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FINAL

SOLID WASTE MANAGEMENT UNIT (SWMU) CONFIRMATORY SAMPLING PROJECT PLANS

MCB CAMP LEJEUNE, NORTH CAROLINA

CONTRACT TASK ORDER 0371

AUGUST 21, 1997

Prepared for:

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

Under the:

LANTDIV CLEAN Program
Contract N62470-89-D-4814

Prepared by:

BAKER ENVIRONMENTAL, INC.
Coraopolis, Pennsylvania

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LIST OF ACRONYMS

AOCs	area of concerns
AST	above ground storage tank
Baker	Baker Environmental, Inc.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Laboratory Program
CMI	Corrective Measures Implementation
CMS	Corrective Measures Study
DOT	Department of Transportation
FMF	Fleet Marine Force
FMFLANT	Fleet Marine Force Atlantic
FSAP	Field Sampling and Analysis Plan
gpm	gallons per minute
GSRA	Greater Sandy Run Area
HASP	Health and Safety Plan
HSWA	Hazardous and Solid Waste Amendments of 1984
IAS	Initial Assessment Study
IDW	investigation derived waste
IR	Installation Restoration
LANTDIV	Naval Facilities Engineering Command, Atlantic Division
MAGTF	Marine Air Ground Task Force
MCAS	Marine Corps Air Station
MCB	Marine Corps Base
MEK	methyl ethyl ketone
mg/L	milligrams per liter
MSL	mean sea level
NC DEHNR	North Carolina Department of Environment, Health and Natural Resources
NFA	no further action
NFESC	Naval Facilities Engineering Service Center
PCBs	polychlorinated biphenyls
PID	photoionization detection
POL	petroleum, oil, and lubricant
QAPP	Quality Assurance Project Plan

LIST OF ACRONYMS
(Continued)

RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
STP	sewage treatment plant
SWMU	solid waste management unit
SVOA	semivolatile organic analysis
TAL	target analyte list
TCE	trichloroethene
TSD	treatment, storage, and disposal
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UST	underground storage tank
VOA	volatile organic analysis

1.0 INTRODUCTION

Marine Corps Base (MCB) Camp Lejeune was issued a Resource Conservation and Recovery Act (RCRA) Part B Permit to operate a hazardous waste container storage facility in September 1984 for the long-term hazardous material/hazardous waste container storage facility (Buildings TP-451 and TP-463). This permit was issued prior to the enactment of the Hazardous and Solid Waste Amendments of 1984 (HSWA), which under Section 3004(u) empowers the United States Environmental Protection Agency (USEPA) to order corrective action at treatment, storage, and disposal (TSD) facilities. This section of the HSWA requires corrective action to be taken for all releases of hazardous waste or hazardous constituents from any solid waste management unit (SWMU) (EnSafe, 1996).

A SWMU is defined by the North Carolina Department of Environment, Health and Natural Resources (NC DEHNR) as: "Any discernible unit which has been used for the treatment, storage, or disposal of solid waste at any time, irrespective of whether the unit is or ever was intended for management of solid waste. RCRA regulated hazardous waste management units are also solid waste management units." A SWMU may include any landfill, surface impoundment, waste pile, land treatment unit, incinerator, injection well, tank, container storage area, septic tank, drain field, waste water treatment unit, elementary neutralization unit, transfer station, or recycling unit (EnSafe, 1996).

A RCRA corrective action can have five stages:

- RCRA Facility Assessment (RFA);
- Interim Measure;
- RCRA Facility Investigation (RFI);
- Corrective Measures Study (CMS); and
- Corrective Measures Implementation (CMI).

An RFA is conducted in response to a real or suspected release. The RFA may consist of three parts: preliminary review, visual site inspection, and sampling visit. The results of the RFA determine if a release has or is occurring. An interim measure can be conducted as a response to a release of hazardous constituents which is imminently endangering human health or the environment. The third corrective action stage, the RFI, involves the process of characterizing the nature and extent of a release (confirmed by the RFA). The CMS is the process of evaluating and selecting technologies to address released hazardous constituents. A CMI is the implementation of the selected remedy.

The USEPA Region IV and NC DEHNR conducted an initial RFA for MCB Camp Lejeune in January 1989. Their report covered 76 sites, of which seven were determined to require RFA sampling visits, 23 to require an RFI and 46 to require no further action (NFA). MCB Camp Lejeune has taken the initial RFA and has expanded it to include units such as landfills, surface impoundments, waste piles, tanks, container storage, septic tanks, drain fields, waste water treatment units, and storm water conveyances. The Base's efforts included the review of preliminary review and visual site inspection on potential SWMUs or areas of concerns (AOCs). More than 3,500 sites/units were identified during a preliminary review of MCB records. Visual site inspections were conducted on nearly 500 of these sites/units. The findings from this investigation are presented in the document entitled, "RCRA Facility Assessment Report for Marine Crops Base Camp Lejeune, North Carolina" (EnSafe, 1996). This report will hereafter be referred to as the 1996 RFA Report. The 1996 RFA Report categorized each of the potential SWMUs and AOCs into four groups:

- Units having a release potential;
- Units being addressed under the Installation Restoration (IR) Program in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA);
- Units being addressed under the IR Underground Storage Tank (UST) Program in accordance with NC DEHNR requirements; and
- Units having a release potential under RCRA corrective action requiring confirmatory sampling.

The 1996 RFA Report identified 41 IR sites, 112 UST sites, and 56 SWMU sites requiring confirmatory sampling or corrective measures. The IR sites and the UST sites were not recommended for confirmatory sampling. Based on these findings and additional information obtained following the 1996 RFA site visits, the Base has assigned Baker Environmental, Inc. (Baker) to conduct confirmatory sampling at 62 SWMUs (this total includes seven IR sites that have been delisted). "Delisted" is defined as being removed from the list of sites at Camp Lejeune that require further action under the Base's IR Program.

1.1 Objective of the Confirmatory Sampling Work Plan

The objective of this Confirmatory Sampling Work Plan is to identify the tasks required to implement a confirmatory sampling investigation for the 62 SWMUs at MCB Camp Lejeune which have been recommended for further investigation. The various procedures required to collect the appropriate data are described in this Work Plan. In addition, the Work Plan documents the scope and objectives of the individual Confirmatory Sampling activities. It serves as a tool for assigning responsibilities and establishing the project schedule and cost. In addition, the specific sampling program to be conducted at each of the 62 SWMU is detailed in this Work Plan.

1.2 Work Plan Format

In addition to Section 1.0, the following sections are presented in this Confirmatory Sampling Work Plan:

- Section 2.0 - Background and Setting
- Section 3.0 - Sampling Objectives
- Section 4.0 - Confirmatory Sampling Tasks
- Section 5.0 - SWMU-Specific Information
- Section 6.0 - Project Management and Staffing
- Section 7.0 - Schedule
- Section 8.0 - References

Section 2.0 summarizes relevant background information pertaining to MCB Camp Lejeune and the 62 SWMUs. Section 3.0 defines the sampling objectives. Section 4.0 identifies and describes the tasks and field investigation activities that will be implemented to complete the Confirmatory Sampling investigation in terms of meeting the SWMU-specific objectives. Section 5.0 presents the SWMU-specific background information and the proposed sampling strategy for each SWMU. The sampling strategy will include the media to be sampled, the number of samples to be collected, and the parameters the samples will be analyzed. Section 6.0 discusses project staffing for implementing the Confirmatory Sampling investigation. The investigation schedule is provided in Section 7.0. References used in developing the Work Plan are provided in Section 8.0.

All of the Work Plan tables, figures, and photographs are presented at the end of the Work Plan.

2.0 BACKGROUND AND SETTING

The purpose of this section is to summarize relevant background information pertaining to MCB Camp Lejeune and the 62 SWMUs under further investigation. Additional background information is presented in the following documents:

- Final Site Summary Report, Marine Corps Base, Camp Lejeune (ESE, 1990)
- Hydrogeology of Aquifers in Cretaceous and Younger Rocks in the Vicinity of Onslow and Southern Jones Counties, North Carolina (USGS, 1990a)
- Continuous Seismic Reflection Profiling of Hydrogeologic Features Beneath New River, Camp Lejeune, North Carolina (USGS, 1990b)
- Assessment of Hydrologic and Hydrogeologic Data at Camp Lejeune Marine Corps Base, North Carolina (USGS, 1989)
- Initial Assessment Study (IAS) of Marine Corps Base Camp Lejeune, North Carolina (Water and Air Research, 1983)

2.1 Marine Corps Base Camp Lejeune

This section provides an overview of the physical features associated with MCB Camp Lejeune, North Carolina (which also includes 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 and southern border of MCB Camp Lejeune is the Atlantic shoreline. The western and northern boundaries are U.S. Route 17 and State Route 24, respectively. The City of Jacksonville, North Carolina, borders MCB Camp Lejeune to the north. Figure 2-1 identifies the general location of MCB Camp Lejeune. 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 MCB or Complex was taken from the document "Master Plan, Camp Lejeune Complex, North Carolina." The Complex consists of 12 identifiable developed areas:

- Hadnot Point
- Paradise Point
- Berkeley Manor/Watkins Village
- Midway Park
- Tarawa Terrace I and II
- Knox Trailer
- Camp Geiger and MCAS New River
- Montford Point
- French Creek
- Onslow Beach
- Courthouse Bay
- Rifle Range

These areas are presented on Figure 2-1. 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, 26th Marine Amphibious Unit, as well as the Headquarters and regimental areas for the 2nd Marine Division, Marine Expeditionary Force, 6th Marine Expeditionary Brigade, 22nd Marine Expeditionary 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).

The MCAS New River and Camp Geiger are considered as a single urban area possessing two separate missions and supported by two unrelated groups of personnel. The 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 marshland.

The Camp Lejeune Complex 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 MCB 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 Expeditionary 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 of Camp Lejeune

Construction of MCB Camp Lejeune began in 1941 with the objective of developing the "World's Most Complete Amphibious Training Base." Construction of the Base started at Hadnot Point, where the major functions of the Base are centered.

The MCB organization functions as the host command to the two Fleet Marine Force Atlantic (FMFLANT) tenant activities -- Headquarters of the II Marine Expeditionary 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 Expeditionary 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 Summary of Hazardous Wastes Generated

MCB Camp Lejeune generates various hazardous wastes which can generally be classified as waste batteries, waste oil filters, waste solvents, waste paint, discarded commercial chemical products, and others (EnSafe, 1996).

Waste batteries are made up of lithium, magnesium, mercury, nickel-cadmium, and electrolyte. Spent lithium batteries, if not deactivated, can be reactive. Magnesium and mercury batteries may be hazardous due to chromium and mercury contents. Nickel-cadmium batteries may be hazardous due to cadmium levels. Waste electrolyte can be generated when lead-acid batteries are drained, wet cell nickel-cadmium batteries are discarded, or when waste electrolyte is discarded. Electrolyte can be hazardous based on corrosivity properties and/or lead or cadmium contents (EnSafe, 1996).

Waste oil filters are routinely generated from vehicle and aircraft maintenance operations. In the past when terne-plated filters were used, they were classified as hazardous waste due to their lead content (EnSafe, 1996).

Solvents such as methyl ethyl ketone (MEK), toluene, xylene, and methylene chloride are used in vehicle, military hardware, and aircraft maintenance. These types of solvents exhibit a RCRA characteristic or are listed as a RCRA hazardous waste (EnSafe, 1996).

Several types of waste paint are generated at the Base: enamel, chemical-resistive coating, epoxy, and oil-based. These waste paints may exhibit a RCRA characteristic and/or contain a RCRA-listed hazardous waste (EnSafe, 1996).

The Bases' Naval Hospital is a major generator of discarded commercial chemical products. Generally, these products are discarded due to expired shelf life. These discarded products may be classified as hazardous waste (EnSafe, 1996).

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 (Water and Air Research, 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; this increases downstream to 11 feet above msl near the coastal area (Water and Air Research, 1983).

2.1.5 Regional Geology

MCB Camp Lejeune is located in the Atlantic Coastal Plain physiographic province. The sediments of the province consist predominantly of sand, silt, and clay. Other sediments may be present, including peat, shell beds and gravel. Sediments may be of marine or continental origin (Back, 1966). These sediments lay in interfingering beds and lenses that gently dip and thicken to the southeast (ESE, 1990). These sediments range in age from early Cretaceous to Quaternary time and overlie igneous and metamorphic rocks of pre-Cretaceous age. Table 2-1 presents a listing of the geologic and hydrogeologic units present in the Coastal Plain of North Carolina.

United States Geological Survey (USGS) studies at MCB Camp Lejeune indicate that the Base is underlain by sand, silt, clay, calcareous clay and partially consolidated limestone. Aquifers that occur beneath the Base include the surficial, Castle Hayne, Beaufort, Peedee, Black Creek, and upper and lower Cape Fear aquifers (see Table 2-1). The combined thickness of these sediments beneath the Base is approximately 1,500 feet. A generalized hydrogeologic cross-section illustrating the relationship between the aquifers in the MCB Camp Lejeune area is presented in Figures 2-2 and 2-3.

2.1.6 Regional Hydrogeology

The aquifers of primary interest at MCB Camp Lejeune are the surficial aquifer and the aquifer immediately below it, the Castle Hayne. The following summary is a compilation of information, including Harned et al. (1989), and Cardinell et al. (1993).

The surficial aquifer consists of interfingering beds of sand, clay, sandy clay, and silt that contain some peat and shells. These beds are thin and discontinuous, and have limited lateral continuity. This aquifer is not currently used as a potable water supply at MCB Camp Lejeune.

The thickness of the surficial aquifer ranges from 0 to 73 feet and averages nearly 25 feet over the MCB Camp Lejeune area. It is generally thickest in the interstream divide areas and presumed absent where it is cut by the New River and its tributaries.

The general lithology of the surficial aquifer and the absence of any thick, continuous clay beds are indications of good vertical conductivity within the aquifer. Data compiled by Cardinell estimate the lateral hydraulic conductivity of the surficial aquifer in the MCB Camp Lejeune area to be 50 feet/day, which is based on a general composition of fine sand mixed with some silt and clay. However, data from slug tests on monitoring wells installed by Baker indicate much lower lateral hydraulic conductivity values, ranging from 0.12 to 9.00 feet/day.

Between the surficial and the Castle Hayne aquifers lies the Castle Hayne confining unit. This unit consists of clay, silt, and sandy clay beds. In general, the Castle Hayne confining unit may be characterized as a group of less permeable beds at the top of the Castle Hayne aquifer that have been partly eroded or incised in places.

The Castle Hayne confining unit is discontinuous, and has a thickness ranging from 0 to 26 feet, averaging nine feet where present. There is no discernable trend in the thickness of the confining unit. There is no information in the USGS literature regarding any trend of the depth of the confining unit.

The data compiled by Cardinell, et. al., indicate that the vertical hydraulic conductivity of the Castle Hayne confining unit ranges from 0.0014 to 0.41 feet/day. Based on the moderate conductivity values and the thin, discontinuous nature of the confining unit, this unit may only be partly effective in retarding the vertical movement of groundwater between the surficial aquifer to the Castle Hayne aquifer.

The Castle Hayne aquifer lies below the surficial aquifer and consists primarily of unconsolidated sand, shell fragments, and fossiliferous limestone. Clay, silt, silty and sandy clay, and indurated limestone also occur within this aquifer. The upper part of the Castle Hayne aquifer consists primarily of calcareous sand with some continuous and discontinuous thin clay and silt beds. The calcareous sand becomes more limey with depth. The lower part of the aquifer consists of consolidated or poorly consolidated limestone and sandy limestone interbedded with clay and sand.

The Castle Hayne aquifer is approximately 150 to 350 feet thick in the MCB Camp Lejeune area, and thickens eastward across the Base. The top of the aquifer lies approximately 20 to 73 feet below the ground surface. The top of the aquifer dips southward, and is deepest at the Atlantic coast, east of the New River. The top of the aquifer also forms a basin in the vicinity of Paradise Point. Estimates of hydraulic conductivity indicate a wide variation in range, from 14 to 91 feet/day.

Onslow County and MCB Camp Lejeune lie in an area where the Castle Hayne aquifer generally contains freshwater. However, the proximity of saltwater in deeper layers just below the aquifer and in the New River estuary is of concern in managing water withdrawals. Over-pumping of the deeper parts of the aquifer could cause encroachment of saltwater. The groundwater from this aquifer generally contains less than 250 milligrams per liter (mg/L) chloride throughout the Base, except for one monitoring well (USGS-8) located in the southern portion of the Base. This monitoring well is screened in the lower portion of the aquifer. Chloride was measured at 960 mg/L in a single groundwater sample collected from this monitoring well in 1989.

Rainfall in the Camp Lejeune area can enter the ground in recharge areas, infiltrate the soil, and move downward until it reaches the surficial aquifer. Recharge areas at Camp Lejeune include the interstream areas. In the surficial aquifer, groundwater flows in the direction of lower hydraulic head until it reaches discharge points or fronts. These discharge areas include the New River and its tributaries, and the ocean. Though most of the rainfall entering the surficial aquifer discharges to local streams, a relatively small amount infiltrates to the Castle Hayne. The surficial aquifer supplies the primary recharge to the Castle Hayne aquifer. Like the surficial aquifer, the Castle Hayne naturally discharges to the New River and major tributaries. However, pumping of the Castle Hayne may locally influence discharge directions.

The potentiometric surface of the surficial aquifer varies seasonally. The potentiometric surface is determined by measuring the water levels in the monitoring wells. The surficial aquifer 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 potentiometric surface of the surficial aquifer is generally highest in the winter months and lowest in the summer or early fall.

Water levels in monitoring wells screened in the deeper aquifers, such as the Castle Hayne, were also used to establish potentiometric surfaces. Because the Castle Hayne is at least partially confined from the surficial aquifer and is not influenced by rainfall as strongly as the surficial aquifer. Therefore, the seasonal variations tend to be slower and smaller than in the surficial aquifer.

2.1.7 Surface Water Hydrology

The dominant surface water feature at MCB Camp Lejeune is the New River. It receives drainage from most of the Base. The New River is short, with a course of approximately 50 miles on the central Coastal Plain of North Carolina. Over most of its course, the New River is confined to a relatively narrow channel entrenched in 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 and are 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 (Water and Air Research, 1983). The New River, the Intracoastal Waterway, and the Atlantic Ocean meet at 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, 1990).

2.1.8 Climatology

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

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

Observations of sky conditions indicate yearly averages of approximately 112 days clear, 105 partly cloudy, and 148 cloudy. Measurable amounts of rainfall occur 120 days per year, on the average. Prevailing winds are generally from the south-southwest 10 months of the year, and from the north-northwest during September and October at an average speed of 6.9 miles per hour.

2.1.9 Natural Resources and Ecological Features

MCB Camp Lejeune is predominantly tree-covered with large amounts of softwood including short-leaf, long-leaf, 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 (Water and Air Research, 1983).

Upland game species including black bear, white-tail deer, gray squirrel, fox squirrel, quail, turkey, and migratory waterfowl are abundant and are considered in the wildlife management programs (Water and Air Research, 1983).

Aquatic ecosystems on MCB Camp Lejeune consist of small lakes, the New River estuary, numerous tributaries, creeks, and part of the Intracoastal Waterway. A wide variety of freshwater and saltwater fish species exist here. Freshwater ponds are under management to produce optimum yields and ensure continued harvest of desirable fish species (Water and Air Research, 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 species. Both recreational and commercial fishing are practiced in the waterways of the New River and its tributaries (Water and Air Research, 1983).

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 (Water and Air Research, 1983).

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 (Water and Air Research, 1983).

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 (Water and Air Research, 1983).

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 (Water and Air Research, 1983).

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 (Water and Air Research, 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 (Water and Air Research, 1983).

2.1.10 Land Use and Demographics

MCB Camp Lejeune presently covers an area of approximately 236 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 and Vietnam conflicts, and the recent Gulf War (i.e., Desert Storm). Toward the end of World War II, the camp was designated as a home base for the Second Marine Division. Since that time, Fleet Marine Force (FMF) units also have been stationed at the Base as tenant commands.

Land uses within MCB Camp Lejeune include: operations, training, maintenance, supply/storage, medical, administration, family housing, troop housing, recreation, and utility (DON, 1988). The existing land uses with respect to acres and percentage of area in the various developed areas within the MCB are listed on Table 2-2. The developed areas are depicted on Figure 2-1.

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 (Water and Air Research, 1983).

Military population of 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. 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

Potable water for MCB Camp Lejeune is supplied entirely by groundwater. The Base has no formally established groundwater preservation areas; however, because the Base controls more than 110,000 acres of land, and because much of this land has remained undeveloped, the undeveloped areas serve the function of groundwater preserves. Groundwater usage is roughly seven million gallons per day (Cardinell, et al., 1993). Groundwater is pumped from approximately 75 of 90 water supply wells located within the boundaries of MCB Camp Lejeune. The extracted groundwater is treated at one of eight water treatment plants which have a total capacity to treat 15.8 million gallons of water per day.

All of the water supply wells utilize the Castle Hayne aquifer. The Castle Hayne aquifer is highly permeable, semi-confined aquifer that is capable of yielding several hundred to 1,000 gallons of water per minute (gpm) in municipal and industrial wells in the MCB Camp Lejeune area. The water supply wells at the Base average 162 feet in depth; eight inches in diameter (casing); and yield 174 gpm (Harned, et al., 1989). The water is typically a hard, calcium bicarbonate type.

2.2 Solid Waste Management Units

There are 62 SWMUs at MCB Camp Lejeune that are included in the confirmatory sampling investigation. Table 2-3 lists the SWMU identification numbers and the corresponding SWMU names. For organizational purposes and ease of reading, the SWMU-specific background information will be presented in Section 5.0 of this Work Plan.

3.0 SAMPLING OBJECTIVES

The overall objective of the confirmatory sampling investigation is to obtain analytical data to determine if contamination is present at each SWMU, and therefore, to determine if additional action is warranted in the form of a RFI or CMI. The type of data required to meet the sampling objective are presented in Section 5.0 of this Work Plan.

As per NC DEHNR's request, the confirmatory sampling is being conducted in two phases. Phase I will be a soil investigation conducted at each of the 62 SWMUs. Surface water and sediment samples will be collected at certain SWMUs as appropriate. Upon review of the analytical data, discussions will be held between MCB Camp Lejeune, Naval Facilities Engineering Command, Atlantic Division, (LANTDIV), NC DEHNR and Baker to determine if additional data is needed in the form of groundwater samples and/or additional borings at any SWMU. The additional work required to acquire this data (if any) will comprise Phase II. Methodology for temporary well installation and groundwater sample acquisition is included as part of these Project Plans even though these activities will not occur until the commencement of Phase II.

The quality of data required for this confirmatory sampling investigation will be Level III which is similar to Naval Facilities Engineering Service Center (NFESC) Level C. Data quality levels differ with respect to the end use of the data. Level IV data quality is 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. 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.

Because this investigation focuses on confirmatory sampling, only USEPA approved analytical methods (Level III) will be employed for organic analyses. In order to maintain consistency, Contract Laboratory Program (CLP) methods (Level IV) will be employed for analysis of the inorganics. All monitoring conducted in the field will be performed as Level I.

4.0 CONFIRMATORY SAMPLING TASKS

This section identifies the tasks and field investigations required to complete confirmatory sampling. investigation for the 62 SWMUs.

4.1 Task 1 - Project Management

The project management effort will involve activities such as daily technical support and guidance, budget and schedule review and tracking, preparation and review of invoices, resource planning and allocation, preparation of monthly progress reports, and communication with LANTDIV and the Activity.

4.2 Task 2 - Subcontract Procurement

Task 2 will involve the procurement of subcontractor services such as drilling and laboratory analysis. Procurement of these services will be performed in accordance with the Navy CLEAN Contract Procurement Manual.

4.3 Task 3 - Field Investigations

The SWMU field investigations will be conducted under Task 3. The confirmatory sampling will be conducted in two phases. Phase I involves a soil investigation and/or surface water and sediment investigation that will be conducted at each of the 62 SWMUs. Upon review of the analytical data, a groundwater investigation may be conducted at selected SWMUs as part of Phase II. A brief overview of the field investigations is presented below. Specific details with respect to the sampling procedures, locations and number of samples, and analytical methods are provided in Section 5.0 of this Work Plan, the Field Sampling and Analysis Plan (FSAP), and/or the Quality Assurance Project Plan (QAPP).

The field-related activities which will be implemented under Task 3 will include:

- Mobilization/Pre-investigation Support Activities
- Soil Investigation (Phase I)
- Surface Water/Sediment Investigation (Phase I)
- Groundwater Investigation (Phase II)
- Investigation Derived Waste (IDW) Handling

The SWMUs are generally smaller in size than the typical IR Program and UST sites at the Base. Many SWMUs are oil/water separators, storage tanks, or small suspected release sites of relatively recent origin. As a result, soil, surface water, and sediment sampling will not be conducted at every SWMU during Phase I. Some SWMUs will only require soil sampling while others may require the sampling of all three media. Section 5.2 of this Work Plan identifies the SWMU-specific sampling strategy for each SWMU.

Typical mobilization/pre-investigation support activities will be implemented under Task 3. This will include mobilizing the appropriate field personnel, equipment, and materials to the Base. It will also include the field personnel reviewing the Health and Safety Plan (HASP).

Soil cuttings are expected to remain at the SWMU unless deemed hazardous. If high photoionization detection (PID) readings or evidence of gross contamination is observed, then the cuttings will be temporarily contained in Department of Transportation (DOT) approved 55-gallon drums and staged at a central location. The contained cuttings will be analyzed and disposed properly. Additional details regarding IDW handling and disposal are provided in the FSAP.

4.4 Task 4 - Sample Analysis and Tracking

Task 4 will involve efforts relating to the following post-field sampling activities:

- Sample Management
- Laboratory Analysis

Sample management activities will involve: laboratory coordination, tracking of samples submitted for analysis, and tracking of analyses received. Sample management may also involve resolving potential problems during the course of the sampling and analytical programs (e.g., reanalysis, or resubmission of information).

Laboratory analysis begins when the samples are shipped from the field and received by the laboratory. The analytical results will not be validated by a third-party validator.

4.5 Task 5 - Data Evaluation

Task 5 will involve efforts related to the data once it is received from the laboratory . It also involves the evaluation of any field-generated data. Efforts under this task will include the tabulation of data and field data, generation of test boring logs (if applicable), and the generation of other diagrams associated with field notes or data received from the laboratory (e.g., sampling location maps, concentration maps).

4.6 Task 6 - Confirmation Sampling Report

Task 6 is intended to cover the work efforts related to the preparation of the confirmatory sampling findings once the data have been evaluated under Task 5. Task 6 includes the preparation of one Confirmatory Sampling report which will incorporate information pertaining to all 62 SWMUs. The report will present the analytical data obtained during the field investigations and will provide recommendations for each of the SWMUs with respect to additional investigations. The information provided in the Confirmatory Sampling report will be used to assist the Base with further actions pertaining to each of the SWMUs.

Draft and Final Confirmatory Sampling Reports will be prepared under this task.

4.7 Task 7 - Meetings and Conference Calls

Task 7 will involve providing technical support to LANTDIV during the project. It is anticipated that the following meetings and conference calls will be required under this task:

> **Meeting with NC DEHNR** - Baker may participate in one meeting with representatives from NC DEHNR, LANTDIV, and the Activity. It is anticipated that this meeting will take place at the Activity.
>
> **Phone Conference** - Baker may host and participate in two telephone conferences to discuss the project progress. Participants in these conference calls may include NC DEHNR, the Activity, and LANTDIV.

Baker will prepare and distribute minutes of the meeting and conference calls.

5.0 SWMU-SPECIFIC INFORMATION

This section presents background information for each of the 62 SWMUs and defines the proposed sampling strategies at each SWMU.

5.1 Background Information

Table 5-1 presents the SWMU-specific background information. This information includes the SWMU name, the type of unit, the period of operation (if known), a SWMU description, and the type of wastes/materials managed at each SWMU. The majority of information presented on Table 5-1 was obtained from the 1996 RFA Report (EnSafe, 1996).

In October 1996, Baker conducted a site visit to view the 62 SWMUs selected for confirmatory sampling. Baker identified differences in several of the SWMUs when compared to the EnSafe site visit conducted in 1993. A summary of the observations noted during Baker's October 1996 site visit to the 62 SWMUs is presented on Table 5-2.

Figures 5-1 through 5-50 present sketches of each of the SWMUs. Some of the SWMUs have been grouped together on a sketch (if they are located near one another). For example, SWMUs 2, 53, 256, 257, and 296 are presented together on Figure 5-1. In addition, photographs taken from the majority of SWMUs are presented as a separate tabbed section at the end of this Work Plan. The photographs are a collaboration from the 1993 EnSafe assessment, MCB Camp Lejeune's photographs, and photographs taken during Baker's October 1996 site visit.

5.2 Proposed Sampling Strategy

The following section details the sampling strategy developed for each of the 62 SWMUs investigated under this project. The number and type of samples along with the proposed analyses are presented below with respect to each of the 62 SWMUs.

The focus of this confirmatory sampling investigation is to determine if contamination has impacted the environmental media in the vicinity of the SWMUs and if additional action is warranted in the form of a Phase II sampling effort, a RFI or a CMS. It is not the focus of the confirmatory sampling investigation to determine the extent (if any) of contamination detected at the SWMUs. Therefore the number of samples collected at the SWMUs are based on the dimensions of the SWMUs and observations made during the site visit. The locations were determined by visual evidence of spills, potential migration routes, topography, etc.

Table 5-3 presents a summary of the sampling strategy proposed for all of the 62 SWMUs. Specific details of the sampling strategy per SWMU are presented below. Soil samples will be collected at the SWMUs using a Geoprobe direct push technology, therefore reducing the quantity of IDW soils. During Phase II, temporary monitoring wells may be installed at selected SWMUs as appropriate. The temporary wells will be constructed in a manner allowing the screen to intercept the water table. Each temporary well will be purged and sampled using low-flow methods. Upon sample collection, the temporary wells will be removed and the boreholes will be backfilled with a mixture of bentonite and soil cuttings. Figures 5-51 through 5-100 present the proposed sampling locations for the SWMUs to be investigated. Note that some of the SWMUs are grouped together on a sketch if they are located near one another.

The sampling scheme for this confirmatory sampling investigation was modeled after the operable unit approach used in conducting remedial investigation/feasibility studies. The analytical program for each of the SWMUs was determined based on characteristics of the site, past and current activities at the SWMU, contaminant waste characteristics (i.e., fuel oil, motor oil, solvents, etc.), and location of the SWMU within MCB Camp Lejeune.

5.2.1 SWMUs 2, 53, 256, 257 and 296

The following sampling strategy is proposed for the confirmatory sampling to be conducted at SWMUs 2, 53, 256, 257 and 296. Figure 5-51 identifies the soil boring locations.

The proposed soil investigation was developed to determine if operations conducted at SWMUs 2, 53, 256, 257 and 296 have had an environmental impact on the soils in the vicinity of each SWMU.

A total of 21 soil borings are proposed for the purpose of collecting surface and subsurface soil samples (Figure 5-51). Six borings are associated with SWMU 2; four with SWMU 256; four with SWMU 257; and seven with SWMU 296 (and SWMU 53). Soil samples will be collected from the surface (0-1 foot, below ground surface) and from just above the water table in each boring. The proposed soil boring locations have been selected based on evidence of contamination (i.e., stains, stressed vegetation, etc.) observed during previous site visits and/or documented in the 1996 RFA report submitted by EnSafe, Inc.

The soil samples collected in the vicinity of SWMUs 2, 53 and 296 will be analyzed for semivolatile organic analysis (SVOAs) via EPA Method 8270 and target analyte list (TAL) metals. The samples collected in the vicinity of SWMUs 256 and 257 will be submitted for volatile organic analysis (VOAs) via EPA Method 8240 and SVOAs via EPA Method 8270.

5.2.2 SWMU 5

The confirmatory sampling to be conducted at SWMU 5 will include soil sampling as outlined below.

The proposed soil investigation at SWMU 5 was developed to determine if liquids collected at the vehicle wash racks (contaminated with petroleum products) have impacted the soils in the vicinity of the oil/water separator and the piping connecting it to the washwater collection structure.

Surface and subsurface soil samples will be collected from three borings to be advanced near the piping and the oil/water separator previously mentioned. The borings will be placed north, southeast and southwest of the oil/water separator. Figure 5-52 depicts the locations of the borings proposed for this SWMU. Each soil sample will be submitted for VOAs (EPA Method 8240), SVOAs (EPA Method 8270) and TAL metals.

5.2.3 SWMU 43

IR Site 11, which is associated with SWMU 43, is used for the storage of pesticides, insecticides, and herbicides as listed on Table 5-4. The IR site is/was used as a control and staging area for pesticide/herbicide related operations. Mixing, filling, cleaning, and maintenance of equipment occurs in this area. The confirmatory sampling to be conducted for SWMU 43 (oil/water separator) is described in the following paragraphs.

Water used to clean equipment is collected in the wash area and transported via underground piping to an oil/water separator. The soil investigation for SWMU 43 was developed to determine if the operations pertaining to the wash area and the oil/water separator have impacted surface and subsurface soils surrounding the oil/water separator. In addition, the investigation will determine if surface soils within the ditch immediately south of the oil/water separator have been contaminated.

Surface and subsurface soil samples will be collected from four soil borings to be advanced around the oil/water separator (Figure 5-53). A boring will be placed on each side of the oil/water separator. In addition, three surface soils will be collected along the drainage ditch downgradient of the oil/water separator.

The soil samples will be submitted for VOAs (EPA Method 8240), SVOAs (EPA Method 8270), pesticides (EPA Method 8080), herbicides (EPA Method 8150) and TAL metals.

5.2.4 SWMU 46

SWMU 46 is also considered as IR Site 15, Montford Point Dump Site. The confirmatory sampling at SWMU 46 will include surface and subsurface soils. SWMU 46 was a former dump site where sewage treatment plant (STP) sludge was reportedly disposed. Surface and subsurface soil samples will be collected from four borings as depicted on Figure 5-54. Each surface and subsurface soil sample will be analyzed for SVOAs (EPA Method 8270) and TAL metals.

5.2.5 SWMU 89

5.2.5 SWMU 89

The sampling program developed for SWMU 89 is outlined in the following paragraphs.

Surface and subsurface soils will be collected from three soil borings to be placed around the oil/water separator. One of the borings will be placed between the vehicle wash rack and the oil/water separator, the others will be advanced west and south of the SWMU (Figure 5-55).

The soil samples will be submitted for VOAs (EPA Method 8240), SVOAs (EPA Method 8270), and TAL metals.

5.2.6 SWMU 253

A single boring will be advanced in the vicinity of the former above ground storage tank (AST) at SWMU 253. A surface and subsurface soil sample will be collected from just above the water table. The soil samples will be submitted for VOAs (EPA Method 8020), SVOAs (EPA Method 8270) and TAL metals (Figure 5-56).

5.2.7 SWMU 254

SWMU 254 is a dumpster that according to the 1996 RFA Report contained unpunched paint cans and approximately one-gallon of Citrakleen during the EnSafe site visit. During the site visit conducted by Baker in 1996, the dumpster could not be located. Since all dumpsters at the Base are emptied on a weekly basis, the materials observed during EnSafe's visit were probably removed from the container within a week of the observation.

A single soil boring will be advanced where the dumpster was formerly located (according to Ensafe's sketches) (Figure 5-57). Surface and subsurface soil samples will be collected from this boring. The subsurface sample will be collected just above the water table. Additionally, a surface soil sample will be collected from the drainage ditch as noted on Figure 5-57. The soils will be analyzed for VOCs (EPA Method 8240), SVOCs (EPA Method 8270) and TAL metals.

5.2.8 SWMU 255

At SWMU 255, a total of four soil borings will be advanced around the oil/water separator and in the vicinity of the grit chamber (Figure 5-58). The placement of these borings were designed to determine if the soils within the vicinity of the SWMU 255 have been contaminated by spills and/or leaks that may have occurred during its operation. During Baker's site visit, it was evident that the grit chamber had overflowed in the past causing contamination of the surface soils. Additionally, evidence that a spill may have occurred was observed in the adjacent concrete drainage channel. It was noted that approximately 4 to 6 inches of soil was present in this drainage channel.

A surface and subsurface soil samples will be collected from each of the four soil borings. In addition, three surface soil samples will be collected from the concrete drainage channel (at locations downgradient of the oil/water separator). All of the soil samples will be submitted for VOAs (EPA Method 8240), SVOAs (EPA Method 8270), and TAL metals.

5.2.9 SWMU 258

A total of six soil borings will be placed in the vicinity of the grit chamber and oil/water separator which comprises SWMU 258 (Figure 5-59). Surface and subsurface soil samples will be collected from each of the borings for the purpose of determining if soils have been contaminated by past operations at the site. Paint stains had been observed on the grating of the oil/water separator indicating that paint had been disposed into this system. Additionally, Building 1711 had previously been a motor transport facility and the use of solvents for degreasing was common. It is likely that solvents may have been disposed into the system as part of a degreasing operation or as a paint thinner or remover.

Soil samples will be submitted for VOAs (EPA Method 8240), SVOAs (EPA Method 8270), and TAL metals.

5.2.10 SWMUs 260, 261, 262, 297 and 298

The following soil investigation has been designed to determine if contamination resides within the soils in the vicinity of SWMUs 260, 261, 262, 297, and 298. A total of eleven soil borings will be advanced to investigate the soil quality surrounding the SWMUs (Figure 5-60). Three borings will be associated with SWMU 260; four borings with SWMUs 261 and 297; two borings with SWMU 262 and two borings with SWMU 298. Surface and subsurface soil samples will be collected from each of the soil borings. An additional surface soil sample will be collected from the ditch leading away from SWMUs 261 and 297. It was noted during the site visit by Baker personnel that this ditch accepts discharge from the oil/water separator (SWMU 297) and transports it to a nearby creek.

Soil samples collected at these five SWMUs will be submitted for VOAs (EPA Methods 8020 and 8240), SVOAs (EPA Method 8270), and TAL metals.

5.2.11 SWMU 264

The site consisted of several drums of unknown material and stained pavement (tar material) when the original site visit was conducted by EnSafe, Inc. (Figure 5-61). However, when Baker re-visited the site in October 1996, the site was covered by wood chips resulting from tree damage from the recent hurricane. It was noted that the parking lot had been repaved within the past few years and all evidence of the previous staining could not be identified.

Baker recommends that two soil borings be advanced at this SWMU. A surface and subsurface sample will be collected from each boring. Subsurface samples will be collected just above the water table. All samples will be analyzed for VOCs (EPA Method 8240), SVOCs (EPA Method 8270), pesticides (EPA Method 8080), and TAL metals.

5.2.12 SWMU 265

SWMU 265 is an oil/water separator that handles overflow from a No.6 fuel oil loading ramp. No.6 fuel oil is a viscous tar-like material that needs to be heated in order to flow through piping. The material cools rapidly in the open atmosphere and becomes fairly immobile. Therefore, the contamination residing at the site will reside in the soil and will probably not reach the groundwater.

Four soil borings will be advanced around the oil/water separator (SWMU 265). The locations of the borings are depicted on Figure 5-62. Surface and subsurface soil samples will be collected from each boring. The soil samples will be submitted for VOCs (EPA Method 8240) and SVOAs (EPA Method 8270).

5.2.13 SWMU 268

SWMU 268 was a dumpster that according to EnSafe's observations only housekeeping activities were recommended at this SWMU. The only documented waste observed in this SWMU by EnSafe was solid waste. During the site visit conducted by Baker in 1996, the dumpster could not be located.

A single soil boring will be installed in the location where the dumpster had been located according to EnSafe's report (Figure 5-63). Surface and subsurface samples will be collected and analyzed for VOCs (EPA Method 8240), SVOCs (EPA Method 8270), and TAL metals.

5.2.14 SWMU 269

The oil/water separator and associated wash rack comprising SWMU 269 have been removed since the site visit conducted by EnSafe, Inc. However, Baker observed a disturbed area of soil in the general area where the SWMU was reported to have been located (Figure 5-64). It appeared that clean sand was backfilled in the former SWMU area.

Four borings will be advanced around the excavated area (formerly SWMU 269). Surface and subsurface soil samples will be collected from each soil boring and submitted for VOAs (EPA Method 8020), SVOAs (EPA Method 8270), and TAL metals.

5.2.15 SWMU 272

SWMU 272 is a newly-constructed oil/water separator which is associated with the Campbell Street Fuel Farm. Existing groundwater monitoring wells were previously installed during a UST investigation conducted at the fuel farm. If groundwater contamination was discovered, it would be difficult to determine if the contamination originated from the oil/water separator and instead of the USTs.

Soil samples will be collected from four soil borings that will be advanced around the SWMU (Figure 5-65). A surface and subsurface soil sample will be collected from each of the borings and submitted for VOAs (EPA Methods 8020 and 8240), SVOAs (EPA Method 8270), and TAL metals.

5.2.16 SWMU 273

SWMU 273 is a dumpster that according to the 1996 RFA Report appeared to have had a one time release of petroleum, oil, and lubricants (POLs). During the site visit conducted by Baker in 1996, the dumpster could not be located.

Two soil borings (Figure 5-66) will be advanced where the dumpster had been located (according to the RFA Report). A surface and subsurface sample will be collected from each boring and analyzed for VOAs (EPA Method 8240), SVOAs (EPA Method 8270), and TAL metals. The subsurface samples will be collected just above the water table.

5.2.17 SWMU 275

SWMU 275 is a dumpster that reportedly had evidence of a past spill. Evidence of a spill or release was not observed during Baker's site visit in October, 1996.

A single soil boring (Figure 5-67) will be advanced in the area previously occupied by the dumpster (according to the RFA Report). A surface and subsurface sample will be collected and analyzed for

VOAs (EPA Method 8240), SVOAs (EPA Method 8270), polychlorinated biphenyls (PCBs) (EPA Method 8080), and TAL metals.

5.2.18 SWMU 276

SWMU 276 is a dumpster that according to the 1996 RFA Report contained evidence of a POL spill. Evidence of a spill or release was not observed during Baker's site visit in October, 1996. A single soil boring will be advanced in the vicinity of the dumpster (Figure 5-68). Surface and subsurface soil samples will be collected and analyzed for VOAs (EPA Method 8240), SVOAs (EPA Method 8270), PCBs (EPA Method 8080), and TAL metals.

5.2.19 SWMU 277

SWMU 277 is an oil/water separator located along Main Service Road that showed no evidence of stains, spills or releases. Three soil borings will be advanced within three feet of the perimeter of the SWMU (Figure 5-69). Each boring will provide a surface and subsurface soil sample that will be analyzed for VOAs (EPA Method 8240), SVOAs (EPA Method 8270), and TAL metals.

5.2.20 SWMU 279

SWMU 279 is an oil/water separator located along Main Service Road. A major erosional problem exists at the site with soils being washed away during every rain event (Figure 5-70). As the rainstorms subside, employees work to restore the soils to the site using heavy equipment. Three soil borings will be advanced near the SWMU (Figure 5-70). Surface and subsurface soil samples will be collected from each of the borings and analyzed for VOAs (EPA Method 8240), SVOAs (EPA Method 8270), and TAL metals.

5.2.21 SWMU 280

SWMU 280 was reportedly a waste oil AST located in the vicinity of Building FC-285 which is located on Gonzalez Boulevard (Figure 5-71). During the site visit conducted by Baker in October, 1996, it was observed that the AST had been removed and the concrete area where the tank had been located showed no signs of a release or a spill. A single soil boring will be advanced in the former location of the AST (as per the RFA Report). Surface and subsurface samples will be collected and analyzed for VOAs (EPA Method 8240), SVOAs (EPA Method 8270), and TAL metals.

5.2.22 SWMU 283

At SWMU 283, two soil borings will be advanced in the area where EnSafe, Inc. had observed evidence of a release (Figure 5-72). A surface and subsurface soil sample will be collected from each boring and submitted for VOAs (EPA Methods 8020/8240), SVOAs (EPA Method 8270), pesticides/PCBs (EPA Method 8080), and TAL metals.

5.2.23 SWMUs 284, 285 and 286

SWMUs 284 and 286 were a former container and waste pile, respectively, located in an area where a paved parking lot for the Recycling Center now exists. During the construction of the parking lot, the soils in the area were graded and fresh asphalt was laid. A single soil boring will be advanced in the vicinity of these SWMUs (Figure 5-73). Surface and subsurface soil samples will be collected and analyzed for VOAs (EPA Method 8240), SVOAs (EPA Method 8270), and TAL metals.

SWMU 285 is an active oil/water separator. Four soil borings will be advanced in locations identified on Figure 5-73. A surface and subsurface sample will be collected from each boring and submitted for VOAs (EPA Methods 8020 and 8240), SVOAs (EPA Method 8270) and TAL metals.

5.2.24 SWMU 291

The confirmatory sampling to be conducted at SWMU 291 will include soil, surface water and sediment sampling as outlined below.

5.2.24.1 Soil Investigation

The proposed soil investigation for SWMU 291 was developed to determine if the historic runoff from Building 1450 and its associated oil/water separator have contaminated the soil leading from the building area to the storm water drainage ditch.

Two soil borings will be advanced at SWMU 291(Figure 5-74). The soil borings will be located in the area between the Building 1450 parking area and the drainage ditch. A surface and subsurface soil sample will be collected from the two soil borings. The soil samples will be submitted for VOAs (EPA Methods 8020 and 8240), SVOAs (EPA Method 8270), pesticides/PCBs (EPA Method 8080), and TAL metals.

5.2.24.2 Surface Water Investigation

The proposed surface water investigation was developed to determine if the runoff from the Building 1450 area and its associated oil/water separator have contaminated the surface water in the drainage ditch. Surface water samples will be collected from two sampling stations within the standing water area of the drainage ditch (Figure 5-74). These samples will aid in determining the quality of the runoff generated from the Building 1450 area.

The surface water samples will be submitted for VOAs (EPA Methods 8020 and 8240), SVOAs (EPA Method 8270), pesticides/PCBs (EPA Method 8080), and TAL metals.

5.2.24.3 Sediment Investigation

The proposed sediment investigation was developed to determine if the runoff from the Building 1450 area and its associated oil/water separator have contaminated the sediment in the drainage ditch. Sediment samples will be collected from two sampling stations within the standing water area of the drainage ditch. The sampling stations will be the same as the surface water stations. Sediment samples will be collected from two depth intervals from each sampling station: 0 to 6 inches and 6 to 12 inches.

The sediment samples will be submitted for VOAs (EPA Methods 8020 and 8240), SVOAs (EPA Method 8270), pesticides/PCBs (EPA Method 8080), and TAL metals.

5.2.25 SWMUs 292 and 293

The proposed soil investigation for SWMUs 292 and 293 was developed to determine if waste oil and other products associated with vehicle maintenance were mishandled and contaminated the soils in the vicinity of the site. It is suspected that solvents used for degreasing parts may have been disposed through the oil/water separator. Four soil borings will be advanced as depicted on Figure 5-75.

Surface and subsurface soil samples will be collected from each of the borings and submitted for VOAs (EPA Methods 8020 and 8240), SVOAs (EPA Method 8270) and TAL metals.

5.2.26 SWMU 294

A soil investigation will be conducted to determine if contamination resides in the soils surrounding SWMU 294 (oil/water separator). A total of six soil borings will be advanced as part of the investigation (Figure 5-76). A surface and subsurface soil sample will be collected from each of the borings. Each sample will be submitted for VOAs (EPA Method 8020), SVOAs (EPA Method 8270) and TAL metals.

5.2.27 SWMU 295

Groundwater in the vicinity of SWMU 295 is known to be contaminated with trichloroethene (TCE). There are existing wells in the vicinity of the SWMU that were installed during a Remedial Investigation and are monitored as part of the long-term groundwater monitoring program being conducted at the Base by the Environmental Management Department of MCB Camp Lejeune.

Three soil borings will be advanced as depicted on Figure 5-77. A surface and subsurface soil sample will be collected from each of the borings. Each sample will be submitted for VOAs (EPA Method 8020), SVOAs (EPA Method 8270), and TAL metals.

5.2.28 SWMU 299

Since SWMU 299 is a used oil AST surrounded by asphalt and concrete. It is assumed that contamination (if any) would most likely reside in the soils along the fence line (Figure 5-78). A total of four soil borings will be advanced in the vicinity of the SWMU. Surface and subsurface soil samples will be collected from each of the four borings. Each sample will be submitted for VOAs (EPA Method 8020), SVOAs (EPA Method 8270), and TAL metals.

5.2.29 SWMU 300

Soils in the vicinity of SWMU 300 may have been contaminated by releases or spills associated with the used oil AST. In order to accurately assess the soils in the area of the SWMU, three soil borings will be advanced in a triangular fashion, surrounding the AST (Figure 5-79). At each boring, a surface and subsurface soil sample will be collected and submitted for VOAs (EPA Method 8020), SVOAs (EPA Method 8270), and TAL metals.

5.2.30 SWMU 301

The soil investigation for SWMU 301 will include the advancement of three soil borings in the vicinity of the ASTs to determine whether the soils have been contaminated by activities conducted at the site (Figure 5-80). Surface and subsurface samples will be collected from each boring and submitted for VOAs (EPA Method 8020), SVOAs (EPA Method 8270), and TAL metals.

5.2.31 SWMU 302

A soil investigation will be conducted at SWMU 302 to determine if soils in the vicinity of the used oil AST site have been impacted by used oil that may have been spilled or released from the AST.

Four soil borings will be positioned around the AST as depicted in Figure 5-81. At each boring, a surface and subsurface sample will be collected and submitted for VOAs (EPA Method 8020), SVOAs (EPA Method 8270), and TAL metals.

5.2.32 SWMU 303

Four soil borings will be advanced around the used oil ASTs comprising SWMU 303 (Figure 5-82). The investigation is designed to determine if activities at the site have contaminated soils in the vicinity of the ASTs. Surface and subsurface soil samples will be collected from each soil boring and submitted for VOAs (EPA Methods 8020/8240), SVOAs (EPA Method 8270) and TAL metals.

5.2.33 SWMU 304

A soil investigation will be conducted to determine if contamination resides in the soils surrounding SWMU 304 (oil/water separator). A total of four soil borings will be advanced (Figure 5-83). Surface and subsurface soil samples will be collected from each of the borings. Each sample will be submitted for VOAs (EPA Method 8020), SVOAs (EPA Method 8270), and TAL metals.

5.2.34 SWMU 305

SWMU 305 was identified in the 1996 RFA Report as a soil pile (Figure 5-84). During Baker's site visit, it was noted that the soil pile had been removed from the area. Three soil borings will be placed in the area where EnSafe, Inc. had observed the soil mound to ensure that residual contamination does not remain in the area. A surface and subsurface soil sample will be collected from each boring and submitted for VOAs (EPA Method 8020), SVOAs (EPA Method 8270), pesticides/PCBs (EPA Method 8080) and TAL metals.

5.2.35 SWMU 306

A total of four soil borings will be placed in the vicinity of the oil/water separator which comprises SWMU 306 (Figure 5-85). Surface and subsurface soil samples will be collected from each boring for the purpose of determining if the soils have been contaminated by past operations at the site.

Soil samples will be submitted for VOAs (EPA Methods 8020 and 8240), SVOAs (EPA Method 8270), and TAL metals.

5.2.36 SWMU 307

Groundwater in the vicinity of the site is known to be contaminated with TCE. Groundwater contamination detected in the vicinity of the SWMU may not necessarily be attributed to operations conducted at this site.

Four soil borings will be advanced around SWMU 307 as depicted on Figure 5-86. A surface and subsurface soil sample will be collected from each of the borings. Each sample will be submitted for VOAs (EPA Methods 8020 and 8240), SVOAs (EPA Method 8270), and TAL metals.

5.2.37 SWMU 308

Four soil borings will be advanced at SWMU 308 to determine whether soils at the site have been contaminated by past/present operations (Figure 5-87). Two of the borings will be advanced near the oil/water separator. The other two soil borings will be advanced in an area that is suspected to have received overflow from the system in the past. Surface and subsurface samples will be collected from each of the borings. All soil samples will be submitted for VOAs (EPA Method 8020), SVOAs (EPA Method 8270), and TAL metals.

5.2.38 SWMU 309

A soil investigation will be conducted to determine if contamination resides in the soils surrounding SWMU 309 (waste oil AST). A total of four soil borings are proposed as part of the investigation (Figure 5-88). Surface and subsurface soil samples will be collected from each of the borings. Each sample will be submitted for VOAs (EPA Method 8020), SVOAs (EPA Method 8270), and TAL metals.

5.2.39 SWMU 310

SWMU 310 is a pair of earthen impoundments used to dewater cooking grease prior to its disposal at an approved landfill (Figure 5-89). There is no history or evidence that the impoundments have been used for petroleum wastes or hazardous materials. The grease contained in the ponds is not petroleum-based. Six soil borings will be advanced around the perimeter of the two impoundments (Figure 5-89). Surface and subsurface soil samples will be collected and analyzed for VOAs (EPA Method 8240), SVOAs (EPA Method 8270), pesticides/PCBs (EPA method 8080), and TAL metals.

5.2.40 SWMU 311

A total of four soil borings will be advanced around the oil/water separator (SWMU 311) and in the vicinity of the wash racks (Figure 5-90). The placement of these borings were designed to determine if the soils within the vicinity of the SWMU have been contaminated by spills and/or leaks that may have occurred during its operation. A surface and subsurface soil sample will be collected from each of the four borings. The soil samples will be submitted for VOAs (EPA Method 8020), SVOAs (EPA Method 8270), and TAL metals.

5.2.41 SWMU 312

A soil investigation will be conducted to determine if contamination resides in the soils surrounding SWMU 312 (oil/water separator). This SWMU receives steam condensate from inside the Steam Plant (Building 1700). However, during the site visit conducted by Baker, petroleum stains were observed on the sides of the unit and a hydrocarbon sheen was observed on the water contained within the separator.

Four soil borings will be advanced around SWMU 312 (Figure 5-91). Surface and subsurface soil samples will be collected from each of the borings. Each sample will be submitted for VOAs (EPA Method 8020), SVOAs (EPA Method 8270), and TAL metals.

5.2.42 SWMU 313

A total of four soil borings will be placed in the vicinity of the AST and oil/water separator which comprises SWMU 313 (Figure 5-92). Building 1709 is presently being used as a small craft maintenance facility and the use of solvents for degreasing is common. It is likely that solvents may be disposed into the system along with waste oils as part of a degreasing operation. In order to determine that soils at the site have not been contaminated by past or present operations at the site, a surface and subsurface soil sample will be collected from each of the four borings. The soil samples will be submitted for VOAs (EPA Methods 8020 and 8240), SVOAs (EPA Method 8270), and TAL metals.

5.2.43 SWMU 314

SWMU 314 is a newly-constructed oil/water separator and vehicle wash rack located along Montford Landing Road. No evidence of stains, spills or releases were noted during Baker's site visit. Four soil borings will be advanced at the locations shown on Figure 5-93. Surface and subsurface soil samples will be analyzed for VOCs (EPA Methods 8020 and 8240) and SVOCs (EPA Method 8270) and TAL metals.

5.2.44 SWMU 315

A total of four soil borings will be placed in the vicinity of the vehicle wash rack and oil/water separator which comprises SWMU 315 (Figure 5-94). During Baker's site visit, it was noted that petroleum stains were observed on the walls of the oil/water separator and a large amount of oil was within the unit. It is suspected that this particular unit is being used for waste oil disposal.

Surface and subsurface soil samples will be collected from each of the four soil borings for the purpose of determining if soils have been contaminated by the operations presently being conducted at the site. Soil samples will be submitted for VOAs (EPA Method 8020), SVOAs (EPA Method 8270), and TAL metals.

5.2.45 SWMU 316

A total of four soil borings will be placed in the vicinity of the vehicle wash rack and oil/water separator which comprises SWMU 316 (Figure 5-95). Surface and subsurface soil samples will be collected from each soil boring for the purpose of determining if soils have been contaminated at the site. Soil samples will be submitted for VOAs (EPA Method 8020), SVOAs (EPA Method 8270), and TAL metals.

5.2.46 SWMU 317

SWMU 317 is an area where the 1996 RFA Report noted that a release had occurred. During the site visit conducted by Baker, no evidence of stains, spills or releases were observed. However, a single soil boring will be advanced in the location shown on Figure 5-96. Surface and subsurface soil samples will be analyzed for VOAs (EPA Methods 8020 and 8240), SVOCs (EPA Method 8270), and TAL metals.

5.2.47 SWMU 318

Water used to clean helicopters stationed at the Base is collected in the wash area and transported via underground piping to an oil/water separator (SWMU 318). The soil investigation for SWMU 318 was developed to determine if the operations pertaining to the wash area and the oil/water separator have impacted surface and subsurface soils surrounding the site. In addition, the investigation will determine if surface soils within the ditch adjacent to the oil/water separator have been contaminated.

Surface and subsurface soil samples will be collected from three borings advanced around the oil/water separator (Figure 5-97). In addition, a surface soil sample will be collected along the drainage ditch downgradient of the SWMU. The soil samples will be submitted for VOAs (EPA Method 8020), SVOAs (EPA Method 8270), and TAL metals.

5.2.48 SWMU 319

EnSafe, Inc. reported in the 1996 RFA Report that an AST was to be investigated at the Camp Geiger Wastewater Treatment Plant. During Baker's site visit in October, 1996, the only AST that existed at the site had been installed within the last year. No evidence of stains or releases were noted and no map showing the location of the previous AST was presented in the RFA Report. Six soil borings will be advanced in various locations around the treatment plant (as per Figure 5-98). Surface and subsurface soil sampleswill be collected from each boring and analyzed for VOAs (EPA Methods 8020 and 8240), SVOAs (EPA Method 8270), and TAL metals.

5.2.49 SWMU 336

SWMU 336 is a pair of paint stripping vats located in a separate room within Building AS-4106. Spills that occur at this SWMU are properly contained and cleaned up. A sample will be collected from each of the two floor drains in the room (Figure 5-94). The samples will be analyzed for VOAs (EPA Methods 8020 and 8240), SVOCs (EPA Method 8270), and TAL metals.

5.2.50 SWMU 337

SWMU 337 is a pair of paint stripping vats located in a separate room within Building AS-518. Spills that occur at this SWMU are properly contained and cleaned up. A single soil boring will be advanced directly outside the entrance to the room (as per Figure 5-100). Surface and subsurface soil samples will be collected from the boring and analyzed for VOAs (EPA Methods 8020 and 8240), SVOAs (EPA Method 8270), and TAL metals.

5.2.51 SWMU 339

The confirmatory sampling to be conducted at SWMU 339 will include soil and sediment investigations.

5.2.51.1 Soil Investigation

A soil investigation will be conducted to determine if the soils in the vicinity of SWMU 339 are contaminated by lead-based paint chips generated by sand blasting activities. A surface soil and subsurface sample will be collected from one soil boring advanced in the vicinity of the SWMU (Sand Blasting Area). The soil samples will be submitted for VOAs (EPA Method 8240), SVOAs (EPA Method 8270), and TAL metals (Figure 5-101).

5.2.51.2 Sediment Investigation

A sediment sample will be collected from a drain that collects stormwater in the area of SWMU 339. The sample will determine if the lead-based paint chips are migrating from the SWMU via the stormwater system. The sample will be submitted for VOAs (EPA Method 8240), SVOAs (EPA Method 8270), and TAL metals.

6.0 PROJECT MANAGEMENT AND STAFFING

The Baker Project Team will be managed by Ms. Tammi Halapin. The primary responsibilities of the Project Manager will be to monitor the technical performance, cost, and schedule, and to maintain close communication with the LANTDIV NTR, Ms. Katherine Landman. The Project Manager will report to Mr. Matthew D. Bartman (Activity Coordinator) who will be responsible for overall quality assurance/quality control. Mr. John W. Mentz will provide program support. At a minimum, the Project Team will consist of a Site Manager, a Project Geologist, and an Environmental Scientist as shown in Figure 6-1.

7.0 SCHEDULE

The proposed project schedule for this project is presented as Figure 7-1. As identified on the figure, the confirmatory sampling effort is scheduled to be conducted during the fall of 1997.

8.0 REFERENCES

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USGS. 1990b. Continuous Seismic Reflection Profiling of Hydrogeologic Features Beneath New River, Camp Lejeune, North Carolina.

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TABLE 2-1

GEOLOGIC AND HYDROGEOLOGIC UNITS IN THE COASTAL PLAIN OF NORTH CAROLINA
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO-0371
MCB CAMP LEJEUNE, NORTH CAROLINA

<table>
<tr><th colspan="3">Geologic Units</th><th>Hydrogeologic Units</th></tr>
<tr><th>System</th><th>Series</th><th>Formation</th><th>Aquifer and Confining Unit</th></tr>
<tr><td>Quaternary</td><td>Holocene/Pleistocene</td><td>Undifferentiated</td><td>Surficial aquifer</td></tr>
<tr><td rowspan="12">Tertiary</td><td>Pliocene</td><td rowspan="2">Yorktown Formation(1)</td><td>Yorktown confining unit</td></tr>
<tr><td rowspan="6">Miocene</td><td rowspan="2">Yorktown aquifer</td></tr>
<tr><td rowspan="2">Eastover Formation(1)</td></tr>
<tr><td rowspan="2">Pungo River confining unit</td></tr>
<tr><td rowspan="2">Pungo River Formation(1)</td></tr>
<tr><td>Pungo River aquifer</td></tr>
<tr><td>Belgrade Formation(2)</td><td>Castle Hayne confining unit</td></tr>
<tr><td>Oligocene</td><td>River Bend Formation</td><td rowspan="2">Castle Hayne aquifer</td></tr>
<tr><td rowspan="2">Eocene</td><td rowspan="2">Castle Hayne Formation</td></tr>
<tr><td>Beaufort confining unit(3)</td></tr>
<tr><td rowspan="2">Paleocene</td><td rowspan="2">Beaufort Formation</td><td>Beaufort Aquifer</td></tr>
<tr><td rowspan="2">Peedee confining unit</td></tr>
<tr><td rowspan="11">Cretaceous</td><td rowspan="9">Upper Cretaceous</td><td rowspan="2">Peedee Formation</td></tr>
<tr><td>Peedee aquifer</td></tr>
<tr><td rowspan="3">Black Creek and Middendorf Formations</td><td>Black Creek confining unit</td></tr>
<tr><td>Black Creek aquifer</td></tr>
<tr><td rowspan="2">Upper Cape Fear confining unit</td></tr>
<tr><td rowspan="4">Cape Fear Formation</td></tr>
<tr><td>Upper Cape Fear aquifer</td></tr>
<tr><td>Lower Cape Fear confining unit</td></tr>
<tr><td>Lower Cape Fear aquifer</td></tr>
<tr><td rowspan="2">Lower Cretaceous(1)</td><td rowspan="2">Unnamed deposits(1)</td><td>Lower Cretaceous confining unit</td></tr>
<tr><td>Lower Cretaceous aquifer(1)</td></tr>
<tr><td colspan="2">Pre-Cretaceous basement rocks</td><td>--</td><td>--</td></tr>
</table>

Notes:

(1) Geologic and hydrologic units probably not present beneath MCB, 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: Harned et al., 1989.

TABLE 2-2

LAND UTILIZATION: DEVELOPED AREAS ACRES/LAND USE (PERCENT)
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO-0371
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 (including the MCAS)	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

LIST OF SWMUs
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO - 0371
MCB CAMP LEJEUNE, NORTH CAROLINA

SWMU Number	SWMU Name
2	1700 Pond A Base Maintenance
5	575 Rack 2nd LAI, 2D MAR DIV
43	IR Number 11 Pest Control Shop
46	IR Number 15 Montford Point Dump Site (1948 - 1958)
53	IR Number 26 Coal Storage Area
89	SLCH785 - Basin Base Maintenance
253	1205 - AST H&S Company HQSVC CO 2D MEF
254	1408 Dumpster Base Motor Transport
255	1502 - OW/-1 MCB Logistics Vehicle Maintenance
256	1700 - O/W-1 Base Maintenance
257	1700 - O/W-2 Base Maintenance
258	S1745 - O/W Truck Company Operations, HQ Battery, 2D MAR DIV
260	1780 - O/W-1 Truck Company Maintenance HQ BN 2D MAR DIV
261	1780 - UST-1 Truck Company, Maintenance, HQ BN, 2D MAR DIV

TABLE 2-3 (Continued)

LIST OF SWMUs
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO - 0371
MCB CAMP LEJEUNE, NORTH CAROLINA

SWMU Number	SWMU Name
262	1780 - UST-2 Truck Company, Maintenance, HQ BN, 2D MAR DIV
264	2611 - Container Gun Club
265	2615 - O/W Officer's Club
268	522 Dumpster 2D MAR DIV
269	816 - O/W 8th Engineer 2D FSSG
272	AS137 - O/W MCAS
273	BA 128/BA 105 Dumpster
275	BB-48 Dumpster Construction Shop
276	BB-49 Dumpster Base Maintenance
277	FC 120 - O/W 2nd FSSG, Combat Engineer BN
279	FC200 - O/W 8th Engineering 2D FSSG
280	FC285 - AST Maintenance Battalion, 2D FSSG
283	Release (FC279) 8th Motor Transport 2D FSSG
284	S947 - Container Environmental Management Division
285	S947 - O/W Environmental Management Division

TABLE 2-3 (Continued)

LIST OF SWMUs
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO - 0371
MCB CAMP LEJEUNE, NORTH CAROLINA

SWMU Number	SWMU Name
286	S947 - Pile Environmental Management Division
291	034 Ditch 5th BN, 10th Marines, 2D MAR DIV
292	1106/1107 - AST Motor T - Auto Hobby Shop MWR
293	1106/1107 - O/W Motor T - Auto Hobby Shop MWR
294	1203 - O/W Base Maintenance
295	1601 - AST 2D FSSG
296	1700 - Basin-B Base Maintenance
297	1780 - O/W-2 Truck Company Maintenance, HQ BN, 2D MAR DIV
298	1780 - O/W-3 Truck Company Maintenance, HQ BN, 2D, MAR DIV
299	ASS114 - AST MCAS Auto Hobby Shop
300	AS118 - AST Logistic Motor Transportation
301	AS4115 - AST MHLA 167, MAG 26, 2D MAW
302	AS504 - AST HMH 362 (AS 566)
303	AS515 - AST-E HMM 266 HMM 261

TABLE 2-3 (Continued)

LIST OF SWMUs
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO - 0371
MCB CAMP LEJEUNE, NORTH CAROLINA

SWMU Number	SWMU Name
304	BA130 - O/W Motor T, 2D RECON BN, 2D MAR DIV
305	BB224 - Pile MCB
306	FC230 - O/W-1 8th Communications BN, 2D SRIG
307	G649 - Rack Base Maintenance
308	GP19 - O/W 8th Engineers 2D FSSG
309	NH 118 - UST Near Building NH118
310	PT33 - Pond-O/W MCB Kitchen Grease Contractor
311	S1619 - O/W 8th Communications BN, 2D SRIG
312	S1735 - O/W Base Maintenance
313	S1753 - O/W-AST Small Craft CO HQ, BN, 2D MAR DIV
314	SM187 - O/W Marine Corps Supported Services School Group
315	SM269 -O/W Near Building M200
316	TC773 - O/W School of Infantry
317	TT2453 - Release Near Building TT2453
318	AS515 - O/W Near Building AS515

TABLE 2-3 (Continued)

LIST OF SWMUs
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO - 0371
MCB CAMP LEJEUNE, NORTH CAROLINA

SWMU Number	SWMU Name
319	Camp Geiger Wastewater Treatment Plant
336	AS4106 Paint Stripper Building 4106, MALS 29
337	AS518 -Paint Stripper MALS 26 Maintenance, MAG-26, 2ND Marine Aircraft Wing
339	AS4146 - Sandblaster MALS 26

TABLE 5-1

SWMU BACKGROUND INFORMATION
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO - 0371
MCB CAMP LEJEUNE, NORTH CAROLINA

SWMU Number	SWMU Name	Type of Unit	Period of Operation	Description	Wastes and/or Hazardous Constituents Managed
2	1700 Pond A Base Maintenance	Coal Water Settling Pond - Surface Impoundment	1985 - Present	Reinforced concrete 80 x 40 x 10 ft; the pond captures runoff from the coal storage area.	Coal, water (source: steam plant); polynuclear aromatics, sulfur bearing compounds, and heavy metals may be present
5	575 Rack 2nd LAI, 2D MAR DIV	Wash Rack - Surface Impoundment	Unknown - Present	Concrete 50 ft x 30 ft; concrete vehicle washracks. Constructed in 1980s. Associated washwater collection structure and oil/water separator.	Oil, grease, and fuel
43	IR Number 11 Pest Control Shop	CERCLA Site - Storage Area	1976 - Present	Area used as a disposal area for radioactive-contaminated animal carcasses. The site was remediated for this problem in 1977. In 1976, the site was used as a pesticide/herbicide storage area. Area contains a curbed wash area and an oil/water separator.	Pesticides; herbicides, fuel oil
46	IR Number 15 Montford Point Dump Site (1948 - 1958)	CERCLA Site - Former Disposal Area	1948 - 1958	Former area of disposed sewage treatment sludge.	Litter, asphalt, STP sludge, and sand
53	IR Number 26 Coal Storage Area	CERCLA Site - Storage Area	Present	300 ft x 300 ft concrete area used for the storage of coal piles (for steam plant).	Coal storage runoff
89	SLCH785 - Basin Base Maintenance	Oil/Water Separator	Not currently being used	Concrete 15 ft x 10 ft separator. Associated with vehicle wash rack.	Oily water
253	1205 - AST H&S Company HQSVC CO 2D MEF	Aboveground Storage Tank	AST Removed (present in July 1994)	Steel - 500 gallons.	Used oil

TABLE 5-1 (Continued)

SWMU BACKGROUND INFORMATION
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO - 0371
MCB CAMP LEJEUNE, NORTH CAROLINA

SWMU Number	SWMU Name	Type of Unit	Period of Operation	Description	Wastes and/or Hazardous Constituents Managed
254	1408 Dumpster Base Motor Transport	Dumpster - Solid Waste	1960 - Present	6 ft x 6 ft x 7 ft steel container with steel cover.	Solid waste
255	1502 - O/W-1 MCB Logistics Vehicle Maintenance	Oil/Water Separator and Grit Chamber	Unknown	Concrete with steel grate; grit chamber 7 ft x 7 ft x 2 ft; oil/water separator 15 ft x 10 ft x 4 ft.	Waste oil, grease, soap, grit and water
256	1700 - O/W-1 Base Maintenance	Oil/Water Separator	1984 - Present	Concrete 15 ft x 25 ft x 12 ft deep in - ground oil/water separator.	Wastes associated with No. 6 fuel oil from Services Loading Area
257	1700 - O/W-2 Base Maintenance	Oil/Water Separator	1984 - Present	Concrete 15 ft x 15 ft x 10 ft; Steam water used to heat No. 6 fuel oil (past) and No. 2 fuel oil is passed through the separator.	Oil/water waste from No. 6 and No. 2 fuel oils generated from Services Loading Area.
258	S1745 - O/W Truck Company Operations, HQ Battery, 2D MAR DIV	Oil/Water Separator and Grit Chamber	Unknown	Concrete units, elevated, with steel grates.	Waste oil, grease, water, and potential paint.
260	1780 - O/W-1 Truck Company Maintenance HQ BN 2D MAR DIV	Oil/Water Separator	1988 - Present	Concrete oil/water separator.	Waste oil, grease, water and debris
261	1780 - UST-1 Truck Company, Maintenance, HQ BN, 2D MAR DIV	Underground Storage Tank	1970 - Present	Steel 550 gallons. Associated with SWMU 297.	Oil, grease, water
262	1780 - UST-2 Truck Company, Maintenance, HQ BN, 2D MAR DIV	Underground Storage Tank	1970 - Present	Steel 550 gallons. Associated with SWMU 298.	Oil, grease, water

TABLE 5-1 (Continued)

SWMU BACKGROUND INFORMATION
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO - 0371
MCB CAMP LEJEUNE, NORTH CAROLINA

SWMU Number	SWMU Name	Type of Unit	Period of Operation	Description	Wastes and/or Hazardous Constituents Managed
264	2611 - Container Gun Club	Container	Unknown	Asphalt parking and staging area. Currently used as a staging area for wood chips resulting from hurricane-damaged trees.	Previous tar material
265	2615 - O/W Officer's Club	Oil/Water Separator	Unknown	Concrete unit. Associated with a No. 6 fuel oil loading unit.	No. 6 fuel oil
268	522 Dumpster 2D MAR DIV	Dumpster - Solid Waste	1960? - Present	6 ft x 6 ft x 7 ft steel container with steel cover. The location of this dumpster could not be found during the October 1996 site visit.	Solid waste
269	816 - O/W 8th Engineer 2D FSSG	Oil/Water Separator	O/W Separator removed (present in July 1994)	Oil/water separator associated with a vehicle wash rack.	Oil/water
272	AS137 - O/W MCAS	Oil/Water Separator	Unknown	Concrete unit. New construction within last year.	Oil, gasoline, fuel oil
273	BA 128/BA 105 Dumpster	Dumpster	1960? - Present	6 ft x 6 ft x 7 ft steel container with steel cover. Not present during October 1996 site visit. Potentially removed following the hurricane.	Solid waste
275	BB-48 Dumpster Construction Shop	Dumpster	Unknown	6 ft x 6 ft x 7 ft steel container with steel cover.	Solid waste
276	BB-49 Dumpster Base Maintenance	Dumpster	1960? - Present	8 ft x ft 8 x 8 ft open steel dumpster. Storm drain located adjacent to the dumpster.	Solid waste

TABLE 5-1 (Continued)

SWMU BACKGROUND INFORMATION
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO - 0371
MCB CAMP LEJEUNE, NORTH CAROLINA

SWMU Number	SWMU Name	Type of Unit	Period of Operation	Description	Wastes and/or Hazardous Constituents Managed
277	FC 120 - O/W 2nd FSSG, Combat Engineer BN	Oil/Water Separator	Unknown	Concrete unit with steel cover.	Oil
279	FC200 - O/W 8th Engineering 2D FSSG	Oil/Water Separator	1973 - Present	Concrete unit located in a highly erosional area.	Oil, water, diesel
280	FC285 - AST Maintenance Battalion, 2D FSSG	Aboveground Storage Tank	Unknown; AST removed	AST no longer present at the site.	Used oil
283	Release (FC279) 8th Motor Transport 2D FSSG	Release	Unknown	Area of soil approximately 20 ft x 5 ft.	Organics
284	S947 - Container Environmental Management Division	Container	Roll-off box has been removed	Steel roll-off box was formerly present at the site. Contained POL soil. Box has been removed, the area was regraded and paved.	Spilled petroleum and soil
285	S947 - O/W Environmental Management Division	Oil/Water Separator	Approximately from 1980 to present	Concrete in-ground oil/water separator connected to WWTP	Oil, grease, photo fix, grit and water
286	S947 - Pile Environmental Management Division	Waste Pile	Waste pile removed	Waste pile was formerly present at the site. It consisted of POL soil. The pile has been removed, the area was regarded and paved. A new structure (Building S-960) was built to hold the POL soil piles.	Spilled petroleum and soil
291	034 Ditch 5th BN, 10th Marines, 2D MAR DIV	Stormwater Drainage Ditch	1950? - Present	Earthen ditch and scour hole. Historically received runoff from Building 1450 oil/water separator.	Oil, grease, soap, grit and water

TABLE 5-1 (Continued)

SWMU BACKGROUND INFORMATION
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO - 0371
MCB CAMP LEJEUNE, NORTH CAROLINA

SWMU Number	SWMU Name	Type of Unit	Period of Operation	Description	Wastes and/or Hazardous Constituents Managed
292	1106/1107 - AST Motor T - Auto Hobby Shop MWR	Aboveground Storage Tank	1980 - Present	Steel AST, 500 gallons.	Waste oil and antifreeze from auto repair/hobby shop'
293	1106/1107 - O/W Motor T - Auto Hobby Shop MWR	Oil/Water Separator	1980 - Present	Poured concrete in-ground oil/water separator with baffles; Outlet connected to WWTP.	Oil filters, waste oil, antifreeze, and possibly solvents
294	1203 - O/W Base Maintenance	Oil/Water Separator	1985 - Present	Concrete 5 x 5 x 3 ft in ground oil/water separator with baffles.	Oil, water and debris
295	1601 - AST 2D FSSG	Aboveground Storage Tank	Unknown	Used motor oil from military vehicle maintenance.	Used motor oil
296	1700 - Basin-B Base Maintenance	Runoff Collection Basin	Unknown	Concrete 300 ft x 300 ft in ground basin connected to WWTP.	Coal pile runoff; heavy metals may be present
297	1780 - O/W-2 Truck Company Maintenance, HQ BN, 2D MAR DIV	Oil/Water Separator	Unknown	Steal unit. Associated with SWMU 261.	Oil, grease, water debris
298	1780 - O/W-3 Truck Company Maintenance HQ BN, 2D MAR DIV	Oil/Water Separator	Unknown	Steel unit. Associated with SWMU 262.	Oil, grease, water debris
299	AS114 - AST MCAS Auto Hobby Shop	Aboveground Storage Tank	1992 - Present	Steel, self contained with steps.	Used motor oil from vehicle maintenance operations
300	AS118 - AST Logistic Motor Transportation	Aboveground Storage Tank	1992 - Present	Steel, self contained with steps.	Used motor oil from vehicle maintenance operations

TABLE 5-1 (Continued)

SWMU BACKGROUND INFORMATION
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO - 0371
MCB CAMP LEJEUNE, NORTH CAROLINA

SWMU Number	SWMU Name	Type of Unit	Period of Operation	Description	Wastes and/or Hazardous Constituents Managed
301	AS4115 - AST MHLA 167, MAG 26, 2D MAW	Aboveground Storage Tanks	1983 - Present	Two steel tanks with concrete secondary containment. Labeled as "POL only".	Used oil, hydraulic fluid, and fuel
302	AS504 - AST HMH 362 (AS 566)	Aboveground Storage Tank	1983 - Present	Steel tank with concrete secondary containment.	Engine oil, hydraulic fluid, transmission oil
303	AS515 - AST-E HMM 266 HMM 261	Aboveground Storage Tank	1983 - Present	Two steel tanks with concrete secondary containment, labeled as "Hydraulic Fluid, Engine and Transmission Oils Only, No Solvents or Other Chemicals."	Used engine oil, hydraulic oil, transmission oil
304	BA130 - O/W Motor T, 2D RECON BN, 2D MAR DIV	Oil/Water Separator	1980 - Present	In ground oil/water separator connected to drain field.	Oil, grease, grit and water
305	BB224 - Pile MCB	Soil Pile	Soil pile has been removed	Soil pile removed prior to October 1996. Very little evidence of location of pile.	Grease and contaminated soil
306	FC230 - O/W-1 8th Communications BN, 2D SRIG	Oil/Water Separator	1988 - Present	Concrete 8 ft x 20 ft x 12 ft in ground tank connected to WWTP.	Oil, grease, water and debris from vehicle maintenance operators
307	G649 - Rack Base Maintenance	Vehicle Wash Rack	Unknown	Concrete 10 ft x 25 ft wash pad with associated oil/water separator.	Oil, water, grease, debris
308	GP19 - O/W 8th Engineers 2D FSSG	Oil/Water Separator	1983 - Present	Concrete 4 ft x 6 ft x 6 ft in ground oil/water separator connected to sanitary sewer.	Oil, grease, water from military vehicle maintenance operations
309	NH 118 - UST Near Building NH118	Underground Storage Tank	Active	Potential UST; Newly installed used oil AST nearby. May be the UST replacement.	Used oil

TABLE 5-1 (Continued)

SWMU BACKGROUND INFORMATION
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO - 0371
MCB CAMP LEJEUNE, NORTH CAROLINA

SWMU Number	SWMU Name	Type of Unit	Period of Operation	Description	Wastes and/or Hazardous Constituents Managed
310	PT33 - Pond-O/W MCB Kitchen Grease Contractor	Dewatering Unit	Unknown	Two earthen ponds with concrete O/W separator used to dewater grease prior to disposal in sanitary landfill.	Kitchen grease; base directives and training preclude intentional disposal of non-kitchen or hazardous waste in grease trap which are the source of waste
311	S1619 - O/W 8th Communications BN, 2D SRIG	Oil/Water Separator	1989 - Present	Concrete in ground oil/water separator connected to WWTP.	Oil, grease, water and debris from vehicle maintenance operations
312	S1735 - O/W Base Maintenance	Oil/Water Separator	1984 - Present	Concrete in ground oil/water separator connected to WWTP.	Oil/water, possibly No. 6 fuel oil
313	S1753 - O/W-AST Small Craft CO; HQ BN, 2D MAR DIV	Aboveground Storage Tank and Oil/Water Separator	Unknown	5 x 10 x 8 ft in ground oil/water separator with steel AST.	Oil, grease, water
314	SM187 - O/W Marine Corps Supported Services School Group	Oil/Water Separator	1990 - Present	Concrete in ground oil/water separator connected to WWTP.	Oil, water and debris from military vehicle maintenance operations
315	SM269 - O/W Near Building M200	Oil/Water Separator	Active	Concrete in ground unit.	Oil, grease, water and debris, possibly No. 6 fuel oil
316	TC773 - O/W School of Infantry	Oil/Water Separator	1985 - Present	Concrete in ground unit connected to WWTP; flush mounted in parking area.	Oil, water and debris from military vehicle maintenance operations

TABLE 5-1 (Continued)

SWMU BACKGROUND INFORMATION
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO - 0371
MCB CAMP LEJEUNE, NORTH CAROLINA

SWMU Number	SWMU Name	Type of Unit	Period of Operation	Description	Wastes and/or Hazardous Constituents Managed
317	TT2453 - Release Near Building TT2453	Release	Facility does not appear to be in use	A one-time release generated from Auto Care/Tune Up facility. Existing UST investigations being conducted in the immediate area.	Oil/grease
318	AS515 - O/W Near Building AS515	Oil/Water Separator	Active	6 ft x 6 ft concrete in ground oil/water separator.	Oily water
319	Camp Geiger Wastewater Treatment Plant	Tertiary Wastewater Treatment Plant	1941 - Present	Fair condition -- The facility has the following units; influent pump station, grit chamber and communitors, aerated equalization basin, dual primary clarifiers, dual trickling filters, dual secondary clarifiers, dual anaerobic digestors, sludge drying beds, dural tertiary treatment units (polymer addition, settling, and sand filtration), and chlorine contact chamber.	Domestic sewage
336	AS4106 Paint Stripper Building 4106, MALS 29	Paint Stripper - Tank	Unknown	Two 5.5 gallon containers elevated about 5 ft off the ground in an enclosed building; both containers are about 4 x 3 x 2 ft and made of either steel or aluminum.	One container holds methylene chloride used in stripping paint; the other contains water and residue methylene chloride; contents from both containers are drained into 55-gallon drums and disposed of as hazardous waste

TABLE 5-1 (Continued)

SWMU BACKGROUND INFORMATION
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO - 0371
MCB CAMP LEJEUNE, NORTH CAROLINA

SWMU Number	SWMU Name	Type of Unit	Period of Operation	Description	Wastes and/or Hazardous Constituents Managed
337	AS518 - Paint Stripper MALS 26 Maintenance, MAG-26, 2ND Marine Aircraft Wing	Paint Stripper - Tank	Unknown	Two 5.5 gallon containers elevated about 5 ft off the ground in an enclosed building; both containers are about 4 x 3 x 2 ft and made of either steel or aluminum.	One container holds methylene chloride use din stripping paint; the other contains water and residue methylene chloride; contents from both containers are drained into 55-gallon drums and disposed of as hazardous waste
339	AS4146 - Sandblaster MALS 26	Sandblaster	December 1995 - Present	10 ft x 15 ft enclosed tarp which has sandblast grit and equipment inside; paint is removed from equipment inside of the tarp. Used sand/grit placed in 55-gallon drums. Disposed as hazardous waste due to lead.	Heavy metals (lead)

TABLE 5-2

SUMMARY OF OBSERVATIONS FROM THE OCTOBER 1996 SITE VISIT
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO-0371
MCB CAMP LEJEUNE, NORTH CAROLINA

SWMU	Observations
SWMU 2 - 1700 Pond A	● The SWMU is a concrete neutralization pond. ● Once the pond is full of runoff from the coal pile area, the water is pumped to a wastewater treatment plant. ● No releases or spills noted.
SWMU 5 - 575 Rack	● The wash water collection structure contained a large amount of sand. Camp Lejeune personnel informed Baker that the last time the structure was cleaned out was in March 1994. The structure has not overflowed. It has an alarm system. ● The wash water is transferred to the nearby oil/water separator. ● No releases or spills noted.
SWMU 43 - Pest Control Shop (IR Site No. 11)	● Oil/water separator (covered) is located in the grass area outside the fenced site area. ● The oil/water separator receives wash water generated from the cleaning of the pesticide vehicles. ● A drainage ditch is located nearby the oil/water separator. ● The pesticide operations began around 1976 at the site. ● The site was previously remediated for buried radioactive waste (animal carcasses). ● Potential contaminants at the site may include pesticides/herbicides and fuel oil (generated from the wash rack).
SWMU 46 - Montford Point Dump Site (IR Site No. 15)	● Area potentially used for the disposal of sewage treatment plant sludge. ● Numerous mounds of material identified in one half of the site; very little evidence of disposal/debris in the other half of the site.

TABLE 5-2 (Continued)

SUMMARY OF OBSERVATIONS FROM THE OCTOBER 1996 SITE VISIT
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO-0371
MCB CAMP LEJEUNE, NORTH CAROLINA

SWMU	Observations
SWMU 53 - Coal Storage Area (IR Site No. 26)	• The AST located near the coal pile storage area is currently used for No. 6 fuel oil. Once the tank is empty, it will be used for No. 2 fuel oil. • Approximately 28 over-packed drums containing boiler waste were being stored within the coal storage area basin.
SWMU 89 - SLCH785 Basin	• The oil/water separator and associated wash rack did not appear to be in use. • There was water in the oil/water separator. The water had a slight sheen on it. • Stains were noted on the interior walls of the oil/water separator. The stains appeared to be No. 6 fuel oil. • Existing monitoring wells nearby and downgradient of the SWMU. • The unit may be removed in early 1997; to be decided.
SWMU 253 - 1205 AST	• The AST was no longer present at the site. • No signs of releases or spills were identified.
SWMU 254 - 1408 Dumpster	• No signs of releases near the dumpster. No indication of why confirmatory sampling necessary at this SWMU.

TABLE 5-2 (Continued)

SUMMARY OF OBSERVATIONS FROM THE OCTOBER 1996 SITE VISIT
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO-0371
MCB CAMP LEJEUNE, NORTH CAROLINA

SWMU	Observations
SWMU 255 - 1502 O/W-1	● Significant amounts of used oil generated at the maintenance operation. ● Staining evident on the soil near the grit chamber, on the concrete driveway and along the drainage pathway adjacent to the building. ● Heavy oil was noted in both the grit chamber and the oil/water separator. ● Several cracks identified in the concrete drainage way. In addition, soil debris was filling the channel. ● Previous hydraulic oil spill; has been remediated.
SWMU 256 - 1700 O/W-1	● The oil/water separator receives No. 6 fuel oil currently; No. 2 fuel oil in the future. ● No stains or releases were identified.
SWMU 257 - 1700 O/W-2	● The oil/water separator services the loading area. ● Stains were noted on two sides of the oil/water separator. The stains appear to be from No. 6 fuel oil.
SWMU 258 - S1745 O/W	● Paint stains were noted on the grates covering the oil/water separator. ● Paint/fuel stains were noted on the asphalt near the oil/water separator. ▸ The oil/water separator is bordered by grass on one side and asphalt on the other three sides.
SWMU 260 - 1780 O/W-1	● No significant observations were noted on this SWMU.
SWMU 261 - 1780 UST-1	● No significant observations were noted on this SWMU.
SWMU 262 - 1780 UST-2	● No significant observations were noted on this SWMU.

TABLE 5-2 (Continued)

SUMMARY OF OBSERVATIONS FROM THE OCTOBER 1996 SITE VISIT
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO-0371
MCB CAMP LEJEUNE, NORTH CAROLINA

SWMU	Observations
SWMU 264 - 2611 Container	• The area potentially stained due to tar material was covered with large piles of wood chips. The wood chips were generated from the trees that had been blown down by Hurricane Fran. Therefore, no evidence of any previous stains could be identified during the site visit.
SWMU 265 - 2615 O/W	• The oil/water separator is associated with the adjacent No. 6 fuel oil loading area. • Minor fuel staining on the loading ramp was identified.
SWMU 268 - 522 Dumpster	• Building 522 could not be found. The site visit team walked around Buildings 521 and 523, but could not find Building 522. Several Base personnel were asked for the location of Building 522; they did not know. Therefore, the dumpster at Building 522 could not be located.
SWMU 269 - 816 O/W	• No oil/water separator or wash rack was found near Building 816. A newly disturbed area of fresh sand was identified between Building 816 and H. M. Smith Boulevard. It appeared that the oil/water separator was recently removed from the disturbed area.
SWMU 272 - AS137 O/W	• Base personnel informed the site visit team that the oil/water structure replaced the existing unit approximately one year ago. • Existing monitoring wells are located nearby. ▸ Base personnel indicated that during major storm events the oil/water separator can overflow.
SWMU 273 - BA128/BA105 Dumpster	• No dumpster was present in the area. The recent Hurricane Fran appeared to significantly disturbed this entire beach front area including the buildings along Ocean Drive.
SWMU 275 - BA-48 Dumpster	• No stains or releases were identified near this dumpster.

TABLE 5-2 (Continued)

SUMMARY OF OBSERVATIONS FROM THE OCTOBER 1996 SITE VISIT
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO-0371
MCB CAMP LEJEUNE, NORTH CAROLINA

SWMU	Observations
SWMU 276 - BB-49 Dumpster	● No stains or releases were identified near this dumpster. ● A storm drain is located next to the dumpster.
SWMU 277 - FC120 O/W	● This SWMU is located nearby to IR Site No. 1. ● The oil/water separator was covered with a heavy, metal cover. ● No spills were identified near the oil/water separator.
SWMU 279 - FC200 O/W	● The area surrounding the oil/water separator is affected by a significant amount of erosion. ● Several existing monitoring wells were noted to be nearby. Some of these monitoring wells should be abandoned due to the resulting erosion in the area. ● No stains or releases were identified.
SWMU 280 - FC285 AST	● The AST is no longer present at Building FC-285. ● The concrete area previously used to store the AST and other materials had some minor stains.
SWMU 283 - FC279 Release	● An area of soil approximately 20 feet long by a maximum of 5 feet wide was identified to be the potential release area. The vegetation in this soil area was stressed.
SWMU 284 - S947 Container	● The area in which the roll-off boxes were located is currently paved with asphalt. The area had been regraded prior to paving. A new structure has been constructed (Building S960) to store POL-contaminated soil. Therefore, the roll-off boxes are no longer used.
SWMU 285 - S947 O/W	● Stormwater containment system. ● Several existing monitoring wells in the area.

TABLE 5-2 (Continued)

SUMMARY OF OBSERVATIONS FROM THE OCTOBER 1996 SITE VISIT
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO-0371
MCB CAMP LEJEUNE, NORTH CAROLINA

SWMU	Observations
SWMU 286 - S947 Pile	● The soil piles have been relocated to a newly-constructed structure (Building S960). The structure has five contained areas to store the POL-contaminated soil. The area formerly used for the soil piles has been regraded and paved with asphalt.
SWMU 291 - 034 Ditch	● The ditch historically received runoff from Building 1450 wash rack (The effluent bypassed the oil/water separator). ● Standing water was observed in the ditch. ● Nearby (Site 24) existing monitoring wells.
SWMU 292 - 1106/1107 AST	● The AST is self-served, therefore several spills/stains noted on the concrete flooring of the open-bay garage structure.
SWMU 293 - 1106/1107 O/W	● Newly installed used oil AST located behind the Ceramic Shop building not being used. ● Grit chambers had oil in them. ● The wash pad was stained and cracked. ● Historically, solvents probably put into the oil/water separator.
SWMU 294 - 1203 O/W	● The wash pad was stained. ● Several unlabeled 55-gallon drums were identified in the area.
SWMU 295 - 1601 AST	● The flow control valve had been removed from the concrete containment area. ● Several existing monitoring wells nearby.
SWMU 296 - 1700 Basin B	● No significant observations were noted at this SWMU.
SWMU 297 - 1780 O/W-2	● No significant observations were noted at this SWMU.

TABLE 5-2 (Continued)

SUMMARY OF OBSERVATIONS FROM THE OCTOBER 1996 SITE VISIT
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO-0371
MCB CAMP LEJEUNE, NORTH CAROLINA

SWMU	Observations
SWMU 298 - 1780 O/W-3	● Oil/water separator is associated with UST-2 (SWMU 262).
SWMU 299 - AS114 AST	● Some stains identified on the asphalt. ● The AST is filled with the use of a hand pump.
SWMU 300 - AS118 AST	● Stains identified on the asphalt. ● The AST is filled with the use of a hand pump. ● Existing monitoring wells in the immediate area. ● A drain is located near a small contained wash area. ● The AST is approximately 3 years old. The old system included a fiberglass UST which was filled via pipes connected to Building AS118.
SWMU 301 - AS4115 AST	● The ASTs are contained within a concrete bermed area. ● The ASTs are labeled for POLs only. ● Stained soils were noted near the drain to the containment structure.
SWMU 302 - AS504 AST	● The drain for the containment structure for the AST is under the steps leading to the AST. ● Stained were noted on the wooden steps leading to the AST. ● JP-5 storage next to this AST.
SWMU 303 - AS515 AST-E	● The ASTs are contained within a concrete bermed structure. ● The ASTs are labeled as “Hydraulic Fluid Head Engine and Transmission Oils Only. No Solvents or Other Chemicals”. ● Stains noted on the outside of the concrete berm.

TABLE 5-2 (Continued)

SUMMARY OF OBSERVATIONS FROM THE OCTOBER 1996 SITE VISIT
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO-0371
MCB CAMP LEJEUNE, NORTH CAROLINA

SWMU	Observations
SWMU 304 - BA130 O/W	● This SWMU was not visited due to the condition of the beach road (i.e., hurricane damage).
SWMU 305 - BB224 Pile	● This SWMU (the waste pile) had been removed prior to the October 1996 site visit. The nearby building appeared to have also been removed. A small soil/vegetated pile was noted during the site visit. Camp Lejeune personnel later confirmed the area to be the former SWMU location.
SWMU 306 - FC230 O/W-1	● The wash rack pit was filled with water. ● Stained soil was noted near the fence line. ● Stains were noted inside the oil/water separator.
SWMU 307 - G649 Rack	● Bales of plastic fiber were identified in the oil/water separator. ● Stains were noted along the interior walls of the oil/water separator. The stains appear to be from No. 6 fuel oil. ● The wash rack appeared to be recently constructed. ● Significant earth-moving/construction activities were noted around the nearby ASTs.
SWMU 308 - GP-19 O/W	● Tree debris was identified throughout the wash area. ● The drain in the center of the wash area appeared to be clogged. ● One side of the wash area had an earthen berm which was not completely intact. ● A potential overflow area in the grass was noted near the oil/water separator.

TABLE 5-2 (Continued)

SUMMARY OF OBSERVATIONS FROM THE OCTOBER 1996 SITE VISIT
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO-0371
MCB CAMP LEJEUNE, NORTH CAROLINA

SWMU	Observations
SWMU 309 - NH118 UST	• A potential location for the UST was identified but not confirmed. This was behind Building NH-118. • A new waste oil AST was noted near the potential UST location. The AST may be a replacement for the UST. No one was in the area to inquire about the tanks. The AST was constructed on a concrete pad with no containment. • An oil/water separator was identified on the side of Building NH-118.
SWMU 310 - PT33 Pond O/W	• One pit was noted to be in use. Strong odor (grease) identified. The second pit was being reconstructed.
SWMU 311 - S1619 O/W	• The oil/water separator is located outside the fenced area containing the vehicle wash rack and Buildings 1604 and 1605. • The drain from the wash rack to the oil/water separator showed signs of overflow (eroded soil). Any overflow would flow through the earthen drainage way and eventually could reach Cogdels Creek.
SWMU 312 - S1735 O/W	• Evidence of No. 6 fuel oil was noted in the separator. Stains were noted on the separator. • Steam condensation from the Steam Plant enters the oil/water separator. • A 55-gallon drum and a lot of sediment was noted in the separator.
SWMU 313 - S1753 O/W & AST	• The general area is used for maintenance of small crafts. • Cracks were noted on the concrete wash pad. • The used oil AST located within the wash pad area had notable overfill spills. • The oil/water separator unit appeared to be relatively new construction (i.e., only a few years old).

TABLE 5-2 (Continued)

SUMMARY OF OBSERVATIONS FROM THE OCTOBER 1996 SITE VISIT
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO-0371
MCB CAMP LEJEUNE, NORTH CAROLINA

SWMU	Observations
SWMU 314 - SM187 O/W	● The wash pad drain was clogged with sediments and tree debris probably caused by the recent weather conditions. It appeared that the drain may be too small for the size of the wash rack and potential runoff. ● The wash rack and oil/water separator unit appear to be recently constructed. No stains noted. ● It appeared that prior to the construction (or reconstruction) of the wash rack, the overflow of runoff and wash water was via natural drainage.
SWMU 315 - SM269 O/W	● Interior walls of the oil/water separator were significantly stained. The stains appeared to be No. 6 fuel oil. Some of the stains appeared to be relatively new. ● Stains were noted along the outside edge of the oil/water separator. ● A dead animal was identified in the oil/water separator.
SWMU 316 - TC773 O/W	● Oil/water separator located within a parking lot. The surrounding area was paved with asphalt, therefore, there is no soil to sample. ● Existing monitoring wells downgradient of the SWMU (near IR Site No. 89).
SWMU 317 - TT2453 Release	● Former release area could not be identified; no stains noted. ● Numerous monitoring wells have been installed in the immediate area of the SWMU. These wells are from a current UST investigation. Several fuel tanks were noted one the one side of Building TT 2453.
SWMU 318 - AS515 O/W	● The sketch from the previous site visit did not match the existing conditions. ● The oil/water separator unit appeared to be relatively new. ● The outfall from the separator discharges to an earthen drainage way.

TABLE 5-2 (Continued)

SUMMARY OF OBSERVATIONS FROM THE OCTOBER 1996 SITE VISIT
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO-0371
MCB CAMP LEJEUNE, NORTH CAROLINA

SWMU	Observations
SWMU 319 - Camp Geiger Wastewater Treatment Plant	● The Wastewater Treatment Plant operator was not aware of the SWMUs to be investigated. ● The site visit team noted a new AST containing fuel oil.
SWMU 336 - AS4106 Paint Stripper	● Floor drains were noted near the stripper vat. ● Paint coat stripper phenolic is used for the paint stripping activities. Fine cleaning of parts is accomplished using acetone and MEK in a spray bottle. These materials are tracks. ● Spent stripping material is drummed and handled by the Camp Lejeune Haz Mat. ● Room had poor ventilation.
SWMU 337 - AS518 Paint Stripper	● No known releases. ● The unit has been in operation since at least 1991. ● Spent stripping material is drummed and handled by the Camp Lejeune Haz Mat.
SWMU 339 - AS146 Sandblaster	● A storm drain is located near the sand blasting unit. ● An existing flush-mounted monitoring well was noted near Building AS4146. ● Spend sand grit is placed in 55-gallon drums. If they contain lead-based paint, they are given to Camp Lejeune Haz Mat for proper disposal.

