toxins, e.g. chlorinated solvents, alcohol, and certain drugs. Pathological pregnancies (abnormal pigmentations, abortions, stillbirths, and underweight births) have been associated with increased PCB serum levels in mothers; PCBs can be passed in breast milk. PCBs can affect the reproductive system of adults. **Medical Conditions Aggravated by Long-Term Exposure:** Skin, liver, and respiratory disease. **Target Organs:** Skin, liver, eyes, mucous membranes, and respiratory tract. **Primary Entry Routes:** Inhalation, dermal contact, ingestion. **Acute Effects:** Exposure to PCB vapor or mist is severely irritating to the skin, eyes, nose, throat, and upper respiratory tract. Intense acute exposure to high concentrations may result in eye, lung, and liver injury. Systemic effects include nausea, vomiting, increased blood pressure, fatigue, weight loss, jaundice, edema and abdominal pain. Cognitive, neurobehavior and psychomotor impairment and memory loss have also been seen after acute exposure. **Chronic Effects:** Repeated exposure to PCBs can cause chloroacne; redness, swelling, dryness, thickening and darkening of the skin and nails; swelling and burning of the eyes, and excessive eye discharge; distinctive hair follicles; gastrointestinal disturbances; neurological symptoms including headache, dizziness, depression, nervousness, numbness of the extremities, and joint and muscle pain; liver enlargement; menstrual changes in women; and chronic bronchitis. Cancer, primarily liver, is also a possible result of exposure, but data is inconclusive.

FIRST AID Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Rinsing eyes with medical oil (olive, mineral) initially may remove PCB and halt irritation better than water rinsing alone. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. *Multiple soap and water washings are necessary.* Avoid the use of organic solvents to clean the skin. For reddened or blistered skin, consult a physician. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** In most cases, accidental PCB ingestion will not be recognized until long after vomiting would be of any value. Never give anything by mouth to an unconscious or convulsing person. Vomiting of the pure substance may cause aspiration. Consult a physician.
Note to Physicians: Monitor patients for increased hepatic enzymes, chloroacne, and eye, gastrointestinal, and neurologic symptoms listed above. Diagnostic tests include blood levels of PCBs and altered liver enzymes.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate all unnecessary personnel, provide adequate ventilation, and isolate hazard area. Cleanup personnel should protect against vapor inhalation and skin or eye contact. For small spills, take up with sand or other noncombustible material and place into containers for later disposal. For larger spills, dike far ahead of spill to contain for later disposal. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Transport:** PCBs have been shown to bio-concentrate significantly in aquatic organisms. **Ecotoxicity:** Bluegill, TLm: 0.278 ppm/96 hr. Mallard Duck, LD_{50}: 2000 ppm. **Environmental Degradation:** In general, the persistence of PCBs increases with an increase degree of chlorination. **Soil Absorption/Mobility:** PCBs are tightly absorbed in soil and generally do not leach significantly in most aqueous soil systems. However, in the presence of organic solvents, PCBs may leach rapidly through the soil. Volatilization of PCBs from soil may be slow, but over time may be significant. **Disposal:** Approved PCB disposal methods include: incineration with scrubbing, high-efficiency boilers, landfills, and EPA-approved alternative disposal methods. Each disposal method has various criteria. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations
RCRA Hazardous Waste (40 CFR 261.33): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1 lb (0.454 kg) [* per CWA, Sec. 311(b)(4) and 307(a)]

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. Minimum respiratory protection should include a combination dust-fume-mist and organic vapor cartridge or canister or air-supplied, depending upon the situation. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent all skin contact. Butyl rubber, neoprene, Teflon, and fluorocarbon rubber have break through times greater than 8 hrs. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Segregate contaminated clothing in such a manner so that there is no direct contact by laundry personnel. Implement quality assurance to ascertain the completeness of the cleaning procedures. Remove this material from your shoes and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in a closed, labelled, container in a ventilated area with appropriate air pollution control equipment. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. **Administrative Controls:** Inform employees of the adverse health effects associated with PCBs. Limit access to PCB work areas to authorized personnel. Consider preplacement and periodic medical examinations with emphasis on the skin, liver, lung, and reproductive system. Monitor PCB blood levels. Consider possible effects on the fetus. Keep medical records for the entire length of employment and for the following 30 yrs.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Polychlorinated biphenyls
DOT Hazard Class: 9
ID No.: UN2315
DOT Packing Group: II
DOT Label: CLASS 9
Special Provisions (172.102): 9, N81