TABLE 5-3

SUMMARY OF THE SAMPLING STRATEGY FOR THE SWMUs
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO - 0371
MCB CAMP LEJEUNE, NORTH CAROLINA

SWMU Number[a]	SWMU Name	Number of Samples	Requested Analyses[b]		
			Soil	Surface Water	Sediment
2	1700 Pond A Base Maintenance	6 soil borings/ 2 samples per boring	SVOAs - 8270 TAL Metals	--	--
5	575 Rack 2nd LAI, 2D MAR DIV	3 soil borings/ 2 samples per boring	VOAs - 8240 SVOAs - 8270 TAL Metals	--	--
43	IR Number 11 Pest Control Shop	4 soil borings/ 2 samples per boring 3 surface soil samples	VOAs - 8240 SVOAs - 8270 Pesticides - 8080 Herbicides - 8150 TAL Metals	--	--
46	IR Number 15 Montford Point Dump Site (1948 - 1958)	4 soil borings/ 2 samples per boring	SVOAs - 8270 TAL Metals	--	--
53	IR Number 26 Coal Storage Area	Included with SWMU 296	Included with SWMU 296	--	--
89	SLCH785 - Basin Base Maintenance	3 soil borings/ 2 samples per boring	VOAs - 8240 SVOAs - 8270 TAL Metals	--	--
253	1205 - AST H&S Company HQSVC CO 2D MEF	1 soil borings/ 2 samples per boring	VOAs - 8020 SVOAs - 8270 TAL Metals	--	--
254	1408 Dumpster Base Motor Transport	1 soil borings/ 2 samples per boring	VOAs - 8240 SVOAs - 8270 TAL Metals	--	--

TABLE 5-3 (Continued)

SUMMARY OF THE SAMPLING STRATEGY FOR THE SWMUs
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO - 0371
MCB CAMP LEJEUNE, NORTH CAROLINA

SWMU Number[a]	SWMU Name	Number of Samples	Requested Analyses[b]		
			Soil	Surface Water	Sediment
255	1502 - OW/-1 MCB Logistics Vehicle Maintenance	4 soil borings/ 2 samples per boring 3 surface soil samples	VOAs - 8240 SVOAs - 8270 TAL Metals	--	--
256	1700 - O/W-1 Base Maintenance	4 soil borings/ 2 samples per boring	VOAs - 8240 SVOAs - 8270	--	--
257	1700 - O/W-2 Base Maintenance	4 soil borings/ 2 samples per boring	VOAs - 8240 SVOAs - 8270	--	--
258	S1745 - O/W Truck Company Operations, HQ Battery, 2D MAR DIV	6 soil borings/ 2 samples per boring	VOAs - 8240 SVOAs - 8270 TAL Metals	--	--
260	1780 - O/W-1 Truck Company Maintenance HQ BN 2D MAR DIV	3 soil borings/ 2 samples per boring	VOAs - 8240/8020 SVOAs - 8270 TAL Metals	--	--
261	1780 - UST-1 Truck Company, Maintenance, HQ BN, 2D MAR DIV	4 soil borings/ 2 samples per boring 1 surface soil sample	VOAs - 8240/8020 SVOAs - 8270 TAL Metals	--	--
262	1780 - UST-2 Truck Company, Maintenance, HQ BN, 2D MAR DIV	2 soil borings/ 2 samples per boring	VOAs - 8240/8020 SVOAs - 8270 TAL Metals	--	--
264	2611 - Container Gun Club	2 soil borings/ 2 samples per boring	VOAs - 8240 SVOAs - 8270 Pesticides - 8080 TAL Metals	--	--

TABLE 5-3 (Continued)

SUMMARY OF THE SAMPLING STRATEGY FOR THE SWMUs
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO - 0371
MCB CAMP LEJEUNE, NORTH CAROLINA

SWMU Number[a]	SWMU Name	Number of Samples	Requested Analyses[b]		
			Soil	Surface Water	Sediment
265	2615 - O/W Officer's Club	4 soil borings/ 2 samples per boring	VOAs - 8240 SVOAs - 8270	--	--
268	522 Dumpster 2D MAR DIV	1 soil boring/ 2 samples per boring	VOAs - 8240 SVOAs - 8270 TAL Metals	--	--
269	816 - O/W 8th Engineer 2D FSSG	4 soil borings/ 2 samples per boring	VOAs - 8020 SVOAs - 8270 TAL Metals	--	--
272	AS137 - O/W MCAS	4 soil borings/ 2 samples per boring	VOAs - 8240/8020 SVOAs - 8270 TAL Metals	--	--
273	BA 128/BA 105 Dumpster	2 soil borings/ 2 samples per boring	VOAs - 8240 SVOAs - 8270 TAL Metals	--	--
275	BB-48 Dumpster Construction Shop	1 soil boring/ 2 samples per boring	VOAs - 8240 SVOAs - 8270 PCBs - 8080 TAL Metals	--	--
276	BB-49 Dumpster Base Maintenance	1 soil boring/ 2 samples per boring	VOAs - 8240 SVOAs 8270 PCB - 8080 TAL Metals	--	--

TABLE 5-3 (Continued)

SUMMARY OF THE SAMPLING STRATEGY FOR THE SWMUs
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO - 0371
MCB CAMP LEJEUNE, NORTH CAROLINA

SWMU Number[(a)]	SWMU Name	Number of Samples	Requested Analyses[(b)]		
			Soil	Surface Water	Sediment
277	FC 120 - O/W 2nd FSSG, Combat Engineer BN	3 soil borings/ 2 samples per boring	VOAs - 8240 SVOAs - 8270 TAL Metals	--	--
279	FC200 - O/W 8th Engineering 2D FSSG	3 soil borings/ 2 samples per boring	VOAs - 8240 SVOAs - 8270 TAL Metals	--	--
280	FC285 - AST Maintenance Battalion, 2D FSSG	1 soil boring/ 2 samples per boring	VOAs - 8240 SVOAs - 8270 TAL Metals	--	--
283	Release (FC279) 8th Motor Transport 2D FSSG	2 soil borings/ 2 samples per boring	VOAs - 8020/8240 SVOAs - 8270 Pesticides/PCBs - 8080 TAL Metals	--	--
284	S947 - Container Environmental Management Division	1 soil boring/ 2 samples per boring	VOAs - 8240 SVOAs - 8270 TAL Metals	--	--
285	S947 - O/W Environmental Management Division	4 soil borings/ 2 samples per boring	VOAs - 8240/8020 SVOAs - 8270 TAL Metals	--	--
286	S947 - Pile Environmental Management Division	Included with SWMU 284	Included with SWMU 284	--	--

TABLE 5-3 (Continued)

SUMMARY OF THE SAMPLING STRATEGY FOR THE SWMUs
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO - 0371
MCB CAMP LEJEUNE, NORTH CAROLINA

SWMU Number[a]	SWMU Name	Number of Samples	Requested Analyses[b]		
			Soil	Surface Water	Sediment
291	034 Ditch 5th BN, 10th Marines, 2D MAR DIV	2 soil borings/ 2 samples per boring; 2 surface water stations; 2 sediment stations/ 2 samples per station	VOAs - 8240/8020 SVOAs - 8270 Pesticides/PCBs - 8080 TAL Metals	VOAs - 8240/8020 SVOAs - 8270 Pesticides/PCBs - 8080 TAL Metals	VOAs - 8240/8020 SVOAs - 8270 Pesticides/PCBs - 8080 TAL Metals
292	1106/1107 - AST Motor T - Auto Hobby Shop MWR	Included with SWMU 293	Included with SWMU 293	--	--
293	1106/1107 - O/W Motor T - Auto Hobby Shop MWR	4 soil borings/ 2 samples per boring	VOAs - 8240/8020 SVOAs - 8270 TAL Metals	--	--
294	1203 - O/W Base Maintenance	6 soil borings/ 2 samples per boring	VOAs - 8020 SVOAs - 8270 TAL Metals	--	--
295	1601 - AST 2D FSSG	3 soil borings/ 2 samples per boring	VOAs - 8020 SVOAs - 8270 TAL Metals	--	--
296	1700 - Basin-B Base Maintenance	7 soil borings/ 2 samples per boring	SVOAs - 8270 TAL Metals	--	--
297	1780 - O/W-2 Truck Company Maintenance, HQ BN, 2D MAR DIV	Included with SWMU 261	Included with SWMU 261	--	--

TABLE 5-3 (Continued)

SUMMARY OF THE SAMPLING STRATEGY FOR THE SWMUs
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO - 0371
MCB CAMP LEJEUNE, NORTH CAROLINA

SWMU Number[a]	SWMU Name	Number of Samples	Requested Analyses[b]		
			Soil	Surface Water	Sediment
298	1780 - O/W-3 Truck Company Maintenance, HQ BN, 2D, MAR DIV	2 soil borings/ 2 samples per boring	VOAs - 8240/8020 SVOAs - 8270 TAL Metals	--	--
299	ASS114 - AST MCAS Auto Hobby Shop	4 soil borings/ 2 samples per boring	VOAs - 8020 SVOAs - 8270 TAL Metals	--	--
300	AS118 - AST Logistic Motor Transportation	3 soil borings/ 2 samples per boring	VOAs - 8020 SVOAs - 8270 TAL Metals	--	--
301	AS4115 - AST MHLA 167, MAG 26, 2D MAW	3 soil borings/ 2 samples per boring	VOAs - 8020 SVOAs - 8270 TAL Metals	--	--
302	AS504 - AST HMH 362 (AS 566)	4 soil borings/ 2 samples per boring	VOAs - 8020 SVOAs - 8270 TAL Metals	--	--
303	AS515 - AST-E HMM 266 HMM 261	4 soil borings/ 2 samples per boring	VOAs - 8240/8020 SVOAs - 8270 TAL Metals	--	--
304	BA130 - O/W Motor T, 2D RECON BN, 2D MAR DIV	4 soil borings/ 2 samples per boring	VOAs - 8020 SVOAs - 8270 TAL Metals	--	--

TABLE 5-3 (Continued)

SUMMARY OF THE SAMPLING STRATEGY FOR THE SWMUs
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO - 0371
MCB CAMP LEJEUNE, NORTH CAROLINA

SWMU Number[a]	SWMU Name	Number of Samples	Requested Analyses[b]		
			Soil	Surface Water	Sediment
305	BB224 - Pile MCB	3 soil borings/ 2 samples per boring	VOAs - 8020 SVOAs - 8270 Pesticides/PCBs - 8080 TAL Metals	--	--
306	FC230 - O/W-1 8th Communications BN, 2D SRIG	4 soil borings/ 2 samples per boring	VOAs - 8240/8020 SVOAs - 8270 TAL Metals	--	--
307	G649 - Rack Base Maintenance	4 soil borings/ 2 samples per boring	VOAs - 8240/8020 SVOAs - 8270 TAL Metals	--	--
308	GP19 - O/W 8th Engineers 2D FSSG	4 soil borings/ 2 samples per boring	VOAs - 8020 SVOAs - 8270 TAL Metals	--	--
309	NH 118 - UST Near Building NH118	4 soil borings/ 2 samples per boring	VOAs - 8020 SVOAs - 8270 TAL Metals	--	--
310	PT33 - Pond-O/W MCB Kitchen Grease Contractor	6 soil borings/ 2 samples per boring	VOAs - 8240 SVOAs - 8270 Pesticide/PCB - 8080 TAL Metals	--	--
311	S1619 - O/W 8th Communications BN, 2D SRIG	4 soil borings/ 2 samples per boring	VOAs - 8020 SVOAs - 8270 TAL Metals	--	--

TABLE 5-3 (Continued)

SUMMARY OF THE SAMPLING STRATEGY FOR THE SWMUs
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO - 0371
MCB CAMP LEJEUNE, NORTH CAROLINA

SWMU Number[a]	SWMU Name	Number of Samples	Requested Analyses[b]		
			Soil	Surface Water	Sediment
312	S1735 - O/W Base Maintenance	4 soil borings/ 2 samples per boring	VOAs - 8020 SVOAs - 8270 TAL Metals	--	--
313	S1753 - O/W-AST Small Craft CO HQ, BN, 2D MAR DIV	4 soil borings/ 2 samples per boring	VOAs - 8240/8020 SVOAs - 8270 TAL Metals	--	--
314	SM187 - O/W Marine Corps Supported Services School Group	4 soil borings/ 2 samples per boring	VOAs - 8240/8020 SVOAs - 8270 TAL Metals	--	--
315	SM269 -O/W Near Building M200	4 soil borings/ 2 samples per boring	VOAs - 8020 SVOAs - 8270 TAL Metals	--	--
316	TC773 - O/W School of Infantry	4 soil borings/ 2 samples per boring	VOAs - 8020 SVOAs - 8270 TAL Metals	--	--
317	TT2453 - Release Near Building TT2453	1 soil boring/ 2 samples per boring	VOAs - 8020/8240 SVOA - 8270 TAL Metals	--	--
318	AS515 - O/W Near Building AS515	3 soil borings/ 2 samples per boring 1 surface soil sample	VOAs - 8020 SVOAs - 8270 TAL Metals	--	--
319	Camp Geiger Wastewater Treatment Plant	6 soil borings/ 2 samples per boring	VOAs - 8240/8020 SVOAs - 8270 TAL Metals	--	--

TABLE 5-3 (Continued)

SUMMARY OF THE SAMPLING STRATEGY FOR THE SWMUs
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO - 0371
MCB CAMP LEJEUNE, NORTH CAROLINA

SWMU Number[a]	SWMU Name	Number of Samples	Requested Analyses[b]		
			Soil	Surface Water	Sediment
336	AS4106 Paint Stripper Building 4106, MALS 29	1 sample collected from each of two floor drains	VOAs - 8240/8020 SVOAs - 8270 TAL Metals	--	--
337	AS518 -Paint Stripper MALS 26 Maintenance, MAG-26, 2ND Marine Aircraft Wing	1 soil boring/ 2 samples per boring	VOAs - 8240/8020 SVOAs - 8270 TAL Metals	--	--
339	AS4146 - Sandblaster MALS 26	1 soil boring/ 2 samples per boring; 1 sediment sample from drain	VOAs - 8240 SVOAs - 8270 TAL Metals	--	VOAs - 8240 SVOAs - 8270 TAL Metals

Notes:

[a] SWMU = solid waste management unit
[b] TAL = Target Analyte List
VOA = volatile organic analysis
SVOA = semivolatile organic analysis
PCBs = polychlorinated biphenyls

TABLE 5-4

PESTICIDES, INSECTICIDES AND HERBICIDES PREVIOUSLY OR CURRENTLY STORED AT SWMU 43
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO - 0371
MCB CAMP LEJEUNE, NORTH CAROLINA

Pesticides (Used at the Golf Course)	Insecticides (Previously or Currently Being Stored)	Herbicides (Previously or Currently Being Stored)
Orthene	Liqua Tox	Oust
Daconil	Malathion 57%	Pramital
Pageant DF	Malathion 91%	Princep
Touche'	Abate	Roundup
Rubigan AS	Precor 1%	Amine 2-4D
Daconate 6 (MSMA)	Precor Plus Fogger	Diquat
Manage	Yardex	Trimec
Illozan	Hi Yield Zineb	Treflan
Fore	It Works	Trexsan
Manicure DG	Cygon 2E	MSMA
Dimension	Diazinon 4E	Devrinol
Ronstar 50 WP	Dursban 4E, LO, and TC	Poast
Princep	Dursban Granules	Embark
Proxol 80 SP	Ficam D	Silvex
Dyrene	ULD BP 100	Dalapon
Sencor	Seven Dust 10%	Hyvar X
Dursban	Seven WP 80%	
Subdue 2E	Scourge	
Bandol	Flitmo	
Kerb	Pyrethrum	
Roundup	DDVP(Vapona)	
Diazinon 4E		

TABLE 5-5

PESTICIDES, INSECTICIDES AND HERBICIDES PREVIOUSLY OR CURRENTLY STORED AT SWMU 43
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO - 0371
MCB CAMP LEJEUNE, NORTH CAROLINA

Pesticides (Used at the Golf Course)	Insecticides (Previously or Currently Being Stored)	Herbicides (Previously or Currently Being Stored)
Orthene	Liqua Tox	Oust
Daconil	Malathion 57%	Pramital
Pageant DF	Malathion 91%	Princep
Touche'	Abate	Roundup
Rubigan AS	Precor 1%	Amine 2-4D
Daconate 6 (MSMA)	Precor Plus Fogger	Diquat
Manage	Yardex	Trimec
Illozan	Hi Yield Zineb	Treflan
Fore	It Works	Trexsan
Manicure DG	Cygon 2E	MSMA
Dimension	Diazinon 4E	Devrinol
Ronstar 50 WP	Dursban 4E, LO, and TC	Poast
Princep	Dursban Granules	Embark
Proxol 80 SP	Ficam D	Silvex
Dyrene	ULD BP 100	Dalapon
Sencor	Seven Dust 10%	Hyvar X
Dursban	Seven WP 80%	
Subdue 2E	Scourge	
Bandol	Flitmo	
Kerb	Pyrethrum	
Roundup	DDVP(Vapona)	
Diazinon 4E		

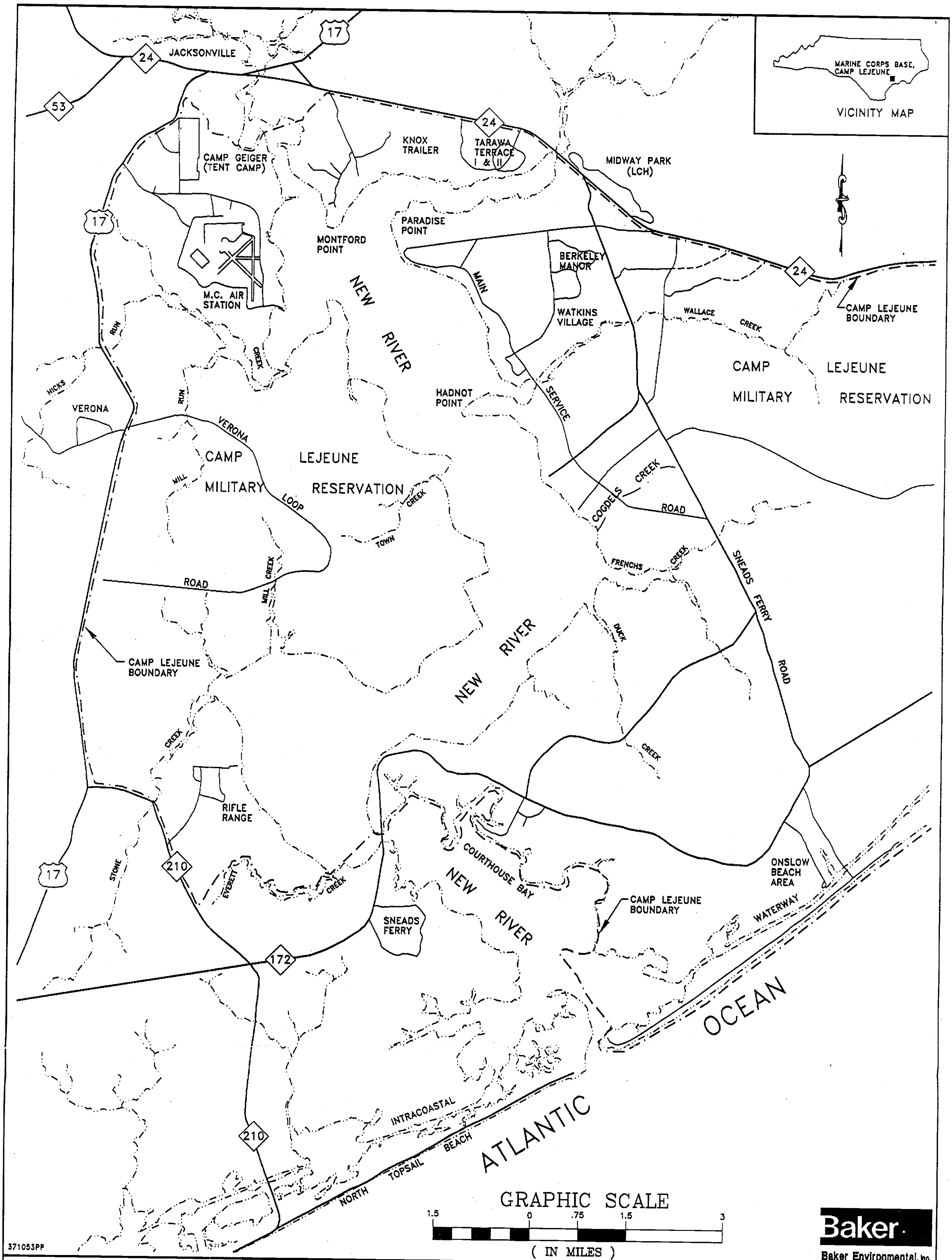
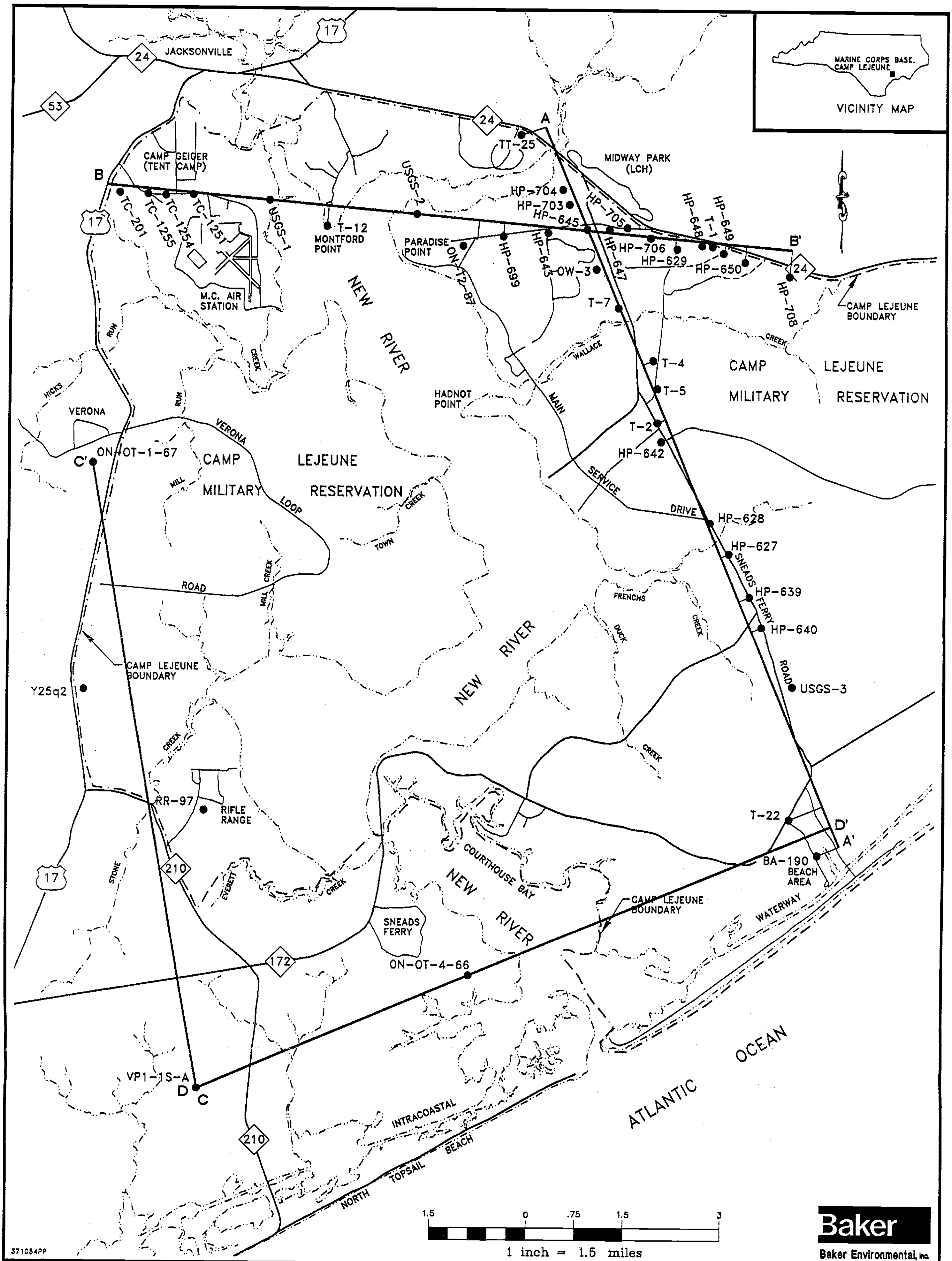


FIGURE 2-1
MCB CAMP LEJEUNE LOCATION MAP
SWMU CONFIRMATORY SAMPLING WORK PLAN
CTO - 0371

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

01757BBB12



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SOURCE: U.S. GEOLOGICAL SURVEY,
WATER-RESOURCES INVESTIGATIONS
REPORT, 93-4049, FIGURE 9

FIGURE 2-2
LOCATION OF HYDROGEOLOGIC CROSS-SECTIONS
MCB CAMP LEJEUNE
SWMU CONFIRMATORY SAMPLING WORK PLAN
CTO - 0371

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

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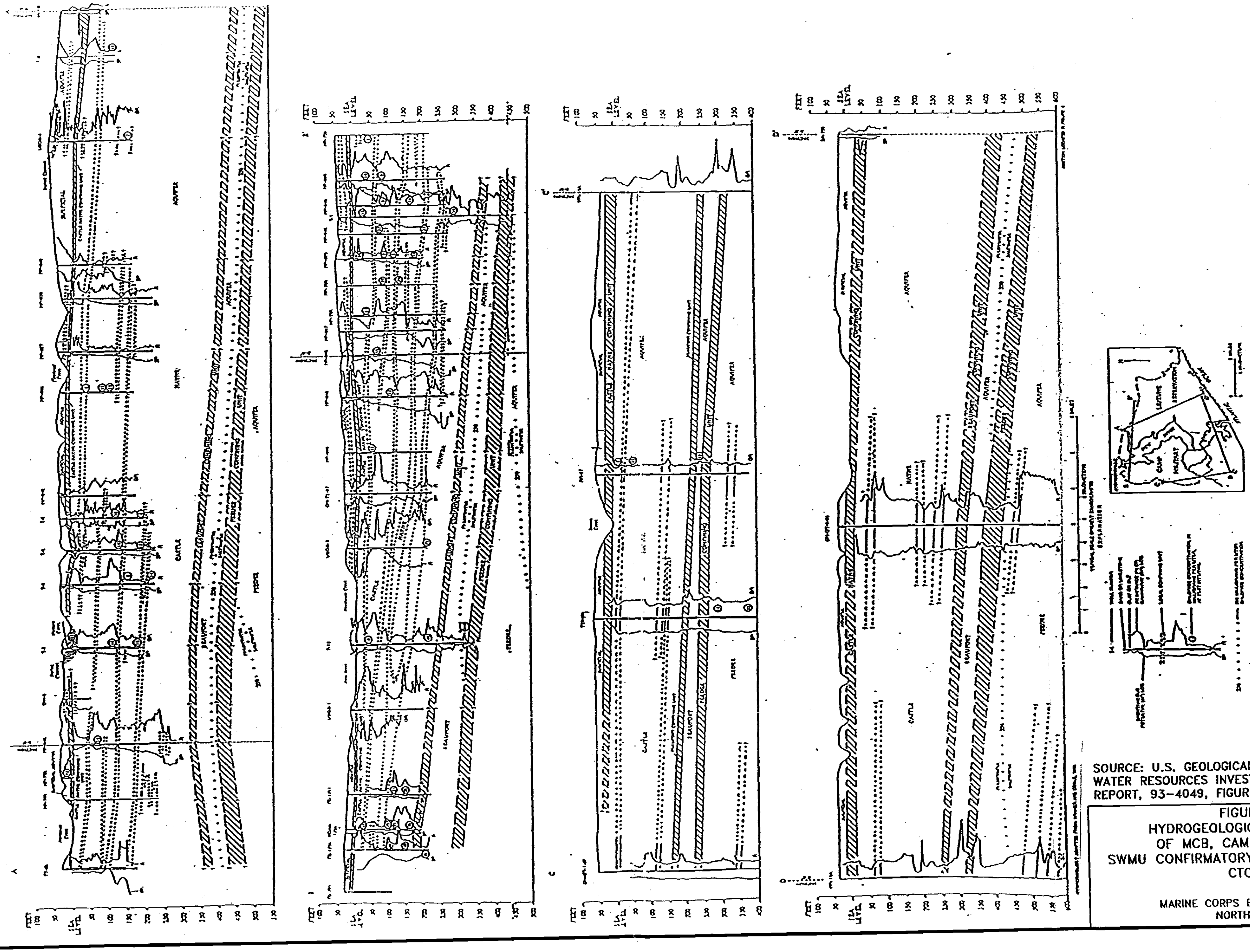

SOURCE: U.S. GEOLOGICAL SURVEY, WATER RESOURCES INVESTIGATIONS REPORT, 93-4049, FIGURE 9

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FIGURE 2-3
HYDROGEOLOGIC CROSS-SECTION
OF MCB, CAMP LEJEUNE AREA
SWMU CONFIRMATORY SAMPLING WORK PLAN
CTO-0371

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

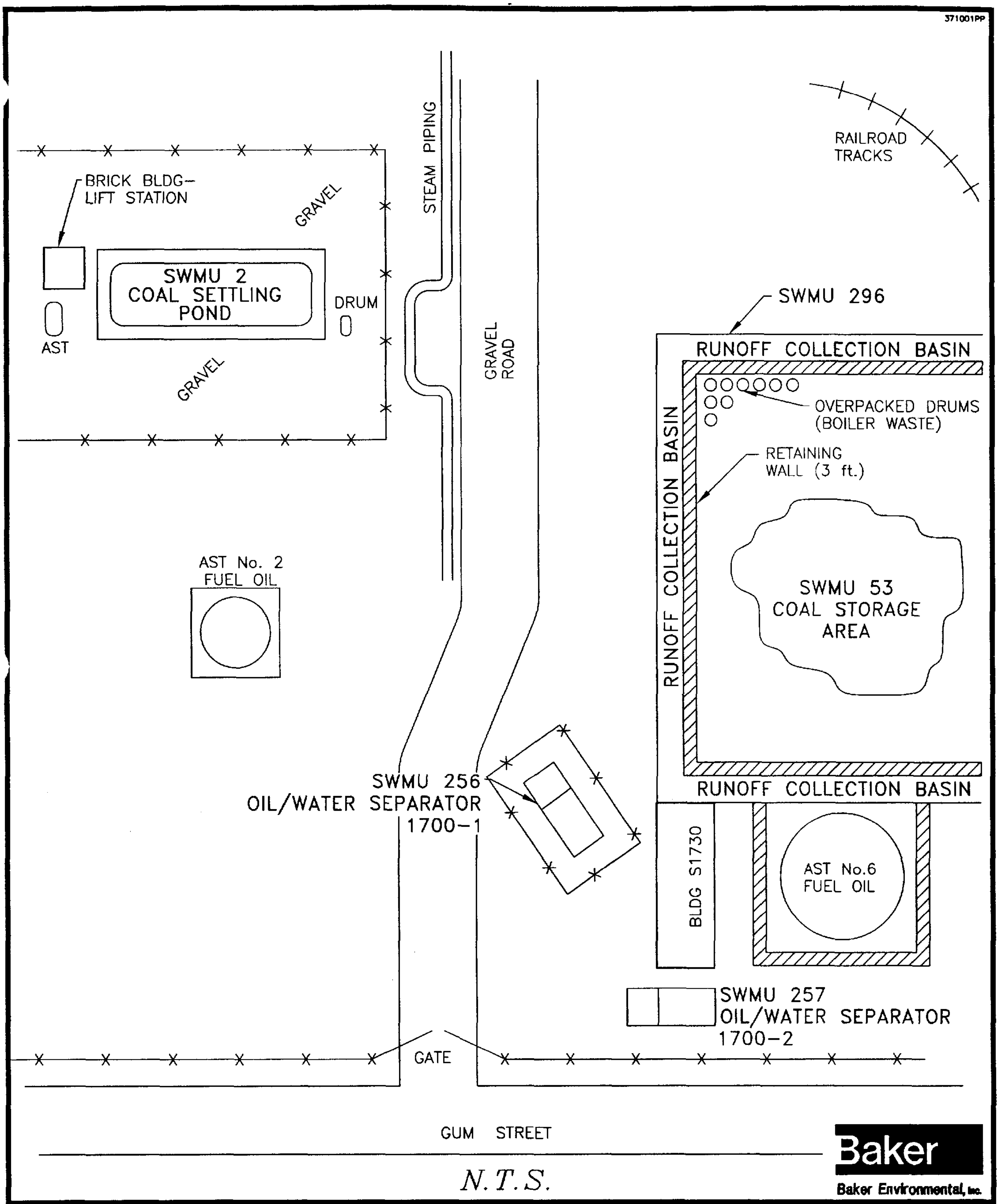

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FIGURE 5-1
SITE SKETCH
SWMUs 2, 53, 256, 257, AND 296
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

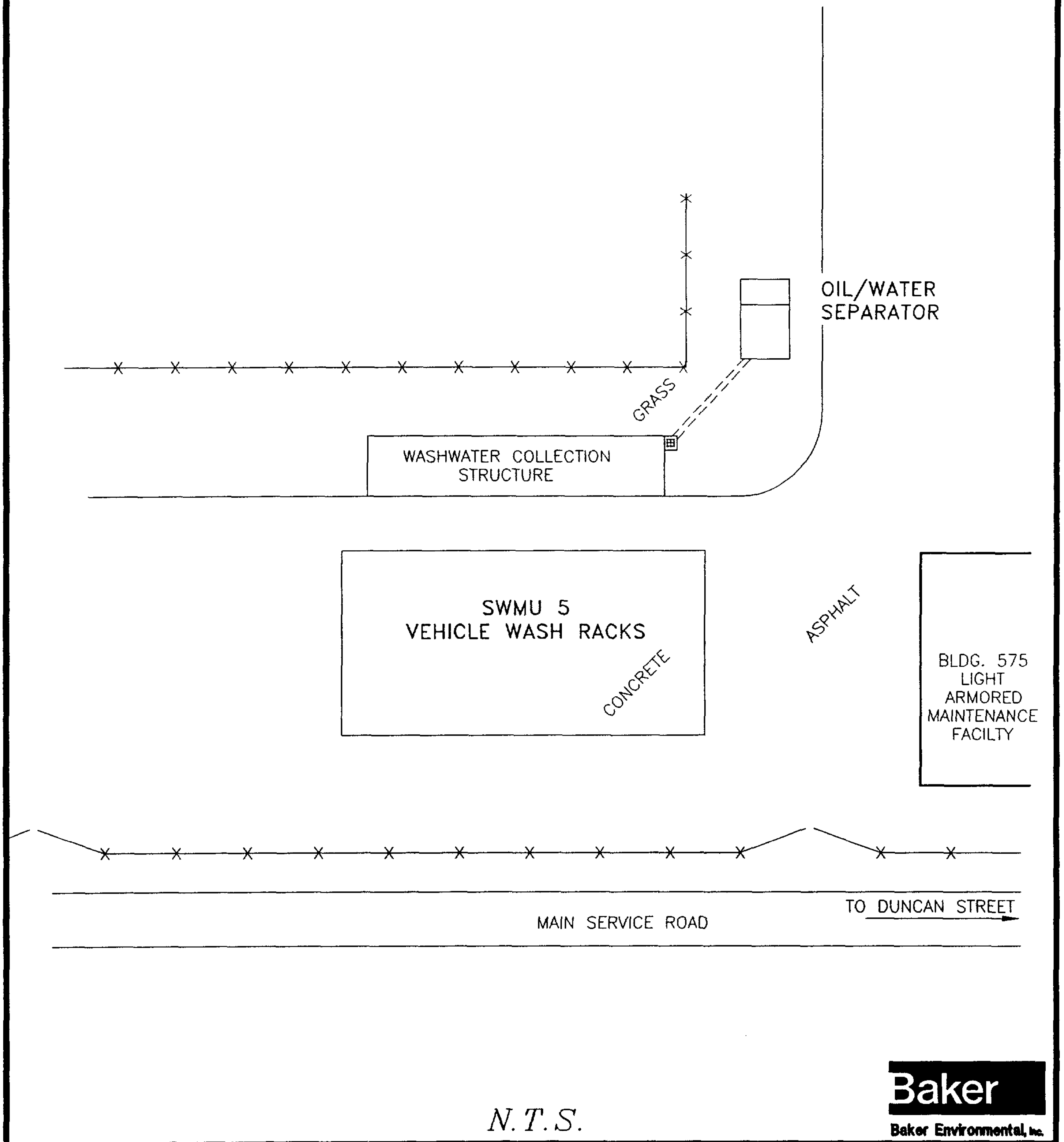

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FIGURE 5-2
SITE SKETCH
SWMU 5
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

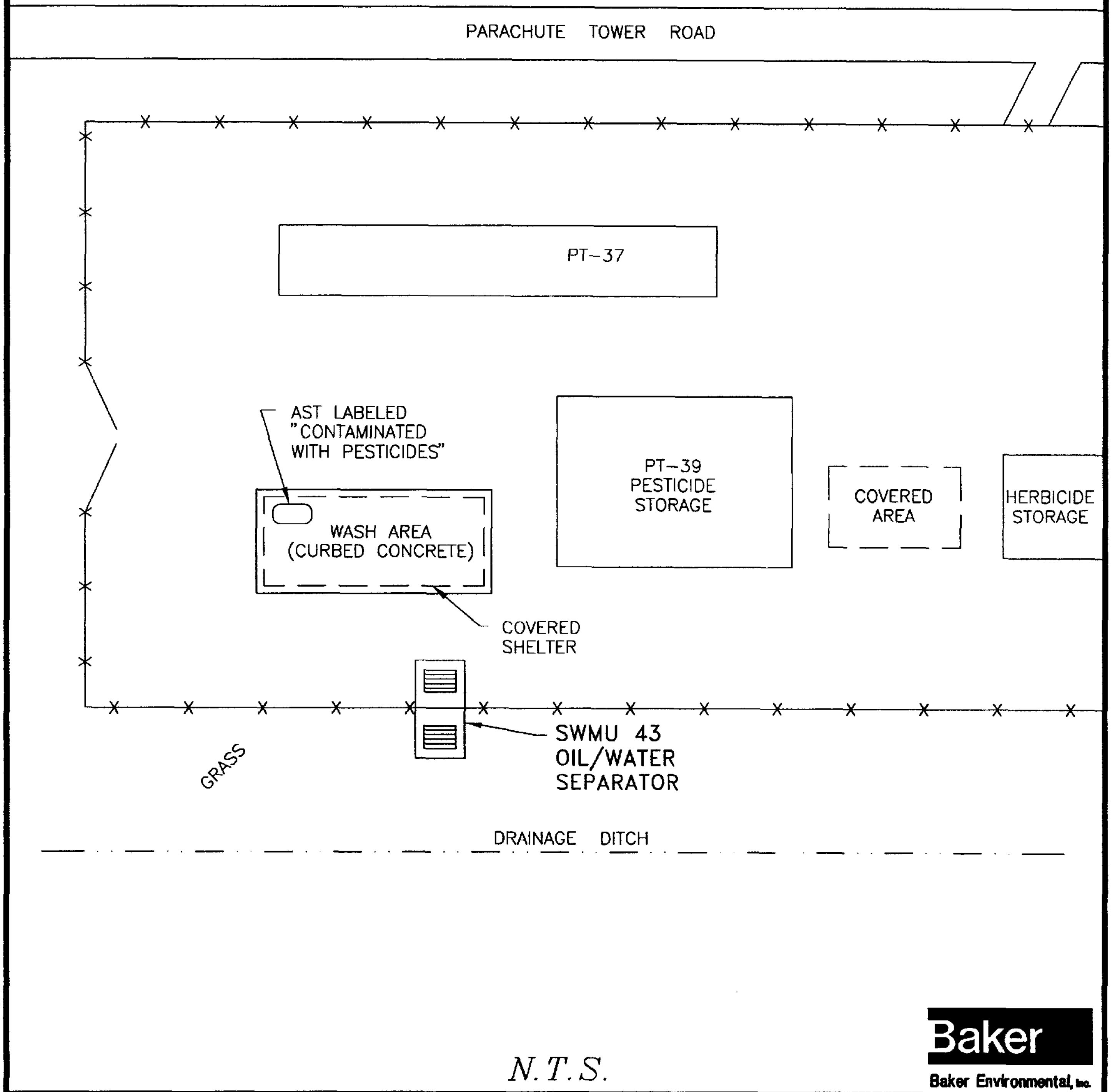

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FIGURE 5-3
SITE SKETCH
SWMU 43
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

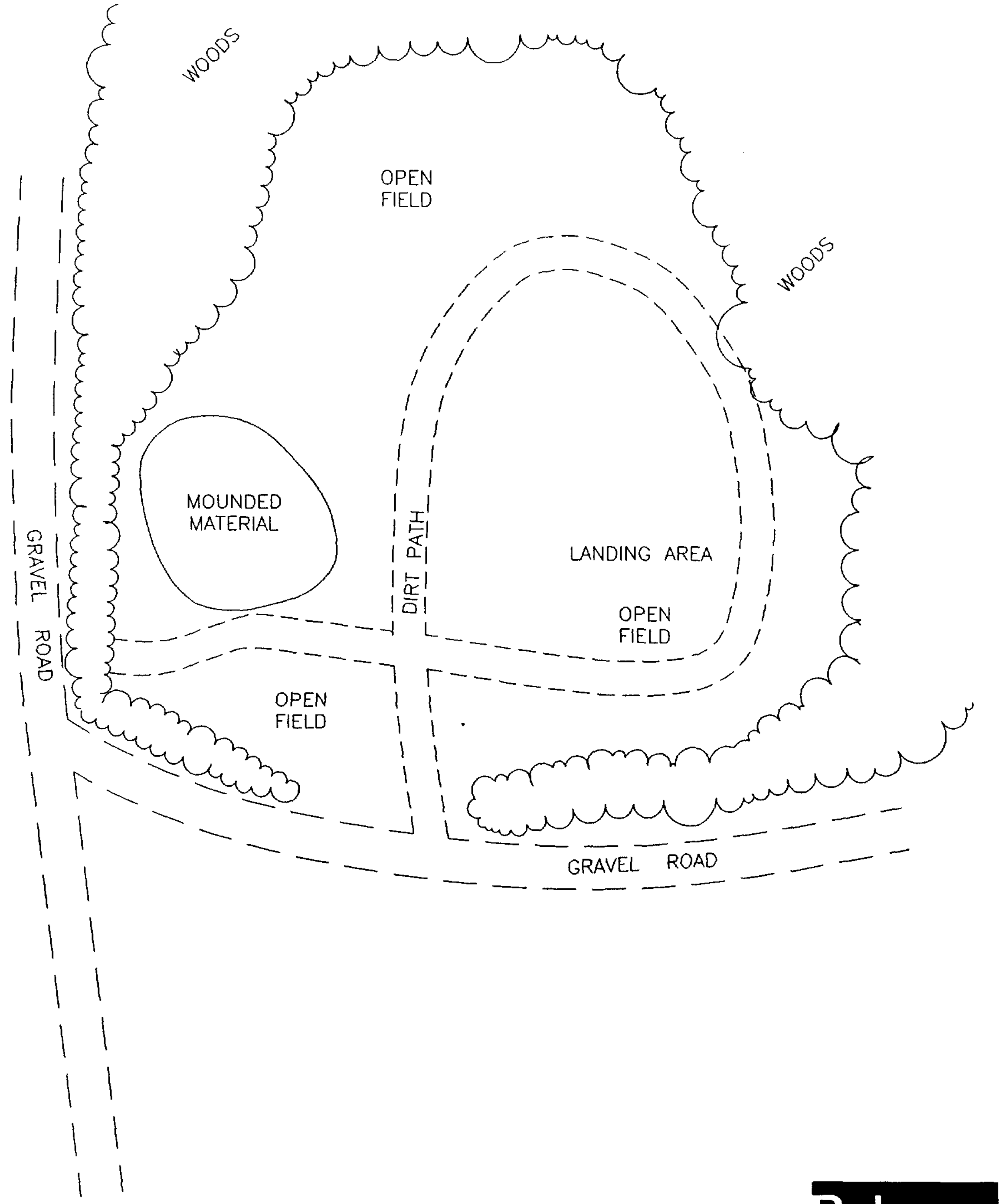

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FIGURE 5-4
SITE SKETCH
SWMU 46
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

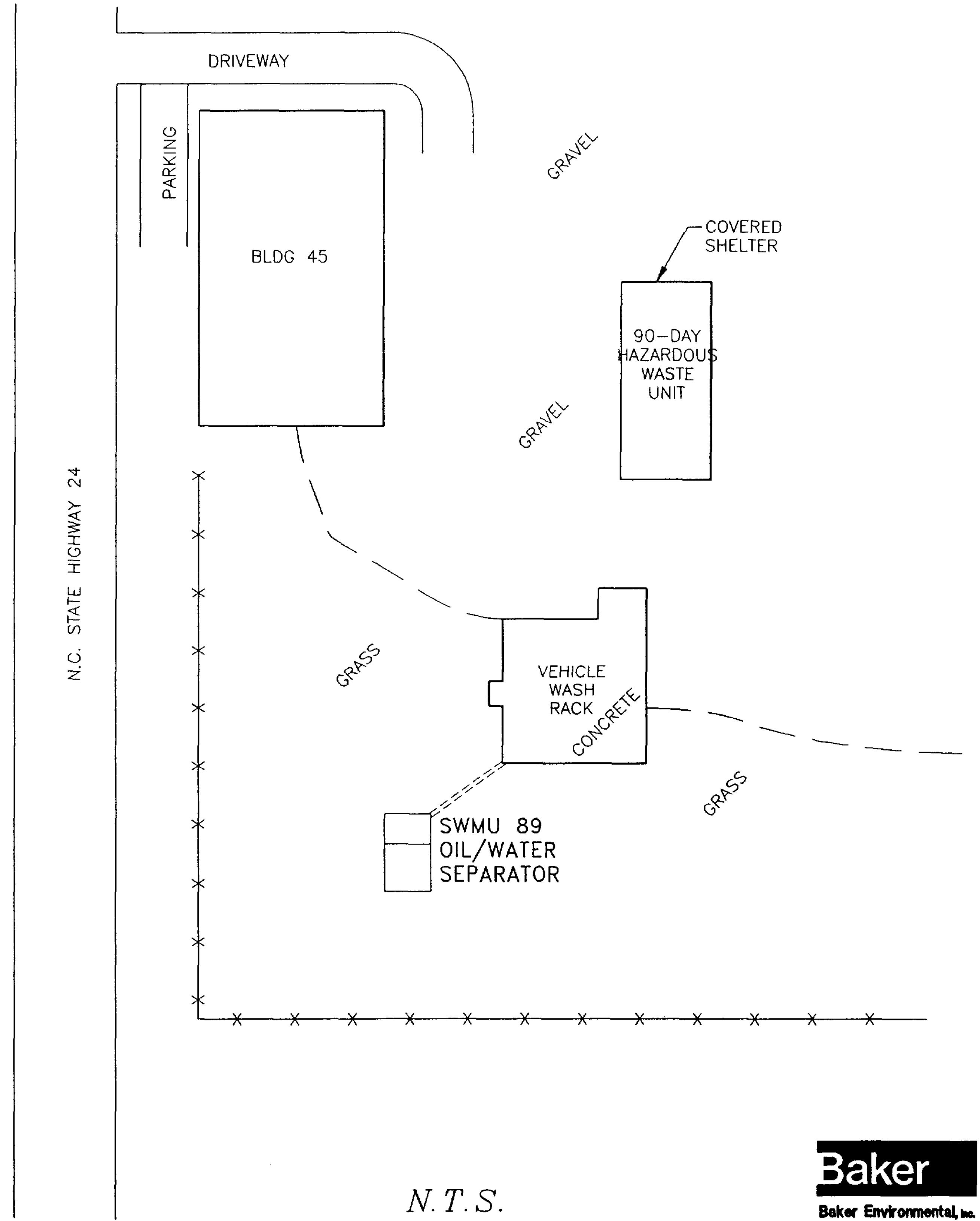

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FIGURE 5-5
SITE SKETCH
SWMU 89
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

371007PP

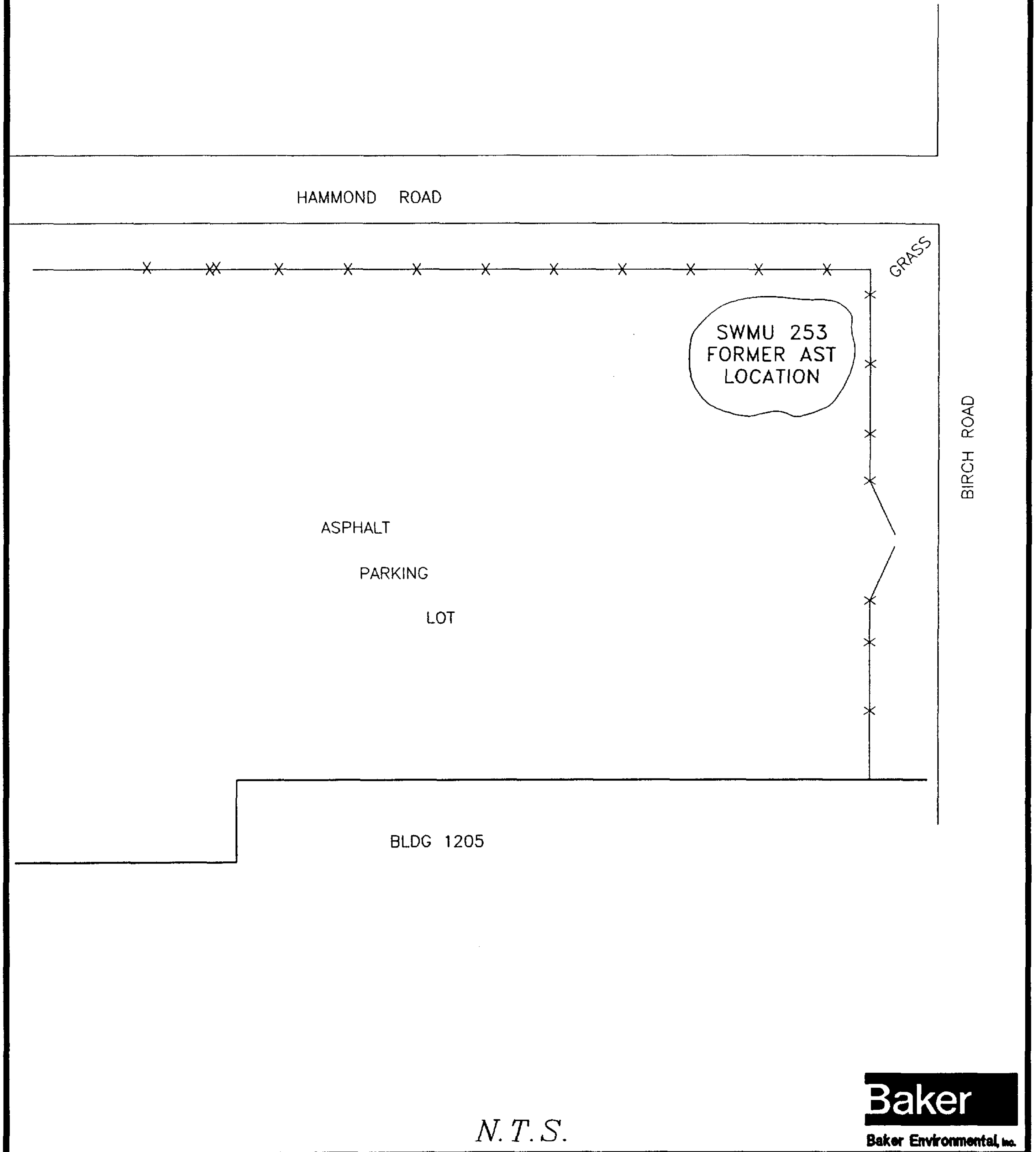

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FIGURE 5-6
SITE SKETCH
SWMU 253
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

371008PP

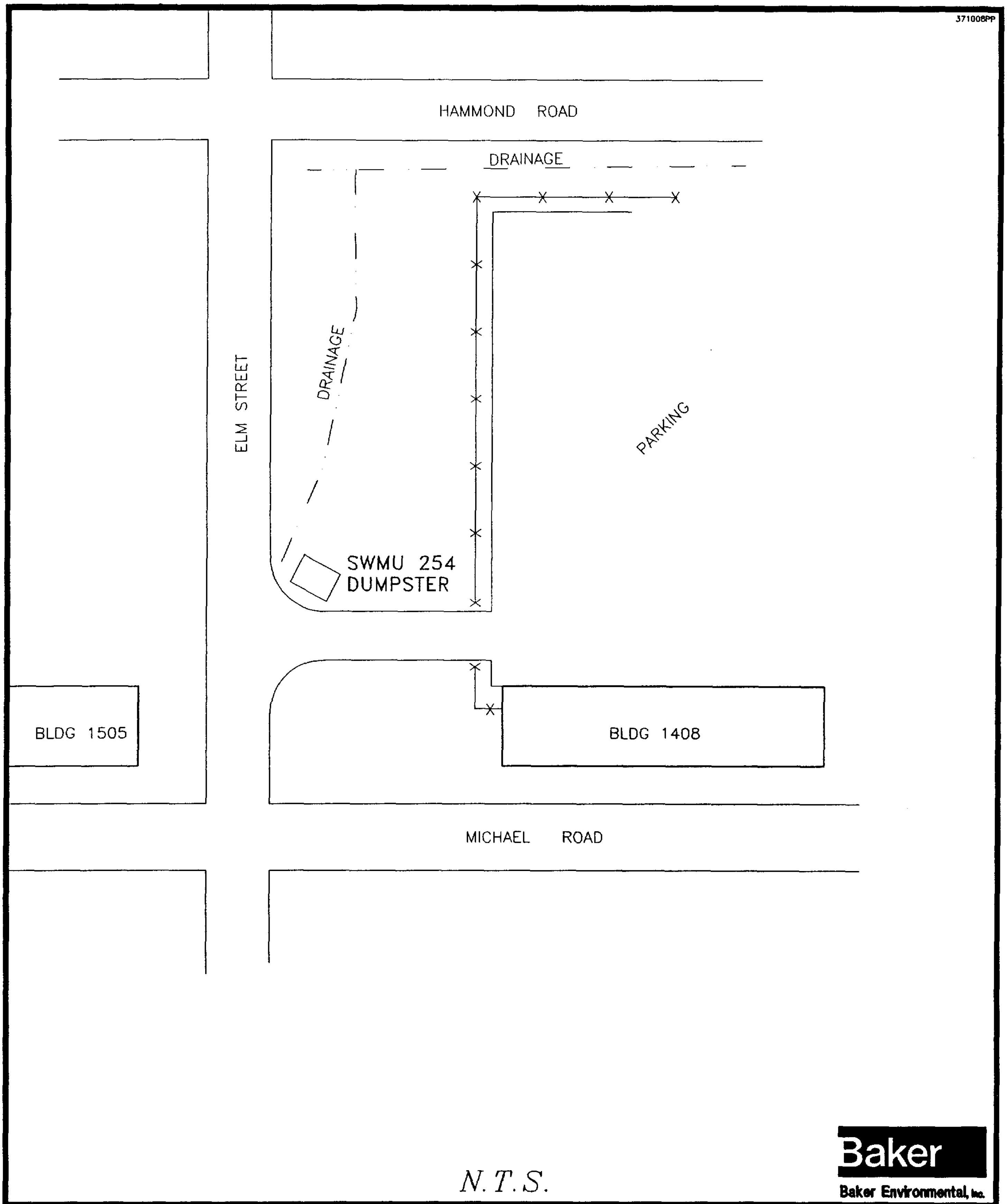

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FIGURE 5-7
SITE SKETCH
SWMU 254
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

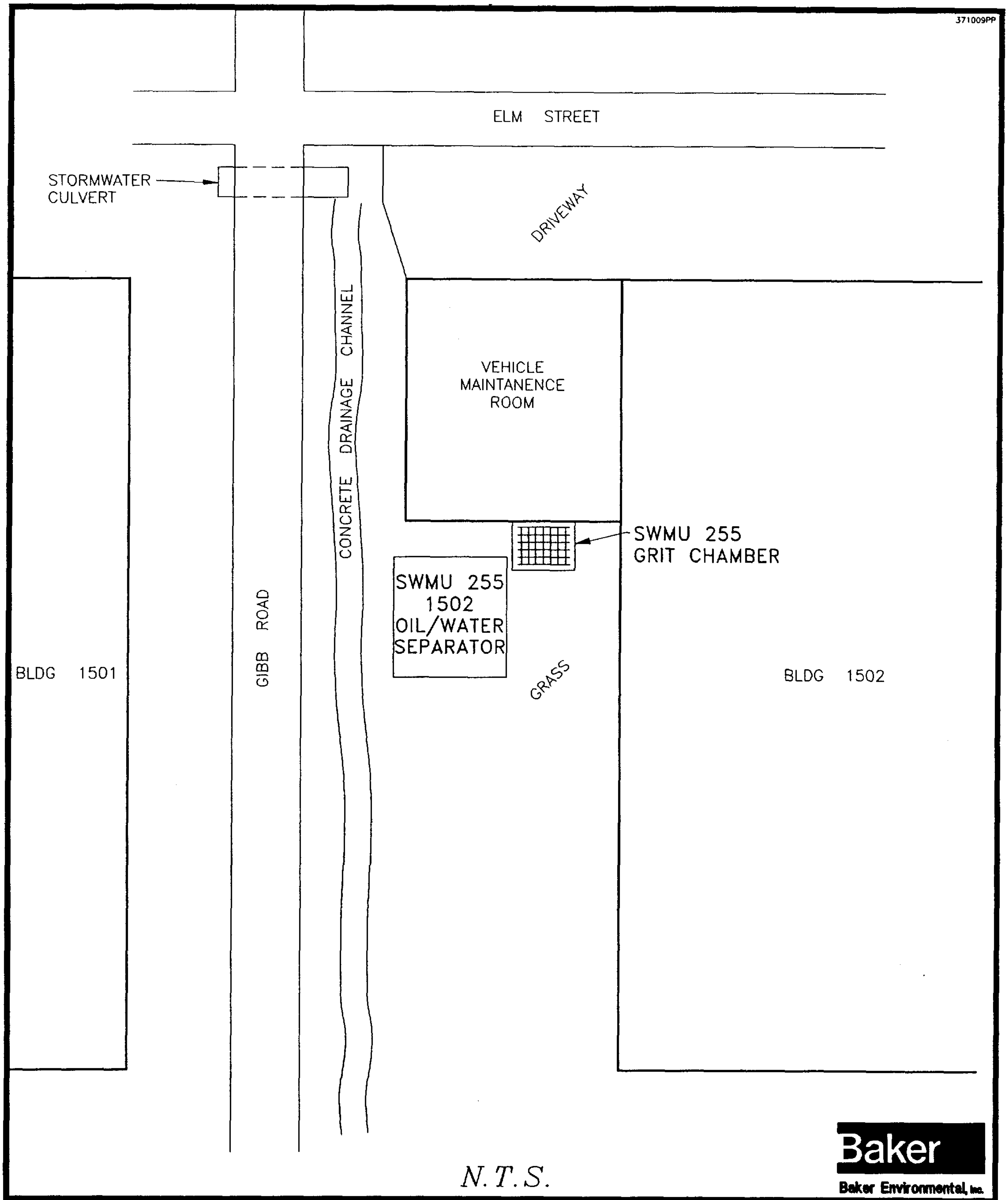

FIGURE 5-8
SITE SKETCH
SWMU 255
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

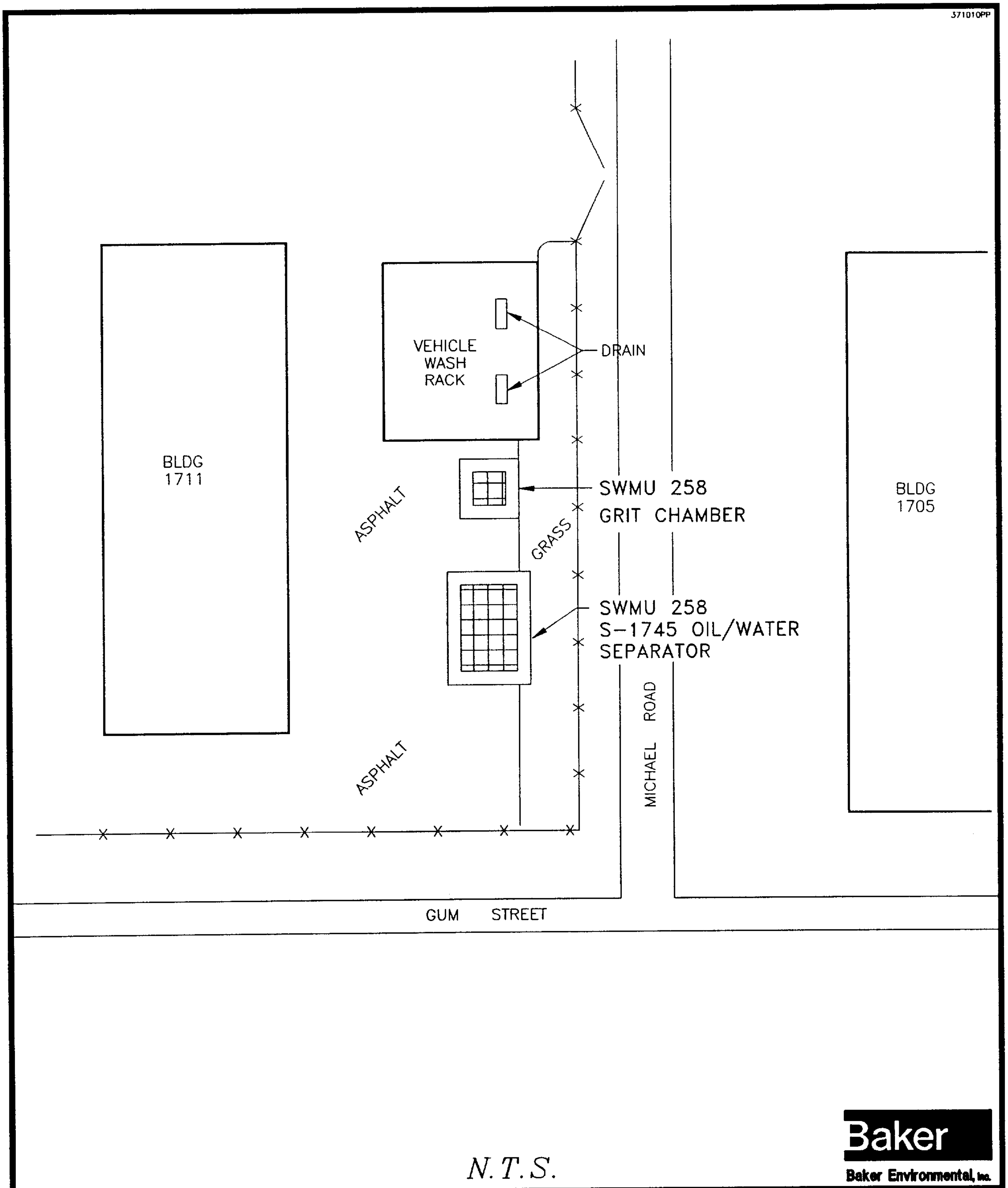

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FIGURE 5-9
SITE SKETCH
SWMU 258
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

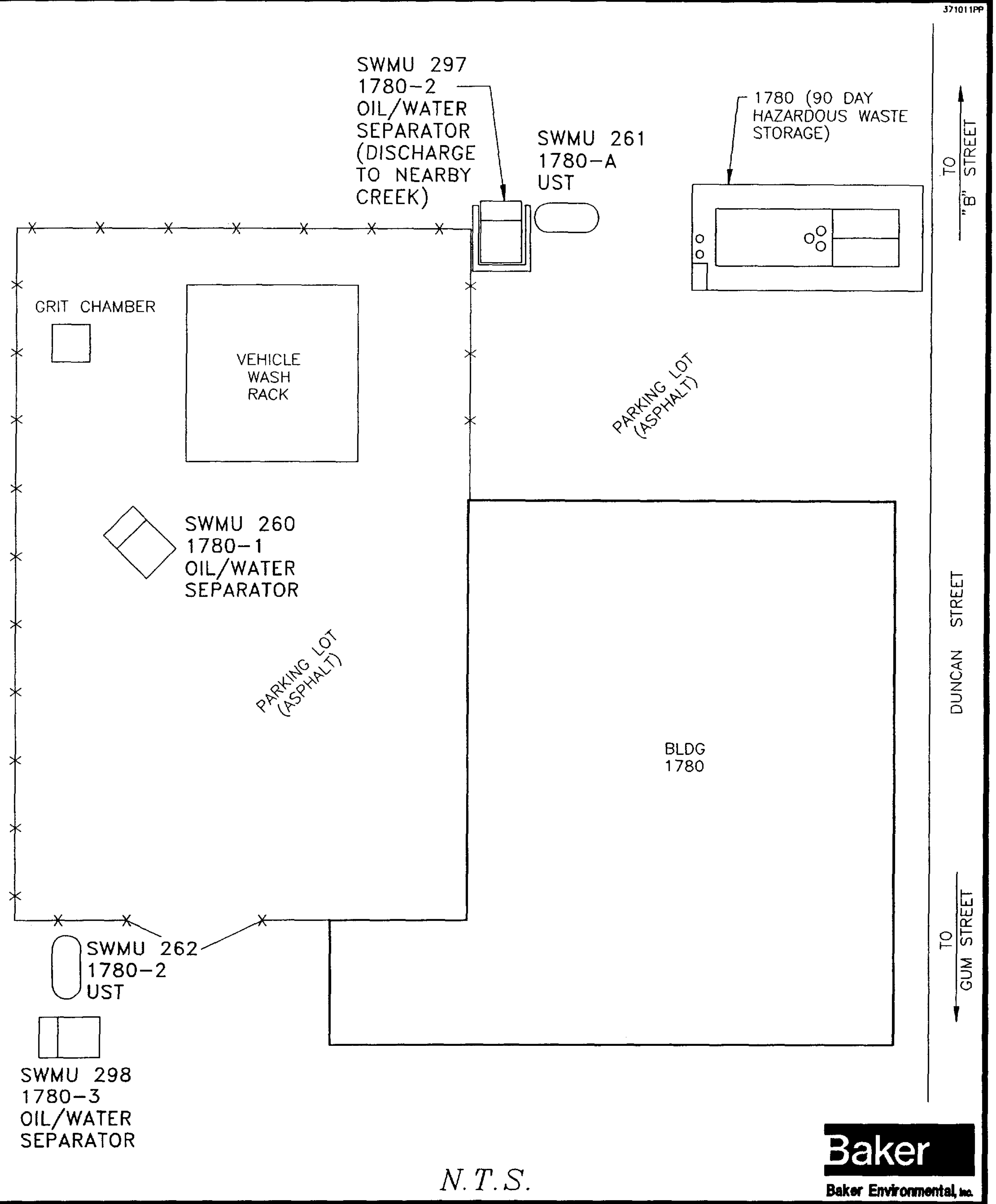

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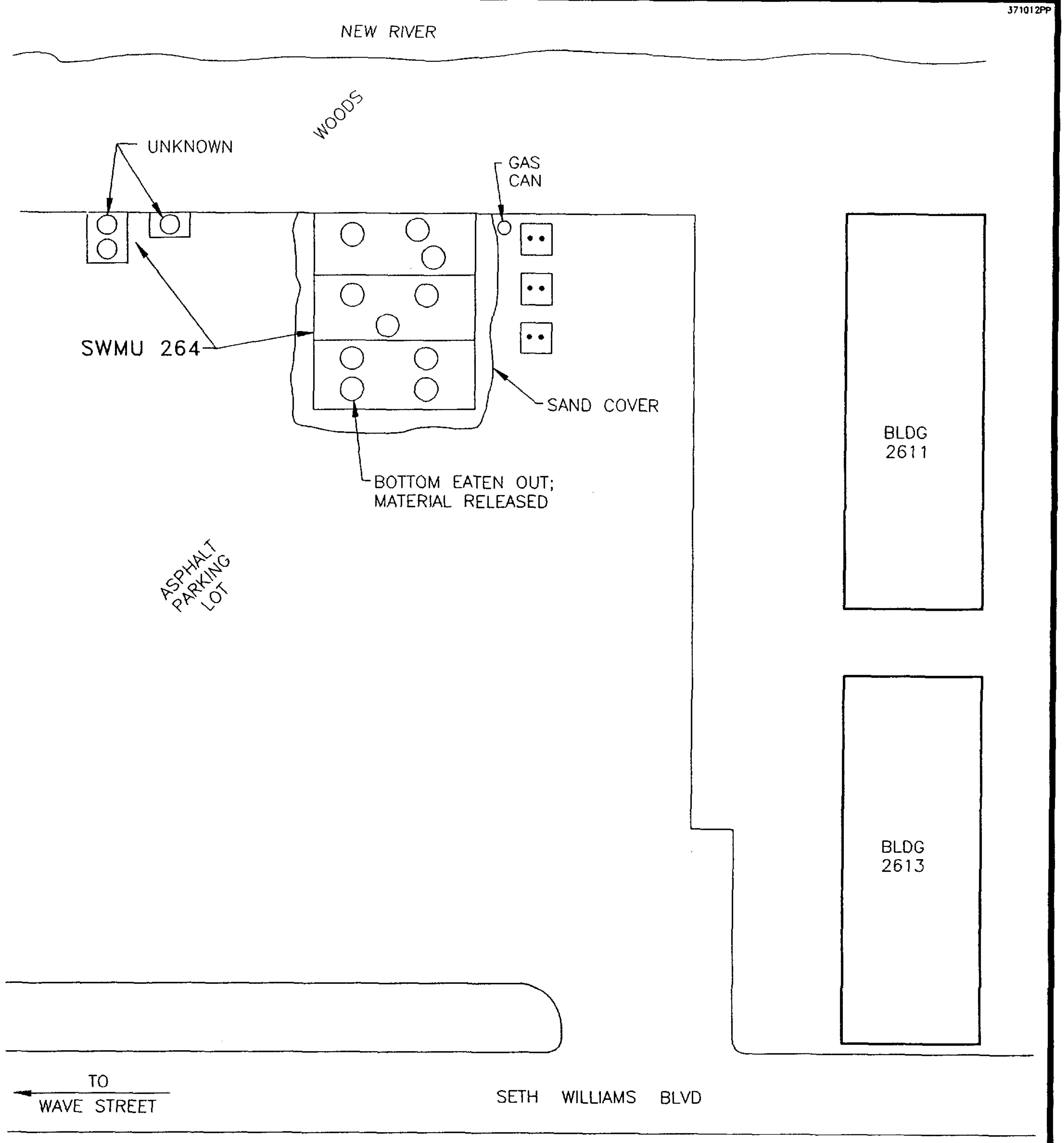
FIGURE 5-10
SITE SKETCH
SWMUs 260, 261, 262, 297, AND 298
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



NOTE: DURING THE OCTOBER 1996 VISIT, THE ENTIRE PARKING LOT AT SWMU 264 WAS COVERED WITH WOOD CHIPS AND NO DETAILS WERE VISIBLE. THE DETAILS IN THIS DRAWING WERE NOTED BY ENSAFE, INC. IN NOVEMBER 1993.

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FIGURE 5-11
SITE SKETCH
SWMU 264
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

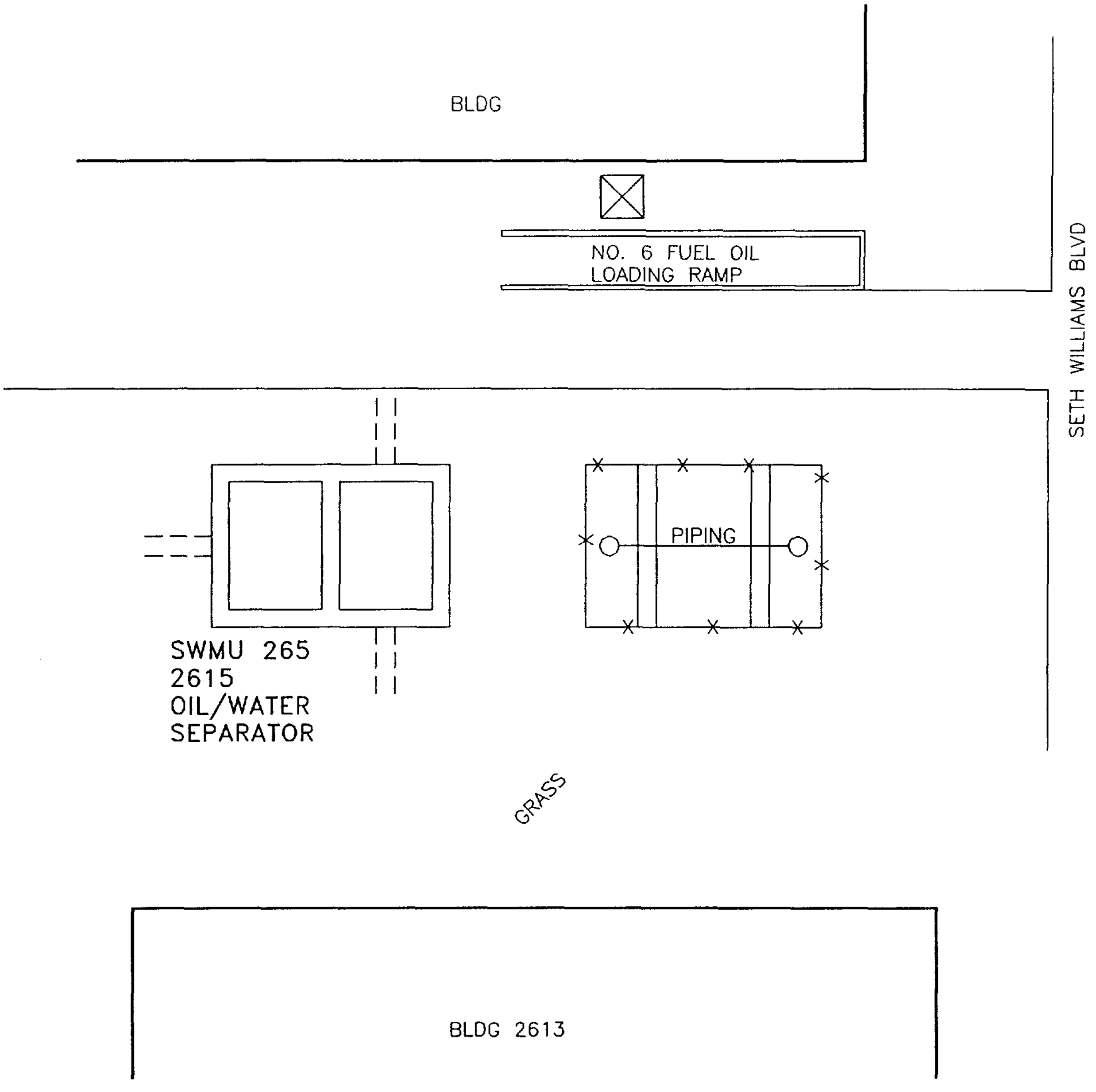

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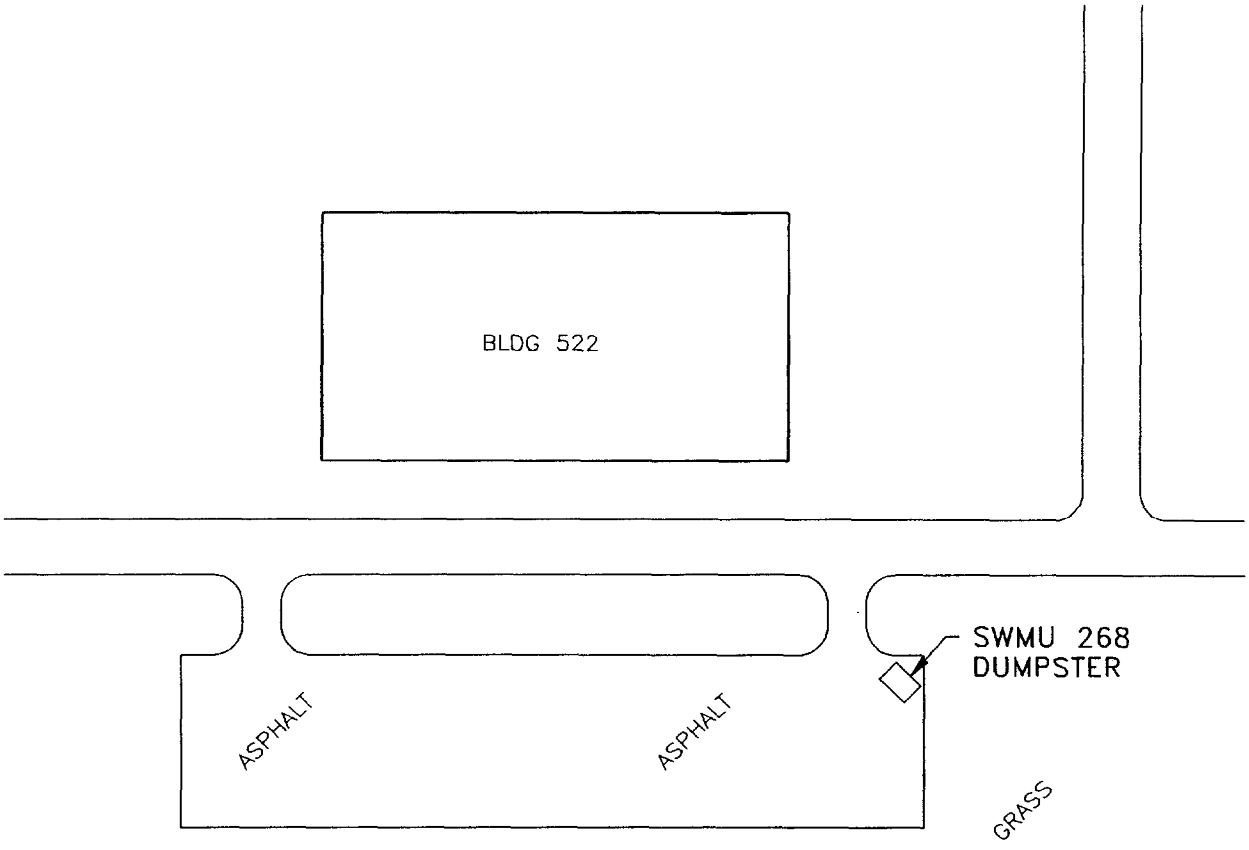
FIGURE 5-12
SITE SKETCH
SWMU 265
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

371014PP



NOTE: THE LOCATION OF THIS DUMPSTER COULD NOT BE FOUND DURING THE OCTOBER 1996 SITE VISIT.

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FIGURE 5-13
SITE SKETCH
SWMU 268
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

371015PP

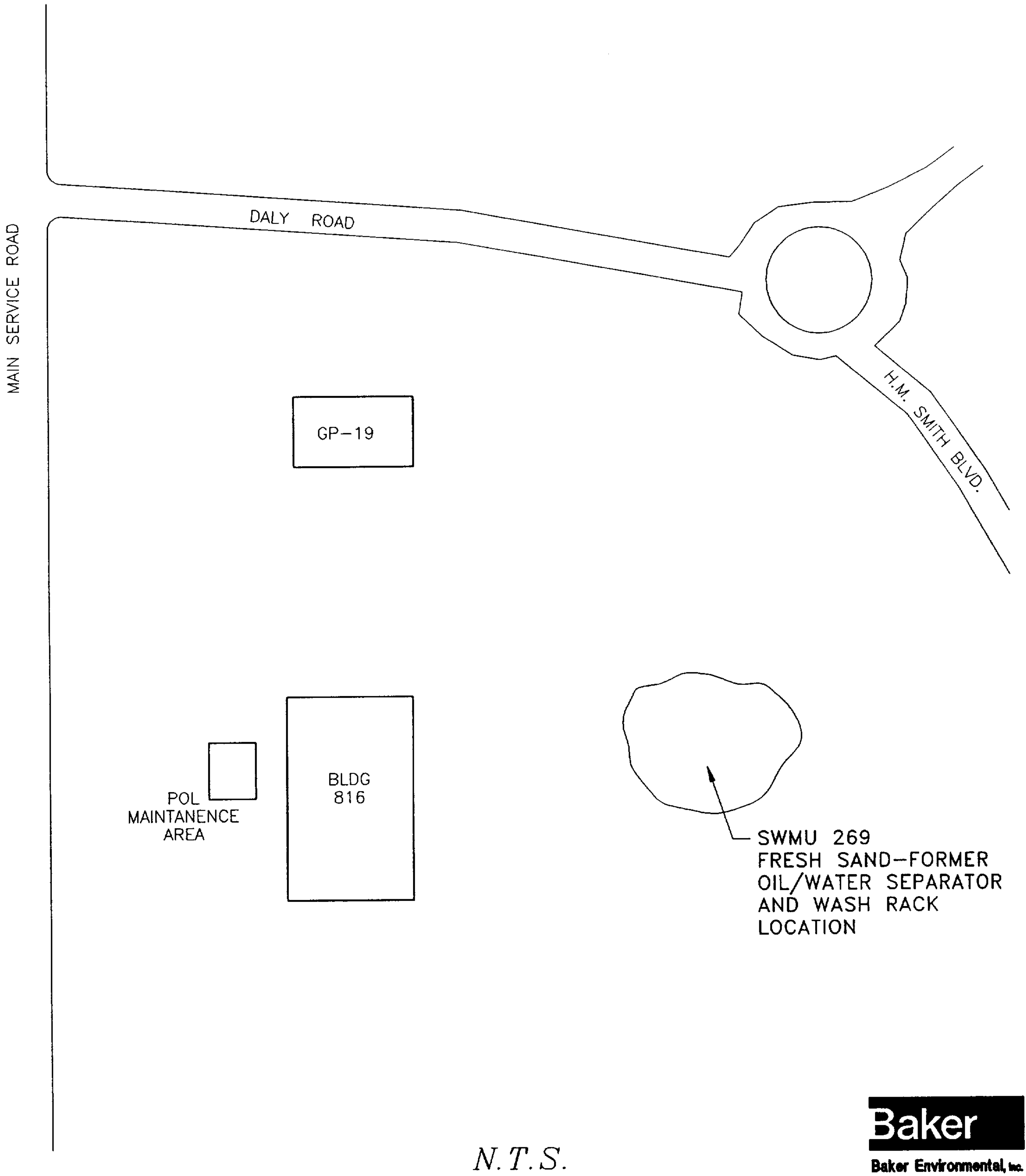

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FIGURE 5-14
SITE SKETCH
SWMU 269
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

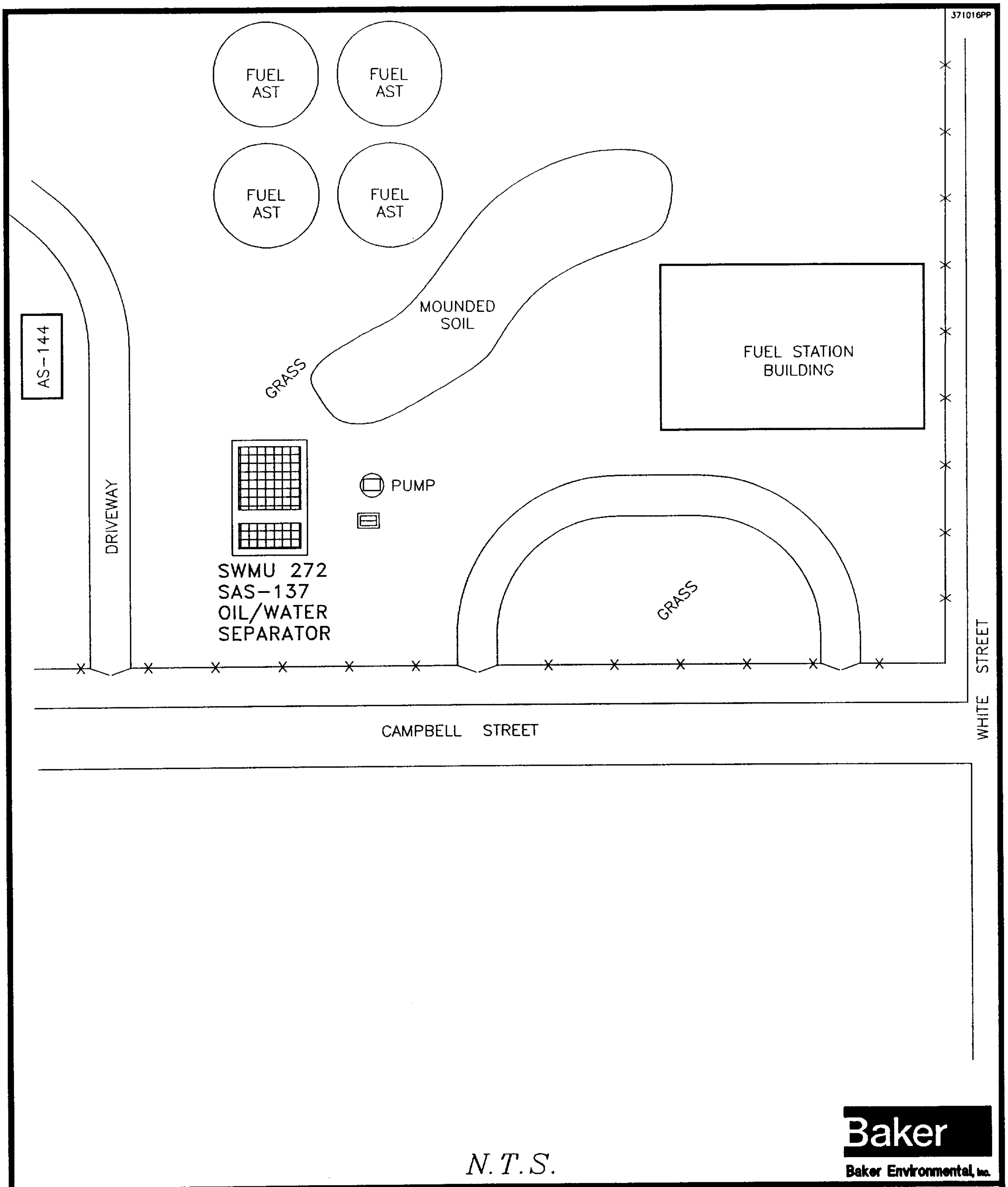

FIGURE 5-15
SITE SKETCH
SWMU 272
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

371017PP

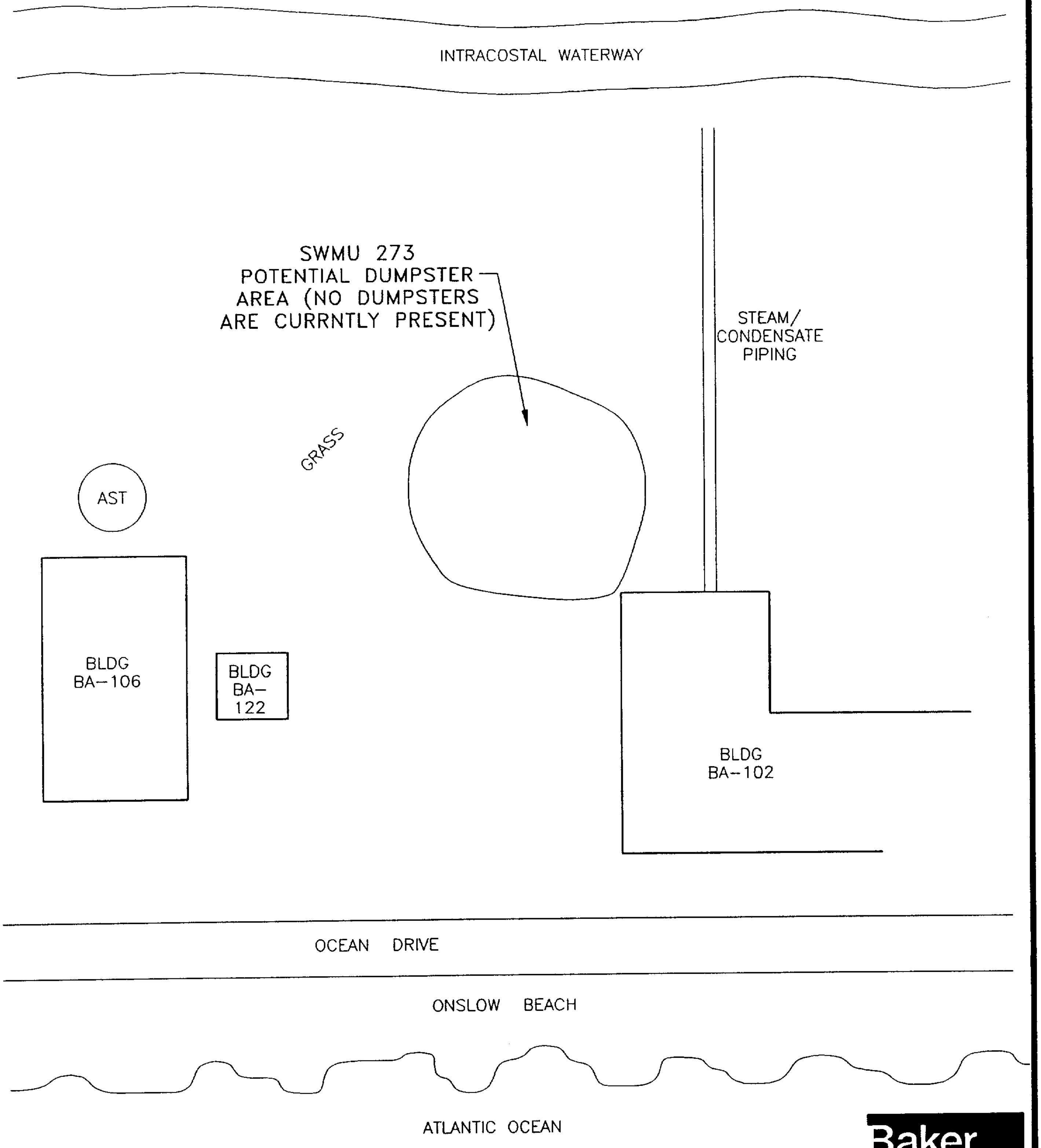

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FIGURE 5-16
SITE SKETCH
SWMU 273
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

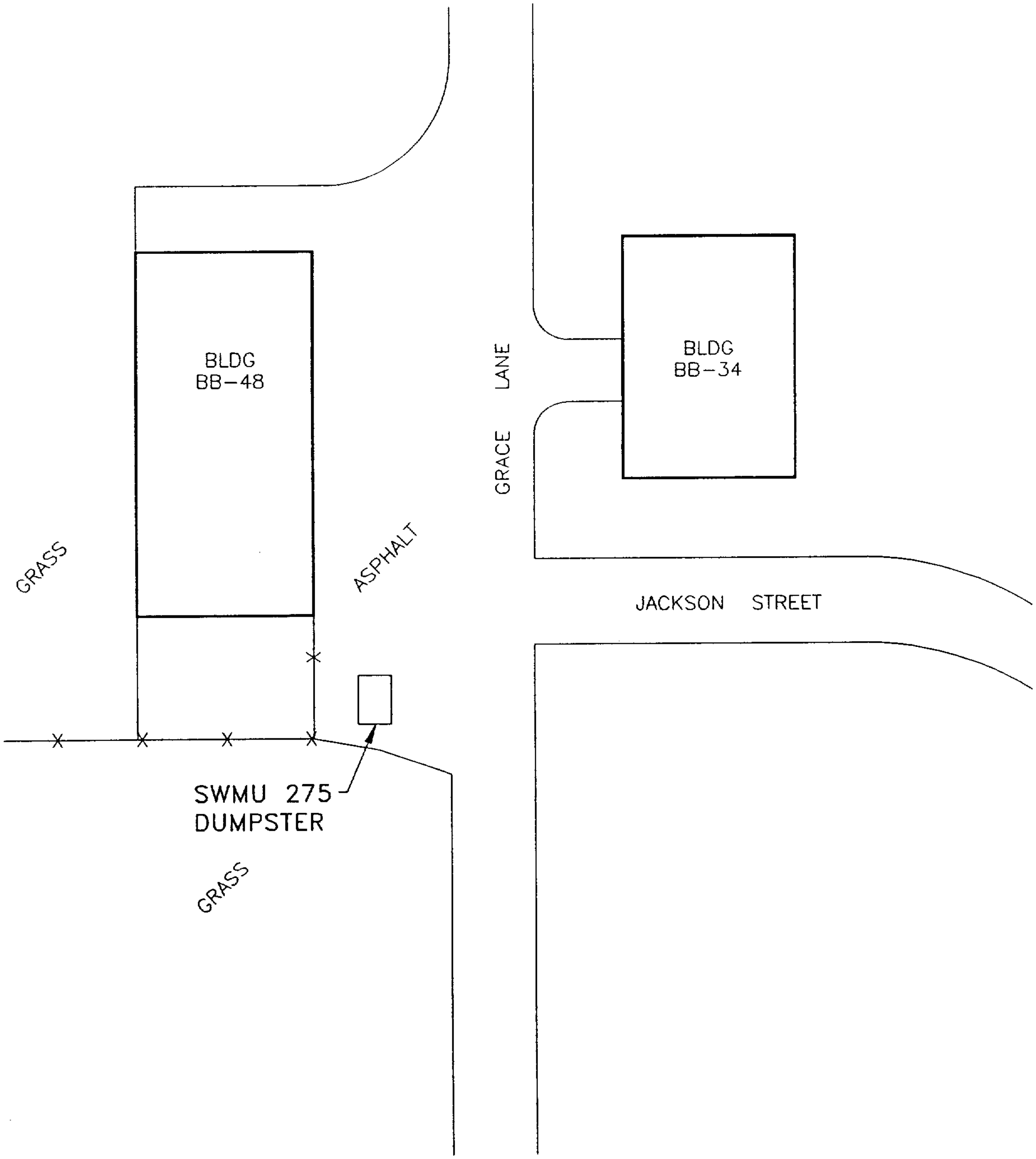

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FIGURE 5-17
SITE SKETCH
SWMU 275
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

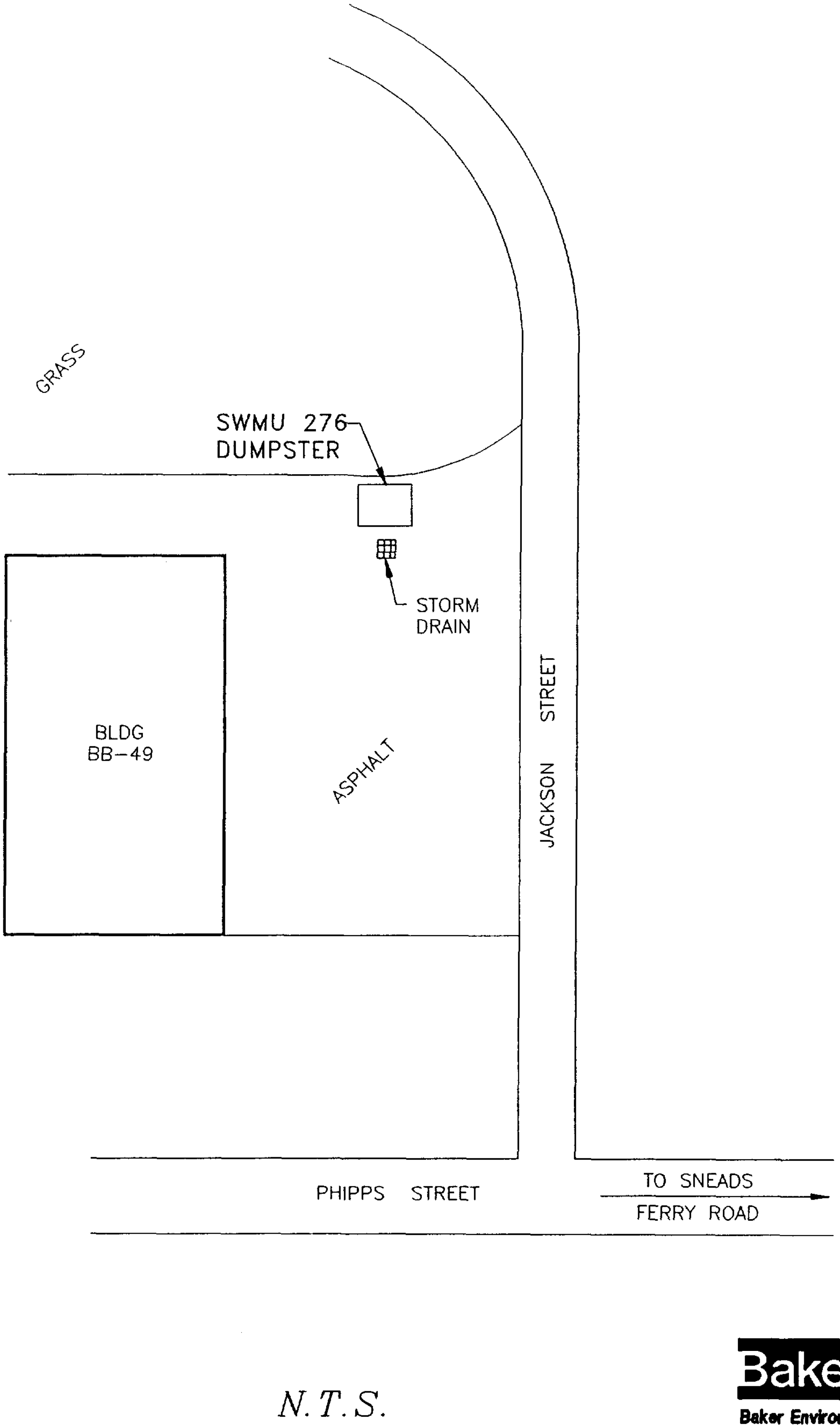

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FIGURE 5-18
SITE SKETCH
SWMU 276
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

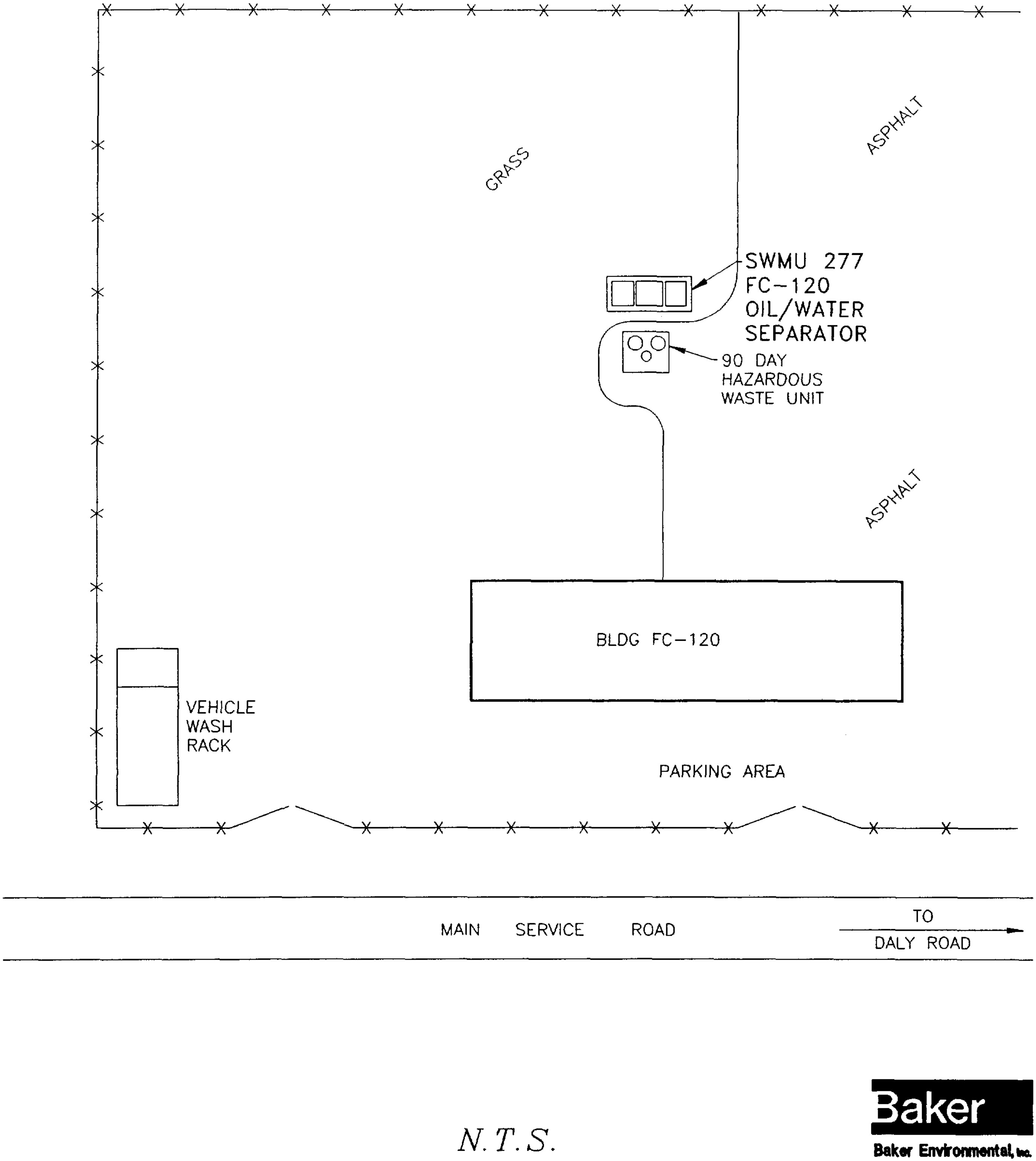

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FIGURE 5-19
SITE SKETCH
SWMU 277
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

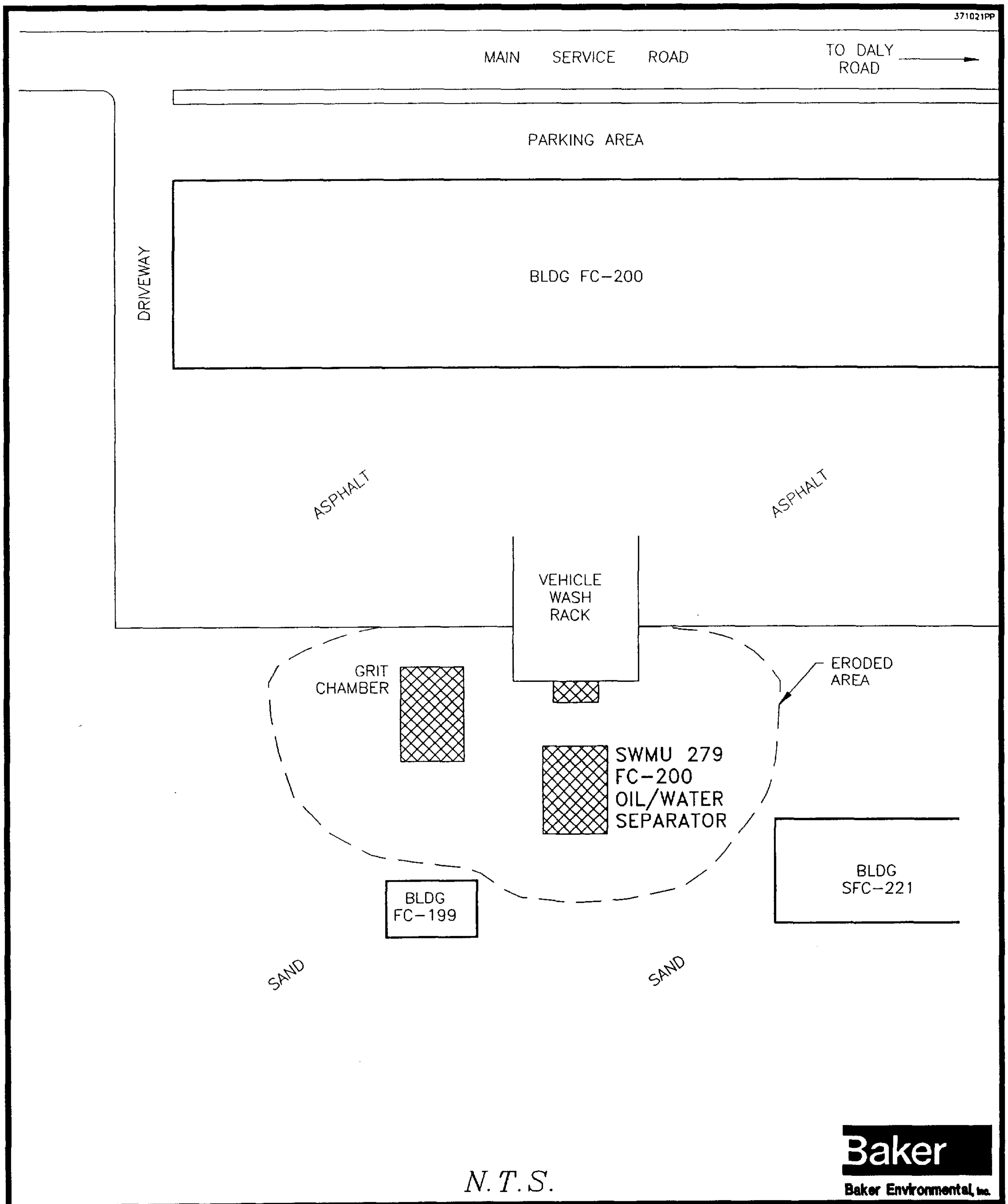
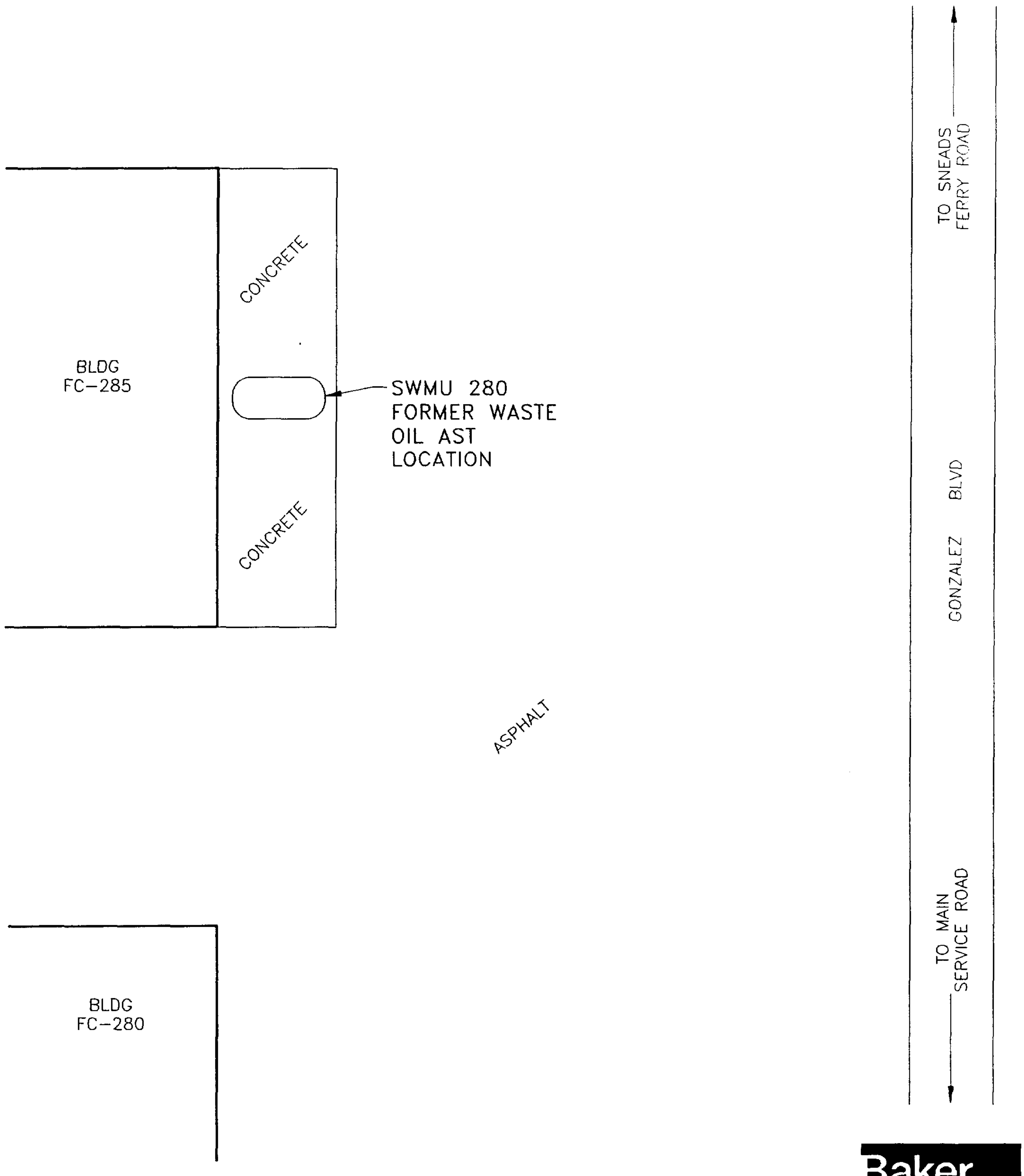


FIGURE 5-20
SITE SKETCH
SWMU 279
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



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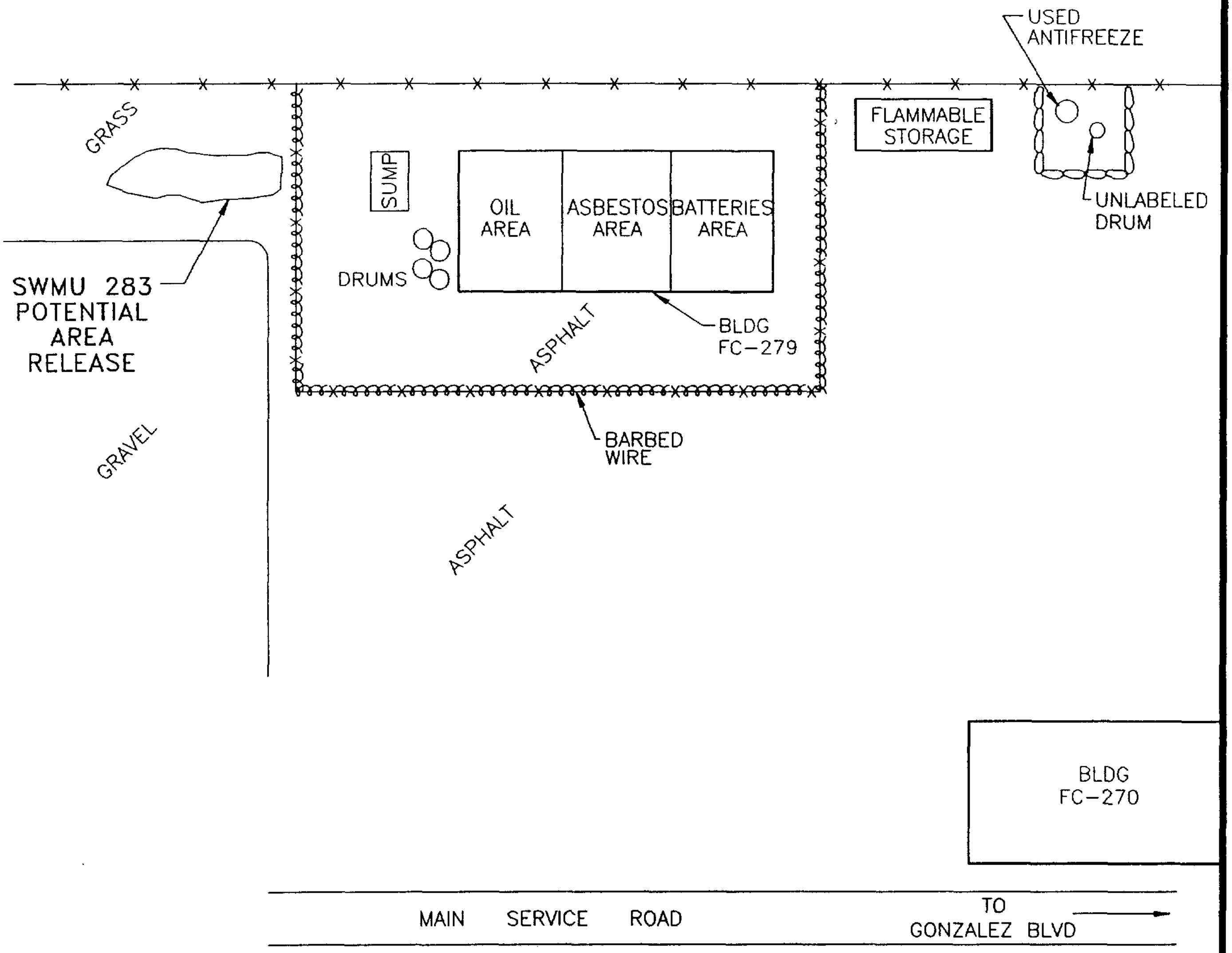
N.T.S.

FIGURE 5-21
SITE SKETCH
SWMU 280
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



N.T.S.

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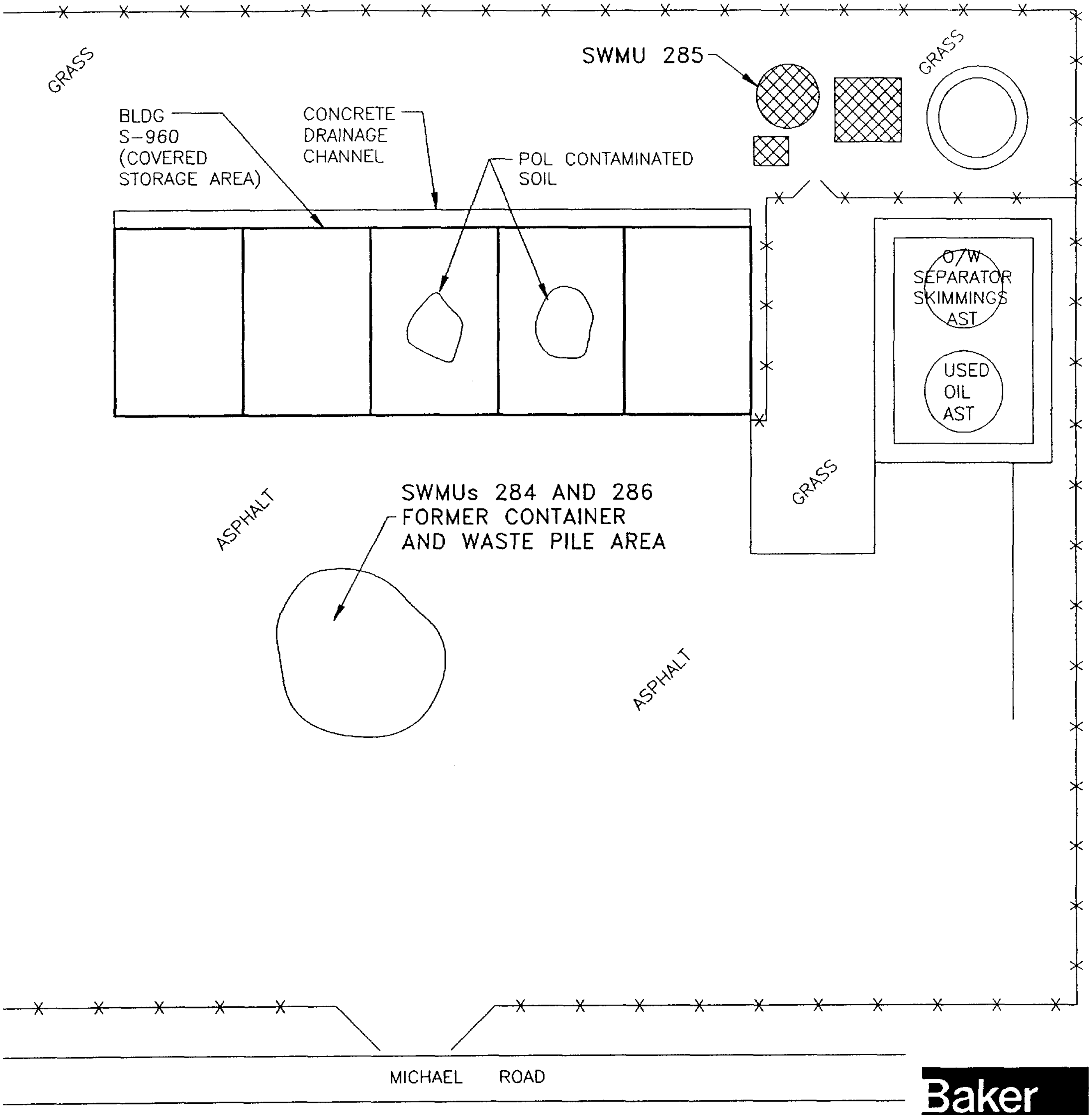
FIGURE 5-22
SITE SKETCH
SWMU 283
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



N.T.S.

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FIGURE 5-23
SITE SKETCH
SWMUs 284, 285 AND 286
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

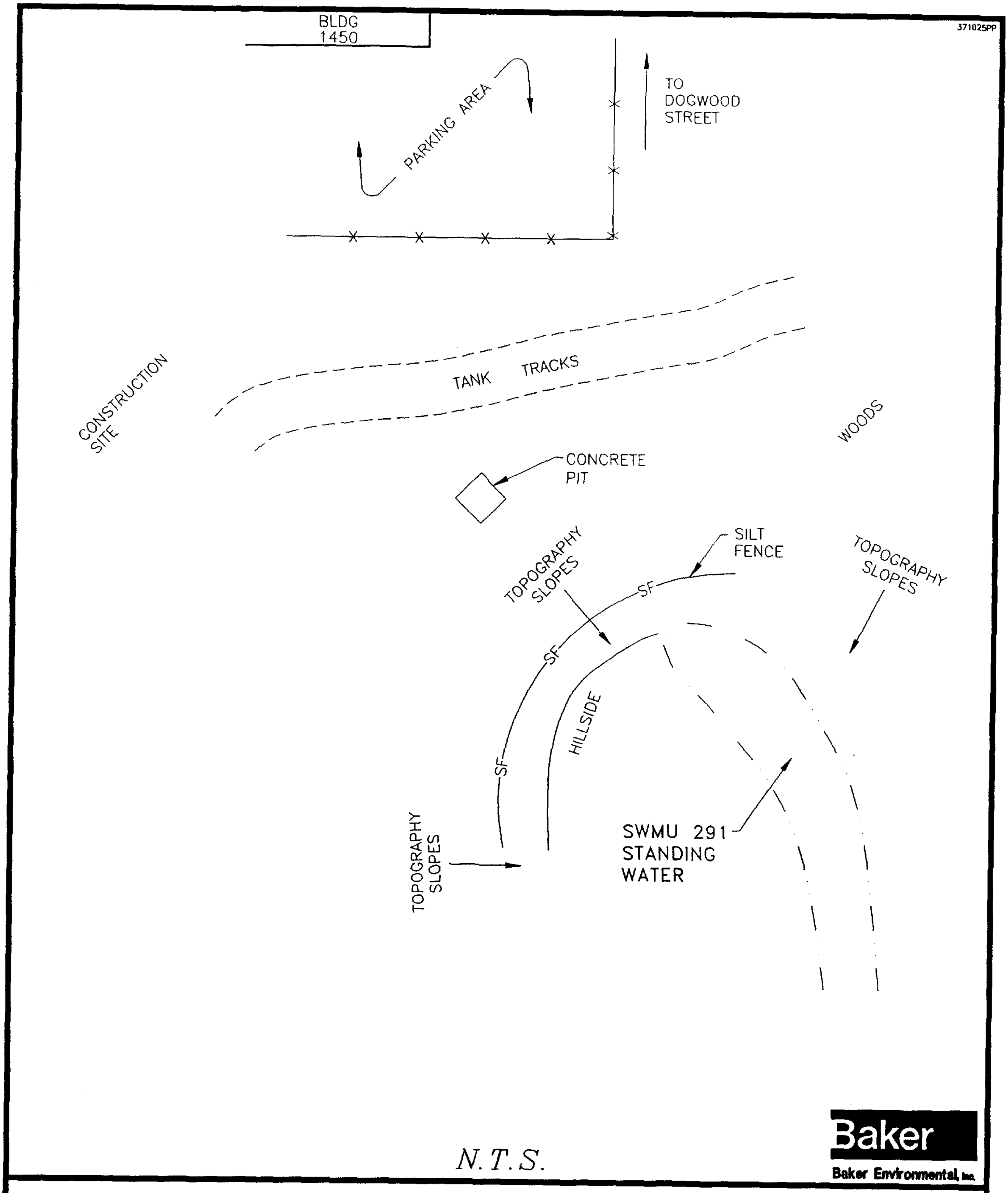

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FIGURE 5-24
SITE SKETCH
SWMU 291
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

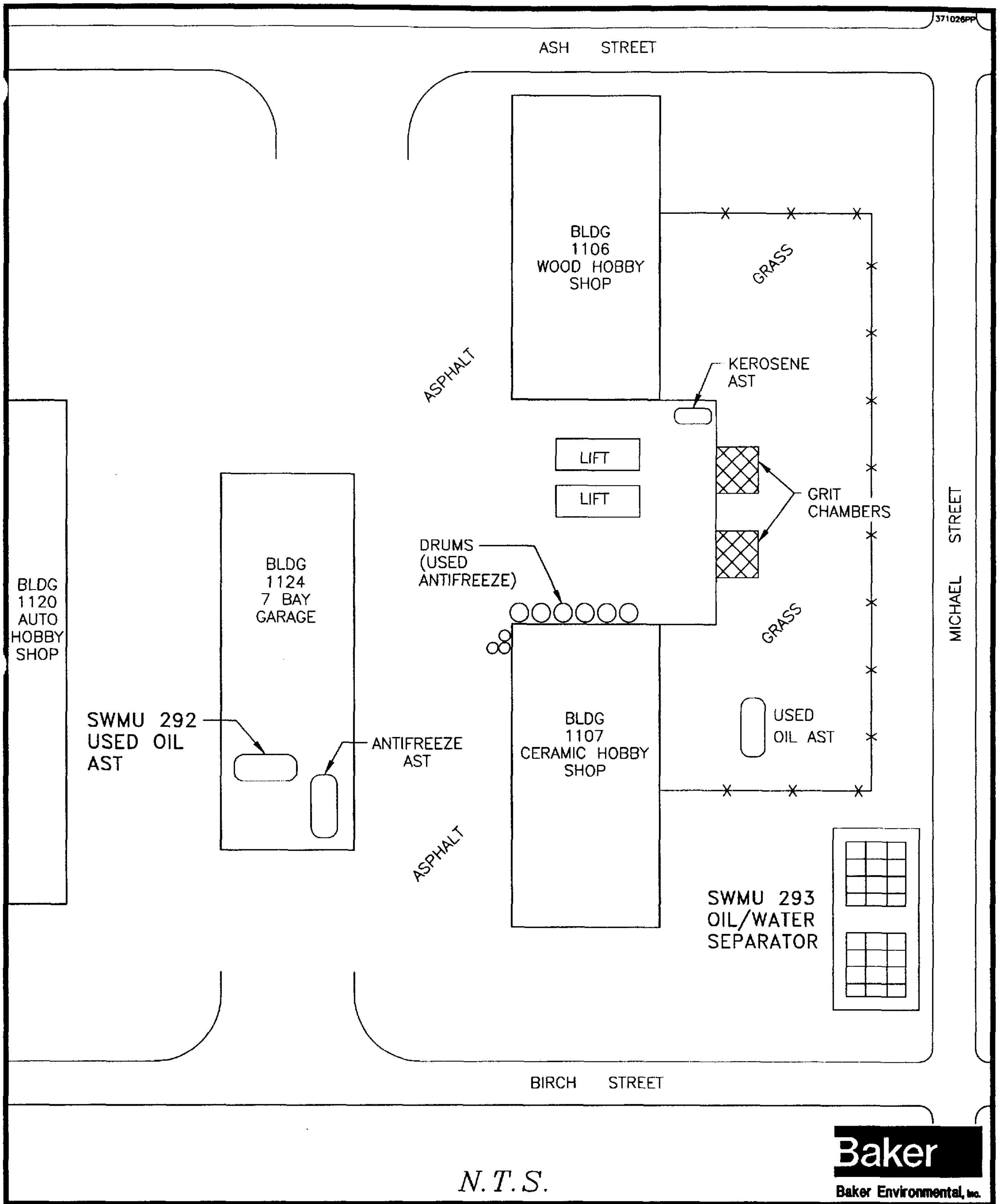

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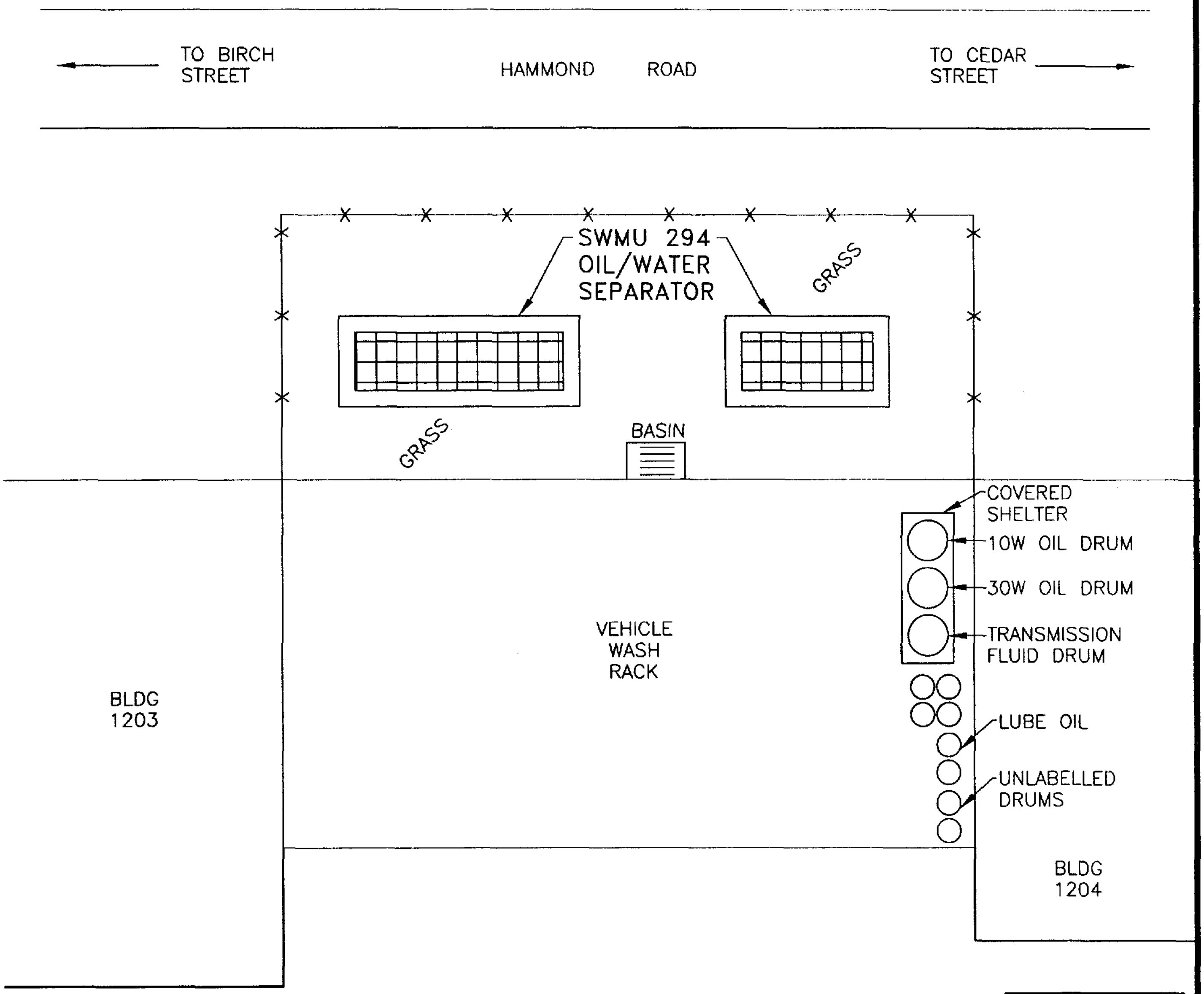
FIGURE 5-25
SITE SKETCH
SWMUs 292 AND 293
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



N.T.S.

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FIGURE 5-26
SITE SKETCH
SWMU 294
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

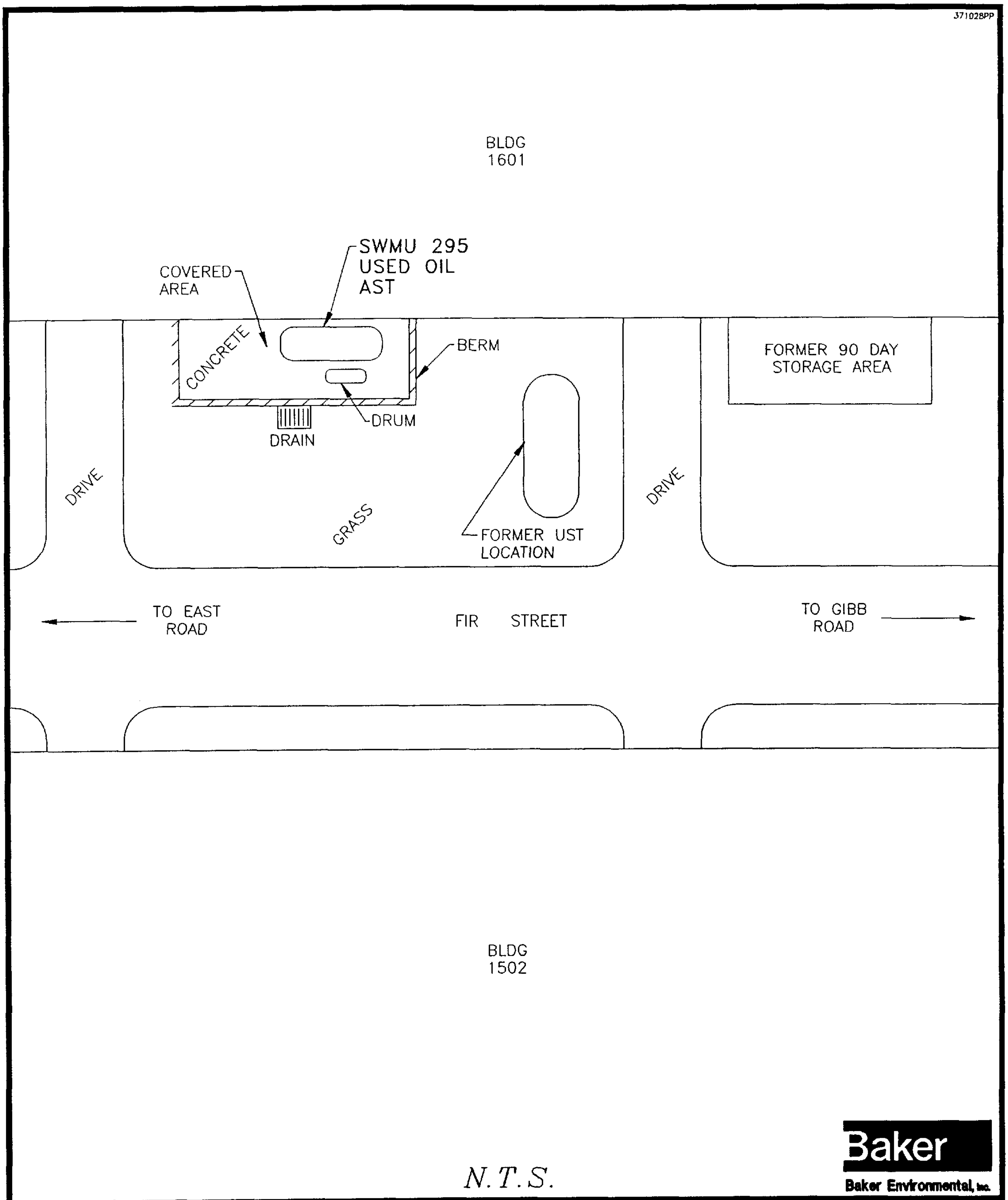

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FIGURE 5-27
SITE SKETCH
SWMU 295
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

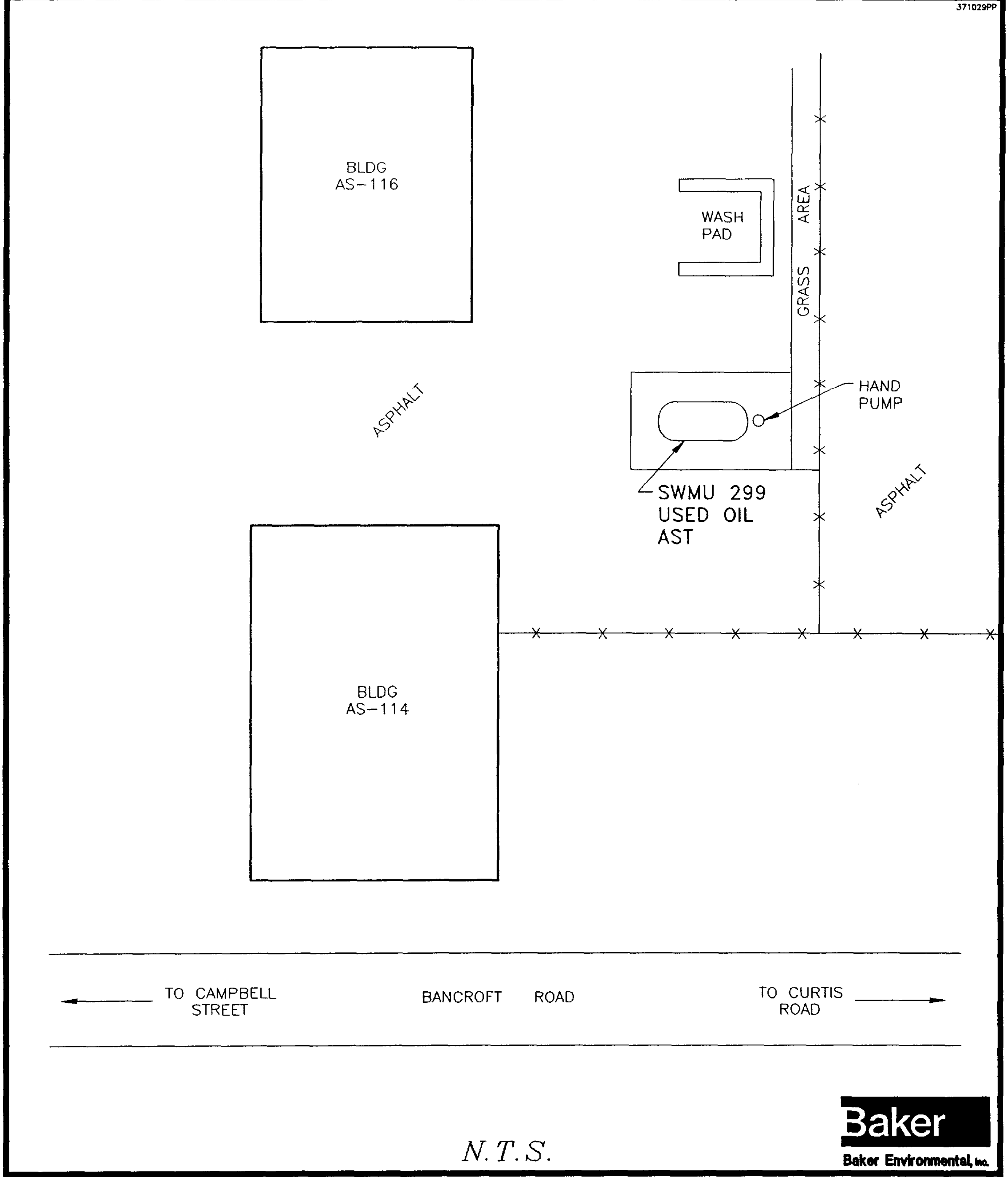

FIGURE 5-28
SITE SKETCH
SWMU 299
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

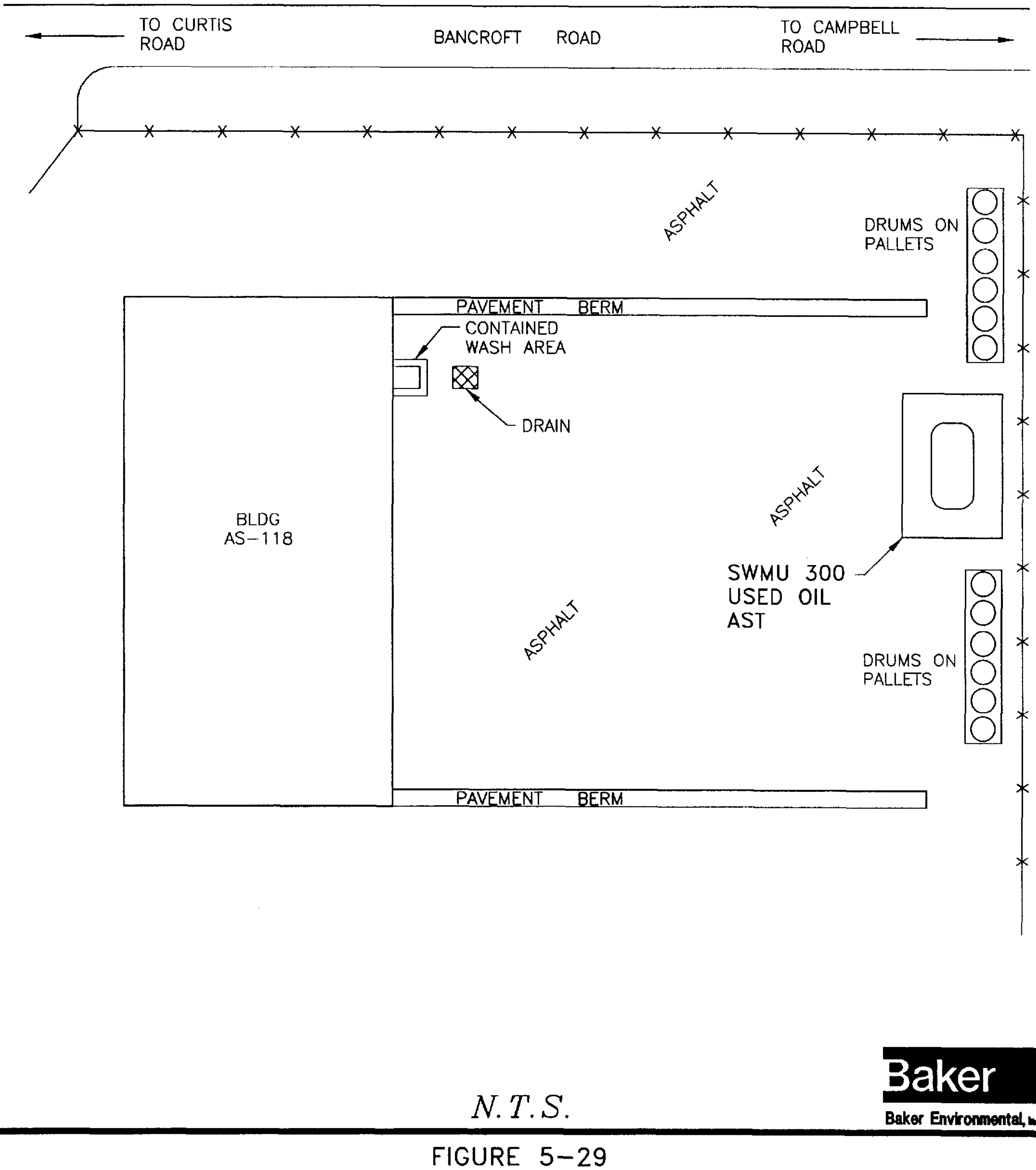

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FIGURE 5-29
SITE SKETCH
SWMU 300
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

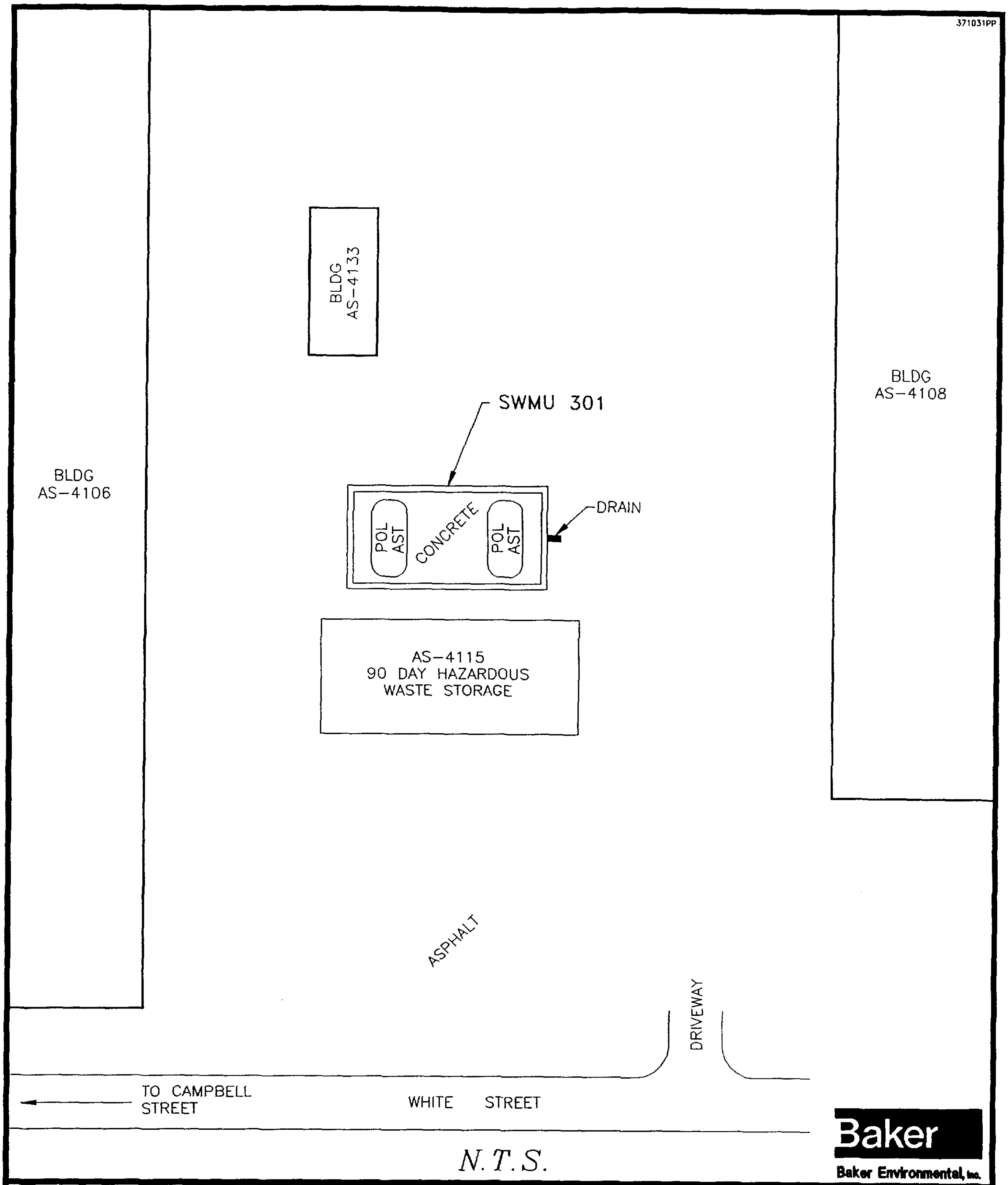
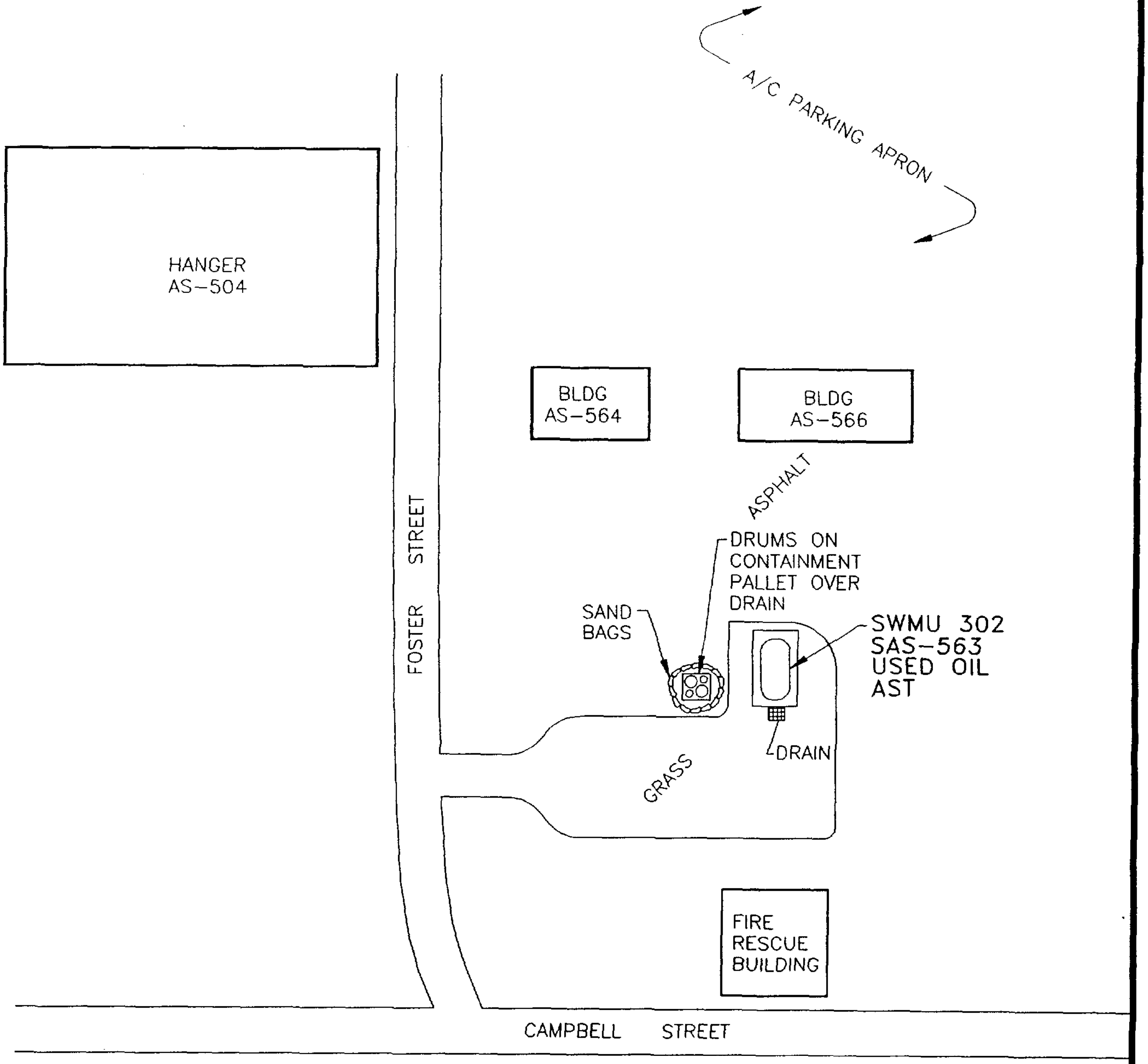


FIGURE 5-30
SITE SKETCH
SWMU 301
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

371032PP



N.T.S.

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FIGURE 5-31
SITE SKETCH
SWMU 302
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

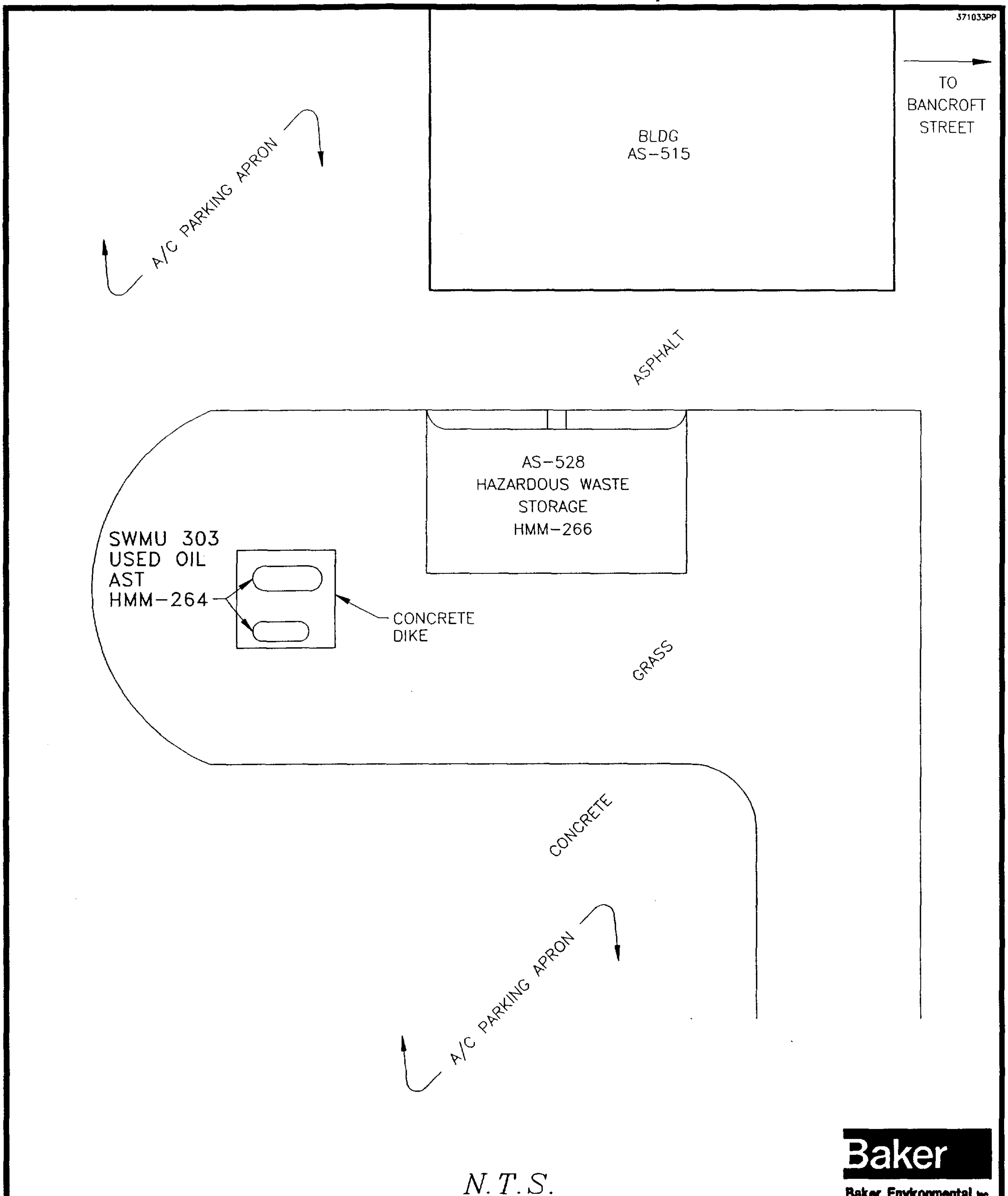

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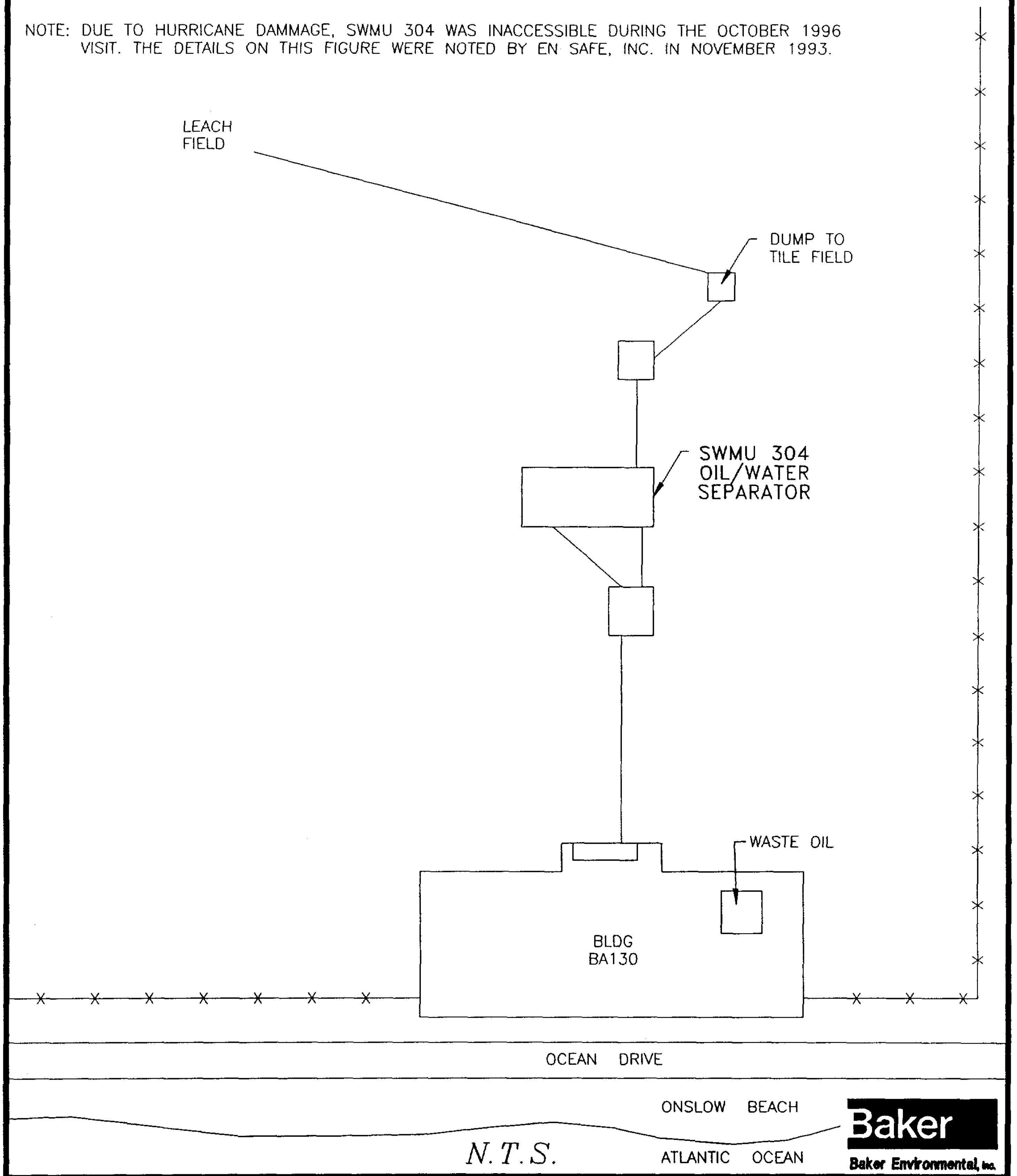
FIGURE 5-32
SITE SKETCH
SWMU 303
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

371034PP

NOTE: DUE TO HURRICANE DAMMAGE, SWMU 304 WAS INACCESSIBLE DURING THE OCTOBER 1996 VISIT. THE DETAILS ON THIS FIGURE WERE NOTED BY EN SAFE, INC. IN NOVEMBER 1993.



Baker

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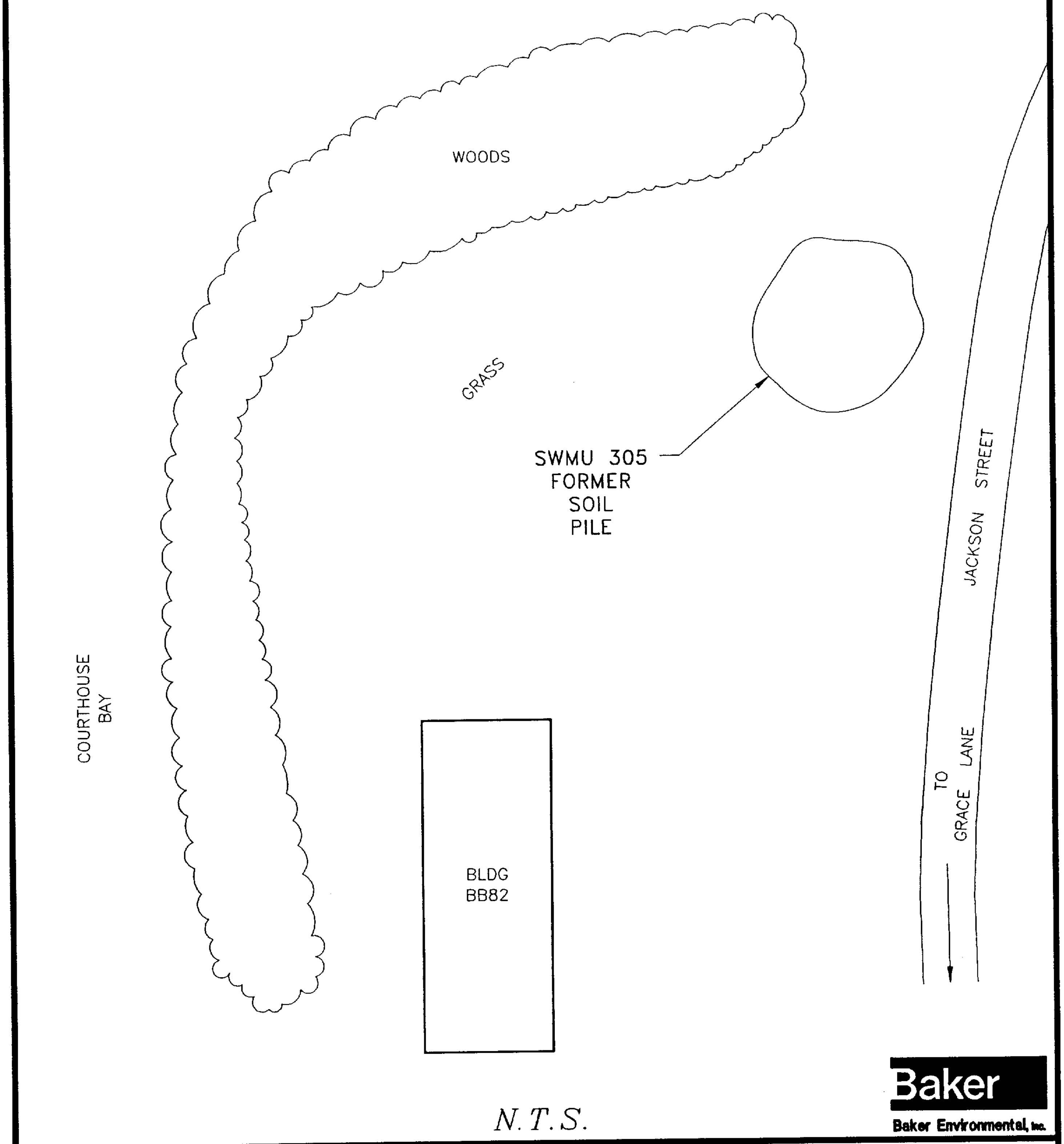
FIGURE 5-33
SITE SKETCH
SWMU 304
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

371035PP



Baker
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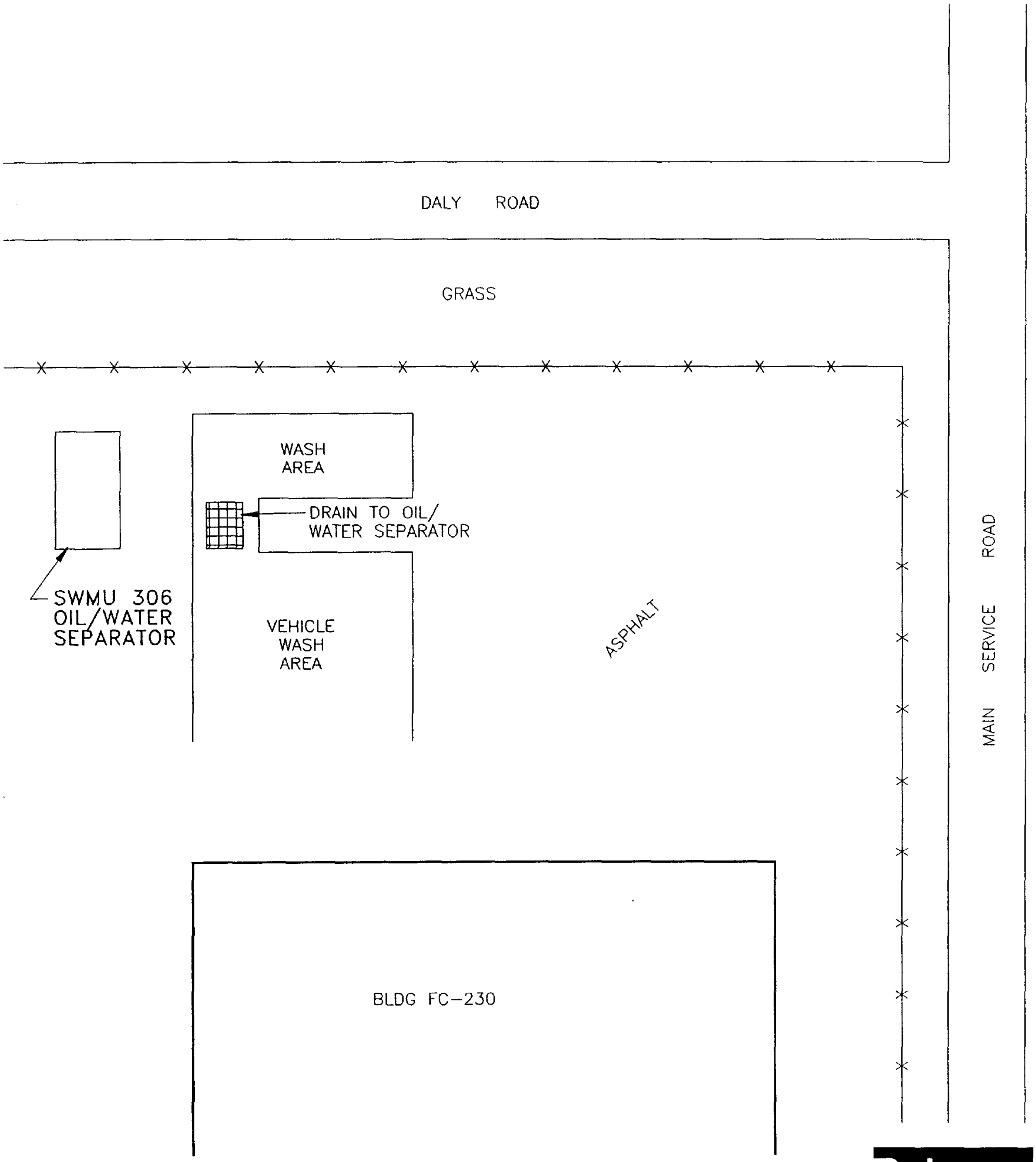
FIGURE 5-34
SITE SKETCH
SWMU 305
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



N.T.S.

Baker
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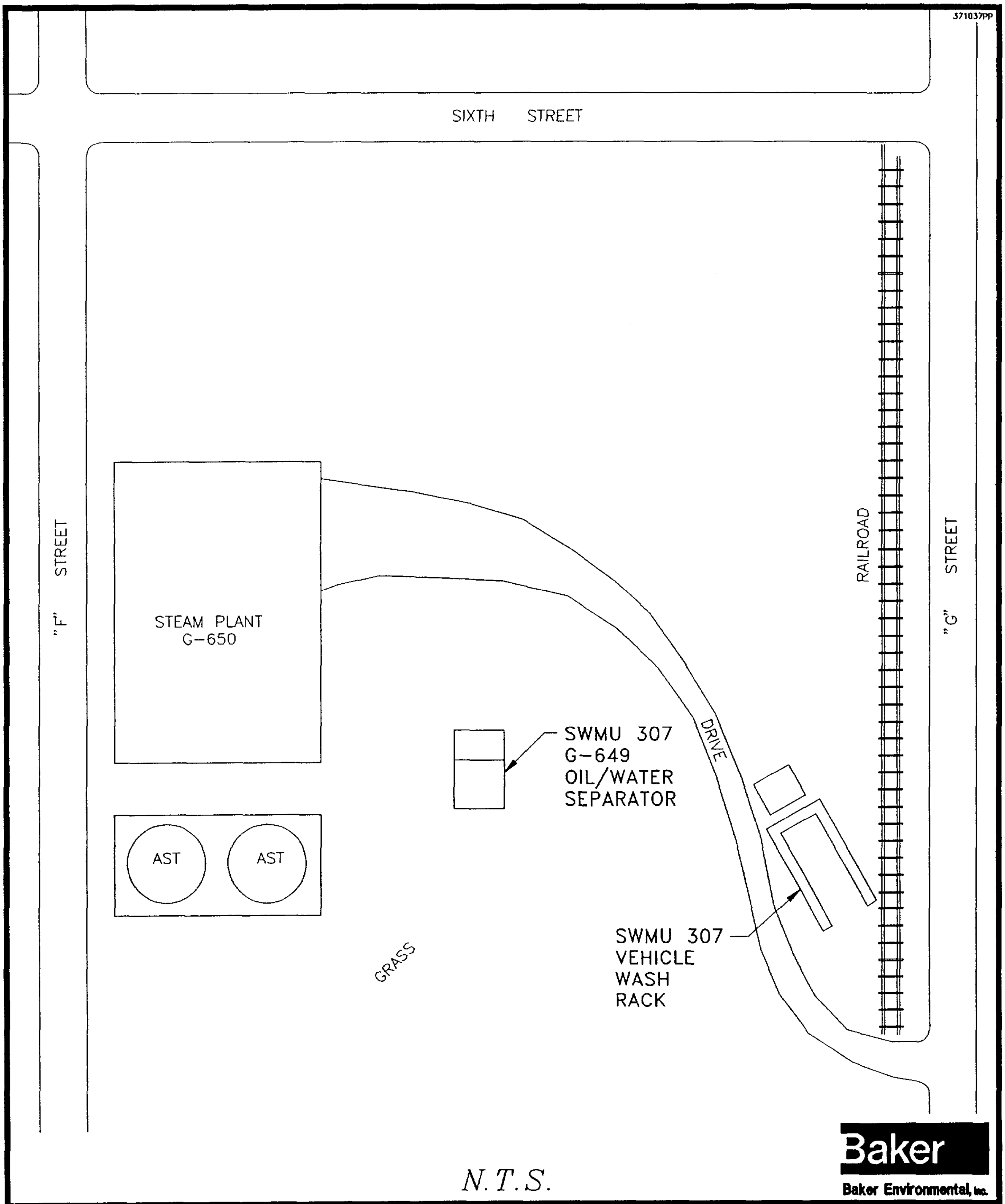
FIGURE 5-35
SITE SKETCH
SWMU 306
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



Baker

Baker Environmental, Inc.

FIGURE 5-36
SITE SKETCH
SWMU 307
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

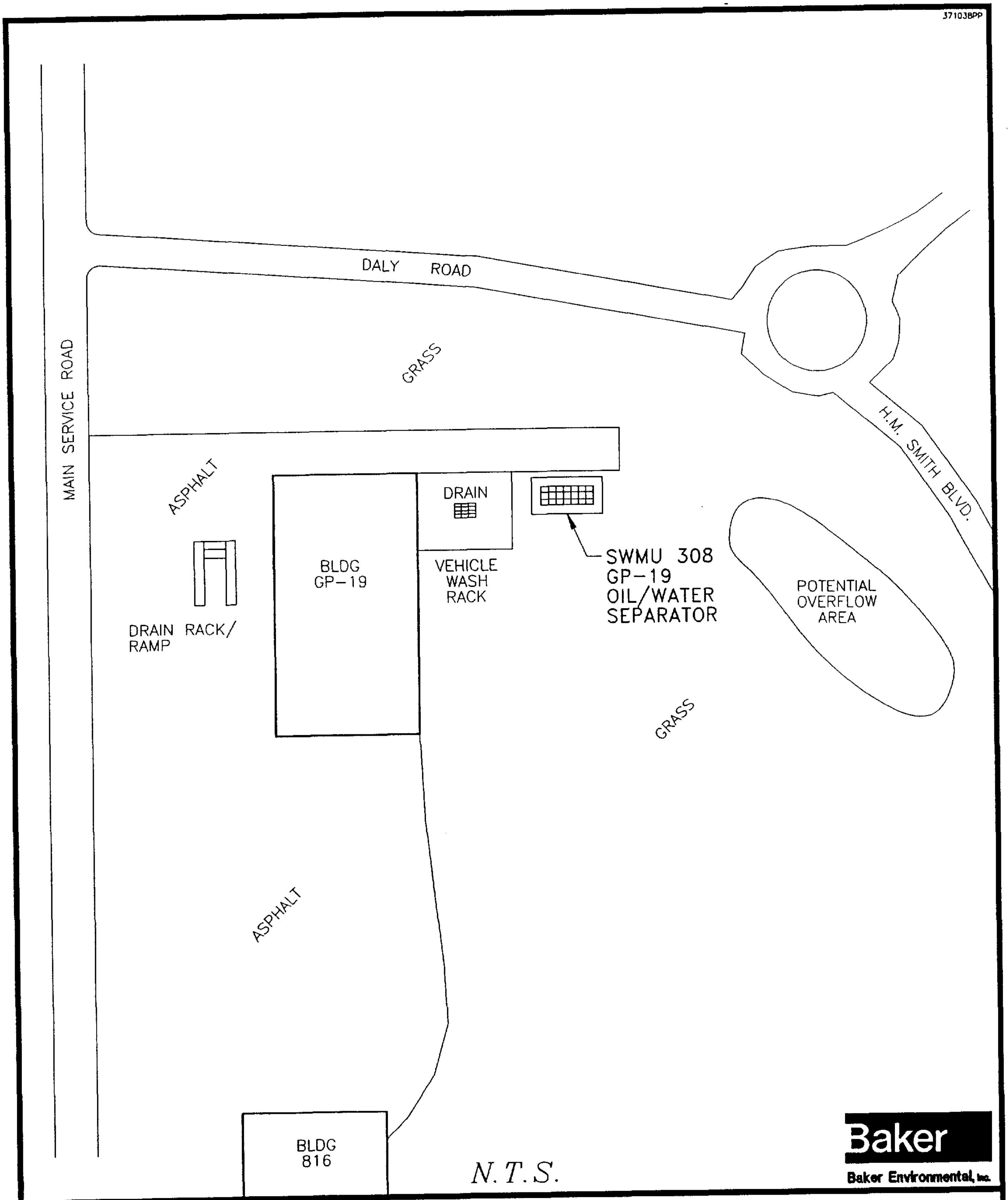
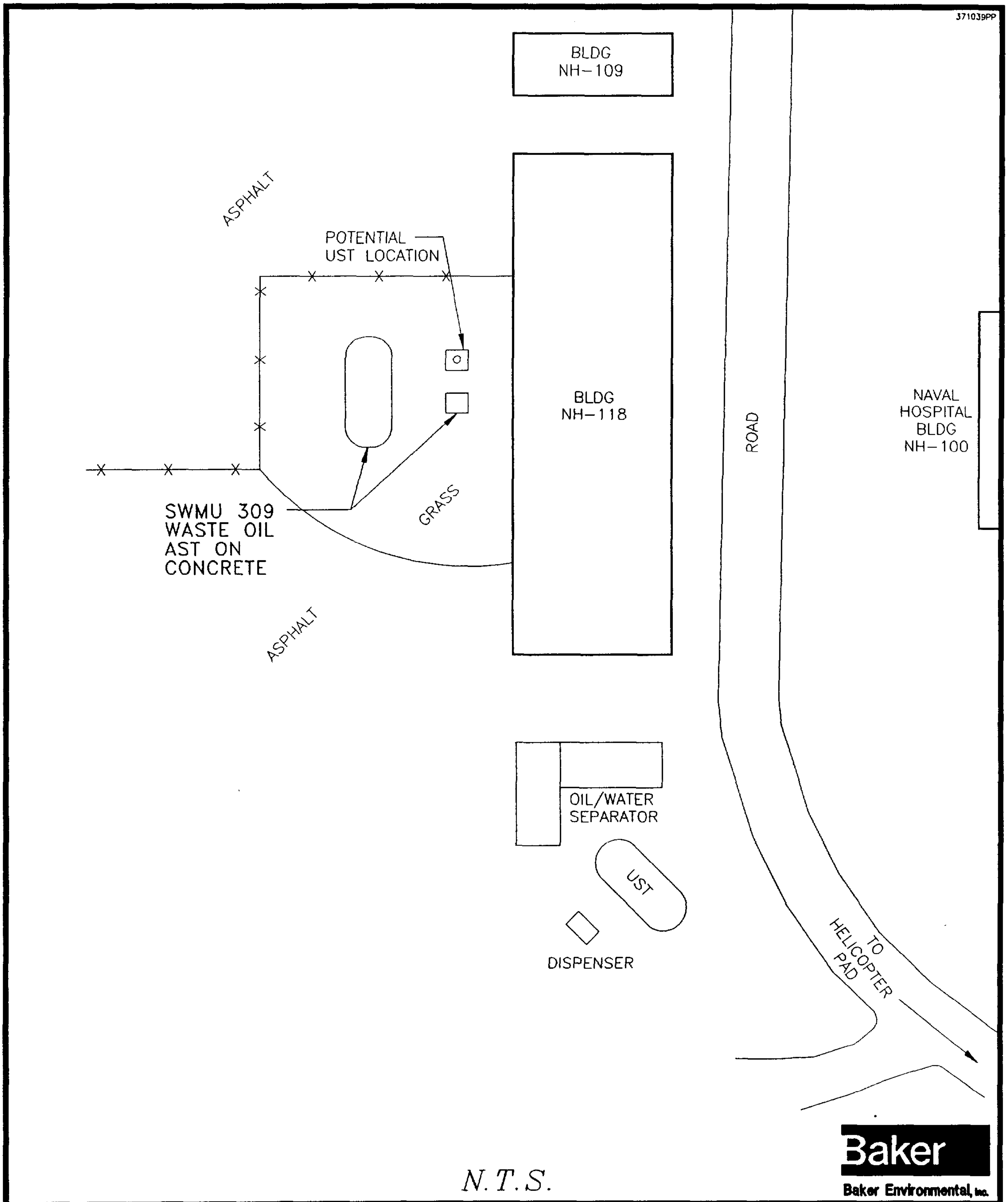


FIGURE 5-37
SITE SKETCH
SWMU 308
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



Baker
Baker Environmental, Inc.

FIGURE 5-38
SITE SKETCH
SWMU 309
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

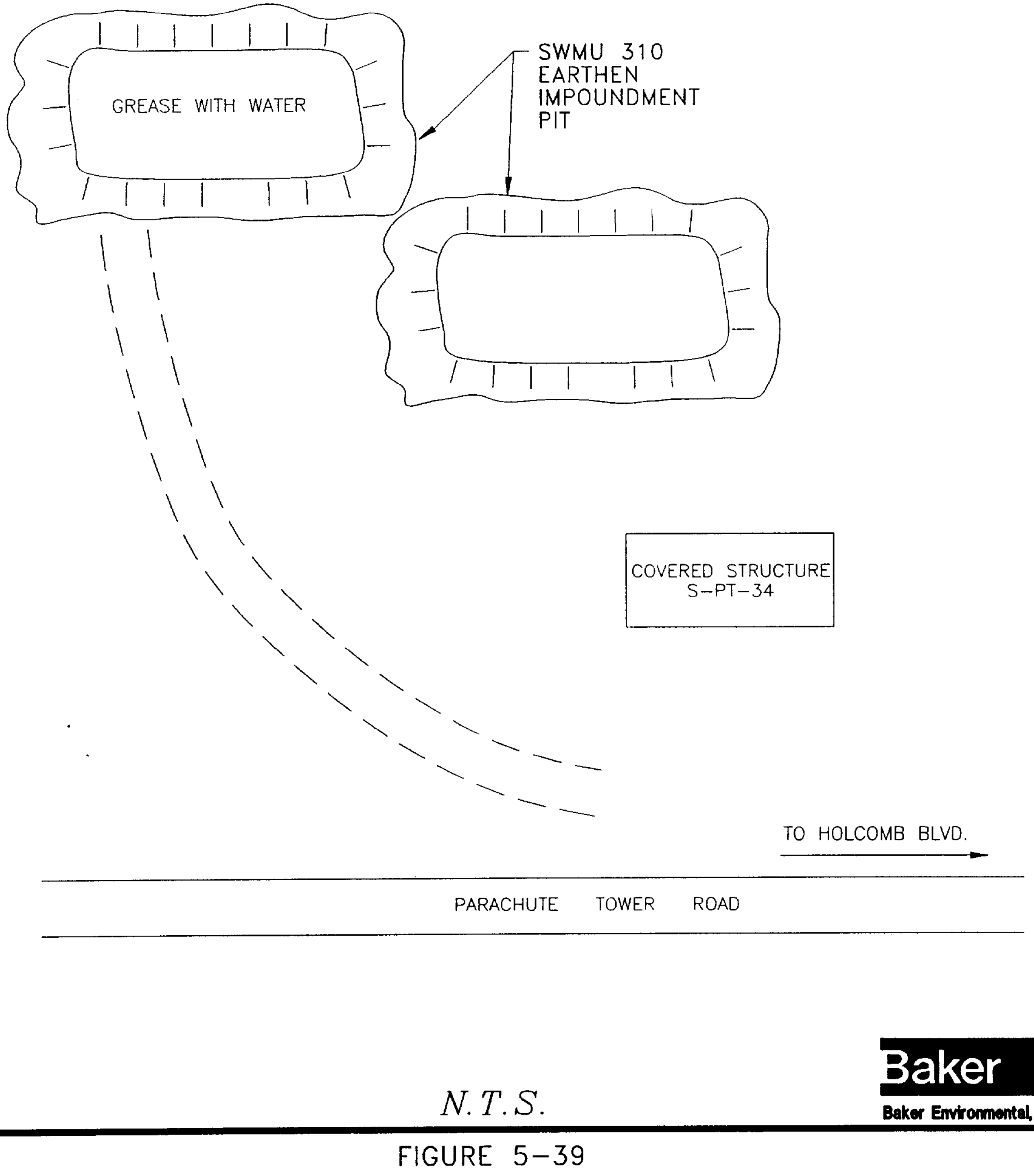


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FIGURE 5-39
SITE SKETCH
SWMU 310
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

371041PP

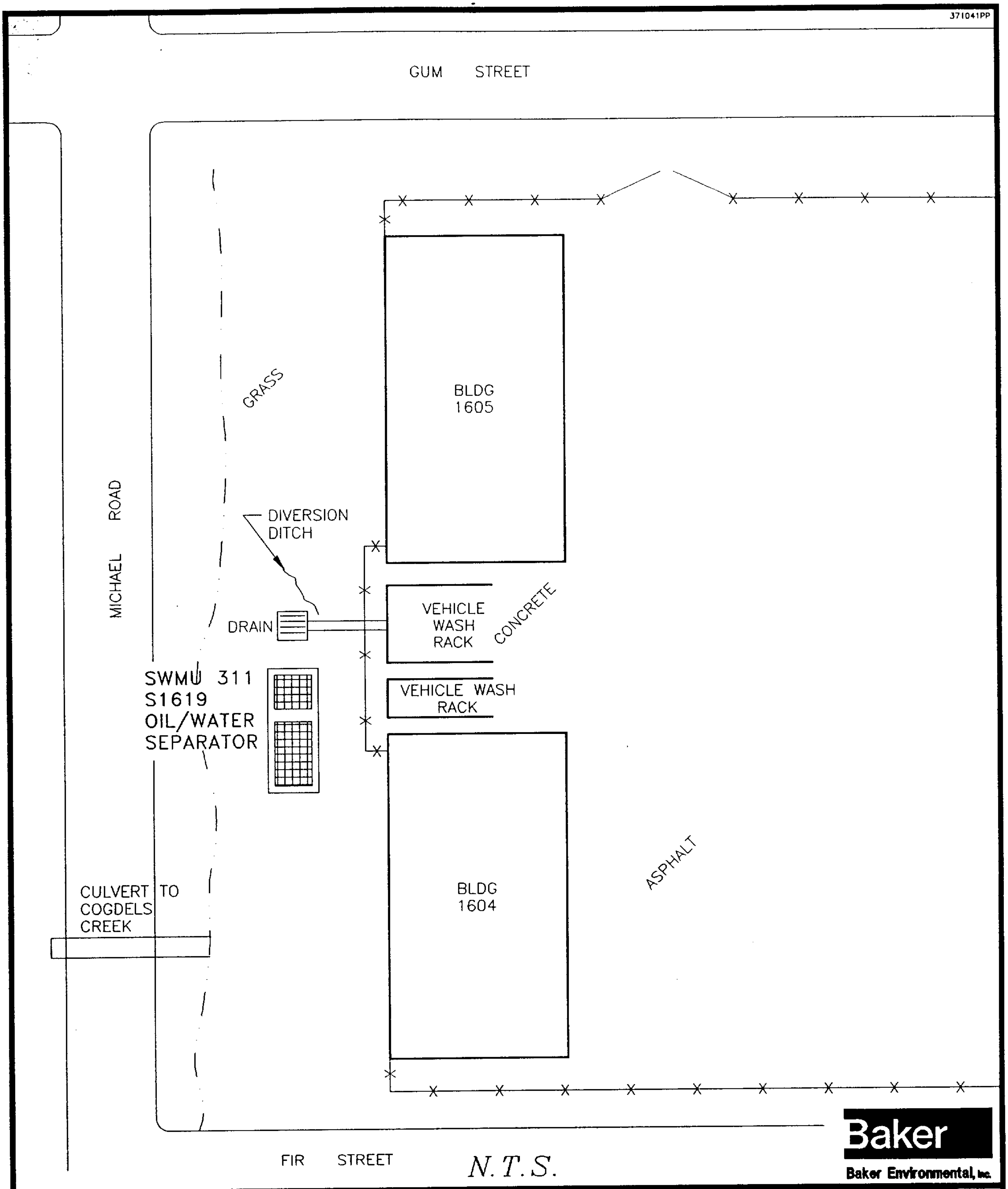

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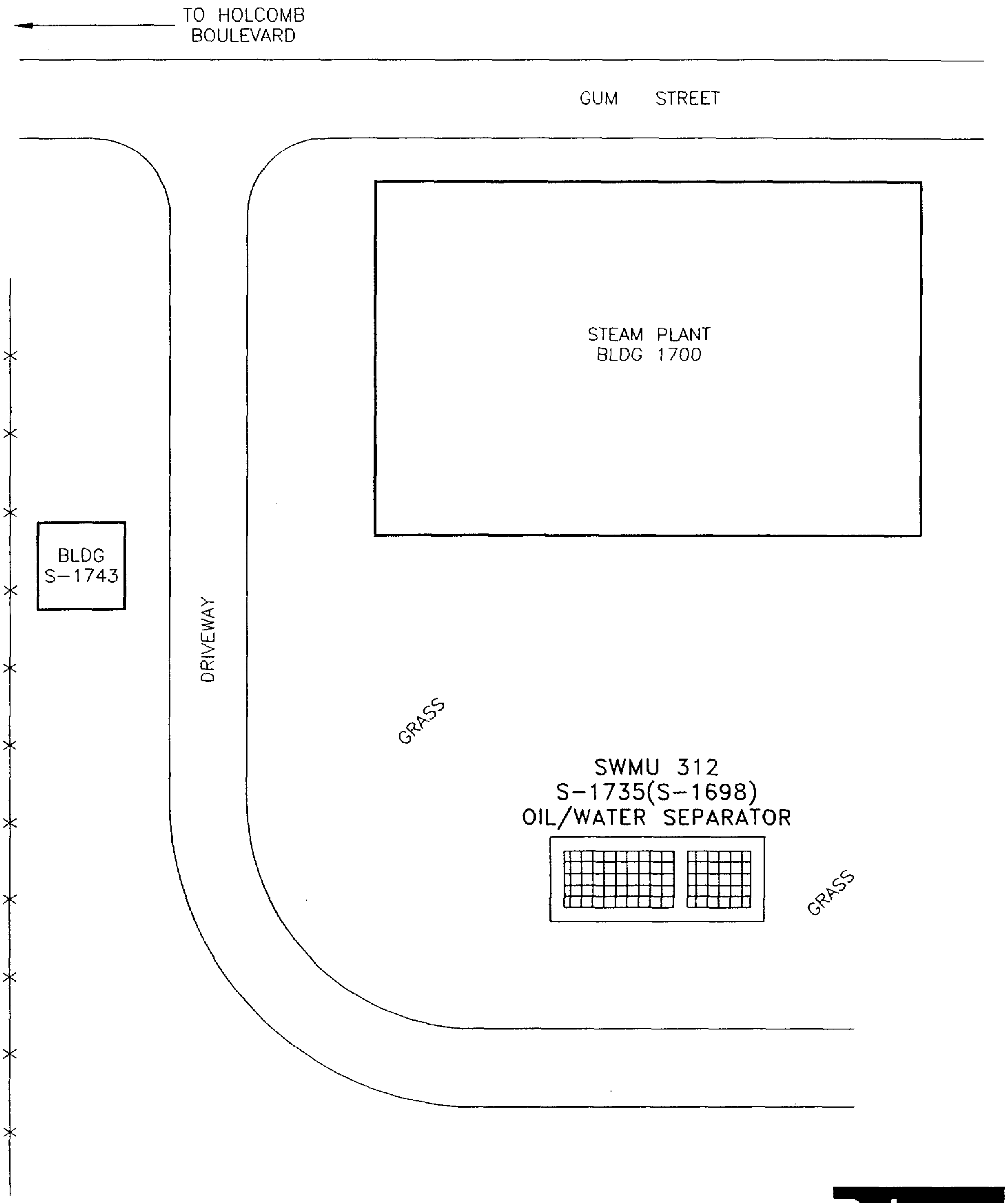
FIGURE 5-40
SITE SKETCH
SWMU 311
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



N.T.S.

Baker
Baker Environmental, Inc.

FIGURE 5-41
SITE SKETCH
SWMU 312
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

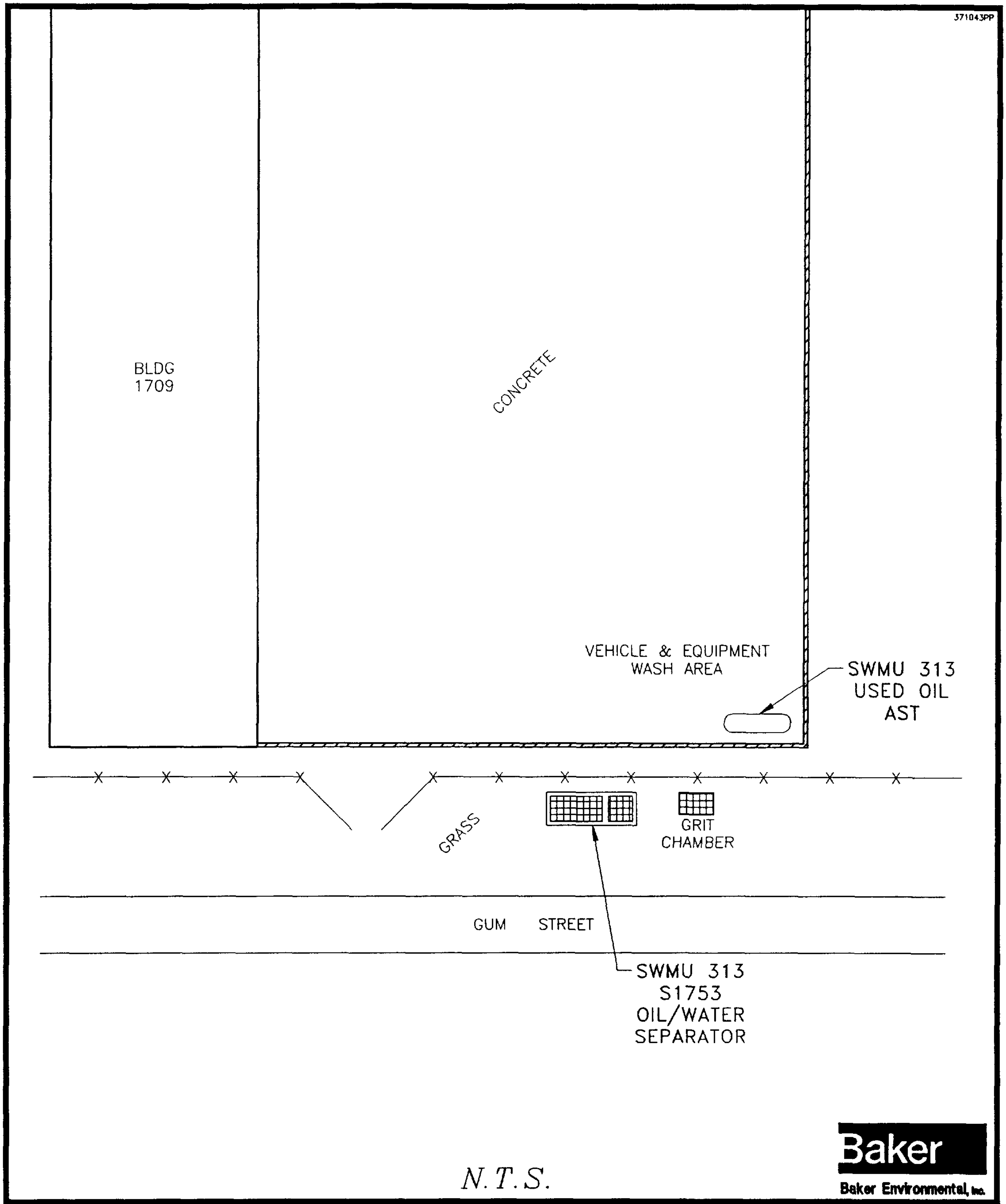


FIGURE 5-42
SITE SKETCH
SWMU 313
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

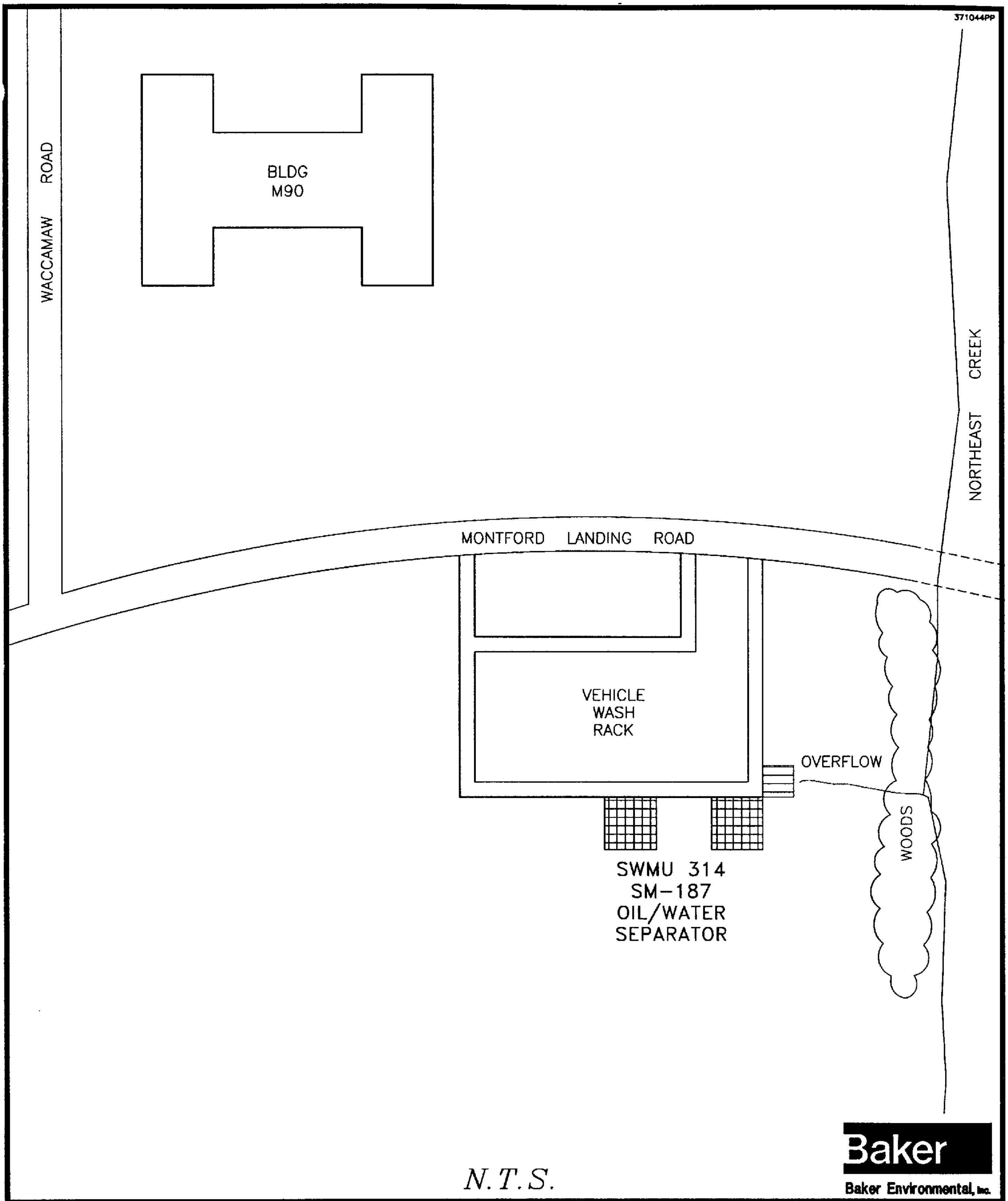
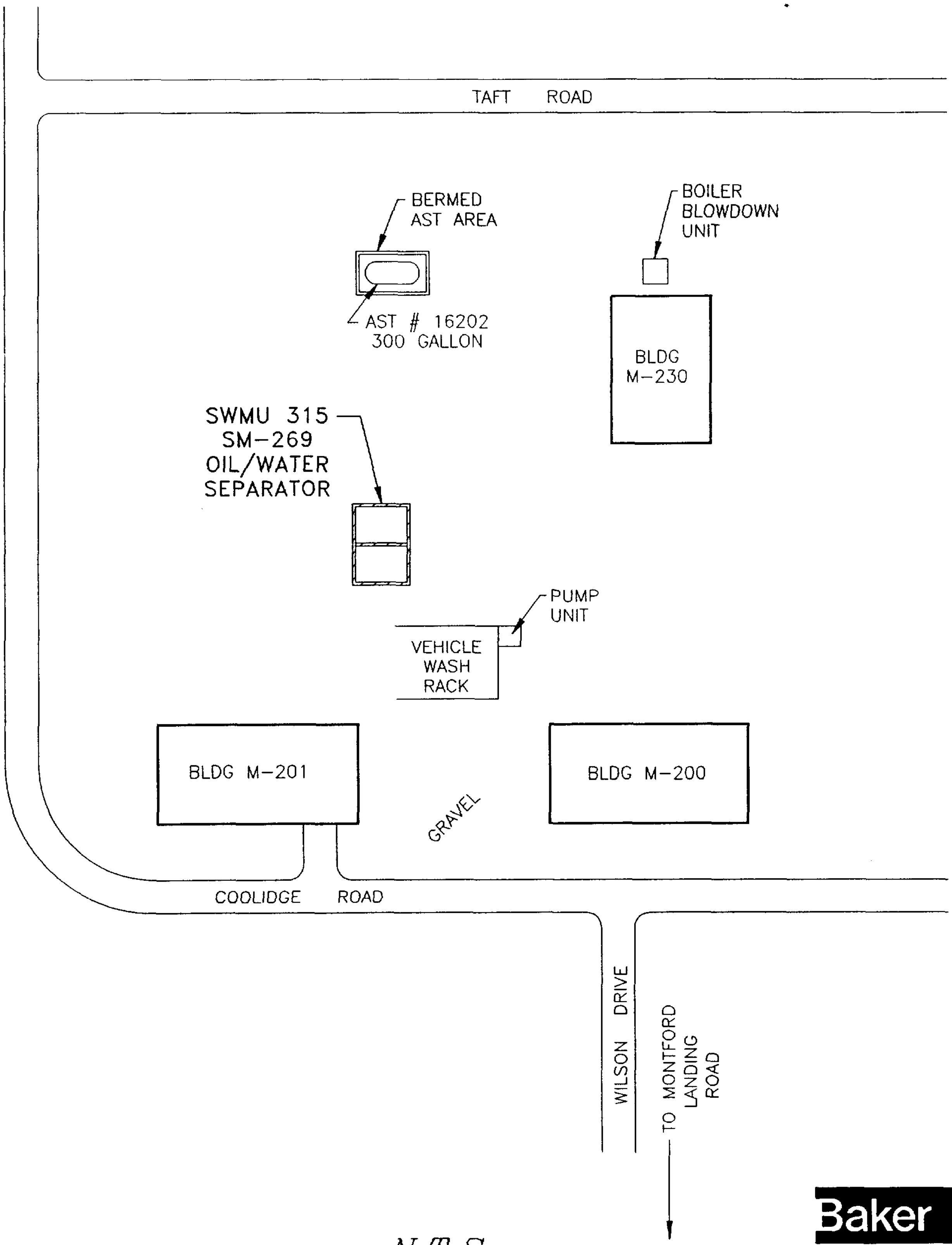


FIGURE 5-43
SITE SKETCH
SWMU 314
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



N.T.S.

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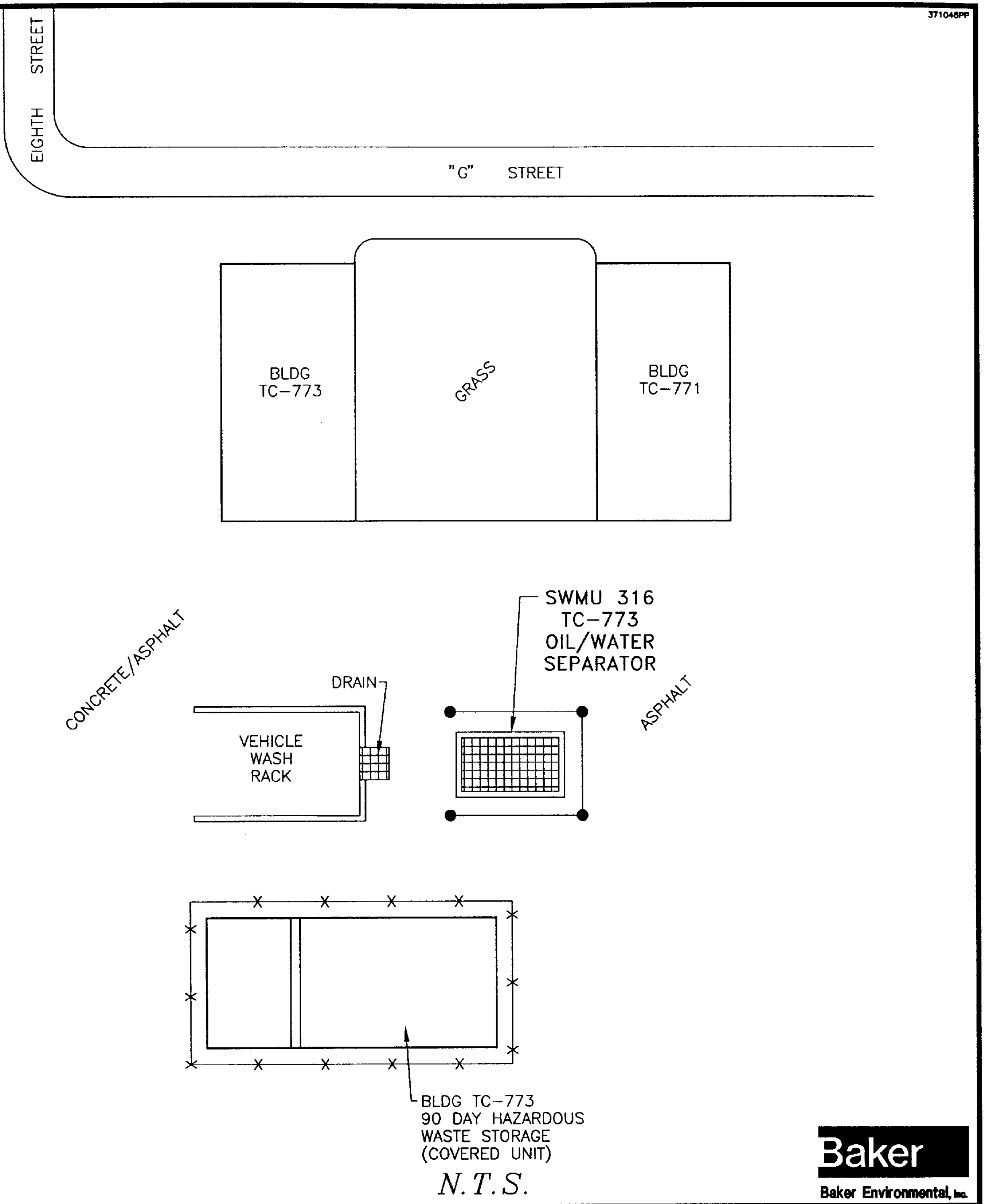
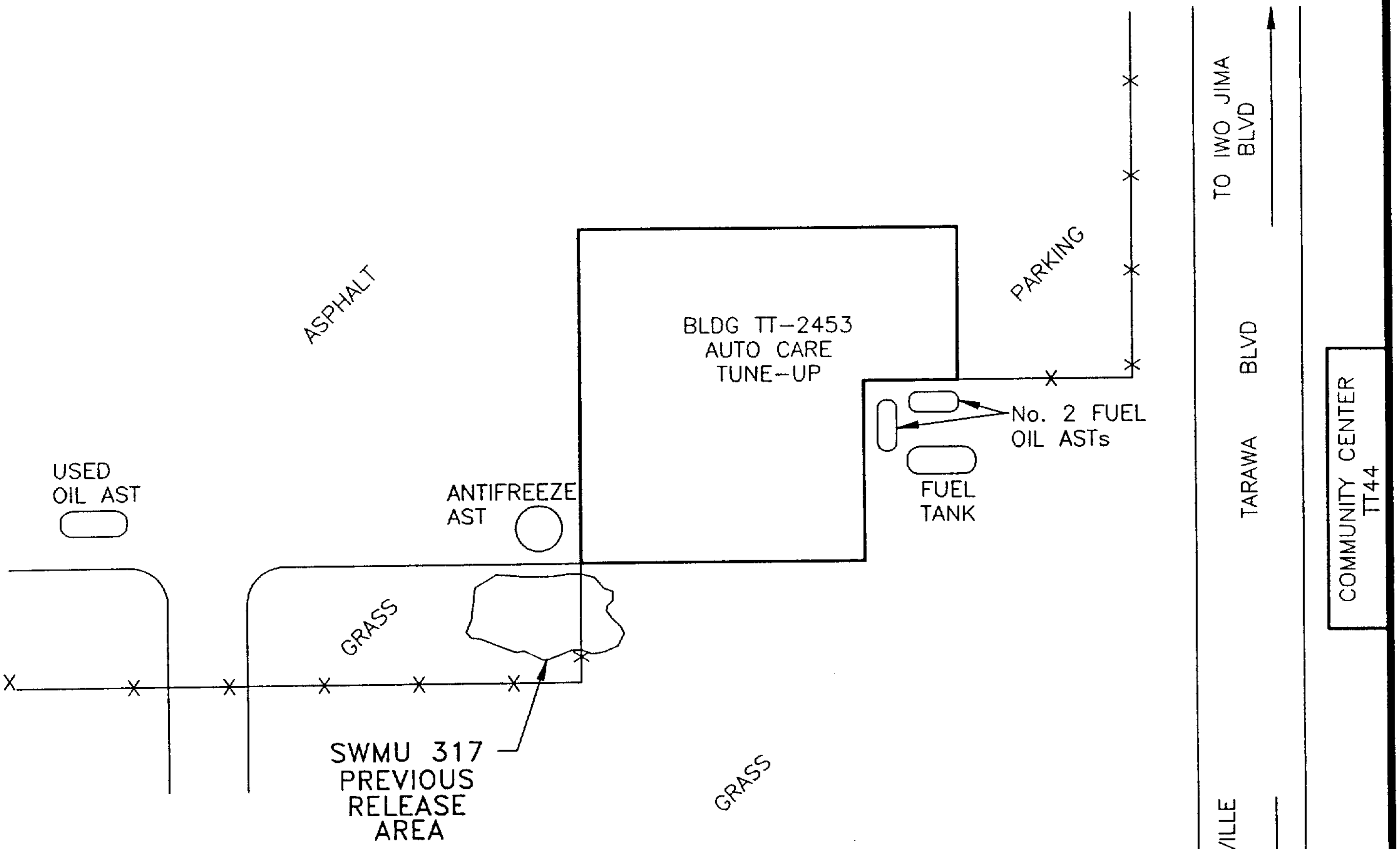
FIGURE 5-44
SITE SKETCH
SWMU 315
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



Baker

Baker Environmental, Inc.

FIGURE 5-45
SITE SKETCH
SWMU 316
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

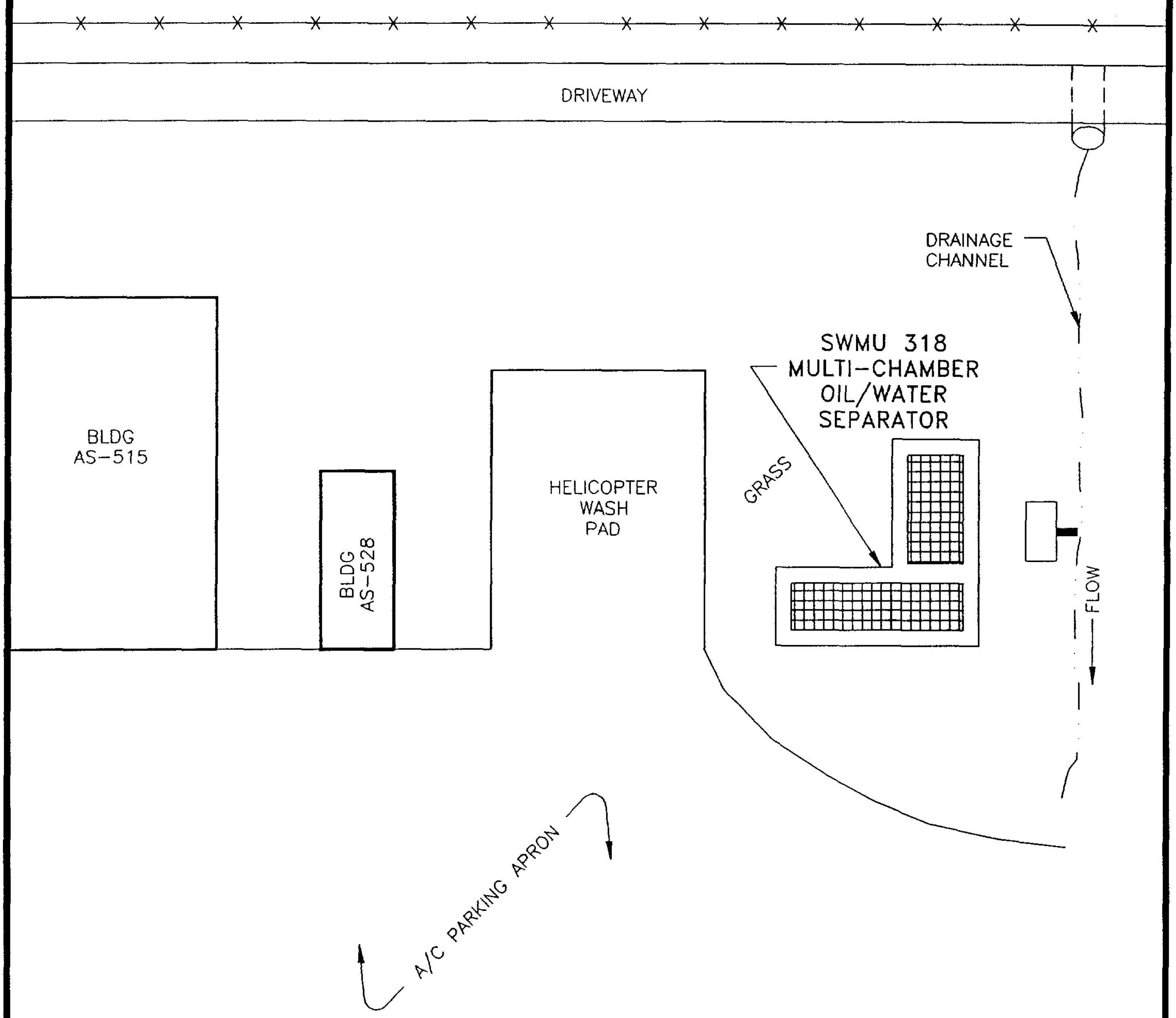


N.T.S.

Baker
Baker Environmental, Inc.

FIGURE 5-46
SITE SKETCH
SWMU 317
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

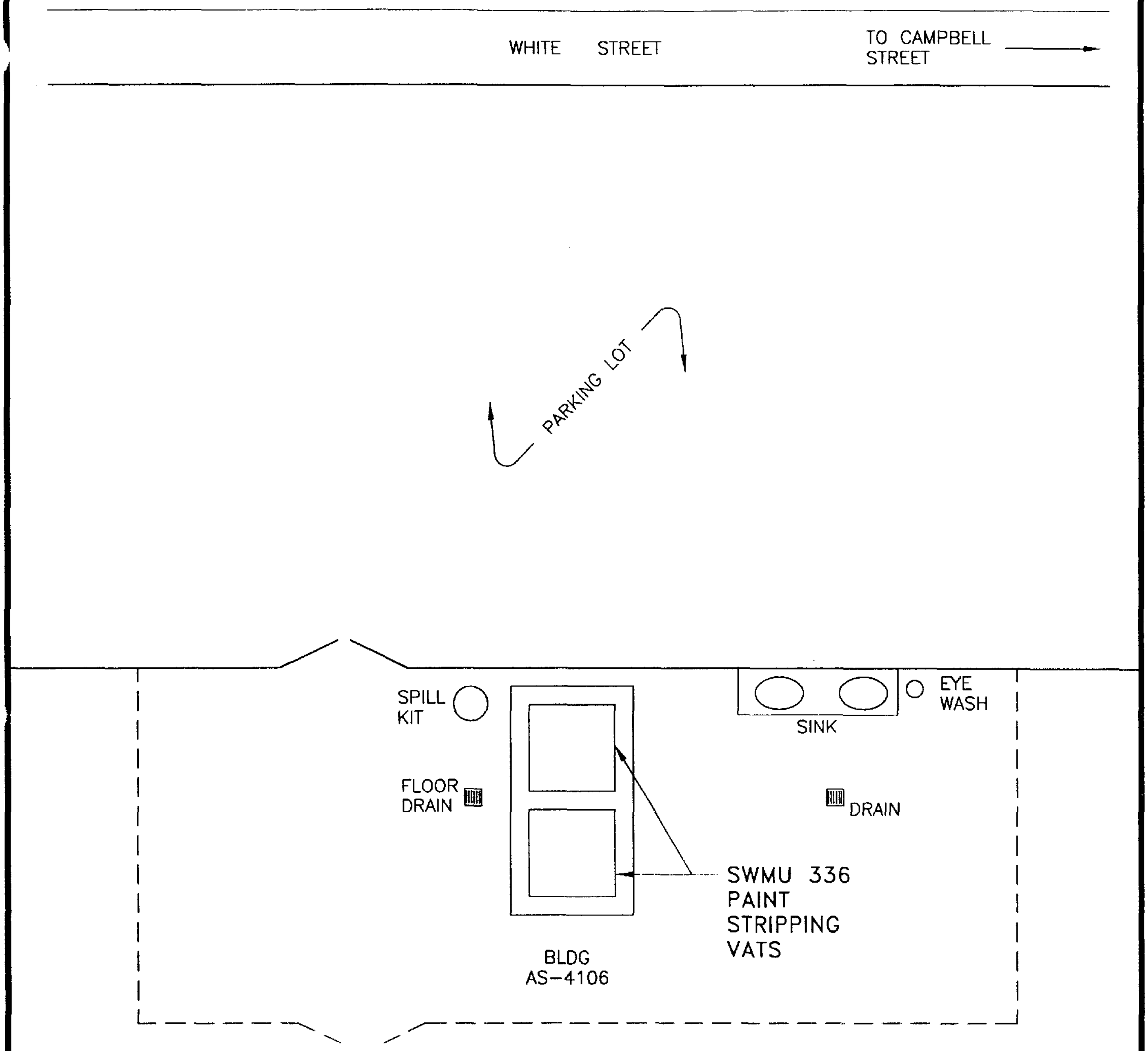
371048PP



N.T.S.

Baker
Baker Environmental, Inc.

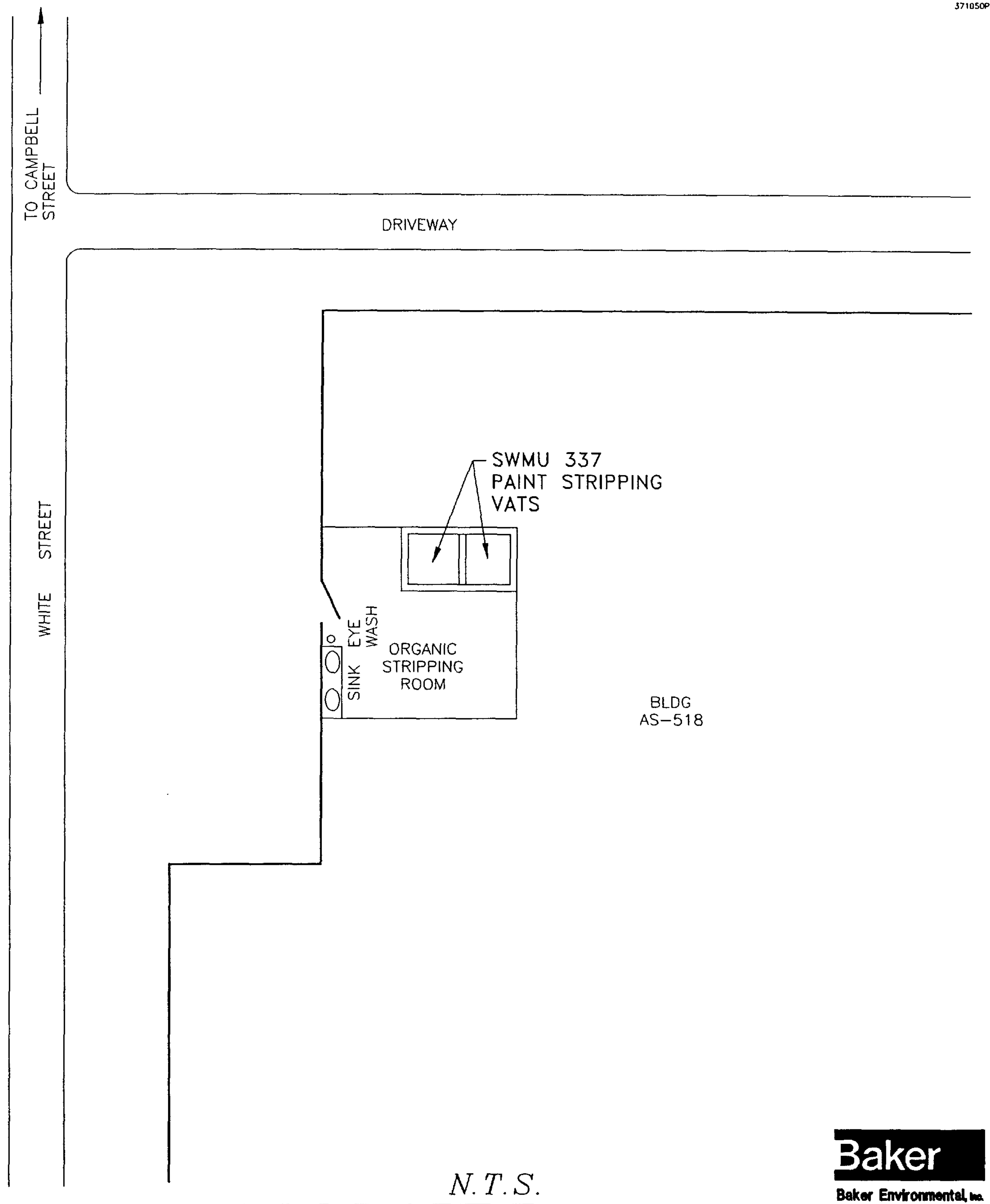
FIGURE 5-47
SITE SKETCH
SWMU 318
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



N.T.S.

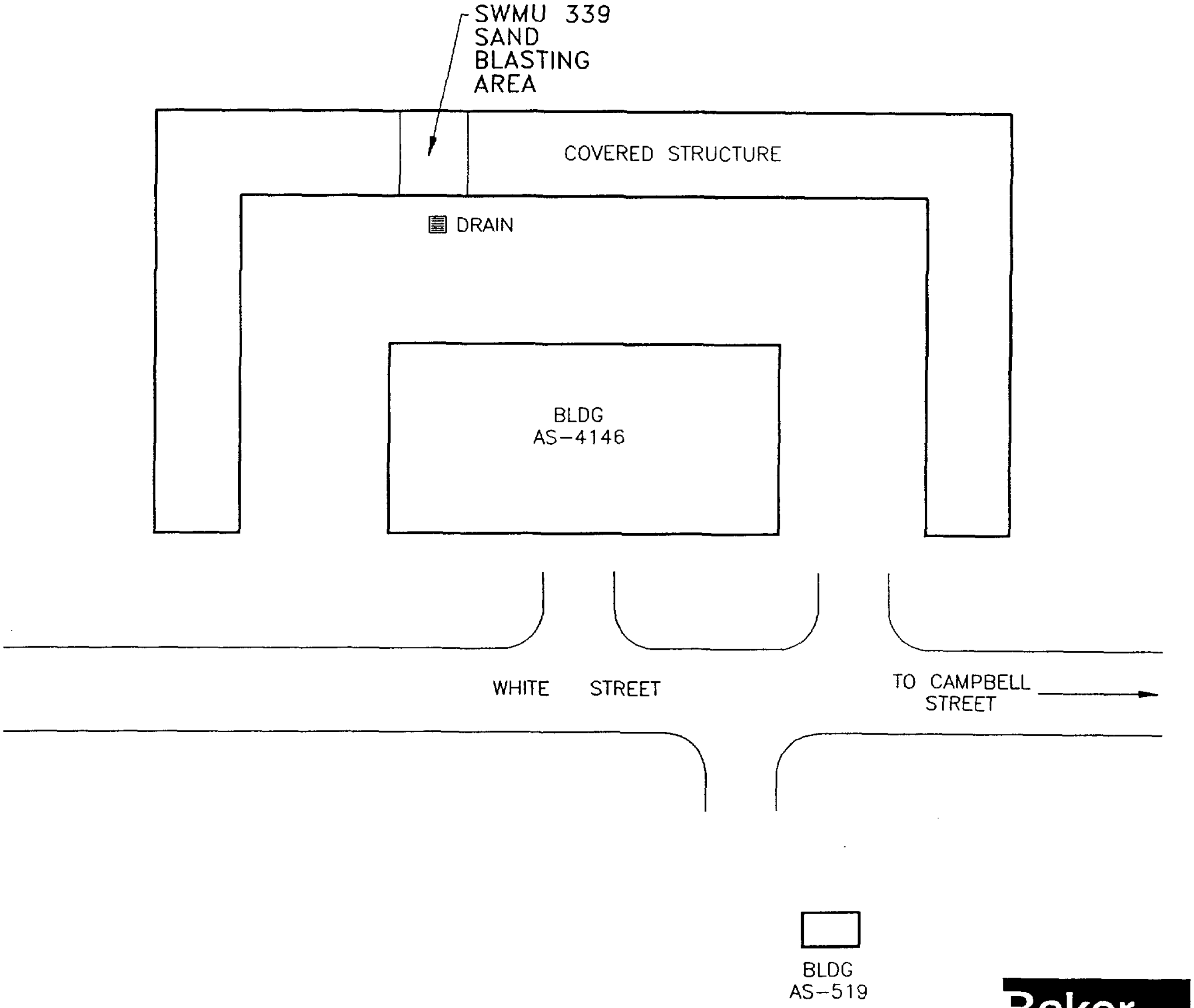
Baker
Baker Environmental, Inc.