Packaging Authorizations
a) Exceptions: 173.155
b) Non-bulk Packaging: 173.202
c) Bulk Packaging: 173.241

Quantity Limitations
a) Passenger Aircraft or Railcar: 100 L
b) Cargo Aircraft Only: 220 L

Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: 34

MSDS Collection References: 26, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 163, 164, 168, 169, 174, 175, 180
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Material Safety Data Sheets Collection:
Sheet No. 317
Toluene
Issued: 8/79 Revision: E, 9/92

Section 1. Material Identification 39

Toluene ($C_6H_5CH_3$) Description: Derived from petroleum i.e., dehydrogenation of cycloparaffin fractions followed by the aromatization of saturated aromatic hydrocarbons or by fractional distillation of coal-tar light oil and purified by rectification. Used widely as a solvent (replacing benzene in many cases) for oils, resins, adhesives, natural rubber, coal tar, asphalt, pitch, acetyl celluloses, cellulose paints and varnishes; a diluent for photogravure inks, raw material for organic synthesis (benzoyl & benzilidene chlorides, saccharine, TNT, toluene diisocyanate, and many dyestuffs), in aviation and high octane automobile gasoline, as a nonclinical thermometer liquid and suspension solution for navigational instruments.

Other Designations: CAS No. 108-88-3, Methacide, methylbenzene, methylbenzol, phenylmethane, toluol, Tolu-sol.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

Cautions: Toluene is an eye, skin, and respiratory tract irritant becoming narcotic at high centrations. Liver and kidney damage has occurred. Pregnant women chronically exposed to toluene have shown teratogenic effects. Toluene is highly flammable.

R 1
I 3
S 2*
K 3
* Skin absorption

NFPA: 3 (top), 2 (left), 0 (right), - (bottom)

HMIS
H 2- Chronic effects
F 3
R 0
PPE-Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Toluene, < 100%; may contain a small amount of benzene (~ 1%), xylene, and nonaromatic hydrocarbons.

1991 OSHA PELs
8-hr TWA: 100 ppm (375 mg/m³)
15-min STEL: 150 ppm (560 mg/m³)

1990 IDLH Level
2000 ppm

1990 NIOSH RELs
TWA: 100 ppm (375 mg/m³)
STEL: 150 ppm (560 mg/m³)

1992-93 ACGIH TLV (Skin)
TWA: 50 ppm (188 mg/m³)

1990 DFG (Germany) MAK*
TWA: 100 ppm (380 mg/m³)
Half-life: 2 hr to end of shift
Category II: Substances with systemic effects
Peak Exposure Limit: 500 ppm, 30 min average value, 2/shift

1985-86 Toxicity Data†
Man, inhalation, TC_{Lo}: 100 ppm caused hallucinations, and changes in motor activity and changes in psychophysiological tests.
Human, oral, LD_{Lo}: 50 mg/kg; toxic effects not yet reviewed
Human, eye: 300 ppm caused irritation.
Rat, oral, LD_{50}: 5000 mg/kg
Rat, liver: 30 µmol/L caused DNA damage.

* Available information suggests damage to the developing fetus is probable.
†See NIOSH, *RTECS* (XS5250000), for additional irritation, mutation, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 232 °F (110.6 °C)
Melting Point: -139 °F (-95 °C)
Molecular Weight: 92.15
Density: 0.866 at 68 °F (20/4 °C)
Surface Tension: 29 dyne/cm at 68 °F (20 °C)
Viscosity: 0.59 cP at 68 °F (20 °C)
Refraction Index: 1.4967 at 20 °C/D
Water Solubility: Very slightly soluble, 0.6 mg/L at 68 °F (20 °C)
Other Solubilities: Soluble in acetone, alcohol, ether, benzene, chloroform, glacial acetic acid, petroleum ether, and carbon disulfide.
Vapor Pressure: 22 mm Hg at 68 °F (20 °C); 36.7 mm Hg at 86 °F (30 °C)
Saturated Vapor Density (Air = 0.075 lb/ft³ or 1.2 kg/m³): 0.0797 lb/ft³ or 1.2755 kg/m³
Odor Threshold (range of all referenced values): 0.021 to 69 ppm

Appearance and Odor: Colorless liquid with a sickly sweet odor.

Section 4. Fire and Explosion Data

Flash Point: 40 °F (4.4 °C) CC	Autoignition Temperature: 896 °F (480 °C)	LEL: 1.27% v/v	UEL: 7.0% v/v

Extinguishing Media: Toluene is a Class 1B flammable liquid. To fight fire, use dry chemical carbon dioxide, or 'alcohol-resistant' foam. Water spray may be ineffective as toluene floats on water and may actually spread fire. **Unusual Fire or Explosion Hazards:** Concentrated vapors are heavier than air and may travel to an ignition source and flash back. Container may explode in heat of fire. Toluenes' burning rate = 5.7 mm/min and its flame speed = 37 cm/sec. Vapor poses an explosion hazard indoors, outdoors, and in sewers. May accumulate static electricity. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighter's protective clothing provides only limited protection. Apply cooling water to sides of tanks until well after fire is out. Stay away from ends of tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holders; if impossible, withdraw from fire and let burn. Withdraw immediately if you hear a rising sound from venting safety device or notice any tank discoloration due to fire because a BLEVE (boiling liquid expanding vapor explosion) may be imminent. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Toluene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization can't occur. **Chemical Incompatibilities:** Strong oxidizers, concentrated nitric acid, nitric acid + sulfuric acid, dinitrogen tetroxide, silver perchlorate, bromine trifluoride, tetranitromethane, and 1,3-dichloro-5,5-dimethyl-2,4-imidazolididione. **Conditions to Avoid:** Contact with heat, ignition sources, or incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of toluene can produce carbon dioxide, and acrid, irritating smoke.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,[164] NTP,[169] and OSHA[164] do not list toluene as a carcinogen. **Summary of Risks:** Toluene is irritating to the eyes, nose, and respiratory tract. Inhalation of high concentrations produces a narcotic effect sometimes leading to coma as well as liver and kidney damage. 93% of inhaled toluene is retained in the body of which 80% is metabolized to benzoic acid, then to hippuric acid and excreted in urine. The remainder is metabolized to *o*-cresol and excreted or exhaled unchanged. Toluene metabolism is inhibited by alcohol ingestion and is synergistic with benzene, asphalt fumes, or chlorinated hydrocarbons (i.e. perchloroethylene). Toluene is readily absorbed through the skin at 14 to 23 mg/cm²/hr. Toluene is absorbed quicker during exercise than at rest and appears to be retained longer in obese versus thin victims; presumably due to its lipid solubility. There is inconsistent data on toluene's ability to damage bone marrow; chronic poisoning has resulted in anemia and leucopenia with biopsy showing bone marrow hypo-plasia. These reports are few and some authorities argue that the effects may have been due to benzene contaminants. Chronic inhalation during pregnancy has been associated with teratogenic effects on the fetus including microcephaly, CNS dysfunction, attentional deficits, developmental delay + language impairment, growth retardation, and physical defects including a small midface, short palpebral fissures, with deep-set eyes, low-set ears, flat nasal bridge with a small nose, micrognathia, and blunt fingertips. There is some evidence that toluene causes an autoimmune illness in which the body produces antibodies that cause inflammation of its own kidney.

Continue on next page

Section 6. Health Hazard Data

Medical Conditions Aggravated by Long-Term Exposure: Alcoholism and CNS, kidney, skin, or liver disease. **Target Organs:** CNS, liver, kidney, skin. **Primary Entry Routes:** Inhalation, skin contact/absorption. **Acute Effects:** Vapor inhalation causes respiratory tract irritation, fatigue, weakness, confusion, dizziness, headache, dilated pupils, watering eyes, nervousness, insomnia, parasthesis, and vertigo progressing to narcotic coma. Death may result from cardiac arrest due to ventricular fibrillation with catecholamines loss. Liquid splashed in the eye causes conjunctival irritation, transient corneal damage and possible burns. Prolonged skin contact leads to drying and fissured dermatitis. Ingestion causes GI tract irritation and symptoms associated with inhalation. **Chronic Effects:** Symptoms include mucous membrane irritation, headache, vertigo, nausea, appetite loss and alcohol intolerance. Repeated heavy exposure may result in encephalopathies (cerebellar ataxia and cognitive dysfunction), liver enlargement, and kidney dystrophy (wasting away). Symptoms usually appear at workdays end, worsen at weeks end and decrease or disappear over the weekend.