FIGURE 5-48
SITE SKETCH
SWMU 336
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



Baker Environmental, Inc.

FIGURE 5-49
SITE SKETCH
SWMU 337
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



N.T.S.

Baker

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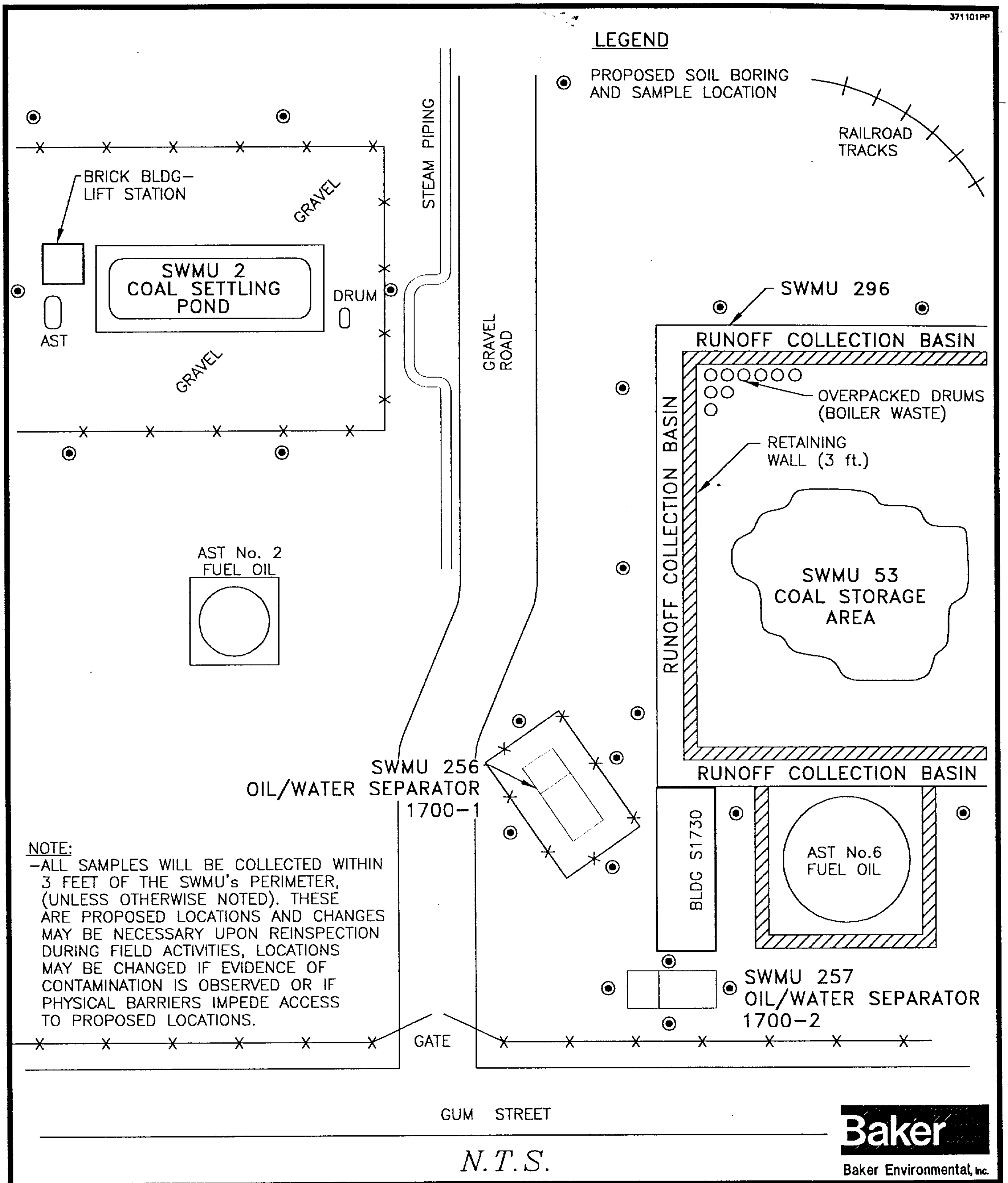
FIGURE 5-50
SITE SKETCH
SWMU 339
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

LEGEND FOR FIGURES 5-51 THROUGH 5-100

◉	Proposed Soil Boring and Sample Location
⨁	Proposed Temporary Well and Groundwater Sample Location
⊞	Proposed Surface Water/Sediment Sampling Location
▚	Proposed Surface Soil Location
⊕	Existing Groundwater Monitoring Well Location



NOTE:
-ALL SAMPLES WILL BE COLLECTED WITHIN 3 FEET OF THE SWMU's PERIMETER, (UNLESS OTHERWISE NOTED). THESE ARE PROPOSED LOCATIONS AND CHANGES MAY BE NECESSARY UPON REINSPECTION DURING FIELD ACTIVITIES, LOCATIONS MAY BE CHANGED IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO PROPOSED LOCATIONS.

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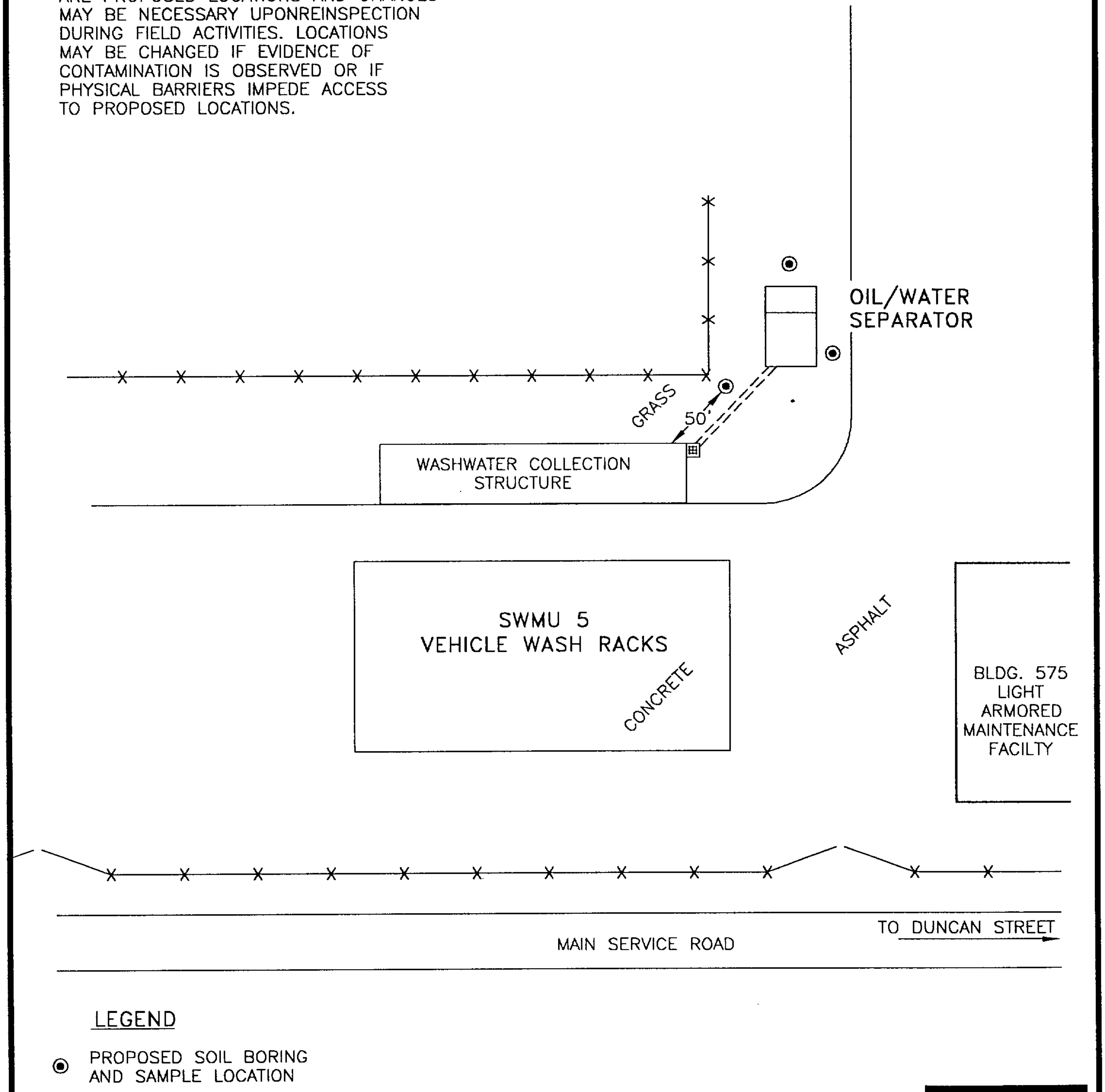
FIGURE 5-51
PROPOSED SAMPLE LOCATIONS
SWMUs 2, 53, 256, 257, AND 296
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

371102PP

NOTE:
—ALL SAMPLES WILL BE COLLECTED WITHIN 3 FEET OF THE SWMU's PERIMETER, (UNLESS OTHERWISE NOTED). THESE ARE PROPOSED LOCATIONS AND CHANGES MAY BE NECESSARY UPONREINSPECTION DURING FIELD ACTIVITIES. LOCATIONS MAY BE CHANGED IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO PROPOSED LOCATIONS.



N.T.S.

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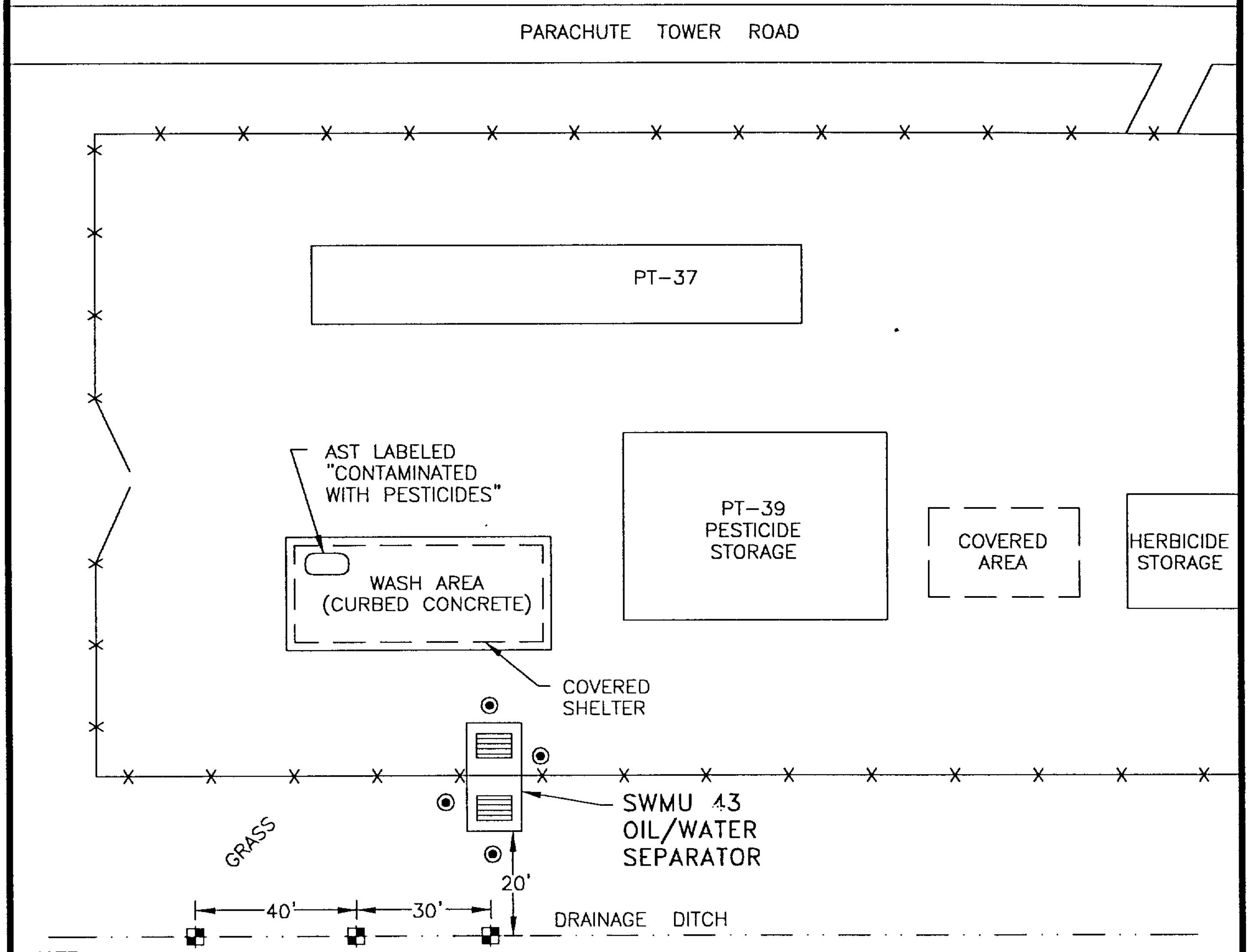
FIGURE 5-52
PROPOSED SAMPLE LOCATIONS
SWMU 5
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

371103PP

LEGEND

◉ PROPOSED SOIL BORING AND SAMPLE LOCATION

▣ PROPOSED SURFACE SOIL LOCATION



NOTE:
-ALL SAMPLES WILL BE COLLECTED WITHIN 3 FEET OF THE SWMU's PERIMETER, (UNLESS OTHERWISE NOTED). THESE ARE PROPOSED LOCATIONS AND CHANGES MAY BE NECESSARY UPON REINSPECTION DURING FIELD ACTIVITIES, LOCATIONS MAY BE CHANGED IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO PROPOSED LOCATIONS.

N.T.S.

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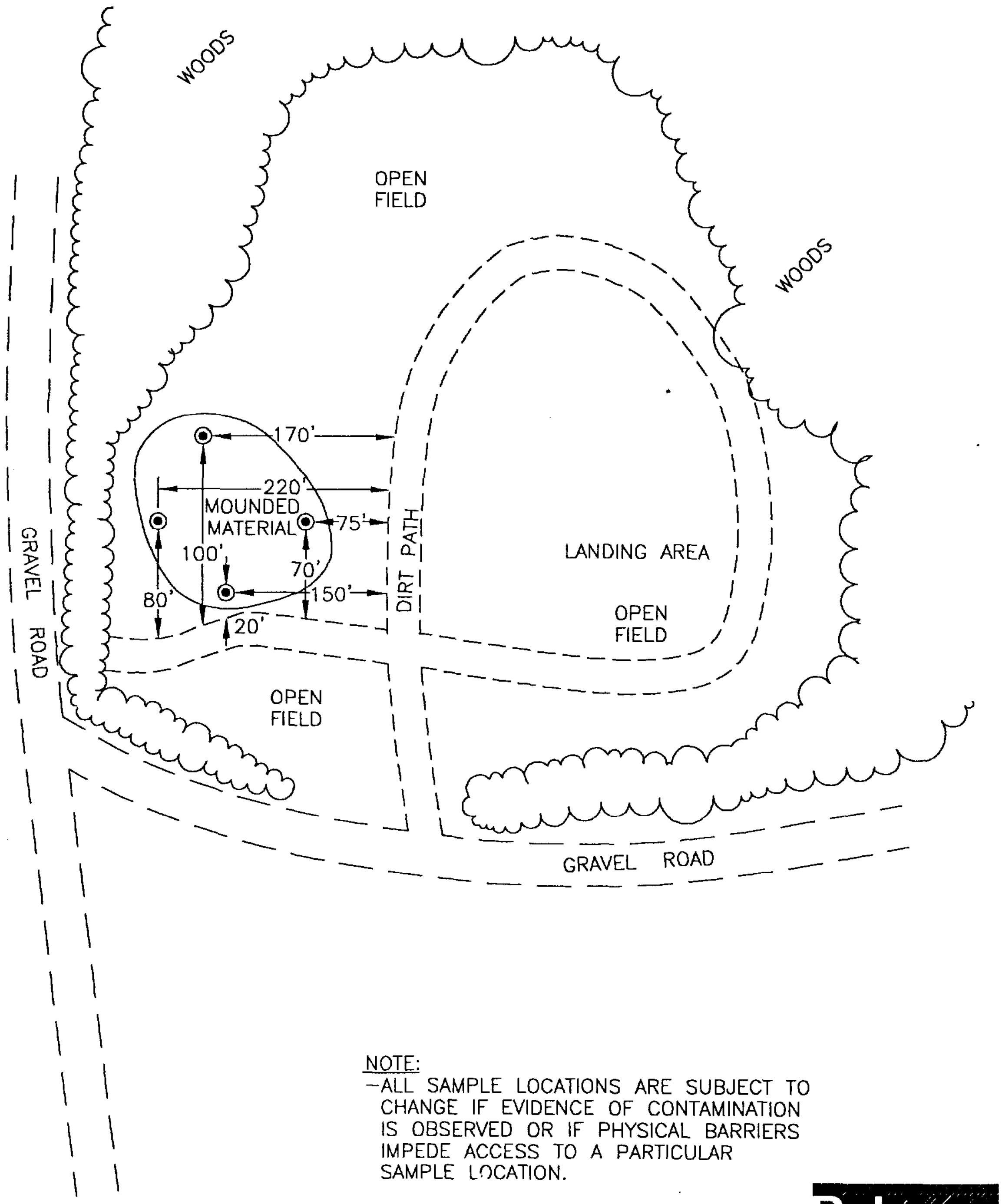
FIGURE 5-53
PROPOSED SAMPLE LOCATIONS
SWMU 43
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

LEGEND

◉ PROPOSED SOIL BORING
AND SAMPLE LOCATION



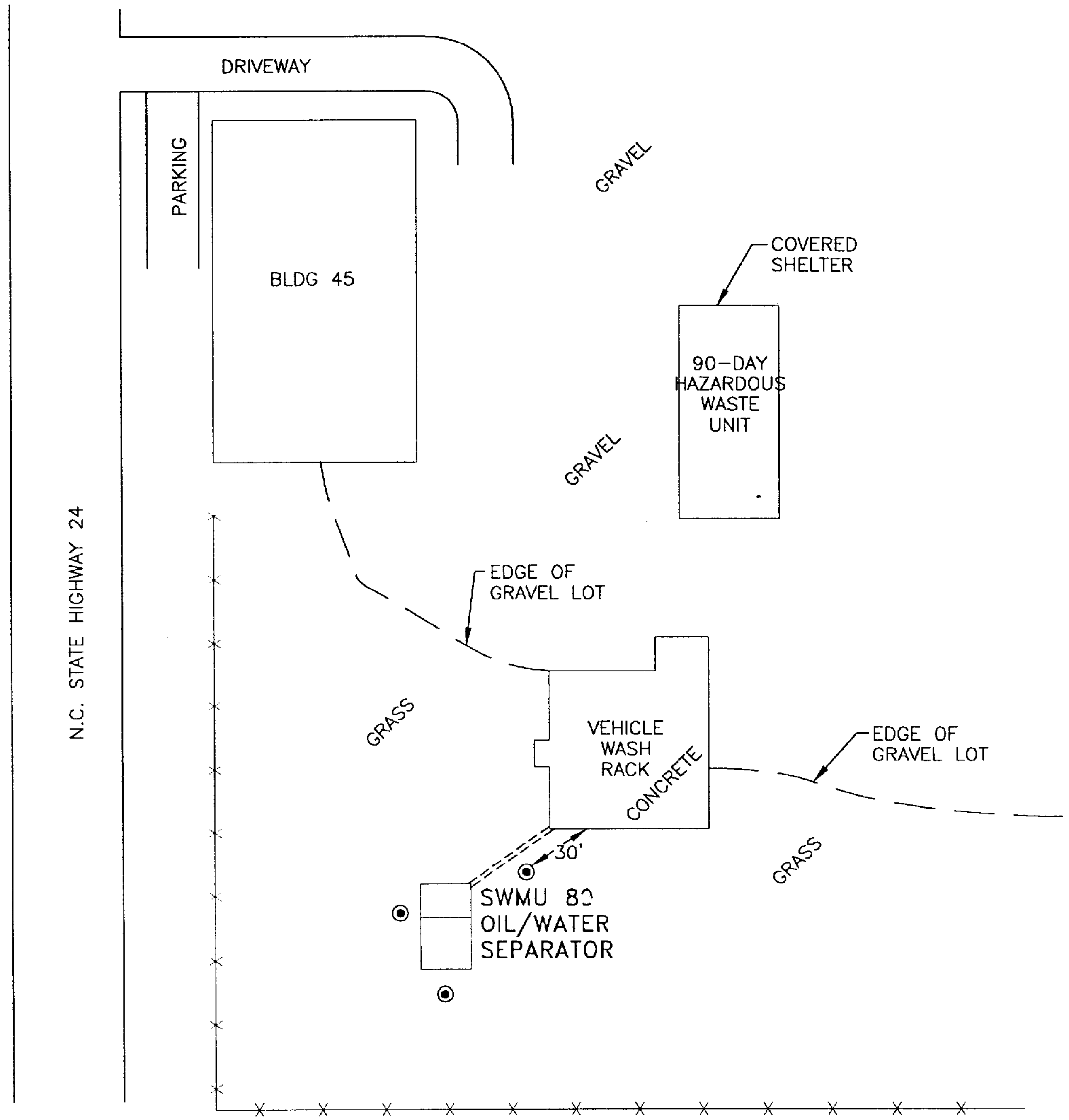
NOTE:
-ALL SAMPLE LOCATIONS ARE SUBJECT TO CHANGE IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO A PARTICULAR SAMPLE LOCATION.

N.T.S.

Baker Environmental, Inc.

FIGURE 5-54
PROPOSED SAMPLE LOCATIONS
SWMU 46
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

371106PP



NOTE:
-ALL SAMPLES WILL BE COLLECTED WITHIN 3 FEET OF THE SWMU's PERIMETER, (UNLESS OTHERWISE NOTED). THESE ARE PROPOSED LOCATIONS AND CHANGES MAY BE NECESSARY UPON REINSPECTION DURING FIELD ACTIVITIES, LOCATIONS MAY BE CHANGED IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO PROPOSED LOCATIONS.

LEGEND

◉ PROPOSED SOIL BORING AND SAMPLE LOCATION

N.T.S.

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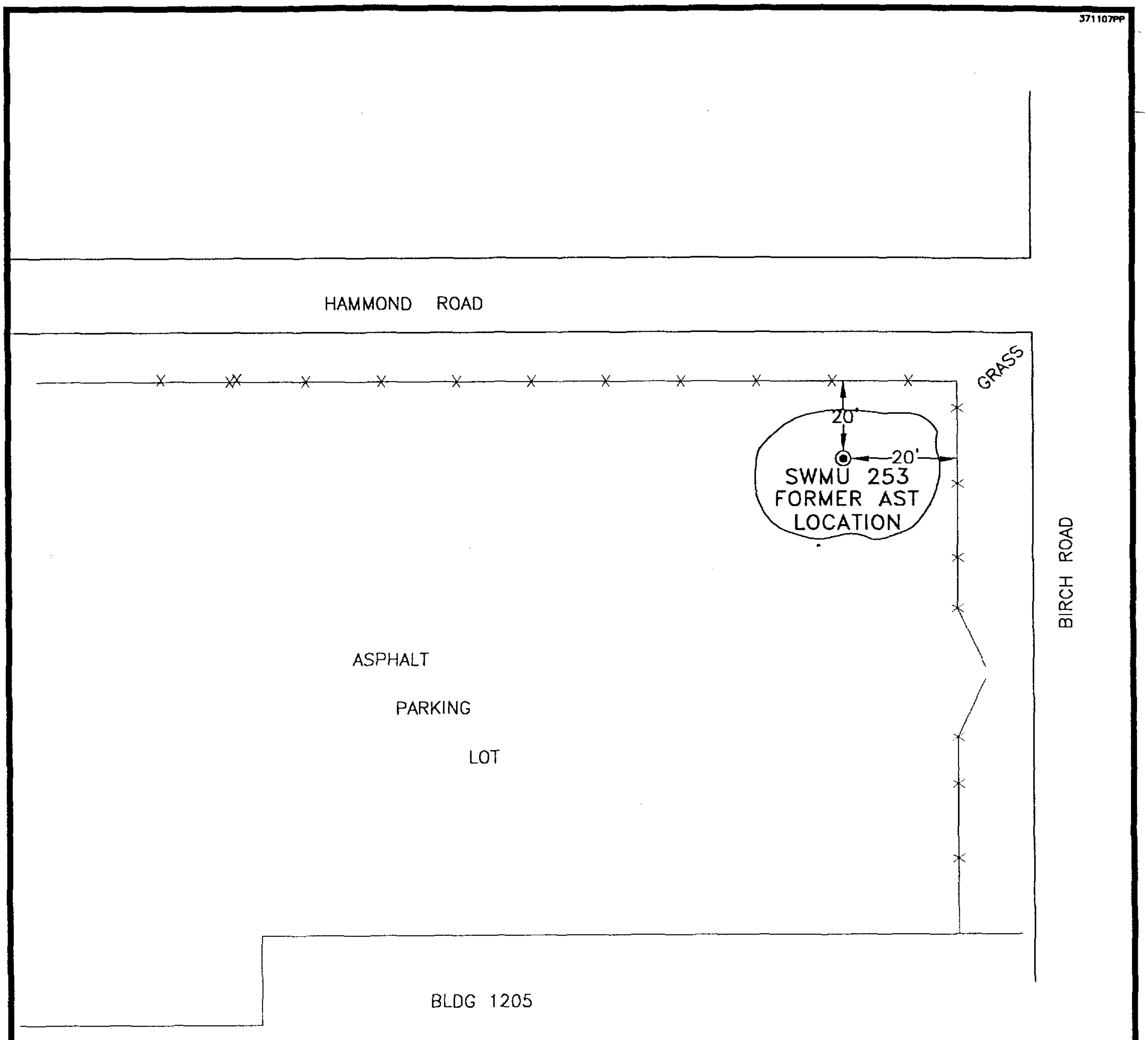
FIGURE 5-55
PROPOSED SAMPLE LOCATIONS
SWMU 89
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



NOTE:
-ALL SAMPLE LOCATIONS ARE SUBJECT TO CHANGE IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO A PARTICULAR SAMPLE LOCATION.

LEGEND

◉ PROPOSED SOIL BORING AND SAMPLE LOCATION

N.T.S.

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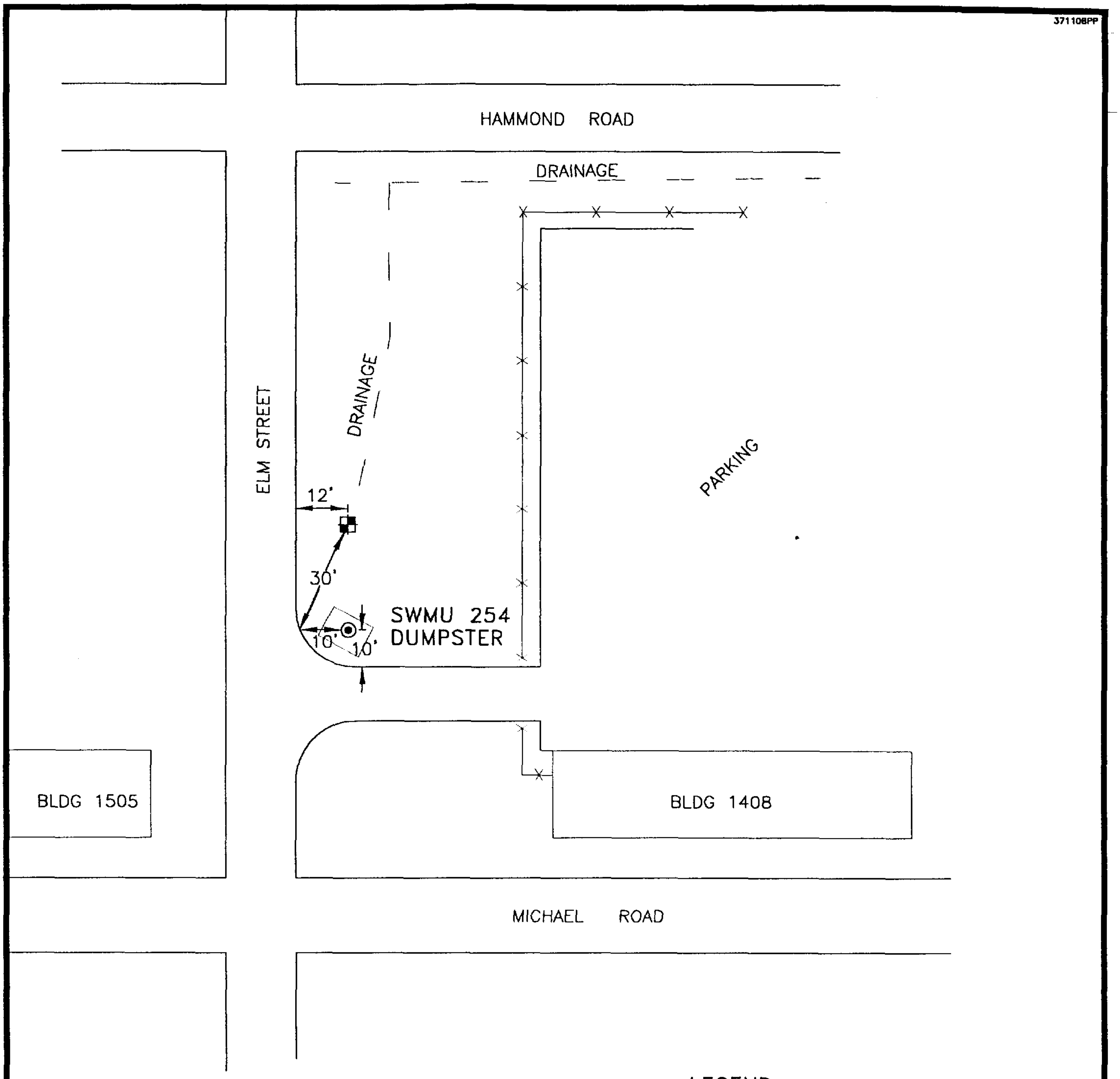
FIGURE 5-56
PROPOSED SAMPLE LOCATIONS
SWMU 253
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

371108PP



NOTE:
-ALL SAMPLE LOCATIONS ARE SUBJECT TO CHANGE IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO A PARTICULAR SAMPLE LOCATION.

LEGEND

◉ PROPOSED SOIL BORING AND SAMPLE LOCATION

▩ PROPOSED SURFACE SOIL LOCATION

N.T.S.

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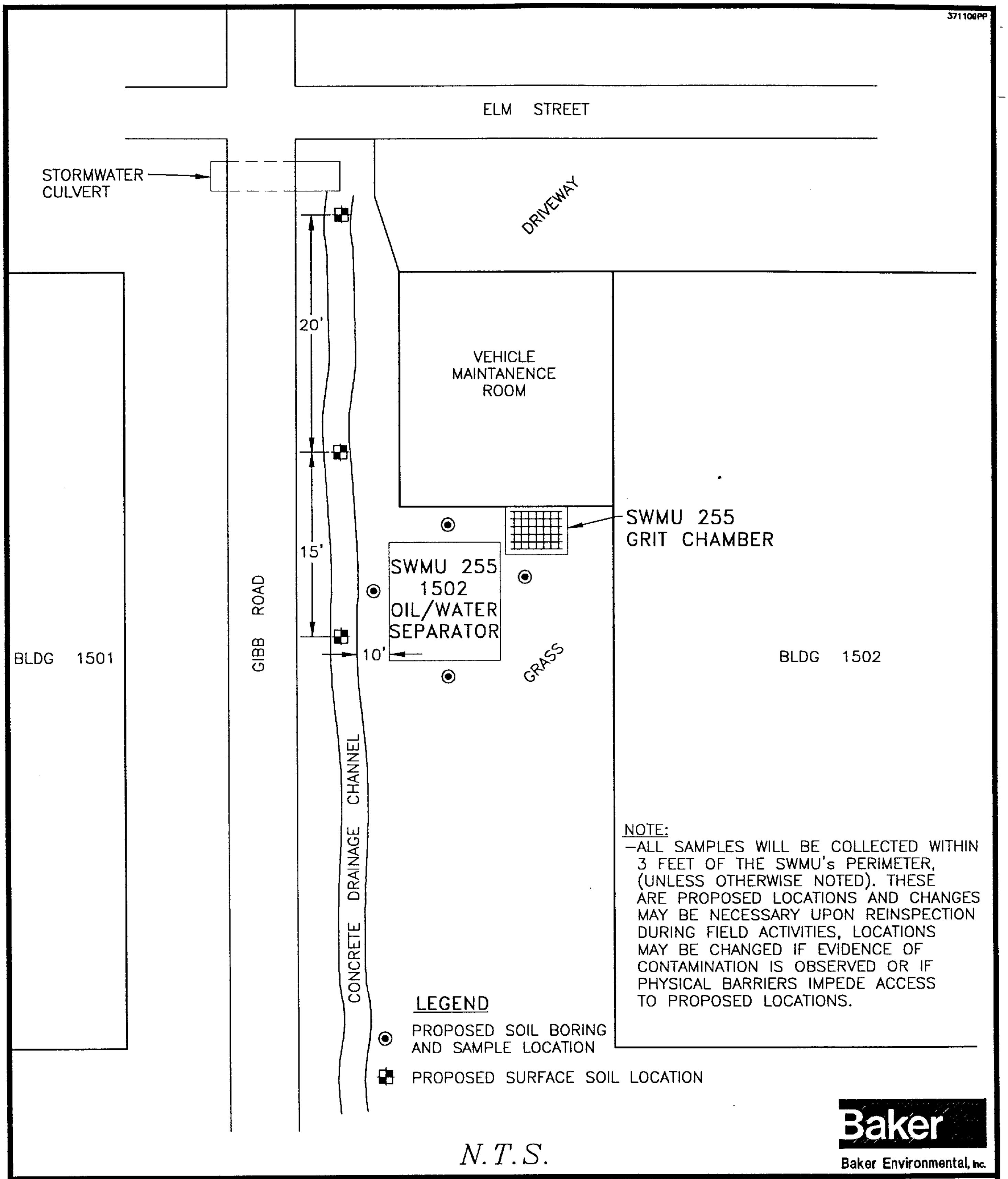
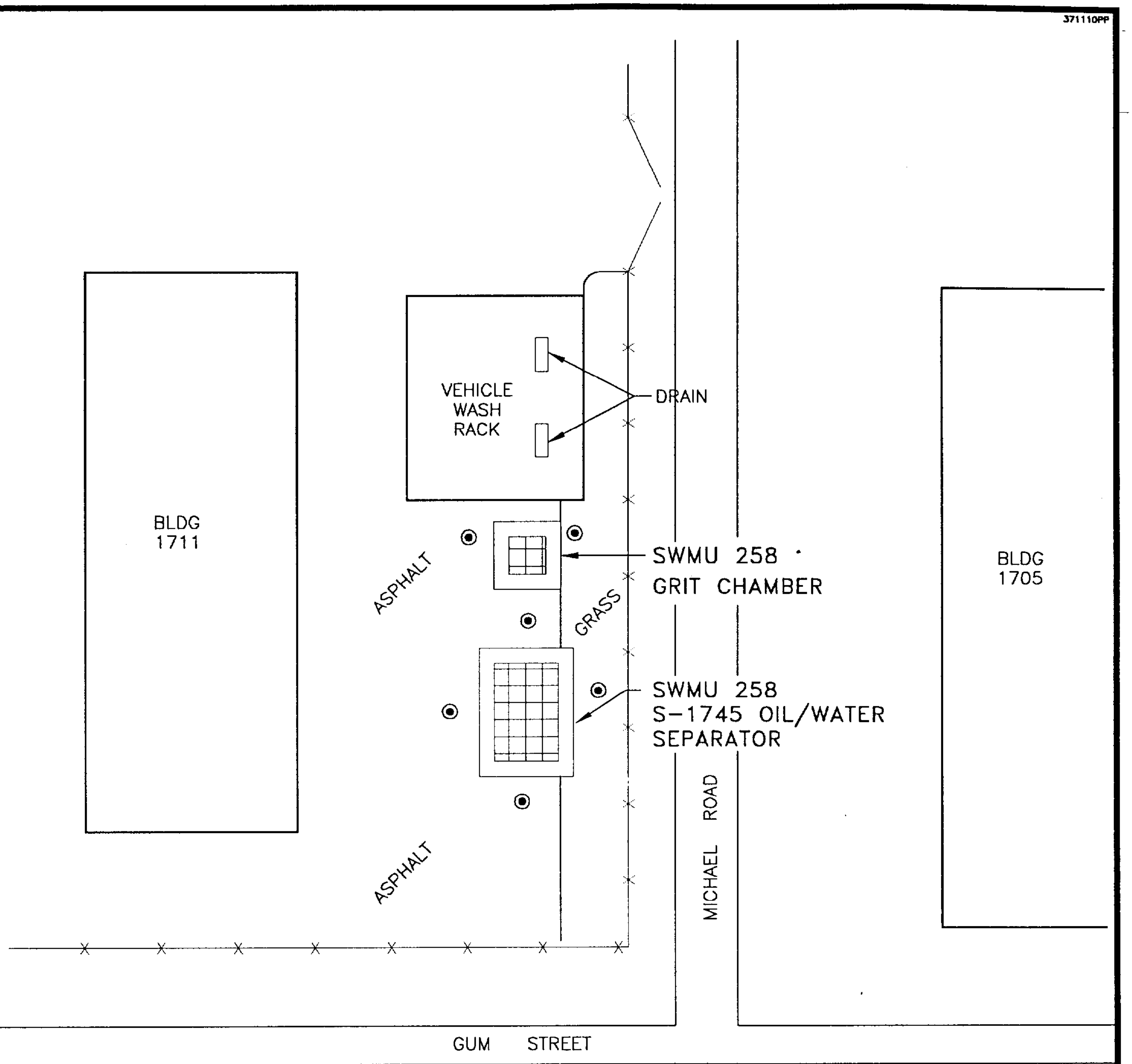
FIGURE 5-57
PROPOSED SAMPLE LOCATIONS
SWMU 254
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



NOTE:
–ALL SAMPLES WILL BE COLLECTED WITHIN 3 FEET OF THE SWMU's PERIMETER, (UNLESS OTHERWISE NOTED). THESE ARE PROPOSED LOCATIONS AND CHANGES MAY BE NECESSARY UPON REINSPECTION DURING FIELD ACTIVITIES, LOCATIONS MAY BE CHANGED IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO PROPOSED LOCATIONS.

FIGURE 5–58
PROPOSED SAMPLE LOCATIONS
SWMU 255
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



NOTE:
-ALL SAMPLES WILL BE COLLECTED WITHIN 3 FEET OF THE SWMU's PERIMETER, (UNLESS OTHERWISE NOTED). THESE ARE PROPOSED LOCATIONS AND CHANGES MAY BE NECESSARY UPON REINSPECTION DURING FIELD ACTIVITIES. LOCATIONS MAY BE CHANGED IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO PROPOSED LOCATIONS.

LEGEND

◉ PROPOSED SOIL BORING AND SAMPLE LOCATION

N.T.S.

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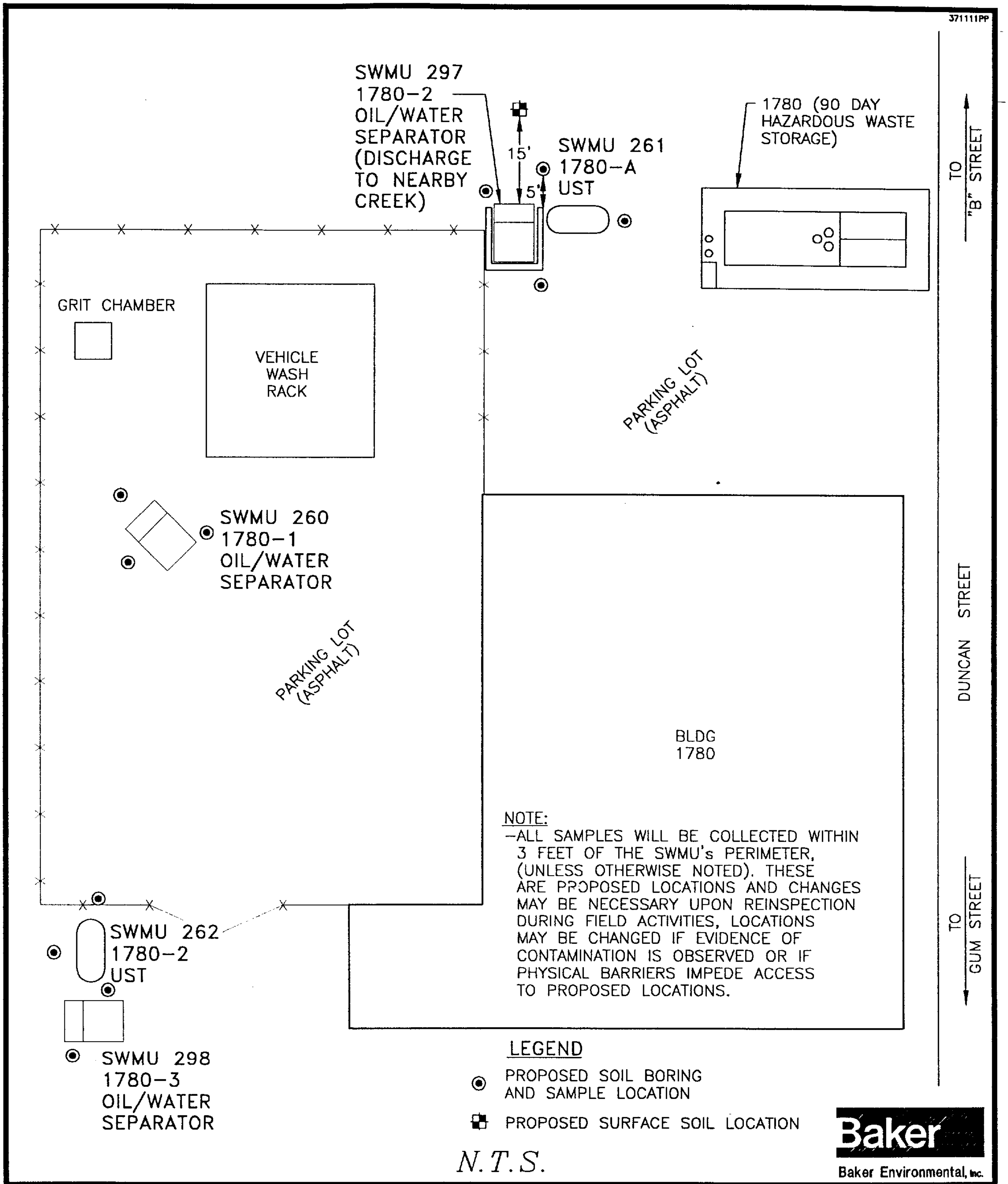
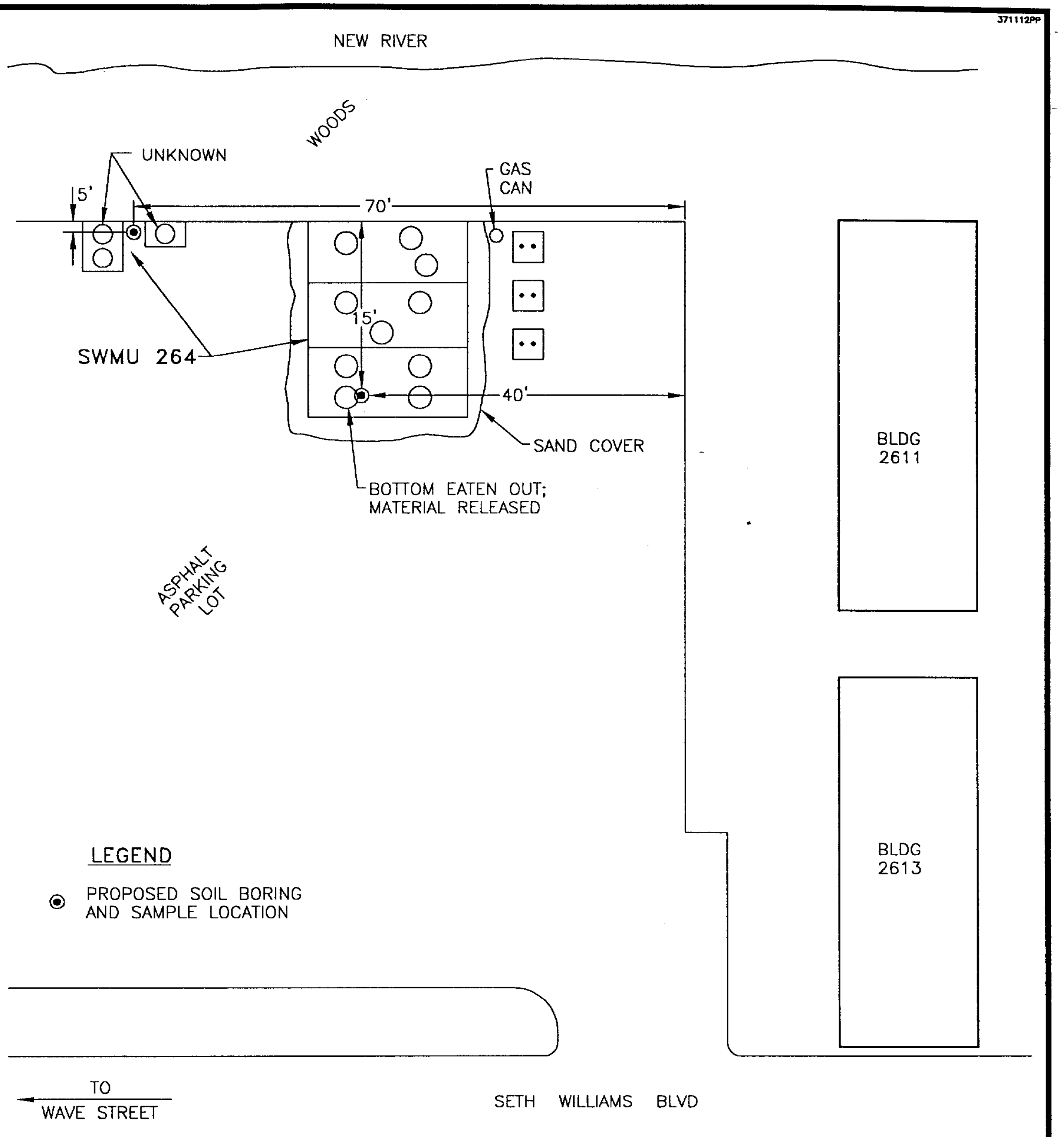
FIGURE 5-59
PROPOSED SAMPLE LOCATIONS
SWMU 258
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



NOTE:
-ALL SAMPLES WILL BE COLLECTED WITHIN 3 FEET OF THE SWMU's PERIMETER, (UNLESS OTHERWISE NOTED). THESE ARE PROPOSED LOCATIONS AND CHANGES MAY BE NECESSARY UPON REINSPECTION DURING FIELD ACTIVITIES, LOCATIONS MAY BE CHANGED IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO PROPOSED LOCATIONS.

FIGURE 5-60
PROPOSED SAMPLE LOCATIONS
SWMUs 260, 261, 262, 297, AND 298
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



NOTES:
- DURING THE OCTOBER 1996 VISIT, THE ENTIRE PARKING LOT AT SWMU 264 WAS COVERED WITH WOOD CHIPS AND NO DETAILS WERE VISIBLE. THE DETAILS IN THIS DRAWING WERE NOTED BT ENSAFE, INC. IN NOVEMBER 1993.
- ALL SAMPLE LOCATIONS ARE SUBJECT TO CHANGE IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO A PARTICULAR SAMPLE LOCATION.

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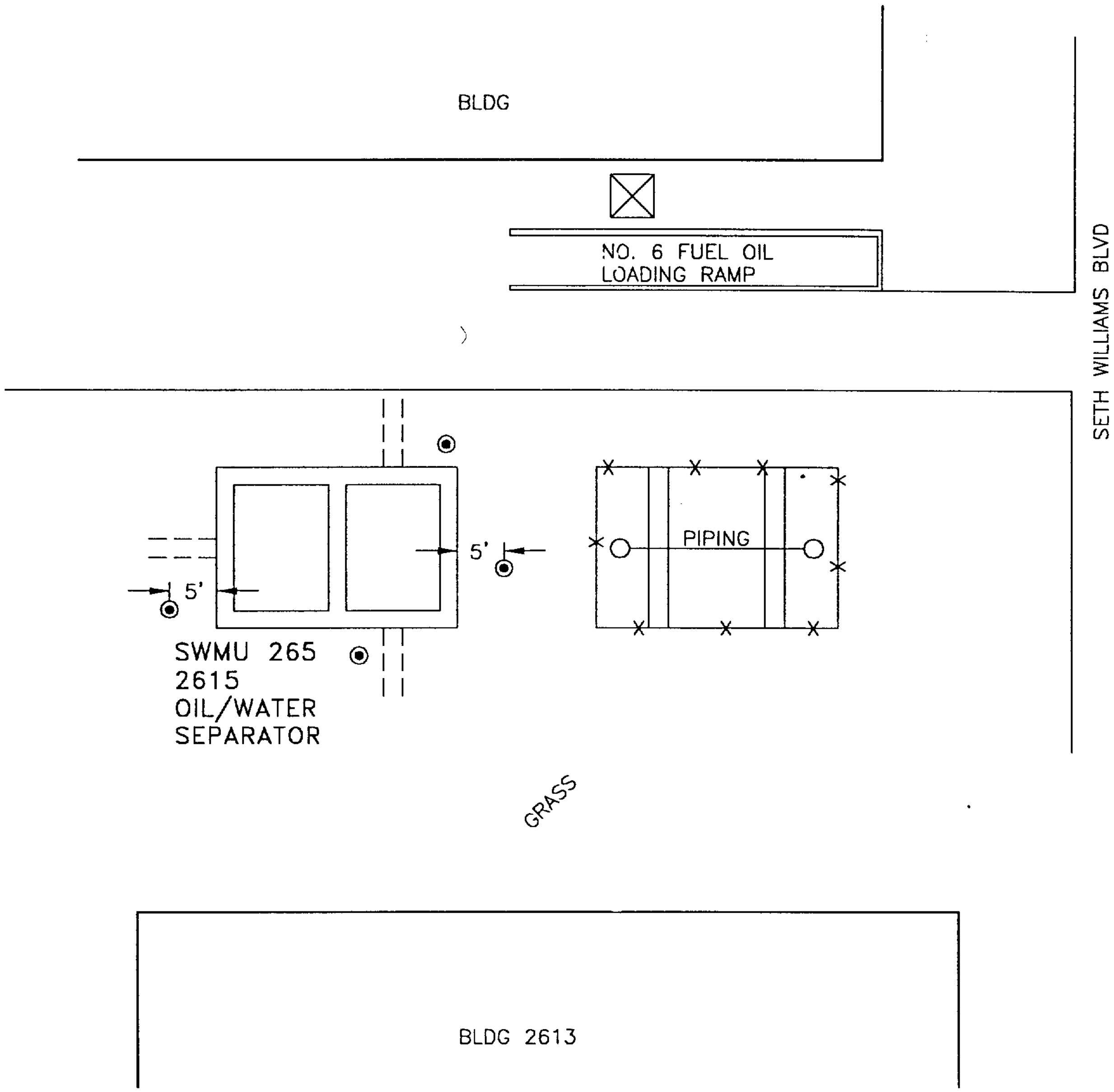
FIGURE 5-61
PROPOSED SAMPLE LOCATIONS
SWMU 264
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



NOTE:
–ALL SAMPLES WILL BE COLLECTED WITHIN 3 FEET OF THE SWMU's PERIMETER, (UNLESS OTHERWISE NOTED). THESE ARE PROPOSED LOCATIONS AND CHANGES MAY BE NECESSARY UPON REINSPECTION DURING FIELD ACTIVITIES, LOCATIONS MAY BE CHANGED IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO PROPOSED LOCATIONS.

LEGEND

◉ PROPOSED SOIL BORING AND SAMPLE LOCATION

N.T.S.

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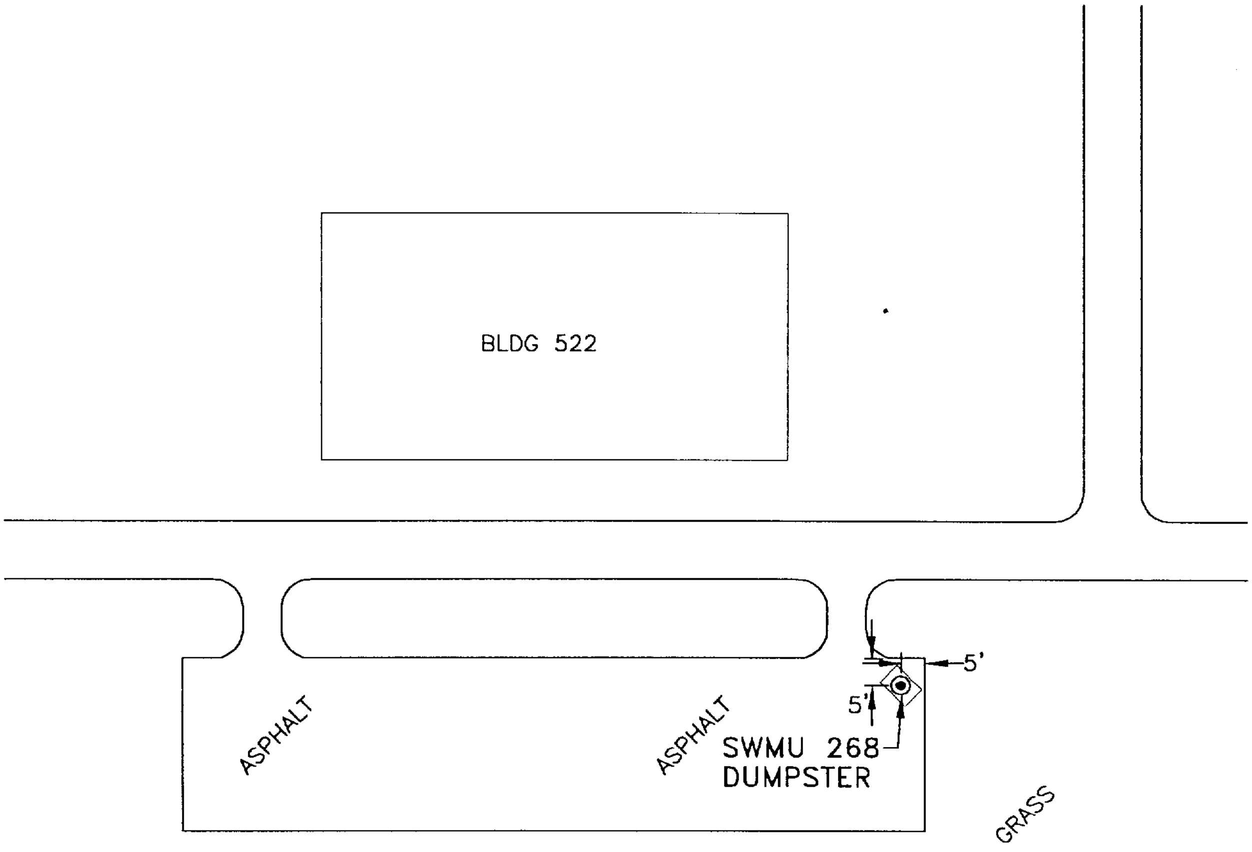
FIGURE 5-62
PROPOSED SAMPLE LOCATIONS
SWMU 265
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



NOTES:

-THE LOCATION OF THIS DUMPSTER COULD NOT BE FOUND DURING THE OCTOBER 1996 SITE VISIT.

-ALL SAMPLES WILL BE COLLECTED WITHIN 3 FEET OF THE SWMU's PERIMETER, (UNLESS OTHERWISE NOTED). THESE ARE PROPOSED LOCATIONS AND CHANGES MAY BE NECESSARY UPON REINSPECTION DURING FIELD ACTIVITIES, LOCATIONS MAY BE CHANGED IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO PROPOSED LOCATIONS.

LEGEND

◉ PROPOSED SOIL BORING AND SAMPLE LOCATION

N.T.S.

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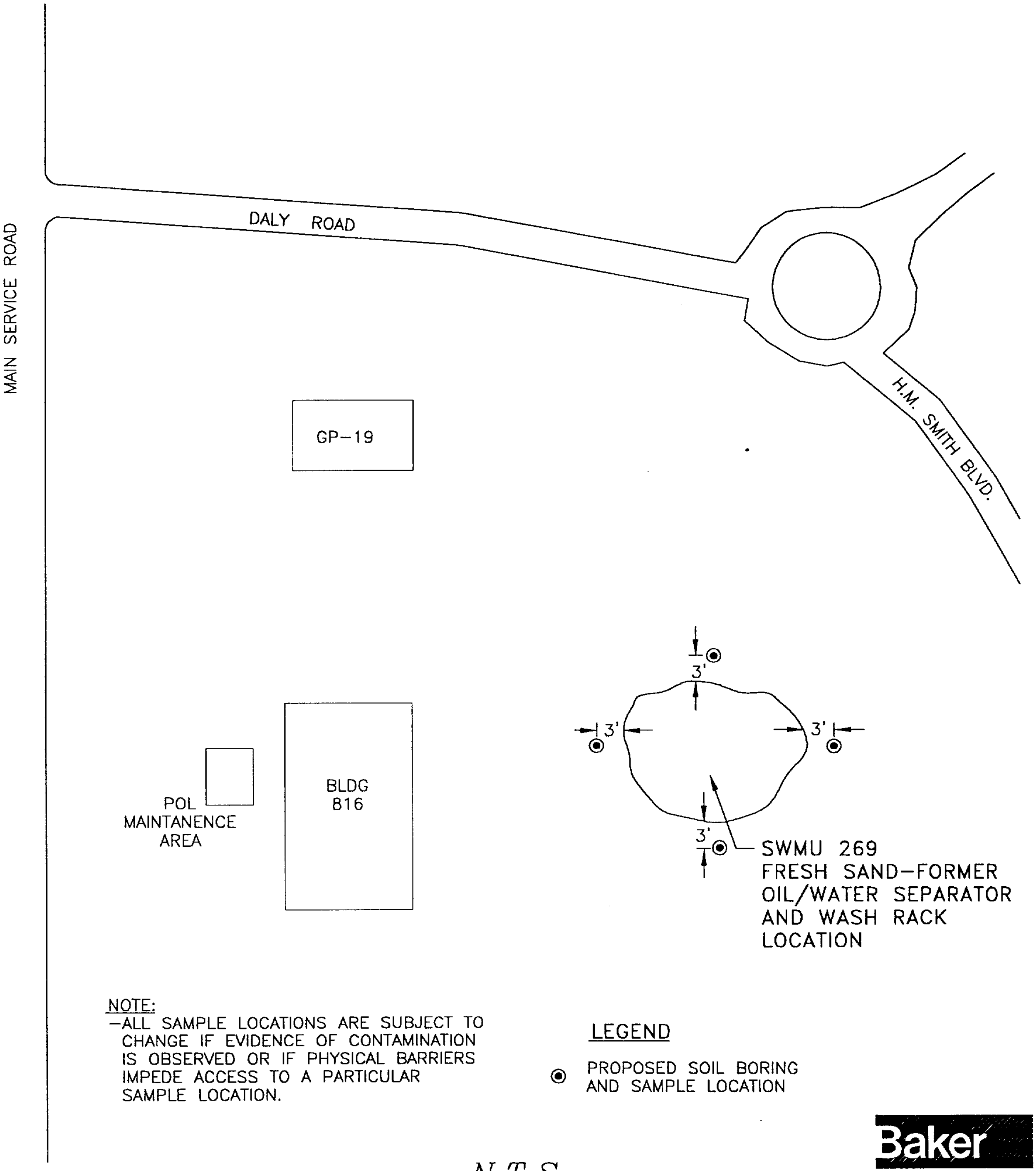
FIGURE 5-63
PROPOSED SAMPLE LOCATIONS
SWMU 268
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

371115PP



NOTE:
- ALL SAMPLE LOCATIONS ARE SUBJECT TO CHANGE IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO A PARTICULAR SAMPLE LOCATION.

LEGEND

⊙ PROPOSED SOIL BORING AND SAMPLE LOCATION

N.T.S.

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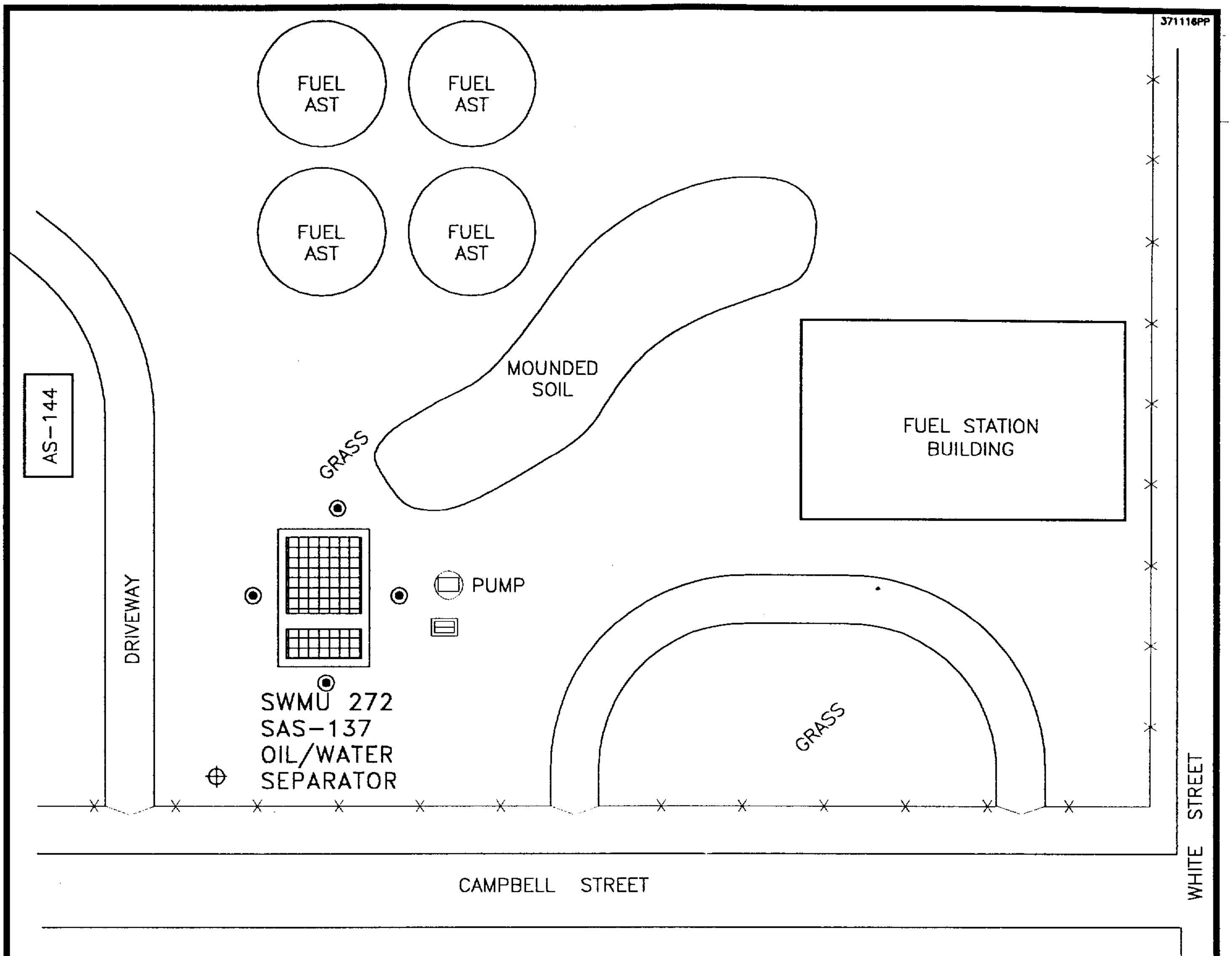
FIGURE 5-64
PROPOSED SAMPLE LOCATIONS
SWMU 269
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



NOTE:
-ALL SAMPLES WILL BE COLLECTED WITHIN 3 FEET OF THE SWMU's PERIMETER, (UNLESS OTHERWISE NOTED). THESE ARE PROPOSED LOCATIONS AND CHANGES MAY BE NECESSARY UPON REINSPECTION DURING FIELD ACTIVITIES, LOCATIONS MAY BE CHANGED IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO PROPOSED LOCATIONS.

LEGEND

◉ PROPOSED SOIL BORING AND SAMPLE LOCATION

⊕ EXISTING GROUNDWATER MONITORING WELL LOCATION

N.T.S.

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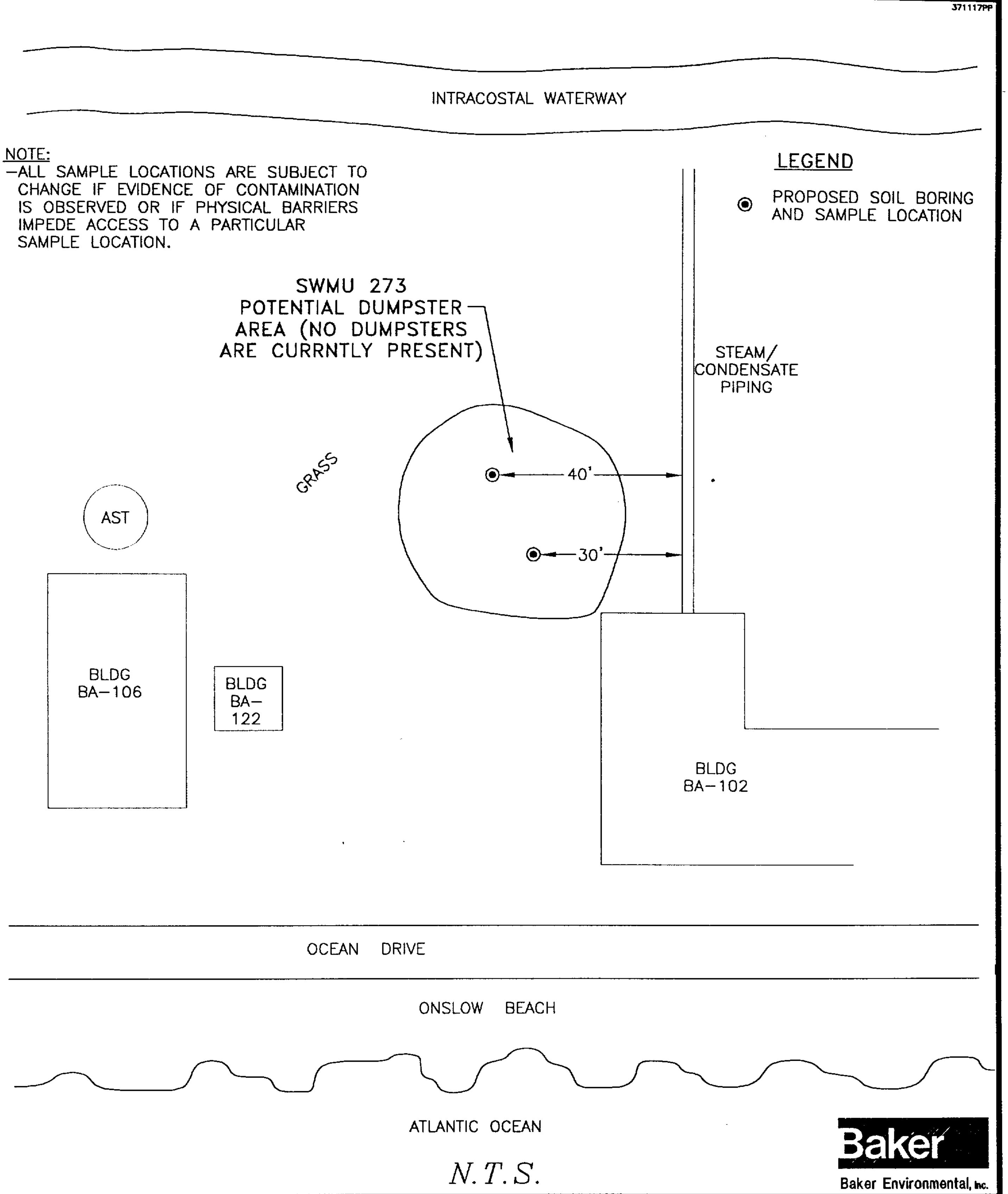
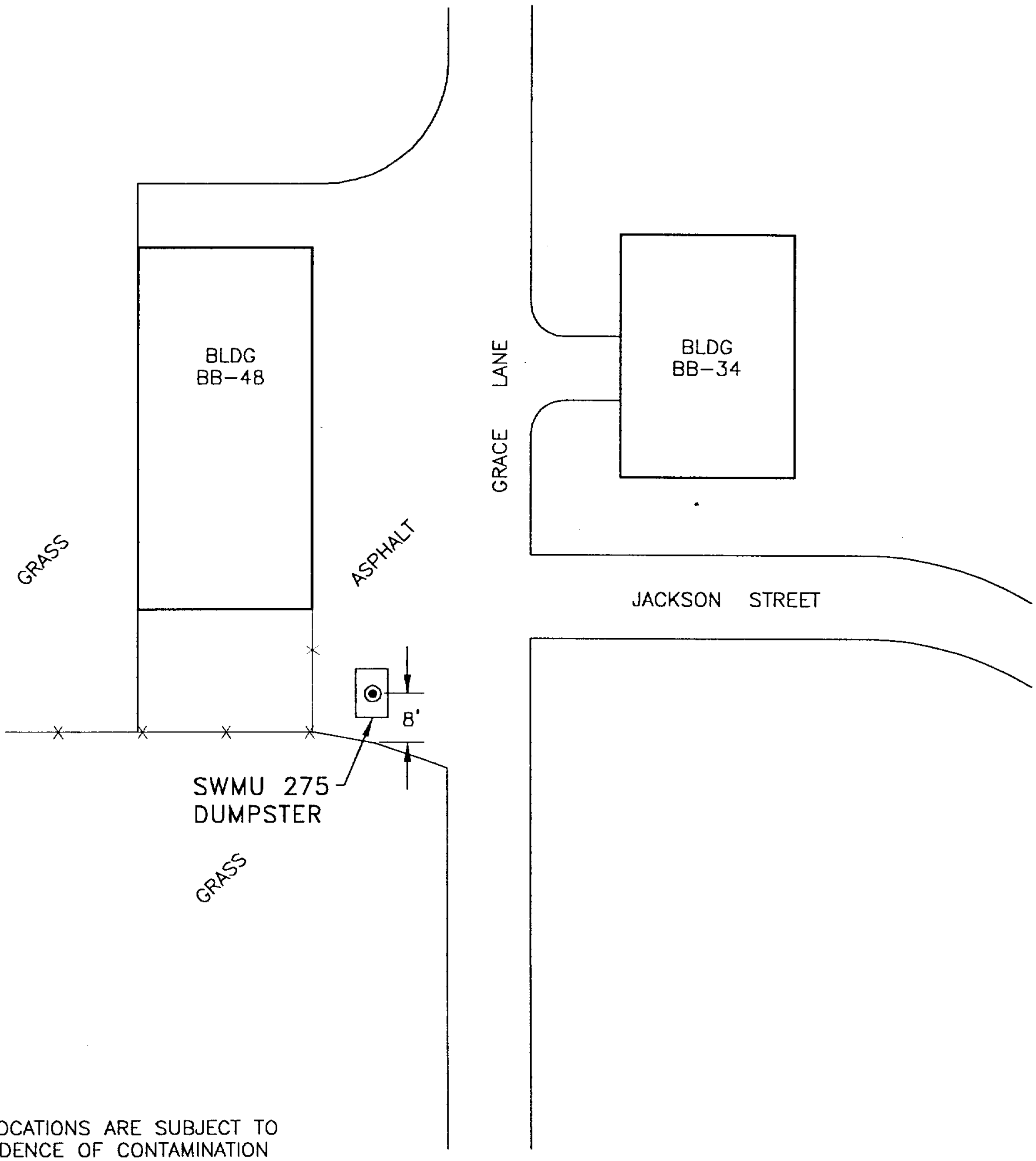
FIGURE 5-65
PROPOSED SAMPLE LOCATIONS
SWMU 272
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



NOTE:
-ALL SAMPLE LOCATIONS ARE SUBJECT TO CHANGE IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO A PARTICULAR SAMPLE LOCATION.

FIGURE 5-66
PROPOSED SAMPLE LOCATIONS
SWMU 273
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



NOTE:
-ALL SAMPLE LOCATIONS ARE SUBJECT TO CHANGE IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO A PARTICULAR SAMPLE LOCATION.

LEGEND

◉ PROPOSED SOIL BORING AND SAMPLE LOCATION

N.T.S.

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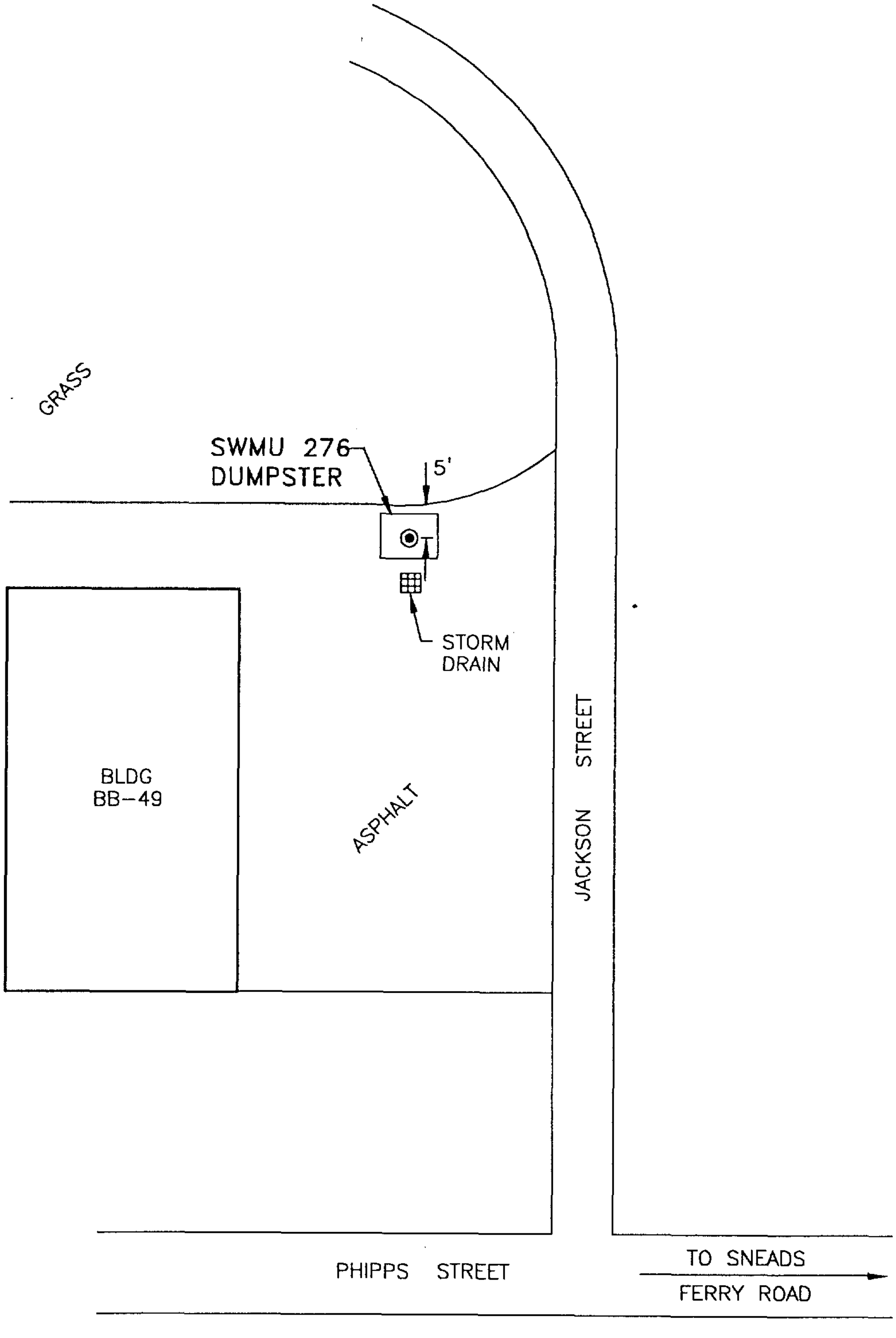
FIGURE 5-67
PROPOSED SAMPLE LOCATIONS
SWMU 275
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

371118PP



NOTE:
-ALL SAMPLE LOCATIONS ARE SUBJECT TO CHANGE IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO A PARTICULAR SAMPLE LOCATION.

LEGEND

◉ PROPOSED SOIL BORING AND SAMPLE LOCATION

N.T.S.

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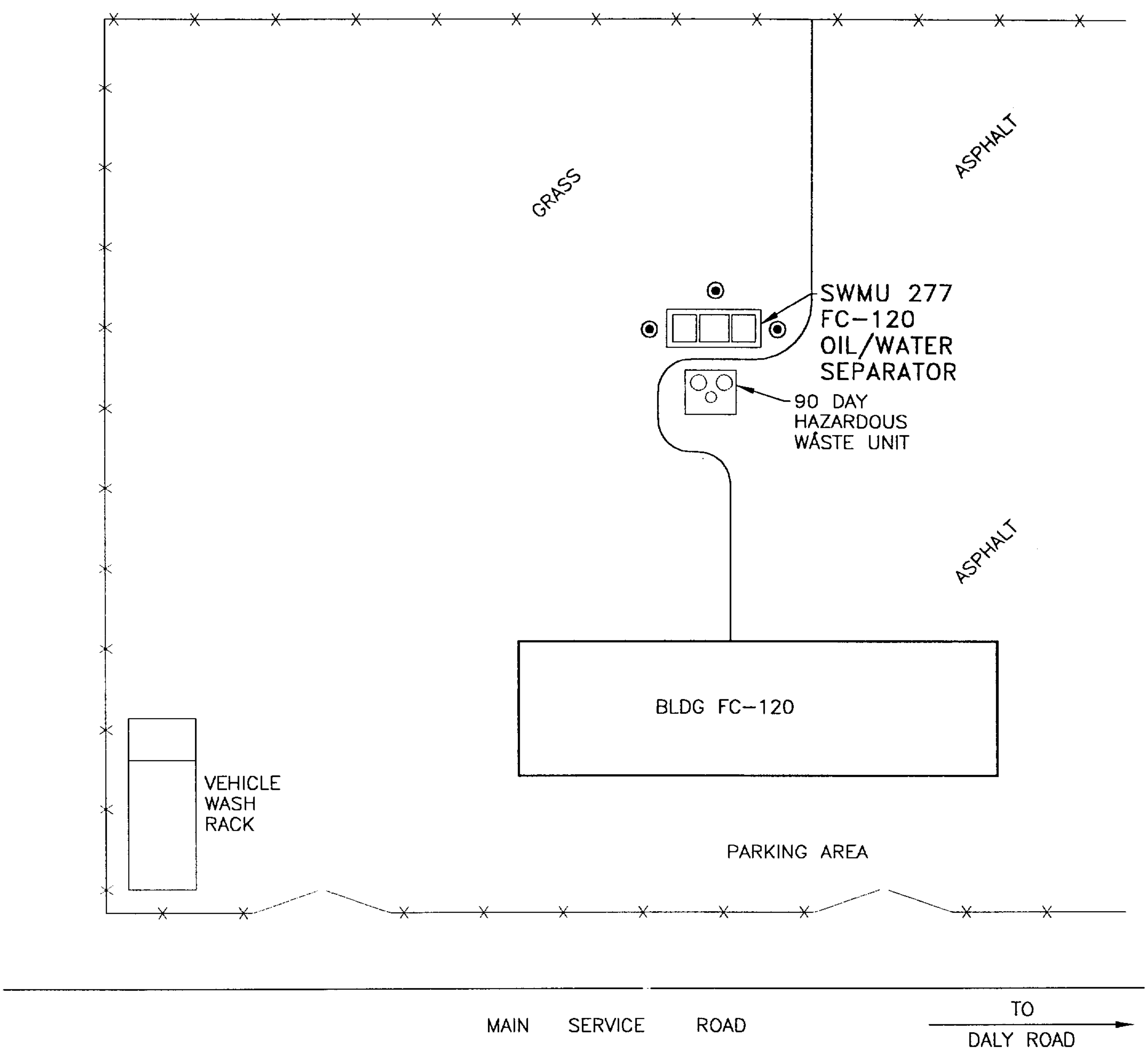
FIGURE 5-68
PROPOSED SAMPLE LOCATIONS
SWMU 276
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



NOTE:

-ALL SAMPLES WILL BE COLLECTED WITHIN 3 FEET OF THE SWMU's PERIMETER, (UNLESS OTHERWISE NOTED). THESE ARE PROPOSED LOCATIONS AND CHANGES MAY BE NECESSARY UPON REINSPECTION DURING FIELD ACTIVITIES, LOCATIONS MAY BE CHANGED IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO PROPOSED LOCATIONS.

LEGEND

◉ PROPOSED SOIL BORING AND SAMPLE LOCATION

N.T.S.

Baker

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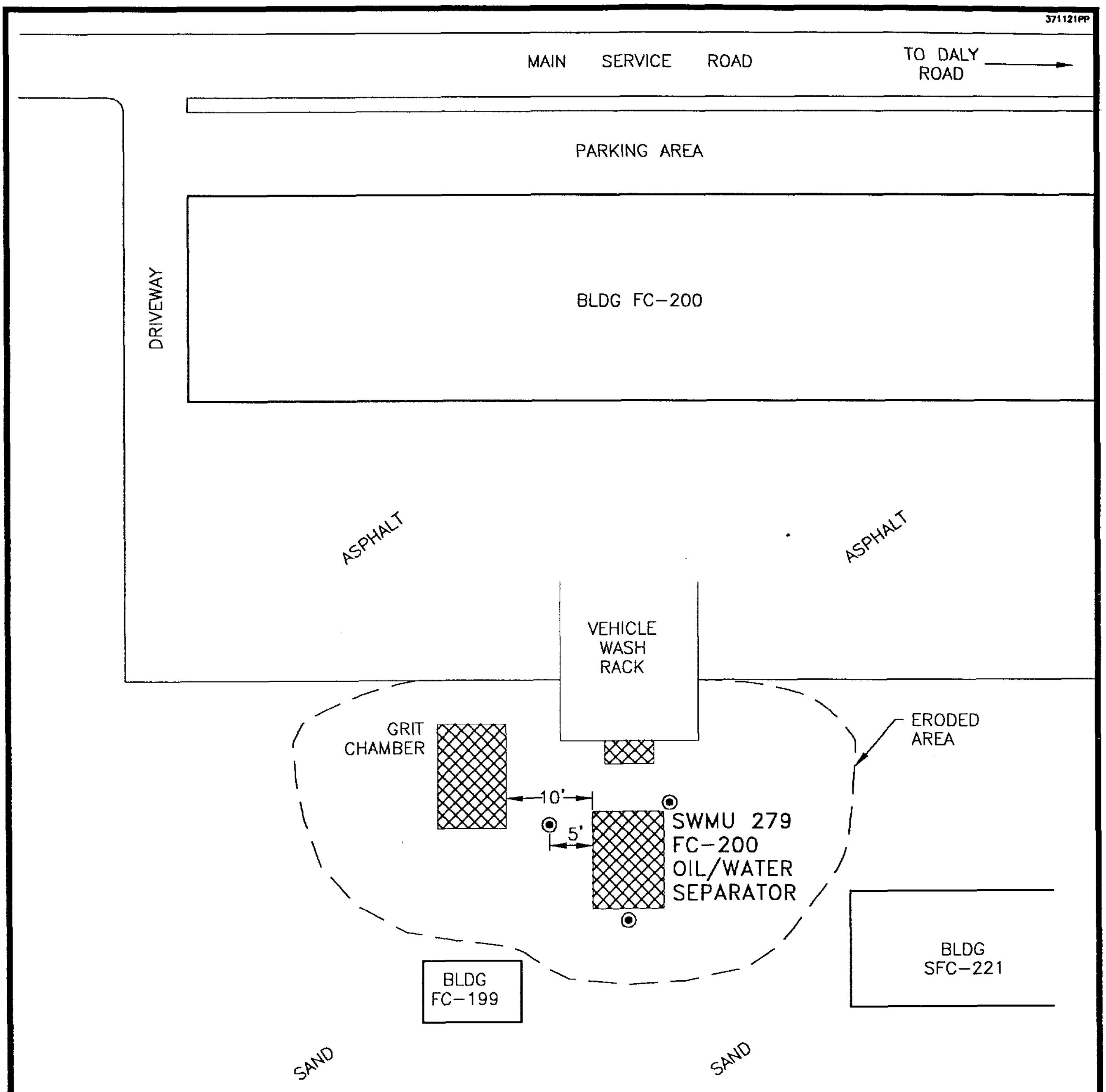
FIGURE 5-69
PROPOSED SAMPLE LOCATIONS
SWMU 277
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



NOTE:
-ALL SAMPLES WILL BE COLLECTED WITHIN 3 FEET OF THE SWMU's PERIMETER, (UNLESS OTHERWISE NOTED). THESE ARE PROPOSED LOCATIONS AND CHANGES MAY BE NECESSARY UPON REINSPECTION DURING FIELD ACTIVITIES, LOCATIONS MAY BE CHANGED IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO PROPOSED LOCATIONS.

LEGEND

◉ PROPOSED SOIL BORING AND SAMPLE LOCATION

N.T.S.

Baker
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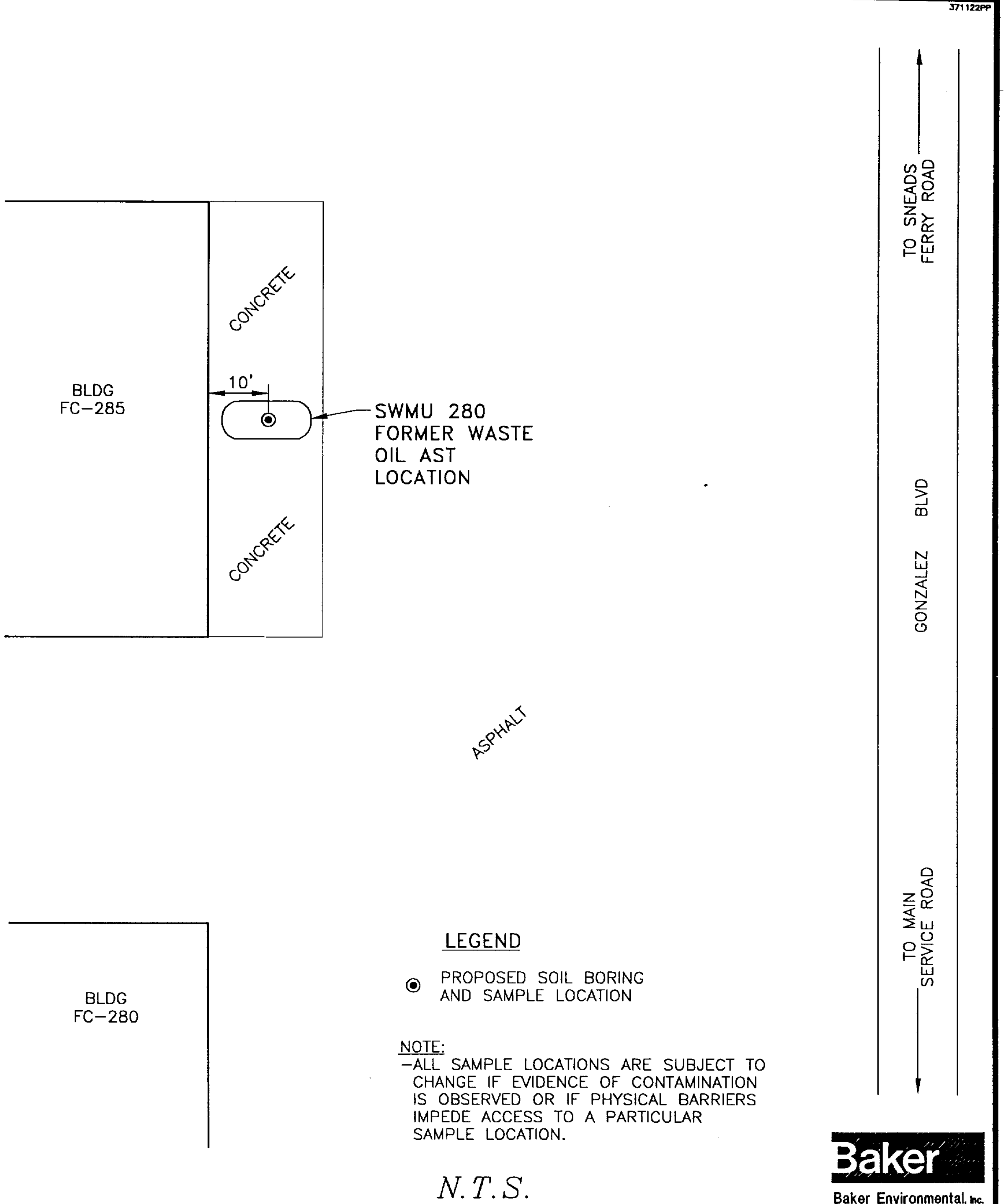
FIGURE 5-70
PROPOSED SAMPLE LOCATIONS
SWMU 279
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



LEGEND

◉ PROPOSED SOIL BORING AND SAMPLE LOCATION

NOTE:
-ALL SAMPLE LOCATIONS ARE SUBJECT TO CHANGE IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO A PARTICULAR SAMPLE LOCATION.

N.T.S.

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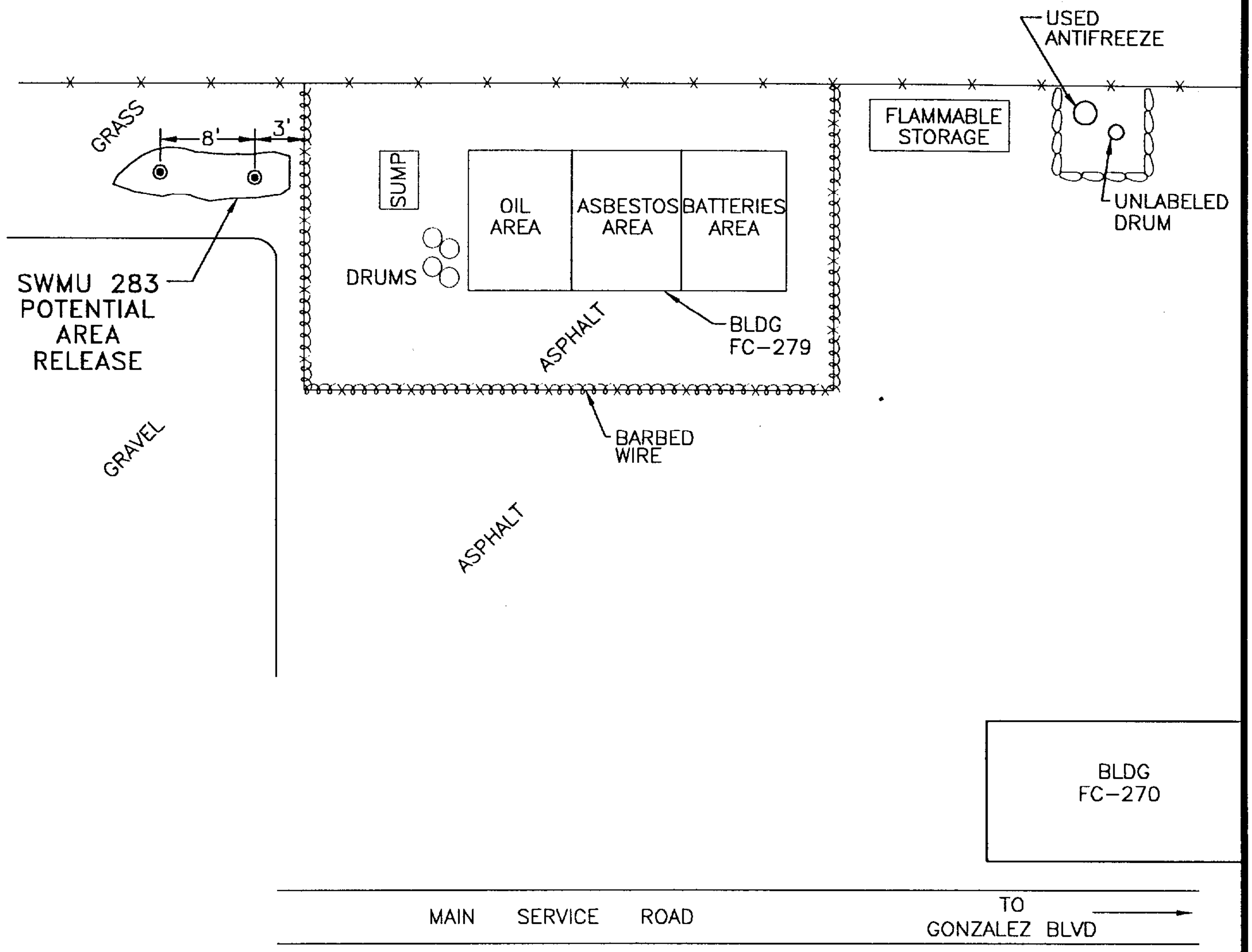
FIGURE 5-71
PROPOSED SAMPLE LOCATIONS
SWMU 280
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

371123PP



NOTE:
-ALL SAMPLES WILL BE COLLECTED WITHIN 3 FEET OF THE SWMU's PERIMETER, (UNLESS OTHERWISE NOTED). THESE ARE PROPOSED LOCATIONS AND CHANGES MAY BE NECESSARY UPON REINSPECTION DURING FIELD ACTIVITIES. LOCATIONS MAY BE CHANGED IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO PROPOSED LOCATIONS.

LEGEND

◉ PROPOSED SOIL BORING AND SAMPLE LOCATION

N.T.S.

Baker
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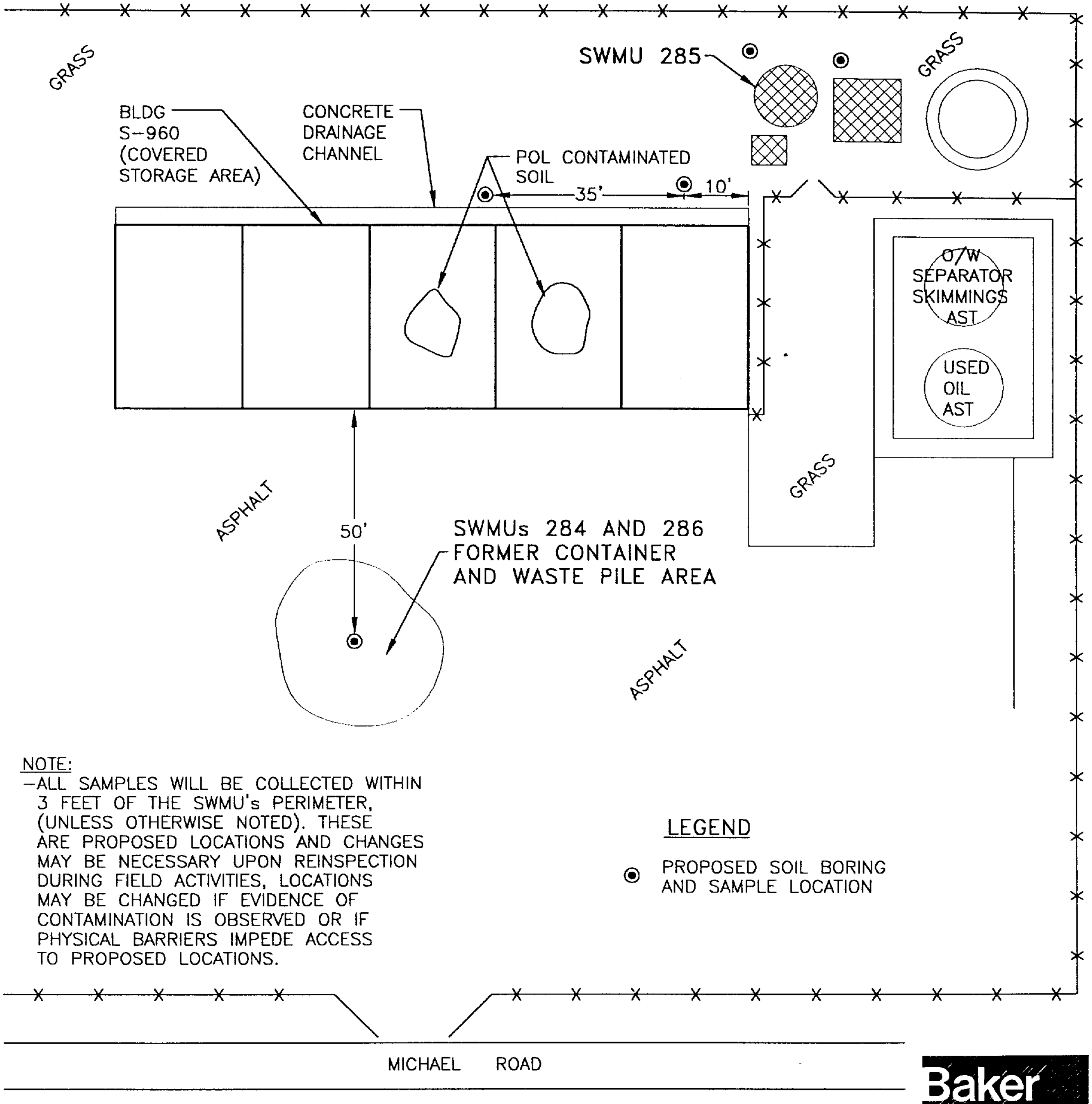
FIGURE 5-72
PROPOSED SAMPLE LOCATIONS
SWMU 283
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

371124PP



NOTE:
- ALL SAMPLES WILL BE COLLECTED WITHIN 3 FEET OF THE SWMU's PERIMETER, (UNLESS OTHERWISE NOTED). THESE ARE PROPOSED LOCATIONS AND CHANGES MAY BE NECESSARY UPON REINSPECTION DURING FIELD ACTIVITIES, LOCATIONS MAY BE CHANGED IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO PROPOSED LOCATIONS.

LEGEND

⊙ PROPOSED SOIL BORING AND SAMPLE LOCATION

N.T.S.

Baker

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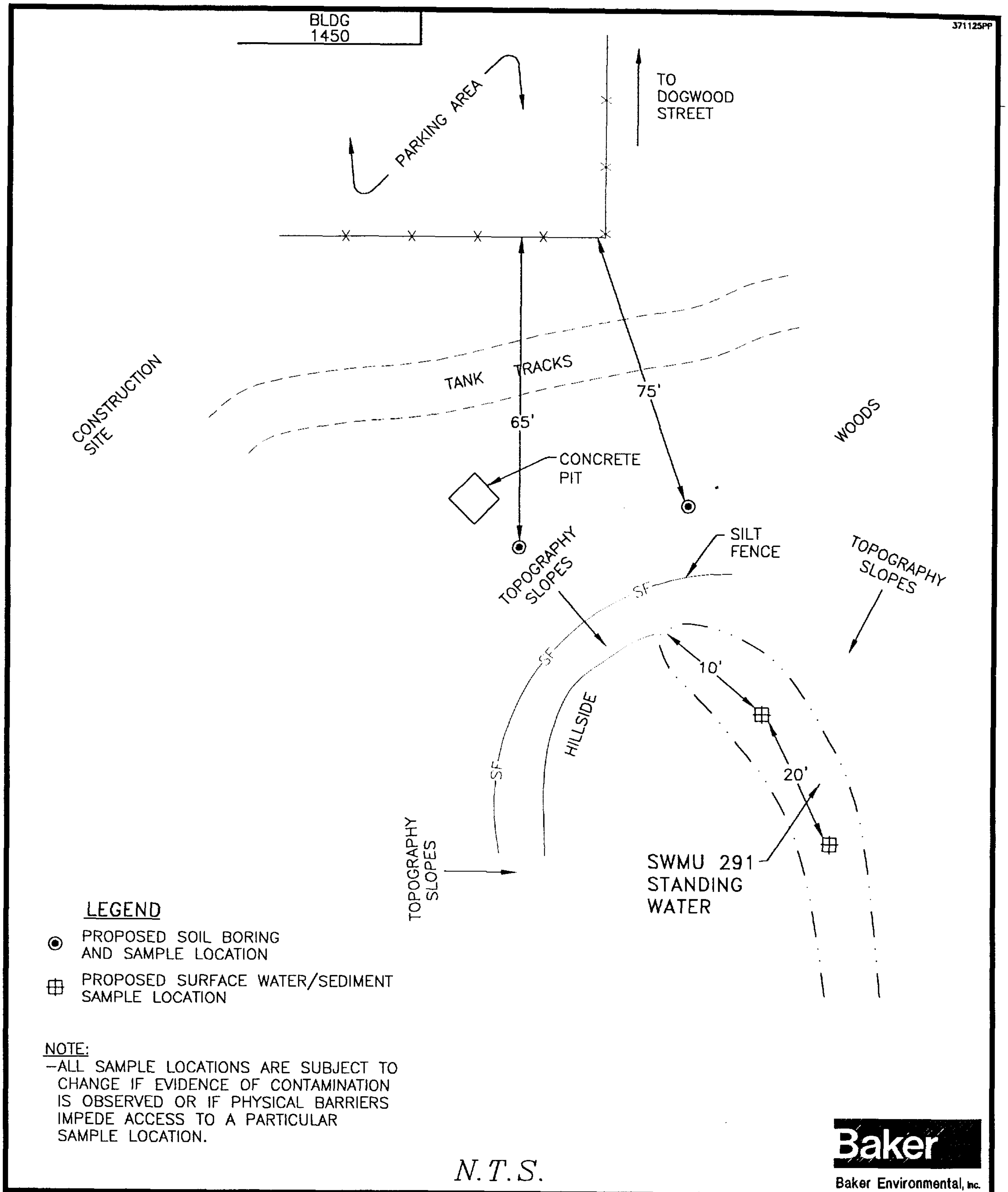
FIGURE 5-73
PROPOSED SAMPLE LOCATIONS
SWMUs 284, 285 AND 286

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

371125PP



LEGEND

◉ PROPOSED SOIL BORING AND SAMPLE LOCATION

⊞ PROPOSED SURFACE WATER/SEDIMENT SAMPLE LOCATION

NOTE:
–ALL SAMPLE LOCATIONS ARE SUBJECT TO CHANGE IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO A PARTICULAR SAMPLE LOCATION.

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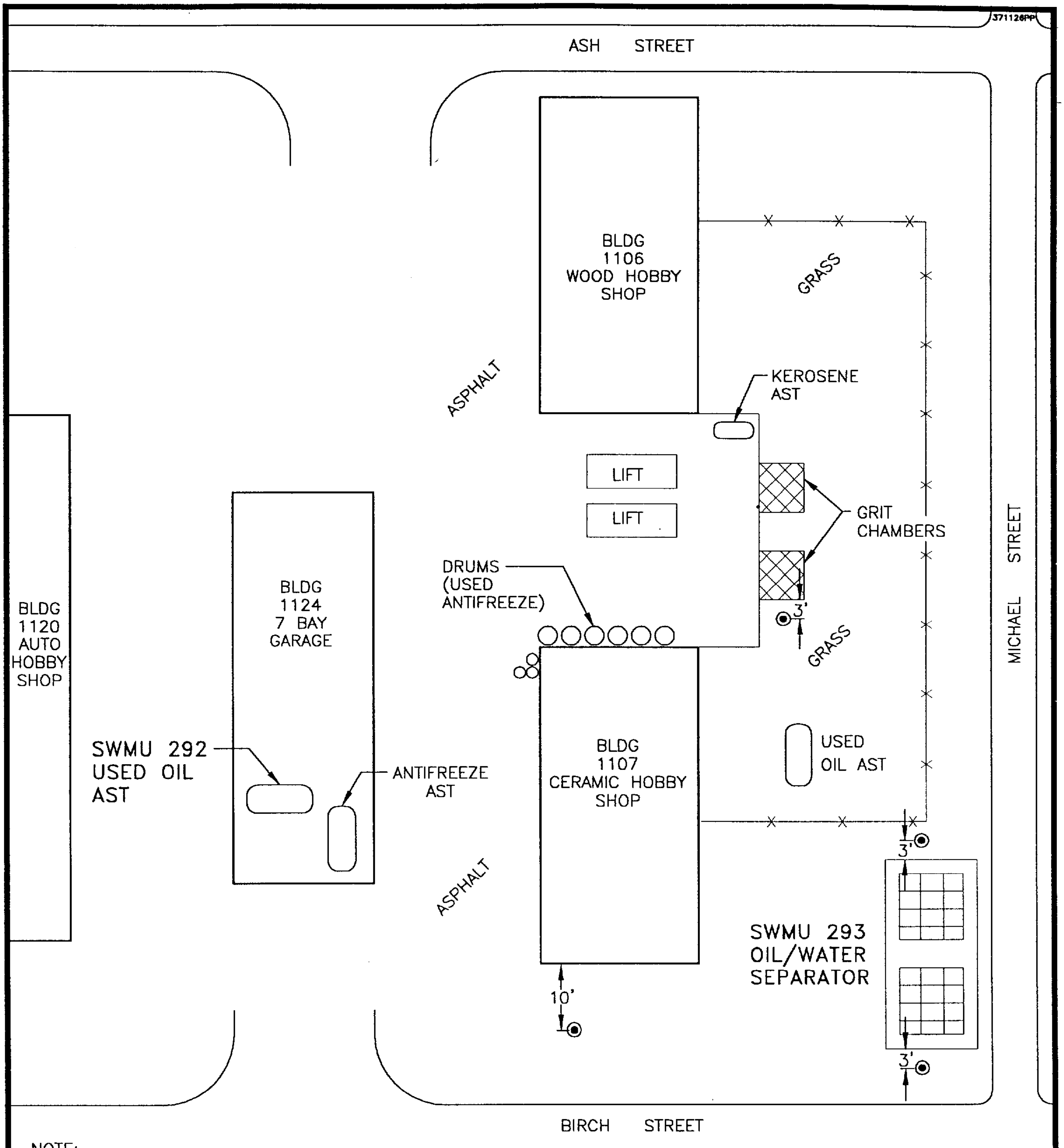
FIGURE 5–74
PROPOSED SAMPLE LOCATIONS
SWMU 291
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



NOTE:

–ALL SAMPLE LOCATIONS ARE SUBJECT TO CHANGE IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO A PARTICULAR SAMPLE LOCATION.