FIRST AID **Eyes:** *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult an ophthalmologist immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water to dilute. *Do not* induce vomiting because of danger of aspiration into the lungs. Gastric lavage may be indicated if large amounts are swallowed; potential toxicity needs to be weighed against aspiration risk when deciding for or against gastric lavage. **Note to Physicians:** Monitor cardiac function. If indicated, use epinephrine and other catecholamines carefully, because of the possibility of a lowered myocardial threshold to the arrhythmogenic effects of such substances. Obtain CBC, electrolytes, and urinalysis. Monitor arterial blood gases. If toluene has > 0.02% (200 ppm) benzene, evaluate for potential benzene toxicity. BEI: hippuric acid in urine, sample at shift end (2.5 g/g creatinine); Toluene in venous blood, sample at shift end (1.0 mg/L).

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Cleanup personnel protect against inhalation and skin/eye contact. Use water spray to cool and disperse vapors but it may not prevent ignition in closed spaces. Cellosolve, hycar absorbent materials, and fluorocarbon water can also be used for vapor suppression/containment. Take up small spill with earth, sand, vermiculite, or other absorbent, noncombustible material. Dike far ahead of large spills for later reclamation or disposal. For water spills, (10 ppm or greater) apply activated carbon at 10X the spilled amount and remove trapped material with suction hoses or use mechanical dredges/lifts to remove immobilized masses of pollutants and precipitates. Toluene can undergo fluidized bed incineration at 842 to 1796 °F (450 to 980 °C), rotary kiln incineration at 1508 to 2912 °F (820 to 1600 °C), or liquid injection incineration at 1202 to 2912 °F (650 to 1600 °C). Follow applicable OSHA regulations (29 CFR 1910.120). **Ecotoxicity Values:** Blue gill, LC_{50} = 17 mg/L/24 hr; shrimp (*Crangonfracis coron*), LC_{50} = 4.3 ppm/96 hr; fathead minnow (*Pimephales promelas*), LC_{50} = 36.2 mg/L/96 hr. **Environmental Degradation:** If released to land, toluene evaporates and undergoes microbial degradation. In water, toluene volatilizes and biodegrades with a half-life of days to several weeks. In air, toluene degrades by reaction with photochemically produced hydroxyl radicals. **Disposal:** Treat contaminated water by gravity separation of solids, followed by skimming of surface. Pass through dual media filtration and carbon absorption units (carbon ratio 1 kg to 10 kg soluble material). Return waste water from backwash to gravity separator. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.33): No. U220
SARA Extremely Hazardous Substance (40 CFR 355), TPQ: Not listed
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1000 lb (454 kg)
[* per RCRA, Sec. 3001; CWA, Sec. 311 (b)(4); CWA, Sec. 307 (a)]
Listed as a SARA Toxic Chemical (40 CFR 372.65): Not listed

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses with shatter-resistant glass and side-shields or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For < 100 ppm, use any chemical cartridge respirator with appropriate organic vapor cartridges, any supplied-air respirator (SAR), or SCBA. For < 200 ppm, use any SAR operated in continuous-flow mode, any SAR or SCBA with a full facepiece, or any air-purifying respirator with a full facepiece having a chin-style, front or back mounted organic vapor canister. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent skin contact. Polyvinyl alcohol with a breakthrough time of > 8 hr, Teflon and Viton are recommended as suitable materials for PPE. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove toluene from your shoes and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Prevent physical damage to containers. Store in a cool, dry, well-ventilated area away from ignition sources and incompatibles. Outside or detached storage is preferred. If stored inside, use a standard flammable liquids warehouse, room, or cabinet. To prevent static sparks, electrically ground and bond all equipment used with toluene. Do not use open lights in toluene areas. Install Class 1, Group D electrical equipment. Check that toluene is free of or contains < 1% benzene before use. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. **Administrative Controls:** Adopt controls for confined spaces (29 CFR 1910.146) if entering areas of unknown toluene levels (holes, wells, storage tanks). Consider preplacement and periodic medical exams of exposed workers that emphasize the CNS, liver, kidney, and skin. Include hemocytometric and thrombocyte count in cases where benzene is a contaminant of toluene. Monitor air at regular intervals to ensure effective ventilation.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Toluene	**Packaging Authorizations**	**Quantity Limitations**	**Vessel Stowage Requirements**
DOT Hazard Class: 3	a) Exceptions: 150	a) Passenger Aircraft or Railcar: 5L	Vessel Stowage: B
ID No.: UN1294	b) Non-bulk Packaging: 202	b) Cargo Aircraft Only: 60L	Other: --
DOT Packing Group: II	c) Bulk Packaging: 242		
DOT Label: Flammable Liquid			
Special Provisions (172.102): T1			

MSDS Collection References: 26, 73, 100, 101, 103, 124, 126, 127, 132, 140, 148, 153, 159, 163, 164, 167, 169, 171, 174, 175, 176, 180.
Prepared by: M Gannon, BA; Industrial Hygiene Review: PA Roy, CIH, MPH; Medical Review: AC Darlington, MD, MPH

Material Safety Data Sheets Collection:

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Sheet No. 318
Xylene *(Mixed Isomers)*

Issued: 11/80 Revision: E, 9/92

Section 1. Material Identification

Xylene (Mixed Isomers) (C_8H_{10}) Description: The commercial product is a blend of the three isomers [*ortho-(o-)*, *meta-(m-)*, *para-(p-)*] with the largest proportion being *m-* xylene. Xylene is obtained from coal tar, toluene by transalkylation, and pseudocumene. Used in the manufacture of dyes, resins, paints, varnishes, and other organics; as a general solvent for adhesives, a cleaning agent in microscope technique; as a solvent for Canada balsam microscopy; as a fuel component; in aviation gasoline, protective coatings, sterilizing catgut, hydrogen peroxide, perfumes, insect repellants, pharmaceuticals, and the leather industry; in the production of phthalic anhydride, isophthalic, and terephthalic acids and their dimethyl esters which are used in the manufacture of polyester fibers; and as an indirect food additive as a component of adhesives. Around the home, xylene is found as vehicles in paints, paint removers, degreasing cleaners, lacquers, glues and cements and as solvent/vehicles for pesticides.

Other Designations: CAS No. 1330-20-7 [95-47-6; 108-38-3; 106-42-3 (*o-, m-, p-*isomers)], dimethylbenzene, methyltoluene, NCI-C55232, Violet 3, xylol.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

Cautions: Xylene is an eye, skin, and mucous membrane irritant and may be narcotic in high concentrations. It is a dangerous fire hazard.

R 1
I 2
S 2
K 3

NFPA
3 (top), 2 (left), 0 (right), – (bottom)

HMIS
H 2†
F 3
R 0
PPE ‡
† Chronic Effects
‡ Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Xylene (mixed isomers): the commercial product generally contains ~ 40% *m*-xylene; 20% each of *o*-xylene, *p*-xylene, and ethylbenzene; and small quantities of toluene. Unpurified xylene may contain pseudocumene.

1991 OSHA PELs
8-hr TWA: 100 ppm (435 mg/m^3)
15-min STEL: 150 ppm (655 mg/m^3)

1990 IDLH Level
1000 ppm

1990 NIOSH RELs
TWA: 100 ppm (435 mg/m^3)
STEL: 150 ppm (655 mg/m^3)

1992-93 ACGIH TLVs
TWA: 100 ppm (434 mg/m^3)
STEL: 150 ppm (651 mg/m^3)
BEI (Biological Exposure Index): Methylhippuric acids in urine at end of shift: 1.5 g/g creatinine

1990 DFG (Germany) MAK
TWA: 100 ppm (440 mg/m^3)
Category II: Substances with systemic effects
Half-life: < 2 hr
Peak Exposure: 200 ppm, 30 min, average value, 4 peaks per shift

1985-86 Toxicity Data*
Human, inhalation, TC_{Lo}: 200 ppm produced olfaction effects, conjunctiva irritation, and other changes involving the lungs, thorax, or respiration.
Man, inhalation, LC_{Lo}: 10000 ppm/6 hr; toxic effects not yet reviewed.
Human, oral, LD_{Lo}: 50 mg/kg; no toxic effect noted.
Rat, oral, LD_{50}: 4300 mg/kg; toxic effect not yet reviewed.
Rat, inhalation, LC_{50}: 5000 ppm/4 hr; toxic effects not yet reviewed.

* See NIOSH, *RTECS* (XE2100000), for additional toxicity data.

Section 3. Physical Data

Boiling Point Range: 279 to 284 °F (137 to 140 °C)*
Boiling Point: *ortho:* 291 °F (144 °C); *meta:* 281.8 °F (138.8 °C); *para:* 281.3 °F (138.5 °C)
Freezing Point/Melting Point: *ortho:* -13 °F (-25 °C); *meta:* -53.3 °F (- 47.4 °C); *para:* 55 to 57 °F (13 to 14 °C)
Vapor Pressure: 6.72 mm Hg at 70 °F (21 °C)
Saturated Vapor Density (Air = 1.2 kg/m^3): 1.23 kg/m^3, 0.077 lbs/ft^3
Appearance and Odor: Clear, sweet-smelling liquid.
Molecular Weight: 106.16
Specific Gravity: 0.864 at 20 °C/4 °C
Water Solubility: Practically insoluble
Other Solubilities: Miscible with absolute alcohol, ether, and many other organic liquids.
Octanol/Water Partition Coefficient: logKow = 3.12-3.20
Odor Threshold: 1 ppm
Viscosity: <32.6 SUS

* Materials with wider and narrower boiling ranges are commercially available.