N.T.S.

LEGEND

◉ PROPOSED SOIL BORING AND SAMPLE LOCATION

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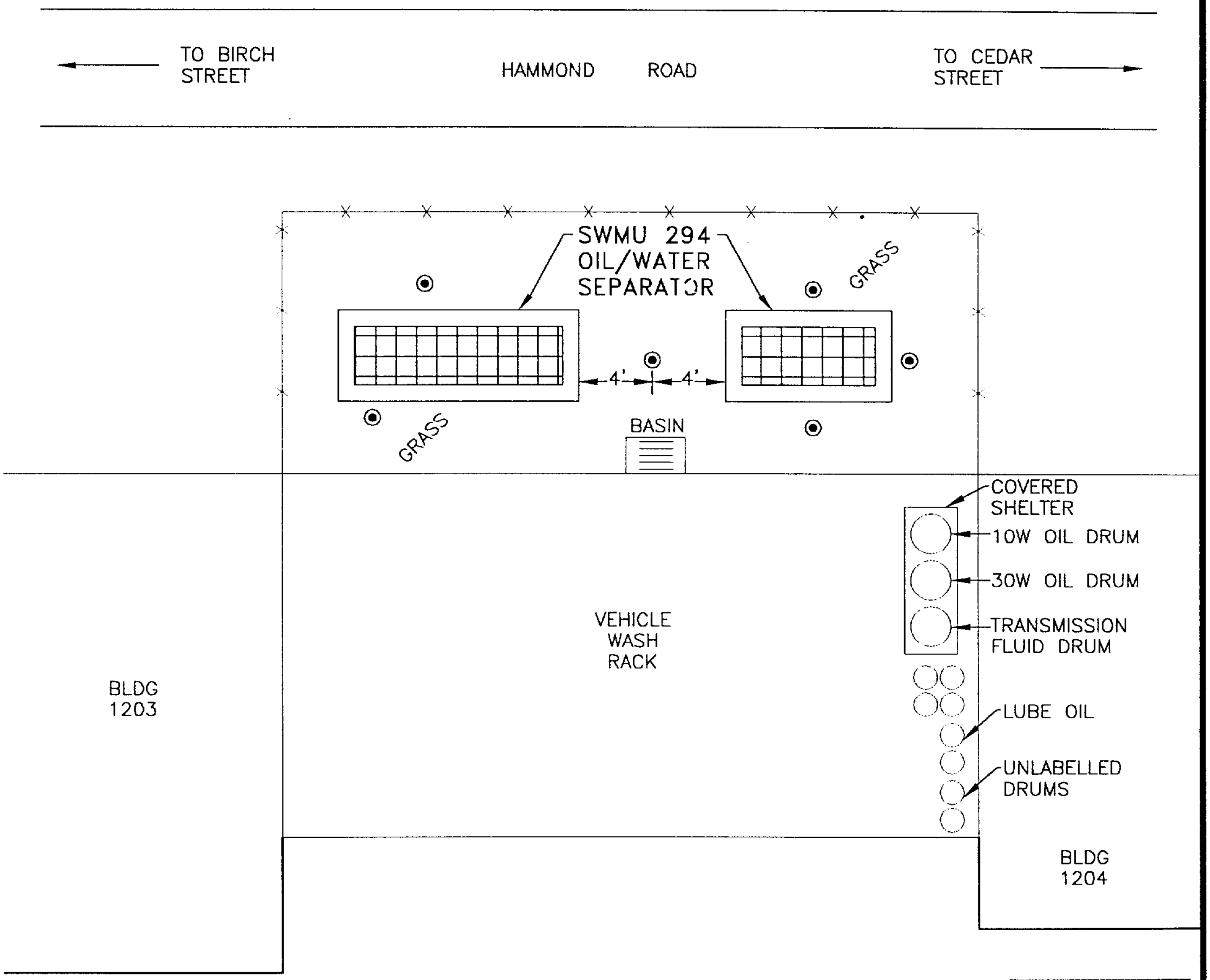
FIGURE 5–75
PROPOSED SAMPLE LOCATIONS
SWMUs 292 AND 293
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

371127PP

NOTE:
-ALL SAMPLES WILL BE COLLECTED WITHIN 3 FEET OF THE SWMU's PERIMETER, (UNLESS OTHERWISE NOTED). THESE ARE PROPOSED LOCATIONS AND CHANGES MAY BE NECESSARY UPON REINSPECTION DURING FIELD ACTIVITIES, LOCATIONS MAY BE CHANGED IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO PROPOSED LOCATIONS.

LEGEND

◉ PROPOSED SOIL BORING AND SAMPLE LOCATION

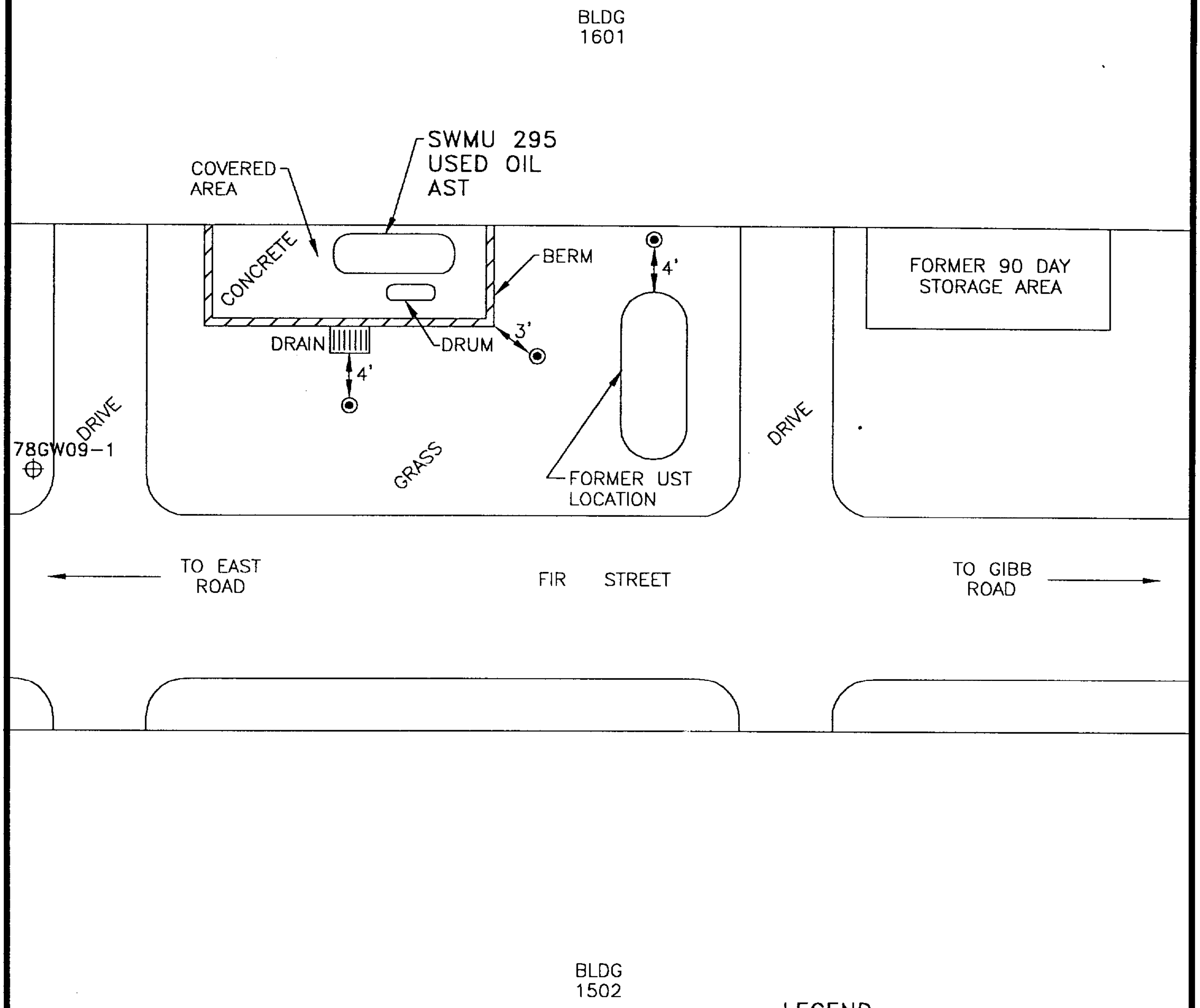


N.T.S.

Baker Environmental, Inc.

FIGURE 5-76
PROPOSED SAMPLE LOCATIONS
SWMU 294
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

371128PP



LEGEND

◉ PROPOSED SOIL BORING AND SAMPLE LOCATION

⊕ EXISTING GROUNDWATER MONITORING WELL LOCATION

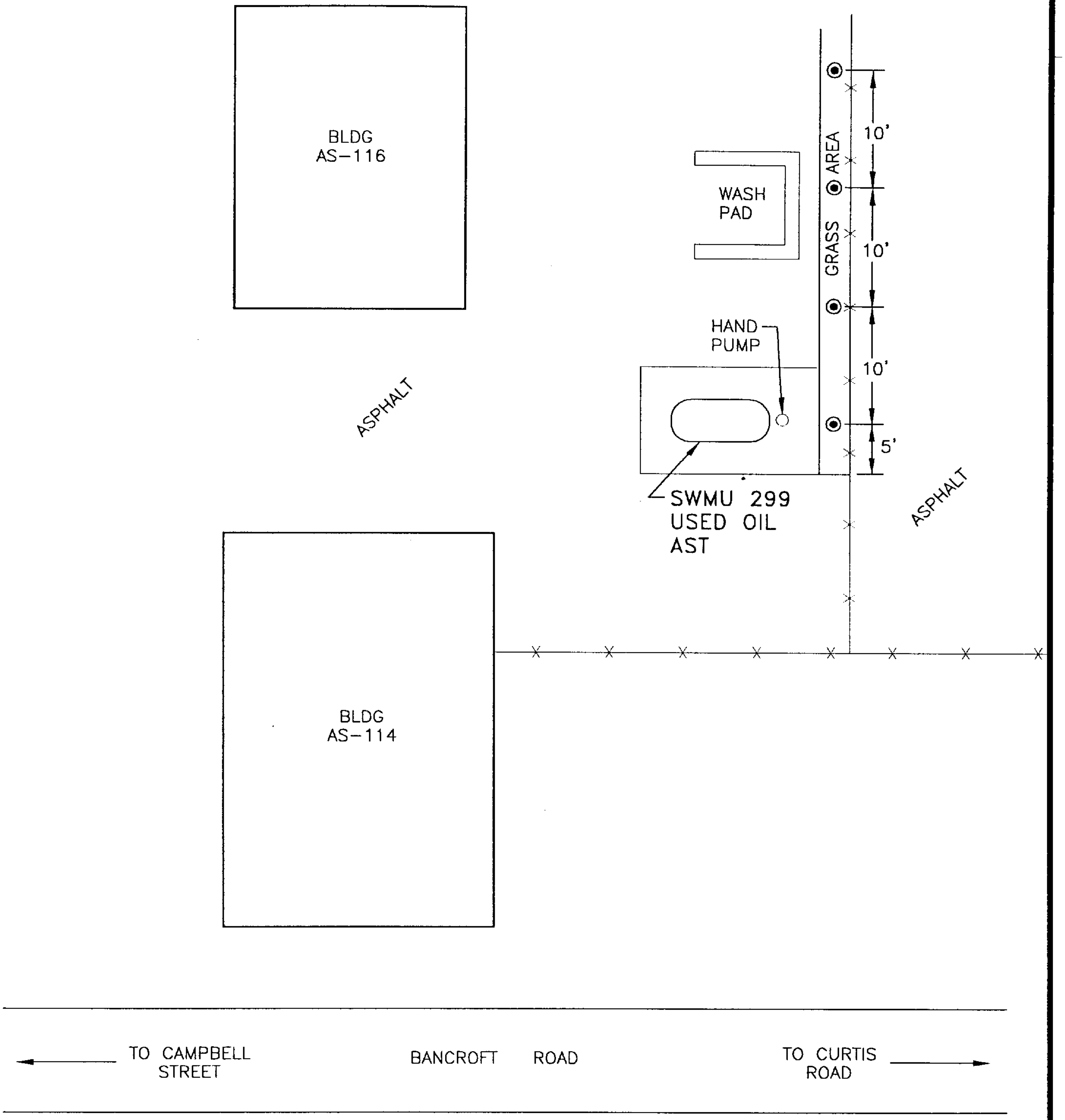
NOTE:
-ALL SAMPLE LOCATIONS ARE SUBJECT TO CHANGE IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO A PARTICULAR SAMPLE LOCATION.

N.T.S.

Baker Environmental, Inc.

FIGURE 5-77
PROPOSED SAMPLE LOCATIONS
SWMU 295
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

371129PP



NOTE:
-ALL SAMPLE LOCATIONS ARE SUBJECT TO CHANGE IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO A PARTICULAR SAMPLE LOCATION.

N.T.S.

LEGEND

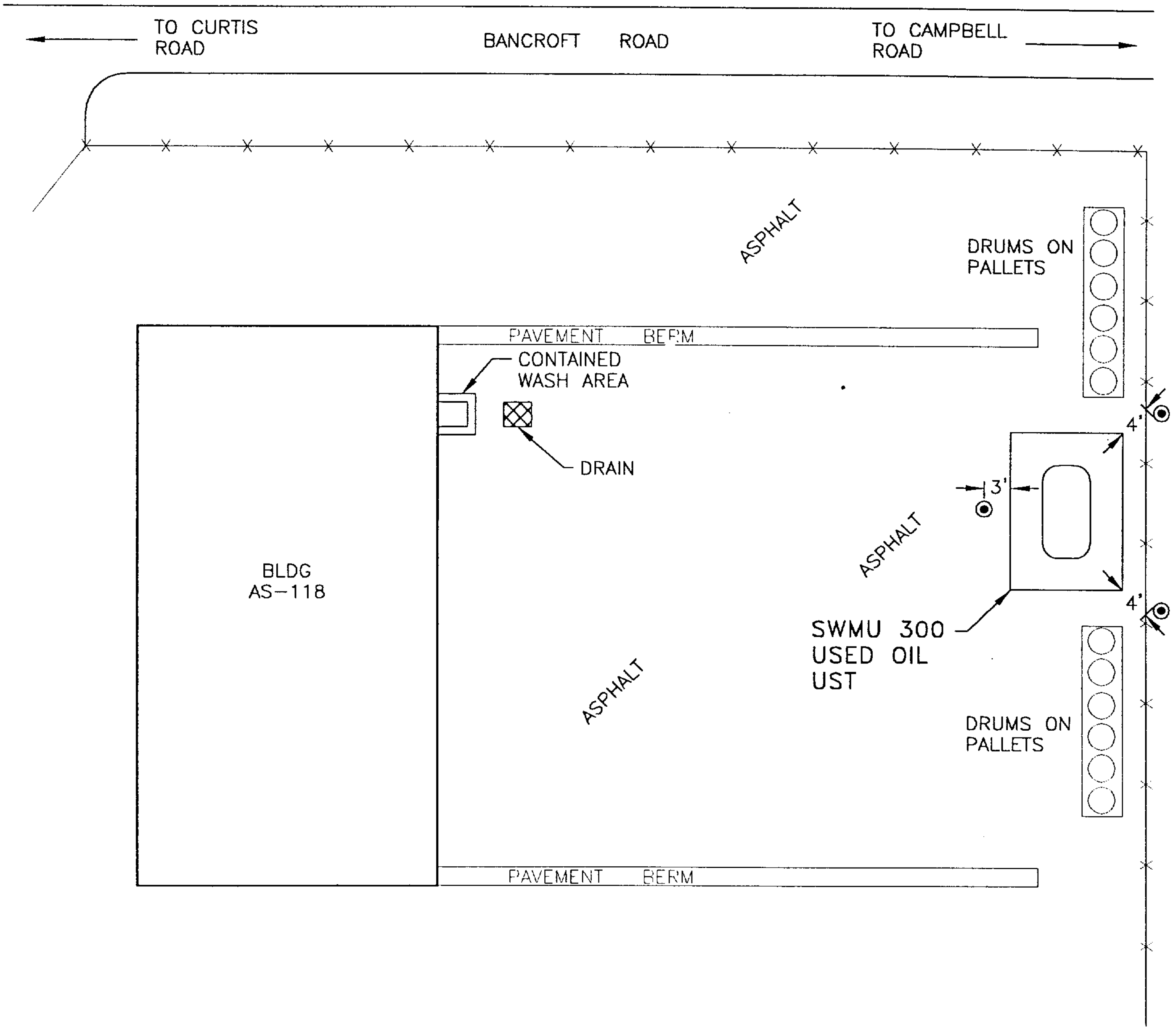
◉ PROPOSED SOIL BORING AND SAMPLE LOCATION

Baker

Baker Environmental, Inc.

FIGURE 5-78
PROPOSED SAMPLE LOCATIONS
SWMU 299
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

371130PP



NOTE:
-ALL SAMPLE LOCATIONS ARE SUBJECT TO CHANGE IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO A PARTICULAR SAMPLE LOCATION.

LEGEND

◉ PROPOSED SOIL BORING AND SAMPLE LOCATION

N.T.S.

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FIGURE 5-79
PROPOSED SAMPLE LOCATIONS
SWMU 300
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

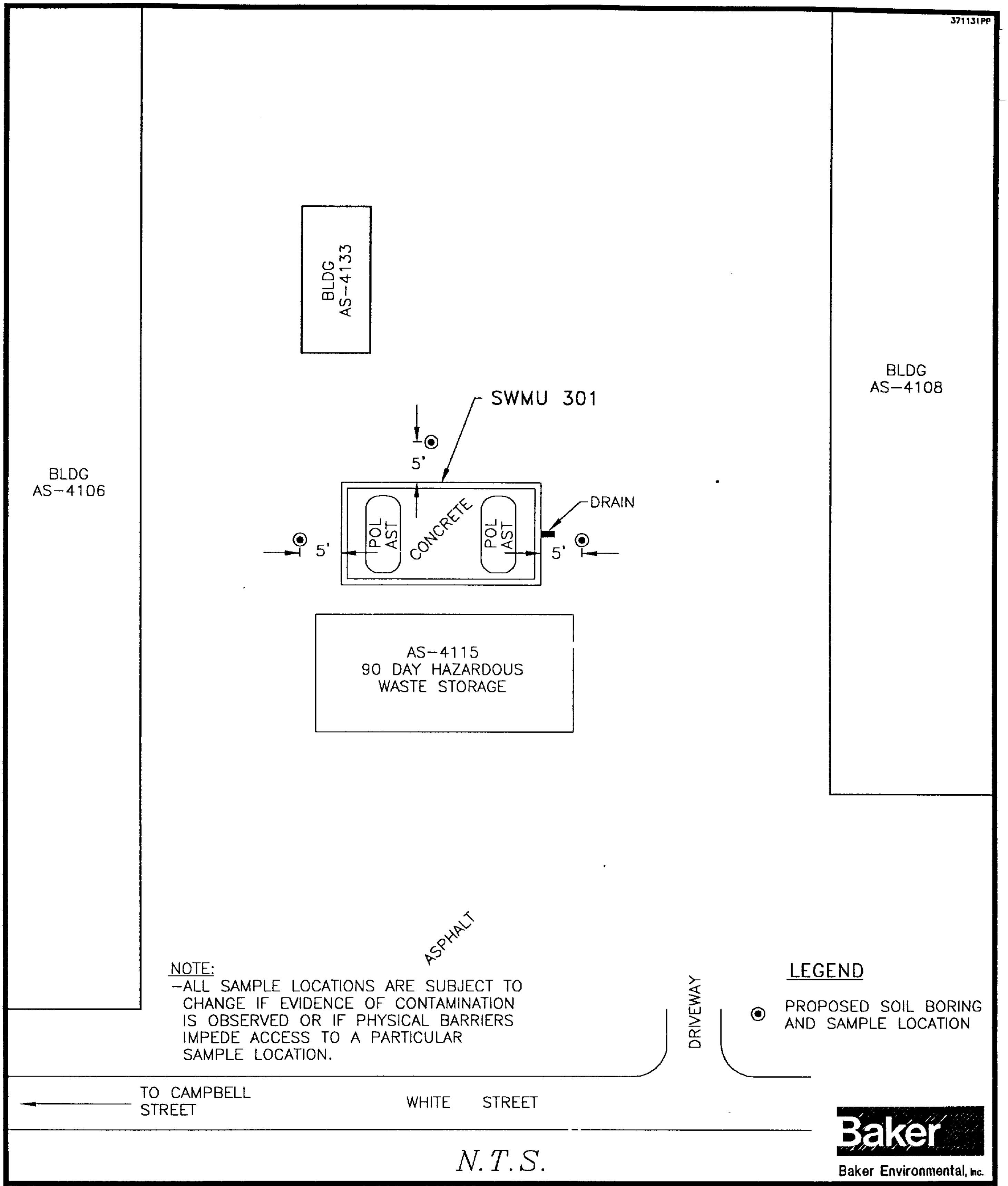
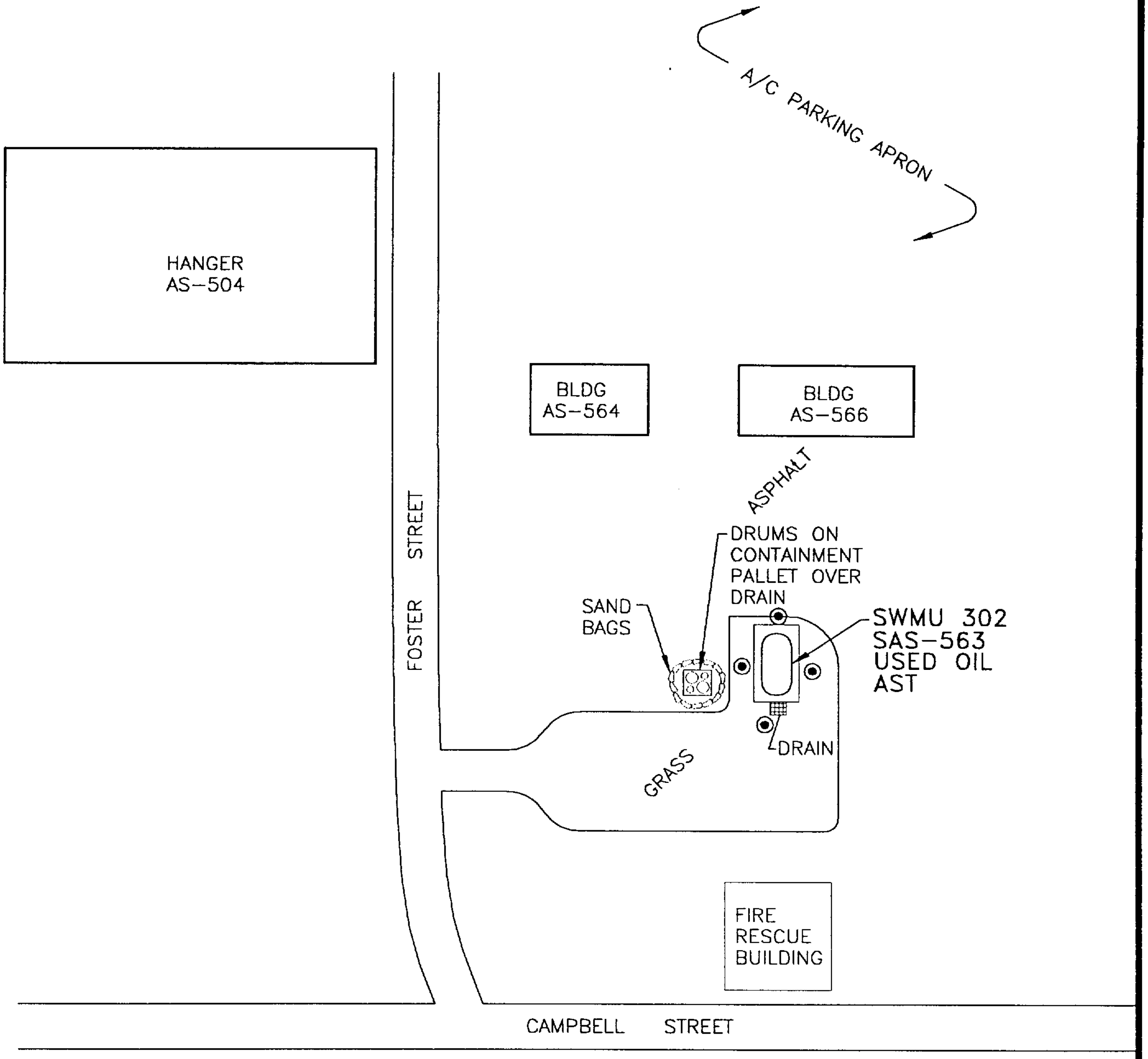


FIGURE 5-80
PROPOSED SAMPLE LOCATIONS
SWMU 301
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

371132PP



NOTE:
-ALL SAMPLES WILL BE COLLECTED WITHIN 3 FEET OF THE SWMU's PERIMETER, (UNLESS OTHERWISE NOTED). THESE ARE PROPOSED LOCATIONS AND CHANGES MAY BE NECESSARY UPON REINSPECTION DURING FIELD ACTIVITIES, LOCATIONS MAY BE CHANGED IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO PROPOSED LOCATIONS.

LEGEND

◉ PROPOSED SOIL BORING AND SAMPLE LOCATION

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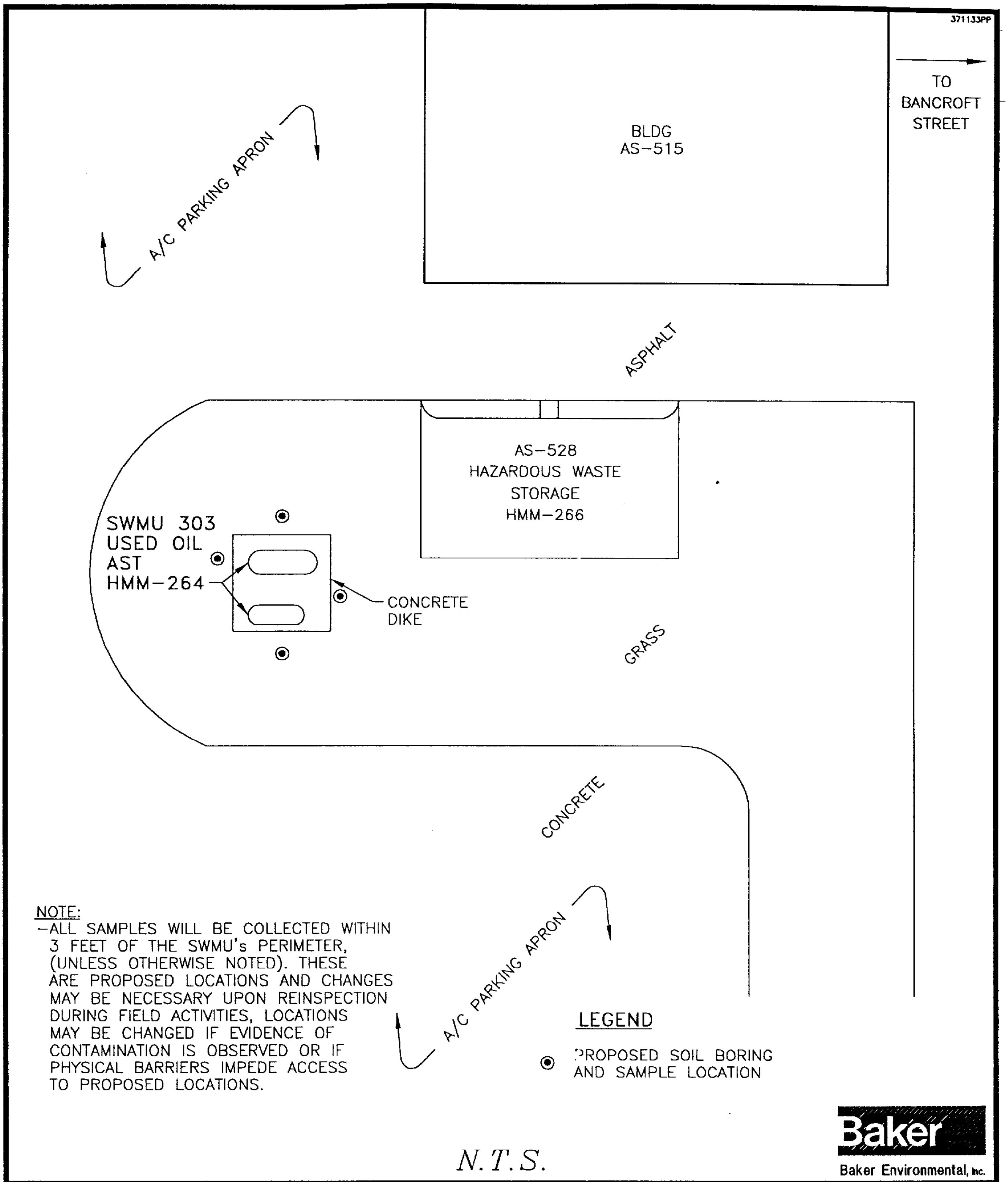
FIGURE 5-81
PROPOSED SAMPLE LOCATIONS
SWMU 302
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



NOTE:
-ALL SAMPLES WILL BE COLLECTED WITHIN 3 FEET OF THE SWMU's PERIMETER, (UNLESS OTHERWISE NOTED). THESE ARE PROPOSED LOCATIONS AND CHANGES MAY BE NECESSARY UPON REINSPECTION DURING FIELD ACTIVITIES, LOCATIONS MAY BE CHANGED IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO PROPOSED LOCATIONS.

LEGEND

◉ PROPOSED SOIL BORING AND SAMPLE LOCATION

N.T.S.

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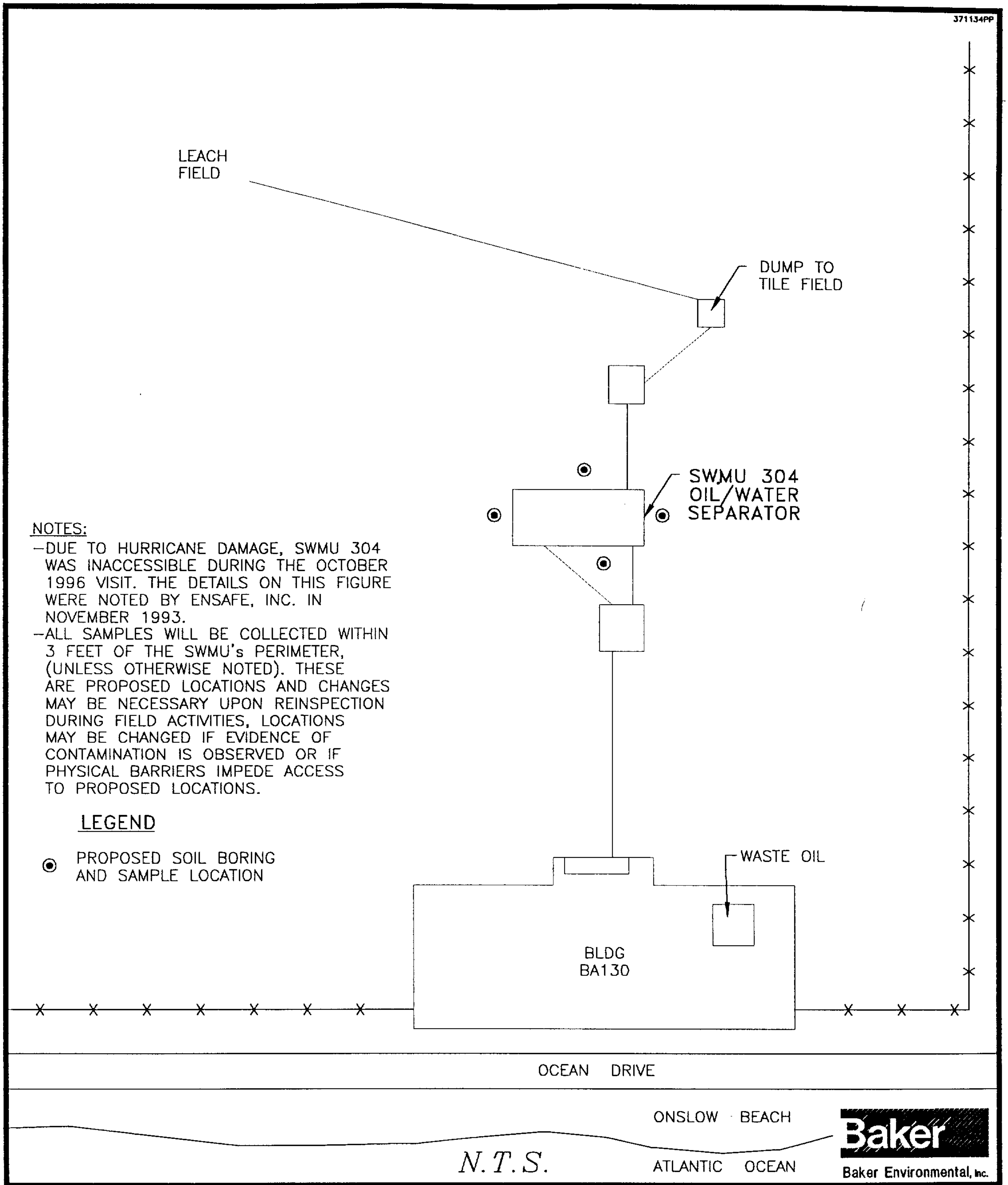
FIGURE 5-82
PROPOSED SAMPLE LOCATIONS
SWMU 303
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



NOTES:
- DUE TO HURRICANE DAMAGE, SWMU 304 WAS INACCESSIBLE DURING THE OCTOBER 1996 VISIT. THE DETAILS ON THIS FIGURE WERE NOTED BY ENSAFE, INC. IN NOVEMBER 1993.
- ALL SAMPLES WILL BE COLLECTED WITHIN 3 FEET OF THE SWMU's PERIMETER, (UNLESS OTHERWISE NOTED). THESE ARE PROPOSED LOCATIONS AND CHANGES MAY BE NECESSARY UPON REINSPECTION DURING FIELD ACTIVITIES, LOCATIONS MAY BE CHANGED IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO PROPOSED LOCATIONS.

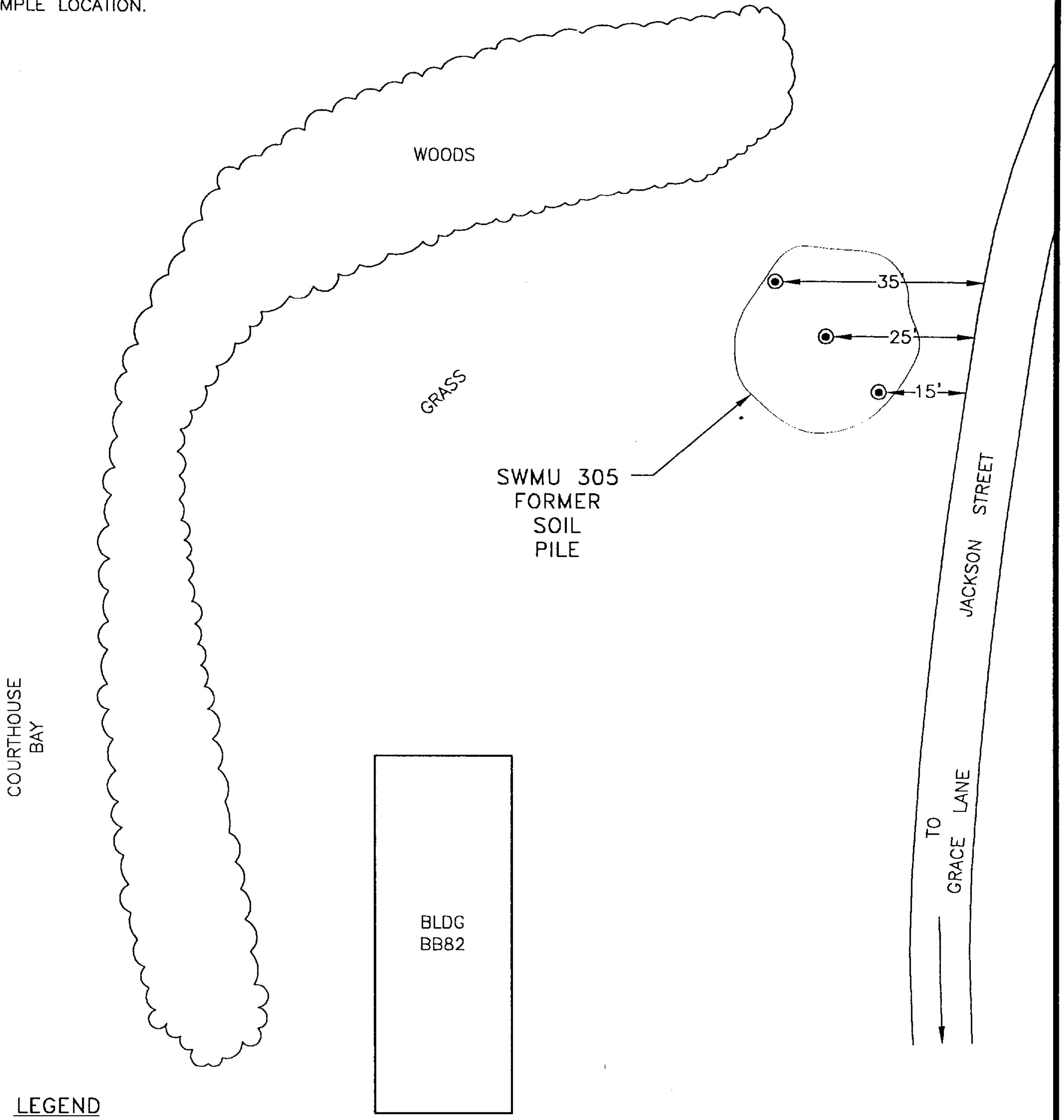
LEGEND

◉ PROPOSED SOIL BORING AND SAMPLE LOCATION

FIGURE 5-83
PROPOSED SAMPLE LOCATIONS
SWMU 304
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

371135PP

NOTE:
-ALL SAMPLE LOCATIONS ARE SUBJECT TO CHANGE IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO A PARTICULAR SAMPLE LOCATION.



LEGEND

⊙ PROPOSED SOIL BORING AND SAMPLE LOCATION

N.T.S.

Baker

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FIGURE 5-84
PROPOSED SAMPLE LOCATIONS
SWMU 305

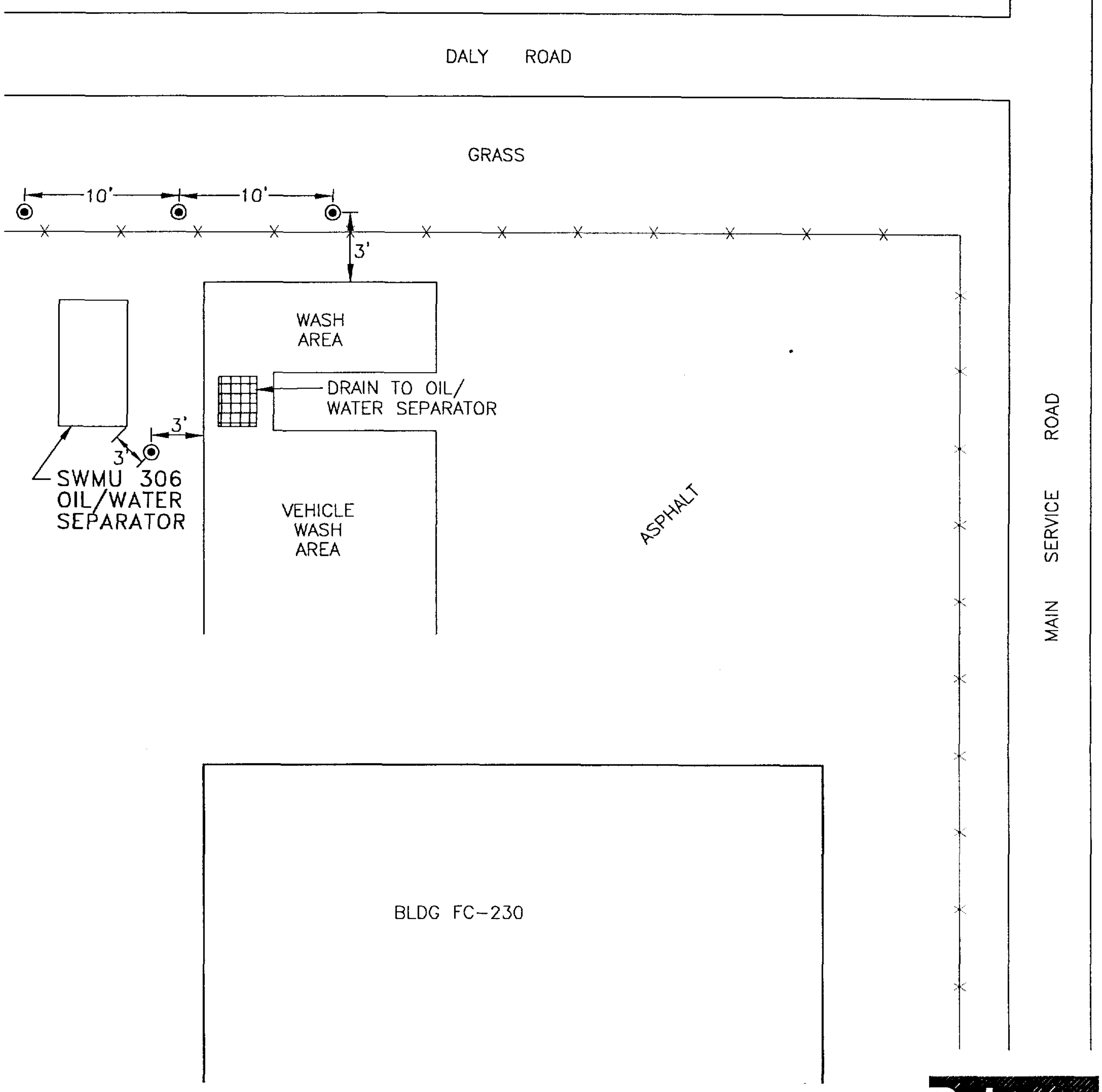
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

371136PP

NOTE:
-ALL SAMPLE LOCATIONS ARE SUBJECT TO CHANGE IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO A PARTICULAR SAMPLE LOCATION.

LEGEND

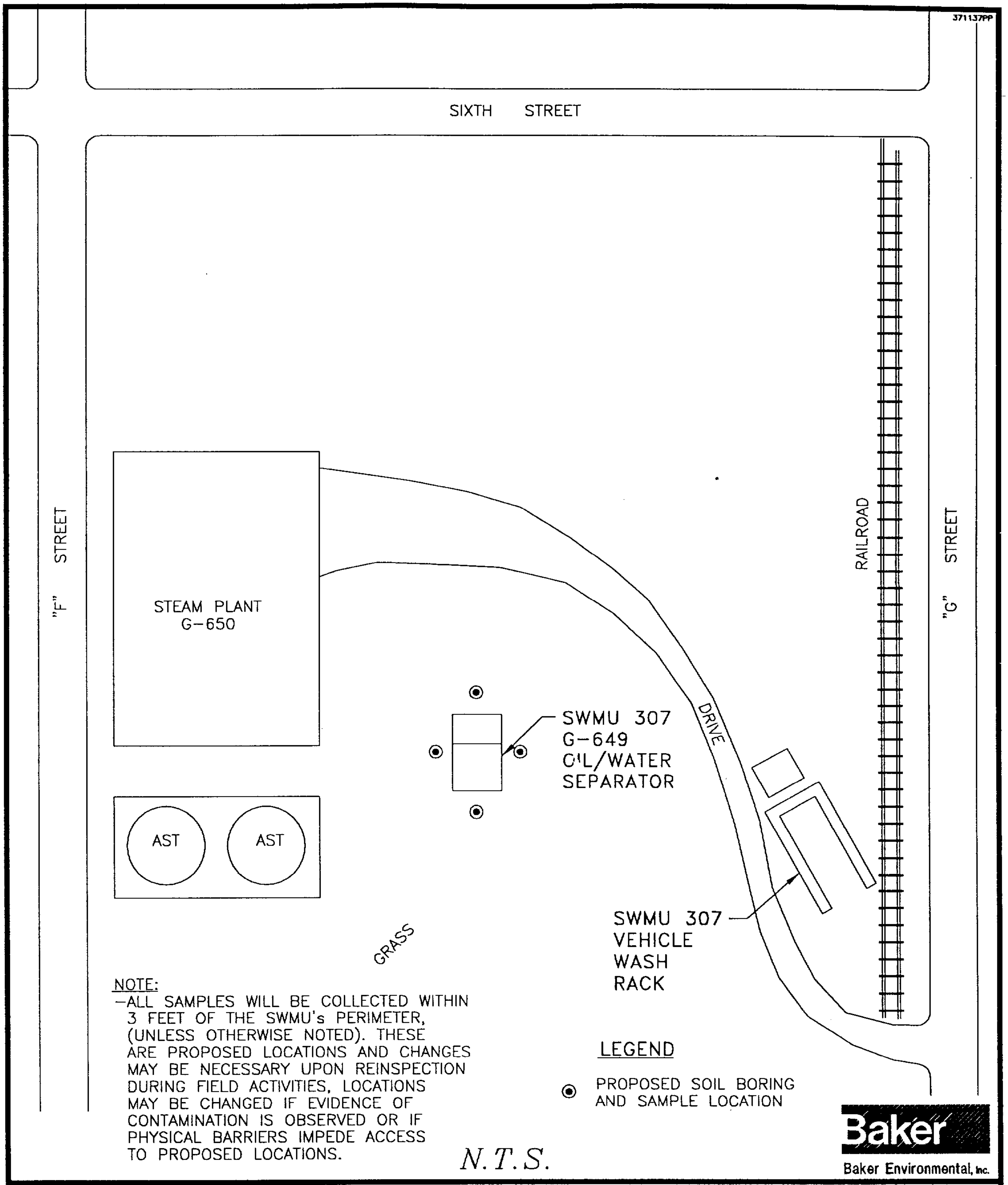
◉ PROPOSED SOIL BORING AND SAMPLE LOCATION



N.T.S.

Baker Environmental, Inc.

FIGURE 5-85
PROPOSED SAMPLE LOCATIONS
SWMU 306
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



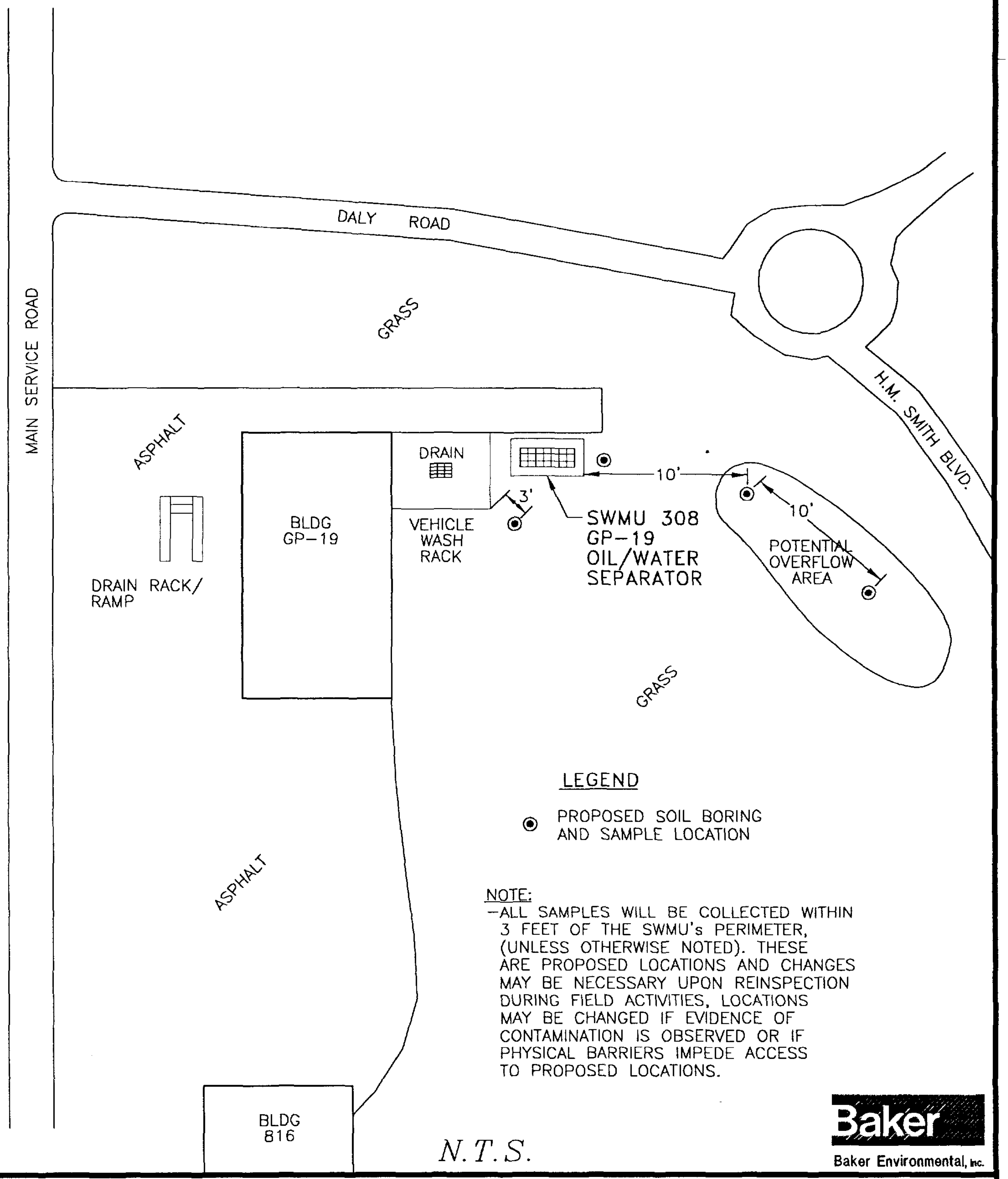
NOTE:
-ALL SAMPLES WILL BE COLLECTED WITHIN 3 FEET OF THE SWMU's PERIMETER, (UNLESS OTHERWISE NOTED). THESE ARE PROPOSED LOCATIONS AND CHANGES MAY BE NECESSARY UPON REINSPECTION DURING FIELD ACTIVITIES. LOCATIONS MAY BE CHANGED IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO PROPOSED LOCATIONS.

LEGEND

⦿ PROPOSED SOIL BORING AND SAMPLE LOCATION

FIGURE 5-86
PROPOSED SAMPLE LOCATIONS
SWMU 307
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

371138PP



LEGEND

◉ PROPOSED SOIL BORING AND SAMPLE LOCATION

NOTE:

-ALL SAMPLES WILL BE COLLECTED WITHIN 3 FEET OF THE SWMU's PERIMETER, (UNLESS OTHERWISE NOTED). THESE ARE PROPOSED LOCATIONS AND CHANGES MAY BE NECESSARY UPON REINSPECTION DURING FIELD ACTIVITIES. LOCATIONS MAY BE CHANGED IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO PROPOSED LOCATIONS.

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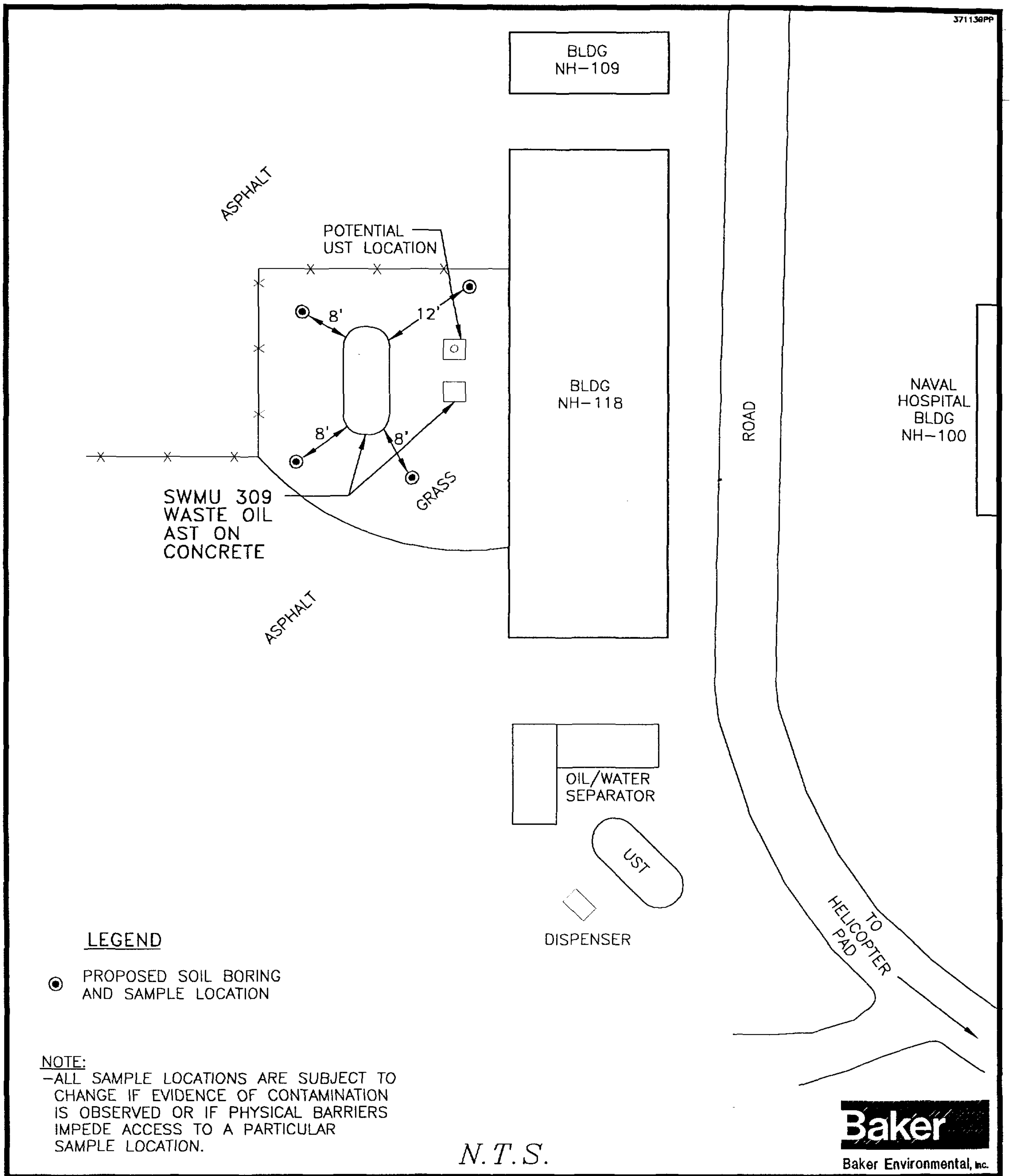
FIGURE 5-87
PROPOSED SAMPLE LOCATIONS
SWMU 308
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



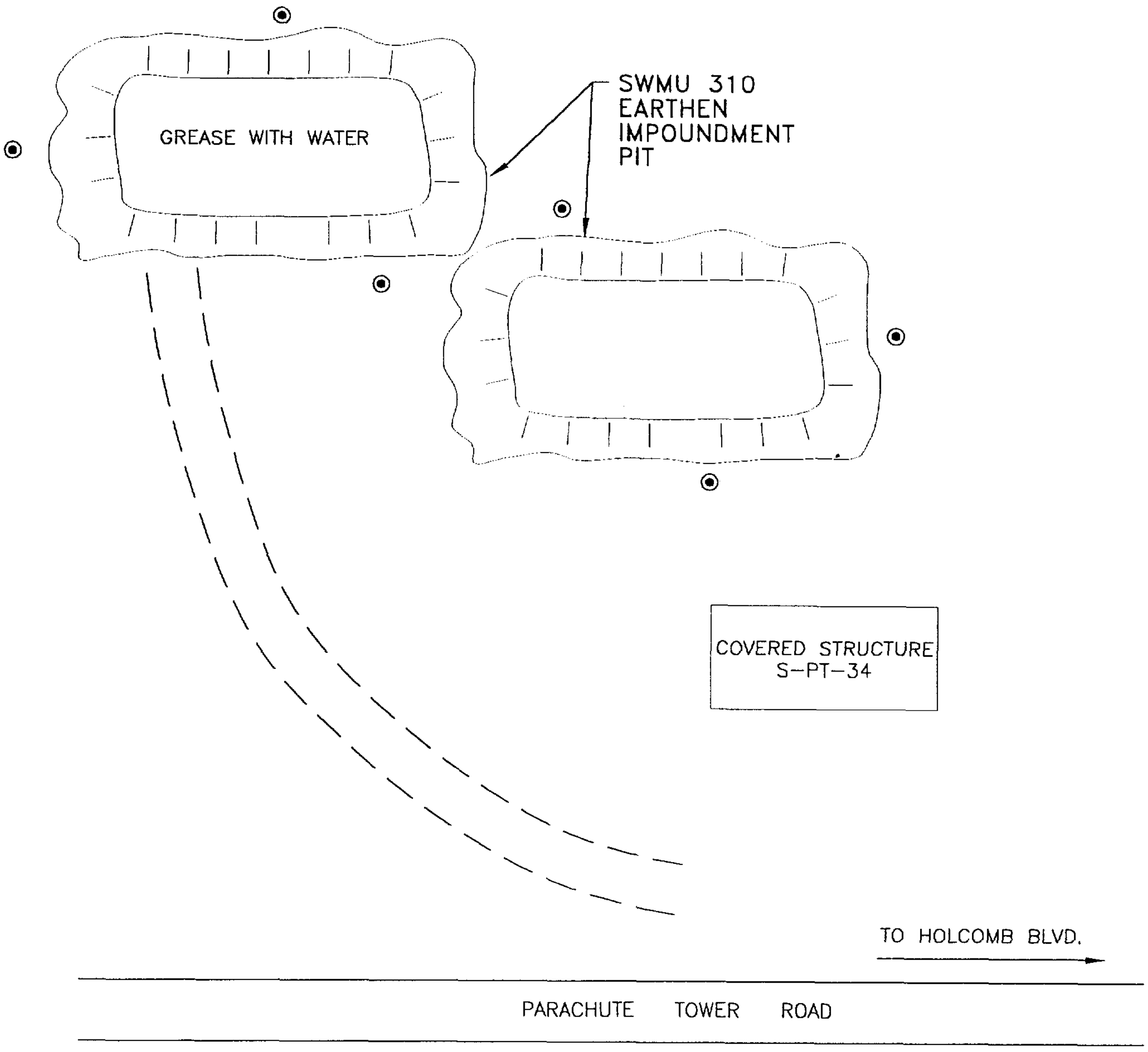
LEGEND

● PROPOSED SOIL BORING AND SAMPLE LOCATION

NOTE:
-ALL SAMPLE LOCATIONS ARE SUBJECT TO CHANGE IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO A PARTICULAR SAMPLE LOCATION.

FIGURE 5-88
PROPOSED SAMPLE LOCATIONS
SWMU 309
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

371140PP



NOTE:

-ALL SAMPLES WILL BE COLLECTED WITHIN 3 FEET OF THE SWMU's PERIMETER, (UNLESS OTHERWISE NOTED). THESE ARE PROPOSED LOCATIONS AND CHANGES MAY BE NECESSARY UPON REINSPECTION DURING FIELD ACTIVITIES, LOCATIONS MAY BE CHANGED IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO PROPOSED LOCATIONS.

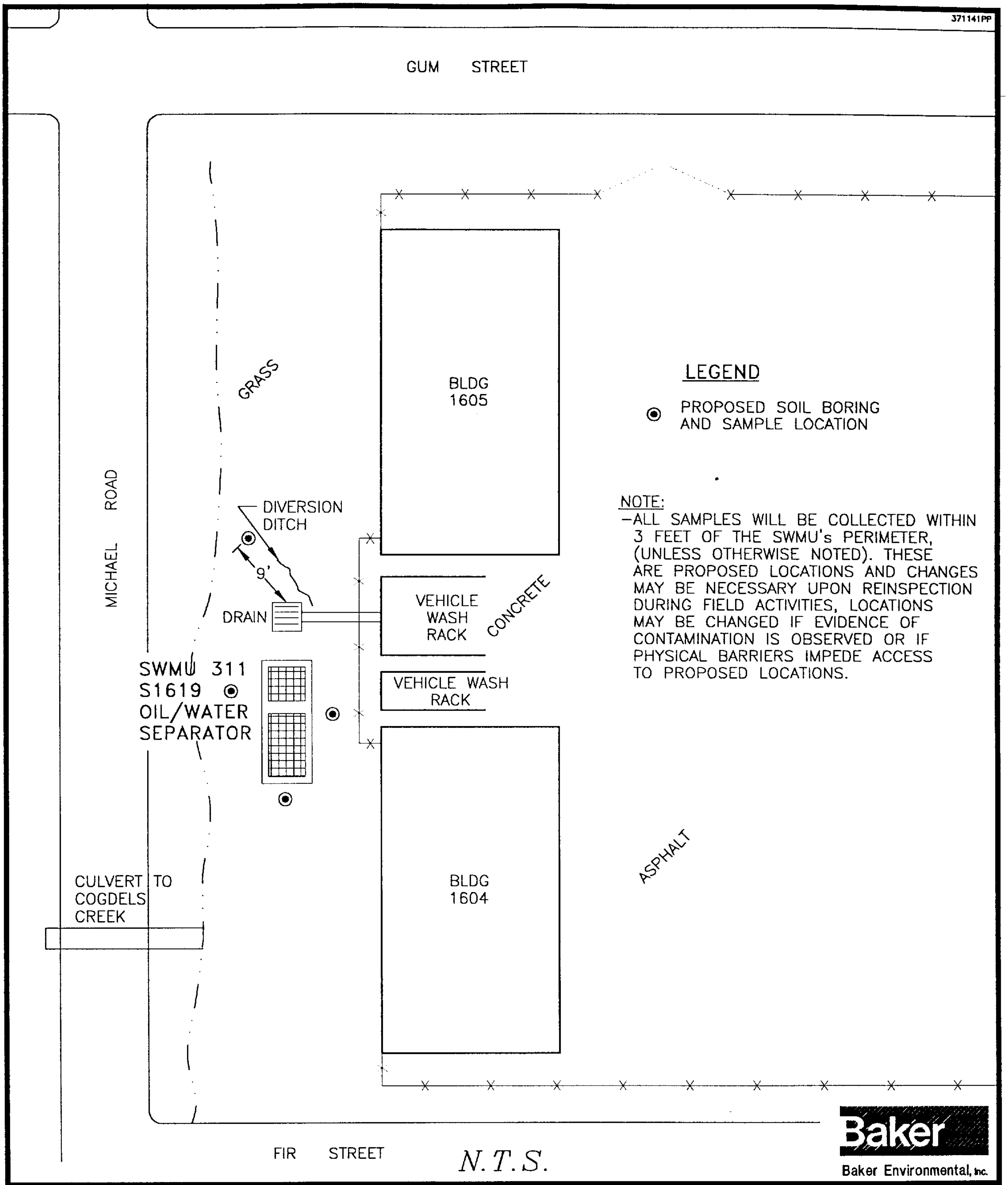
LEGEND

◉ PROPOSED SOIL BORING AND SAMPLE LOCATION

N.T.S.

Baker Environmental, Inc.

FIGURE 5-89
PROPOSED SAMPLE LOCATIONS
SWMU 310
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

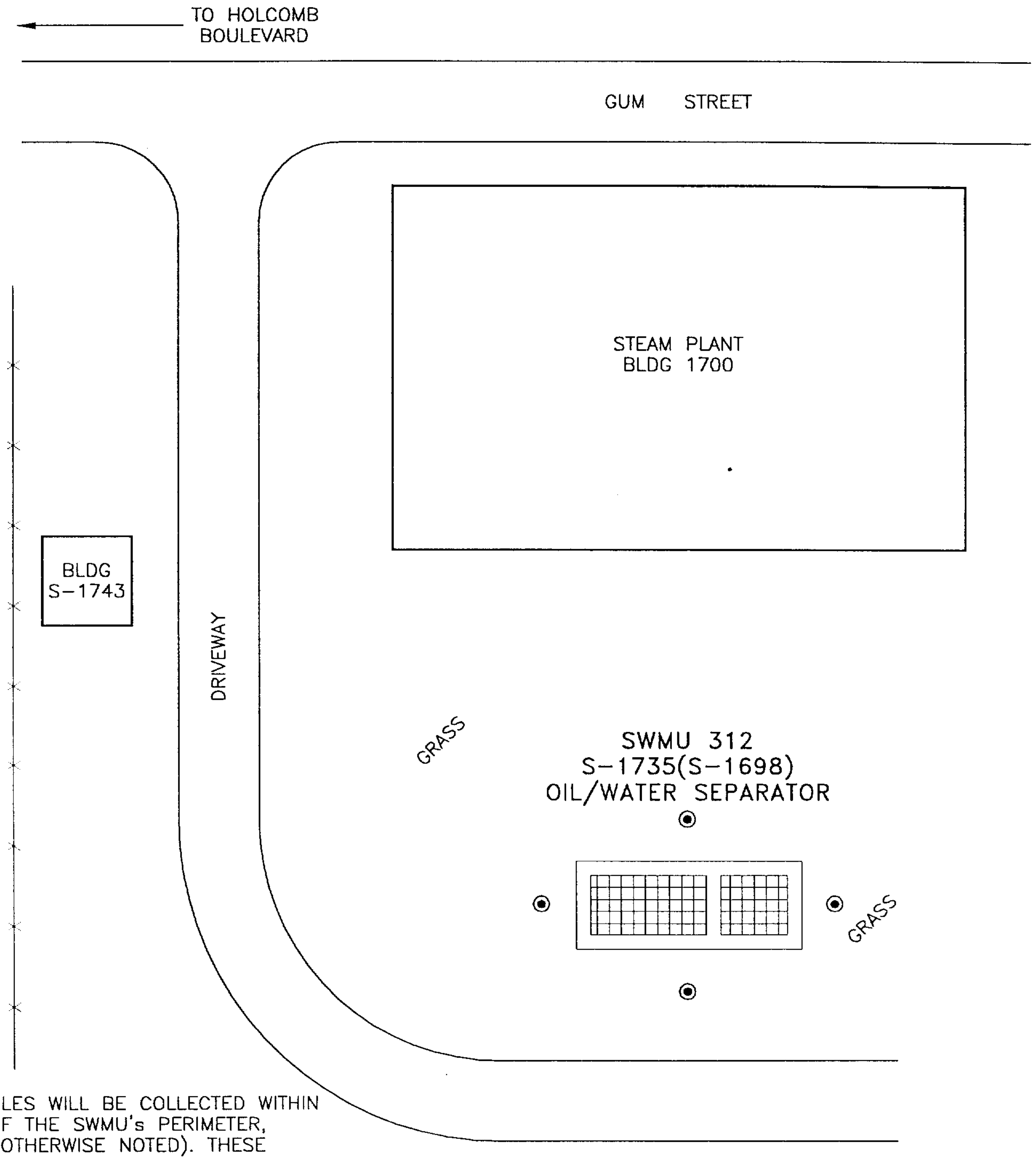


LEGEND

● PROPOSED SOIL BORING AND SAMPLE LOCATION

NOTE:
-ALL SAMPLES WILL BE COLLECTED WITHIN 3 FEET OF THE SWMU's PERIMETER, (UNLESS OTHERWISE NOTED). THESE ARE PROPOSED LOCATIONS AND CHANGES MAY BE NECESSARY UPON REINSPECTION DURING FIELD ACTIVITIES. LOCATIONS MAY BE CHANGED IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO PROPOSED LOCATIONS.

FIGURE 5-90
PROPOSED SAMPLE LOCATIONS
SWMU 311
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



NOTE:
-ALL SAMPLES WILL BE COLLECTED WITHIN 3 FEET OF THE SWMU's PERIMETER, (UNLESS OTHERWISE NOTED). THESE ARE PROPOSED LOCATIONS AND CHANGES MAY BE NECESSARY UPON REINSPECTION DURING FIELD ACTIVITIES, LOCATIONS MAY BE CHANGED IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO PROPOSED LOCATIONS.

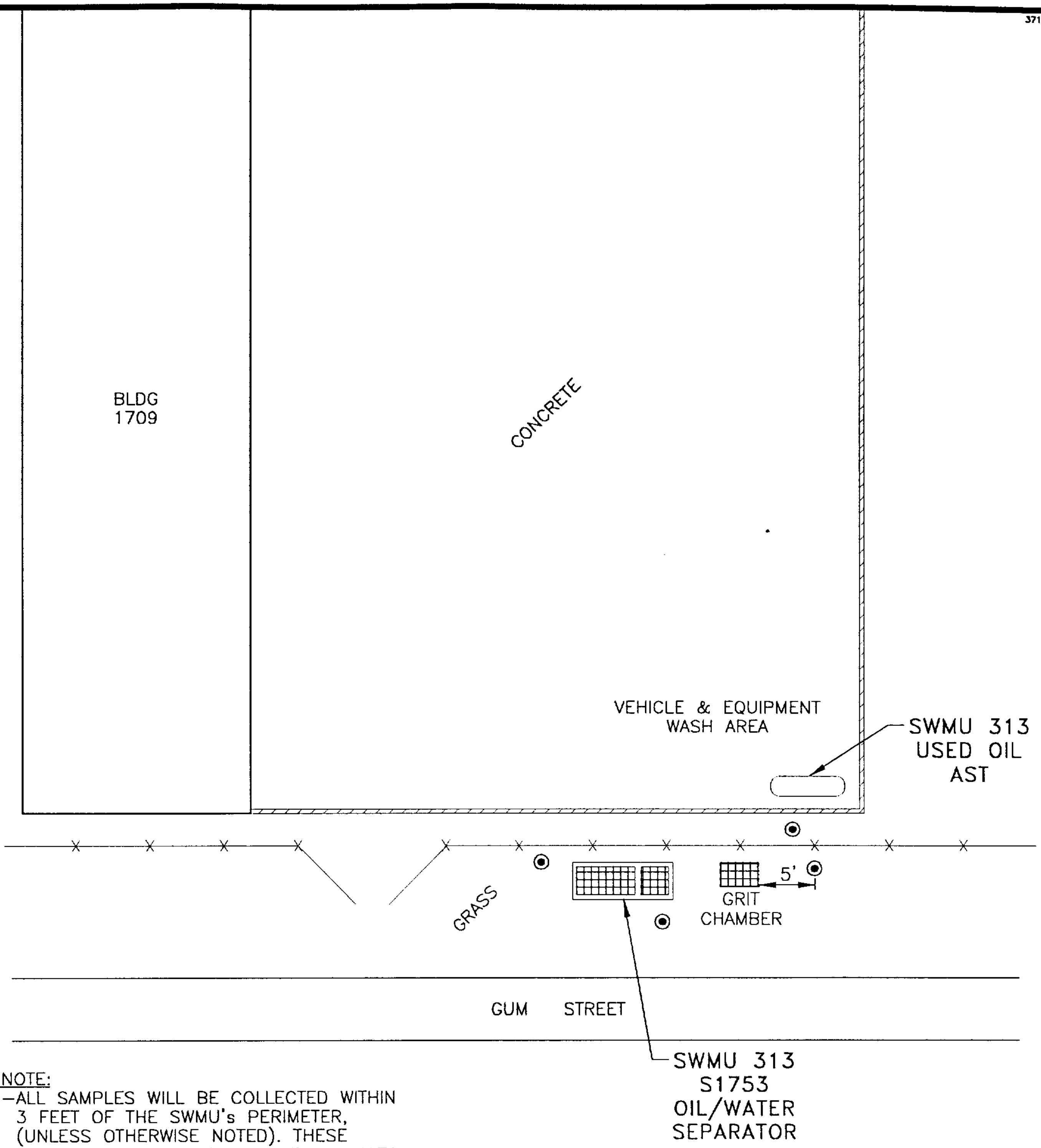
LEGEND

◉ PROPOSED SOIL BORING AND SAMPLE LOCATION

N.T.S.

Baker
Baker Environmental, Inc.

FIGURE 5-91
PROPOSED SAMPLE LOCATIONS
SWMU 312
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



NOTE:
-ALL SAMPLES WILL BE COLLECTED WITHIN 3 FEET OF THE SWMU's PERIMETER, (UNLESS OTHERWISE NOTED). THESE ARE PROPOSED LOCATIONS AND CHANGES MAY BE NECESSARY UPON REINSPECTION DURING FIELD ACTIVITIES, LOCATIONS MAY BE CHANGED IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO PROPOSED LOCATIONS.

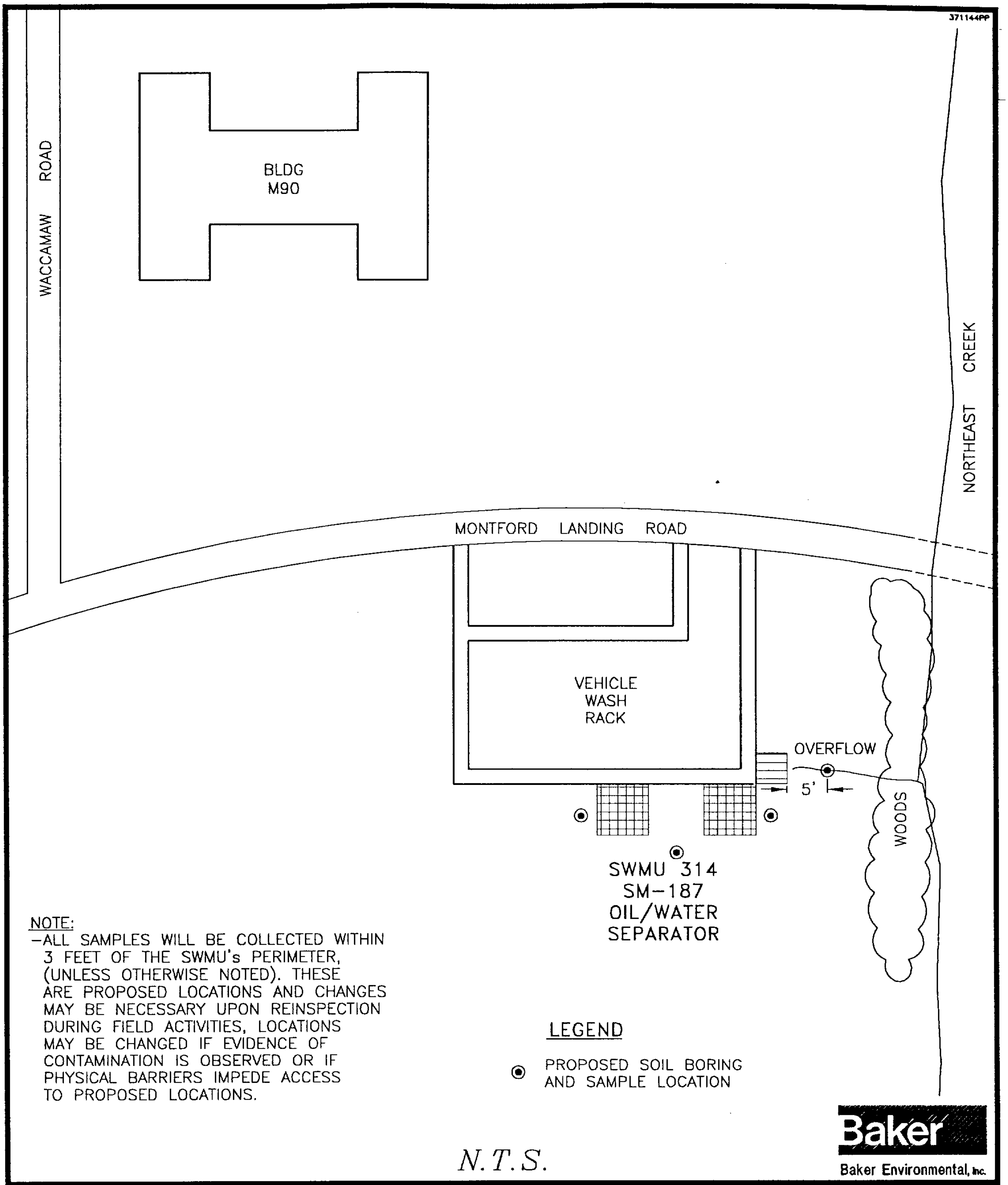
LEGEND

◉ PROPOSED SOIL BORING AND SAMPLE LOCATION

N.T.S.

Baker Environmental, Inc.

FIGURE 5-92
PROPOSED SAMPLE LOCATIONS
SWMU 313
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



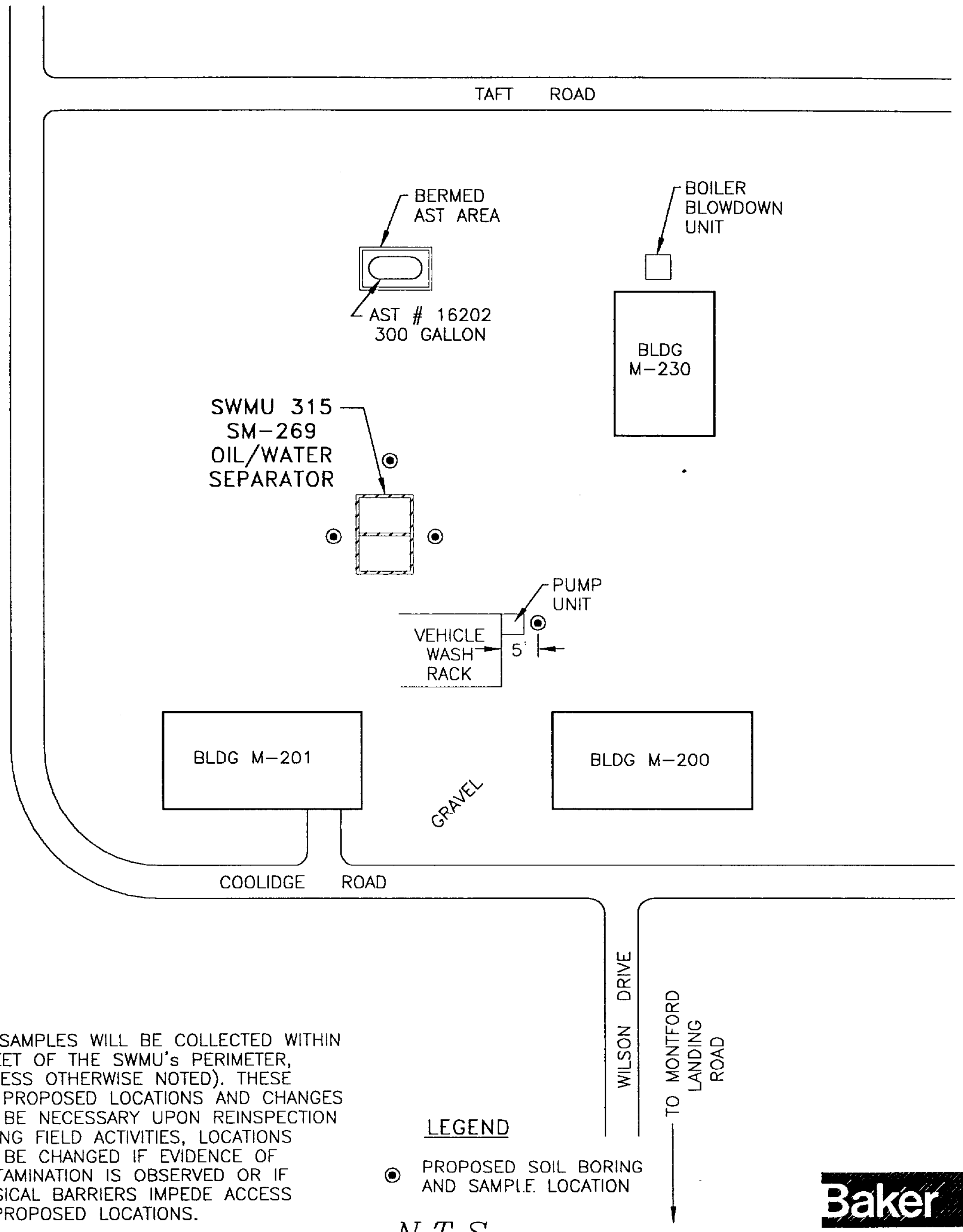
NOTE:
-ALL SAMPLES WILL BE COLLECTED WITHIN 3 FEET OF THE SWMU's PERIMETER, (UNLESS OTHERWISE NOTED). THESE ARE PROPOSED LOCATIONS AND CHANGES MAY BE NECESSARY UPON REINSPECTION DURING FIELD ACTIVITIES, LOCATIONS MAY BE CHANGED IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO PROPOSED LOCATIONS.

LEGEND

◉ PROPOSED SOIL BORING AND SAMPLE LOCATION

FIGURE 5-93
PROPOSED SAMPLE LOCATIONS
SWMU 314
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

371145PP



NOTE:
-ALL SAMPLES WILL BE COLLECTED WITHIN 3 FEET OF THE SWMU's PERIMETER, (UNLESS OTHERWISE NOTED). THESE ARE PROPOSED LOCATIONS AND CHANGES MAY BE NECESSARY UPON REINSPECTION DURING FIELD ACTIVITIES, LOCATIONS MAY BE CHANGED IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO PROPOSED LOCATIONS.

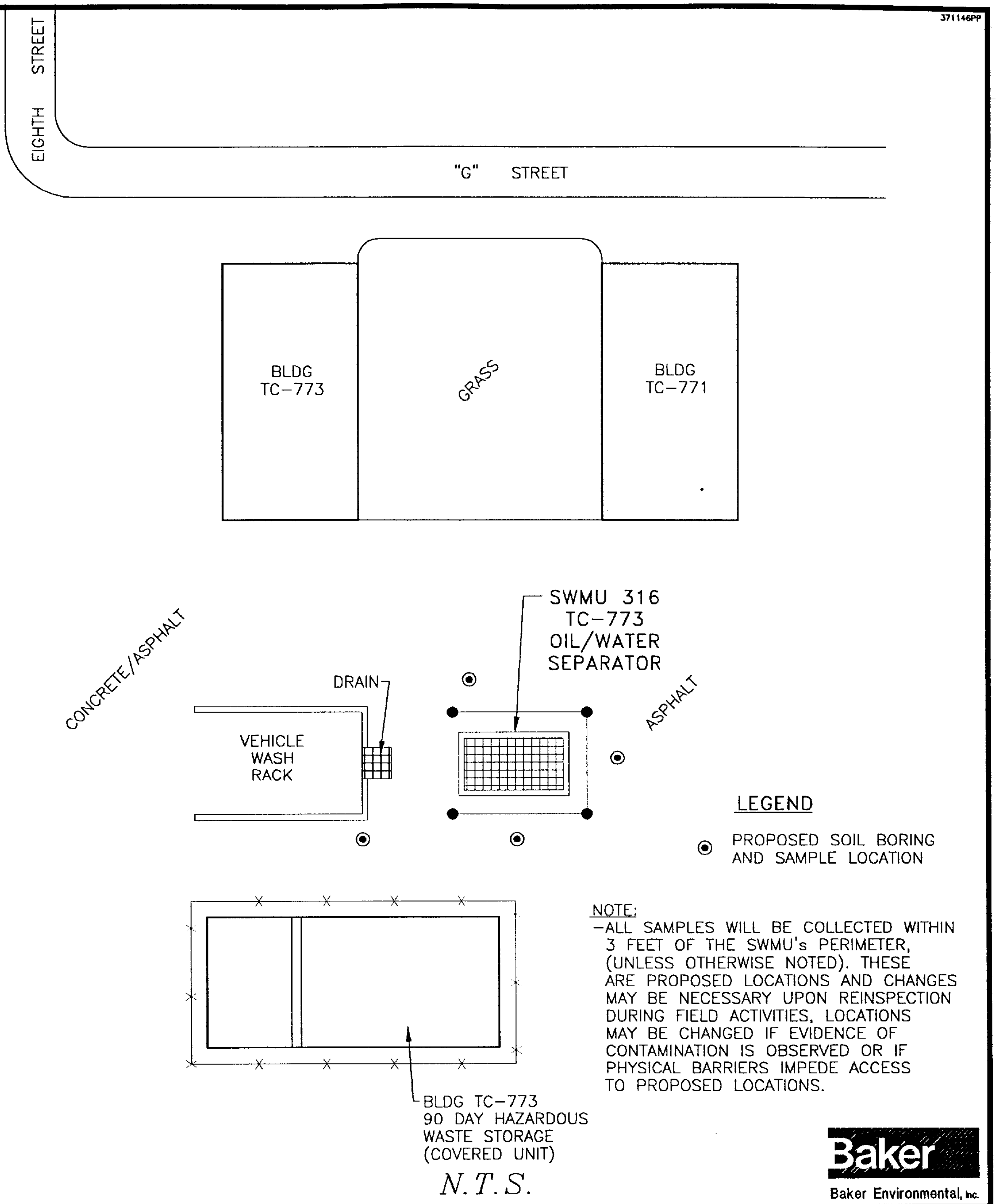
LEGEND

⊙ PROPOSED SOIL BORING AND SAMPLE LOCATION

N.T.S.

Baker Environmental, Inc.

FIGURE 5-94
PROPOSED SAMPLE LOCATIONS
SWMU 315
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



LEGEND

◉ PROPOSED SOIL BORING AND SAMPLE LOCATION

NOTE:
-ALL SAMPLES WILL BE COLLECTED WITHIN 3 FEET OF THE SWMU's PERIMETER, (UNLESS OTHERWISE NOTED). THESE ARE PROPOSED LOCATIONS AND CHANGES MAY BE NECESSARY UPON REINSPECTION DURING FIELD ACTIVITIES. LOCATIONS MAY BE CHANGED IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO PROPOSED LOCATIONS.

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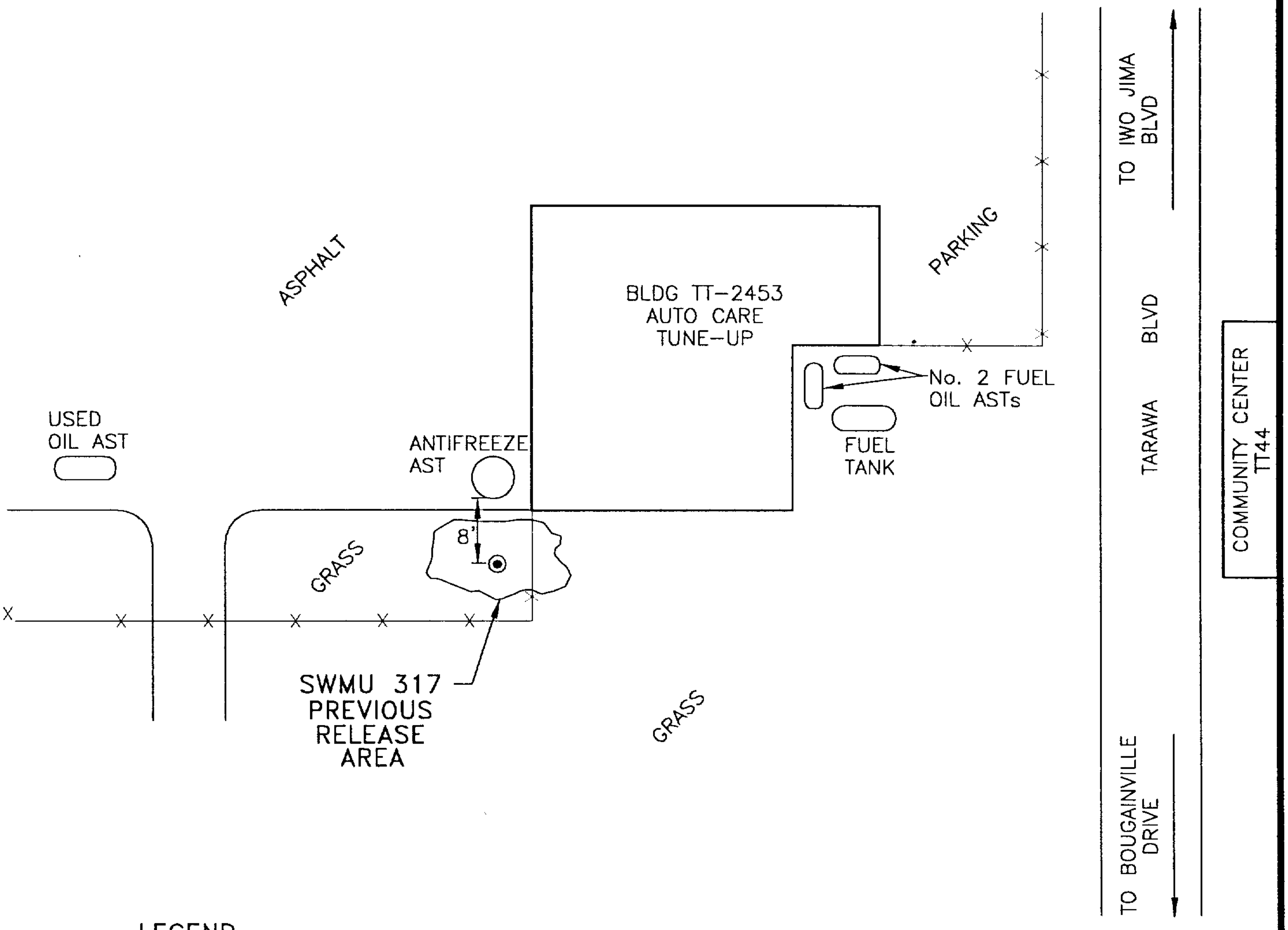
FIGURE 5-95
PROPOSED SAMPLE LOCATIONS
SWMU 316
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

371147PP



LEGEND

◉ PROPOSED SOIL BORING AND SAMPLE LOCATION

NOTE:

-ALL SAMPLE LOCATIONS ARE SUBJECT TO CHANGE IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO A PARTICULAR SAMPLE LOCATION.

N.T.S.

Baker

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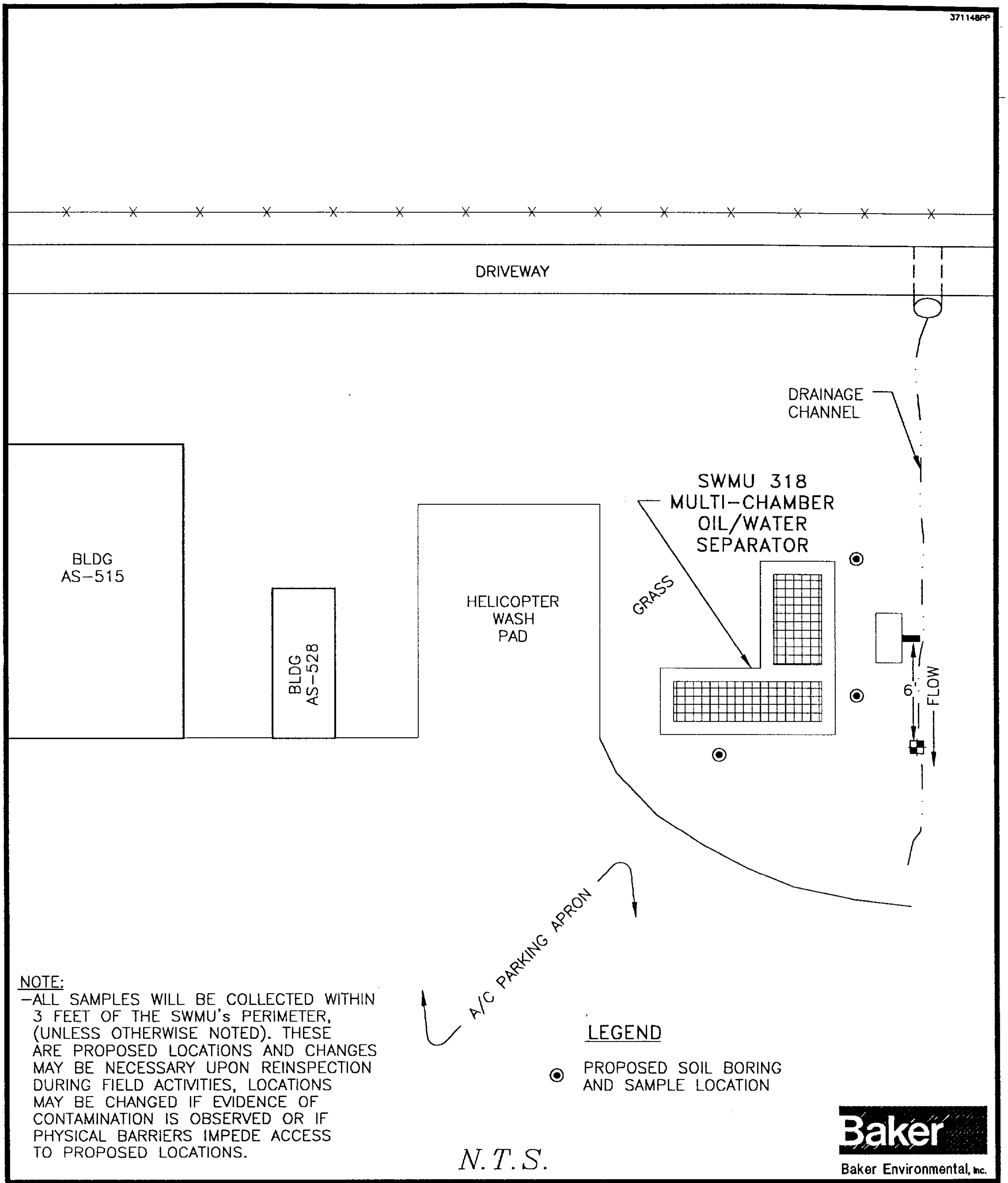
FIGURE 5-96

PROPOSED SAMPLE LOCATIONS
SWMU 317

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

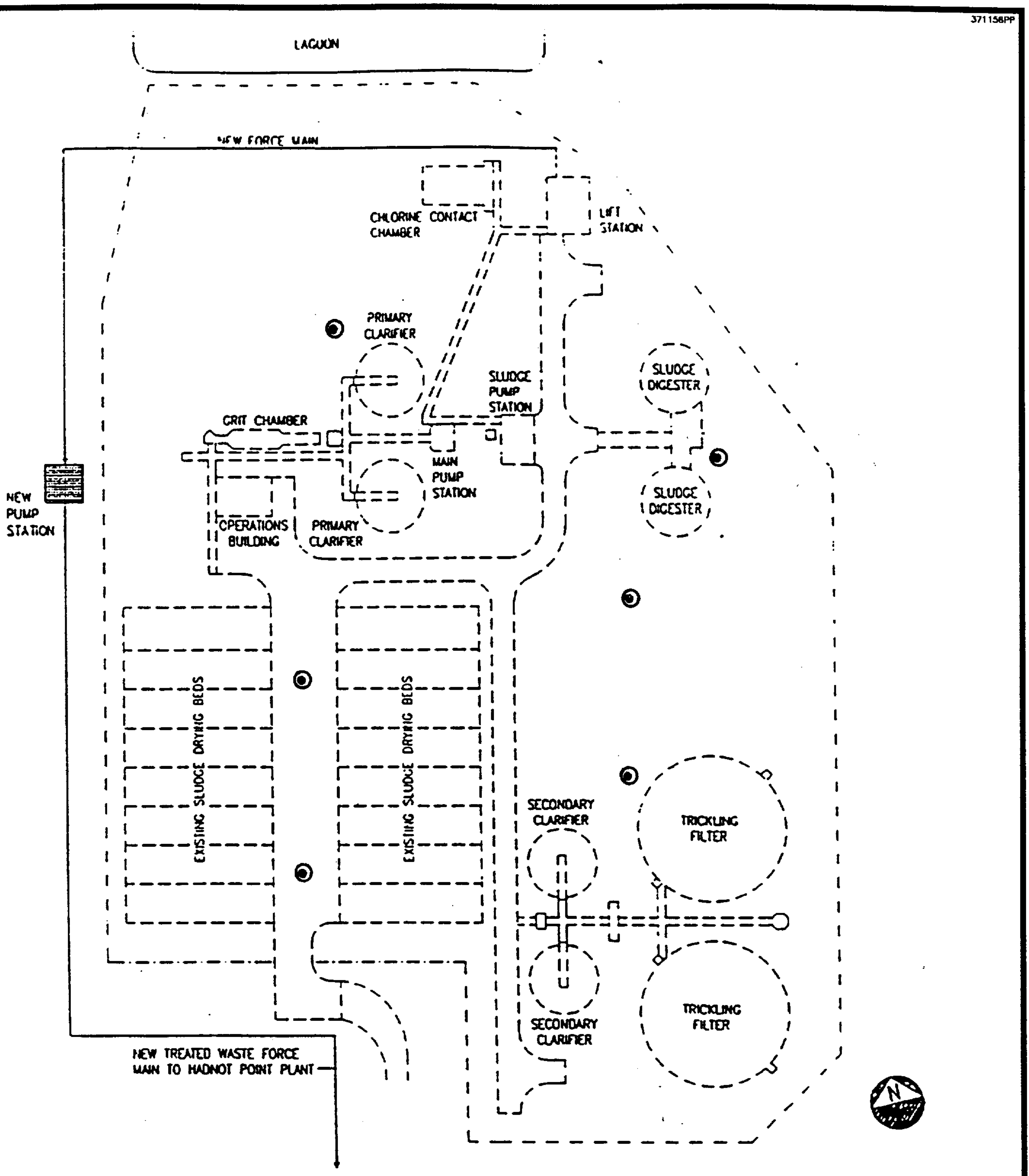


NOTE:
-ALL SAMPLES WILL BE COLLECTED WITHIN 3 FEET OF THE SWMU's PERIMETER, (UNLESS OTHERWISE NOTED). THESE ARE PROPOSED LOCATIONS AND CHANGES MAY BE NECESSARY UPON REINSPECTION DURING FIELD ACTIVITIES, LOCATIONS MAY BE CHANGED IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO PROPOSED LOCATIONS.

LEGEND

◉ PROPOSED SOIL BORING AND SAMPLE LOCATION

FIGURE 5-97
PROPOSED SAMPLE LOCATIONS
SWMU 318
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



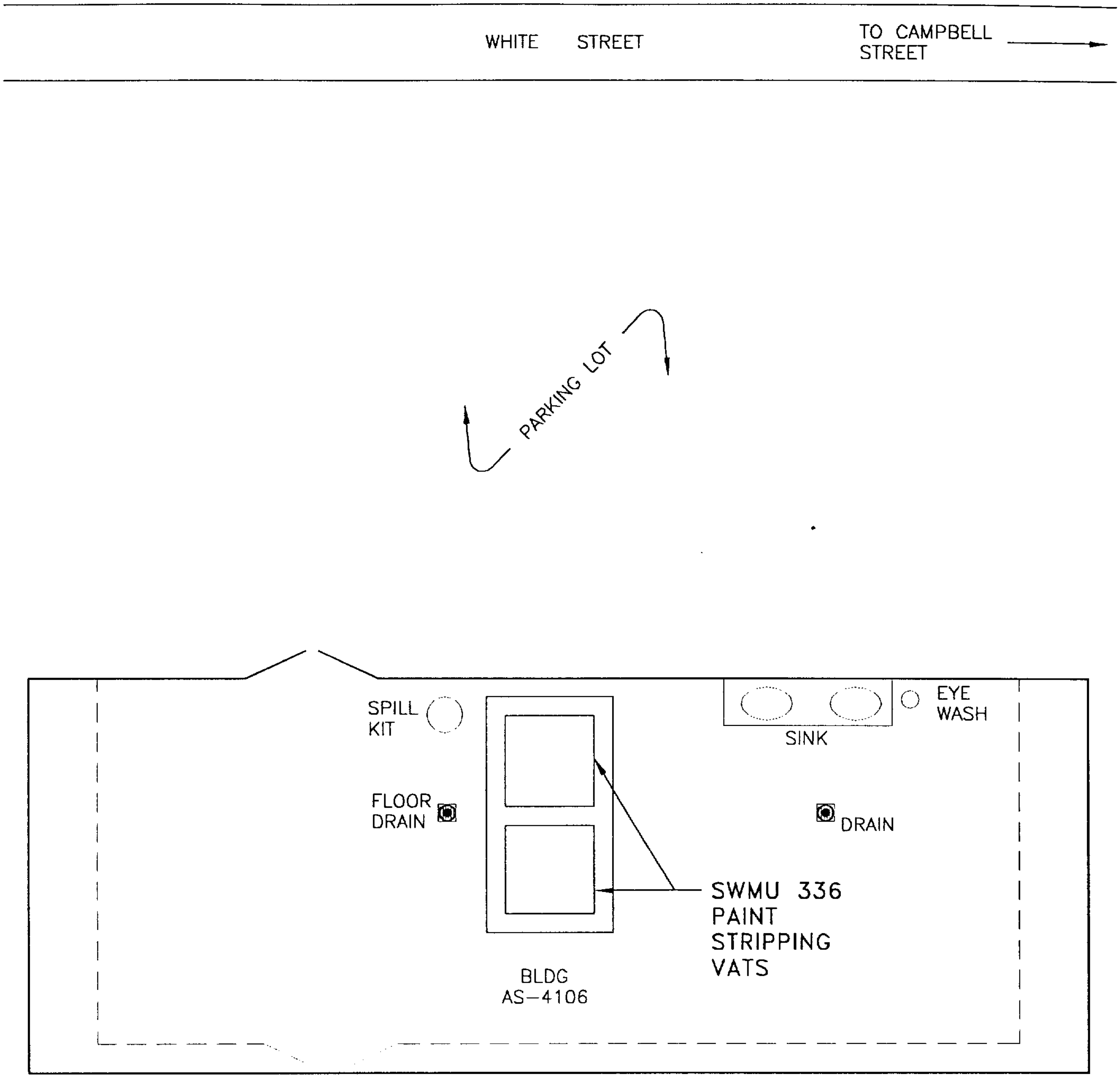
SOURCE:
–FINAL RCRA FACILITY ASSESSMENT REPORT,
MARINE CORPS BASE CAMP LEJEUNE
(ENSAFE, JULY 25, 1996)

N.T.S.

Baker
Baker Environmental, Inc.

FIGURE 5–98
PROPOSED SAMPLE LOCATIONS
SWMU 319
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

371146PP



NOTE:
-ALL SAMPLE LOCATIONS ARE SUBJECT TO CHANGE IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO A PARTICULAR SAMPLE LOCATION.

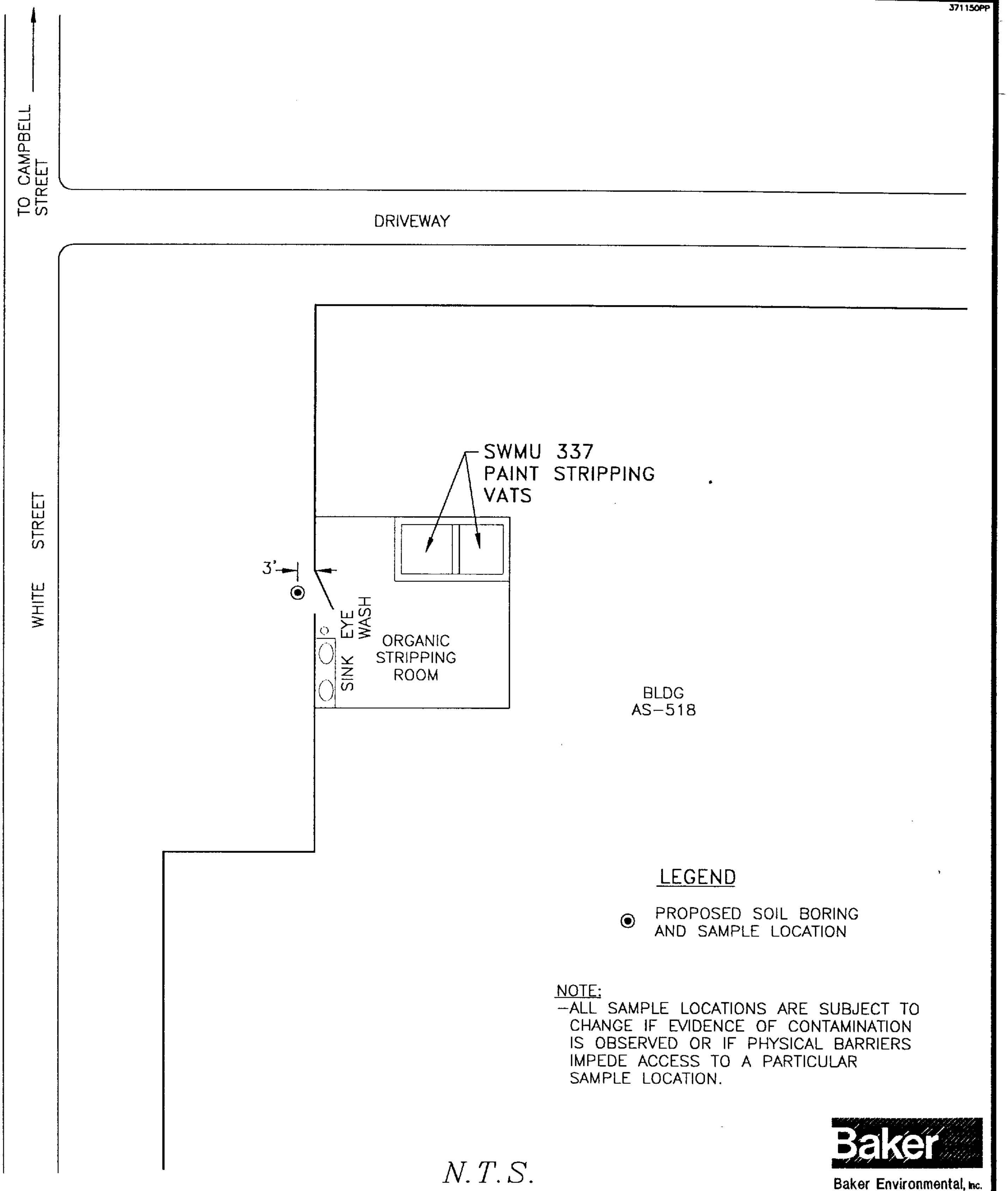
LEGEND

⊙ PROPOSED SOIL BORING AND SAMPLE LOCATION

N.T.S.