Section 4. Fire and Explosion Data

Flash Point: 63 to 77 °F (17 to 25 °C) CC	Autoignition Temperature: 982 °F (527 °C) (*m*-)	LEL: 1.1 (*m-, p-*); 0.9 (*o-*)	UEL: 7.0 (*m-, p-*); 6.7 (*o-*)

Extinguishing Media: For small fires, use dry chemical, carbon dioxide (CO_2), water spray or regular foam. For large fires, use water spray, fog or regular foam. Water may be ineffective. Use water spray to cool fire-exposed containers. **Unusual Fire or Explosion Hazards:** Xylene vapors or liquid (which floats on water) may travel to an ignition source and flash back. The heat of fire may cause containers to explode and/or produce irritating or poisonous decomposition products. Xylene may present a vapor explosion hazard indoors, outdoors, or in sewers. Accumulated static electricity may occur from vapor or liquid flow sufficient to cause ignition. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighter's protective clothing will provide limited protection. If feasible and without risk, move containers from fire area. Otherwise, cool fire-exposed containers until well after fire is extinguished. Stay clear of tank ends. Use unmanned hose holder or monitor nozzles for massive cargo fires. If impossible, withdraw from area and let fire burn. Withdraw immediately in case of any tank discoloration or rising sound from venting safety device. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Xylene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur. Xylene is easily chlorinated, sulfonated, or nitrated. **Chemical Incompatibilities:** Incompatibilities include strong acids and oxidizers and 1,3-dichloro-5,5-dimethyl-2,4-imidazolidindione (dichlorohydrantoin). Xylene attacks some forms of plastics, rubber, and coatings. **Conditions to Avoid:** Avoid heat and ignition sources and incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of xylene can produce carbon dioxide, carbon monoxide, and various hydrocarbon products.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,[164] NTP,[169] and OSHA[164] do not list xylene as a carcinogen. **Summary of Risks:** Xylene is an eye, mucous membrane, and respiratory tract irritant. Irritation starts at 200 ppm; severe breathing difficulties which may be delayed in onset can occur at high concentrations. It is a central nervous system (CNS) depressant and at high concentrations can cause coma. Kidney and liver damage can occur with xylene exposure. With prolonged or repeated cutaneous exposure, xylene produces a defatting dermatitis. Chronic toxicity is not well defined, but it is less toxic than benzene. Prior to the 1950s, benzene was often found as a contaminant of xylene and the effects attributed to xylene such as blood dyscrasias are questionable. Since the late 1950s, xylenes have been virtually benzene-free and blood dyscrasias have not been associated with xylenes. Chronic exposure to high concentrations of xylene in animal studies have demonstrated milk reversible decrease in red and white cell counts as well as increases in platelet counts.

Continue on next page

Section 6. Health Hazard Data, *continued*

irregularity was reported in association with workplace exposure to xylene perhaps due to effects on liver metabolism. Xylene crosses the human placenta, but does not appear to be teratogenic under conditions tested to date. **Medical Conditions Aggravated by Long-Term Exposure:** CNS, respiratory, eye, skin, gastrointestinal (GI), liver and kidney disorders. **Target Organs:** CNS, eyes, GI tract, liver, kidneys, and skin. **Primary Entry Routes:** Inhalation, skin absorption (slight), eye contact, ingestion. **Acute Effects:** Inhalation of high xylene concentrations may cause dizziness; nausea, vomiting, and abdominal pain; eye, nose, and throat irritation; respiratory tract irritation leading to pulmonary edema (fluid in lung); drowsiness; and unconsciousness. Direct eye contact can result in conjunctivitis and corneal burns. Ingestion may cause a burning sensation in the oropharynx and stomach and transient CNS depression. **Chronic Effects:** Repeated or prolonged skin contact may cause drying and defatting of the skin leading to dermatitis. Repeated eye exposure to high vapor concentrations may cause reversible eye damage, peripheral and central neuropathy, and liver damage. Other symptoms of chronic exposure include headache, fatigue, irritability, chronic bronchitis, and GI disturbances such as nausea, loss of appetite, and gas.

FIRST AID *Emergency personnel should protect against exposure.* **Eyes:** *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. Carefully dispose of contaminated clothing as it may pose a fire hazard. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. Monitor exposed person for respiratory distress. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, *do not induce vomiting!* If spontaneous vomiting should occur, keep exposed person's head below the hips to prevent aspiration (breathing liquid xylene into the lungs). *Aspiration of a few millimeters of xylene can cause chemical pneumonitis, pulmonary edema, and hemorrhage.* **Note to Physicians:** Hippuric acid or the ether glucuronide of *ortho*-toluic acid may be useful in diagnosis of *meta-*, *para-* and *ortho*-xylene exposure, respectively. Consider gastric lavage if a large quantity of xylene was ingested. Proceed gastric lavage with protection of the airway from aspiration; consider endotracheal intubation with inflated cuff.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate all unnecessary personnel, remove all heat and ignition sources, and ventilate spill area. Cleanup personnel should protect against vapor inhalation and skin or eye contact. If feasible and without undue risk, stop leak. Use appropriate foam to blanket release and suppress vapors. Water spray may reduce vapor, but does not prevent ignition in closed spaces. For small spills, absorb on paper and evaporate in appropriate exhaust hood or absorb with sand or some non-combustible absorbent and place in containers for later disposal. For large spills dike far ahead of liquid to contain. Do not allow xylene to enter a confined space such as sewers or drains. On land, dike to contain or divert to impermeable holding area. Apply water spray to control flammable vapor and remove material with pumps or vacuum equipment. On water, contain material with natural barriers, booms, or weirs; apply universal gelling agent; and use suction hoses to remove spilled material. Report any release in excess of 1000 lb. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Transport:** Little bioconcentration is expected. Biological oxygen demand 5 (after 5 days at 20 °C): 0.64 (no stated isomer). **Ecotoxicity values:** LD_{50}, Goldfish, 13 mg/L/24 hr, conditions of bioassay not specified, no specific isomer. **Environmental Degradation:** In the atmosphere, xylenes degrade by reacting with photochemically produced hydroxyl radicals with a half-life ranging from 1-1.7 hr. in the summer to 10-18 hr in winter or a typical loss of 67-86% per day. Xylenes are resistant to hydrolysis. **Soil Absorption/Mobility:** Xylenes have low to moderate adsorption to soil and when spilled on land, will volatilize and leach into groundwater. **Disposal:** As a hydrocarbon, xylene is a good candidate for controlled incineration. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

Listed as a SARA Toxic Chemical (40 CFR 372.65)

Listed as a RCRA Hazardous Waste (40 CFR 261.33): No. U239, F003 (spent solvent)

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1000 lb (454 kg) [* per Clean Water Act, Sec. 311(b)(4); per RCRA, Sec. 3001]

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For concentrations >1000 ppm, use any chemical cartridge respirator with organic vapor cartridges; any powered, air-purifying respirator with organic vapor cartridges; any supplied-air respirator; or any self-contained breathing apparatus. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent all skin contact. With breakthrough times > 8 hr, consider polyvinyl alcohol and fluorocarbon rubber (Viton) as materials for PPE. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes. Launder contaminated work clothing before wearing. Remove this material from your shoes and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in clearly labelled, tightly closed, containers in a cool, well-ventilated place, away from strong oxidizing materials and heat and ignition sources. During transferring operations, electrically ground and bond metal containers. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. Use hermetically sealed equipment, transfer xylene in enclosed systems, avoid processes associated with open evaporating surfaces, and provide sources of gas release with enclosures and local exhaust ventilation. Use Class I, Group D electrical equipment. **Administrative Controls:** Establish air and biological monitoring programs and evaluate regularly. Consider preplacement and periodic medical examinations including a complete blood count, a routine urinalysis, and liver function tests. Consider hematologic studies if there is any significant contamination of the solvent with benzene. If feasible, consider the replacement of xylene by less toxic solvents such as petrol (motor fuel) or white spirit. Before carrying out maintenance and repair work, steam and flush all equipment to remove any xylene residues.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Xylenes
DOT Hazard Class: 3
ID No.: UN1307
DOT Packing Group: II
DOT Label: Flammable Liquid
Special Provisions (172.102): T1

Packaging Authorizations
a) Exceptions: 173.150
b) Nonbulk Packaging : 173.202
c) Bulk Packaging: 173.242

Quantity Limitations
a) Passenger, Aircraft, or Railcar: 5L
b) Cargo Aircraft Only: 60L

Vessel Stowage Requirements
a) Vessel Stowage: B
b) Other: –

MSDS Collection References: 26, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 140, 148, 149, 153, 159, 163, 164, 167, 171, 174, 176, 180.