Baker Environmental, Inc.

FIGURE 5-99
PROPOSED SAMPLE LOCATIONS
SWMU 336
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



LEGEND

◉ PROPOSED SOIL BORING AND SAMPLE LOCATION

NOTE:
-ALL SAMPLE LOCATIONS ARE SUBJECT TO CHANGE IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO A PARTICULAR SAMPLE LOCATION.

N.T.S.

Baker

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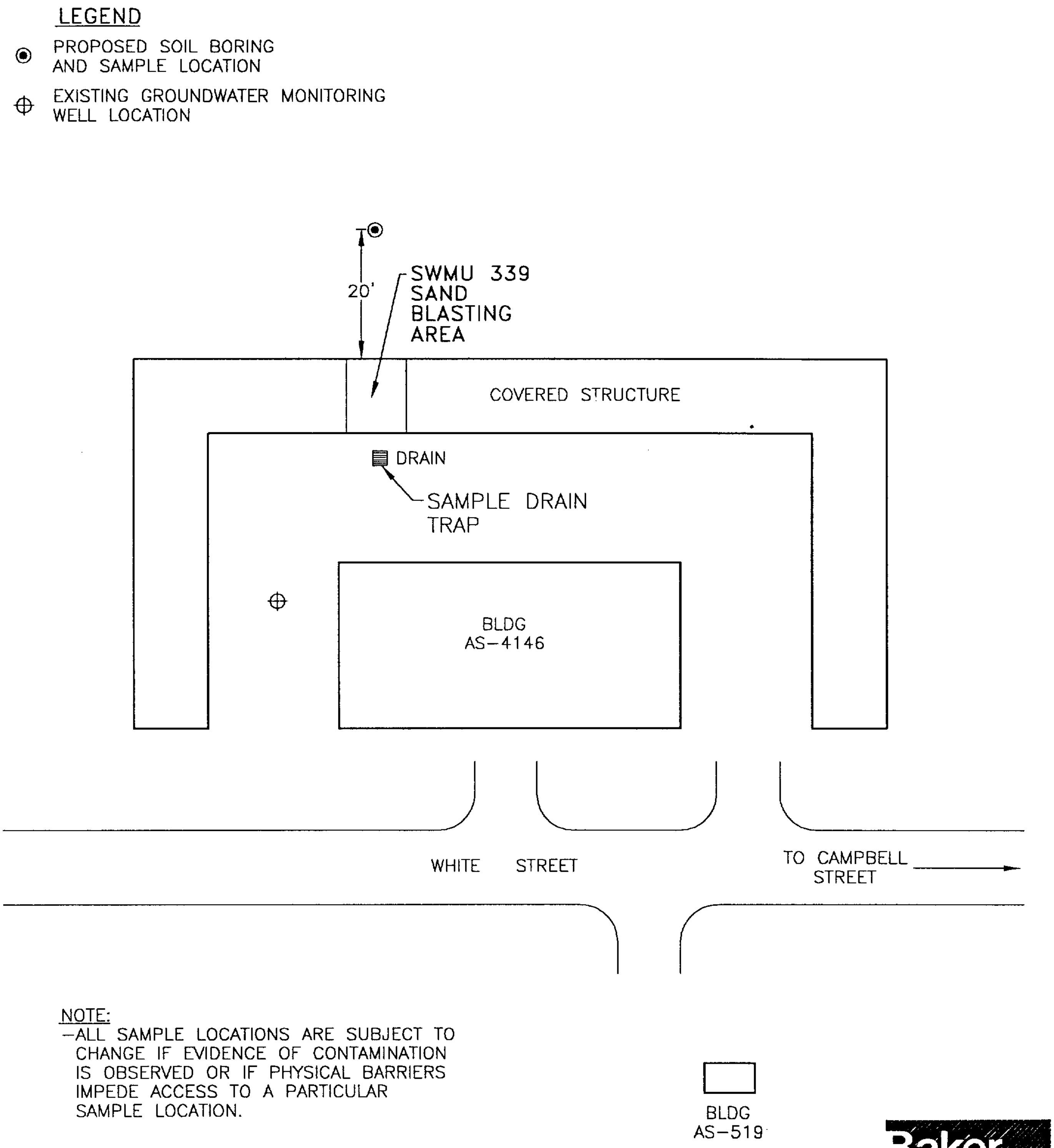
FIGURE 5-100
PROPOSED SAMPLE LOCATIONS
SWMU 337
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

371151PP



NOTE:
-ALL SAMPLE LOCATIONS ARE SUBJECT TO CHANGE IF EVIDENCE OF CONTAMINATION IS OBSERVED OR IF PHYSICAL BARRIERS IMPEDE ACCESS TO A PARTICULAR SAMPLE LOCATION.

N.T.S.

Baker

Baker Environmental, Inc.

FIGURE 5-101
PROPOSED SAMPLE LOCATIONS
SWMU 339
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

FIGURE 6-1

PROJECT ORGANIZATION
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO-0371
MCB CAMP LEJEUNE, NORTH CAROLINA

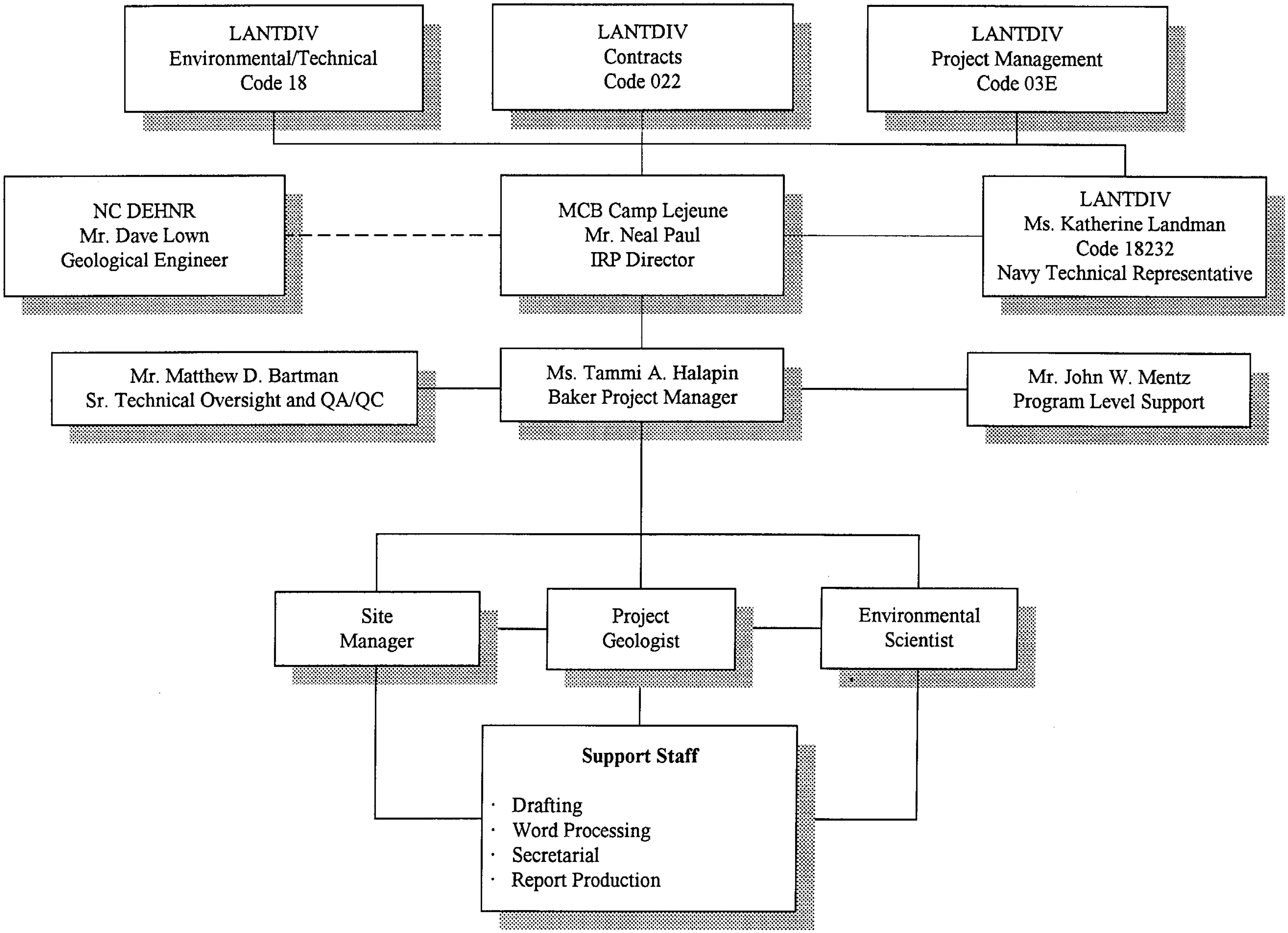
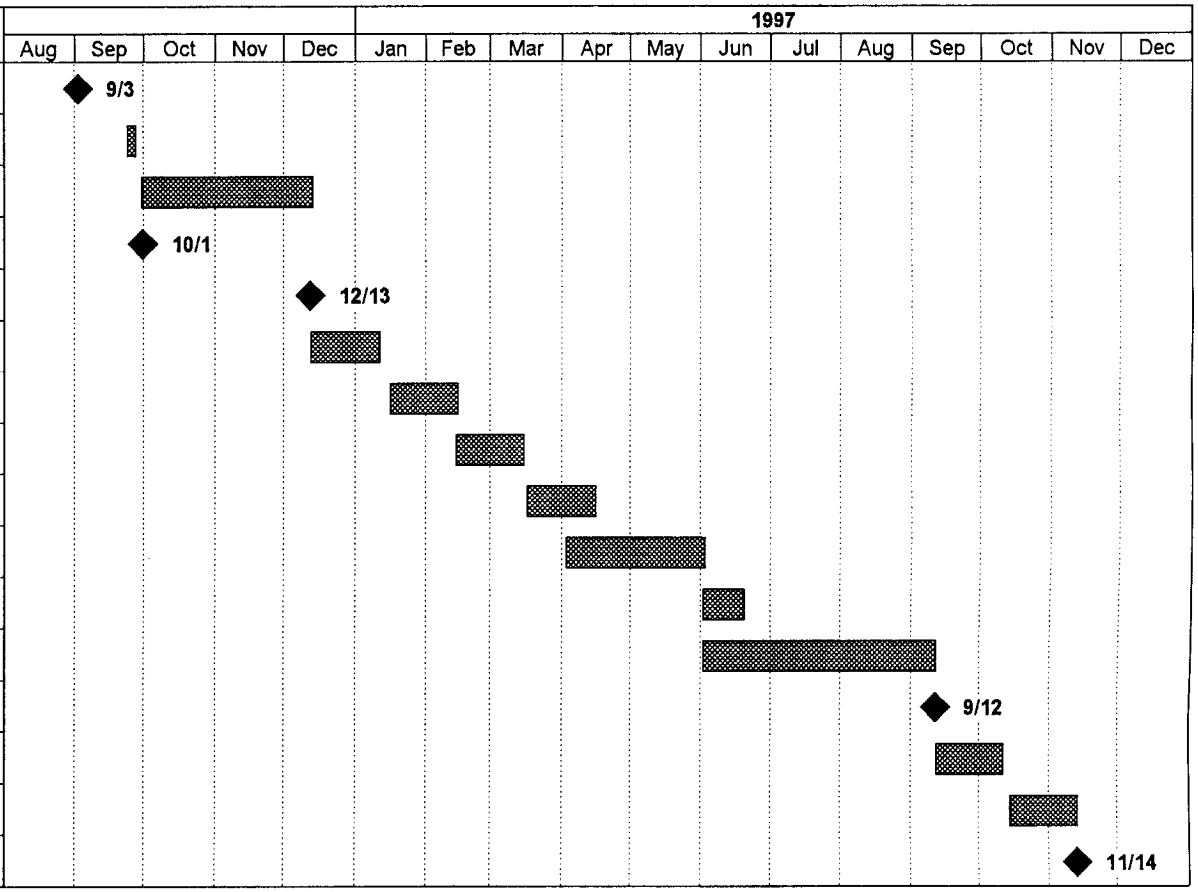


Fig. -1
Project Schedule
SWMU Confirmatory Sampling Work Plan, CTO-0371

Task Name	Duration	Start	Finish
Notice to Proceed	0ed	9/3/96	9/3/96
Site Visit	4d	9/24/96	9/27/96
Prepare Draft Project Plans	55d	9/30/96	12/13/96
Draft Permit Issued	0ed	10/1/96	10/1/96
Submit Draft Project Plan	0ed	12/13/96	12/13/96
Agency Review	30ed	12/13/96	1/12/97
Prepare Final Project Plans	30ed	1/15/97	2/14/97
Agency Approval of Project Plans	30ed	2/14/97	3/16/97
Confirmatory Sampling	30ed	3/17/97	4/16/97
Sample Analysis and Validation	61ed	4/2/97	6/2/97
Data Evaluation	18ed	6/2/97	6/20/97
Prepare Draft Confirmation Report	102ed	6/2/97	9/12/97
Submit Draft Confirmation Report	0ed	9/12/97	9/12/97
Agency Review	30ed	9/12/97	10/12/97
Prepare Final Confirmation Report	30ed	10/15/97	11/14/97
Submit Final Confirmation Report	0ed	11/14/97	11/14/97



Project: CTO-0371
Date: 8/27/96

SWMU 2
1700 Pond A

SWMU 89
SLCH785 - Basin
Oil/Water Separator

SWMU 89
SLCH785 - Basin

SWMU 89
SLCH785 - Basin

SWMU 253
1205 - AST

SWMU 254
1408 Dumpster

SWMU 255
15092 - OW/1
Oil/Water Separator

SWMU 255
15092 - OW/1
Drainage Way

SWMU 256
1700 - O/W - 1
Oil/Water Separator

SWMU 256
1700 - O/W - 1
Oil/Water Separator

SWMU 257
1700 - O/W - 2
Oil/Water Separator

SWMU 257
1700 - O/W - 2
Oil/Water Separator

SWMU 258
S1745 - O/W
Oil/Water Separator

SWMU 258
S1745 - O/W
Oil/Water Separator

SWMU 258
S1745 - O/W
Oil/Water Separator

SWMU 260
1780 - O/W - 1
Oil/Water Separator

SWMU 261
1780 - UST - 1
Underground Storage Tank

SWMU 262
1780 - UST - 2
Underground Storage Tank

SWMU 264
2611 - Container
Hurricane Debris

SWMU 265
2615 - O/W
Oil/Water Separator

SWMU 268
522 Dumpster

SWMU 269
816 - O/W
Oil/Water Separator

SWMU 269
816 - O/W
Oil/Water Separator

SWMU 272
SAS137 - Basin

SWMU 273
BA 102/BA 128
Dumpster

SWMU 275
BB - 48
Dumpster

SWMU 276
BB - 49 Dumpster

SWMU 277
FC 120 - O/W

SWMU 277
FC 120 - O/W
Hazardous Materials Storage Area

SWMU 277
FC 120 - O/W
Oil/Water Separator

SWMU 279
FC200 - O/W
Oil/Water Separator

SWMU 280
FC285 - AST

SWMU 284
S947 - Container

SWMU 286
S947 - Pile

SWMU 291
034 Ditch

SWMU 292
1106/1107 - AST
Waste Oil Storage Tank (Moved underneath the garage bay since this photo was taken)

SWMU 292
1106/1107 - AST
Waste Oil Storage Tank

SWMU 292
1106/1107 - AST
Antifreeze Storage Tank (Moved underneath the garage bay since this photo was taken)

SWMU 293
1106/1107 - O/W
Oil/Water Separator

SWMU 294
1203 - O/W
Oil/Water Separator

SWMU 294
1203 - O/W
Oil Storage Area

SWMU 295
1601 - AST
Aboveground Storage Tank

SWMU 295
1601 - AST
Former 90-day Hazardous Materials Storage Area

SWMU 295
1601 - AST
Drainage Basin for Hazardous Materials Storage Area

SWMU 296
1700 - Basin - B

SWMU 297
1780 - O/W02
Oil/Water Separator

SWMU 298
1780 - O/W - 3
Oil/Water Separator

SWMU 299
ASS114 - AST
Aboveground Storage Tank

SWMU 300
AS118 - AST
Aboveground Storage Tank

SWMU 301
AS4115 - AST
Aboveground Storage Tank

SWMU 302
AS504 - AST
Aboveground Storage Tank

SWMU 303
AS515 - AST - E
Aboveground Storage Tanks

SWMU 304
BA130 - O/W
Oil/Water Separator

SWMU 304
BA130 - O/W

SWMU 305
BB224 - Pile

SWMU 306
FC230 - O/W - 1
Oil/Water Separator

SWMU 306
FC230 - O/W - 1
Oil/Water Separator

SWMU 307
G649 - Rack
Vehicle Wash Rack

SWMU 308
GP19 - O/W
Oil/Water Separator

SWMU 309
NH 118 - UST
Underground Storage Tank

SWMU 310
PT33 - Pond - O/W

SWMU 310
PT33 - Pond - O/W

SWMU 310
PT33 - Pond - O/W

SWMU 311
S1619 - O/W
Oil/Water Separator

SWMU 312
S1735 - O/W
Oil/Water Separator

SWMU 312
S1735 - O/W
Oil/Water Separator

SWMU 313
S1753 - O/W - AST
Oil/Water Separator

SWMU 314
SM187 - O/W
Vehicle Wash Pad

SWMU 314
SM187 - O/W
Oil/Water Separator

SWMU 315
SM269 - Basin
Vehicle Wash Pad

SWMU 315
SM269 - Basin
Oil/Water Separator

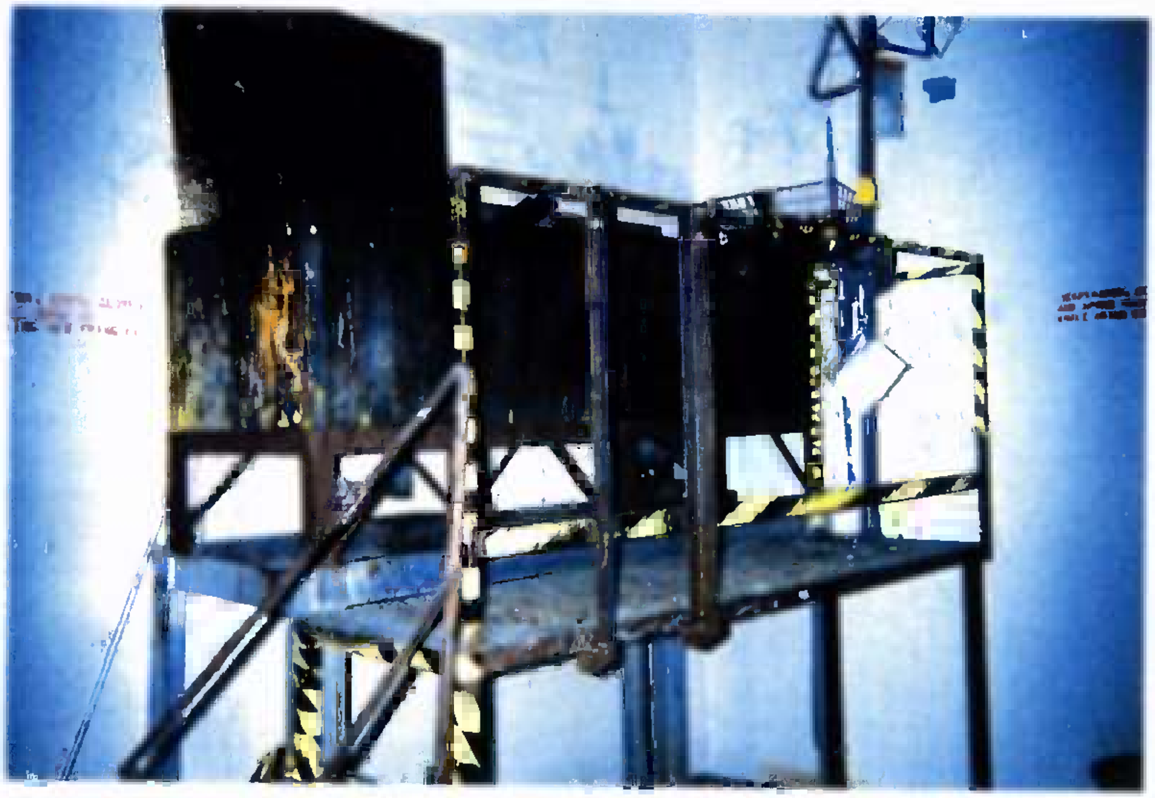
SWMU 316
TC773 - O/W
Oil/Water Separator

SWMU 317
TT2453 - Release

SWMU 318
AS515 - O/W

SWMU 319
Camp Geiger Wastewater Treatment Plant

SWMU 336
4106 Stripper



SWMU 337
AS518 - VAT

SWMU 339
AS4146 - Blast

FINAL

SOLID WASTE MANAGEMENT UNIT (SWMU)
CONFIRMATORY SAMPLING
FIELD SAMPLING AND ANALYSIS PLAN

MCB CAMP LEJEUNE, NORTH CAROLINA

CONTRACT TASK ORDER 0371

AUGUST 21, 1997

Prepared for:

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

Under the:

LANTDIV CLEAN Program
Contract N62470-89-D-4814

Prepared by:

BAKER ENVIRONMENTAL, INC.
Coraopolis, Pennsylvania

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APPENDICES

1.0 INTRODUCTION

This Field Sampling and Analysis Plan (FSAP) presents the sampling and analytical requirements for the confirmatory sampling to be conducted at 62 solid waste management units (SWMUs) located throughout Marine Corps Base (MCB) Camp Lejeune, North Carolina.

The primary purpose of the FSAP is to provide guidance for all project field activities by describing in detail the sampling and data collection methods to be used to implement the various field tasks identified in the Work Plan for this project. This document also helps to ensure that project activities are carried out in accordance with U.S. Environmental Protection Agency (USEPA) Region IV and Naval Facilities Engineering Service Center (NFESC) practices, so that data obtained during the field investigation are of sufficient quantity and quality to determine if contamination exists within various media. The data will be used to evaluate the potential need for a RCRA Facility Investigation (RFI) and possibly a Corrective Measures Study (CMS).

2.0 SITE BACKGROUND

A description of the history and setting of MCB Camp Lejeune, and a description of each of the 62 SWMUs to be evaluated is contained in Sections 2.0 and 5.0 of the Work Plan for this project, respectively.

3.0 SAMPLING OBJECTIVES

The sampling and data quality objectives (DQOs) for field investigations at each SWMU are summarized in Section 3.0 of the Work Plan.

4.0 SAMPLING LOCATIONS AND FREQUENCY

The location, quantity and type of environmental samples to be collected during the sampling program is described in Section 5.2 of the Work Plan for this project. In addition, support activities, sampling locations, sample matrices, and constituents to be analyzed are also discussed within Section 5.2 of the Work Plan. Detailed investigation procedures, sampling handling, and analytical requirements are described in Sections 6.0 and 7.0 of this FSAP.

4.1 Quality Assurance/Quality Control Samples

Quality assurance/quality control (QA/QC) requirements for this project are presented in the Quality Assurance Project Plan (QAPP). The following QA/QC samples will be collected 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, kept with the investigative samples throughout the sampling event, and returned to the laboratory with the volatile organic analysis (VOA) samples. One trip blank will accompany each cooler containing samples for volatile organic analysis. The blanks will only be analyzed for volatile organics. The purpose of a trip blank is to determine if samples were contaminated during storage and transportation back to the laboratory.

- Equipment Rinsates (Equipment Blanks)

  Equipment rinsates or equipment blanks are defined as samples which are obtained by running organic-free water over/through sample collection equipment after it has been decontaminated. Equipment rinsates will be collected daily during each sampling event. One rinsate per media sampled per day will be collected. For example, if groundwater and soil samples were collected on one given day, two rinsates would be collected. Initially, samples from every other day will be analyzed. If analytes pertinent to the project are found in the rinsates, the remaining samples will be analyzed. The results from the rinsates will be used to evaluate the decontamination methods. The rinsates will be analyzed for the same parameters as the related samples.

- Field Blanks

  Field blanks consist of the source water used in decontamination. Field blanks will be collected by pouring the water from its original container directly into sample bottles. Field blanks should not be collected in dusty environments and/or from areas where volatile organic contamination is present in the atmosphere or originating from a source other than the source being sampled. One field blank will be prepared at the commencement of the project.

- 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 sampling 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 for the entire sampling program (not per SWMU).

- 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

  Due to the limited number of samples at each SWMU, MS/MSD samples will be collected at a frequency of 5 percent for the entire sampling program (not per SWMU).

4.2 Investigation Derived Waste Handling

Investigation derived waste (IDW) will include drill cuttings and purge water (Phase II). Drill cuttings or excavated soils will be collected and contained in five 55-gallon drums and staged in a central location if they are determined in the field to be potentially contaminated based on visual observations and HNu readings. Otherwise, the soil cuttings will be left at each SWMU. Groundwater collected during the second phase will be collected and contained in 55-gallon drums. The water will be disposed off-site as hazardous. Additional details regarding IDW handling and disposal are provided in Section 6.8.

5.0 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 SWMU, the sample media, sampling location, the depth (soil) or round (groundwater), and QA/QC qualifiers.

The sample designation format is as follows:

SWMU#-Media/Station# -Depth/Round or QA/QC

An explanation of each of these identifiers is given below.

SWMU#	This will be the number assigned to each SWMU during the RCRA Facility Assessment (RFA) report submitted by ENSAFE, Inc. (1996).
Media	SB = Soil Boring (soil sample from a boring) TW = Temporary Well (groundwater sample from a temporary well) SW = Surface Water SD = Sediment MW = Groundwater Monitoring Well
Station#	Each sample location will be identified with a unique identification number.
Depth/Round	Depth indicators will be used for soil samples. The number will reference the depth interval of the sample. For example: 00 = ground surface to 1 foot below ground surface 01 = 1 to 3 feet below ground surface 02 = 3 to 5 feet below ground surface 03 = 5 to 7 feet below ground surface Depth indicators will be used for sediment samples. The number will reference the depth interval of the sample. For example: 06 = 0 to 6 inches below the sediment/surface interface 612 = 6 to 12 inches below the sediment/surface interface Round indicator will be used for groundwater samples. For example: 01 = initial round of sampling 02 = second round of sampling
QA/QC	(D) = Duplicate Sample (following depth/round) (MS/MSD) = Matrix Spike/Matrix Spike Duplicate (TB) = Trip Blank (ER) = Equipment Rinsate (FB) = Field Blank

Under this sample designation format the sample number 10-TW04-01D refers to:

10-TW04-01D	SWMU 10
10-TW04-01D	Groundwater sample from a temporary well
10-TW04-01D	Temporary well #4
10-TW04-01D	Round 1
10-TW04-01D	Duplicate (QA/QC) sample

The sample designation 10SB11-00D refers to:

10SB11-00D	SWMU 10
10SB11-00D	Soil sample from a soil boring
10SB11-00D	Soil Boring #11
10SB11-00D	Sample depth interval 0 to 1 foot
10SB11-00D	Duplicate (QA/QC) Sample

The sample designation 10SD01-612 MS/MSD refers to:

10SD01-612MS/MSD	SWMU 10
10SD01-612 MS/MSD	Sediment Sample
10SD01-612 MS/MSD	Sediment Sample Location #1
10SD01-612 MS/MSD	Sample Depth 6-12 inches
10SD01-612 MS/MSD	Matrix Spike/Matrix Spike Duplicate sample

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

6.0 INVESTIGATIVE PROCEDURES

The investigative procedures to be used for both phases of the Confirmatory Sampling will be discussed in the following subsections. These procedures include soil sample collection, temporary well installation (Phase II), groundwater sample collection (Phase II), surface water and sediment sample collection, decontamination procedures and handling of site IDW. 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), May 1996. Additional guidance from other sources such as the American Society for Testing Materials (ASTM) may be used, but if the ASTM and ESD methods conflict, the ESD procedure will be used. Additionally, in instances where the ESD has no standard operating procedure (SOP), other guidance sources will be used, such as manufacturer's SOP manuals.

6.1 Soil Sample Collection

Surface and subsurface soil samples will be collected at many of the SWMUs. Soil samples will be collected from borings advanced by a direct-push soil sampler. Soil borings will either be advanced by a pick-up truck mounted rig, or by a hand sampler unit. All boring locations will receive utility clearance from the appropriate Base personnel. Appendix A contains the SOP for a direct-push (GeoProbe) soil sampling system.

Soil samples from borings advanced either by a direct-push rig or by hand will be collected using a GeoProbe "Macro-Core Sampler", or "Large Bore Soil Sampler", respectively. Some borings may be difficult to access by pick-up truck. In these instances, the samples will be collected using the hand sampler.

The Macro-Core Sampler is a 48-inch long, stainless-steel tube with a 2-inch outside diameter (OD). Threaded to the base, is a 1-1/2 inch inside diameter (ID) cutting shoe. Soil samples are collected in a 45-inch long by 1-1/2 inch wide acetate liner that is inserted into the tube. Although the sampler is capable of collecting 45 inch long samples, the sampler will be driven 24 inches for higher percentage recoveries.

The Large Bore Soil Sampler is a 24-inch long, stainless-steel tube with a 1-3/8 inch OD. Attached at its base is a 1-1/16 inch ID cutting shoe. Soil samples are collected in a 22-inch long by 1-1/8 inch wide acetate liner that is inserted into the tube.

Soil samples will be collected continuously from the ground surface to the water table. Soil borings that will be converted into shallow monitoring wells will be advanced approximately 7 feet below the water table. Soils will be classified according to the Unified Soil Classification System (USCS). Soil sample descriptions will be recorded in the field geologist's notebook.

The surface soil sample from each boring (0 to 1 foot) will be collected by hand. The remaining samples will be collected using the GeoProbe samplers. The following procedure will be used for collecting all of the soil samples:

1. A stainless steel spoon will be used to scrape away the first inch of soil and remove the soil from the ground. Soil for volatile organic analysis will be placed directly into the sample jar. Soil for all other analysis will be placed into an aluminum pan, thoroughly homogenized, then placed into the appropriate sample jar(s).

2. A 2-inch OD pre-probe will be used to ream the surface sample hole to 2 inches in diameter. A 1-3/8 inch pre-probe will be used to ream the surface sample hole at the hand sampler locations.

3. The sampler will be placed into the hole. The sampler will be driven 24 inches by the truck-mounted hydraulic drive assembly or by a hand-held drive hammer. Once the desired depth is reached, the sampler will be pulled from the hole.

4. The sampler will be dissembled, and the liner containing the sample will be handed to the geologist for logging and, as necessary, containerization for chemical analysis.

5. The sampler tube and cutting shoe will be decontaminated following procedures outlined in Section 6.6, and then reassembled using a new liner.

6. Repeat Steps 3, 4, and 5 until the desired, final depth is reached.

The following procedure will be used for surface and subsurface soil samples to be submitted to the laboratory:

1. The sample will be removed from the liner by letting it fall gently onto a sheet of aluminum foil. In some instances, the soil sample may have to be extruded from the top end using a wooden dowel covered with aluminum foil. Photoionization detector (PID) measurements will then be taken.

2. Soil for volatile organic analysis will be placed directly into the sample jar. Small aliquots will be collected from discrete locations over the entire length of the sample interval. The VOA sample jar will be filled completely, without headspace, to minimize volatilization. Sample bottles will be labeled prior to sample collection.

3. A small, representative portion of sample will be set aside for description purposes. The remaining soil will be placed into an aluminum pan, and thoroughly mixed. The sample jar(s) for all other analysis will then be filled.

4. All pertinent sampling information such as soil description, sample depth, sample number and location, and the time of sample collection will be recorded in the field logbook. In addition, the sample bottles will be labeled as outlined in Section 7.0.

5. The sample jars will be stored in a cooler with ice until shipped to an off-site laboratory.

6.2 Monitoring Well Installation (Phase II)

Temporary wells may be installed at some SWMUs to sample the shallow (water table) water-bearing zone during Phase II. The wells will be installed such that the bottom of the screen is seven feet below the water table. The procedure for the installation and construction of the temporary wells is presented below (also see Figure 6-1):

1. A borehole will be advanced by direct-push sampling, using the Macro-Core Sampler. Soil samples will be collected as described in Section 6.1.

2. Upon completion of the borehole to the desired depth, a pre-assembled monitoring well will be installed into the open borehole. Well construction procedures are detailed below.

   Ten feet of 1-inch OD, Schedule 40, #10 slot (0.010 inch) polyvinyl chloride (PVC) screen with a bottom plug will be used. The screen will be wrapped with polyester "well sock" material, that will be used as filter media. The screen will be connected to threaded, flush-joint, 1 inch OD, Schedule 40, PVC casing. The casing will extend 2 to 3 feet above the ground surface. A PVC slip-cap, with a vent hole, will be placed at the top of the casing.

   PVC was selected for well materials based on its inertness with respect to metals, its likely exposure to only low concentrations of organic compounds, and short duration of use (Appendix B contains a seven-point justification). Polyester was selected for the filter media based on its inertness with respect to metals, its likely exposure to only low concentrations of organic compounds, and its durability.

3. The system will be allowed to equilibrate before sampling.

6.3 Groundwater Sample Collection (Phase II)

The temporary wells will be sampled via low-flow methods. Low-flow is defined as a flow rate similar to the ambient flow rate in the screened formation. A peristaltic pump will be used to purge the wells and collect the samples. Volatile organic compound (VOC) loss through suction degassing is expected to be insignificant due to the very slow flow rates to be used. Baker personnel have reported observance of minimal bubbling in the groundwater stream during recent peristaltic pump use. The procedure for collecting groundwater samples is detailed in this section, and has been assembled from ESD guidance and recently published papers and other documents.

6.3.1 Low-Flow Purging Vs. High-Flow Purging

A number of recent studies have demonstrated that low-flow purging and sampling is a preferable to bailing or high-flow purging and sampling. High-rate pumping is described as a rate greater than, or similar to, the development rate. Some findings include:

- High-flow pumping and bailing may overdevelop a well, causing damage to the well and filter pack (USEPA, 1992).
- High-flow pumping and bailing may disturb accumulated corrosion/reaction products, or sediment (USEPA, 1992), or potentially mobilize particulate or colloidal matter from the formation (Barcelona, Wehrmann and Varljen, 1994).
- High-flow pumping and bailing may cause loss of VOCs. The velocities at which groundwater enters a bailer can actually correspond to unacceptably high purge rates (USEPA, 1992).
- The use of bailers can result in composite averaging by mixing of water across the screen interval (Barcelona, Wehrmann and Varljen, 1994), resulting in unreproducible and unrepresentative data.

6.3.2 Selection of Water Quality Indicator Parameters

The water quality indicator parameters (WQP) for stabilization will include dissolved oxygen, turbidity, pH, and specific conductance. Use of these WQPs has precedence in recent studies. Dissolved oxygen and turbidity are more sensitive indicators of "fresh" groundwater than pH, specific conductance, and temperature (Puls and Powell, 1995). Barcelona, Wehrmann and Varljen, 1994, suggest that dissolved oxygen and specific conductance are good indicators of stabilization with respect to VOA sampling. Puls and Paul, 1995 used dissolved oxygen, turbidity, pH, and specific conductance as indicators of stabilization.

6.3.3 Purge Requirements

Consistent with USEPA's ECBSOPQAM, a minimum of three well volumes will be purged from each temporary well prior to sampling.

6.3.4 Purging and Sampling Procedure

The low-flow purge and groundwater sampling procedures that will be used at selected SWMUs follows:

1. The well cap will be removed, and escaping gases will be measured at the well head using a PID or flame ionization detector (FID). This will determine the need for respiratory protection.

2. The temporary well will be allowed to equilibrate to atmospheric pressure, in the event that a vent hole was not installed in the well.

3. The static water level will be measured. The total depth of the well will not be measured, as not to stir up any sediment. The total well depth will be obtained from boring logs. The water volume in the well will then be calculated.

4. The sampling device intake (virgin, 1/4 inch ID polypropylene or polyethylene tubing) will be slowly lowered until the bottom end of the intake tube is 2 to 3 feet below the top of water. Based on water levels, this depth will be a point within the screened interval. Next, the water level probe will be placed into the well, just above the water.

5. Purging will then begin. The discharge rate will be measured using a stopwatch and calibrated container. The flow rate will be adjusted to ambient flow conditions (i.e., no drawdown is observed in the well.) Flow rates of less than 1 liter per minute (L/min) are expected.

6. The WQPs, including dissolved oxygen, turbidity, pH, and specific conductance will be measured frequently (e.g., every 2 minutes). Temperature will also be measured.

7. Purging will be complete when a minimum of three well volumes have been removed and three successive WQP readings have stabilized within 10%, or there is no further discernable upward or downward trend. It is Baker's experience that at low values, certain WQPs (such as turbidity and dissolved oxygen) may vary by more than 10%, but have reached a stable plateau.

8. Upon WQP stabilization, groundwater samples will be collected. Samples for VOA analysis will be collected first, followed by semivolatiles, pesticides and total metals, as applicable. Sample bottles will be labeled prior to sample collection.

9. The sample jars will be stored in a cooler with ice until shipped off-site to the laboratory.

The temporary well will be removed from the ground once sampling is complete . The open borehole will be backfilled with "clean" cuttings mixed with bentonite powder.

Sample preservation and handling procedures are outlined in Section 7.0. Appendix C presents a generic SOP for groundwater sampling.

6.4 Surface Water Sample Collection

The following procedures will be used for the collection of surface water samples at various SWMUs. At each sampling station, surface water 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 sampling device (i.e., the sample bottles) 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 nitrile 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. Sampling personnel shall stand downstream at each station in order to minimize sediment disturbance.

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 for 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.

The following information will be recorded in the field log book:

- Project location, date and time
- Weather
- Sample location, number, and identification number
- Flow conditions (i.e., high, low, in flood, etc.)
- Visual description of water (i.e., clear, cloudy, muddy, etc.)
- Sketch of sampling location including boundaries of the water body, sample location and depth, and relative position with respect to the SWMU
- Names of sampling personnel
- Sampling technique, procedure, and equipment used

Sample preservation and handling procedures are outlined in Section 7.0.

Details on surface water/sediment sample acquisition are presented in Appendix D.

6.5 Sediment Sample Collection

The following procedures will be used for the collection of sediment samples at various SWMUs. At each sampling 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 sampling 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. Increase 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 the 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.

10. The sample jars will be stored in a cooler with ice until shipped off-site to the laboratory.

6.6 Decontamination

Equipment and materials that require decontamination fall into two broad categories:

1. Field measurement, sampling, and monitoring equipment (e.g. water level meters, stainless steel spoons, etc.)

2. Machinery, equipment, and materials (e.g. drilling rigs, backhoes, drilling equipment, monitoring well materials, etc.)

Appendices E and F detail procedures for decontaminating the two categories of equipment and materials, respectively.

6.7 Monitoring and Data Collection Equipment

Field support activities and investigations will require the use of monitoring and data collection equipment. Dissolved oxygen, turbidity, specific conductance, temperature, pH, and specific conductance readings will be recorded during groundwater sample collection. Appendix G, On-Site Water Quality Testing, provides specific procedures for collecting conductance, temperature, and pH readings. This SOP does not include the procedure for operation of a turbidity meter. A copy of an instruction manual for the LaMotte 2008 turbidity meter has been included as Attachment C of the SOP.

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 H.

Health and safety monitoring and environmental media screening will be conducted using a photoionization detector (PID) and a combustible gas/oxygen meters (O_2/LEL). The operation and use of the PID is described in Appendix I. The Bacharach O_2/LEL meter will also be used during the sampling program, primarily to monitor health and safety conditions. Appendix J provides a description of the Bacharach O_2/LEL meter and operating procedures.

6.8 Investigation Derived Waste Handling

The following sections deal with the responsibilities, sources, containerization, sampling and analysis, and disposal of investigation derived wastes (IDW). These wastes include soil from borings, groundwater from purging wells, decontamination fluids, and personal protection equipment. Soil cuttings will remain at each SWMU. Due to the limited amount of IDW expected for the entire investigation, purge water, development water, and decontamination fluids will be containerized in five 55-gallon drums staged in a central location, then disposed off-site as hazardous.

6.8.1 Responsibilities

LANTDIV - Atlantic Division, Naval Facilities Engineering Command (LANTDIV) or the Activity must ultimately be responsible for the final disposition of site wastes. As such, a LANTDIV or MCB, Camp Lejeune representative will sign waste disposal manifests as the generator of the material, in the event off-site disposal is required. However, it may be the responsibility of Baker, depending on the contingency discussions during execution of the investigation, to provide assistance to LANTDIV in arranging for final disposition and preparing manifests.

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

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

6.8.2 Sources of Investigation Derived Wastes

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

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

- Soil sampling and monitoring well construction (soil cuttings)
- Groundwater sampling (purge water)
- Sampling equipment decontamination (decontamination fluids)
- Personal protection equipment (health and safety disposables)

It is likely that only a small amount of IDW will be generated for the investigations associated with the SWMU.

6.8.3 Designation of Potentially Hazardous and Nonhazardous Investigation Derived Wastes

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

6.8.3.1 Drill Cuttings

Minimal amounts of soil cuttings will be generated during soil sample acquisition and temporary monitoring well installation. These cuttings will be containerized in DOT approved drums for temporary storage on site, and subsequent treatment and/or disposal.

6.8.3.2 Purge Water

All purge water shall be containerized in five 55-gallon drums. Purge water that exhibits elevated HNu readings will be kept separate from water that does not exhibit elevated levels for purposes of subsequent treatment and/or disposal, potentially requiring an additional storage vessel.

6.8.3.3 Decontamination Fluids

Equipment and personal decontamination fluids shall be containerized in 55-gallon drums. The fluids shall be collected from the decontamination/wash pads.

6.8.3.4 Personal Protective Equipment

All personal protective equipment (i.e., tyveks, gloves, and other health and safety disposables) shall be placed in garbage bags and disposed in trash dump boxes.

6.8.4 Investigation Derived Waste Sampling and Analysis

Soil cuttings collected during the investigation will remain at each SWMU unless deemed hazardous. If the soils are determined to be hazardous or are grossly contaminated, they will be contained in 55-gallon drums and disposed off-site. Purge water, development water, and decontamination fluids collected during the investigation shall be containerized in 55-gallon drums and disposed off-site as hazardous. Sampling procedures for contained IDW are included in Appendices K and L.

6.8.5 Labeling

If 55-gallon drums are used to containerize IDW, the containers will be numbered and labeled by the field team during the site investigation. Information shall be stenciled in paint on both the container lid and side. Container labels shall include, at a minimum:

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

6.8.6 Container Log

A container log shall be maintained in the site logbook. The container log shall contain the same information as the container label plus any additional remarks or information.

6.8.7 Container Storage

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

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

6.8.8 Container Disposition

The disposition of the containers of IDW shall be determined by LANTDIV, with the assistance of Baker, as necessary. Container disposition shall be based on quantity and types of materials.

6.8.9 Disposal of Contaminated Materials

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

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

7.0 SAMPLE HANDLING AND ANALYSIS

Field activities will be conducted in accordance with the USEPA's ECBSOPQAM. Procedures for sample preservation, labeling, handling, and maintaining a field logbook are detailed in SOPs. Because these procedures are not specific to this project, they are provided as appendices, rather than detailed herein. Major components of sample handling and analysis are discussed in the following subsections.

7.1 Sample Preservation and Handling

Sample preservation, sample bottle packing and shipping are important components to maintaining the integrity of the samples. Preservation and handling procedures to be used in this investigation are detailed in Appendix M and Section 6.1 of the Quality Assurance Project Plan (QAPP).

7.2 Chain-of-Custody

Chain-of-custody is another important component to maintaining sample integrity. Chain-of-custody procedures to be followed during this investigation are detailed in Appendix N. This SOP details sample bottle labeling and chain-of-custody procedures.

Chain-of-custody procedures 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.

7.3 Field Logbook

Field logbooks will be used to record sampling activities and information. Entries will include general and specific sampling information so that site activities may be reconstructed. In addition to the logbook, field forms, such as boring logs, will be completed as support documentation for the logbook. Appendix O describes a general format for the logbook.

Each field person will have and maintain a logbook. Logbooks will be copied daily and stored at the field trailer as back-up in case the original is lost or destroyed. Additionally, copies of completed logbooks will be filed in the project files.

8.0 SITE MANAGEMENT

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

8.1 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 direct push rig for soil boring and temporary monitoring well installation. The rig will be supervised by a Baker geologist. A sampling technician will be assigned to the field team to assist with soil boring/temporary monitoring well installation, groundwater sampling and will serve as the Site Health and Safety Officer.

8.2 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, Camp Lejeune EMD and the North Carolina DEHNR.

9.0 REFERENCES

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Puls, R.W. and Paul, C.J. Low-Flow Purging and Sampling of Groundwater Monitoring Wells with Dedicated Systems. Groundwater Monitoring and Remediation. Winter, 1995.

FIGURES

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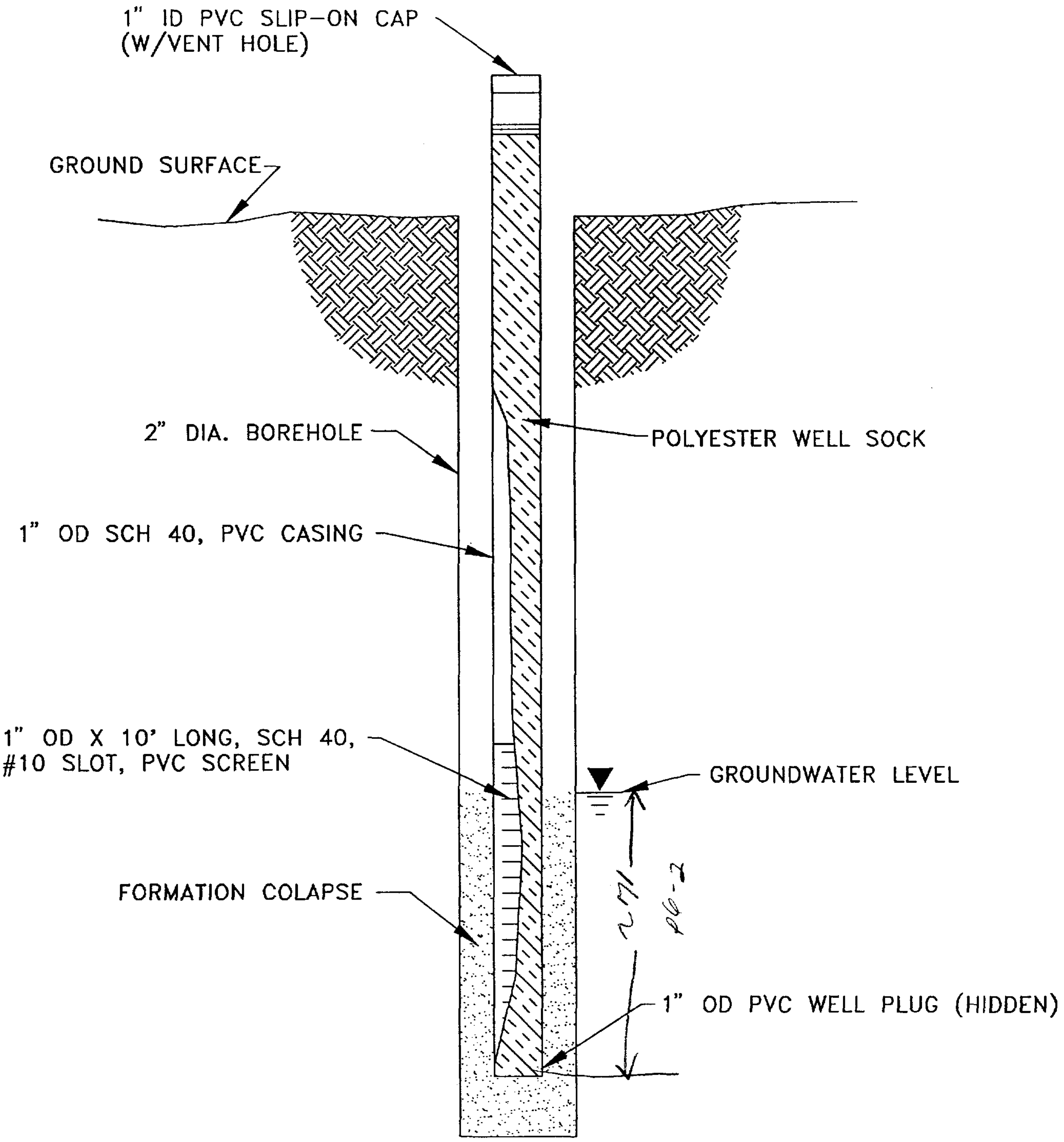

N.T.S.

Baker
Baker Environmental, Inc.

FIGURE 6-1
TYPICAL TEMPORARY, SHALLOW GROUNDWATER
MONITORING WELL

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

APPENDIX A
GEOPROBE SYSTEMS® SOP

GEOPROBE AT-660 SERIES LARGE BORE SOIL SAMPLER

Standard Operating Procedure (SOP)

Technical Bulletin No. 93-660

PREPARED: 9/21/1993

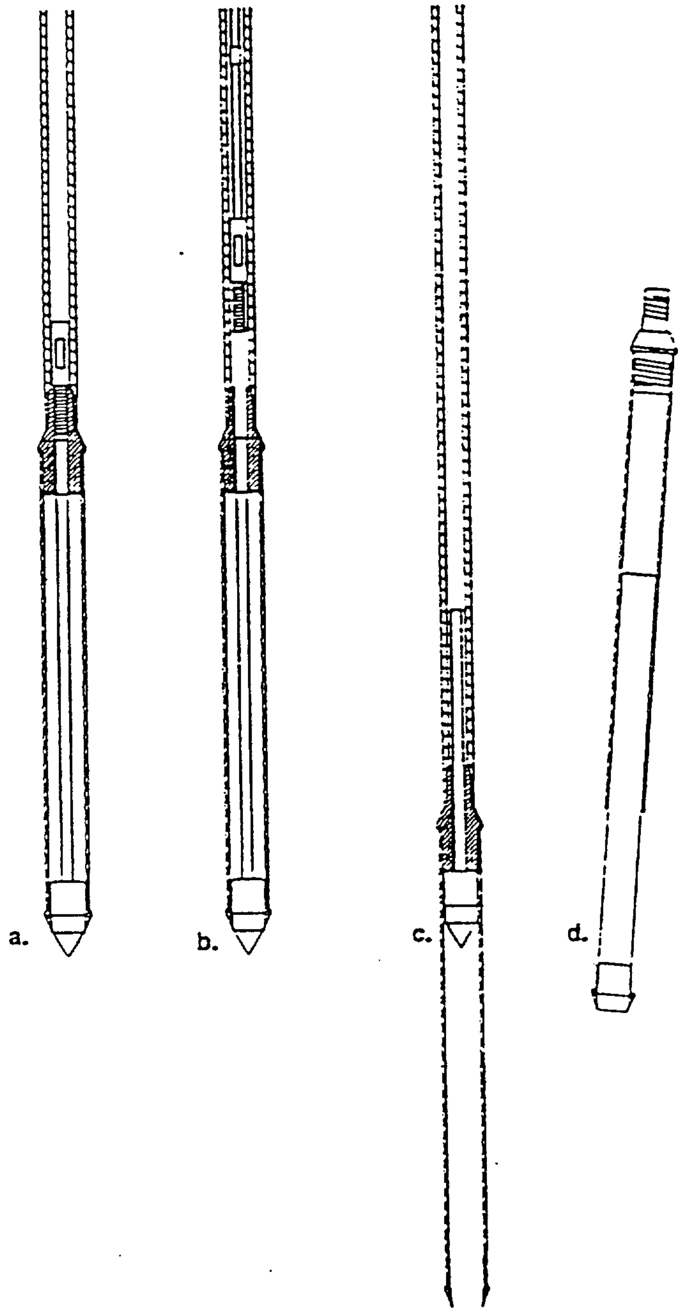

Figure 1. Driving and Sampling with the Large Bore Soil Sampler.
a. Driving the Sealed Sampler b. Removing the Stop-pin
c. Collecting a Sample d. Recovering Sample in Liner

1.0 OBJECTIVE

The objective of this procedure is to collect a discrete soil sample at depth and recover it for visual inspection and/or chemical analysis.

2.0 BACKGROUND

2.1 Definitions

Geoprobe*: A vehicle-mounted, hydraulically-powered, soil probing machine that utilizes static force and percussion to advance small diameter sampling tools into the subsurface for collecting soil core, soil gas, or ground water samples.
**(Geoprobe is a registered trademark of Kejr Engineering, Inc., Salina, Kansas.)*

Large Bore Sampler: A 24-inch long x 1-3/8-inch diameter piston-type soil sampler capable of recovering a discrete sample that measures up to 320 ml in volume, in the form of a 22-inch x 1-1/16-inch core contained inside a removable liner.

Liner: A 24-inch long x 1-1/8-inch diameter removable/replaceable, thin-walled tube inserted inside the Large Bore Sampler body for the purpose of containing and storing soil samples. Liner materials include brass, stainless steel, Teflon, and clear plastic (either PETG or cellulose acetate butyrate).

2.2 Discussion

In this procedure, the assembled Large Bore Sampler is connected to the leading end of a Geoprobe brand probe rod and driven into the subsurface using a Geoprobe machine. Additional probe rods are connected in succession to advance the sampler to depth. The sampler remains sealed (closed) by a piston tip as it is being driven. The piston is held in place by a reverse-threaded stop-pin at the trailing end of the sampler. When the sampler tip has reached the top of the desired sampling interval, a series of extension rods, sufficient to reach depth, are coupled together and lowered down the inside diameter of the probe rods. The extension rods are then rotated clock-wise (using a handle). The male threads on the leading end of the extension rods engage the female threads on the top end of the stop-pin, and the pin is removed. After the extension rods and stop-pin have been removed, the tool string is advanced an additional 24 inches. The piston is displaced inside the sampler body by the soil as the sample is cut. To recover the sample, the sampler is recovered from the hole and the liner containing the soil sample is removed. The operation is illustrated in Figure 1.

3.0 REQUIRED EQUIPMENT

The following equipment is required to recover soil core samples using the Geoprobe Large Bore Sampler and driving system. (Figure 2.) Note that the sample liners for the Large Bore Sampler are available in four different materials. Liner materials should be selected based on sampling purpose, analytical parameters, and data quality objectives.

Large Bore Sampler Parts	Quantity	Part Number
STD Piston Stop-pin, O-ring	1	AT-63, 63 R
LB Cutting Shoe	1	AT-660
LB Drive Head	1	AT-661
LB Sample Tube	1	AT-662
LB Piston Tip	1	AT-663
LB Piston Rod	1	AT-664
LB Clear Plastic Liner	variable	AT-665
LB Brass Liner	variable	AT-666
LB Stainless Steel Liner	variable	AT-667
LB Teflon* Liner	variable	AT-668
LB Cutting Shoe Wrench	1	AT-669
Vinyl End Caps	variable	AT-641
Teflon* Tape	variable	AT-640 T

**(Teflon is a Registered Trademark of E.I. du Pont de Nemours & Co.)*

Geoprobe Tools	Quantity	Part Number
Probe Rod (3 foot)	variable	AT-10 B
Probe Rod (2 foot)	1	AT-10 B
Probe Rod (1 foot)	1	AT-10 B
Drive Cap	1	AT-11 B
Pull Cap	1	AT-12 B
Extension Rod	variable	AT-67
Extension Rod Coupler	variable	AT-68
Extension Rod Handle	1	AT-69

Optional		
LB Manual Extruder	1	AT-659 K
Extension Rod Jig	1	GW-469
LB Pre-Probe	1	AT-146B

Additional Tools

Vise Grips
Open Ended Wrench (3/8-inch)
1-inch or Adjustable Wrench

4.0 OPERATION

4.1 Decontamination

Before and after each use, thoroughly clean all parts of the soil sampling system according to project specific requirements. A clean, new liner is recommended for each use. Parts should also be inspected for wear or damage at this time.

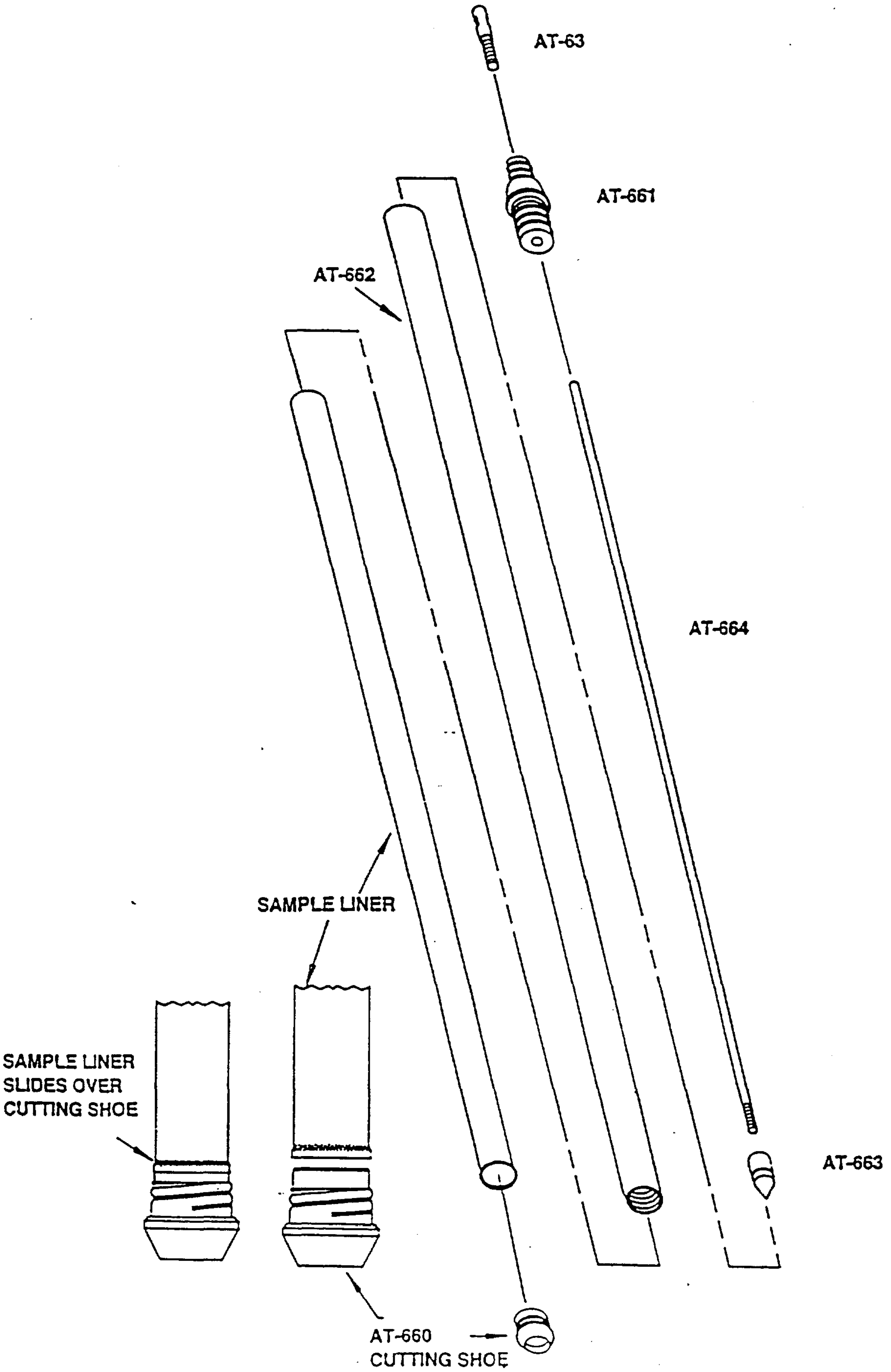

Figure 2. Large Bore Sampler Parts

4.2 Assembly

1. Install a new AT-63R O-ring into the O-ring groove on the AT-63 Stop-pin.

2. Seat the pre-flared end of the LB Liner (AT-665, -666, -667, or -668) over the interior end of the AT-660 Cutting Shoe. (Figure 3.) It should fit snugly.

3. Insert the liner into either end of the AT-662 Sample Tube and screw the cutting shoe and liner into place. If excessive resistance is encountered during this task, it may be necessary to use the AT-669 LB Shoe Wrench. Place the wrench on the ground and position the sampler assembly with the shoe end down so that the recessed notch on the cutting shoe aligns with the pin in the socket of the wrench. (Figure 4.) Push down on the sample tube while turning it, until the cutting shoe is threaded tightly into place.

4. Screw the AT-664 Piston Rod into the AT-663 Piston Tip. Insert the piston tip and rod into the sample tube from the end opposite the cutting shoe. Push and rotate the rod until the tip is seated completely into the cutting shoe.

5. Screw the AT-661 Drive Head onto the top end of the sample tube, aligning the piston rod through the center bore.

6. Screw the reverse-threaded AT-63 Stop-pin into the top of the drive head and turn it counter-clockwise with a 3/8-inch wrench until tight. Hold the drive head in place with a 1-inch or adjustable wrench while completing this task to assure that the drive head stays completely seated. The assembly is now complete.

4.3 Pilot Hole

A pilot hole is appropriate when the surface to be penetrated contains gravel, asphalt, hard sands, or rubble. Pre-probing can prevent unnecessary wear on the sampling tools. A Large Bore Pre-Probe (AT-146B) may be used for this purpose. The pilot hole should be made only to a depth above the sampling interval. Where surface pavements are present, a hole may be drilled with the Geoprobe using a Drill Steel (AT-32, -33, -34, or -35, depending upon the thickness of the pavement), tipped with a 1.5-inch diameter Carbide Drill Bit (AT-36) prior to probing. For pavements in excess of 6 inches, the use of compressed air to remove cuttings is recommended.

4.4 Driving

1. Attach an AT-106B 1-foot Probe Rod to the assembled sampler and an AT-11B Drive Cap to the probe rod. Position the assembly for driving into the subsurface.

2. Drive the assembly into the subsurface until the drive head of the LB sample tube is just above the ground surface.

3. Remove the drive cap and the 1-foot probe rod. Secure the drive head with a 1-inch or adjustable wrench and re-tighten the stop-pin with a 3/8-inch wrench. (Figure 5.)

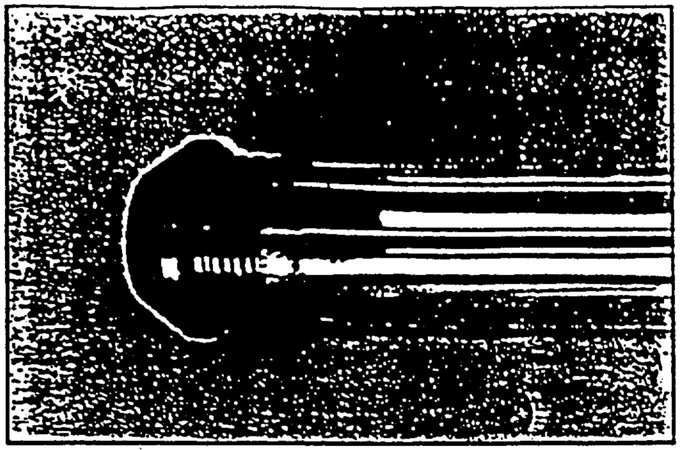

Figure 3. Liner fits snugly over interior end of cutting shoe.

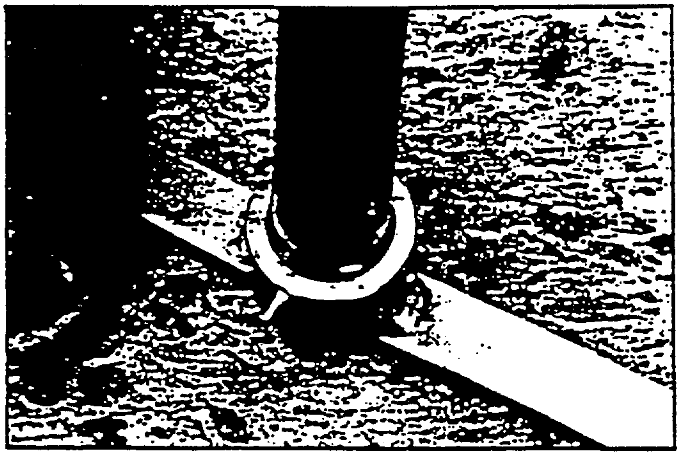

Figure 4. Using the AT-669 Cutting Shoe Wrench to attach cutting shoe.

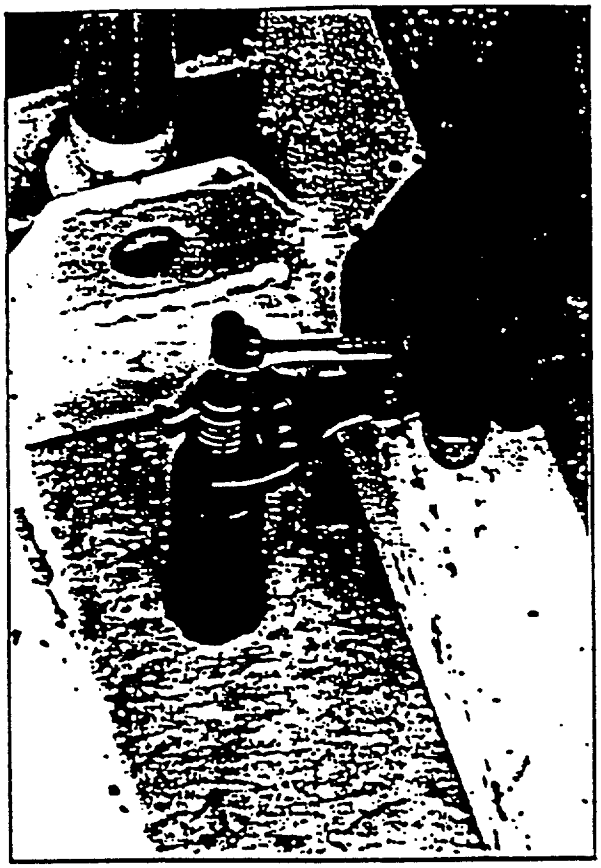

Figure 5. Tightening the Stop-pin.

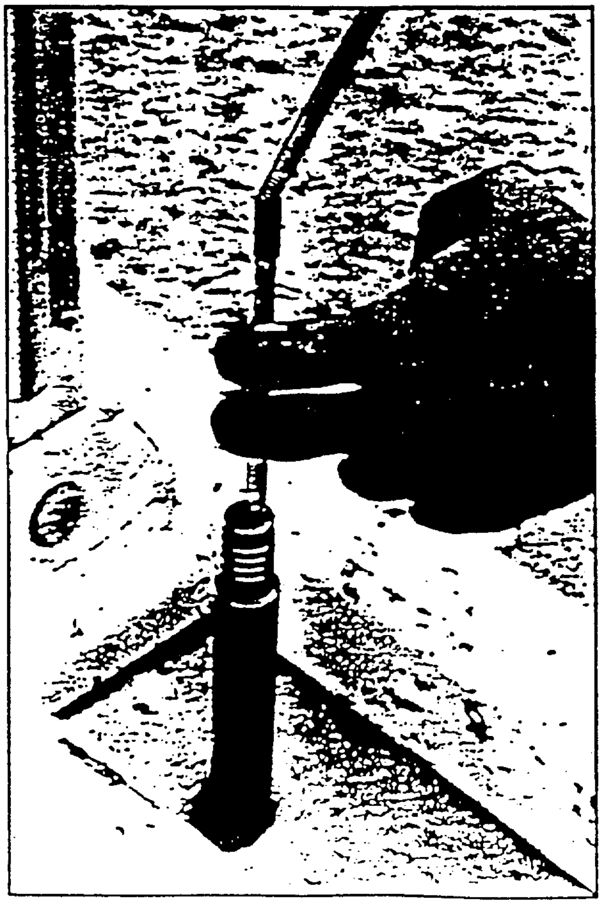

Figure 6. Coupling Extension Rods together.

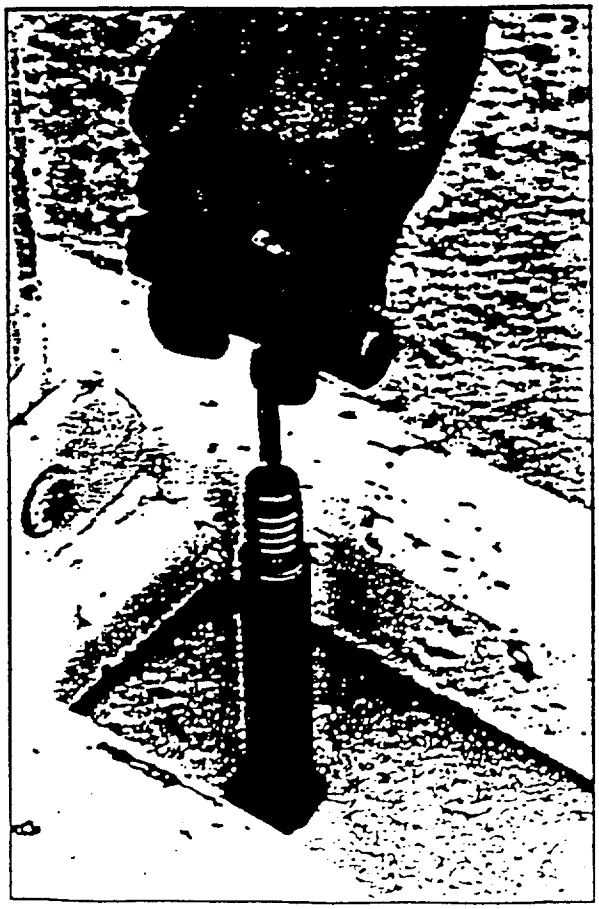

Figure 7. Rotating the Extension Rod Handle.

4.4 Driving (continued from page 5)

4. Attach an AT-105B 2-foot Probe Rod and a drive cap, and continue to drive the sampler into the ground. Attach AT-10B 3-foot Probe Rods in succession until the leading end of the sampler reaches the top of the desired sampling interval.

4.5 Preparing to Sample

1. When sampling depth has been reached, position the Geoprobe machine away from the top of the probe rod to allow room to work.

2. Insert an AT-67 Extension Rod down the inside diameter of the probe rods. Hold onto it and place an AT-68 Extension Rod Coupler on the top threads of the extension rod (the down-hole end of the leading extension rod should remain uncovered). Attach another extension rod to the coupler and lower the jointed rods down-hole. (Figure 6.)

3. Couple additional extension rods together in the same fashion as in Step 2. Use the same number of extension rods as there are probe rods in the ground. The leading extension rod must reach the stop-pin at the top of the sampler assembly. When coupling extension rods together, you may opt to use the GW-469 Extension Rod Jig to hold the down-hole extension rods while adding additional rods.

4. When the leading extension rod has reached the stop-pin down-hole, attach the AT-69 Extension Rod Handle to the top extension rod.

5. Turn the handle clockwise (right-handed) until the stop-pin detaches from the threads on the drive head. (Figure 7.) Pull up lightly on the extension rods during this procedure to check thread engagement.

6. Remove the extension rods and uncouple the sections as each joint is pulled from the hole. The Extension Rod Jig may be used to hold the rod couplers in place as the top extension rods are removed.

7. The stop-pin should be attached to the bottom of the last extension rod upon removal. Inspect it for damage. Once the stop-pin has been removed, the sampler is ready to be re-driven to collect a sample.

4.6 Sample Collection

1. Reposition the Geoprobe machine over the probe rods, adding an additional probe rod to the tool string if necessary. Make a mark on the probe rod 24 inches above the ground surface (this is the distance the tool string will be advanced).

2. Attach a drive cap to the probe rod and drive the tool string and sampler another 24 inches. Use of the Geoprobe's hammer function during sample collection may increase the sample recovery in certain formations. Do not over-drive the sampler.

4.7 Retrieval

1. Remove the drive cap on the top probe rod and attach an AT-12B Pull Cap. Lower the probe shell and close the hammer latch over the pull cap.

2. With the Geoprobe foot firmly on the ground, pull the tool string out of the hole. Stop when the top (drive head) of the sampler is about 12 inches above the ground surface.

3. Because the piston tip and rod have been displaced inside the sample tube, the piston rod now extends into the 2-foot probe rod section. In loose soils, the 2-foot probe rod and sampler may be recovered as one piece by using the foot control to lift the sampler the remaining distance out of the hole.

4. If excessive resistance is encountered while attempting to lift the sampler and probe rod out of the hole using the foot control, unscrew the drive head from the sampler and remove it with the probe rod, the piston rod, and the piston tip. Replace the drive head onto the sampler and attach a pull cap to it. Lower the probe shell and close the hammer latch over the pull cap and pull the sampler the remaining distance out of the hole with the probe machine foot firmly on the ground.

4.8 Sample Recovery

1. Detach the 2-foot probe rod if it has not been done previously.

2. Unscrew the cutting shoe using the AT-669 LB Cutting Shoe Wrench, if necessary. Pull the cutting shoe out with the liner attached. (Figure 8.) If the liner doesn't slide out readily with the cutting shoe, take off the drive head and push down on the side wall of the liner. The liner and sample should slide out easily.

4.9 Core Liner Capping

1. The ends of the liners can be capped off using the AT-641 Vinyl End Cap for further storage or transportation. A black end cap should be used at the bottom (down end) of the sample core and a red end cap at the top (up end) of the core.

2. On brass, stainless steel, and teflon liners, cover the end of the sample tube with AT-640T Teflon Tape before placing the end caps on the liner. (Figure 9.) The tape should be smoothed out and pressed over the end of the soil core so as to minimize headspace. However, care should be taken not to stretch and, therefore, thin the teflon tape.

4.10 Sample Removal

1. Large Bore Clear Plastic and Teflon Liners can be slit open easily with a utility knife for the samples to be analyzed or placed in appropriate containers.

2. Large Bore Brass and Stainless Steel liners separate into four 6-inch sections. The AT-659K Large Bore Manual Extruder may be used to push the soil cores out of the liner sections for analysis or for transfer to other containers. (Figure 10.)

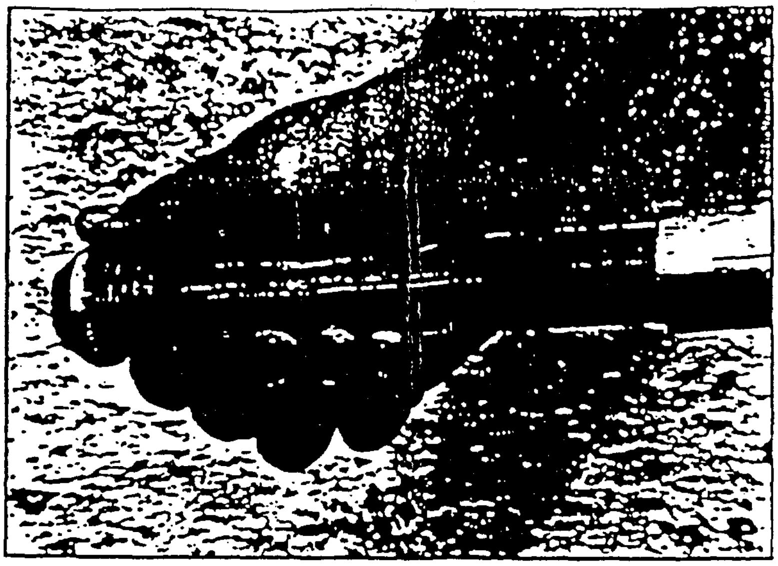

Figure 8. Removing the liner to recover the Sample.

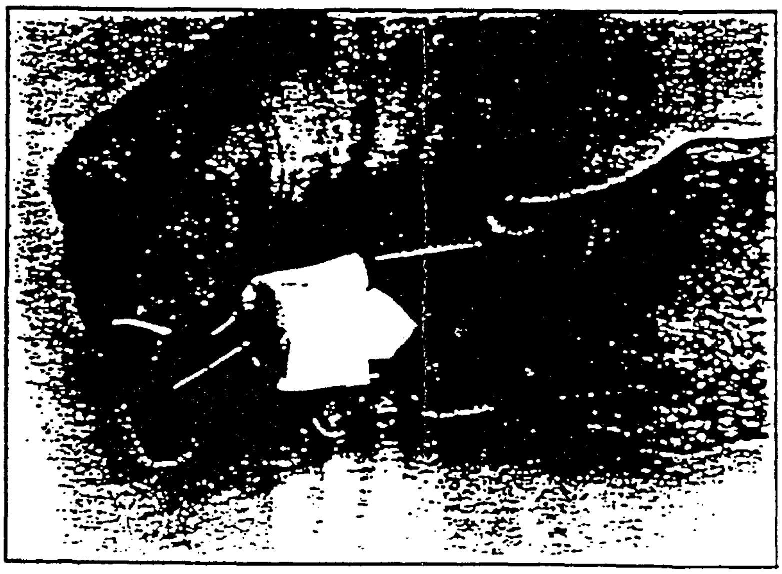

Figure 9. Covering the liner end with Teflon tape for capping.

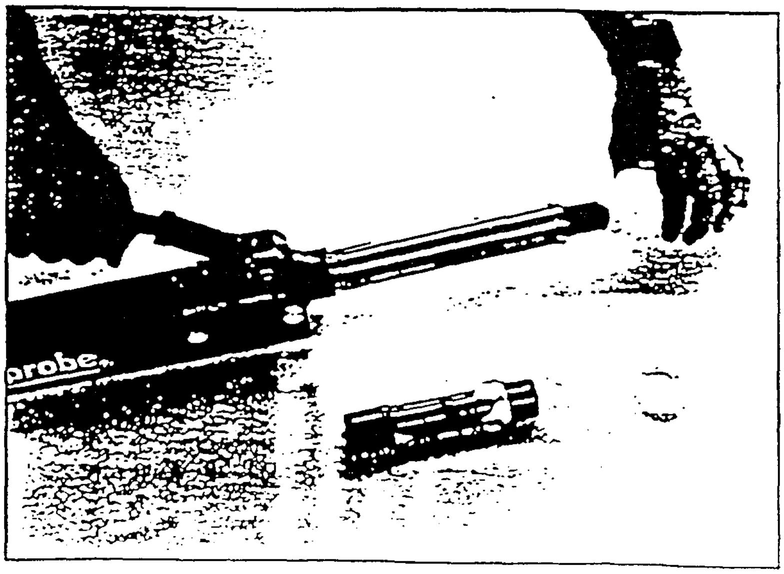

Figure 10. Extruding a sample in a metal liner using the AT-659K manual extruder.

5.0 REFERENCES

Geoprobe Systems, August 1993, "1993-94 Equipment and Tools Catalog".

Geoprobe Systems®

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Hydraulic Probing Machines • Mobile Laboratories • Small Diameter Sampling Tools

APPENDIX B
JUSTIFICATION CRITERIA FOR USE OF PVC WELL CASING AND SCREEN MATERIAL

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

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

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

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

Well	Constituent	Maximum Groundwater Concentration (μg/L)
63-MW02	benzoic acid	3.0
	bis(2-ethylhexyl)phthalate	9.0
	carbon disulfide	1.0
63-MW01	carbon disulfide	1.0

   The concentrations listed above represent maximums at the site.

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

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

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

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

   Aquifer productivity: Subsurface soil samples are mostly fine sand.

   The wells should recharge (enough to sample) before any sorbing/leaching of organics can occur.

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

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

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

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

Miller (1982) conducted a study to determine if PVC exhibited any tendency to sorb potential contaminants from solution. Trichloroethene and 1,1,2-trichloroethane did not sorb to PVC. Reynolds and Gillham (1985) found that 1,1,2,2-tetrachloroethane could sorb to PVC. The sorption was slow enough that groundwater sampling bias would not be significant if well development (purging the well of stagnant water) and sampling were to take place in the same day. No data was available for the organic compounds listed in Item #2.

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

It will not. The 2" diameter borehole will be of sufficient diameter for installation of the 1" PVC casing and screen.

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

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

References for Attachment A:

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

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

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

APPENDIX C
GROUNDWATER SAMPLE ACQUISITION

GROUNDWATER SAMPLE ACQUISITION
TABLE OF CONTENTS

GROUNDWATER SAMPLE ACQUISITION

1.0 PURPOSE

The purpose of this guideline is to provide general reference information on the sampling of groundwater wells. The methods and equipment described are for the collection of water samples from the saturated zone of the subsurface.

2.0 SCOPE

This guideline provides information on proper sampling equipment and techniques for groundwater sampling. Review of the information contained herein will facilitate planning of the field sampling effort by describing standard sampling techniques. The techniques described should be followed whenever applicable, noting that site-specific conditions or project-specific plans may require adjustments in methods.

3.0 DEFINITIONS

None.

4.0 RESPONSIBILITIES

Project Manager - The Project Manager is responsible for ensuring that project-specific plans are in accordance with these procedures, where applicable, or that other, approved procedures are developed. The Project Manager is responsible for development of documentation of procedures which deviate from those presented herein.

Field Team Leader - The Field Team Leader is responsible for selecting and detailing the specific groundwater sampling techniques and equipment to be used, and documenting these in the Sampling and Analysis Plan. It is the responsibility of the Field Team Leader to ensure that these procedures are implemented in the field and that personnel performing sampling activities have been briefed and trained to execute these procedures.

Sampling Personnel - It is the responsibility of the field sampling personnel to follow these procedures, or to follow documented, project-specific procedures as directed by the Field Team

Leader and the Project Manager. The sampling personnel are responsible for the proper acquisition of groundwater samples.

5.0 PROCEDURES

To be useful and accurate, a groundwater sample must be representative of the particular zone being sampled. The physical, chemical, and bacteriological integrity of the sample must be maintained from the time of sampling to the time of testing in order to minimize any changes in water quality parameters.

The groundwater sampling program should be developed with reference to ASTM D4448-85A, Standard Guide for Sampling Groundwater Monitoring Wells (Attachment A). This reference is not intended as a monitoring plan or procedure for a specific application, but rather is a review of methods. Specific methods shall be stated in the Sampling and Analysis Plan (SAP).

Methods for withdrawing samples from completed wells include the use of pumps, compressed air, bailers, and various types of samplers. The primary considerations in obtaining a representative sample of the groundwater are to avoid collection of stagnant (standing) water in the well and to avoid physical or chemical alteration of the water due to sampling techniques. In a non-pumping well, there will be little or no vertical mixing of water in the well pipe or casing, and stratification will occur. The well water in the screened section will mix with the groundwater due to normal flow patterns, but the well water above the screened section will remain largely isolated and become stagnant. To safeguard against collecting non-representative stagnant water in a sample, the following approach should be followed during sample withdrawal:

1. All monitoring wells shall be pumped or bailed prior to withdrawing a sample. Evacuation of three to five volumes is recommended for a representative sample.
2. Wells that can be pumped or bailed to dryness with the sampling equipment being used, shall be evacuated and allowed to recover prior to sample withdrawal. If the recovery rate is fairly rapid and time allows, evacuation of at least three well volumes of water is preferred; otherwise, a sample will be taken when enough water is available to fill the sample containers.

Stratification of contaminants may exist in the aquifer formation. This is from concentration gradients due to dispersion and diffusion processes in a homogeneous layer, and from separation of flow streams by physical division (for example, around clay leases) or by contrasts in permeability (for example, between a layer of silty, fine sand and a layer of medium sand).

Pumping rates and volumes for non-production wells during sampling development should be moderate; pumping rates for production wells should be maintained at the rate normal for that well. Excessive pumping can dilute or increase the contaminant concentrations in the recovered sample compared to what is representative of the integrated water column at that point, thus result in the collection of a non-representative sample. Water produced during purging shall be collected, stored or treated and discharged as allowed. Disposition of purge water is usually site specific and must be addressed in the Sampling and Analysis Plan.

5.1 Sampling, Monitoring, and Evacuation Equipment

Sample containers shall conform with EPA regulations for the appropriate contaminants and to the specific Quality Assurance Project Plan.

The following list is an example of the type of equipment that generally must be on hand when sampling groundwater wells:

1. Sample packaging and shipping equipment - Coolers for sample shipping and cooling, chemical preservatives, and appropriate packing cartons and filler, labels and chain-of-custody documents.

2. Field tools and instrumentation - Thermometer; pH meter; specific conductivity meter; appropriate keys (for locked wells) or bolt-cutter; tape measure; water-level indicator; and, where applicable, flow meter.

3. Pumps

    a. Shallow-well pumps - Centrifugal, pitcher, suction, or peristaltic pumps with droplines, air-lift apparatus (compressor and tubing), as applicable.

    b. Deep-well pumps - Submersible pump and electrical power generating unit, bladder pump with compressed air source, or air-lift apparatus, as applicable.

4. Tubing - Sample tubing such as teflon, polyethylene, polypropylene, or PVC. Tubing type shall be selected based on specific site requirements and must be chemically inert to the groundwater being sampled.

5. Other Sampling Equipment - Bailers, teflon-coated wire, stainless steel single strand wire, and polypropylene monofilament line (not acceptable in EPA Region I) with

tripod-pulley assembly (if necessary). Bailers shall be used to obtain samples for volatile organics from shallow and deep groundwater wells.

6. Pails - Plastic, graduated.
7. Decontamination solutions - Decontamination materials are discussed in SOP F501 and F502.

Ideally, sample withdrawal equipment should be completely inert, economical, easily cleaned, sterilized, and reusable, able to operate at remote sites in the absence of power sources, and capable of delivering variable rates for well flushing and sample collection.

5.2 Calculations of Well Volume

Calculation of gallons/linear feet from a well

$$V = \pi r^2 h$$

Where: V = volume of standing water in well
r = well radius
h = feet of standing water in well

Table 5-1 lists gallons and cubic feet of water per standing foot of water for a variety of well diameter.

TABLE 5-1
WELL VOLUMES

Diameter of Casing or Hole (in.)	Gallons per Foot of Depth	Cubic Feet per Foot of Depth
1	0.041	0.0055
2	0.163	0.0218
4	0.653	0.0873
6	1.469	0.1963
8	2.611	0.3491
10	4.080	0.5454

Notes:
1. Gallons per foot of depth will be multiplied by amount of standing water to obtain well volume quantity.
2. 1 gallon = 3.785 liters
1 meter = 3.281 feet
1 gallon water weighs 8.33 pounds = 3.785 kilograms
1 liter water weighs 1 kilogram = 2.205 pounds
1 gallon per foot of depth = 12.419 liters per foot of depth
1 gallon per meter of depth = 12.419×10^{-3} cubic meters per meter of depth

To insure that the proper volume of water has been removed from the well prior to sampling, it is first necessary to determine the volume of standing water in the well pipe or casing. The volume can be easily calculated by the following method. Calculations shall be entered in the field logbook:

1. Obtain all available information on well construction (location, casing, screens, etc.).
2. Determine well or casing diameter.
3. Measure and record static water level (depth below ground level or top of casing reference point), using one of the methods described in Section 5.1 of SOP F202.
4. Determine the depth of the well (if not known from past records) to the nearest 0.01-foot by sounding using a clean, decontaminated weighted tape measure.
5. Calculate number of linear feet of static water (total depth or length of well pipe or casing minus the depth to static water level).
6. Calculate the volume of water in the casing:

$$VW = \pi D^2 (TD - DW)$$

$$V_{gal} = VW \times 7.48 \text{ gallons/ft}^3$$

$$V_{purge} = Vgal\,(\#\text{ Well Vol})$$

Where:

V_W = Volume of water in well in cubic feet (i.e., one well volume)
π = pi, 3.14
D = Well diameter in feet (use (D/12) if D is in inches)
TD = Total depth of well in feet (below ground surface or top of casing)
DW = Depth to water in feet (below ground surface or top of casing)
V_{gal} = Volume of water in well in gallons
V_{purge} = Volume of water to be purged from well in gallons
\# Well Vol. = Number of well volumes of water to be purged from the well (typically three to five)

7. Determine the minimum number of gallons to be evacuated before sampling. (Note: V_{purge} should be rounded to the next highest whole gallon. For example, 7.2 gallons should be rounded to 8 gallons.)

5.3 Evacuation of Static Water (Purging)

The amount of flushing a well should receive prior to sample collection will depend on the intent of the monitoring program and the hydrogeologic conditions. Programs to determine overall quality of water resources may require long pumping periods to obtain a sample that is representative of a large volume of that aquifer. The pumped volume may be specified prior to sampling so that the sample can be a composite of a known volume of the aquifer.

For defining a contaminant plume, a representative sample of only a small volume of the aquifer is required. These circumstances require that the well be pumped enough to remove the stagnant water but not enough to induce significant groundwater flow from a wide area. Generally, three to five well volumes are considered effective for purging a well.

An alternative method of purging a well, and one accepted in EPA Regions I and IV, is to purge a well continuously (usually using a low volume, low flow pump) while monitoring specific conductance, pH, and water temperature until the values stabilize. The well is considered properly purged when the values have stabilized.

The Project Manager shall define the objectives of the groundwater sampling program in the Sampling and Analysis Plan, and provide appropriate criteria and guidance to the sampling personnel on the proper methods and volumes of well purging.

5.3.1 Evacuation Devices

The following discussion is limited to those devices which are commonly used at hazardous waste sites. Note that all of these techniques involve equipment which is portable and readily available.

Bailers - Bailers are the simplest evacuation devices used and have many advantages. They generally consist of a length of pipe with a sealed bottom (bucket-type bailer) or, as is more useful and favored, with a ball check-valve at the bottom. An inert line (e.g., Teflon-coated) is used to lower the bailer and retrieve the sample.

Advantages of bailers include:

- Few limitations on size and materials used for bailers.
- No external power source needed.
- Inexpensive.
- Minimal outgassing of volatile organics while the sample is in the bailer.
- Relatively easy to decontaminate.

Limitations on the use of bailers include the following:

- Potentially excessively time consuming to remove stagnant water using a bailer.
- Transfer of sample may cause aeration.
- Use of bailers is physically demanding, especially in warm temperatures at protection levels above Level D.

Suction Pumps - There are many different types of inexpensive suction pumps including centrifugal, diaphragm, peristaltic, and pitcher pumps. Centrifugal and diaphragm pumps can be used for well evacuation at a fast pumping rate and for sampling at a low pumping rate. The peristaltic pump is a low volume pump (generally not suitable for well purging) that uses rollers to squeeze a flexible tubing, thereby creating suction. This tubing can be dedicated to a well to prevent cross contamination. The pitcher pump is a common farm hand-pump.

These pumps are all portable, inexpensive and readily available. However, because they are based on suction, their use is restricted to areas with water levels within 10 to 25 feet of the ground surface. A significant limitation is that the vacuum created by these pumps will cause significant loss of dissolved gases, including volatile organics. In addition, the complex internal components of these pumps may be difficult to decontaminate.

Gas-Lift Samples - This group of samplers uses gas pressure either in the annulus of the well or in a venturi to force the water up a sampling tube. These pumps are also relatively inexpensive. Gas lift pumps are more suitable for well development than for sampling because the samples may be aerated, leading to pH changes and subsequent trace metal precipitation or loss of volatile organics. An inert gas such as nitrogen is generally used as a gas source.

Submersible Pumps - Submersible pumps take in water and push the sample up a sample tube to the surface. The power sources for these samplers may be compressed air or electricity. The operation principles vary and the displacement of the sample can be by an inflatable bladder, sliding piston, gas bubble, or impeller. Pumps are available for two-inch diameter wells and larger. These pumps can lift water from considerable depths (several hundred feet).

Limitations of this class of pumps include:

- Potentially low delivery rates.
- Many models of these pumps are expensive.
- Compressed gas or electric power is needed.
- Sediment in water may cause clogging of the valves or eroding the impellers with some of these pumps.
- Decontamination of internal components is difficult and time-consuming.

5.4 Sampling

The sampling approach consisting of the following, should be developed as part of the Sampling and Analysis Plan prior to the field work:

1. Background and objectives of sampling.

2. Brief description of area and waste characterization.

3. Identification of sampling locations, with map or sketch, and applicable well construction data (well size, depth, screened interval, reference elevation).

4. Sampling equipment to be used.

5. Intended number, sequence volumes, and types of samples. If the relative degrees of contamination between wells is unknown or insignificant, a sampling sequence which facilitates sampling logistics may be followed. Where some wells are known or strongly suspected of being highly contaminated, these should be sampled last to reduce the risk of cross-contamination between wells as a result of the sampling procedures.

6. Sample preservation requirements.

7. Schedule.

8. List of team members.

9. Other information, such as the necessity for a warrant or permission of entry, requirement for split samples, access problems, location of keys, etc.

5.4.1 Sampling Methods

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 according to Section 5.2 of this SOP.

3. Lower purging equipment or intake into the well to a short distance below the water level and begin water removal. Collect the purged water and dispose of it in an acceptable manner (e.g., DOT-approved 55-gallon drum).

4. Measure the rate of discharge frequently. A bucket and stopwatch are most commonly used; other techniques include using pipe trajectory methods, weir boxes or flow meters.

5. Observe peristaltic pump intake for degassing "bubbles" and all pump discharge lines. If bubbles are abundant and the intake is fully submerged, this pump is not suitable for collecting samples for volatile organics. The preferred method for collecting volatile organic samples and the accepted method by EPA Regions I through IV is with a bailer.

6. 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.

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

8. If sampling using a pump, lower the pump intake to midscreen or the middle of the open section in uncased wells and collect the sample. If sampling with a bailer, lower the bailer to the sampling level before filling (this requires use of other than a "bucket-type" bailer). Purged water should be collected in a designated container and disposed of in an acceptable manner.

9. (For pump and packer assembly only). Lower assembly into well so that packer is positioned just above the screen or open section and inflate. Purge a volume equal to at least twice the screened interval or unscreened open section volume below the packer before sampling. Packers should always be tested in a casing section above ground to determine proper inflation pressures for good sealing.

10. In the event that recovery time of the well is very slow (e.g., 24 hours), sample collection can be delayed until the following day. If the well has been bailed early in

the morning, sufficient water may be standing in the well by the day's end to permit sample collection. If the well is incapable of producing a sufficient volume of sample at any time, take the largest quantity available and record in the logbook.

11. Add preservative if required (see SOP F301). Label, tag, and number the sample bottle(s).
12. Purgeable organics vials (40 ml) should be completely filled to prevent volatilization and extreme caution should be exercised when filling a vial to avoid turbulence which could also produce volatilization. The sample should be carefully poured down the side of the vial to minimize turbulence. As a rule, it is best to gently pour the last few drops into the vial so that surface tension holds the water in a "convex meniscus." The cap is then applied and some overflow is lost, but air space in the bottle is eliminated. After capping, turn the bottle over and tap it to check for bubbles; if any are present, repeat the procedure.
13. Replace the well cap. Make sure the well is readily identifiable as the source of the samples.
14. Pack the samples for shipping (see SOP F301). Attach custody seals to the shipping container. Make sure that Chain-of-Custody forms and Sample Analysis Request forms are properly filled out and enclosed or attached (see SOP F302).
15. Decontaminate all equipment.

5.4.2 Sample Containers

For most samples and analytical parameters, either glass or plastic containers are satisfactory. SOP F301 describes the required sampling containers for various analytes at various concentrations. Container requirements shall follow those given in NEESA 20.2-047B.

5.4.3 Preservation of Samples and Sample Volume Requirements

Sample preservation techniques and volume requirements depend on the type and concentration of the contaminant and on the type of analysis to be performed. SOP F301 describes the sample preservation and volume requirements for most of the chemicals that will be encountered during hazardous waste site investigations. Sample volume and preservation requirements shall follow those given in NEESA 20.2-047B.

5.4.4 Field Filtration

In general, preparation and preservation of water samples involve some form of filtration. All filtration must occur in the field immediately upon collection. The recommended method is through the use of a disposable in-line filtration module (0.45 micron filter) utilizing the pressure provided by the upstream pumping device for its operation.

In Region I, all inorganics are to be collected and preserved in the filtered form, including metals. In Region II, metals samples are to be collected and preserved unfiltered. In Regions III and IV, samples collected for metals analysis are also to be unfiltered. However, if metals analysis of monitoring wells is required, then both an unfiltered and filtered sample are to be collected, regardless of regulatory requirements. Filtration and preservation are to occur immediately in the field with the sample aliquot passing through a 0.45 micron filter. Samples for organic analyses shall never be filtered. Filters must be prerinsed with organic-free, deionized water.

5.4.5 Handling and Transporting Samples

After collection, samples should be handled as little as possible. It is preferable to use self-contained "chemical" ice (e.g., "blue ice") to reduce the risk of contamination. If water ice is used, it should be double-bagged and steps taken to ensure that the melted ice does not cause sample containers to be submerged, and thus possibly become cross-contaminated. All sample containers should be enclosed in plastic bags or cans to prevent cross-contamination. Samples should be secured in the ice chest to prevent movement of sample containers and possible breakage. Sample packing and transportation requirements are described in SOP F301.

5.4.6 Sample Holding Times

Holding times (i.e., allowed time between sample collection and analysis) for routine samples are given in NEESA 20.2-047B.

6.0 QUALITY ASSURANCE RECORDS

Quality assurance records will be maintained for each sample that is collected. The following information will be recorded in the Field Logbook:

- Sample identification (site name, location, project no.; sample name/number and location; sample type and matrix; time and date; sampler's identity).
- Sample source and source description.
- Field observations and measurements (appearance; volatile screening; field chemistry; sampling method; volume of water purged prior to sampling; number of well volumes purged).
- Sample disposition (preservatives added; lab sent to; date and time).
- Additional remarks, as appropriate.

Proper chain-of-custody procedures play a crucial role in data gathering. SOP F302 describes the requirements for correctly completing a chain-of-custody form. Chain-of-custody forms (and sample analysis request forms) are considered quality assurance records.

7.0 REFERENCES

American Society of Testing and Materials. 1987. Standard Guide for Sampling Groundwater Monitoring Wells. Method D4448-85A, Annual Book of Standards, ASTM, Philadelphia, Pennsylvania.

U. S. EPA, 1991. Standard Operating Procedures and Quality Assurance Manual. Environmental Compliance Branch, U. S. EPA, Environmental Services Division, Athens, Georgia.

ATTACHMENT A

ASTM D4448-85A
STANDARD GUIDE FOR SAMPLING GROUNDWATER MONITORING WELLS

Designation: D 4448 - 85a

AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Guide for Sampling Groundwater Monitoring Wells[1]

This standard is issued under the fixed designation D 4448; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide covers procedures for obtaining valid, representative samples from groundwater monitoring wells. The scope is limited to sampling and "in the field" preservation and does not include well location, depth, well development, design and construction, screening, or analytical procedures.

1.2 This guide is only intended to provide a review of many of the most commonly used methods for sampling groundwater quality monitoring wells and is not intended to serve as a groundwater monitoring plan for any specific application. Because of the large and ever increasing number of options available, no single guide can be viewed as comprehensive. The practitioner must make every effort to ensure that the methods used, whether or not they are addressed in this guide, are adequate to satisfy the monitoring objectives at each site.

1.3 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of whoever uses this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Summary of Guide

2.1 The equipment and procedures used for sampling a monitoring well depend on many factors. These include, but are not limited to, the design and construction of the well, rate of groundwater flow, and the chemical species of interest. Sampling procedures will be different if analyzing for trace organics, volatiles, oxidizable species, or trace metals is needed. This guide considers all of these factors by discussing equipment and procedure options at each stage of the sampling sequence. For ease of organization, the sampling process can be divided into three steps: well flushing, sample withdrawal, and field preparation of samples.

2.2 Monitoring wells must be flushed prior to sampling so that the groundwater is sampled, not the stagnant water in the well casing. If the well casing can be emptied, this may be done although it may be necessary to avoid oxygen contact with the groundwater. If the well cannot be emptied, procedures must be established to demonstrate that the sample represents groundwater. Monitoring an indicative parameter such as pH during flushing is desirable if such a parameter can be identified.

2.3 The types of species that are to be monitored as well as the concentration levels are prime factors for selecting sampling devices (**1, 2**).[2] The sampling device and all materials and devices the water contacts must be constructed of materials that will not introduce contaminants or alter the analyte chemically in any way.

2.4 The method of sample withdrawal can vary with the parameters of interest. The ideal sampling scheme would employ a completely inert material, would not subject the sample to negative pressure and only moderate positive pressure, would not expose the sample to the atmosphere, or preferably, any other gaseous atmosphere before conveying it to the sample container or flow cell for on-site analysis.

2.5 The degree and type of effort and care that goes into a sampling program is always dependent on the chemical species of interest and the concentration levels of interest. As the concentration level of the chemical species of analytical interest decreases, the work and precautions necessary for sampling are increased. Therefore, the sampling objective must clearly be defined ahead of time. For example, to prepare equipment for sampling for mg/L (ppm) levels of Total Organic Carbon (TOC) in water is about an order of magnitude easier than preparing to sample for μg/L (ppb) levels of a trace organic like benzene. The specific precautions to be taken in preparing to sample for trace organics are different from those to be taken in sampling for trace metals. No final Environmental Protection Agency (EPA) protocol is available for sampling of trace organics. A short guidance manual, (**3**) and an EPA document (**4**) concerning monitoring well sampling, including considerations for trace organics are available.

2.6 Care must be taken not to cross contaminate samples or monitoring wells with sampling or pumping devices or materials. All samples, sampling devices, and containers must be protected from the environment when not in use. Water level measurements should be made before the well is flushed. Oxidation-reduction potential, pH, dissolved oxygen, and temperature measurements and filtration should all be performed on the sample in the field, if possible. All but temperature measurement must be done prior to any significant atmospheric exposure, if possible.

2.7 The sampling procedures must be well planned and all sample containers must be prepared and labeled prior to going to the field.

3. Significance and Use

3.1 The quality of groundwater has become an issue of national concern. Groundwater monitoring wells are one of

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[1] This guide is under the jurisdiction of ASTM Committee D-34 on Waste Disposal and is the direct responsibility of Subcommittee D34.01 on Sampling and Monitoring.

Current edition approved Aug. 23 and Oct. 25, 1985. Published May 1986.

[2] The boldface numbers in parentheses refer to a list of references at the end of this guide.

TABLE 1 Typical Container and Preservation Requirements for a Ground-Water Monitoring Program

Sample and Measurement	Volume Required (mL)	Container P—Polyethylene G—Glass	Preservative	Maximum Holding Time
Metals As/Ba/Cd/Cr/Fe Pb/Se/Ag/Mn/Na	1000–2000	P/G (special acid cleaning)	high purity nitric acid to pH <2	6 months
Mercury	200–300	P/G (special acid cleaning)	high purity nitric acid to pH <2 +0.05 % $K_2Cr_2O_7$	28 days
Radioactivity alpha/beta/radium	4000	P/G (special acid cleaning)	high purity nitric acid to pH <2	6 months
Phenolics	500–1000	G	cool, 4°C H_2SO_4 to pH <2	28 days
Miscellaneous	1000–2000	P	cool, 4°C	28 days
Fluoride	300–500	P		28 days
Chloride	50–200	P/G		28 days
Sulfate	100–500	P/G		48 hours
Nitrate	100–250	P/G		6 h
Coliform	100	P/G		on site/24 h
Conductivity	100	P/G		on site/6 h
pH	100	P/G		48 h
Turbidity	100	P/G		
Total organic carbon (TOC)	25–100	P/G	cool, 4°C or cool, 4°C HCl or H_2SO_4 to pH <2	24 h 28 days
Pesticides, herbicides and total organic halogen (TOX)	1000–4000	G/TFE-fluorocarbon lined cap solvent rinsed	cool, 4°C	7 days/extraction +30 days/analysis
Extractable organics	1000–2000	G/TFE-fluorocarbon-lined cap solvent rinsed	cool, 4°C	7 days/extraction +30 days/analysis
Organic purgeables acrolein/acrylonitrile	25–120	G/vial TFE-fluorocarbon-lined septum	cool, 4°C	14 days 3 days

the more important tools for evaluating the quality of groundwater, delineating contamination plumes, and establishing the integrity of hazardous material management facilities.

3.2 The goal in sampling groundwater monitoring wells is to obtain samples that are truly representative of the aquifer or groundwater in question. This guide discusses the advantages and disadvantages of various well flushing, sample withdrawal, and sample preservation techniques. It reviews the parameters that need to be considered in developing a valid sampling plan.

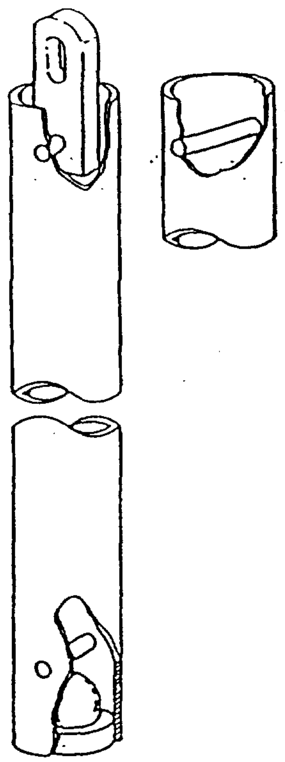
4. Well Flushing (Purging)

4.1 Water that stands within a monitoring well for a long period of time may become unrepresentative of formation water because chemical or biochemical change may cause water quality alterations and even if it is unchanged from the time it entered the well, the stored water may not be representative of formation water at the time of sampling, or both. Because the representativeness of stored water is questionable, it should be excluded from samples collected from a monitoring well.

4.2 The surest way of accomplishing this objective is to remove all stored water from the casing prior to sampling. Research with a tracer in a full scale model 2 in. PVC well (5) indicates that pumping 5 to 10 times the volume of the well via an inlet near the free water surface is sufficient to remove all the stored water in the casing. The volume of the well may be calculated to include the well screen and any gravel pack if natural flow through these is deemed insufficient to keep them flushed out.