Prepared by: MJ Wurth, BS; Industrial Hygiene Review: PA Roy, MPH, CIH; Medical Review: W Silverman, MD

ATTACHMENT C
EMERGENCY PROCEDURES FOR EXPOSURE TO HAZARDOUS MATERIALS/WASTE

ATTACHMENT C

EMERGENCY PROCEDURES FOR EXPOSURE TO HAZARDOUS MATERIALS/WASTE

1. Call ambulance or transport individual to hospital/clinic immediately. Monitor airway, breathing and circulation during trip to hospital or while waiting for the ambulance. Administer first aid or CPR, as necessary. Don't forget to take the HASP with you; it contains information on the contaminants expected to be found on site and will assist the physician in his/her assessment of the exposure.

2. Fill in Potential Exposure Report, answering each of the questions to the best of your ability.

3. Contact our physician(s) at EMR as soon as possible. The procedure is as follows:

   a. **Call EMR at 1-800-229-3674!**

   b. Ask to speak with:

      Dr. David L. Barnes;
      Dr. Elaine Theriault; or
      Ms. T.J. Wolff, R.N.

Note: During nonbusiness hours (after 6 p.m.) call 1-800-229-3674 and follow directions for paging the aforementioned individuals.

4. Once in contact with any of these individuals, explain what has happened (they will review the information on the form with you and may ask you to fax the form to them, if possible), and allow either of them to speak with the attending physician.

5. When asked about payment (and they will ask), inform the Hospital/Clinic/Physician that this is a "work related injury" and have them contact the Benefits Coordinator at (412) 269-2744. Have invoices sent to:

   Michael Baker Jr. Inc.
   Attn: Benefits Coordinator
   Airport Office Park, Bldg. 3
   Coraopolis, PA 15108

6. Contact the Project Manager and the Project Health and Safety Officer as soon as it is feasible, but wait no longer than 24 hours.

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POTENTIAL EXPOSURE REPORT

Name: ______________________ Date of Exposure: ______________

Social Security No.: ______________ Age: ________ Sex: ________

I. Exposing Agent

Name of Product or Chemicals (if known) ______________________

____

Characteristics (if the name is not known)

Solid Liquid Gas Fume Mist Vapor

II. Dose Determinants

What was individual doing? ______________________

How long did individual work in area before signs/symptoms developed?

____

Was protective gear being used? If yes, what was the PPE?

____

Was there skin contact? ______________________

Was the exposing agent inhaled? ______________________

Were other persons exposed? If yes, did they experience symptoms?

____

III. Signs and Symptoms (check off appropriate symptoms)

Immediately with Exposure:

- ☐ Burning of eyes, nose, or throat
- ☐ Tearing
- ☐ Headache
- ☐ Cough
- ☐ Shortness of breath
- ☐ Delirium
- ☐ Chest tightness/pressure
- ☐ Nausea/vomiting
- ☐ Dizziness
- ☐ Weakness
- ☐ Heat flashes
- ☐ Other ______________

Delayed Symptoms:

- ☐ Weakness
- ☐ Nausea/vomiting
- ☐ Shortness of breath
- ☐ Cough
- ☐ Loss of appetite
- ☐ Abdominal pain
- ☐ Headache
- ☐ Numbness/tingling
- ☐ Other ______________

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Baker Environmental, Inc.

POTENTIAL EXPOSURE REPORT

IV. Present Status of Symptoms (check off appropriate symptoms)

- ☐ Burning of eyes, nose, or throat
- ☐ Tearing
- ☐ Headache
- ☐ Cough
- ☐ Shortness of breath
- ☐ Chest tightness/pressure
- ☐ Cyanosis (bluish skin color)
- ☐ Nausea/vomiting
- ☐ Dizziness
- ☐ Weakness
- ☐ Loss of appetite
- ☐ Abdominal pain
- ☐ Numbness/tingling
- ☐ Other ______________________

Have symptoms (please check off appropriate response and give duration of symptoms):

Improved ________ Worsened ________ Remain Unchanged ________

V. Treatment of Symptoms (check off appropriate response)

None ________ Self-medicated ________ Physician treated ________

VI. Name ____________________________________
(Attending physician)

VII. Hospital/Clinic ____________________________________

Source: EMR, Inc.