4.3 In deep or large diameter wells having a volume of water so large as to make removal of all the water impractical, it may be feasible to lower a pump or pump inlet to some point well below the water surface, purge only the volume below that point then withdraw the sample from a deeper level. Research indicates this approach should avoid most contamination associated with stored water (5, 6, 7). Sealing the casing above the purge point with a packer may make this approach more dependable by preventing migration of stored water from above. But the packer must be above the top of the screened zone, or stagnant water from above the packer will flow into the purged zone through the well's gravel/sand pack.

4.4 In low yielding wells, the only practical way to remove all standing water may be to empty the casing. Since it is not always possible to remove all water, it may be advisable to let the well recover (refill) and empty it again at least once. If introduction of oxygen into the aquifer may be of concern, it would be best not to uncover the screen when performing the above procedures. The main disadvantage of methods designed to remove all the stored water is that large volumes may need to be pumped in certain instances. The main advantage is that the potential for contamination of samples with stored water is minimized.



NOTE—Taken from Ref (15).

FIG. 1 Single Check Valve Bailer

4.5 Another approach to well flushing is to monitor one or more indicator parameters such as pH, temperature, or conductivity and consider the well to be flushed when the indicator(s) no longer change. The advantage of this method is that pumping can be done from any location within the casing and the volume of stored water present has no direct bearing on the volume of water that must be pumped. Obviously, in a low yielding well, the well may be emptied before the parameters stabilize. A disadvantage of this approach is that there is no assurance in all situations that the stabilized parameters represent formation water. If significant drawdown has occurred, water from some distance away may be pulled into the screen causing a steady parameter reading but not a representative reading. Also, a suitable indicator parameter and means of continuously measuring it in the field must be available.

4.6 Gibb (4, 8) has described a time-drawdown approach using a knowledge of the well hydraulics to predict the percentage of stored water entering a pump inlet near the top of the screen at any time after flushing begins. Samples are taken when the percentage is acceptably low. As before, the advantage is that well volume has no direct effect in the duration of pumping. A current knowledge of the well's hydraulic characteristics is necessary to employ this approach. Downward migration of stored water due to effects other than drawdown (for example density differences) is not accounted for in this approach.

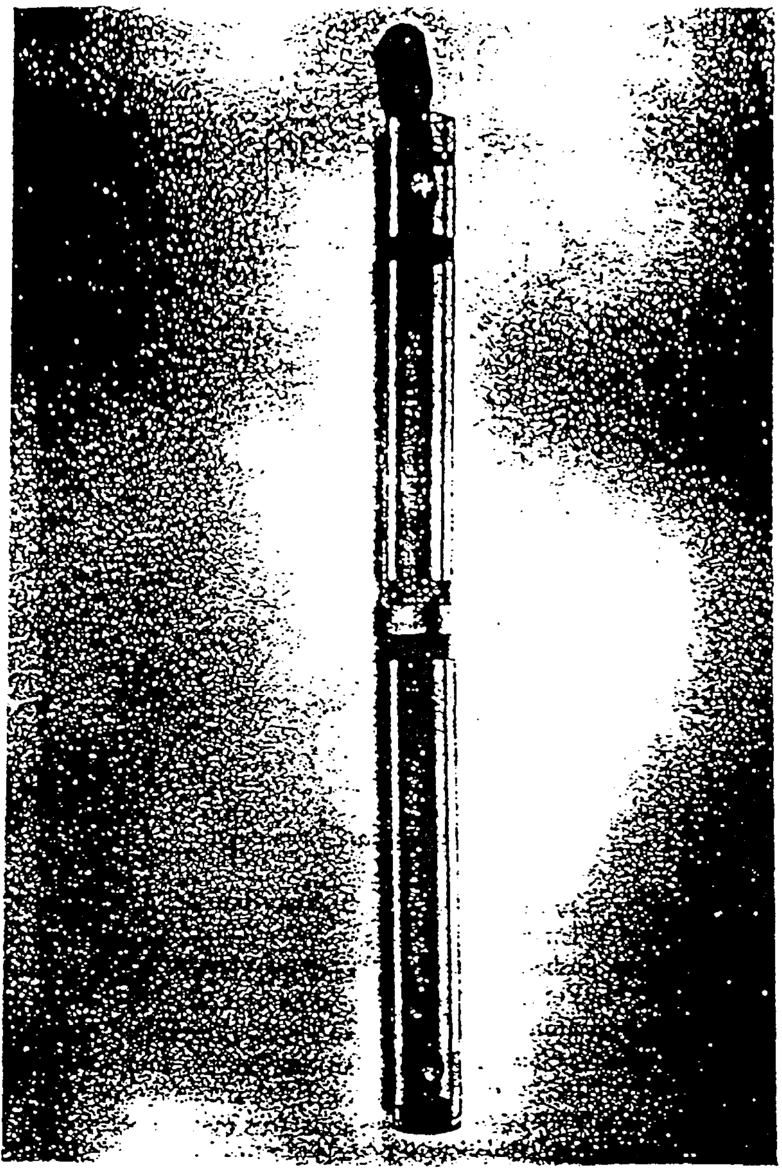
4.7 In any flushing approach, a withdrawal rate that minimizes drawdown while satisfying time constraints should be used. Excessive drawdown distorts the natural flow patterns around a well and can cause contaminants that were not present originally to be drawn into the well.

5. Materials and Manufacture

5.1 The choice of materials used in the construction of sampling devices should be based upon a knowledge of what compounds may be present in the sampling environment and how the sample materials may interact via leaching, adsorption, or catalysis. In some situations, PVC or some other plastic may be sufficient. In others, an all glass apparatus may be necessary.

5.2 Most analytical protocols suggest that the devices used in sampling and storing samples for trace organics analysis (μg/L levels) must be constructed of glass or TFE-fluorocarbon resin, or both. One suggestion advanced by the EPA is that the monitoring well be constructed so that only TFE-fluorocarbon tubing be used in that portion of the sampling well that extends from a few feet above the water table to the bottom of the borehole. (3, 5) Although this type of well casing is now commercially available, PVC well casings are currently the most popular. If adhesives are avoided, PVC well casings are acceptable in many cases although their use may still lead to some problems if trace organics are of concern. At present, the type of background presented by PVC and interactions occurring between PVC and groundwater are not well understood. Tin, in the form of an organotin stabilizer added to PVC, may enter samples taken from PVC casing. (9)

5.3 Since the most significant problem encountered in trace organics sampling, results from the use of PVC adhesives in monitoring well construction, threaded joints might avoid the problem (3, 5). Milligram per litre (parts per million) levels of compounds such as tetrahydrofuran, methyl-ethyl-ketone, and toluene are found to leach into



NOTE—Taken from Ref (17).

FIG. 2 Acrylic Point Source Bailer

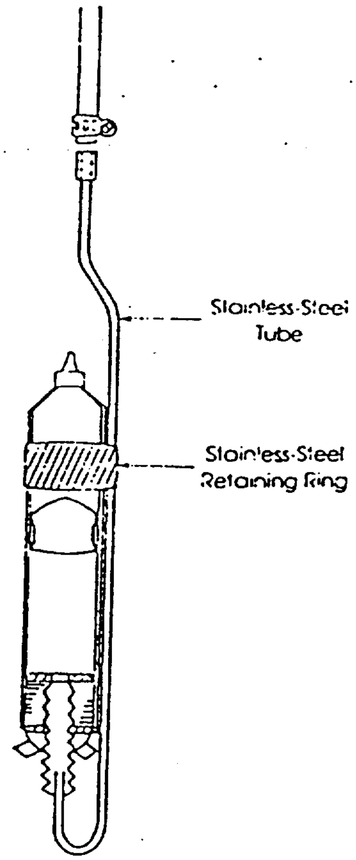
groundwater samples from monitoring well casings sealed with PVC solvent cement. Pollutant phthalate esters (8, 10) are often found in water samples at ppb levels; the EPA has found them on occasion at ppm levels in their samples. The ubiquitous presence of these phthalate esters is unexplained, except to say that they may be leached from plastic pipes, sampling devices, and containers.

5.4 TFE-fluorocarbon resins are highly inert and have sufficient mechanical strength to permit fabrication of sampling devices and well casings. Molded parts are exposed to high temperature during fabrication which destroys any organic contaminants. The evolution of fluorinated compounds can occur during fabrication, will cease rapidly, and does not occur afterwards unless the resin is heated to its melting point.

5.5 Extruded tubing of TFE-fluorocarbon for sampling may contain surface traces of an organic solvent extrusion aid. This can be removed easily by the fabricator and, once removed by flushing, should not affect the sample. TFE-fluorocarbon FEP and TFE-fluorocarbon PFA resins do not require this extrusion aid and may be suitable for sample tubing as well. Unsintered thread-sealant tape of TFE-fluorocarbon is available in an "oxygen service" grade and contains no extrusion aid and lubricant.

5.6 Louneman, et al. (11) alludes to problems caused by a lubricating oil used during TFE-fluorocarbon tubing extrusion. This reference also presents evidence that a fluorinated ethylene-propylene copolymer adsorbed acetone to a degree that later caused contamination of a gas sample.

5.7 Glass and stainless steel are two other materials generally considered inert in aqueous environments. Glass is probably among the best choices though it is not inconceivable it could adsorb some constituents as well as release other contaminants (for example, Na, silicate, and Fe). Of cour glass sampling equipment must be handled carefully in t field. Stainless steel is strongly and easily machined



NOTE—Taken from Ref (21).

FIG. 3 Schematic of the Inverted Syringe Sampler

fabricate equipment. Unfortunately, it is not totally immune to corrosion that could release metallic contaminants. Stainless steel contains various alloying metals, some of these (for example Ni) are commonly used as catalysts for various reactions. The alloyed constituents of some stainless steels can be solubilized by the pitting action of nonoxidizing anions such as chloride, fluoride, and in some instances sulfate, over a range of pH conditions. Aluminum, titanium, polyethylene, and other corrosion resistant materials have been proposed by some as acceptable materials, depending on groundwater quality and the constituents of interest.

5.8 Where temporarily installed sampling equipment is used, the sampling device that is chosen should be nonplastic (unless TFE-fluorocarbon), cleanable of trace organics, and must be cleaned between each monitoring well use in order to avoid cross-contamination of wells and samples. The only way to ensure that the device is indeed "clean" and acceptable is to analyze laboratory water blanks and field water blanks that have been soaked in and passed through the sampling device to check for the background levels that may result from the sampling materials or from field conditions. Thus, all samplings for trace materials should be accompanied by samples which represent the field background (if possible), the sampling equipment background, and the laboratory background.

5.9 Additional samples are often taken in the field and spiked (spiked-field samples) in order to verify that the sample handling procedures are valid. The American Chemical Society's committee on environmental improvement h published guidelines for data acquisition and data evaluati which should be useful in such environmental evaluatio (10, 12).

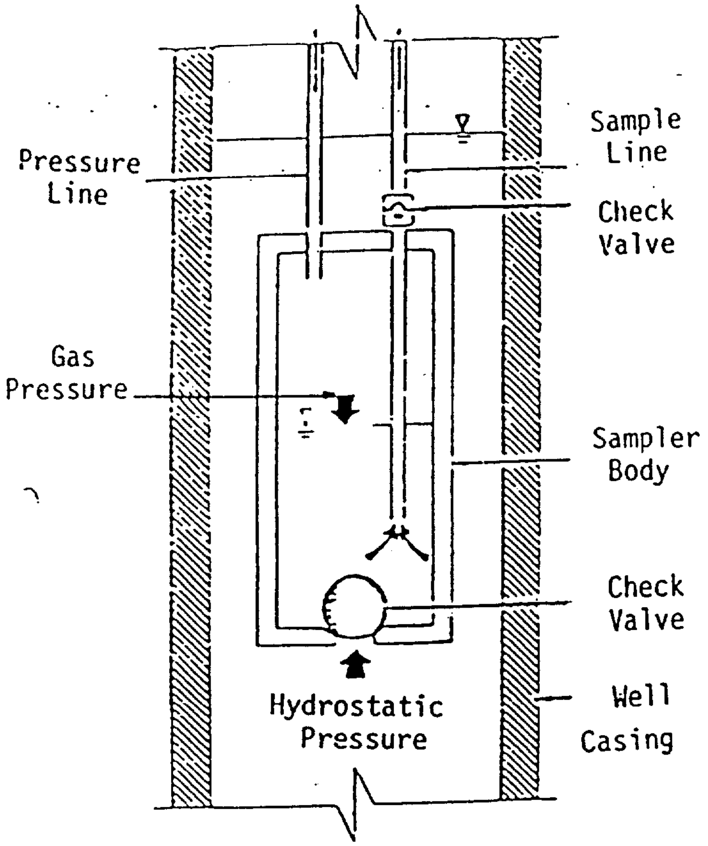
6. Sampling Equipment

6.1 There is a fairly large choice of equipment present available for groundwater sampling from single screen wells and well clusters. The sampling devices can be categ rized into the following eight basic types.

6.1.1 *Down-Hole Collection Devices:*

6.1.1.1 Bailers, messenger bailers, or thief samplers (1 14) are examples of down-hole devices that probably provi valid samples once the well has been flushed. They are n practical for removal of large volumes of water. The devices can be constructed in various shapes and sizes from variety of materials. They do not subject the sample t pressure extremes.

6.1.1.2 Bailers do expose part of the sample to th atmosphere during withdrawal. Bailers used for sampling volatile organic compounds should have a sample cock draft valve in or near the bottom of the sampler allowin withdrawal of a sample from the well below the expose surface of the water or the first few inches of the sampl should be discarded. Suspension lines for bailers and oth samplers should be kept off the ground and free of oth contaminating materials that could be carried into the wel Down-hole devices are not very practical for use in dee



NOTE—Taken from Ref (5).

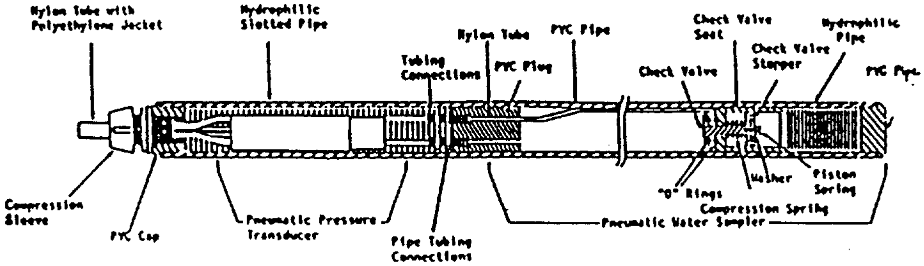
FIG. 4 The Principal of Gas Displacement Pumping

wells. However, potential sample oxidation during transfer of the sample into a collection vessel and time constraints for lowering and retrieval for deep sampling are the primary disadvantages.

6.1.1.3 Three down-hole devices are the single and double check valve bailers and thief samplers. A schematic of a single check valve unit is illustrated in Fig. 1. The bailer may be threaded in the middle so that additional lengths of blank casing may be added to increase the sampling volume. TFE-fluorocarbon or PVC are the most common materials used for construction (15).

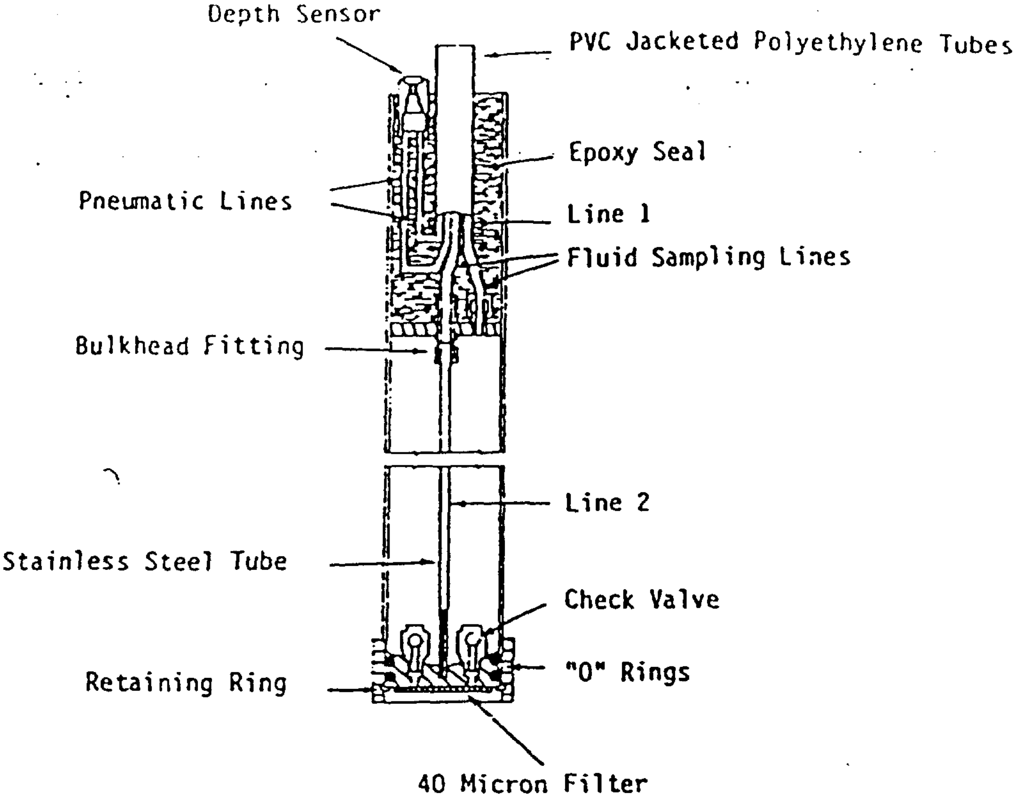
6.1.1.4 In operation, the single check valve bailer is lowered into the well, water enters the chamber through the bottom, and the weight of the water column closes the check valve upon bailer retrieval. The specific gravity of the ball should be about 1.4 to 2.0 so that the ball almost sits on the check valve seat during chamber filling. Upon bailer withdrawal, the ball will immediately seat without any samples loss through the check valve. A similar technique involves lowering a sealed sample container within a weighted bottle into the well. The stopper is then pulled from the bottle via a line and the entire assembly is retrieved upon filling of the container (14, 16).

6.1.1.5 A double check valve bailer allows point source sampling at a specific depth (15, 17). An example is shown in Fig. 2. In this double check valve design, water flows through the sample chamber as the unit is lowered. A venturi tapered inlet and outlet ensures that water passes freely through the



NOTE—Taken from Ref (41).

FIG. 5 Pneumatic Water Sampler With Internal Transducer



NOTE—Taken from Ref (42).

FIG. 6 Pneumatic Sampler With Externally Mounted Transducer

unit. When a depth where the sample is to be collected is reached, the unit is retrieved. Because the difference between each ball and check valve seat is maintained by a pin that blocks vertical movement of the check ball, both check valves close simultaneously upon retrieval. A drainage pin is placed into the bottom of the bailer to drain the sample directly into a collection vessel to reduce the possibility of air oxidation. The acrylic model in Fig. 2 is threaded at the midsection allowing the addition of threaded casing to increase the sampling volume.

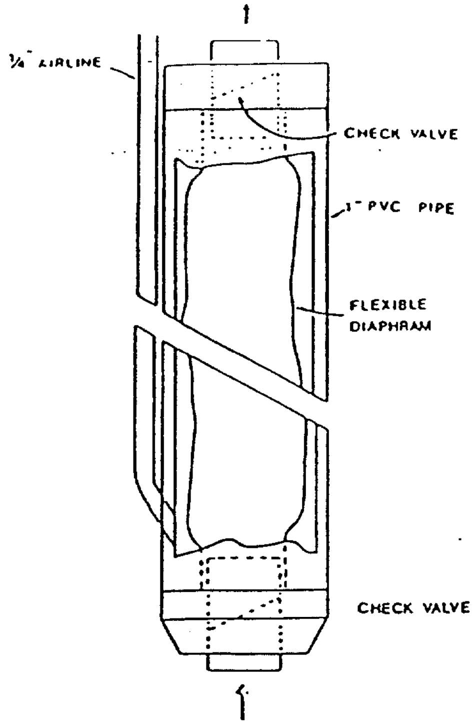
6.1.1.6 Another approach for obtaining point source samples employs a weighted messenger or pneumatic change to "trip" plugs at either end of an open tube (for example, tube water sampler or thief sampler) to close the chamber **(18)**. Foerst, Kemmerer, and Bacon samplers are of this variety **(14, 17, 19)**. A simple and inexpensive pneumatic sampler was recently described by Gillham (20). The device (Fig. 3) consists of a disposable 50 mL plastic syringe modified by sawing off the plunger and the finger grips. The syringe is then attached to a gas-line by means of a rubber stopper assembly. The gas-line extends to the surface, and is used to drive the stem-less plunger, and to raise and lower the syringe into the hole. When the gas-line is pressurized, the rubber plunger is held at the tip of the syringe. The sampler is then lowered into the installation, and when the desired depth is reached, the pressure in the gas-line is reduced to atmospheric (or slightly less) and water enters the syringe. The sampler is then retrieved from the installation and the syringe detached from the gas-line. After the tip is sealed, the syringe is used as a short-term storage container. A number of thief or messenger devices are available in various materials and shapes.

6.1.2 *Suction Lift Pumps:*

6.1.2.1 Three types of suction lift pumps are the direct line, centrifugal, and peristaltic. A major disadvantage of any suction pump is that it is limited in its ability to raise water by the head available from atmospheric pressure. Thus, if the surface of the water is more than about 25 ft below the pump, water may not be withdrawn. The theoretical suction limit is about 34 ft, but most suction pumps are capable of maintaining a water lift of only 25 ft or less.

6.1.2.2 Many suction pumps draw the water through some sort of volute in which impellers, pistons, or other devices operate to induce a vacuum. Such pumps are probably unacceptable for most sampling purposes because they are usually constructed of common materials such as brass or mild steel and may expose samples to lubricants. They often induce very low pressures around rotating vanes or other such parts such that degassing or even cavitation may occur. They can mix air with the sample via small leaks in the casing, and they are difficult to adequately clean between uses. Such pumps are acceptable for purging of wells, but should not generally be used for sampling.

6.1.2.3 One exception to the above statements is a peristaltic pump. A peristaltic pump is a self-priming, low volume suction pump which consists of a rotor with ball bearing rollers **(21)**. Flexible tubing is inserted around the pump rotor and squeezed by heads as they revolve in a circular pattern around the rotor. One end of the tubing is placed into the well while the other end can be connected



NOTE—Taken from Ref (4).

FIG. 7 Bladder Pump

directly to a receiving vessel. As the rotor moves, a reduced pressure is created in the well tubing and an increased pressure (<40 psi) on the tube leaving the rotor head. A drive shaft connected to the rotor head can be extended so that multiple rotor heads can be attached to a single drive shaft.

6.1.2.4 The peristaltic pump moves the liquid totally within the sample tube. No part of the pump contacts the liquid. The sample may still be degassed (cavitation is unlikely) but the problems due to contact with the pump mechanism are eliminated. Peristaltic pumps do require a fairly flexible section of tubing within the pumphead itself. A section of silicone tubing is commonly used within the peristaltic pumphead, but other types of tubing can be used particularly for the sections extending into the well or from the pump to the receiving container. The National Council of the Paper Industry for Air and Stream Improvement (22) recommends using medical grade silicone tubing for organic sampling purposes as the standard grade uses an organic vulcanizing agent which has been shown to leach into samples. Medical grade silicone tube is, however, limited to use over a restricted range of ambient temperatures. Various manufacturers offer tubing lined with TFE-fluorocarbon or Viton[3] for use with their pumps. Gibb (1, 8) found little difference between samples withdrawn by a peristaltic pump and those taken by a bailer.

6.1.2.5 A direct method of collecting a sample by suction consists of lowering one end of a length of plastic tubing into the well or piezometer. The opposite end of the tubing is connected to a two way stopper bottle and a hand held or mechanical vacuum pump is attached to a second tubing leaving the bottle. A check valve is attached between the two lines to maintain a constant vacuum control. A sample can then be drawn directly into the collection vessel without contacting the pump mechanism (5, 23, 24).

6.1.2.6 A centrifugal pump can be attached to a length of plastic tubing that is lowered into the well. A foot valve is usually attached to the end of the well tubing to assist in priming the tube. The maximum lift is about 4.6 m (15 ft) for such an arrangement (23, 25, 26).

6.1.2.7 Suction pump approaches offer a simple sample retrieval method for shallow monitoring. The direct line method is extremely portable though considerable oxidation and mixing may occur during collection. A centrifugal pump will agitate the sample to an even greater degree although pumping rates of 19 to 151 Lpm (5 to 40 gpm) can be attained. A peristaltic pump provides a lower sampling rate with less agitation than the other two pumps. The withdrawal rate of peristaltic pumps can be carefully regulated by adjustment of the rotor head revolution.

6.1.2.8 All three systems can be specially designed so that the water sample contacts only the TFE flourocarbon or silicone tubing prior to sample bottle entry. Separate tubing is recommended for each well or piezometer sampled.

6.1.3 *Electric Submersible Pumps:*

6.1.3.1 A submersible pump consists of a sealed electric motor that powers a piston or helical single thread worm at a high rpm. Water is brought to the surface through an access tube. Such pumps have been used in the water well industry for years and many designs exist (5, 26).

6.1.3.2 Submersible pumps provide relatively high discharge rates for water withdrawal at depths beyond suction

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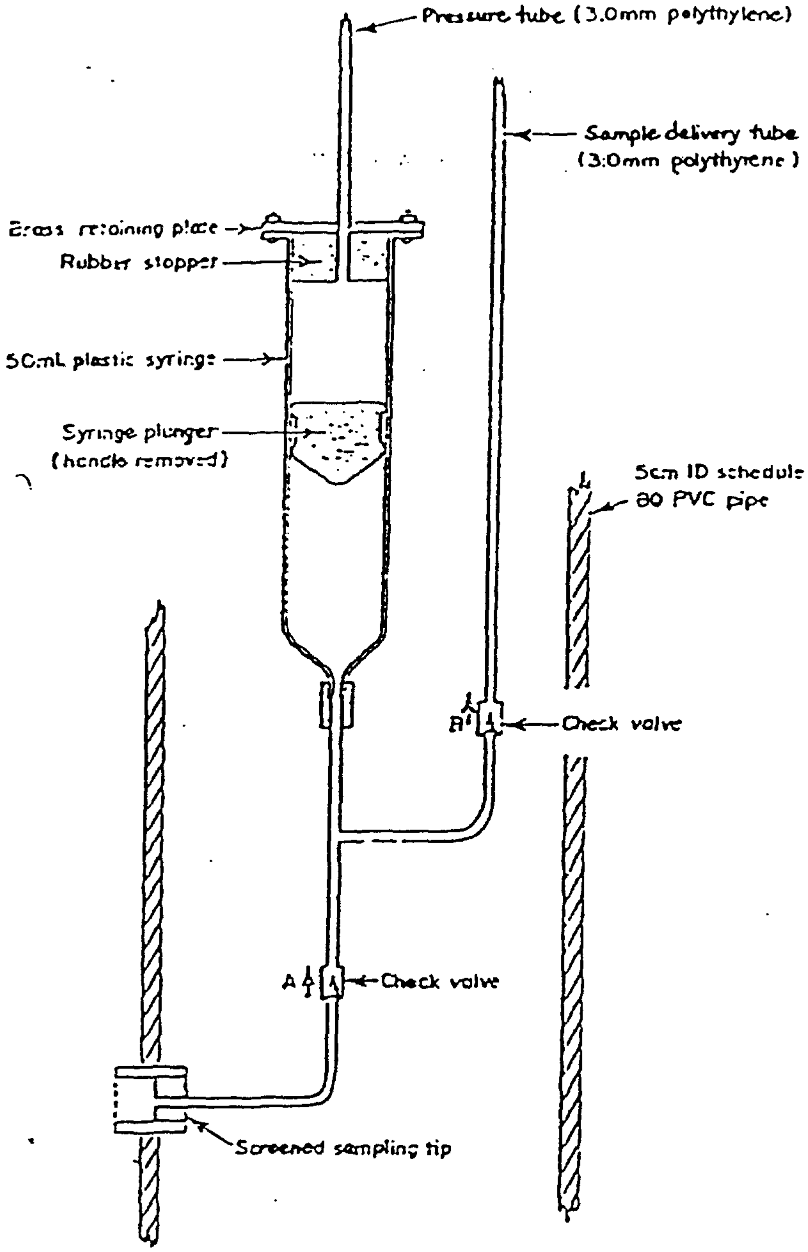
[3] Viton is a trademark of E. I. du Pont de Nemours & Co., Wilmington, DE 19898 and has been found suitable for this purpose.



NOTE—Taken from Ref (48).

FIG. 8 Positive Displacement Syringe Pump

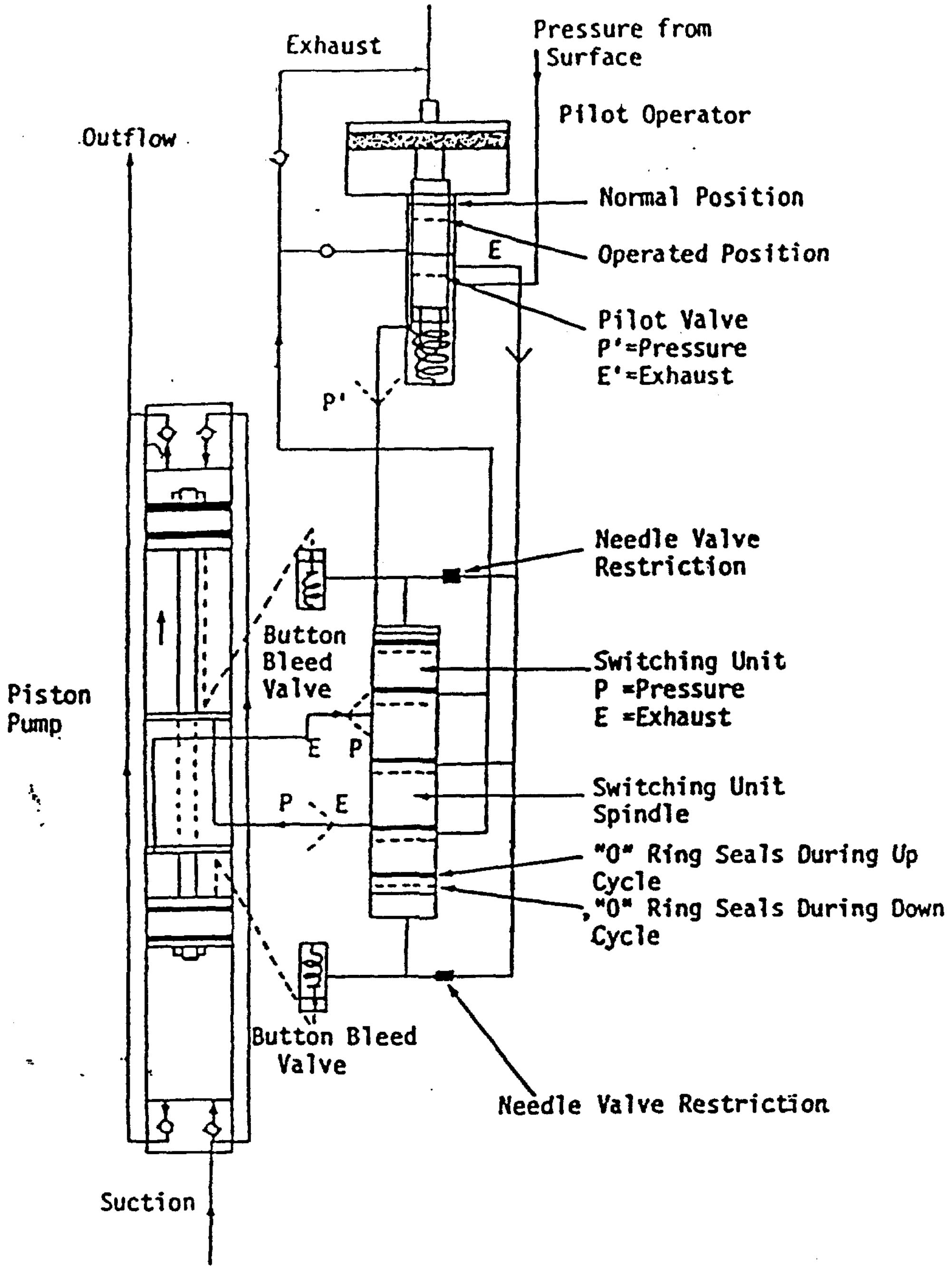
lift capabilities. A battery operated unit 3.6 cm (1.4 in.) in diameter and with a 4.5 Lpm (1.2 gpm) flow rate at 33.5 m (110 ft) has been developed (27). Another submersible pump has an outer diameter of 11.4 cm (4.5 in.) and can pump water from 91 m (300 ft). Pumping rates vary up to 53.0 Lpm (14 gpm) depending upon the depth of the pump (28).

6.1.3.3 A submersible pump provides higher extraction rates than many other methods. Considerable sample agitation results, however, in the well and in the collection tube during transport. The possibility of introducing trace metals into the sample from pump materials also exists. Steam cleaning of the unit followed by rinsing with unchlorinated, deionized water is suggested between sampling when analysis for organics in the parts per million (ppm) or parts per billion (ppb) range is required (29).

6.1.4 *Gas-Lift Pumps:*

6.1.4.1 Gas-lift pumps use compressed air to bring a water sample to the surface. Water is forced up an eductor pipe that may be the outer casing or a smaller diameter pipe inserted into the well annulus below the water level (30, 31).

6.1.4.2 A similar principle is used for a unit that consists of a small diameter plastic tube perforated in the lower end. This tube is placed within another tube of slightly larger diameter. Compressed air is injected into the inner tube; the air bubbles through the perforations, thereby lifting the water sample via the annulus between the outer and inner tubing (32). In practice, the eductor line should be submerged to a depth equal to 60 % of the total submerged eductor length during pumping (26). A 60 % ratio is considered optimal although a 30 % submergence ratio is adequate.



NOTE—Taken from Ref (49).

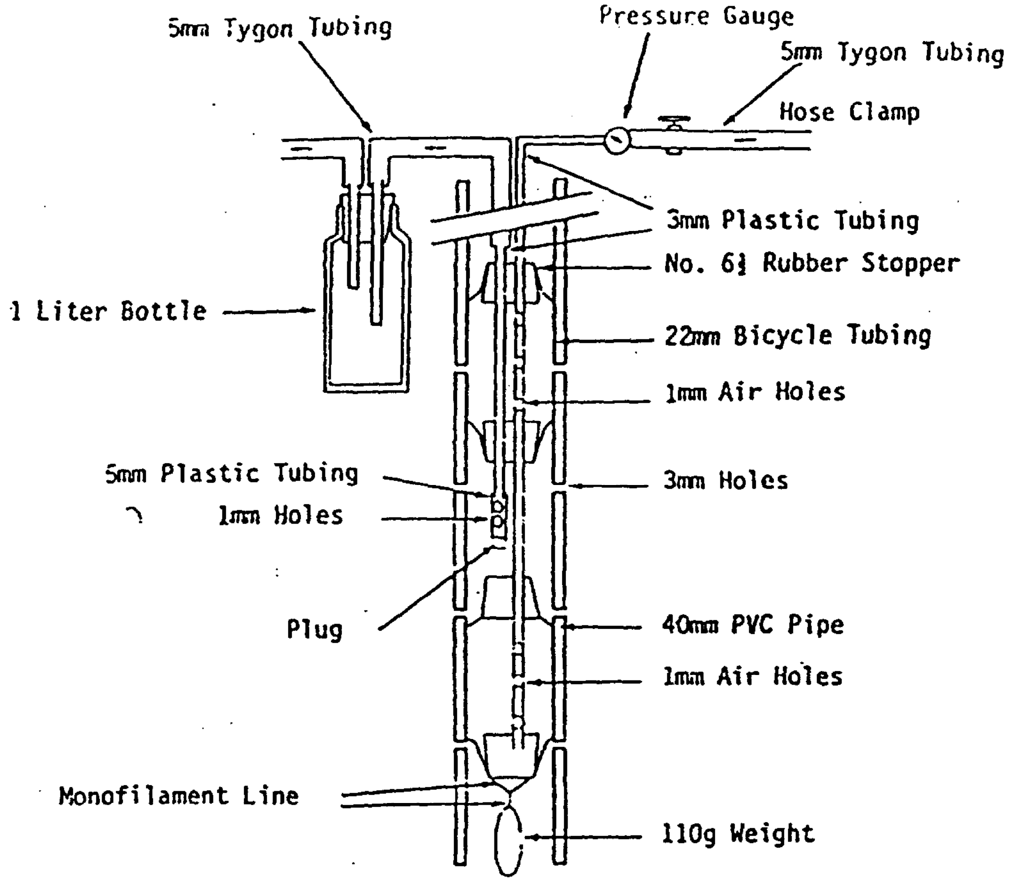
FIG. 9 Gas Driven Piston Pump

6.1.4.3 The source of compressed gas may be a hand pump for depths generally less than 7.6 m (25 ft). For greater depths, air compressors, pressurized air bottles, and air compressed from an automobile engine have been used.

6.1.4.4 As already mentioned, gas-lift methods result in considerable sample agitation and mixing within the well, and cannot be used for samples which will be tested for volatile organics. The eductor pipe or weighted plastic tubing is a potential source of sample contamination. In addition, Gibb (8) uncovered difficulties in sampling for inorganics. These difficulties were attributed to changes in redox, pH, and species transformation due to solubility constant changes resulting from stripping, oxidation, and pressure changes.

6.1.5 *Gas Displacement Pumps:*

6.1.5.1 Gas displacement or gas drive pumps are distinguished from gas-lift pumps by the method of sample transport. Gas displacement pumps force a discrete column of water to the surface via mechanical lift without extensive mixing of the pressurized gas and water as occurs with air-lift equipment. The principle is shown schematically in Fig. / Water fills the chamber. A positive pressure is applied to tl



NOTE—Taken from Ref (53).

FIG. 10 Packer Pump Arrangement

gas line closing the sampler check valve and forcing water up the sample line. By removing the pressure the cycle can be repeated. Vacuum can also be used in conjunction with the gas (30). The device can be permanently installed in the well (33, 34, 35) or lowered into the well (36, 37).

6.1.5.2 A more complicated two stage design constructed of glass with check valves made of TFE-fluorocarbon has been constructed (38, 39). The unit was designed specifically for sample testing for trace level organics. Continuous flow rates up to 2.3 Lpm (0.6 gpm) are possible with a 5.1 cm (2 in.) diameter unit.

6.1.5.3 Gas displacement pumps have also been developed with multiple functions. The water sample in Fig. 5 provides piezometric data measurements with an internally mounted transducer (40). A sample with its transducer exposed externally for piezometric measurements is illustrated in Fig. 6 (41). The sensor can activate the gas source at the surface to cause sample chamber pressurization at the predetermined depth. Another design can be used as a water sampler or as a tool for injecting brine or other tracers into a well (42).

6.1.5.4 Gas displacement pumps offer reasonable potential for preserving sample integrity because little of the driving gas comes in contact with the sample as the sample is conveyed to the surface by a positive pressure. There is, however, a potential loss of dissolved gasses or contamination from the driving gas and the housing materials.

6.1.6 *Bladder Pumps:*

6.1.6.1 Bladder pumps, also referred to as gas-operated squeeze pumps, consist of a flexible membrane enclosed by a rigid housing. Water enters the membrane through a check valve in the vessel bottom; compressed gas injected into the cavity between the housing and bladder forces the sample through a check valve at the top of the membrane and into a discharge line (Fig. 7). Water is prevented from re-entering the bladder by the top check valve. The process is repeated to cycle the water to the surface. Samples taken from depths of 30.5 m (100 ft) have been reported.

6.1.6.2 A variety of design modifications and materials are available (43, 44). Bladder materials include neoprene, rubber, ethylene propylene terpolymer (E.P.T.), nitrile, and the fluorocarbon Viton.[3] A bladder made of TFE-fluorocarbon is also under development (45). Automated sampling systems have been developed to control the time between pressurization cycles (46).

6.1.6.3 Bladder pumps provide an adaptable sampling tool due primarily to the number of bladder shapes that are feasible. These devices have a distinct advantage over gas displacement pumps in that there is no contact with the driving gas. Disadvantages include the large gas volumes required, low pumping rates, and potential contamination from many of the bladder materials, the rigid housing, or both.

6.1.7 *Gas Driven Piston Pumps:*

6.1.7.1 A simple and inexpensive example of a gas driven piston pump is a syringe pump (47). The pump (Fig. 8) is constructed from a 50 mL plastic syringe with plunger stem removed. The device is connected to a gas line to the surface and the sample passes through a check valve arrangement to a sampling container at the surface. By successively applying positive and negative pressure to the gas-line, the plunger is activated driving water to the surface.

6.1.7.2 A double piston pump powered by compressed air is illustrated in Fig. 9. Pressurized gas enters the chamber between the pistons; the alternating chamber pressurization activates the piston which allows water entry during the suction stroke of the piston and forces the sample to the surface during the pressure stroke (48). Pumping rates between 9.5 and 30.3 L/hr (2.5 to 8 gal/hr) have been reported from 30.5 m (100 ft). Depths in excess of 457 m (1500 ft) are possible.

6.1.7.3 The gas piston pump provides continuous sample withdrawal at depths greater than is possible with most other approaches. Nevertheless, contribution of trace elements from the stainless steel and brass is a potential problem and the quantity of gas used is significant.

6.1.8 *Packer Pump Arrangement:*

6.1.8.1 A packer pump arrangement provides a means by which two expandable "packers" isolate a sampling unit between two packers within a well. Since the hydraulic or pneumatic activated packers are wedged against the casing wall or screen, the sampling unit will obtain water samples only from the isolated well portion. The packers are deflated for vertical movement within the well and inflated when the desired depth is attained. Submersible, gas lift, and suction pumps can be used for sampling. The packers are usually constructed from some type of rubber or rubber compound (48, 49, 50, 51). A packer pump unit consisting of a vacuum sampler positioned between two packers is illustrated in Fig. 10 (52).

6.1.8.2 A packer assembly allows the isolation of discrete sampling points within a well. A number of different samplers can be situated between the packers depending upon the analytical specifications for sample testing. Vertical movement of water outside the well casing during sampling is possible with packer pumps but depends upon the pumping rate and subsequent disturbance. Deterioration of the expandable materials will occur with time with the increased possibility of undesirable organic contaminants contributing to the water sample.

7. Sample Containers and Preservation

7.1 Complete and unequivocal preservation of samples, whether domestic wastewater, industrial wastes, or natural waters, is practically impossible. At best, preservation techniques only retard the chemical and biological changes that inevitably continue after the sample is removed from the source. Therefore, insuring the timely analysis of a sample should be one of the formost considerations in the sampling plan schedule. Methods of preservation are somewhat limited and are intended to retard biological action, retard hydrolysis of chemical compounds and complexes, and reduce the volatility of constituents. Preservation methods are generally limited to pH control, chemical addition, refrigeration and freezing. For water samples, immediate refrigeration just above freezing (4°C in wet ice) is often the best preservation technique available, but it is not the only measure nor is it applicable in all cases. There may be special cases where it might be prudent to include a recordi thermometer in the sample shipment to verify the maximu. and minimum temperature to which the samples wer exposed. Inexpensive devices for this purpose are available.

7.2 All bottles and containers must be specially precleaned, pre-labelled, and organized in ice-chests (isolating samples and sampling equipment from the environment) before one goes into the field. Otherwise, in any comprehensive program utter chaos usually develops in the field or laboratory. The time in the field is very valuable and should be spent on taking field notes, measurements, and in documenting samples, not on labelling and organizing samples. Therefore, the sampling plan should include clear instructions to the sampling personnel concerning the information required in the field data record logbook (notebook), the information needed on container labels for identification, the chain-of-custody protocols, and the methods for preparing field blanks and spiked samples. Example of detailed plans and documentation procedures have been published (14, 53).

7.3 The exact requirements for the volumes of sample needed and the number of containers to use may vary from laboratory to laboratory. This will depend on the specific analyses to be performed, the concentration levels of interest, and the individual laboratory protocols. The manager of the sampling program should make no assumptions about the laboratory analyses. He should discuss the analytical requirements of the sampling program in detail with the laborator' coordinator beforehand. This is especially the case sin some analyses and preservation measures must be performe at the laboratory as soon as possible after the samples arriv Thus, appropriate arrangements must be made.

7.4 There are a number of excellent references available which list the containers and preservation techniques appropriate for water and soils (13, 14, 50, 54, 55, 56). The "Handbook for Sampling and Sample Preservation of Water and Wastewater" is an excellent reference and perhaps the most comprehensive one (14). Some of this information is summarized in Table 1.

7.5 Sample containers for trace organic samples require special cleaning and handling considerations (57). The sample container for purgeable organics consist of a screw-cap vial (25 to 125 mL) fitted with a TFE-flourocarbon faced silicone septum. The vial is sealed in the laboratory immediately after cleaning and is only opened in the field just prior to pouring sample into it. The water sample then must be sealed into the vial headspace free (no air bubbles) and immediately cooled (4°C) for shipment. Multiple samples (usually about four taken from one large sample container) are taken because leakage of containers may cause losses, may allow air to enter the containers, and may cause erroneous analysis of some constituents. Also, some analyses are best conducted on independent protected samples.

7.6 The purgeable samples must be analyzed by the laboratory within 14 days after collection, unless they are to be analyzed for acrolein or acrylonitrile (in which case th' are to be analyzed within 3 days). For samples for solve extractions (extractable organics-base neutrals, acids a.

pesticides), the sample bottles are narrow mouth, screw cap quart bottles or half-gallon bottles that have been precleaned, rinsed with the extracting organic solvent and oven dried at 105°C for at least 1 h. These bottles must be sealed with TFE-fluorocarbon lined caps (Note). Samples for organic extraction must be extracted within 7 days and analyzed within 30 days after extraction. Special pre-cleaned, solvent rinsed and oven-dried stainless steel beakers (one for each monitoring well) may be used for transferring samples from the sampling device to the sample containers.

NOTE—When collecting samples, the bottles should not be overfilled or prerinsed with sample before filling because oil and other materials may remain in the bottle. This can cause erroneously high results.

7.7 For a number of groundwater parameters, the most meaningful measurements are those made in the field at the time of sample collection or at least at an on-site laboratory. These include the water level in the well and parameters that sometimes can change rapidly with storage. A discussion of the various techniques for measuring the water level in the well is contained in a NCASI publication (5) and detailed procedures are outlined in a U.S. Geological Survey publication (58). Although a discussion of these techniques is beyond the scope of this guide, it is important to point out that accurate measurements must be made before a well is flushed or only after it has had sufficient time to recover. Parameters that can change rapidly with storage include specific conductance, pH, turbidity, redox potential, dissolved oxygen, and temperature. For some of the other parameters, the emphasis in groundwater monitoring is on the concentration of each specific dissolved component, not the total concentration of each. Samples for these types of measurements should be filtered through 0.45 μm membrane filters ideally in the field or possibly at an on-site laboratory as soon as possible. Analyses often requiring filtered samples include all metals, radioactivity parameters, total organic carbon, dissolved orthophosphate (if needed), and total dissolved phosphorous (if needed) (13, 14). If metals are to be analyzed, filter the sample prior to acid preservation. For TOC organics, the filter material should be tested to assure that it does not contribute to the TOC. The type or size of the filter to be used is not well understood. However, if results of metal, TOC or other parameters that could be effected by solids are to be compared, the same filtering procedure must be used in each case. Repeated analytical results should state whether the samples were filtered and how they were filtered.

7.8 Shipment and receipt of samples must be coordinated with the laboratory to minimize time in transit. All samples for organic analysis (and many other parameters), should arrive at the laboratory within one day after it is shipped and be maintained at about 4°C with wet ice. The best way to get them to the laboratory in good condition is to send them in sturdy insulated ice chests (coolers) equipped with bottle dividers. 24-h courier service is recommended, if personal delivery service is not practical.

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APPENDIX D
SURFACE WATER AND SEDIMENT SAMPLE ACQUISITION

SURFACE WATER AND SEDIMENT SAMPLE ACQUISITION
TABLE OF CONTENTS

SURFACE WATER AND SEDIMENT SAMPLE ACQUISITION

1.0 PURPOSE

This procedure describes methods and equipment commonly used for collecting environmental samples of surface water and aquatic sediment either for on-site examination and chemical testing or for laboratory analysis.

2.0 SCOPE

The information presented in this SOP is generally applicable to all environmental sampling of surface waters (Section 5.2) and aquatic sediments (Section 5.3), except where the analyte(s) may interact with the sampling equipment.

Specific sampling problems may require the adaptation of existing equipment or design of new equipment. Such innovations shall be documented and presented in the Sampling and Analysis Plan.

3.0 DEFINITIONS

<u>Grab Sample</u> - An individual sample collected from a single location at a specific time or period of time generally not exceeding 15 minutes.

<u>Composite Sample</u> - A sample collected over time that typically consists of a series of discrete samples which are combined or composited.

4.0 RESPONSIBILITIES

Project Manager - The Project Manager is responsible for ensuring that project-specific plans are in accordance with these procedures, where applicable, or that other, approved procedures are developed. The Project Manager is responsible for development of documentation for procedures which deviate from those presented herein.

Field Team Leader - The Field Team Leader is responsible for selecting and detailing the specific surface water and/or sediment sampling techniques and equipment to be used, and documenting these in the Sampling and Analysis Plan. It is the responsibility of the Field Team Leader to ensure that these procedures are implemented in the field and that personnel performing sampling activities have been briefed and trained to execute these procedures.

Sampling Personnel - It is the responsibility of the field sampling personnel to follow these procedures, or to follow documented, project-specific procedures as directed by the Field Team Leader and/or the Project Manager. The sampling personnel are responsible for the proper acquisition of surface water and sediment samples.

5.0 PROCEDURES

Collecting a representative sample from surface water or sediments is difficult due to water movement, stratification or patchiness. To collect representative samples, one must standardize sampling bias related to site selection; sampling frequency; sample collection; sampling devices; and sample handling, preservation, and identification.

Representativeness is a qualitative description of the degree to which an individual sample accurately reflects population characteristics or parameter variations at a sampling point. It is therefore an important quality not only of assessment and quantification of environmental threats posed by the site, but also for providing information for engineering design and construction. Proper sample location, selection, and collection methods are important to ensure that a truly representative sample has been collected. Regardless of scrutiny and quality control applied during laboratory analyses, reported data are only as good as the confidence that can be placed on the representativeness of the samples.

5.1 Defining the Sampling Program

Many factors must be considered in developing a sampling program for surface water or sediments including study objectives; accessibility; site topography; flow, mixing and other physical characteristics of the water body; point and diffuse sources of contamination; and personnel and equipment available to conduct the study. For waterborne constituents, dispersion depends on the vertical and lateral mixing within the body of water. For sediments, dispersion depends on bottom current or flow characteristics, sediment characteristics (density, size) and geochemical properties (which effect adsorption/desorption). The sampling plan must therefore reflect not only the mixing characteristics of streams and lakes, but also the role of fluvial-sediment transport, deposition, and chemical sorption.

5.1.1 Sampling Program Objectives

The objective of surface water sampling is to determine the surface water quality entering, leaving or remaining within the site. The scope of the sampling program must consider the sources and potential pathways for transport of contamination to or within a surface water body. Sources may include point sources (leaky tanks, outfalls, etc.) or nonpoint sources (e.g., spills). The major pathways for surface water contamination (not including airborne deposition are: (a) overland runoff; (b) leachate influx to the waterbody; (c) direct waste disposal (solid or liquid) into the water body; and (d) groundwater flow influx to the water body. The relative importance of these pathways, and therefore the design of the sampling program, is controlled by the physiographic and hydrologic features of the site, the drainage basin(s) which encompass the site, and the history of site activities.

Physiographic and hydrologic features to be considered include slopes and runoff direction, areas of temporary flooding or pooling, tidal effects, artificial surface runoff controls such as berms or drainage ditches (when constructed relative to site operation), and locations of springs, seeps, marshes, etc. In addition, the obvious considerations such as the location of man-made discharge points to the nearest stream (intermittent or flowing), pond, lake, estuary, etc., shall be considered.

A more subtle consideration in designing the sampling program is the potential for dispersion of dissolved or sediment-associated contaminants away from the source. The dispersion could lead to a more homogeneous distribution of contamination at low or possibly nondetectable concentrations. Such dispersion does not, however, always readily occur throughout the entire body of water; the mixing may be limited to specific flow streams within the water body. For example, obtaining a representative sample of contamination from the center of a channel immediately below an outfall or a tributary is difficult because the inflow frequently follows a stream bank with little lateral mixing for some distance. Sampling alternatives to overcome this situation are: (1) move the site far enough downstream to allow for adequate mixing, or (2) collect integrated samples in a cross section. Also, nonhomogeneous distribution is a particular problem with regard to sediment-associated contaminants which may accumulate in low-energy environments while higher-energy areas (main stream channels) near the source may show no contaminant accumulation.

The distribution of particulates within a sample itself is an important consideration. Many organic compounds are only slightly water soluble and tend to adsorb on particulate matter. Nitrogen, phosphorus, and the heavy metals also may be transported by particulates. Samples will be collected with a representative amount of suspended material; transfer from the sampling device shall include transferring a proportionate amount of the suspended material.

The first step in selecting sampling locations; therefore, is to review site history, define hydrologic boundaries and features of the site, and identify the sources, pathways and potential distribution of contamination based on these considerations. The numbers, types and general locations of required samples upgradient, on site and downgradient can then be identified.

5.1.2 Location of Sampling Stations

Accessibility is the primary factor affecting sampling costs. The desirability and utility of a sample for analysis and description of site conditions must be balanced against the costs of collection as controlled by accessibility. Wading or sampling from a stream bank often is sufficient for springs, seeps, and small streams. Bridges or piers are the first choice for locating a sampling station on a larger stream or small river; they provide ready access and also permit the sampling technician to sample any point across the stream or river. A boat or pontoon (with an associated increase in cost) may be needed to sample locations on lakes and reservoirs, as well as those on larger rivers. Frequently, however, a boat will take longer to cross a water body and will hinder manipulation of the sampling equipment.

If it is necessary to wade into the water body to obtain a sample, the sampler shall be careful to minimize disturbance of bottom sediments and must enter the water body downstream of the sampling location. If necessary, the sampling technician shall wait for the sediments to settle before taking a sample. Use of boats or wading to collect samples requires the use of U. S. Coast Guard approved personal flotation devices (PFDs).

Sampling in marshes or tidal areas may require the use of an all-terrain-vehicle (ATV). The same precautions mentioned above with regard to sediment disturbance will apply.

The availability of stream flow and sediment discharge records can be an important consideration in choosing sampling sites in streams. Stream flow data in association with contaminant concentration data are essential for estimating the total contaminant load carried by the stream. If a gaging station is not conveniently located on a selected stream, obtaining stream flow data by direct or indirect methods shall be explored.

5.1.3 Frequency of Sampling

The sampling frequency and the objectives of the sampling event will be defined by the Sampling and Analysis Plan. For single-event, site- or area-characterization sampling, both bottom material and overlying water samples shall be collected at the specified sampling stations. If valid data are available on the distribution of the contaminant between the solid and aqueous phases it may be appropriate to sample only one phase, although this often is not recommended. If samples are collected primarily for monitoring purposes, consisting of repetitive, continuing measurements to define variations and trends at a given location, water samples shall be collected at established and consistent intervals, as specified in the Sampling and Analysis Plan (often monthly or quarterly), and during droughts and floods. Samples of bottom material shall be collected from fresh deposits at least yearly, and preferably during both spring and fall seasons.

The variability in available water quality data shall be evaluated before deciding on the number and collection frequency of samples required to maintain an effective monitoring program.

5.2 Surface Water Sample Collection

This section presents methods for collection of samples from various surface water bodies, as well as a description of types of surface water sampling equipment. The guidance in this section should be used to develop specific sampling procedures based on site conditions and investigation goals. A summary of sampling techniques and procedures is given in Section 5.2.5.

5.2.1 Streams, Rivers, Outfalls and Drainage Features (Ditches, Culverts)

Methods for sampling streams, rivers, outfalls and drainage features at a single point vary from the simplest of hand sampling procedures to the more sophisticated multi-point sampling techniques known as the equal-width-increment (EWI) method or the equal-discharge-increment (EDI) method.

Samples from different depths or cross-sectional locations, collected during the same sampling episode, shall be composited. However, samples collected along the length of the watercourse or at different times may reflect differing inputs or dilutions and therefore shall not be composited. Generally, the number and type of samples to be collected depend on the river's width, depth, discharge, and amount of suspended sediment. With a greater number of individual points sampled, it is more likely that the composite sample will truly represent the overall characteristics of the water.

In small streams less than about 20 feet wide, a sampling location can generally be found where the water is well mixed. In such cases, a single grab sample taken at mid-depth in the center of the channel is adequate to represent the entire cross-section.

For larger streams greater than three feet in depth, two samples at each station shall be taken from just below the surface, and just above the bottom.

5.2.2 Lakes, Ponds and Reservoirs

Lakes, ponds, and reservoirs have a much greater tendency to stratify according to physical or chemical differences than rivers and streams. The relative lack of mixing requires that more samples be obtained.

The number of water sampling locations on a lake, pond, or impoundment will vary with the size and shape of the basin. In ponds and small lakes, a single vertical composite at the deepest point may be sufficient. Similarly, the measurement of DO, pH, temperature, etc., is conducted on each aliquot of the vertical composite. In naturally-formed ponds, the deepest point may have to be determined empirically; in impoundments, the deepest point is usually near the dam.

In lakes and larger reservoirs, several vertical grab samples shall be composited to form a single sample. These vertical samples often are collected along a transect or grid. In some cases, it may be of interest to form separate composites of epilimnetic and hypolimnetic zones. In a stratified lake, the epilimnion is the thermocline which is exposed to the atmosphere. The hypolimnion is the lower, "confined" layer which is only mixed with the epilimnion and vented to the atmosphere during seasonal "overturn" (when density stratification disappears). These two zones may thus have very different concentrations of contaminants if input is only to one zone, if the contaminants are volatile (and therefore vented from the epilimnion but not the hypolimnion), or if the epilimnion only is involved in short-term flushing (i.e., inflow from or outflow to shallow streams). Normally, however, a composite sample consists of several vertical samples collected at various depths.

As it is likely that poor mixing may occur in lakes with irregular shape (with bays and coves that are protected from the wind), separate composite samples may be needed to adequately represent water quality. Similarly, additional samples are recommended where discharges, tributaries, land use characteristics, and other such factors are suspected of influencing water quality.

Many lake measurements now are made in-situ using sensors and automatic readout or recording devices. Single and multi-parameter instruments are available for measuring temperature, depth, pH, oxidation-reduction potential (ORP), specific conductance, dissolved oxygen, some cations and anions, and light penetration.

5.2.3 Estuaries

Estuarine areas are by definition among those zones where inland freshwaters (both surface and ground) mix with marine waters. Estuaries generally are categorized into three types dependent upon freshwater inflow and mixing properties. Knowledge of the estuary type is necessary to determine sampling locations:

- Mixed estuary - characterized by the absence of a vertical halocline (gradual or no marked increase in salinity in the water column) and a gradual increase in salinity seaward. Typically this type of estuary is shallow and is found in major freshwater sheetflow areas. Being well mixed, the sampling locations are not critical in this type of estuary.

- Salt wedge estuary - characterized by a sharp vertical increase in salinity and stratified freshwater flow along the surface. In these estuaries the vertical mixing forces cannot override the density differential between fresh and saline waters. In effect, a salt wedge tapering inland moves horizontally, back and forth, with the tidal phase. If contamination is being introduced into the estuary from upstream, water sampling from the salt wedge may miss it entirely.

- Oceanic estuary - characterized by salinities approaching full strength oceanic waters. Seasonally, freshwater inflow is small with the preponderance of the fresh-saline water mixing occurring near, or at, the shore line.

Sampling in estuarine areas normally is based upon the tidal phases, with samples collected on successive slack tides (i.e., when the tide turns). Estuarine sampling programs shall include vertical salinity measurements coupled with vertical dissolved oxygen and temperature profiles.

5.2.4 Surface Water Sampling Equipment

The selection of sampling equipment depends on the site conditions and sample type required. The most frequently used samplers are:

- Dip sampler
- Weighted bottle
- Kemmerer
- Depth-Integrating Sampler

The dip sampler and the weighted bottle sampler are used most often.

The criteria for selecting a sampler include:

- Disposable and/or easily decontaminated
- Inexpensive (if the item is to be disposed of)
- Ease of operation
- Nonreactive/noncontaminating - Teflon-coating, glass, stainless steel or PVC sample chambers are preferred (in that order)

Each sample (grab or each aliquot collected for compositing) shall be measured for: specific conductance; temperature; pH; and dissolved oxygen (optional) as soon as it is recovered. These analyses will provide information on water mixing/stratification and potential contamination.

5.2.4.1 Dip Sampling

Water often is sampled by filling a container, either attached to a pole or held directly, from just beneath the surface of the water (a dip or grab sample). Constituents measured in grab samples are only indicative of conditions near the surface of the water and may not be a true representation of the total concentration that is distributed throughout the water column and in the cross section. Therefore, whenever possible it is recommended to augment dip samples with samples that represent both dissolved and suspended constituents, and both vertical and horizontal distributions. Dip sampling often is the most appropriate sampling method for springs, seeps, ditches, and small streams.

5.2.4.2 Weighted Bottle Sampling

A grab sample also can be taken using a weighted holder that allows a sample to be lowered to any desired depth, opened for filling, closed, and returned to the surface. This allows discrete sampling with depth. Several of these samples can be combined to provide a vertical composite. Alternatively, an open bottle can be lowered to the bottom and raised to the surface at a uniform rate so that the bottle collects sample throughout the total depth and is just filled on reaching the surface. The resulting sample using either method will roughly approach what is known as a depth-integrated sample.

A closed weighted bottle sampler consists of a stopped glass or plastic bottle, a weight and/or holding device, and lines to open the stopper and lower or raise the bottle. The procedure for sampling is as follows:

- Gently lower the sampler to the desired depth so as not to remove the stopper prematurely (watch for bubbles).
- Pull out the stopper with a sharp jerk of the sampler line.
- Allow the bottle to fill completely, as evidenced by the absence of air bubbles.
- Raise the sampler and cap the bottle.
- Decontaminate the outside of the bottle. The bottle can be used as the sample container (as long as original bottle is an approved container).

5.2.4.3 Kemmerer

If samples are desired at a specific depth, and the parameters to be measured do not require a Teflon coated sampler, a standard Kemmerer sampler may be used. The Kemmerer sampler is a brass, stainless steel or acrylic cylinder with rubber stoppers that leave the ends open while being lowered in a vertical position to allow free passage of water through the cylinder. A "messenger" is sent down the line when the sampler is at the designated depth, to cause the stoppers to close the cylinder, which is then raised. Water is removed through a valve to fill sample bottles.

5.2.5 Surface Water Sampling Techniques

Most samples taken during site investigations are grab samples. Typically, surface water sampling involves immersing the sample container directly in the body of water. The following suggestions are applicable to sampling springs, seeps, ditches, culverts, small streams and other relatively small bodies of water, and are presented to help ensure that the samples obtained are representative of site conditions:

- The most representative samples will likely be collected from near mid-stream, the center of flow in a culvert, etc.

- Downstream samples shall be collected first, with subsequent samples taken while moving upstream. Care shall be taken to minimize sediment disturbance while collecting surface water samples. If necessary, sediment samples shall be collected after the corresponding surface water sample.

- Samples may be collected either by immersing the approved sample container or a glass or nalgene beaker into the water. Sample bottles (or beakers) which do not contain preservatives shall be rinsed at least once with the water to be sampled prior to sample collection.

- Care shall be taken to avoid excessive agitation of the water which may result in the loss of volatile constituents. Additionally, samples for volatile organic analyses shall be collected first, followed by the samples for other constituents.

- Measurements for temperature, pH, specific conductance, or other field parameters, as appropriate, shall be collected immediately following sample collection for laboratory analyses.

- All samples shall be handled as described in SOP F301.

- The sampling location shall be marked via wooden stake placed at the nearest bank or shore. The sampling location number shall be marked with indelible ink on the stake.

- The following information shall be recorded in the field logbook:

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

General guidelines for collection of samples from larger streams, ponds or other water bodies are as follows:

- The most <u>representative</u> samples are obtained from mid-channel at mid- stream depth in a well-mixed stream.
- For sampling running water, it is suggested that the farthest downstream sample be obtained first and that subsequent samples be taken as one works upstream. Work may also proceed from zones suspected of low contamination to zones of high contamination.
- It is suggested that sample containers which do not contain preservative be rinsed at least once with the water to be sampled before the sample is taken.
- To sample a pond or other standing body of water, the surface area may be divided into grids. A series of samples taken from each grid is combined into one composite sample, or several grids are selected at random.
- Care should be taken to avoid excessive agitation of the water that would result in the loss of volatile constituents.
- When obtaining samples in 40 ml septum vials for volatile organics analysis, it is important to exclude any air space in the top of the bottle and to be sure that the Teflon liner faces inward. The bottle can be turned upside down to check for air bubbles after the bottle is filled and capped.
- Do not sample at the surface unless sampling specifically for a known constituent which is immiscible and on top of the water. Instead, the sample container should be inverted, lowered to the approximate depth, and held at about a 45-degree angle with the mouth of the bottle facing upstream.
- Measurements for temperature, pH, specific conductance, or other field parameters, as appropriate shall be collected immediately following sample collection for laboratory analysis.
- All samples shall be handled as described in SOP F301.
- Items to be recorded in the field logbook are the same as those described above for small streams.

5.3 Sediment Sampling

Sediment samples usually are collected at the same locations as surface water samples. If only one sediment sample is to be collected, the sample location shall be approximately at the center of the water body. If, however, multiple samples are required, sediment samples should be collected along a cross-section to characterize the bed material. A common procedure for obtaining multiple samples is to sample at quarter points along the cross-section of flow. As with surface water samples, sediment samples should be collected from downstream to upstream.

5.3.1 Sampling Equipment and Techniques

A bottom-material sample may consist of a single scoop or core or may be a composite of several individual samples in the cross section. Sediment samples may be obtained using on-shore or off-shore techniques.

When boats are used for sampling, U. S. Coast Guard approved personal flotation devices must be provided and two individuals must undertake the sampling. An additional person shall remain on-shore in visual contact at all times.

The following samplers may be used to collect bottom materials:

- Scoop sampler
- Dredge samplers
- Bucket/hand auger
- Stainless steel spoon or trowel

5.3.1.1 Scoop Sampler

A scoop sampler consists of a pole to which a jar or scoop is attached. The pole may be made of bamboo, wood or aluminum and be either telescoping or of fixed length. The scoop or jar at the end of the pole is usually attached using a clamp.

If the water body can be sampled from the shore or if it can be waded, the easiest and "cleanest" way to collect a sediment sample is to use a scoop sampler. This reduces the potential for cross-contamination. This method is accomplished by reaching over or wading into the water body and, while facing upstream (into the current), scooping in the sample along the bottom in the upstream direction. It is very difficult not to disturb fine-grained materials of the sediment-water interface when using this method.

5.3.1.2 Dredges

Dredges are generally used to sample sediments which cannot easily be obtained using coring devices (i.e., coarse-grained or partially-cemented materials) or when large quantities of materials are required. Dredges generally consist of a clam shell arrangement of two buckets. The buckets may either close upon impact or be activated by use of a messenger. Most dredges are heavy (up to several hundred pounds) and require use of a winch and crane assembly for sample retrieval. There are three major types of dredges: Peterson, Eckman and Ponar dredges.

The Peterson dredge is used when the bottom is rocky, in very deep water, or when the flow velocity is high. The dredge shall be lowered very slowly as it approaches bottom, because it can force out and miss lighter materials if allowed to drop freely.

The Eckman dredge has only limited usefulness. It performs well where bottom material is unusually soft, as when covered with organic sludge or light mud. It is unsuitable, however, for sandy, rocky, and hard bottoms and is too light for use in streams with high flow velocities.

The Ponar dredge is a Peterson dredge modified by the addition of side plates and a screen on the top of the sample compartment. The screen over the sample compartment permits water to pass through the sampler as it descends thus reducing the "shock wave" and permits direct access to the secured sample without opening the closed jaws. The Ponar dredge is easily operated by one person in the same fashion as the Peterson dredge. The Ponar dredge is one of the most effective samplers for general use on all types of substrates. Access to the secured sample through the covering screens permits subsampling of the secured material with coring tubes or Teflon scoops, thus minimizing the chance of metal contamination from the frame of the device.

5.3.1.3 Bucket (Hand) Auger

Bucket (hand) augering is a viable method for collecting sediment samples in narrow, intermittent streams or tidal flats. Typically, a 4-inch auger bucket with a cutting head is pushed and twisted into the ground and removed as the bucket is filled. The auger hole is advanced one bucket at a time, to a depth specified in the project plans.

When a specific vertical sampling interval is required, one auger bucket is used to advance the auger hole to the first desired sampling depth. If the sample at this location is to be a vertical composite of all intervals, the same bucket may be used to advance the hole, as well collect subsequent samples in the same hole. However, if discrete grab samples are to be collected to characterize each depth, a new bucket must be placed on the end of the auger extension immediately prior to collecting the next sample. The top several inches of sediment should be removed from the bucket to minimize the changes of cross-contamination of the sample from fall-in of material from the upper portions of the hole. The bucket auger should be decontaminated between samples as outlined in SOP F502.

5.3.1.4 Stainless Steel Spoon or Trowel

For loosely packed sediments, a stainless steel scoop or trowel can be used to collect a representative sample, in narrow intermittent streams or tidal flats.

Use the scoop or trowel to collect the sample from a desired depth. Remove heavy debris, rocks, and twigs before collecting the sample. Immediately transfer the sample to the appropriate sample container. Attach a label and identification tag. Record all required information in the field logbook and on the sample log sheet, chain-of-custody record, and other required forms.

5.3.2 Sediment Sampling Procedure

The following general procedure should be used, where applicable, for sampling sediment from springs, seeps, small streams, ditches, or other similar small bodies of water. Procedures sampling larger bodies of water (i.e., rivers, lakes, estuaries, etc.) should be developed on a project-specific basis, as needed.

- Sediment samples shall be collected only after the corresponding surface water sample has been collected, if one is to be collected.
- Sediment samples shall be collected from downstream locations to upstream locations.
- Samples shall be collected by excavating a sufficient amount of bottom material using a scoop, beaker, spoon, trowel, or auger. Samples should be collected with the sampling device facing upstream and the sample collected from downstream to upstream. Care should be taken to minimize the loss of fine-grained materials from the sample.
- The sample shall be transferred to the appropriate sample containers. Sampling personnel shall use judgment in removing large plant fragments to limit bias caused by bio-organic accumulation.
- All samples shall be handled as described in SOP F301.
- The sampling location shall be marked via a wooden stake placed at the nearest bank or shore. The sample location number shall be marked on the stake with indelible ink.
- The following information shall be recorded in the field logbook:
    - Project location, date and time.
    - Weather.
    - Sample location number and sample identification number.
    - Flow conditions.
    - Sketch of sampling location including boundaries of water body, sample location, water depth, sample collection depth, relative position with respect to the site, location of wooden identifier stake.
    - Chemical analyses to be performed.
    - Description of sediment (refer to SOP F001).

6.0 QUALITY ASSURANCE RECORDS

The description of the sampling event in the field logbook shall serve as a quality assurance record. Other records include chain-of-custody and sample analysis request forms as discussed in SOP F302.

7.0 REFERENCES

1. Feltz, H. R., 1980. Significance of Bottom Material Data in Evaluating Water Quality in Contaminants and Sediments. Ann Arbor, Michigan, Ann Arbor Science Publishers, Inc., V. 1, p. 271-287.

2. Kittrell, F. W., 1969. A Practical Guide to Water Quality Studies of Streams. U.S. Federal Water Pollution Control Administration, Washington, D.C., 135p.

3. U.S. EPA, 1991. Standard Operating Procedures and Quality Assurance Manual. Environmental Compliance Branch, USEPA Environmental Services Division, Athens, Georgia.

4. U.S. Geological Survey, 1977. National Handbook of Recommended Methods for Water-Data Acquisition. Office of Water Data Coordination, USGS, Reston, Virginia.

APPENDIX E
DECONTAMINATION OF SAMPLING AND MONITORING EQUIPMENT

DECONTAMINATION OF SAMPLING AND MONITORING EQUIPMENT

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DECONTAMINATION OF SAMPLING AND MONITORING EQUIPMENT

1.0 PURPOSE

The purpose of this SOP is to provide a general methodology and protocol, and to reference information for the proper decontamination of field chemical sampling and analytical equipment.

2.0 SCOPE

This procedure applies to all field sampling equipment including, but not limited to, split-barrel soil samplers (split-spoons), bailers, beakers, trowels, filtering apparatus, and pumps. This procedure should be consulted when decontamination procedures are being developed as part of project-specific plans. Additionally, current USEPA regional procedures and decontamination guidance as well as state guidance should be reviewed.

3.0 DEFINITIONS

Decontamination - Decontamination is the process of removing or neutralizing contaminants which may have accumulated on field equipment. This process ensures protection of personnel from penetrating substances, reduces or eliminates transfer of contaminants to clean areas, prevents mixing of incompatible substances, and minimizes the likelihood of sample cross-contamination.

4.0 RESPONSIBILITIES

Project Manager - It is the responsibility of the Project Manager to ensure that project-specific plans are in accordance with these procedures. Documentation should be developed for areas where project plans deviate from these procedures.

Field Team Leader - It is the responsibility of the Field Team Leader to ensure that these procedures are implemented in the field. The Field Team Leader is responsible for ensuring field personnel performing decontamination activities have been briefed and trained to execute these procedures.

Sampling Personnel - It is the responsibility of field sampling personnel to follow these procedures, or to follow documented, project-specific procedures as directed by the Field Team Leader.

5.0 PROCEDURES

In order to ensure that chemical analysis results reflect actual concentrations present at sampling locations, sampling equipment must be properly decontaminated prior to the field effort, during the sampling program (i.e., between sampling locations) and at the conclusion of the sampling program. This will minimize the potential for cross-contamination between sampling locations and the transfer of contamination off site.

Preferably, sampling equipment should be dedicated to a given sampling location. If this is not possible, equipment must be decontaminated between sampling locations. Sampling personnel also must use disposable gloves and change them between sampling locations.

5.1 Sampling Equipment Decontamination Procedures

Soil and sediment sampling equipment including, but not limited to trowels, beakers, dredges, etc., shall be decontaminated using the following USEPA Region procedures.

The following sections summarize decontamination procedures for USEPA Regions I through IV for overall comparison. Each region should be contacted prior to initiation of sampling activities to assure that the most recent, accepted decontamination procedures are used.

USEPA Region I

Prior to use, all sampling equipment should be carefully cleaned using the following procedure:

1. A dilute hydrochloric acid rinse
2. Deionized water rinse
3. Methanol or acetone rinse; and,
4. Distilled, organic-free water rinse.

For badly contaminated equipment, a hot water detergent wash may be needed prior to the rinse procedure. Additionally, a hexane rinse also may be needed, prior to the final distilled water rinse, when sampling for low-level organic pollutants.

USEPA Region II

Prior to use, all sampling equipment will be decontaminated using the following procedure:

1. Low-phosphate detergent wash (i.e., Alconox or Liquinox)
2. Tap water rinse
3. 10 percent nitric acid solution rinse
4. Tap water rinse
5. Methanol followed by a hexane or an acetone rinse
6. Analyte-free deionized water rinse
7. Air dry
8. Wrap in aluminum foil, shiny side out, for storage or transport

If the samples will not be analyzed for metals, then steps 3 and 4 may be omitted; if samples will not be analyzed for organics, then step 5 may be omitted. All solvents must be pesticide-grade.

USEPA Region III

Prior to use, all sampling equipment will be decontaminated using the following procedure:

1. Potable water rinse
2. Alconox or Liquinox detergent wash
3. Scrubbing, as necessary
4. Potable water rinse
5. 10 percent nitric acid rinse
6. Distilled-deionized water rinse
7. Methanol or hexane rinse
8. Distilled-deionized water rinse
9. Air dry

USEPA Region IV

Prior to use, all sampling equipment will be decontaminated using the following procedures:

1. Clean with tap water and laboratory detergent using a brush if necessary to remove particulate matter and surface films.
2. Rinse thoroughly with tap water.
3. Rinse thoroughly with deionized water.
4. Rinse twice with pesticide grade isopropanol.
5. Rinse thoroughly with organic-free water and allow to air dry as long as possible.
6. If organic-free water is not available, allow equipment to air dry as long as possible. Do not rinse with deionized or distilled water.
7. Wrap with aluminum foil, if appropriate, to prevent contamination if equipment is going to be stored or transported.

* Portable power augers (such as the Little Beaver®) or large soil boring/drill rigs should be cleaned before boring or drilling operations.

5.2 Field Analytical Equipment Decontamination

Field analytical equipment which may come in direct contact with the sample or sample media, including, but not limited to water level meters, water/product level meters, pH or specific ion probes, specific conductivity probes, thermometers, and/or borehole geophysical probes must be decontaminated before and after use, according to the procedures outlined in Section 5.1, unless manufacturers instructions indicate otherwise. Probes that contact water samples not used for laboratory analyses may be rinsed with distilled water. Probes which make no direct contact (e.g. HNu or OVA probes) will be wiped clean with clean paper towels or an alcohol-saturated cloth.

6.0 QUALITY ASSURANCE RECORDS

Decontamination procedures are monitored through the collection of equipment rinsate samples and field blanks. Collection of these samples shall be specified in the project-specific Sampling and Analysis and Quality Assurance Plans following the requirements of NEESA 20.2-047B. Documentation recorded in the field logbook also shall serve as a quality assurance record.

7.0 REFERENCES

NEESA 20.2-047B. Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program. Naval Energy and Environmental Support Activity. Port Hueneme, CA. June 1988.

U. S. EPA Office of Waste Program Enforcement. RCRA Ground Water Monitoring Technical Enforcement Guidance Document (TEGD). OSWER Directive 9950.1. 1986.

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APPENDIX F
DECONTAMINATION OF DRILL RIGS AND MONITORING WELL MATERIALS

DECONTAMINATION OF DRILLING RIGS AND MONITORING WELL MATERIALS

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DECONTAMINATION OF DRILLING RIGS AND MONITORING WELL MATERIALS

1.0 PURPOSE

The purpose of this SOP is to provide a general reference regarding the proper decontamination of drilling rigs and monitoring well materials used in the performance of field investigations.

2.0 SCOPE

This procedure addresses drilling equipment, test pit equipment (i.e. backhoe) and monitoring well material decontamination and should be consulted during the preparation of project-specific plans. This procedure does not pertain to personnel decontamination, or to chemical sampling or field analytical equipment decontamination.

3.0 DEFINITIONS

Decontamination - Decontamination is the process of removing or neutralizing contaminants which may have accumulated on field equipment. This process ensures protection of personnel from penetrating substances, reduces or eliminates transfer of contaminants to clean areas, prevents mixing of incompatible substances, and minimizes the likelihood of sample cross-contamination.

4.0 RESPONSIBILITIES

Project Manager - It is the responsibility of the Project Manager to ensure that project-specific plans are in accordance with these procedures. Documentation should be developed for areas where project plans deviate from these procedures.

Field Team Leader - It is the responsibility of the Field Team Leader to ensure that these procedures are implemented in the field. The Field Team Leader is responsible for ensuring the field personnel overseeing decontamination activities, and personnel conducting the activities have been briefed and trained to execute these procedures.

Drilling Inspector (Site Geologist, Rig Geologist etc.) - It is the responsibility of the drilling inspector to ensure that the drilling subcontractor follows these, or other project-specific procedures as directed by the Field Team Leader.

5.0 PROCEDURE

The various drilling equipment and materials involved with test boring, test pit excavation, subsurface soil sampling, and monitoring well construction must be properly decontaminated to ensure that chemical analysis results reflect actual concentrations present at sampling locations. These procedures will minimize the potential for cross contamination between sampling locations and the transfer of contamination off site.

5.1 Equipment

All drilling equipment involved in field sampling activities shall be decontaminated prior to drilling, excavation, or sampling activities. Such equipment includes drilling rigs, backhoes, augers, downhole tools, well casings, and screens. Split-spoon soil samplers and other similar soil sampling devices shall be decontaminated according to the procedures given in SOP F502.

5.2 Decontamination Procedures

Prior to drilling, or leaving the site, large equipment not directly utilized for sampling will be decontaminated by steam-cleaning in a designated area. The decontamination procedure consists of steam-cleaning the equipment, using potable water as the steam source, to remove visible signs of soils or wastes, and allowing the equipment to air dry. If necessary, the equipment may be cleaned with a scrub brush and alconox/liquinox-water solution prior to steam cleaning to remove visible signs of contamination.

The steam cleaning area will be designed to contain decontamination wastes and waste waters, and can be a lined, excavated pit or a bermed concrete or asphalt pad. For the latter, a floor-drain must be provided which is connected to a holding tank. A shallow, above-surface tank may be used or a pumping system with discharge to a waste tank may be installed.

At certain sites, due to the type of contaminants or proximity to residences, concerns may exist about air emissions from steam cleaning operations. These concerns can be alleviated by utilizing one or more of the following practices:

- Locate the steam cleaning area on site to minimize potential impacts.
- Enclose steam cleaning operations. For example, augers and drilling rods can be steam cleaned in drums. Tarpaulins also can be placed around the steam cleaning area to control emissions.

For a given project, the location of the steam cleaning area will be identified in the Sampling and Analysis Plan.

Decontamination wastes will be collected and contained unless otherwise directed by LANTDIV. The eventual disposition of these wastes will be determined on a project-specific basis, but may include on-site treatment and/or transport off site to an approved treatment/disposal facility.

6.0 QUALITY ASSURANCE RECORDS

Rinsate samples may be collected from steam-cleaned equipment as quality assurance records. The frequency of rinsate samples from either drilling tools or well casings/screens shall be specified in the Sampling and Analysis and Quality Assurance Project Plans for a given project, as appropriate. Documentation in the field logbook also shall serve as a quality assurance record of decontamination activities.

7.0 REFERENCES

None.

APPENDIX G
ON-SITE WATER QUALITY TESTING

ON-SITE WATER QUALITY TESTING
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ON-SITE WATER QUALITY TESTING
(FIELD PARAMETERS)

1.0 PURPOSE

This SOP describes the procedures and equipment required to measure the following parameters of an aqueous sample in the field:

- pH
- Specific Conductance (Sc)/Salinity
- Temperature (T)
- Dissolved Oxygen Concentration (DO)
- Turbidity (Secchi Disc)

The first three are the usual field parameters; dissolved oxygen may be used in particular applications according to project requirements.

2.0 SCOPE

These procedures are applicable for use in an on-site water quality monitoring program to be conducted during a Remedial Investigation or Site Investigation at a hazardous or nonhazardous site. The procedures and equipment described are applicable to nearly all aqueous samples, including potable well water, monitoring well water, surface water, leachate and drummed water, etc.

This procedure provides generic information for measuring the parameters listed above with instruments and techniques in common use. Since instruments from different manufacturers may vary, review of the manufacturer's literature pertaining to the use of a specific instrument is required before use.

3.0 DEFINITIONS

Conductance - A measurement of water's capacity for conveying electrical current and is directly related to the concentrations of ionized substances in the water. The units of measurement for conductance (mhos) are the inverse of ohms, the unit commonly used to express resistance. Conductivity and specific conductance are used synonymously.

Electrolytic Cell - An electrochemical cell in which electrical energy is supplied from an external source. This cell functions in much the same way as a galvanic cell, only in the opposite direction due to the external source of applied voltage.

Galvanic Cell - An electrochemical cell in which chemical energy is spontaneously converted to electrical energy. The electrical energy produced is supplied to an external circuit.

Oxidation - The process in which an atom or group of atoms loses electrons to achieve an increasing positive charge.

pH - The negative logarithm (base 10) of the hydrogen ion activity. The hydrogen ion activity is related to the hydrogen ion concentration, and, in a relatively weak solution, the two are nearly equal. Thus, for all practical purposes, pH is a measure of the hydrogen ion concentration. The range of pH is 0 to 14 standard units.

Resistance - A measure of the solution's ability to oppose the passage of electrical current. For metals and solutions, resistance is defined by Ohm's Law, $E = IR$, where E is the potential difference (in units of volts), I is the current (in units of Amperes), and R is the resistance (in units of ohms).

Secchi disc - A metal disc having four quadrants, two opposing ones painted black and the other two either white or unpainted. The Secchi disc is used to measure turbidity based on the depth of light penetration.

Turbidity - An optical property of water that causes light to be scattered or absorbed in the water, resulting in decrease in water transparency. It is a function of at least three variables: 1) dissolved chemicals, such as tannins, acids, or salts; 2) suspended particles, such as silt, clay, and organic matter; and, 3) density of microbial and planktonic life.

Salinity refers to the total amount of soluble salts in water, either naturally or added to the environment as pollutants.

4.0 RESPONSIBILITIES

Project Manager - The Project Manager is responsible for ensuring that project-specific plans are in accordance with these procedures, where applicable, or that other, approved procedures are developed. The Project Manager is responsible for determining which on-site water quality measurements shall be made, the data quality objectives (DQOs) for these measurements, and for ensuring that these measurements are made in accordance with project-specific plans.

Field Team Leader - The Field Team Leader is responsible for determining that these water quality measurement procedures are implemented in the field in accordance with this SOP, or in accordance with project-specific plans, and to ensure that personnel performing sampling activities have been briefed and trained to execute these procedures.

Sampling Personnel - It is the responsibility of the field sampling personnel to follow these procedures for collecting on-site water quality measurements including instrument calibration, quality control and recording of results, as well as care and maintenance of the instruments in the field.

5.0 PROCEDURES

The following sections provide general procedures for collecting pH, specific conductance/salinity, temperature, dissolved oxygen concentration and turbidity measurements.

5.1 Measurement of pH

Measurement of pH is one of the most important and frequently used tests in water chemistry. Practically every phase of water supply and wastewater treatment, such as acid-base neutralization, water softening, and corrosion control, is pH dependent. Likewise, the pH of leachate can be correlated with other chemical analyses to determine the probable source of contamination. It is therefore important that reasonably accurate pH measurements be taken.

Measurements of pH also can be used to check the quality and corrosivity of soil and solid waste samples. However, these samples must be immersed in water prior to analysis; specific measurement techniques for solids are not described here.

Two methods are given for pH measurement: the pH meter and pH indicator paper. The indicator paper is used when only a rough estimate of the pH is required; the pH meter is used when a more accurate measurement is needed. The response of a pH meter can be affected to a slight degree by high levels of colloidal or suspended solids, but the effect is usually small and generally of little significance. Consequently, specific methods to overcome this interference are not described. The response of pH paper is unaffected by solution interferences from color, turbidity, colloidal or suspended materials unless extremely high levels capable of coating or masking the paper are encountered. In most cases, use of a pH meter will be required.

5.1.1 Principles of Equipment Operation

Use of pH papers for pH measurement relies on a chemical reaction caused by the acidity or alkalinity of the solution with the indicator compound on the paper. Depending on the indicator and the pH range of interest, a variety of different colors can be used. Typical indicators are weak acids or bases, or both. Process chemistry and molecular transformations leading to the color change are variable and complex.

Use of a pH meter relies on the same principle as other ion-specific electrodes. Measurement relies on the establishment of a potential difference across a glass or other type of membrane. The membrane is conductive to ionic species and, in combination with a standard or reference electrode, a potential difference proportional to hydrogen ion concentration can be generated and measured.

5.1.2 Equipment

The following equipment and reagents are needed for taking pH measurements:

- Portable pH meter, or pH indicator paper, such as Mydrion or Alkacid, to cover the pH range 2 through 12.

- Laboratory-prepared buffer solutions of pH 4, 7 and 10, or other buffers which bracket the expected pH range.

5.1.3 Measurement Techniques for Field Determination of pH

A. *pH Meter*

Standardization, calibration, and operation and maintenance shall be performed according to the manufacturers instructions. The following procedure is used for measuring pH with a pH meter:

1. The batteries and instrument shall be checked and calibrated prior to initiation of the field effort.
2. The accuracy of the buffer solutions used for field and laboratory calibration shall be checked. Buffer solutions need to be changed often due to degradation upon exposure to the atmosphere.
3. Immerse the tip of the electrodes in water overnight. If this is not possible due to field conditions, immerse the electrode tip in water for at least an hour before use. The electrode tip may be immersed in a rubber or plastic sack containing buffer solution for field transport or storage. This is not applicable for all electrodes as some must be stored dry.
4. Make sure all electrolyte solutions within the electrode(s) are at their proper levels and that no air bubbles are present within the electrode(s).
5. Immerse the electrode(s) in a pH-7 buffer solution.
6. Adjust the temperature compensator to the proper temperature (on models with automatic temperature adjustment, immerse the temperature probe into the buffer solution). It is best to maintain the buffer solution at or near expected sample temperature before calibration, if possible.
7. Adjust the pH meter to read 7.0.

8. Remove the electrode(s) from the buffer and rinse well with distilled-deionized water. Immerse the electrode(s) in pH-4 or 10 buffer solution (depending on the expected pH of the sample) and adjust the slope control to read the appropriate pH. For best results, the standardization and slope adjustments shall be repeated at least once.

9. Immerse the electrode(s) in the unknown solution, slowly stirring the probe until the pH stabilizes. Stabilization may take several seconds to minutes. If the pH continues to drift, the sample temperature may not be stable, a chemical reaction (e.g., degassing) may be taking place in the sample, or the meter or electrode may be malfunctioning. This must be clearly noted in the logbook.

10. After adjusting the temperature compensator to the sample temperature, read and record the pH of the solution. The pH value shall be recorded to the nearest 0.1 pH unit. Also record the sample temperature. All measurements shall be recorded in the Field Logbook.

11. Upon completion of measurement and removal of the electrode from the sample, the electrode shall be thoroughly rinsed with deionized water.

12. The electrode(s) shall remain immersed in deionized water when not in use.

The sample used for pH measurement shall never be saved for subsequent conductivity or chemical analysis. All pH electrodes leak small quantities of electrolytes (e.g., sodium or potassium chloride) into the solution. Precipitation of saturated electrolyte solution within the electrode, especially at colder temperatures, or in cold water, may result in slow electrode response. Any visual observation of conditions which may interfere with pH measurement, such as oily materials, or turbidity, shall be noted in the Field Logbook.

B. pH Paper

Use of pH paper is very simple and requires no sample preparation, standardization, etc. pH paper is available in several ranges, including wide-range (indicating approximately pH 1 to 12), mid-range (approximately pH 0 to 6, 6 to 9, or 8 to 14) and narrow-range (many available, with ranges as narrow as 1.5 pH units). The appropriate range of pH paper shall be selected. If the pH is unknown the investigation shall start with wide-range paper.

5.2 Measurement of Specific Conductance/Salinity

Conductance provides a measure of dissolved ionic species in water and can be used to suggest the direction and extent of migration of contaminants in groundwater or surface water. Salinity refers to the total amount of soluble salts in water, either naturally or added to the environment as pollutants. One basic measure of salinity is the ability of water to conduct electric current, and, therefore, a measurement of specific conductance provides a measurement of salinity and the same instrument can be used. Salinity measurements are important in ecological field investigations because flora and fauna can be limited in their distribution based on the salinity of the sampled waters.

Conductivity is a numerical expression of the ability of a water sample to carry an electric current. This value depends on the total concentration of the ionized substances dissolved in the water and the temperature at which the measurement is made. The mobility of each of the various dissolved ions, their valences, and their actual and relative concentrations affect conductivity.

It is important to obtain a specific conductance and salinity measurement soon after taking a sample, since temperature changes, precipitation reactions, and absorption of carbon dioxide from the air all affect the specific conductance.

5.2.1 Principles of Equipment Operation

An aqueous system containing ions will conduct an electric current. In a direct-current field, the positive ions (cations) migrate toward the negative electrode (cathode), while the negatively charged ions (anions) migrate toward the positive electrode (anode). Most inorganic acids, bases and salts (such as hydrochloric acid, sodium carbonate, or sodium chloride, respectively) are relatively good conductors. Conversely, organic compounds such as sucrose or benzene, which do not disassociate in aqueous solution, conduct a current very poorly, if at all.

A conductance cell and a Wheatstone Bridge (for the measurement of potential difference) may be used for measurement of electrical resistance. The ratio of current applied to voltage across the cell also may be used as a measure of conductance. The core element of the apparatus is the conductivity cell containing the solution of interest. Depending on ionic strength of the aqueous solution to be tested, a potential difference is developed across the cell which can be converted directly or indirectly (depending on instrument type) to a measurement of specific conductance.

5.2.2 Equipment

A portable conductivity meter, probe and thermometer are needed for taking specific conductance and salinity measurements. A variety of conductivity meters are available which also may be used to monitor salinity and temperatures. Probe types and cable lengths vary, so equipment may be obtained to meet the specific requirements of the sampling program.

5.2.3 Measurement Techniques for Specific Conductance/Salinity

Standardization, calibration, and operation and maintenance shall be performed according to manufacturers instructions. The steps involved in taking specific conductance and salinity measurements are listed below.

1. Check batteries and calibrate instrument before going into the field.
2. Calibrate the instrument daily when used. Potassium chloride solutions with a specific conductance closest to the values expected in the field shall be used. Calibration information shall be recorded in the field logbook.
3. Rinse the cell with one or more portions of the sample to be tested or with deionized water.

4. Immerse the electrode in the sample and measure the conductivity and salinity. If specified, adjust the temperature setting to the sample temperature.

5. Read and record the results on the Calibration Form (in the absence of the Calibration Form, the Field Logbook will be used).

6. If the meter does not compensate for temperature variations, the corrections given in Attachment A shall be applied.

7. On some meters, specific conductivity and salinity measurements may need to be reported with the associated temperature measurement. If the conductivity and salinity has been corrected, the measurements shall be reported as "corrected to 25°C." (See Attachment A)

    a. Do not take readings if the sample temperature is less than 10° C, because the calibration curve no longer follows a straight line below this temperature. If necessary, heat the sample in your vehicle to at least 10° C.

    b. Measure the sample temperature to the nearest 0.1° C to comply with SW-846.

    c. Only report results to the nearest two significant digits for the most circumstances, because of the inherent inacurracy in the test and conversion procedure.

    examples:

    - a calculated reading of 2353 umhos/cm @ 25° C should be reported as 2400 umhos/cm @ 25° C
    - a calculated reading of 2325 should be reported as 2300
    - a calculated reading of 337 should be reported as 340
    - etc.

5.3 Measurement of Temperature

In combination with other parameters, temperature can be a useful indicator of the likelihood of biological action in a water sample. It can also be used to trace the flow direction of contaminated groundwater. Temperature measurements shall be taken in-situ, or as quickly as possible in the field prior to sample collection. Collected water samples may rapidly equilibrate with the temperature of their surroundings.

5.3.1 Equipment

Temperature measurements may be taken with Thermistor, alcohol-toluene, mercury or bimetal thermometers. In addition, various meters such as specific conductance or dissolved oxygen meters, which have temperature measurement capabilities, may also be used. Using such instrumentation along with suitable probes and cables, in-situ measurements of temperature can be performed.

5.3.2 Measurement Techniques for Water Temperature

If a thermometer is used on a collected water sample:

- Immerse the thermometer in the sample until temperature equilibrium is obtained (1-3 minutes). To avoid the possibility of contamination, the thermometer shall not be inserted into samples which will undergo subsequent chemical analysis.

- Record values in a Field Logbook to the nearest 0.5 or 0.1°C, depending on the measurement device used.

If a temperature meter or probe is to be used, the instrument shall be calibrated according to the manufacturer's recommendations with an approved thermometer.

5.4 Measurement of Dissolved Oxygen Concentration

Dissolved oxygen (DO) levels in natural water and wastewater depend on the physical, chemical and biochemical activities in the water body. Conversely, the growth of many aquatic organisms, as well as the rate of corrosivity, are dependent on the dissolved oxygen concentration. Thus, analysis for dissolved oxygen is a key test in water pollution and waste treatment process control. If at all possible, DO measurements shall be taken in-situ, since concentration may show a large change in a short time, if the sample is not adequately preserved.

The method discussed here is limited to the use of dissolved oxygen meters only. Chemical methods of analysis (i.e., Winkler methods) are available, but require more equipment and greater sample manipulation. Furthermore, DO meters, using a membrane electrode, are suitable for highly polluted waters, because the probe is completely submersible. DO meters also are free from interference caused by color, turbidity, colloidal material or suspended matter.

5.4.1 Principles of Equipment Operation

Dissolved oxygen probes normally are electrochemical cells that have two solid metal electrodes of different potential immersed in an electrolyte. The electrolyte is retained by an oxygen-permeable membrane. The metal of higher nobility (the cathode) is positioned at the membrane. When a suitable potential exists between the two metals, reduction of oxygen to hydroxide ion (OH) occurs at the cathode surface. An electrical current is developed directly proportional to the rate of arrival of oxygen molecules at the cathode.

Since the current produced in the probe is directly proportional to the rate of arrival of oxygen at the cathode, it is important that a fresh supply of sample always be in contact with the membrane. Otherwise, the oxygen in the aqueous layer along the membrane is quickly depleted and false low readings are obtained. It is therefore necessary to stir the sample (or the probe) constantly to maintain fresh solution near the membrane interface. Stirring, however, shall not be so vigorous that additional oxygen is introduced through the air-water interface at the sample surface. To avoid this possibility, some probes are equipped with stirrers to agitate the solution near the probe, but to leave the surface of the solution undisturbed.

Dissolved oxygen probes are relatively free of interferences. Interferences that can occur are reactions with oxidizing gases (such as chlorine) or with gases such as hydrogen sulfide which are not easily depolarized from the indicating electrode. If gaseous interference is suspected, it shall be noted in the Field Logbook and checked if possible. Temperature variations also can cause interference because probes exhibit temperature sensitivity. Automatic temperature compensation normally is provided by the manufacturer. Attachment B presents variations of DO in water as a fraction of temperature and salinity.

5.4.2 Equipment

The following, similar or equivalent, equipment is needed to measure dissolved oxygen concentration:

- YSI Model 56 dissolved oxygen monitor (or equivalent).
- Dissolved oxygen/temperature probe.
- Sufficient cable to allow the probe to contact the sample.

5.4.3 Measurement Techniques for Dissolved Oxygen Determination

Probes differ as to specifics of use. Follow the manufacturer's instructions to obtain an accurate reading. The following general steps shall be used to measure the dissolved oxygen concentration.

1. Calibrate equipment and check batteries in the laboratory before going to the field.

2. The probe shall be conditioned in a water sample for as long as practical before use in the field. Long periods of dry storage followed by short periods of use in the field may result in inaccurate readings.

3. The instrument shall be calibrated in the field before each measurement or group of closely spaced measurements by placing the probe in a water sample of known dissolved oxygen concentration (i.e., determined by Winkler method) or in a freshly air-saturated water sample of known temperature. Dissolved oxygen values for air-saturated water can be determined by consulting a table listing oxygen solubilities as a function of temperature and salinity (see Attachment B).

4. Immerse the probe in the sample. Be sure to provide for sufficient flow past the membrane, either by stirring the sample, or placing the probe in a flowing stream. Probes without stirrers which are placed in wells should be moved up and down.

5. Record the dissolved oxygen content and temperature of the sample in a Field Logbook.

6. Recalibrate the probe when the membrane is replaced, or following similar maintenance, or as needed. Follow the manufacturer's instructions.

Note that in-situ placement of the probe is preferable, since sample handling is not involved. This, however, may not always be practical. Be sure to record whether the liquid was analyzed in-situ, or whether a sample was taken.

Special care shall be taken during sample collection to avoid turbulence which can lead to increased oxygen dissolution and positive test interferences.

5.5 Measurement of Turbidity Using a Secchi Disc

In combination with other parameters, turbidity can be a useful indicator of the likelihood of biological action in a water body. It can be used to determine the depth of light penetration of surface water and the distribution and intensity of photosynthesis in the body of water. Turbidity measurements shall be taken in-situ with a Secchi disc.

5.5.1 Equipment

Turbidity measurements may be taken with a Secchi disc. In addition, turbidity may be measured using a colimeter or a spectrophotometer. These are ex-situ measurements conducted in a laboratory environment.

5.5.2 Measurement Techniques for Turbidity

Observations must be made through a shaded area of water surface.

- Standard conditions for the use of the Secchi disc are: 1) clear sky; (2) sun directly overhead; 3) shaded, protected side of boat or under a sun shade; 4) minimal waves or ripples; and, 5) any departure from these conditions should be specifically stated on field sheets.

- Rope accurately graduated in meters with 0.1 meter graduations for the first meter and 0.5 meters thereafter.

- Observer's eye should be 1 meter above the surface of the water.
- Observations should be made during the middle of the day.
- Lower the disc into the water, noting the depth at which it disappears, then lift the disc and note the depth at which it reappears. The average of the two readings is considered to be the limit of visibility and is recorded in a Field Logbook to the nearest 0.1 meter (first meter) or 0.5 meter, depending on the depth of visibility.

6.0 QUALITY ASSURANCE RECORDS

Quality assurance records for on-site water quality management consists principally of observations and measurements recorded in the Field Logbook. Records of instrument calibration, malfunction, repair, etc., shall be maintained in an Equipment Logbook as described in the Navy CLEAN Contractor Quality Control Plan.

7.0 REFERENCES

American Public Health Association, 1980. Standard Methods for the Examination of Water and Wastewater, 15th Edition, APHA, Washington, D.C.

U.S. EPA, 1979. Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020.

U.S. Geological Survey, 1984. National Handbook of Recommended Methods for Water Data Acquisition, Chapter 5: Chemical and Physical Quality of Water and Sediment. U.S. Department of the Interior, Reston, Virginia.

ATTACHMENT A

SPECIFIC CONDUCTANCE CONVERSION TABLE

ATTACHMENT A
SPECIFIC CONDUCTANCE CONVERSION TABLE

Temperature Degrees C	Calculated Multiplier	Temperature Degrees C	Calculated Multiplier	Temperature Degrees C	Calculated Multiplier	Temperature Degrees C	Calculated Multiplier	Temperature Degrees C	Calculated Multiplier
10	1.402	12	1.330	14	1.266	16	1.208	20	1.106
10.1	1.398	12.1	1.327	14.1	1.263	16.1	1.205	20.1	1.103
10.2	1.394	12.2	1.324	14.2	1.260	16.2	1.202	20.2	1.101
10.3	1.390	12.3	1.320	14.3	1.257	16.3	1.199	20.3	1.099
10.4	1.387	12.4	1.317	14.4	1.254	16.4	1.197	20.4	1.096
10.5	1.383	12.5	1.314	14.5	1.251	16.5	1.194	20.5	1.094
10.6	1.379	12.6	1.310	14.6	1.248	16.6	1.191	20.6	1.092
10.7	1.376	12.7	1.307	14.7	1.245	16.7	1.188	20.7	1.089
10.8	1.372	12.8	1.304	14.8	1.242	16.8	1.186	20.8	1.087
10.9	1.369	12.9	1.301	14.9	1.239	16.9	1.183	20.9	1.085
11	1.365	13	1.297	15	1.236	17	1.180	21	1.083
11.1	1.361	13.1	1.294	15.1	1.233	17.1	1.178	21.1	1.080
11.2	1.358	13.2	1.291	15.2	1.230	17.2	1.175	21.2	1.078
11.3	1.354	13.3	1.288	15.3	1.227	17.3	1.172	21.3	1.076
11.4	1.351	13.4	1.285	15.4	1.225	17.4	1.170	21.4	1.074
11.5	1.347	13.5	1.281	15.5	1.222	17.5	1.167	21.5	1.072
11.6	1.344	13.6	1.278	15.6	1.219	17.6	1.165	21.6	1.069
11.7	1.341	13.7	1.275	15.7	1.216	17.7	1.162	21.7	1.067
11.8	1.337	13.8	1.272	15.8	1.213	17.8	1.159	21.8	1.065
11.9	1.334	13.9	1.269	15.9	1.210	17.9	1.157	21.9	1.063

Notes:

- Do not make specific conductance measurements at temperatures below 10° C.
- Measure temperature to the nearest 0.1° C.
- Report all conductivities at 25° C, to two significant digits.
- This conversion table is based on a temperature coefficient of 0.0191 (as per SW-846) and a cell constant of 1, where the ratio of conductivity at 25 C to the conductivity at temperature t° C equals 1/(1 + 0.0191[t-25]).
- The temperature coefficient and cell constants are only approximate, actual values may differ.
- The more the temperature deviates from 25° C, the greater the uncertainty in applying the temperature correction.

ATTACHMENT A (Continued)
SPECIFIC CONDUCTANCE CONVERSION TABLE

Temperature Degrees C	Calculated Multiplier	Temperature Degrees C	Calculated Multiplier	Temperature Degrees C	Calculated Multiplier	Temperature Degrees C	Calculated Multiplier	Temperature Degrees C	Calculated Multiplier
22	1.061	24	1.019	26	0.981	28	0.946	30	0.913
22.1	1.059	24.1	1.017	26.1	0.979	28.1	0.944	30.1	0.911
22.2	1.057	24.2	1.016	26.2	0.978	28.2	0.942	30.2	0.910
22.3	1.054	24.3	1.014	26.3	0.976	28.3	0.941	30.3	0.908
22.4	1.052	24.4	1.012	26.4	0.974	28.4	0.939	30.4	0.907
22.5	1.050	24.5	1.010	26.5	0.972	28.5	0.937	30.5	0.905
22.6	1.048	24.6	1.008	26.6	0.970	28.6	0.936	30.6	0.903
22.7	1.046	24.7	1.006	26.7	0.969	28.7	0.934	30.7	0.902
22.8	1.044	24.8	1.004	26.8	0.967	28.8	0.932	30.8	0.900
22.9	1.042	24.9	1.002	26.9	0.965	28.9	0.931	30.9	0.899
23	1.040	25	1.000	27	0.963	29	0.929	31	0.897
23.1	1.038	25.1	0.998	27.1	0.961	29.1	0.927	31.1	0.896
23.2	1.036	25.2	0.996	27.2	0.960	29.2	0.926	31.2	0.894
23.3	1.034	25.3	0.994	27.3	0.958	29.3	0.924	31.3	0.893
23.4	1.032	25.4	0.992	27.4	0.956	29.4	0.922	31.4	0.891
23.5	1.029	25.5	0.991	27.5	0.954	29.5	0.921	31.5	0.890
23.6	1.027	25.6	0.989	27.6	0.953	29.6	0.919	31.6	0.888
23.7	1.025	25.7	0.987	27.7	0.951	29.7	0.918	31.7	0.887
23.8	1.023	25.8	0.985	27.8	0.949	29.8	0.916	31.8	0.885
23.9	1.021	25.9	0.983	27.9	0.948	29.9	0.914	31.9	0.884

Notes:

- Do not make specific conductance measurements at temperatures below 10° C.
- Measure temperature to the nearest 0.1° C.
- Report all conductivities at 25° C, to two significant digits.
- This conversion table is based on a temperature coefficient of 0.0191 (as per SW-846) and a cell constant of 1, where the ratio of conductivity at 25 C to the conductivity at temperature t° C equals 1/(1 + 0.0191[t-25]).
- The temperature coefficient and cell constants are only approximate, actual values may differ.
- The more the temperature deviates from 25° C, the greater the uncertainty in applying the temperature correction.

ATTACHMENT B

VARIATION OF DISSOLVED OXYGEN CONCENTRATION IN WATER AS A FUNCTION OF TEMPERATURE AND SALINITY

ATTACHMENT B

VARIATION OF DISSOLVED OXYGEN CONCENTRATION IN WATER AS A FUNCTION OF TEMPERATURE AND SALINITY

Temperature °C	Dissolved Oxygen mg/l					
	Chloride Concentration in Water					Difference/ 100 mg chloride
	0	5,000	10,000	15,000	20,000	
0	14.6	13.8	13.0	12.1	11.3	0.017
1	14.2	13.4	12.6	11.8	11.0	0.106
2	13.8	13.1	12.3	11.5	10.8	0.015
3	13.5	12.7	12.0	11.2	10.5	0.015
4	13.1	12.4	11.7	11.0	10.3	0.014
5	12.8	12.1	11.4	10.7	10.0	0.014
6	12.5	11.8	11.1	10.5	9.8	0.014
7	12.2	11.5	10.9	10.2	9.6	0.013
8	11.9	11.2	10.6	10.0	9.4	0.013
9	11.6	11.0	10.4	9.8	9.2	0.012
10	11.3	10.7	10.1	9.6	9.0	0.012
11	11.1	10.5	9.9	9.4	8.8	0.011
12	10.8	10.3	9.7	9.2	8.6	0.011
13	10.6	10.1	9.5	9.0	8.5	0.011
14	10.4	9.9	9.3	8.8	8.3	0.010
15	10.2	9.7	9.1	8.6	8.1	0.010
16	10.0	9.5	9.0	8.5	8.0	0.010
17	9.7	9.3	8.8	8.3	7.8	0.010
18	9.5	9.1	8.6	8.2	7.7	0.009
19	9.4	8.9	8.5	8.0	7.6	0.009
20	9.2	8.7	8.3	7.9	7.4	0.009
21	9.0	8.6	8.1	7.7	7.3	0.009
22	8.8	8.4	8.0	7.6	7.1	0.008
23	8.7	8.3	7.9	7.4	7.0	0.008
24	8.5	8.1	7.7	7.3	6.9	0.008
25	8.4	8.0	7.6	7.2	6.7	0.008

ATTACHMENT B
(Continued)

VARIATION OF DISSOLVED OXYGEN CONCENTRATION IN WATER AS A FUNCTION OF TEMPERATURE AND SALINITY

Temperature °C	Dissolved Oxygen mg/l					
	Chloride Concentration in Water					Difference/ 100 mg chloride
	0	5,000	10,000	15,000	20,000	
26	8.2	7.8	7.4	7.0	6.6	0.008
27	8.1	7.7	7.3	6.9	6.5	0.008
28	7.9	7.5	7.1	6.8	6.4	0.008
29	7.8	7.4	7.0	6.6	6.3	0.008
30	7.6	7.3	6.9	6.5	6.1	0.008

Note: In a chloride solution, conductivity can be roughly related to chloride concentration (and therefore used to correct measured D.O. concentration) using Attachment A.

ATTACHMENT C
OPERATION MANUAL FOR LaMOTTE MODEL 2008 TURBIDITY METER

LaMOTTE COMPANY
HELPING PEOPLE SOLVE ANALYTICAL CHALLENGES℠
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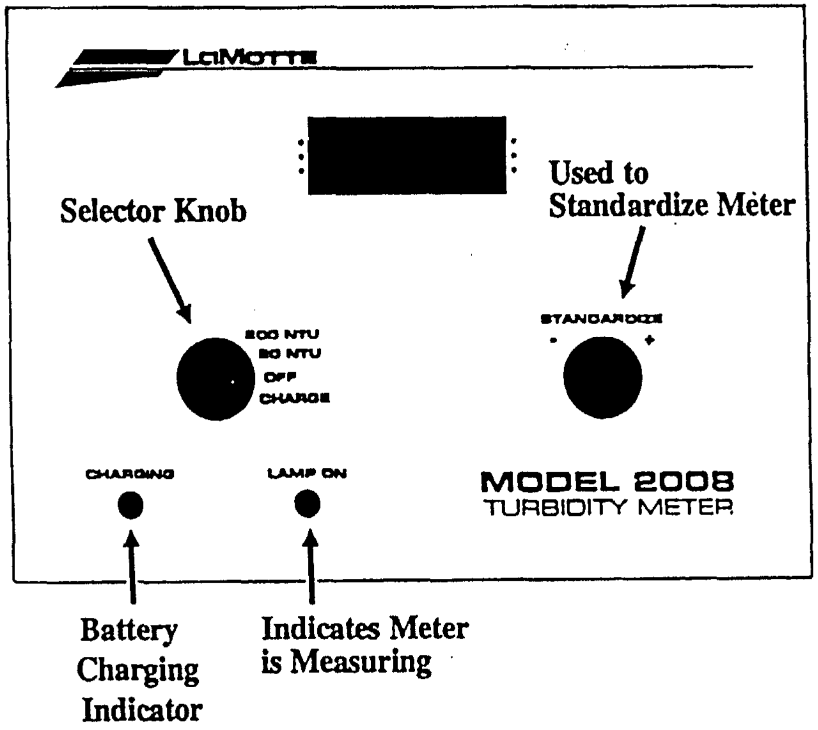
7/94

LaMOTTE

TURBIDITY MANUAL
MODEL 2008



The Model 2008 portable turbidimeter is acceptable for turbidity measurements reportable under either the National Primary Drinking Water Regulations (NPDWR) or the EPA's Surface Water Treatment compliance monitoring program. This instrument is suitable for testing municipal waters, food and beverage processing waters, and any aqueous solutions in which control of clarity is critical. The unit may be operated from line power via an AC adapter of from self-contained rechargeable batteries.

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SPECIFICATIONS & ACCESSORIES

RANGE	0-19.99 NTU 0-199.9 NTU
ACCURACY	± 2% of reading or 0.05 NTU, whichever is greater, referenced to LaMotte AMCO® standards
DISPLAY	0.5" LCD
WARM-UP TIME	<2 seconds
PHOTODETECTOR	Silicon photodiode, aligned 90° to the incident light path
LAMP	Tungsten, lens-end long life, operated at a color temperature of 2230° K
SAMPLE	Distance traversed by incident light and scattered light within tube is 2.5 cm
LAMP LIFE	45,000 hours
RANGE SELECTOR	4-position: Charge only, Off, 0-20 NTU, 0-200 NTU
POWER SOURCE	Ni-Cad rechargeable batteries, not user replaceable
SIZE	19 cm x 7 cm x 14 cm 7.5" x 2¾" x 5⅜"
WEIGHT	1.1 Kg 2.4 lbs.

REPLACEMENT PARTS & ACCESSORIES

5115PT-J	Deionized Water, 100 mL
1793	AMCO® Turbidity Standard, 0.5 NTU
1794	AMCO® Turbidity Standard, 5.0 NTU
1795	AMCO® Turbidity Standard, 20.0 NTU
1796	AMCO® Turbidity Standard, 60.0 NTU
1797	AMCO® Turbidity Standard, 100.0 NTU
1798	AMCO® Turbidity Standard, 40.0 NTU
1744	AC Adapter, 9 Volt
0273	Turbidity tubes, set of 6
0943	Syringe
0598	Filter holder
1103-6	Member filters, 0.45 micron, pkg of 6

CALIBRATING

The Model 2008 has been calibrated at the factory using a primary standard manufactured by Advanced Polymer Systems, Inc., which is a suspension of uniformly sized plastic "microspheres." These AMCO® standards require no preparation, and are stable for longer periods of time than formazin. However, with proper preparation techniques, formazin standards should be equivalent to the AMCO® standards, and can be used as primary standards for meter calibration. For proper procedures, consult the current edition of *Standard Methods for the Examination of Water and Wastewater.*

AMCO® TURBIDITY STANDARDS

Two AMCO® turbidity standards are supplied with the Model 2008; additional standards are available from LaMotte Company. Only use LaMotte AMCO® standards with the Model 2008. These standards are manufactured exclusively for LaMotte and are guaranteed to be accurate to within ± 1%, if the following procedures are observed:

1. Once the seal on the bottle is broken, the standard is good for 9 months, and must be stored between 10° and 40° C. The standards are good indefinitely prior to opening if stored under the same conditions.
2. Never put any unused standard or other possible contaminant into the bottle.
3. Do not open the standards in a dusty environment, and guard against dust and other contaminants entering the bottle while opened.
4. Rinse sample tube with standard before filling with standard to be used.
5. Cap the sample tube and standard bottle immediately after filling tube with standard.

WHAT IS IT?

Water and other liquids vary widely in their color and clarity. Some liquids, such as bottled water, are clear, while others, such as heavily polluted industrial waste, are murky and cloudy. This murkiness is called turbidity.

Turbidity is caused by fine particles suspended in the water which cause light to scatter rather than traveling in a straight line through the water. Clay, silt, plankton and other microorganisms are all examples of particulate which cause turbidity.

Many of the causes of turbidity are not necessarily harmful to human health, but turbidity can be a sign of another, more serious problem. For instance, cloudy pool water may not be dangerous to the swimmer, but it could indicate the presence of excess carbonates, which may damage the pool itself. Generally, as the pollutant level of water increases, the turbidity increases. The EPA's Surface Water Treatment requirements state that finished water has turbidity levels below 1 NTU.

Over time, turbidity measurements can be used to determine if the pollution level of a lake or other water body has changed. Biologists and others monitoring the health of a specific lake will track the turbidity level over time to see if runoff from construction, agriculture, or other man-made changes is polluting the water.

HOW IS IT MEASURED?

Turbidity can be measured in many ways. Traditionally, the Jackson Candle method was used to measure turbidity, and results were expressed as Jackson Turbidity Units (JTU). In lakes and other deep waters, a Secchi Disk is commonly used to measure the turbidity. However, neither of these methods can accurately measure low turbidities, such as those encountered at a wastewater plant, so a turbidimeter must be used.

One type of turbidimeter is the nephelometer, which determines the turbidity level by measuring the amount of light scattered 90° by the suspended particles. A light of known strength is beamed through the solution, where particles will cause the light to scatter. The intensity of this scattered light is measured by sensors located on the sides of the chamber. The meter converts these measurements to a reading, which is displayed. Nephelometers give readings in Nephelometric Turbidity Units (NTU).

Since the nephelometer measures the amount of light which is scattered by the turbid solution, it is important that no stray light interfere with the test. For this reason many turbidimeters, including the Model 2008, include a cap to cover the sample chamber during testing. Additionally, scratches, fingerprints, and water droplets on the outside of the sample tubes can cause additional light scatter, leading to inaccurate readings.

In addition to scratches and water droplets, the actual glassware itself is very important in turbidity readings, and differences between tubes and their orientation in the chamber can cause differences in test results. To assure the tubes are always placed in the chamber in the same orientation, the cap can be marked in some way, such as with a piece of tape. If this cap is always used with the same tube, by orienting the tape in the same way in the chamber each time, more accurate results can be obtained.

The Model 2008 is a versatile turbidimeter. It offers a choice of two ranges, which measure from 0 to 19.99 NTU or 0 to 199.9 NTU, allowing it to be used in treated water, natural water, or wastewater. The meter is precalibrated prior to leaving LaMotte's manufacturing facility, but it should be standardized prior to use.

TURBIDITY TUBES

To assure accurate readings the tubes supplied with the Model 2008 should be paired with marked caps. Mark each cap with a piece of tape, and pair with a tube. When the tubes are inserted into the chamber, the tape should always be oriented the same way, for instance, the tape should always point toward the operator. If greater accuracy is required, for instance for Surface Water requirements, the tubes supplied with the Model 2008 should be calibrated. Fill all the tubes with the same turbidity standard, preferably one at the higher end of the testing range. Insert each tube into the meter, and record the reading. This data will indicate the correction factor which should be used when comparing results in different tubes.

THE MODEL 2008 TURBIDIMETER

1. Select the AMCO® standard closest to the value of the sample.

NOTE: Only use LaMotte specific AMCO® turbidity standards with the Model 2008. Contact LaMotte for replacement standards.

2. Switch the selection knob to the proper range (0 - 20 or 0 - 200 NTU).
3. Fill turbidity tube with standard. Cap with paired, marked cap. Wipe tube with a lint-free tissue.
4. Insert tube into chamber. Cap chamber.

NOTE: The green LED will light to indicate tube is fully inserted, and the meter is working.

5. Adjust STANDARDIZE knob until display reads value of standard. The Model 2008 is now calibrated and ready for use.

TESTING

1. Fill a clean container with at least 50 mL of sample water. Set container aside to allow sample to equilibrate to air temperature, and to let gasses escape.

NOTE: Do not let dust or other airborne contaminants contact sample.

2. Rinse an empty turbidity tube with sample. Fill turbidity tube to neck with sample water.

NOTE: Pour sample down the side of tube to avoid creating air bubbles.

3. Cap with paired, marked cap. Wipe tube with a lint free tissue.
4. Insert tube into chamber. Cap chamber. Select appropriate range on selection knob. As soon as reading stabilizes, record reading as NTU.

NOTE: The green LED will light to indicate tube is fully inserted, and the meter is working.

5. If the sample has a turbidity reading of greater than 200 NTU, the sample must be diluted with turbidity-free water before being tested. Multiply result by the appropriate factor.

PREPARING TURBIDITY-FREE WATER

If the sample turbidity is higher than 200 NTU, it must be diluted with turbidity-free water, and retested. It is very important that no foreign matter be introduced into the water. Water prepared using this procedure can be stored in a clean glass jar, with a cap, in a dark area at room temperature, and used as required. Always check the water for particles or other foreign matter before using.

1. Unscrew the filter holder (0598), and place a white membrane filter (1103) on the screen inside. Make sure the membrane is centered on the screen and covers the entire surface. Replace top of filter holder.
2. Remove the plunger from the syringe and attach filter holder to bottom of syringe (0943).
3. Fill syringe with deionized or distilled water. Insert plunger and, exerting pressure, slowly force water through filter. Collect water in a suitable clear, glass storage container.
4. Remove filter holder from syringe, then remove plunger from barrel.
5. Replace filter holder, and repeat Steps 3 and 4 until desired amount of turbidity-free water has been collected.

NOTE: Periodically examine the membrane filter to assure no holes or cracks are present.

DILUTING THE SAMPLE

If the sample has a reading greater than 200 NTU's, it must be diluted with turbidity-free deionized water to bring the reading within the range of the Model 2008.

The following table gives quick reference guidelines on dilutions of various proportions. All dilutions are based on a 25 mL volume. Graduated pipets should be used for all dilutions.

SIZE OF SAMPLE	TURBIDITY-FREE WATER TO BRING VOLUME TO 25 mL	MULTIPLICATION FACTOR
25 mL	0 mL	1
12.5 mL	12.5 mL	2
2.5 mL	22.5 mL	10

EXAMPLE: Measure 12.5 mL of sample water into a graduated cylinder. Add turbidity-free water until the cylinder is filled to the 25 mL line. The sample has been diluted by one-half, and the dilution factor is therefore 2. Perform the test procedure, then multiply the reading from the display by 2 to obtain the test result.

RECHARGING THE BATTERY

The Model 2008 is supplied with Ni-Cad rechargeable batteries. These batteries can be recharged, but can only be replaced by LaMotte personnel. **Attempting to replace the batteries yourself will void the warranty.** A small indicator will appear on the left side of the display when the batteries need to be recharged.

NOTE: The Model 2008 can continue to make measurements while the battery is recharging. See Testing on page 9 for procedures.

1. Connect AC adapter to the Model 2008.
2. Set selection knob to CHARGE BATTERY. The red LED will light, indicating the batteries are recharging.

NOTE: Measurements can be made while the batteries are recharging.

3. The batteries will be completely recharged in approximately 4.5 hours. The red LED will extinguish when the batteries are recharged.

   If there is no display when the selector knob is switched to 0-20 or 0-200, the battery has no charge. Plug in the adapter, switch the selector knob to "OFF", and leave the meter plugged in overnight. The battery can be recharged using the above procedure.

REPLACING THE BATTERIES

When the batteries are no longer able to hold a charge, return the instrument to LaMotte Company for new batteries. Replacing the batteries yourself voids the meter warranty.

REPLACING THE LAMP

The tungsten lamp included with the Model 2008 will last approximately 45,000 hours. If you suspect the lamp is dimming, insert a clean empty sample tube into the chamber. If the display is unstable, the lamp needs to be replaced. Call LaMotte Company for a return authorization number to have the lamp replaced.

The Model 2008 was factory calibrated using AMCO® standards. If formazin or other standards are used, or the front panel calibration procedure does not supply sufficient range, an internal calibration procedure should be used.

NOTE: Adjusting any internal components other than those specified will void the meter warranty.

1. Select two standards to use during the calibration procedure. The lowest and highest NTU standards should be chosen. (Ex. 0.5 and 5.0)
2. Make sure all glassware is clean and scratch-free. Wipe tubes with a lint free tissue to remove all fingerprints.
3. Set the selection knob to OFF.
4. Remove the four screws from the base of the turbidimeter. Holding the meter face down, carefully lift the back off the meter.

NOTE: The back and faceplate are connected by a short ribbon-cable. Do not disconnect this cable.

5. Set the meter in an upright, operating position on a flat surface.
6. Set the STANDARDIZE knob to the 12 o'clock position.
7. Set the selection knob to the proper range for the chosen standards (0 - 20 NTU or 0 - 200 NTU).
8. Insert the tube containing the low standard into the chamber. Place cap on chamber. Use a screwdriver to adjust the zero trim pot until the display reads the proper NTU value.

CAUTION: Only adjust the zero trim pot. Do not adjust other potentiometers. See diagram on following page to determine position of zero trim pot.

NOTE: Rapid hand movements near the circuit board may cause readings to fluctuate. Allow readings to stabilize before continuing.

(continued)

9. Insert the tube containing the high standard into the chamber. Place cap on chamber. Use a screwdriver to adjust the slope trim pot until the display reads the proper NTU value.

CAUTION: Only adjust the slope trim pot. Do not adjust other potentiometers. See diagram below to determine position of slope trim pot.

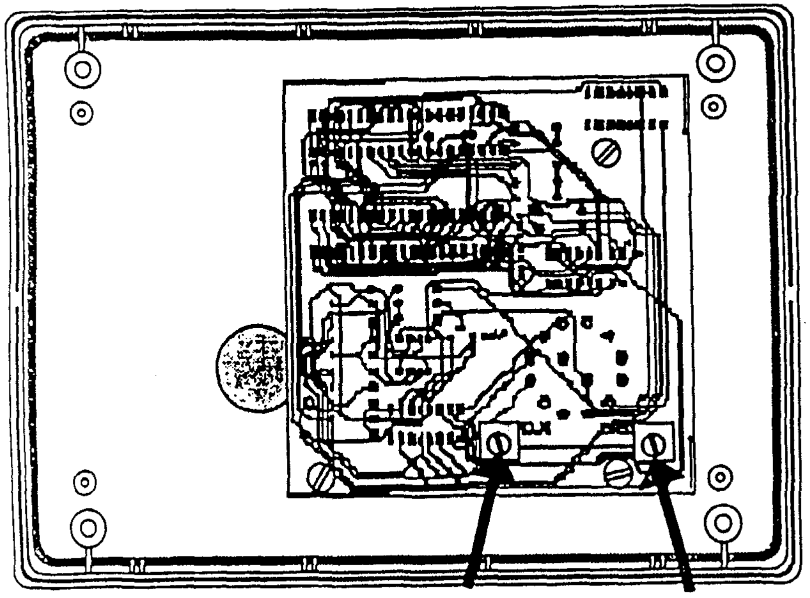
NOTE: Rapid hand movements near the circuit board may cause readings to fluctuate. Allow readings to stabilize before continuing.

10. Repeat Steps 8 and 9 until both the low and high standard values are correctly displayed.

NOTE: Use the orientation mark on the caps to assure the tubes are being placed in the meter the same way each time.

11. Reattach faceplate to back. The Model 2008 is now *calibrated and ready to use.*

Inside View of Front Panel



WARRANTY INFORMATION

REPAIRS

If it is necessary to return the instrument for repair, contact LaMotte Company at 1-800-344-3100 for a return authorization number.

INSTRUMENT GUARANTEE

This instrument is guaranteed to be free of defects in material and workmanship for one year from date of original purchase. If, in that time, it is found to be defective, it will be repaired without charge, except for transportation expenses. This guarantee does not cover the batteries.

This guarantee is void under the following circumstances:

- operator's negligence
- improper application
- unauthorized servicing

LIMITS OF LIABILITY

Under no circumstances shall LaMotte Company be liable for loss of life, profits, or other damages incurred through the use or misuse of their products.

PACKAGING AND DELIVERY

Experienced packaging personnel at LaMotte Company assure adequate protection against normal hazards encountered during shipping. After the product leaves the manufacturer, all responsibility for its safe delivery is assured by the transporter. Damage claims must be filed immediately with the transporter to receive compensation for damaged goods.

APPENDIX H
WATER LEVEL, WATER-PRODUCT LEVEL MEASUREMENTS AND WELL DEPTH MEASUREMENTS

WATER LEVEL, WATER-PRODUCT LEVEL MEASUREMENTS, AND WELL DEPTH MEASUREMENTS

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WATER LEVEL, WATER-PRODUCT LEVEL MEASUREMENTS, AND WELL DEPTH MEASUREMENTS

1.0 PURPOSE

The purpose of this procedure is to describe the method of determining various down-hole measurements: groundwater levels and product (or non-aqueous phase liquid, NAPL) levels, if present, and total depth of groundwater monitoring wells and piezometers.

2.0 SCOPE

The methods described in this SOP generally are applicable to the measurement of groundwater levels, product or NAPL levels, and well depths in monitoring wells and piezometers.

3.0 DEFINITIONS

None.

4.0 RESPONSIBILITIES

Project Manager - The Project Manager is responsible for ensuring that project-specific plans are in accordance with these procedures, where applicable, or that other approved procedures are developed.

Field Team Leader - The Field Team Leader is responsible for ensuring that these procedures are implemented in the field, and for ensuring that personnel performing these activities have been briefed and trained to execute these procedures.

Sampling Personnel - It is the responsibility of the sampling personnel to follow these procedures or to follow documented, project-specific procedures as directed by the Field Team Leader and/or the Project Manager. The sampling personnel are responsible for the proper acquisition of down-hole measurements.

5.0 PROCEDURES

Calculations of groundwater elevations and product or NAPL interface level measurements collected from a monitoring well give an indication of:

- The horizontal hydraulic gradient and the direction of groundwater flow.
- The vertical hydraulic gradient, if well nests are used (i.e., the direction of groundwater flow in the vertical plane).
- Floating or sinking product thicknesses which are also known as Light Non-Aqueous Phase Liquids (LNAPLS) and Dense Non-Aqueous Phase Liquids (DNAPLS), respectively.

This information, when combined with other site specific information such as hydraulic conductivity or transmissivity, extent of contamination, and product density, may be used to estimate the rate of contaminant movement or source areas, etc.

Well depth is one of the factors used to determine the zone that a well monitors. Well depth also is used in the calculation of purge volumes as discussed in SOP F104, Groundwater Sample Acquisition.

The following sections briefly discuss the procedures for measuring groundwater levels, product or NAPL levels, and well depth. For all of the procedures discussed, it is assumed that the measurement will be taken from the top of the PVC or stainless steel casing (though other measuring points can be used), and that horizontal and vertical control is available for each well through a site survey, such that measurements may be converted to elevations above Mean Sea Level (MSL) or some other consistent datum. A permanent notch, placed on the inner PVC or stainless steel casing by the surveyor will facilitate consistent water level measurements.

The manufacturer's instructions for all equipment referenced herein should be read by the equipment operator(s) and accompany the equipment to the field.

5.1 Water Level Measurement

Water levels in groundwater monitoring wells shall be measured from the permanent point indicated at the top of the inner casing (they surveyed elevation point, as marked by the surveyor), unless otherwise specified in the project plans, using an electronic water level measuring device (water level indicator). The point of measurement will be documented in the field logbook if different from the top of the inner casing. The reason for deviating from the measurement point should also be noted.

Water levels are measured by lowering the probe into the well until the device indicates that water has been encountered, usually with either a constant buzz, or a light, or both. The water level is recorded to the nearest foot (0.01) using the graduated markings on the water level indicator cord. This measurement, when subtracted from the measuring point elevation, yields the groundwater elevation.

Groundwater levels shall always be measured to the nearest 0.01 foot. However, reporting of water level elevations depends on the accuracy of the vertical control (typically either 0.1 or 0.01 foot).

5.2 Product or NAPL Level Measurements

The procedure for product or NAPL level measurement is nearly identical to that for groundwater elevation measurements. The only differences are the use of an interface probe that detects both NAPLs and water, and the indication signal given by the measurement device. Typically, encountering NAPLs in a monitoring well is indicated by a constant sound. When water is encountered, the signal becomes an alternating on/off beeping sound. This allows for the collection of measurements for both the top of the NAPL layer in a well and the water/NAPL interface.

The apparent water table elevation below the product level will be determined by subtracting the "depth to water" from the measuring point elevation. The corrected water table elevation will then be calculated using the following equation:

$$WTE_c = WTE_a + (\text{Free Product Thickness} \times 0.80)$$

Where:

WTE_c = Corrected water table elevation
WTE_a = Apparent water table elevation
0.80 = Average value for the density of petroleum hydrocarbons. Site-specific data will be used where available.

5.3 Well Depth Measurements

Well depths typically are measured using a weighted measuring tape. A water level meter may also be used. The tape is lowered down the well until resistance is no longer felt, indicating that the weight has touched the bottom of the well. The weight should be moved in an up and down motion a few times so that obstructions, if present, may be bypassed. The slack in the tape then is collected until the tape is taut. The well depth measurement is read directly off of the measuring tape, at the top of the PVC or stainless steel casing, to the nearest 0.01-foot and recorded in the Field Logbook. If a water level indicator is used, add the distance from the bottom of the probe to the point where water levels are measured.

5.4 Decontamination of Measuring Devices

Water level indicators, interface probes and weighted measuring tapes that come in contact with groundwater must be decontaminated using the following steps after use in each well:

- Rinse with potable water
- Rinse with deionized water
- Rinse with:
  - Methanol or acetone (EPA Region I)
  - Methanol or acetone (EPA Region II)
  - Methanol (EPA Region III)
  - Isopropanol (EPA Region IV)
- Rinse with deionized water

Portions of the water level indicators or other similar equipment that do not come into contact with groundwater, but may encounter incidental contact during use, need only undergo potable water and deionized water rinses.

6.0 QUALITY ASSURANCE RECORDS

The Field Logbook shall serve as the quality assurance record for water, product level or well depth measurements.

7.0 REFERENCE

U. S. EPA, 1991. Standard Operating Procedures and Quality Assurance Manual. Environmental Compliance Branch, U. S. EPA, Environmental Services Division, Athens, Georgia.

APPENDIX I
PHOTOIONIZATION DETECTOR (PID)
HNU MODELS PI 101 AND DL 101

PHOTOIONIZATION DETECTOR (PID)
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PHOTOIONIZATION DETECTOR (PID)
HNu MODELS PI 101 and DL 101

1.0 PURPOSE

The purpose of this SOP is to provide general reference information for using the HNu Model PI 101 or DL 101 photoionization detector (PID), or an equivalent or similar instrument, in the field. Calibration and operation, along with field maintenance will be included in this SOP.

2.0 SCOPE

This procedure provides information on the field operation and general maintenance of the HNu (PID). Application of the information contained herein will ensure that this type of field monitoring equipment will be used properly. Review of the manufacturer's instruction manual is necessary for more complete information.

These procedures refer only to monitoring for health and safety. The methods are not directly applicable to surveillance of air quality for analytical purposes.

3.0 DEFINITIONS

Ionization Potential - In this case, a numeric equivalent that expresses the amount of energy needed to replace an electron with a photon. This energy is further defined in terms of electron volts (eV).

PID - Photoionization Detector

ppm - parts per million: parts of vapor or gas per million parts of air (directly proportional to calibration gas).

4.0 RESPONSIBILITIES

Project Manager - The Project Manager is responsible for ensuring that project-specific plans are in accordance with these procedures, where applicable, or that other approved procedures are developed. The Project Manager is responsible for selecting qualified individuals for the monitoring activities.

Project Health and Safety Officer (PHSO) - The Project Health and Safety Officer is responsible for developing a site-specific Health and Safety Plan (HASP) which specifies air monitoring requirements.

Field Team Leader - It is the responsibility of the Field Team Leader to implement these procedures in the field, and to ensure that the Field Investigation Personnel performing air monitoring activities, have been briefed and trained to execute these procedures before the start of site operations.

Site Health and Safety Officer (SHSO) - The SHSO is responsible for ensuring that the specified air monitoring equipment is on site, calibrated, and used correctly by the Field Personnel. The SHSO will coordinate these activities with the Field Team Leader.

Field Investigation Personnel - It is the responsibility of the Field Investigation Personnel to follow these procedures or to follow documented project-specific procedures as directed by the Field Team Leader/Site Health and Safety Officer. The Field Investigation Personnel are responsible for documenting all air monitoring results in both the Field Logbook and the daily Realtime Air Monitoring Log during each field investigation.

5.0 PROCEDURES

The HNu utilizes the principle of photoionization whereby contaminant molecules enter the ion chamber and electrons are displaced by ultraviolet photons producing positive ions. These displaced positive ions are in turn collected on a special electrode. As the positive ions collect on the electrode, they create an electrical current which is amplified and displayed on the meter as a concentration in parts per million (ppm).

The HNu is only effective for contaminants that have ionization potentials (IP) of less than or equal to the electron volt (eV) capacity of the lamp (i.e., methane, having an IP of 12.98 eV, will not be detected at a lamp potential of 11.7 eV). The standard lamp is 10.2 eV with optional lamps of 9.5 eV and 11.7 eV, respectively. For the PI 101 the span settings should be as follows: 1.0 for 9.5 eV lamps; 9.8 for 10.2 eV lamps; and 5.0 for 11.7 eV lamps. During calibration, these span settings will be adjusted as necessary, using the span control knob.

The following subsections will discuss HNu calibration, operation, and maintenance. These sections, however, should not be used as a substitute for the manufacturer's instruction manual.

5.1 Calibration

For calibration purposes, the following items will be needed:

- *Gas cylinder containing 95 to 100 parts per million (ppm) of isobutylene, balance in air.
- A 0.30 liters per minute regulator.
- Connector tubing.
- Screwdriver set.
- Calibration Gas Humidifier (for high humidity environments).
- Photoionization Detector (PID) Calibration Form.

*Note: Do not rely on accuracy of rated cylinder concentration when content drops to <200 psi.

Prior to each use, make sure that the battery is fully charged, the ultraviolet lamp is working, and that the fan is operating and drawing air into the probe (fan operates at approximately 100-200 cc/minute for the PI 101 and 225 cc/minute for the DL 101). Procedures for completing these preliminary activities are given in the manufacturer's instruction manual.

PI 101

To calibrate the HNu PI 101, the steps provided below should be followed. For an itemized description of the calibration process, refer to Section 3-5 in the manufacturer's instruction manual. The HNu PI 101 should be calibrated on a daily basis.

- Turn the function control switch to the standby position and zero the instrument by turning the zero adjustment knob to align the indicator needle with zero on the readout meter.

- Set the range on the HNu and allow the instrument to warm up a few minutes before calibrating. Choices for range are 0-20, 0-200, and 0-2,000 ppm, respectively. Range choice must take into account the concentration of the calibration gas. For example, if you are using a concentration of 100 ppm isobutylene as the calibration gas, your range should be set on the 0-200 scale. If you have to zero the instrument in the desired range, record background if present.

- Attach tubing to the regulator (use the Calibration Gas Humidifier in high humidity environments).
- Attach the free end of the tubing to the probe and turn on the calibration gas.
- Calibrate the PID to benzene equivalents. Using the 10.2 eV (lamp) probe and 100 ppm isobutylene, the meter should read 56 units. Using the 11.7 eV (lamp) probe and 100 ppm isobutylene, the meter should read 65 units. If the reading on the meter is not ±5 percent of the concentration of the calibration gas, adjust the span setting knob until the meter reads accordingly. If after adjusting the span setting knob the readout meter is still not responding, refer to the manufacturer's instruction manual. Also, when the HNu is calibrated it should respond to a minimum of 90 percent of the concentration of the calibration gas within three seconds after introduction of that gas. If proper calibration cannot be obtained, internal calibration may be required. Note, only qualified personnel should perform internal calibrations.
- Record the calibration on the "Photoionization Detector (PID) Calibration Form".

DL 101

To calibrate the HNu DL 101, the steps provided below should be followed. For an itemized description of the calibration process, refer to Section 4.4 in the manufacturer's instruction manual.

- Press and release the POWER button on the keypad and wait for the screen to stabilize then press the CALIBRATE key until "Calibrate?" appears. At this point press the ENTER key until "Elec_Zero? Yes" appears on the screen in which case you will press the ENTER key, again, to confirm the electronic zero.
- The display will now read "CE/ENT/EXIT Conc = ____ ppm" which requires the concentration of the calibration gas (noted on the side of the calibration gas bottle) to be entered on the keypad. The display will prompt you to "Attach gas to probe and /ENTER/" so attach tubing to probe (use the calibration gas humidifier in high humidity environments), open valve, and press ENTER key. Press ENTER again when "Press ENTER when Ready: xxx ppm" appears on screen. This will cause "Calibrating...Please Wait" to appear on screen.

Note: This calibration is effective when the instrument is in the Survey Mode, which is the default mode. For calibrations other the one described, or if proper calibration cannot be obtained, refer to the manufacturer's instruction manual.

- For calibrations using an alternate gas or span values, refer to Section 4.5 of the manufacturer's instruction manual.

- Record the calibration on the "Photoionization Detector (PID) Calibration Form" which accompanies each HNu.

5.2 Operation

PI 101

Note: IMPORTANT - The HNu should be "zeroed" in a fresh air environment if at all possible. If there is a background concentration, it must be documented and then zeroed out.

- Prior to each use of the HNu, check that the battery is fully charged by turning the dial to BATT and making sure that it is within range. Also make sure that the ultraviolet lamp and the fan are working properly.

- Select your desired range. HNu ranges consists of a 0-20, 0-200, and 0-2,000 ppm, respectively. Consult with the Field Team Leader for more information when choosing the appropriate range, however, in most instances the range will be set initially at 0-20.

- When HNu is used intermittently, turn knob to STANDBY to help in extending the life of the UV lamp when operating in a low humidity environment. Otherwise, leave the knob set to the range desired so that the UV lamp will "burn off" any accumulated moisture.

Note: When using the PI 101 HNu, make sure that the probe does not contact water or soil during sampling. This will cause erroneous readings and will possibly damage the instrument.

DL 101

The DL 101 is designed to default to the survey mode when initially powered up, therefore once the calibration has been completed, the instrument is ready to go. Within the survey mode several options are available, briefly these options include:

1. The Site Function

The Site function assigns a number to a site that is being analyzed. Press the Site Key on the keypad to enter a specific site number, or press the gray button on the rear of the probe to increment a site number.

2. Logging Data

The Log function stores data in memory. To log data, press the Log key on the keypad or the Log button on the back of the probe. "Log" will appear in the upper right corner of the display when activated and disappears when not activated. To turn logging off, press either the Log key on the keypad or the red Log button on the rear of the probe.

- The DL 101 allows for the interchanging of different voltage lamps, however, refer to the manufacturer's instructions before attempting to change the lamp.
- The DL 101 also offers three other modes of operation, the Hazardous Waste Mode, the Industrial Hygiene Mode, and the Leak Detection Mode. Each of these modes increases the range of capabilities for this instrument which is covered in detail in the manufacturer's instruction manual.

Note: When using the DL 101 HNu, make sure that the probe does not contact water or soil during sampling. This will cause erroneous readings and will possibly damage the instrument.

5.3 Interferences and Potential Problems

A number of factors can affect the response of the PI 101 HNu and DL 101 HNu.

- High humidity can cause lamp fogging and decreased sensitivity. This can be significant when soil moisture levels are high, or when monitoring a soil gas well that is accessible to groundwater.
- High concentrations of methane can cause a downscale deflection of the meter.
- High and low temperature, electrical fields, FM radio transmission, and naturally occurring compounds, such as terpines in wooded areas, will also affect instrument response.

5.4 Maintenance

The best way to keep an HNu operating properly is to keep it as clean as possible. HNu's should be decontaminated and wiped down after each use.

Corrective Maintenance

- The ultraviolet lamp should be periodically cleaned using a special compound supplied by HNu Systems, Inc. for the 10.2 eV lamp, and a chlorinated solvent such as 1,1,1-trichloroethane for the 11.7eV lamp. Consult the manufacturer's instruction manual for specific cleaning instructions.
- The ionization chamber can be periodically cleaned with methyl alcohol and a swab.

Note: UV lamp and ion chamber cleaning is accomplished by following the procedures outlined in Section 5.2, however, this should only be performed by trained personnel.

- Documenting the HNu's observed symptoms and then referring to the manufacturer's instruction manual section on troubleshooting (Section 6.0) also can be employed. If this does not work, the Field Team Leader should be consulted for an appropriate course of action.

Repair and Warranty Repair - HNu's have different warranties for different parts, so documenting the problem and sending it into the manufacturer assists in expediting repair time and obtaining appropriate warranty service.

5.5 SHIPPING AND HANDLING

Following is information regarding the transport of the HNu meter and calibration gas.

- If HNu is to be carried on in aircraft, the calibration gas must be removed from the carrying case as cylinders of compressed gas are not permitted on passenger aircraft. The calibration gas should either be shipped to the site of its intended use, or purchased locally.

- Shipping of the calibration gas requires the completion of a form (specified by the shipping company) that identifies the package as a compressed gas. Compressed gas stickers must be affixed to the package.

6.0 QUALITY ASSURANCE RECORDS

Quality assurance records will be maintained for each air monitoring event. The following information shall be recorded in the Field Logbook.

- Identification - Site name, location, CTO number, activity monitored, (surface water sampling, soil sampling, etc.) serial number, time, resulting concentration, comments and identity of air monitoring personnel.
- Field observations - Appearance of sampled media (if definable).
- Additional remarks (e.g., the HNu meter had wide range fluctuations during air monitoring activities).

7.0 REFERENCES

HNu Systems, Inc. Instruction Manual. Model PI 101, 1986.

HNu Systems, Inc. Operator's Manual. Model DL 101, 1991.

APPENDIX J
BACHARACH COMBUSTIBLE GAS/OXYGEN METER AND PERSONAL GAS MONITOR

BACHARACH COMBUSTIBLE GAS/ OXYGEN METER PERSONAL GAS MONITOR
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BACHARACH COMBUSTIBLE GAS/ OXYGEN METER AND PERSONAL GAS MONITOR

1.0 PURPOSE

The purpose of this SOP is to provide general reference information for using the Bacharach Sentinel 4 and Bacharach Sniffer® 503-A meters in the field. Calibration and operation, along with field maintenance, will be included in this SOP.

2.0 SCOPE

This procedure provides information into the field operation and general maintenance of the Sentinel 4 Sniffer and 503-A. Review of the information contained herein will ensure that this type of field monitoring equipment will be properly utilized. Review of the owner's instruction manuals is a necessity for more detailed descriptions.

3.0 DEFINITIONS

<u>Carbon Monoxide Sensor</u> - Expresses the Carbon Monoxide concentration in parts per million (ppm).

<u>Combustible Gas</u> - Combustible gas is expressed as a percent of the lower explosive limit (LEL).

<u>Hydrogen Sulfide Sensor</u> - Expresses the Hydrogen Sulfide concentration in parts per million (ppm).

<u>Oxygen Sensor</u> - Expresses the Oxygen concentration as a percentage.

<u>ppm</u> - parts per million: parts of vapor or gas per million parts of air by volume.

<u>Sentinel 4</u> - Combustible Gas/Oxygen/Hydrogen Sulfide/Carbon Monoxide meter.

<u>Sniffer 503-A</u> - portable Combustible Gas and Oxygen Alarm instrument.

4.0 RESPONSIBILITIES

Project Manager - The Project Manager is responsible for ensuring that project-specific plans are in accordance with these procedures, where applicable, or that other approved procedures are developed. The Project Manager is responsible for selecting qualified individuals for the monitoring activities.

Project Health and Safety Officer (PHSO) - The Project Health and Safety Officer is responsible for developing a site-specific Health and Safety Plan (HASP) which specifies air monitoring requirements.

Field Team Leader - It is the responsibility of the Field Team Leader to implement these procedures in the field, and to ensure that the Field Investigation Personnel performing air monitoring activities, have been briefed and trained to execute these procedures before the start of site operations.

Site Health and Safety Officer (SHSO) - The SHSO is responsible for ensuring that the specified air monitoring equipment is on site, calibrated, and used correctly by the Field Personnel. The SHSO will coordinate these activities with the Field Team Leader.

Field Investigation Personnel - It is the responsibility of the Field Investigation Personnel to follow these procedures or to follow documented project-specific procedures as directed by the Field Team Leader/Site Health and Safety Officer. The Field Investigation Personnel are responsible for documenting all air monitoring results in the Field Logbook during each field investigation.

5.0 PROCEDURES

The Sentinel 4 Personal Gas Monitor and Sniffer 503-A utilize the principle of detecting sensors. The following four paragraphs discuss theory of operation as it applies to each functional sensor.

The combustible gas sensor uses two elements that are wound with a platinum wire. One of the elements is impregnated with a catalyst to oxidize combustible gases. The other element is impregnated with material that will also oxidize combustible gases, but will respond to temperature and humidity conditions. When the meter is turned on, an electrical current is passed through the elements and wires. As a combustible gas enters the chamber the elements will oxidize the combustible gas, thus increasing the heat and resistance of the element. This change in resistance causes a system imbalance, which produces a measurable signal proportional to the combustible gas concentration.

The percent oxygen is measured utilizing an electrochemical sensor. As atmospheric oxygen enters the meter it diffuses into the sensor which converts the amount of oxygen in the sensor to a voltage signal. This voltage is directly proportional to percent oxygen in the atmosphere.

The concentration of hydrogen sulfide is measured utilizing an electrochemical sensor. As atmospheric hydrogen sulfide enters the meter it diffuses into the sensor which converts the amount of hydrogen sulfide in the sensor to a voltage signal. This voltage is directly proportional to the atmospheric hydrogen sulfide concentration.

The concentration of carbon monoxide as measured utilizing an electrochemical sensor. As atmospheric carbon monoxide enters the meter it diffuses into the sensor which converts the amount of carbon monoxide in the sensor to a voltage signal. This voltage is directly proportional to the atmospheric carbon monoxide concentration.

The Sentinel 4 Personal Gas Monitor and Sniffer 503-A are intrinsically safe for use in Class I, Division 1, Groups A, B, C and D hazard areas. One fact that needs to be expressed is that this type of monitoring equipment utilizes internal oxidation of combustibles, if the meter is placed in an oxygen deficient atmosphere, the combustible reading may be affected. Review of each of the instruction manuals will aid in determining the percentage of oxygen that affects the combustible gas readings.

The following subsections will discuss Sentinel 4 and Sniffer 503-A calibration, operation, and maintenance. These sections, however, do not take the place of the instruction manual.

5.1 Calibration

Sentinel 4

Due to the numerous steps involved in calibration, it is recommended that you follow the calibration procedures (on a daily basis) as outlined in the instruction manual from pages 5-12 to 5-20.

NOTE: A calibration kit will be provided for each Sentinel 4. This kit contains a cylinder for the combustible gas sensor, one cylinder for the hydrogen sulfide sensor, and one cylinder for the carbon monoxide sensor. The oxygen sensor can be calibrated with (uncontaminated/fresh air environment) atmospheric air and does not need cylinder gas.

Note: When a single sensor doesn't zero, none of the sensors are zeroed.

Sniffer® 503-A

Oxygen Detector

1. Check battery charge by turning function switch to "BATTERY TEST," if battery is in recharge zone instrument will need to be charged.

2. To zero the oxygen detector, turn function switch to "BATTERY TEST" position and press "TEST" switch and observe the O_2 meter indication. If indicator is zero, no further adjustment is necessary. If not, follow procedures in Section 5.4.1 of the Operations Manual.

3. To calibrate the oxygen detector, turn function switch to "BATTERY TEST" position. Unlock the "OXYGEN CALIB" knob and adjust it for an O2 meter indication of 21 or at the CAL mark. Relock "OXYGEN CALIB" knob. If using zero calibration gas, follow procedures in Section 5.4.2 of the Operator's Manual.

4. Record on Calibration Sheet.

% LEL Detector

1. Check battery charge by turning function switch to "BATTERY TEST," if batter is in recharge zone, instrument will need to be charged. Allow 5 minutes for the instrument to warm up.

2. Turn function switch to the % LEL position.

   Note: To eliminate the annoyance of the audible alarm, cover the alarm with a hand or duct tape during calibration. The tape must be removed, prior to operation!!

3. Connect calibration gas (typically 30% of the LEL) and allow gas to flow for 1 minute.

   Note: If calibration gas has a concentration value, not a % LEL value, the % LEL can be calculated as follows:

   > % calibration gas (i.e., methane) x 20% LEL (meter alarm setting) = % LEL calibration setting

   If meter indication is within ±5% of LEL calibration gas, no further adjustment is required. If not, follow procedures in Section 5.5.4 of Operator's Manual.

Sniffer® 503-A

1. Connect sample probe and tubing to the instrument's sample inlet (refer to Sections 8.4 and 8.5 for the Operator's Manual for available hoses and probes.

2. Check that battery is in Operational Range.

3. Turn instrument to % LEL range and allow to warm up for 1 minute.

4. Check in a fresh air environment that % LEL reads 0% and that O_2 indicator reads 21% (calibration mark).

5. Sample air/gas from area to be tested, allow 30 seconds for readings to stabilize. When finished, allow at least 10 seconds (longer if extension line is used) to purge sample line.

6. If instrument is operating erratically, refer to "TROUBLESHOOTING" Section (Table 5-2) in Operator's Manual.

5.2 Operation

Sentinel 4

Due to the Sentinel 4 having many functions in terms of operation, it is recommended that you follow the operational procedures as outlined in the instruction manual from pages 6-1 to 6-34. NOTE: Since the Sentinel 4 is capable of measuring four different parameters, an understanding of the alarm, error, and fault messages must be obtained. This can be done by reviewing the troubleshooting table found on pages 9-2 to 9-9.

5.3 Site Maintenance

After each use, the meters should be recharged and the outside of the instruments should be wiped clean with a soft cloth.

5.4 Scheduled Maintenance

Function	Frequency
Check alarm and settings	Monthly/before each use
Clean screens and gaskets around sensors	Monthly
Replace sensors	Biannually or when calibration is unsuccessful

6.0 QUALITY ASSURANCE RECORDS

Quality assurance records will be maintained for each air monitoring event. The following information shall be recorded in the Field Logbook.

- Identification - Site name, date, location, CTO number,activity monitored, (surface water sampling, soil sampling, etc), serial number, time, resulting concentration, comments and identity of air monitoring personnel.

- Field observations - Appearance of sampled media (if definable).

- Additional remarks (e.g., the Sentinel 4 or Sniffer 503-A had wide range fluctuations during air monitoring activities.)

NOTE: The "Toxic Gas Meter Calibration Form" will be completed daily, prior to performing any air monitoring.

7.0 REFERENCES

Bacharach Installation, Operation, Maintenance Manual, Sentinel 4 Personal Gas Monitor, 1990.

Bacharach Installation, Operation, Maintenance Manual, Sniffer® 503-A, Rev. 3 - October 1990.

APPENDIX K
DRUM SAMPLING

DRUM SAMPLING
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DRUM SAMPLING

1.0 PURPOSE

The purpose of this SOP is intended to provide general information for the sampling of drums by qualified individuals in the field. Due to widely varied (and potentially hazardous) conditions posed by drum sampling, specific SOPs must be determined on a case-by-case basis. This SOP provides information to assist in ensuring that safe procedures are followed as applicable to the inspection, opening, and sampling of drums in the field.

2.0 SCOPE AND APPLICATION

This SOP provides technical guidance on safe and cost-effective response actions at sites containing both known and unknown drum contents. Container contents are sampled and characterized for disposal, bulking, recycling, grouping and/or classification purposes.

3.0 DEFINITIONS

Bung - a threaded metal or plastic plug usually positioned at the top or side of a drum.

Over Pack - a metal or plastic drum-like container that is larger than the container(s) stored therein.

Lab Pack - a drum holding multiple individual containers of laboratory materials normally surrounded by cushioning absorbent material.

4.0 RESPONSIBILITIES

Project Manager - The Project Manager is responsible for ensuring that project-specific plans are in accordance with these procedures where applicable, or that other approved procedures are developed. The Project Manager is responsible for selecting qualified individuals for the drum sampling activities.

Project Health and Safety Officer (PHSO) - The PHSO is responsible for developing a site-specific Health and Safety Plan (HASP) for drum sampling activities which include personal protection levels, air monitoring requirements, and safe drum sampling procedures.

Site Health and Safety Officer (SHSO) - The SHSO is responsible for ensuring that the proper respiratory and personal protective equipment for each member of the sampling team is selected in compliance with the HASP, and coordinating these efforts with the Field Team Leader.

Field Team Leader - The Field Team Leader is responsible for selecting and detailing the drum sampling techniques and equipment to be used. It is the responsibility of the Field Team Leader to ensure that these procedures are implemented in the field and to ensure that the Field Investigation personnel performing drum sampling activities have been briefed and trained to execute these procedures.

Field Investigation Personnel - It is the responsibility of the Field Investigation Personnel to follow these procedures or to follow documented project-specific procedures as directed by the Field Team Leader and Project Manager. The Field Investigation Personnel are responsible for documenting all sampling data on the appropriate Drum Sample Characterization Sheet presented as Attachment A and in the Field Logbook.

5.0 METHOD SUMMARY

Prior to sampling, drums should be inventoried and properly staged in a secure area. An inventory entails recording visual qualities of each drum and any characteristics pertinent to the contents' classification. Staging involves the organization and sometimes consolidation of drums which have similar wastes or characteristics.

6.0 INTERFERENCES

The practice of tapping drums to determine their contents is neither safe nor effective and should not be used if the drums are visually overpressurized (bulging) or if shock-sensitive materials are suspected. Drums that have been overpressurized, to the extent that the head is swollen several inches above the chime (beveled edge of drumtop), should not be moved. A number of devices have been developed for venting critically swollen drums. One method that has proven to be effective is a tube and spear device. A light aluminum tube (3 meters long) is positioned at the vapor space of the drum. A rigid hooking device attached to the tube goes over the chime and holds the spear securely in place. The spear is inserted in the tube and positioned against the drum wall. A sharp blow on the end of the spear drives the sharpened tip through the drum and the gas vents along the grooves. The device can be inexpensively and easily designed and constructed where needed. Once the pressure has been relieved, the bung can be removed and the drum contents sampled.

7.0 EQUIPMENT APPARATUS

The following are standard materials and equipment required for drum sampling:

- Health and Safety Plan
- Air monitoring equipment
- Fire extinguishing equipment
- Personnel protective equipment
- Wide mouth glass jars with teflon cap liner, approximately 500 ml volume
- Uniquely numbered sample identification labels with corresponding data sheets
- One-gallon covered (paint) cans half-filled with absorbent (i.e. kitty litter or vermiculite)
- Chain-of-Custody forms
- Decontamination plan and materials
- Glass thieving tubes or Composite Liquid Waste Sampler (COLIWASA)
- Drum opening devices

7.1 Bung Wrench

A common method for opening drums manually is using a universal bung wrench (see Figure 1, Attachment B). These wrenches have fittings made to remove nearly all commonly encountered bungs. They are usually constructed of cast-iron, brass or a bronze-beryllium, nonsparking alloy formulated to reduce the likelihood of sparks. The use of a "NONSPARKING" wrench does not completely eliminate the possibility of a spark being produced, therefore extreme caution should be exercised.

7.2 Drum Deheader

One means by which a drum can be opened manually (when a bung is not removable with a bung wrench) is by using a drum deheader (see Figure 2, Attachment B). This tool is designed to cut the lid of a drum off (or part way off) by means of a scissors-like cutting action. This device is limited in that it can be attached only to closed head drums. Drums with removable heads must be opened by other means.

7.3 Backhoe Spike

The most common means used to open drums remotely for sampling is the use of a metal spike attached or welded to a backhoe bucket (see Figure 3 and 4, Attachment B). In addition to being very efficient, this method can greatly reduce the likelihood of personnel exposure to the potentially hazardous nature of the drum's contents.

7.4 Hydraulic Drum Opener

Another remote drum opening procedure is the utilization of remotely operated hydraulic devices. One such device uses hydraulic pressure to pierce through the wall of a drum (see Figure 5, Attachment B). The device consists of a manually operated pump which pressurizes oil through a length of hydraulic line.

7.5 Pneumatic Devices

A pneumatic bung remover consists of a compressed air supply that is controlled by a heavy-duty, two-stage regulator. A high pressure air line of desired length delivers compressed air to a pneumatic drill, which is adapted to turn a bung fitting selected to fit the bung to be removed (see Figure 6, Attachment B). It should be noted that this bung removal method does not permit the slow venting of the container, and therefore appropriate precautions must be taken to reduce personnel exposure to pressurized, potentially hazardous drum contents. It also requires the container to be upright and relatively level. Bungs that are rusted shut or are in very poor condition cannot be removed with this device.

8.0 PROCEDURES

It is anticipated that the procedures for drum sampling may include a limited degree of drum handling. Therefore, it will be necessary to inspect the drum(s) for certain conditions prior to sampling.

8.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and which equipment and supplies will be needed.

2. Obtain necessary sampling and monitoring equipment.

3. Decontaminate or preclean equipment, and ensure that the equipment is in good working order.

4. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.

5. Perform a general site survey prior to site entry in accordance with the site-specific Health and Safety Plan.

6. Use marking devices to identify and mark all sampling locations. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions.

8.2 Inspection

Prior to sampling, drums will be visually inspected to gain as much information as possible about their contents. Items to consider during inspection include:

- Symbols, wording, labels, or other marks indicating that drum contents are hazardous, e.g., radioactive, explosive, corrosive, toxic, or flammable.

- Symbols, wording, labels, or other marks indicating that the drum contains discarded laboratory chemicals, reagents, or other potentially dangerous materials in small-volume individual containers.
- Signs of deterioration such as corrosion, rust, and leaks.
- Signs of the chemical nature of the contents, such as residue, crystal buildup, etc. at bung opening.
- Signs that the drum is under pressure such as swelling and bulging.
- Special drum types (refer to Table 1).
- Configuration of the drumhead (ringtop or bung).
- Orientation such as whether the drum is standing upright, tilted, or lying on its side.
- Accessibility of the drum.

Monitoring will be conducted around the drums using instruments such as a gamma radiation survey instrument, organic vapor monitor (OVA or HNu), colorimetric tubes (Dräger tubes), and/or a combustible gas meter. The results can be used to classify the drums into categories such as radioactive, leaking/deteriorating, bulging, explosive/shock-sensitive, or laboratory packs.

> **Personnel will not handle, move, open, sample or in anyway disturb a drum containing radioactive waste, explosive or shock-sensitive waste, laboratory packs, or biohazardous waste until specific direction and safe procedures are received from the Project Manager, PHSO and the Field Team Leader.**

TABLE 1

SPECIAL DRUM TYPES

Polyethylene or PVC-lined Drums	Often contain strong acids or bases. If the lining is punctured, the substance will usually corrode the steel, resulting in a significant leak or spill.
Exotic Metal Drums (e.g., aluminum, nickel, stainless steel, or other unusual metal)	Very expensive drums that usually contain an extremely dangerous and/or corrosive/reactive material.
Single-Walled Drums used as a Pressure Vessel	These drums have fittings for both product filling and placement of an inert gas, such as nitrogen. May contain reactive, flammable, or explosive substances.
Laboratory Packs	Used for disposal of expired chemicals and process samples from university laboratories, hospitals, and similar institutions. Individual containers within the lab pack are often not packed in absorbent material. They may contain incompatible materials, radioisotopes, shock-sensitive, highly volatile, highly corrosive, or extremely toxic exotic chemicals. Laboratory packs can be an ignition source for fires at hazardous waste sites.

When drums exhibit the characteristics of the aforementioned categories, the following procedures will be followed:

- Radioactive Wastes - If the drum exhibits radiation levels above background, normally 0.01-0.02 mrem/hr (milliroentgen equivalent in man per hour), that are less than or equal to 2 mrem/hr, there is a possible radiation source present. Continue the investigation with caution, and inform the SHSO. If the radiation levels are greater than 2 mrem/hr there is a potential radiation hazard. Work will stop, and the Field Team Leader and Project Manager will be notified so that new procedures can be developed and implemented.

- Explosive or Shock-Sensitive Waste - If handling is necessary, exercise extreme caution, have nonessential personnel move to a safe distance, and use a grappler unit for initial handling which is constructed for explosive containment. Use nonsparking equipment and/or remote control devices.

- Bulging Drums - Do not move drums under internal pressure unless proper equipment is used, such as a grappler unit constructed for explosive containment.

- Packaged Laboratory Wastes (Lab Packs) - Lab Packs can be an ignition source for fires and sometimes contain shock-sensitive materials. Once a lab pack has been opened, a chemist or other qualified individual should inspect, classify and segregate the bottles (without opening), according to the hazards of the wastes. The objective of such a classification system is to ensure safe segregation of the lab packs' contents (refer to Table 2 for an example of a lab pack classification). If crystalline material is noted at the neck of any bottle, handle it as a shock-sensitive waste (due to the potential presence of picric acid, potassium permanganate or explosive mixtures resulting when the aqueous solution crystallizes), or other inimical (harmful) materials, and obtain advice from qualified personnel prior to handling.

Until drum contents are characterized, sampling personnel will assume that unlabeled drums contain hazardous materials. Personnel also should be aware that drums are frequently mislabeled and may not contain the material identified.

TABLE 2

LAB PACK CLASSIFICATION EXAMPLES

Classification	Examples
Inorganic acids	Hydrochloric Acid Sulfuric Acid
Inorganic bases	Sodium hydroxide Potassium hydroxide
Strong oxidizing agents	Ammonium nitrate Barium nitrate Sodium chlorate Sodium peroxide
Strong reducing agents	Sodium thiosulfate Oxalic acid Sodium sulphite
Anhydrous organics and organometallics	Tetraethyl lead Phenylmercuric chloride
Anhydrous inorganics and metal hydrides	Potassium hydride Sodium hydride Sodium metal Potassium
Toxic organics	PCBs Insecticides
Flammable organics	Hexane Toluene Acetone
Inorganics	Sodium carbonate Potassium chloride
Inorganic cyanides	Potassium cyanide Sodium cyanide Copper cyanide
Organic cyanides	Cyanoacetamide
Toxic metals	Arsenic Cadmium Lead Mercury

8.3 Drum Opening

Drums are to be opened and sampled in place. For opening drums manually, equipment such as a nonsparking metal (brass, bronze/manganese, aluminum, molybdenum) bung/plug wrench and a drum deheading device will be used for waste contents that are known to be nonreactive and nonexplosive, within a structurally sound drum.

While opening drums manually with a bung wrench, the following procedures will be used:

- Drums will be positioned bung up, or, for drums with bungs on the side, laid on their sides with the bung plug up. Note that care should be taken when moving a drum into position for opening.

- Use a wrenching motion that is a slow and steady pull across the drum, using a "cheater bar" if the leverage for unscrewing the bung is poor.

- If there is evidence of incompatible chemical reactions, a sudden pressure buildup, or a release of potentially toxic fumes while the bung is being loosened, field personnel will immediately leave the area and arrange for remote drum opening equipment to be used.

- If the drum cannot be opened successfully using a nonsparking hand wrench, then other methods of drum opening (deheading or puncturing) must be considered. If deheading or puncturing a drum, it will be necessary to overpack the drum to minimize the potential for spilling the drum's contents.

- If the drum shows signs of swelling or bulging, perform all steps slowly. From a remote location, relieve excess pressure prior to drum opening using the devices listed below, if possible. If performing drum opening activities manually, place a barrier such as an explosion-resistant plastic shield between the worker and bung to deflect any gas, liquid, or solids which may be expelled as the bung is loosened.

Whenever possible, use the following remote-controlled devices for opening drums:

- A pneumatically operated impact wrench to remove drum bungs.

- A hydraulically or pneumatically operated drum piercer.
- A backhoe equipped with bronze spikes for penetrating drum tops (typical in large-scale operations).

Additional general procedures for drum opening are as follows:

- If a supplied-air respiratory protection system is used, the bank of air cylinders must be maintained outside of the work area.
- If personnel must be located near the drums being opened, place explosion-resistant plastic shields between them and the drums, in case of detonation. Locate controls for drum opening equipment, monitoring equipment, and fire suppression equipment behind the explosion-resistant plastic shield. Nonessential personnel must be positioned upwind from the drum opening and sampling operations.
- When feasible, monitor air quality continuously during drum opening, and as close as possible to the potential source of contaminants, (i.e., placing probes as close as practical without hindering drum opening operations), and hang or balance the drum opening equipment to minimize exertion.
- Do not use picks, chisels, etc. to open drums manually.
- Open exotic metal drums and polyethylene or polyvinylchloride-lined (PVC-lined) drums by removing or manually drilling the bung, while exercising extreme caution.
- Do not open or sample individual containers within laboratory packs.
- Reseal open bungs and/or drill openings as soon as possible, with new bungs or plugs to avoid explosions and/or vapor generation. If an open drum cannot be resealed, place the drum into an overpack.
- Plug any openings in pressurized drums with pressure venting caps set to a 5-psi release to allow venting of vapor pressure.

- Decontaminate and/or properly dispose of sampling equipment after each use to avoid mixing incompatible wastes and contaminating subsequent samples.

8.4 Drum Sampling

When sampling a previously sealed vessel, check for the presence of bottom sludge. Since some layering or stratification is likely in any solution left undisturbed over time, take a sample that represents the entire depth of the vessel.

The most widely used instrument for sampling is a glass tube commonly referred to as a glass thief (Figure 7, Attachment B). This tool is simple, cost effective, quick and collects a sample without having to decontaminate. Glass thieves are typically 6 mm to 16 mm I.D. and 48 inches long.

Drum sampling can be a very hazardous activity because it often involves direct contact with unidentified wastes. Prior to collecting any sample, field team personnel will become familiar with the procedures identified in the Sampling Plan and in this SOP.

Certain information can be construed from the drumhead configuration prior to sampling, such as:

- Removable "Whole" Lid = designed to contain solid material
- Bung opening = designed to contain liquids
- Drum Liner = may contain a highly corrosive or otherwise hazardous material

When manually sampling from a drum, use the following techniques:

- Keep sampling personnel at a safe distance while drums are being opened. Sample only after opening procedures are complete.

- Do not lean over or between other drums to reach the drum being sampled.

- Cover drum tops with plastic sheeting or other suitable uncontaminated materials to avoid excessive contact with the drum tops.

- Never stand on drums. Use mobile steps or another platform to achieve the height necessary to safely sample from the drums.

- After the drum has been opened, monitor headspace gases with no less than an explosimeter and an organic vapor analyzer. In most cases it is impossible to observe the contents of these sealed or partially sealed vessels.

- Obtain samples with either glass rods (thiefs) or with a vacuum pump and tubing. Do not use contaminated items such as discarded rags during sampling. Glass rods will be removed prior to pumping to minimize damage to pumps.

- Identify each drum with a sample number. Record the number on the Drum Waste Characterization Sheet and permanently on the drum (mark lid and side) using either a label, permanent marker, or spray paint. Cover drums with plastic sheeting and secure to minimize degradation of labeling from variable weather conditions.

8.4.1 Procedures for using a glass thief are as follows:

1. Remove cover from sample container.

2. Insert glass tubing almost to the bottom of the drum or until a solid layer is encountered. About one foot of tubing should extend above the drum.

3. Allow the waste in the drum to reach its natural level in the tube.

4. Cap the top of the sampling tube with a tapered stopper or thumb, ensuring liquid does not come into contact with stopper.

5. Carefully remove the capped tube from the drum and insert the uncapped end in the sample container.

6. Release stopper and allow the glass thief to drain until the container is approximately 2/3 full.

7. Remove tube from the sample container.

8. Cap the sample container tightly and place prelabeled sample container in a carrier.

9. Replace bung or lid securely on drum.

10. Break the thief into pieces inside a drum which has been designated for solid hazardous waste disposal. Previously, drum thiefs were broken and disposed inside the drum being sampled. However, this activity hinders the future disposal of liquid drum contents by introducing solid material.

11. Log all samples in the site logbook and on field data sheets.

12. Package samples and complete necessary paperwork.

13. Transport sample to decontamination zone in preparation for transport to analytical laboratory.

8.4.2 COLIWASA Sampler

The Composite Liquid Waste Sampler (COLIWASA) is designed to collect a sample from the full depth of a drum and maintain it in the transfer tube until delivery to the sample bottle. The COLIWASA (Figure 8, Attachment B) is a much cited sampler designed to permit representative sampling of multiphase wastes from drums and other containerized materials. One configuration consists of a 152 cm x 4 cm inside diameter (I.D.) section of tubing with a neoprene stopper at one end attached by a rod running the length of the tube to a locking mechanism at the other end. Manipulation of the locking mechanism opens and closes the sampler by raising and lowering the neoprene stopper.

9.0 QUALITY ASSURANCES/QUALITY CONTROL

The following quality assurance procedures apply:

- Document all data on standard chain of custody forms, field data sheets and/or within site logbooks.

- Operate all instrumentation in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the Work Plan and Sampling Plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and must be documented in the field logbook.

Quality assurance records shall consist of completed Drum Waste Characterization Sheets and data entered into the Field Logbook. A sample Drum Waste Characterization Sheet is presented as Attachment A. Attachment B contains example figures of drum sampling equipment.

10.0 REFERENCES

NIOSH/OSHA/USCG/EPA, 1985. Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health. Publication No. 85-115.

U.S. EPA, 1986. Drum Handling Practices at Hazardous Waste Sites. Wetzel, Furman, Wickline, and Hodge, JRB Associates, McLean, Virginia. Publication No. 86-165362.

NIOSH, 1990. NIOSH Pocket Guide to Chemical Hazards. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, Cincinnati, Ohio. Publication No. 90-117.

U.S. EPA, 1991 Compendium of ERT Waste Sampling Procedures. OSWER Directive 9360.4-07. EPA/540/P-91/008

ATTACHMENT A

DRUM WASTE CHARACTERIZATION SHEET

Baker Environmental, Inc

Drum/Sample No.

Project Location ____________________ Project No. ____________________

Project Manager ____________________ Telephone ____________________

Logger ____________________ Sampler ____________________

Weather ____________________ Date ____________ Time ____________

Drum Type: ☐ Fiber ☐ Steel ☐ Poly ☐ Stainless Steel ☐ Nickel ☐ Poly-Lined ☐ Ring Top ☐ Closed Top ☐ Overpacked

Drum Size: 85 ☐ 55 ☐ 42 ☐ 30 ☐ 16 ☐ 10 ☐ 5 ☐ Other ____________

Drum Contents: Amount Full ☐ 3/4 ☐ 1/2 ☐ 1/4 ☐ <1/4 ☐ MT ☐

Drum Condition: Good ☐ Fair ☐ Poor ☐

	Physical State				Color	Clarity			Layer Thickness (Inches)
	Liquid	Solid	Gel	Sludge	Use Std. Colors	Clear	Cloudy	Opaque	
Top									
Middle									
Bottom									

pH ____________ PID ____________ ppm

Rad Meter ____________________ mr/hr

Other ____________________

____

MFG Name ____________________

Chemical Name ____________________

Additional Information: ____

____

LABORATORY COMPATIBILITY ANALYSES

	Physical State				Color	Clarity			Water Sol.	React.	pH	Hex. Sol.	Per.	Oxid.	CN	Sul.	Biel-Stein	Flash Point
	Liquid	Solid	Gel	Sludge	Use Std. Colors	Clear	Cloudy	Opaque	Sol. S or I Density	A - Air W - Water	Std. Unit	S or I	+ or -	+ or -	+ or -	+ or -	+ or -	°C or°F
Top																		
Middle																		
Bottom																		

Comments: ____

PCB Conc. ____________ ppm Flash Point ____________ °C

Data Reviewer ____________________ Compatibility Comp. Bulk No. ____________________

Field Reviewer ____________________

ATTACHMENT B

LIST OF FIGURES

Figure 1: Universal Bung Wrench

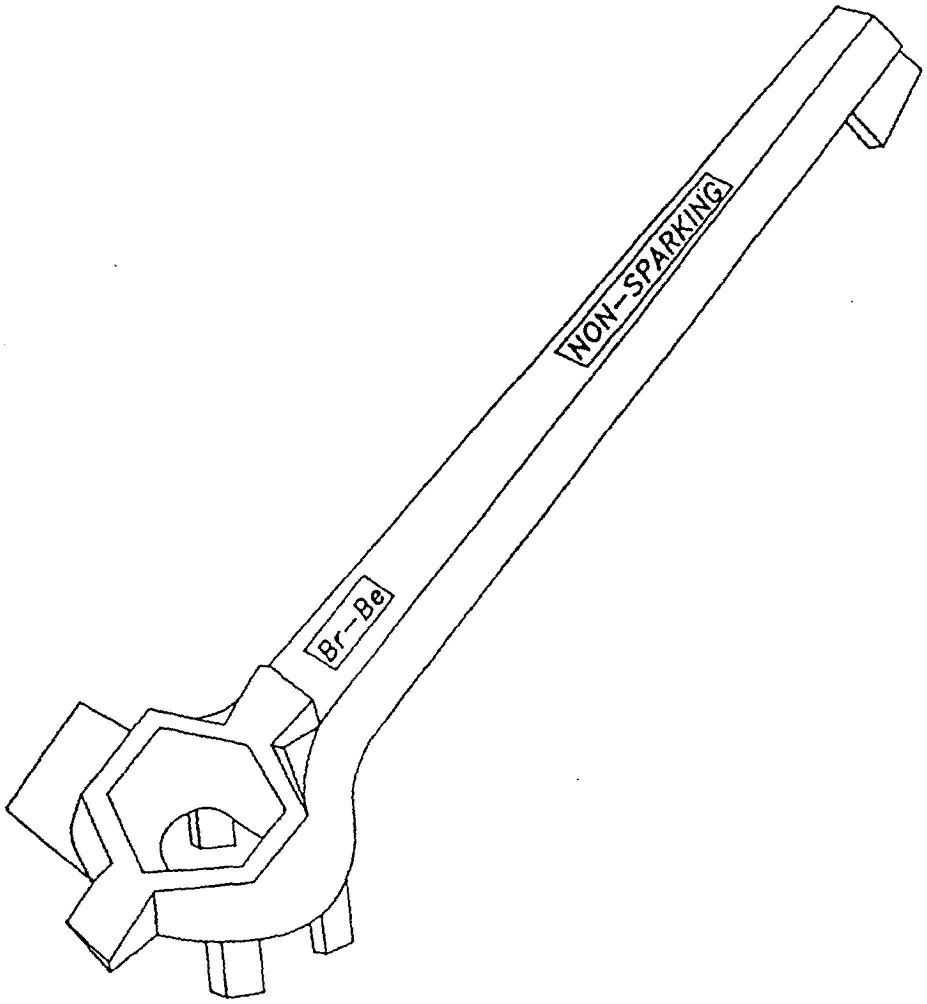
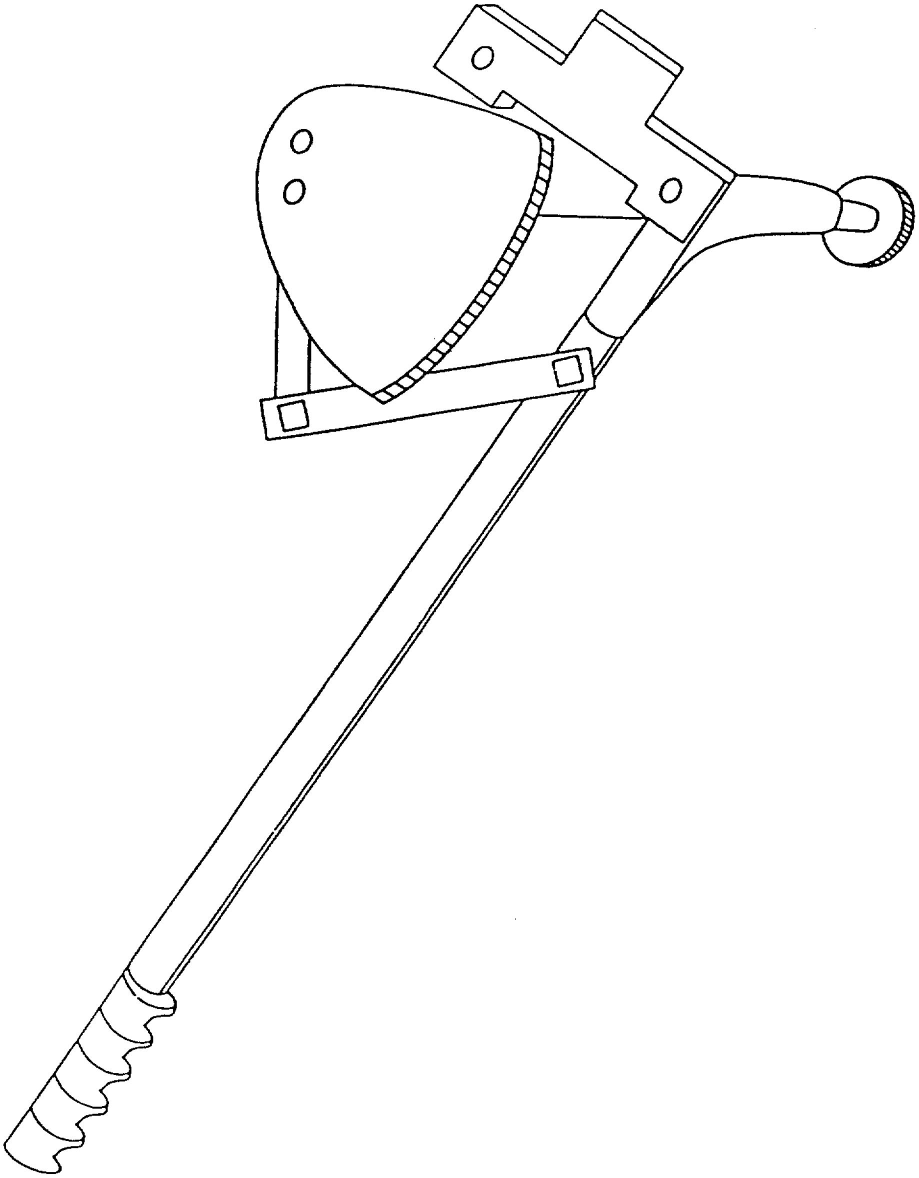


Figure 2: Drum Deheader



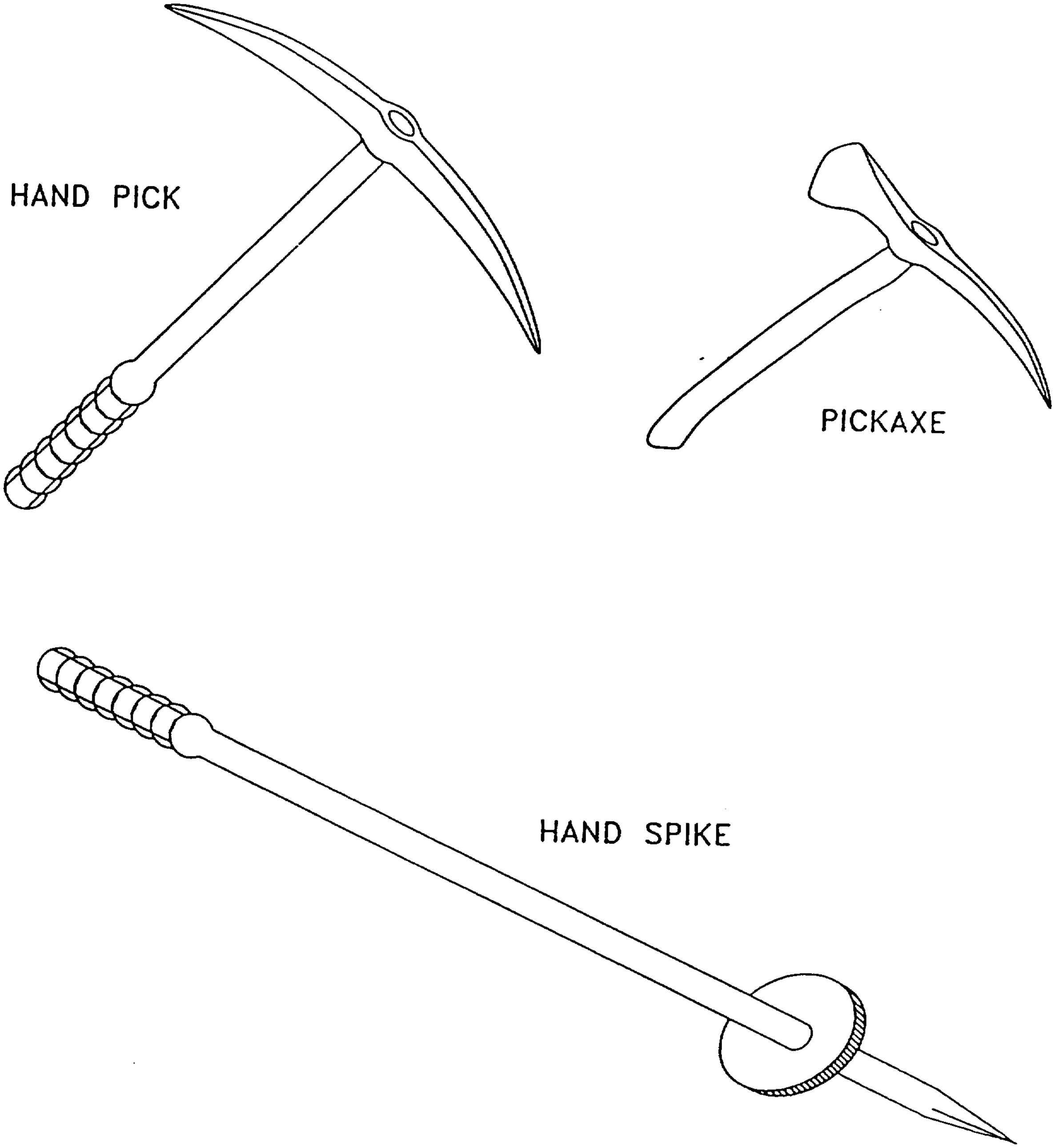


Figure 3: Hand Pick, Pickaxe, and Hand Spike

Figure 4: Backhoe Spike

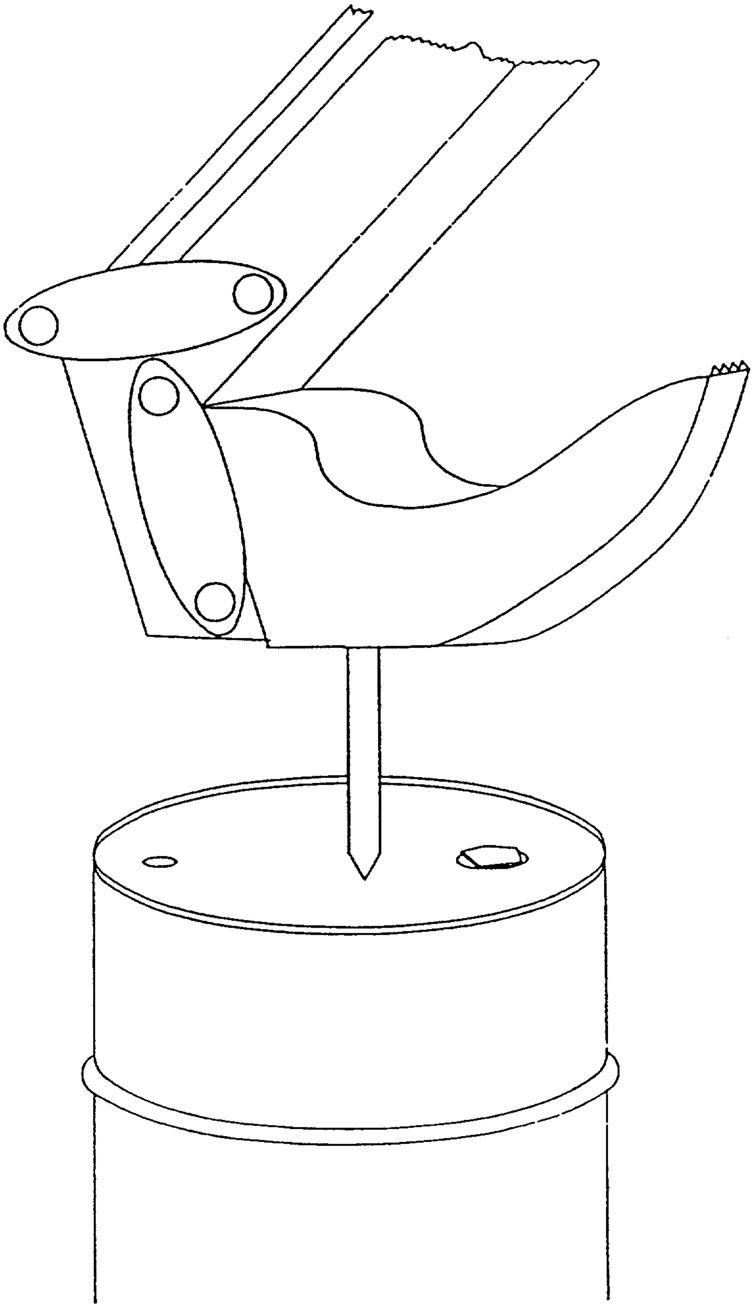


Figure 5: Hydraulic Drum Opener

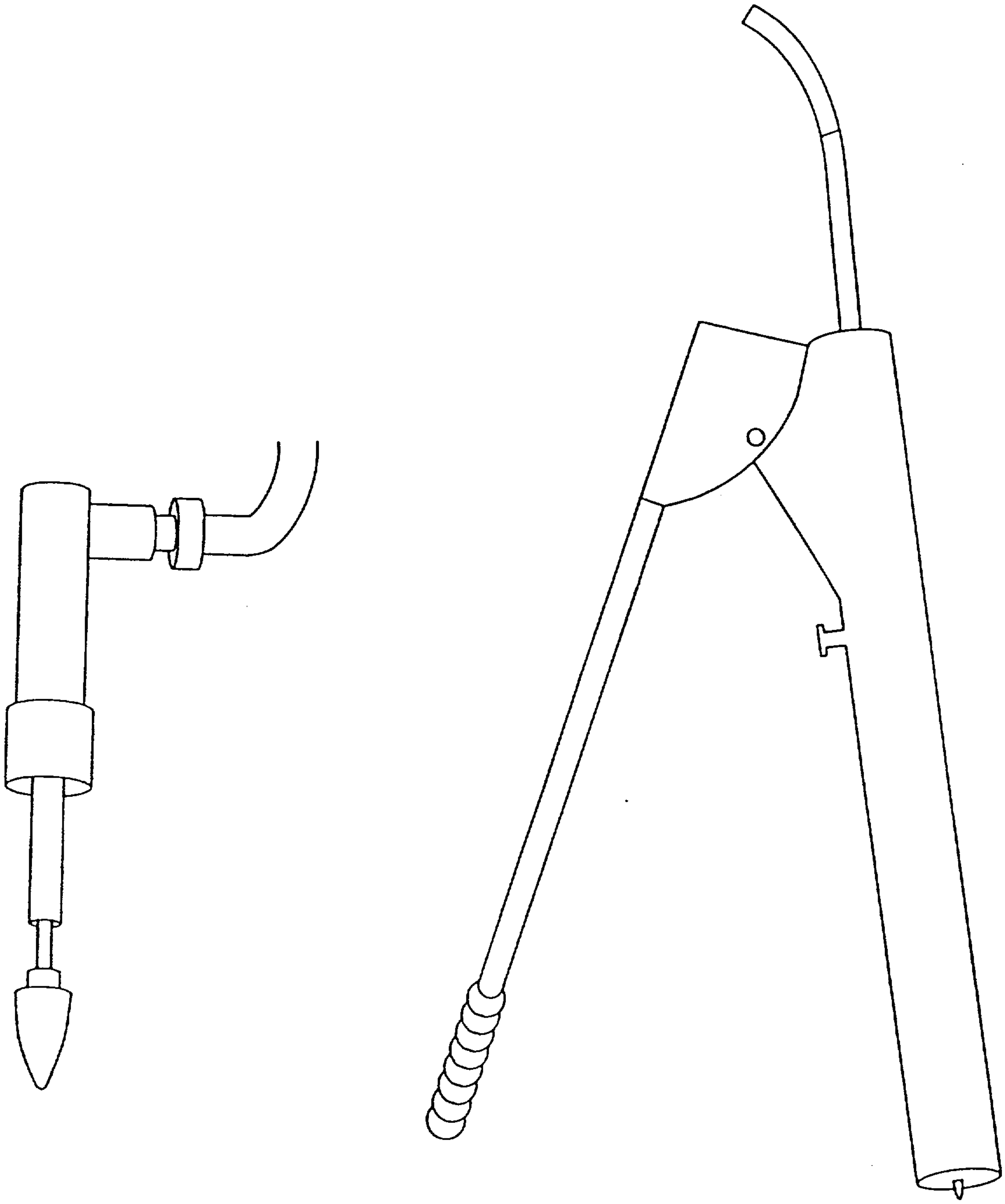


Figure 6: Pneumatic Bung Remover

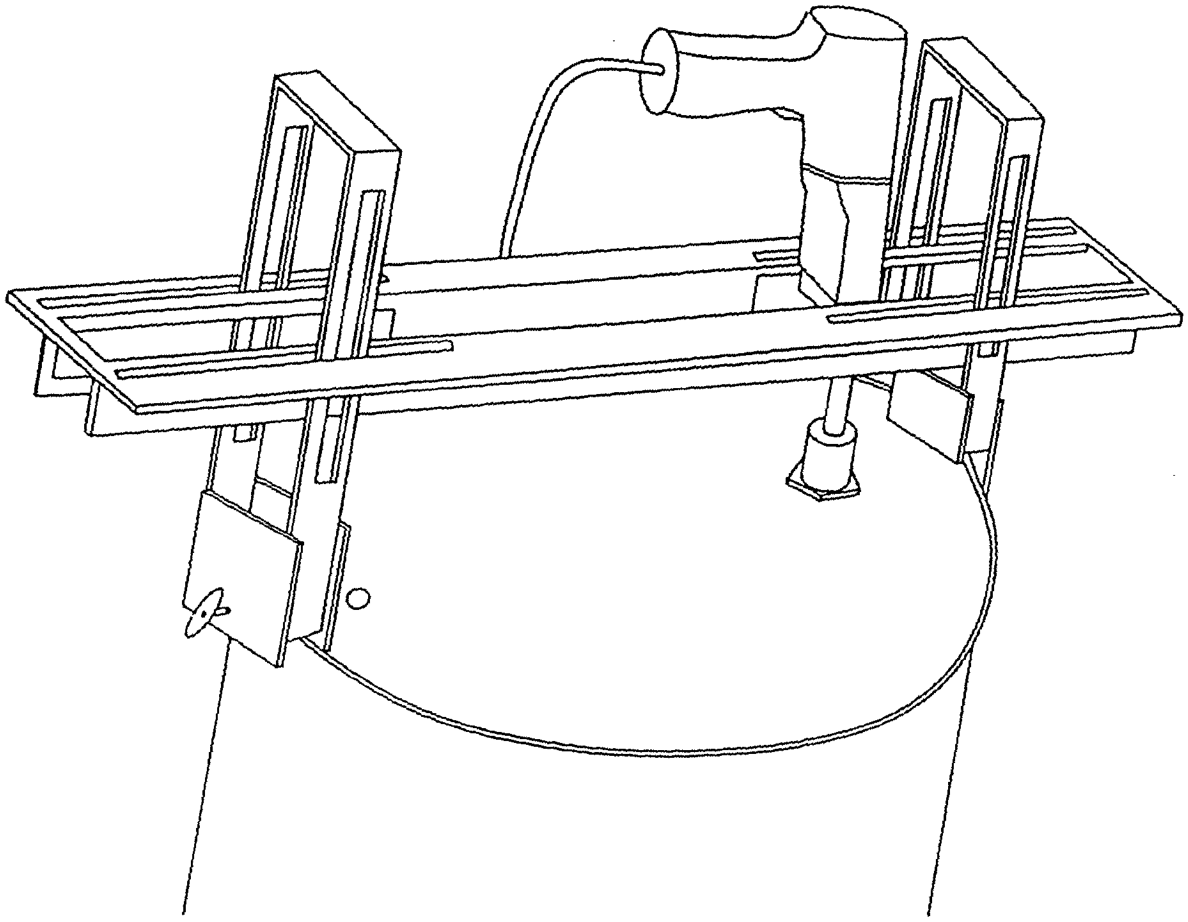
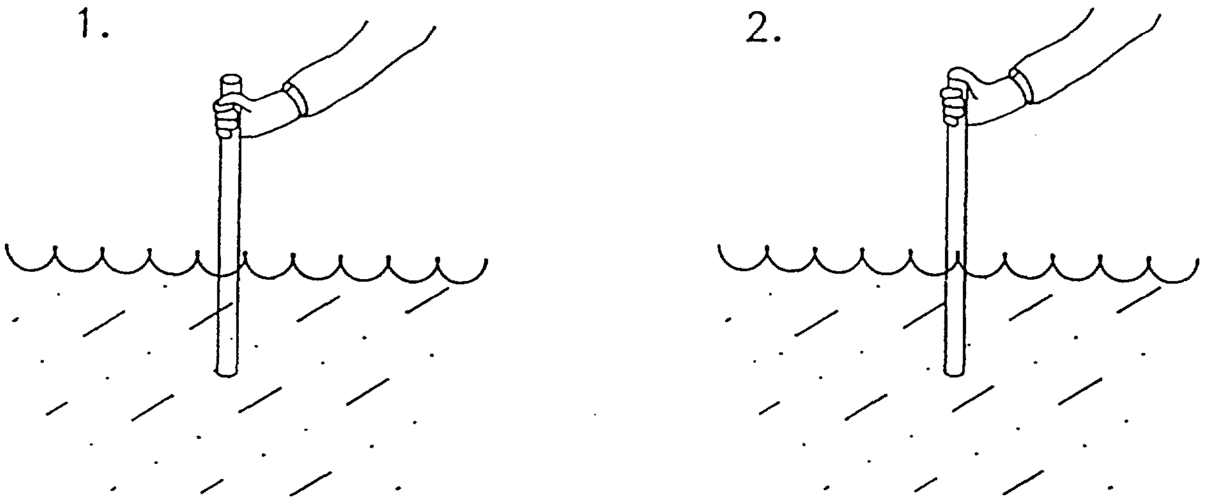
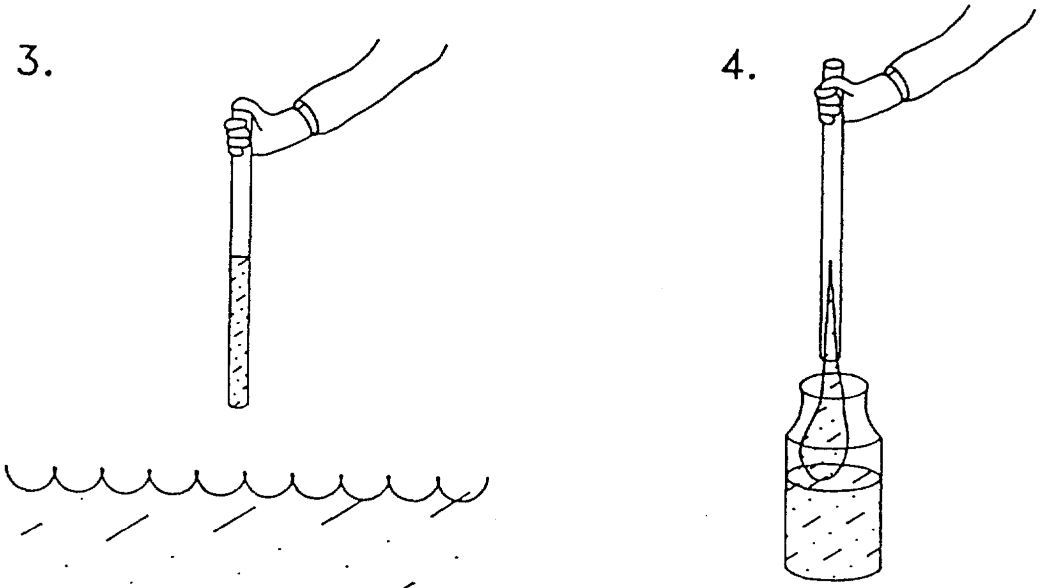


Figure 7: Glass Thief



Insert open tube (thief) sampler in containerized liquid.

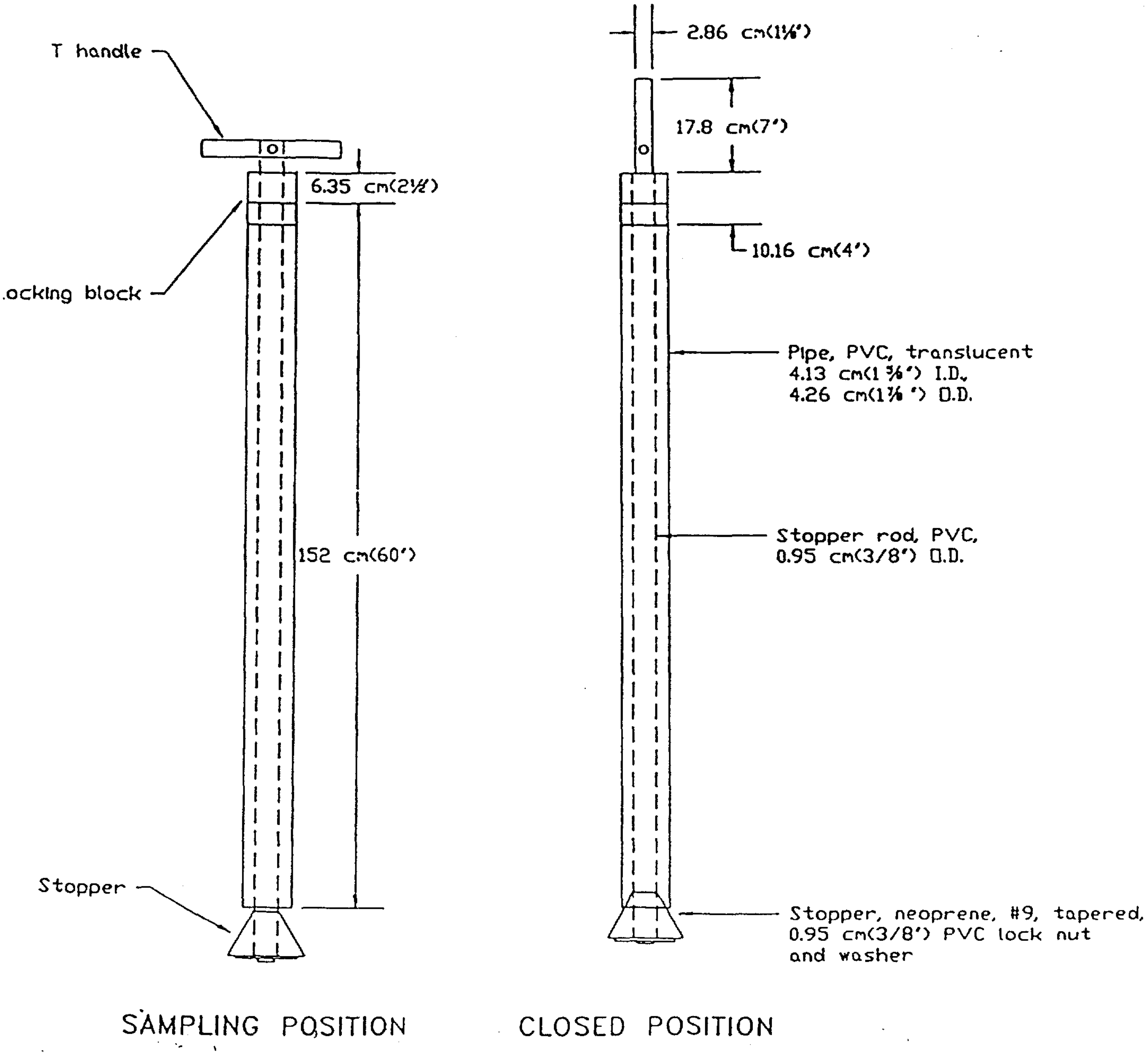
Cover top of sampler with gloved thumb.



Remove open tube (thief) sampler from containerized liquid.

Place open tube sampler over appropriate sample bottle and remove gloved thumb.

Figure 8: COLIWASA



APPENDIX L
WASTEWATER SAMPLE ACQUISITION

WASTEWATER SAMPLE ACQUISITION
TABLE OF CONTENTS

WASTEWATER SAMPLE ACQUISITION

1.0 PURPOSE

The purpose of this SOP is to provide general reference information for collecting wastewater samples.

2.0 SCOPE

This procedure provides information for the acquisition of waste water samples. Review of the information contained herein will ensure that sample acquisition is properly conducted.

3.0 DEFINITIONS

Sampling Plan - A "plan of action" that guides the implementation of methods that will lead to achieving the plans objective(s).

Grab Sample - An entire sample which is collected at one specific sample location at a specific point in time.

Composite Sample - A sample which is collected at several different locations and/or at different points in time.

Environmental Sample - Samples of naturally occurring materials; soil, sediment, air, water.

Waste Sample - Samples which are comprised of process wastes or other manmade waste material(s).

4.0 RESPONSIBILITIES

Project Manager - The Project Manager is responsible for ensuring that project specific plans are in accordance with procedures where applicable, or that other approved procedures are developed. The Project Manager is responsible for development of documentation of procedures which deviate from those presented herein.

Field Team Leader - The Field Team Leader is responsible for selecting and detailing the waste water sample acquisition techniques and equipment to be used. It is the responsibility of the Field Team Leader to ensure that these procedures are implemented in the field and to ensure that the Field Investigation personnel performing the sample acquisition activities have been briefed and trained to execute these procedures.

Field Investigation Personnel - It is the responsibility of the Field Investigation Personnel to follow these procedures or to follow documented project specific procedures as outlined in the Work Plan and as directed by the Field Team Leader and Project Manager. The Field Investigation Personnel are responsible for documenting all wastewater sampling activities and ambient air monitoring results in the field log book.

5.0 PROCEDURES

This protocol outlines procedures and equipment for the collection of representative liquid samples and sediment/sludge samples from standing lakes, ponds and lagoons, and flowing streams, rivers, channels, sewers and leachate seeps.

The collection of samples from these sources presents a unique challenge. Often sampling can be quite easy and routine (e.g., collecting a surface water sample from a two foot deep stream). Other times, the nature of site specific conditions may dictate that: 1) special equipment is needed to access the sample, 2) appropriate health and safety measures are critical, 3) proper timing is essential due to waste release times or tidal fluctuations, and/or 4) wastewater flow rate is a factor for consideration.

Prior to sample collection, impoundment characteristics (size, depth, flow) should be recorded in the field log book. Sampling should proceed from downstream locations to upstream locations so that sediment disturbance (turbidity) caused by sampling does not affect sample quality. Additionally, if a sediment sample will be collected at the same location as a liquid sample, the liquid sample must be collected first to minimize sample turbidity.

If the Sampling Plan requires that samples are to be collected from the shore of an impoundment, specific health and safety considerations must be addressed. The person collecting the sample should be fitted with a safety harness and rope secured to a sturdy, immobile object on shore. Backup personnel should be available to assist in sample collection and should be prepared and able to pull the sampler to safety if unstable banks are encountered.

To more adequately characterize the content and/or quality of an impoundment, samples may be collected away from the shoreline, often at various depths. If the content of the impoundment is suspected to be highly hazardous, the risk to sampling personnel must be weighed against the need to collect the sample. If a barge or boat is used, each person on the vessel must be equipped with a life preserver and/or lifeline.

The sampling of liquids in lakes, ponds, lagoons, streams, rivers, channels, sewers and leachate seeps is generally accomplished through the use of one of the following samplers:

- Laboratory cleaned sample bottle
- Pond sampler
- Weighted bottle sampler
- Wheaton dip sampler
- Kemmerer Depth Sampler
- Bacon Bomb Sampler

The factors that will contribute to the selection of a sampler include the width, depth and flow of the location being sampled, and whether the sample will be collected from the shore or a vessel.

For flowing liquids, tidal influence on the collected sample is an additional concern and should be addressed in the Sampling Plan. At a minimum, the stage of the tide at the time of sample collection should be recorded. Consideration should be given to sampling at varied tidal stages as well as seasonally. Tidal information can be obtained from local bait shops, newspaper listings and/or local radio or television news reports.

Samplers may encounter situations where rate of flow affects their ability to collect a sample. For fast flowing rivers and steams it may be nearly impossible to collect a mid-channel sample at a specific point. Low flowing streams and leachate seeps present the opposite problem. In these cases the sampler should attempt to locate an area where flow is obstructed and a pool is created. If this is not possible, sediment may be dug with a decontaminated trowel to create a pooled area where sufficient liquid will accumulate for sampling.

5.1 On-Shore

If the banks are not sloped, sampling personnel may be able to collect the liquid directly into the sample bottle. In some instances where access is limited, a pond sampler, by virtue of its extension capabilities, may be necessary. For a stream, channel or river, collect the sample at mid-depth. For standing liquid, collect the sample from just below the surface or at mid-depth. Once the sample is obtained by sample vessel, transfer it directly into the sample bottle. If volatile organic compounds (VOCs) are to be analyzed, fill the appropriate sample containers for VOCs first, then fill sample containers for other chemical analyses. Decontaminate the sampling device following procedures outlined in the Sampling Plan and/or SOP F502 before obtaining the next sample.

5.2 Off-Shore

Collect a liquid sample using the sample bottle or decontaminated pond sampler, if necessary. If the liquid has stratified, a sample of each strata should be collected. One of the depth samplers listed above will allow collection of discrete representative liquid samples at various depths. Proper use of the chosen sampling device includes slowly lowering and careful retrieval of the sample, immediate transfer of the liquid into the appropriate sampling container, and logbook notation of the depth at which the sample was collected. After collection, the sampling device must be decontaminated prior to obtaining the next sample.

6.0 QUALITY ASSURANCE RECORDS

Quality assurance records shall consist of recording sample date and acquisition time(s), sample number, sample location(s), sample depth(s), name of the Field Investigation Personnel collecting the sample(s), and Service Order Number in the field logbook. The type of container used to hold the sample and preservative agent, if needed, also will be documented, as will the method of sampling equipment decontamination. In addition, if photographs are taken of the sample site, the photograph number and direction of view shall be recorded as well.

7.0 REFERENCES

Field Sampling Procedures Manual. Chapter 8. New Jersey Department of Environmental Protection, Trenton, New Jersey. February 1988.

Sampling and Analysis Methods. Compilation of EPA's Sampling and Analysis Methods, USEPA, Washington, D.C. 1991.

Characterization of Hazardous Waste Sites. USEPA, Washington, D. C. 1990.

APPENDIX M
SAMPLE PRESERVATION AND HANDLING

SAMPLE PRESERVATION AND HANDLING
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SAMPLE PRESERVATION AND HANDLING

1.0 PURPOSE

This SOP describes the appropriate containers for samples of particular matrices, and the steps necessary to preserve those samples when shipped off site for chemical analysis. It also identifies the qualifications for individuals responsible for the transportation of hazardous materials and samples and the regulations set forth by the Department of Transportation regarding the same.

2.0 SCOPE

Some chemicals react with sample containers made of certain materials; for example, trace metals adsorb more strongly to glass than to plastic, while many organic chemicals may dissolve various types of plastic containers. It is therefore critical to select the correct container in order to maintain the integrity of the sample prior to analysis.

Many water and soil samples are unstable and may change in chemical character during shipment. Therefore, preservation of the sample may be necessary when the time interval between field collection and laboratory analysis is long enough to produce changes in either the concentration or the physical condition of the constituent(s). While complete and irreversible preservation of samples is not possible, preservation does retard the chemical and biological changes that may occur after the sample is collected.

Preservation techniques are usually limited to pH control, chemical addition(s), and refrigeration/freezing. Their purposes are to (1) retard biological activity, (2) retard hydrolysis of chemical compounds/complexes, (3) reduce constituent volatility, and (4) reduce adsorption effects.

Typical sample container and preservation requirements for the CLEAN Program are referenced in NEESA 20.2-047B and are provided in Attachment A of this SOP. Note that sample container requirements (i.e., volumes) may vary by laboratory.

The Department of Transportation, Code of Federal Regulations (CFR) Title 49 establishes regulations for all materials offered for transportation. The transportation of environmental samples for analysis is regulated by Code of Federal Regulations Title 40 (Protection of the Environment), along with 49 CFR Part 172 Subpart H. The transportation of chemicals used as preservatives and samples identified as hazardous (as defined by 49 CFR Part 171.8) are regulated by 49 CFR Part 172.

3.0 DEFINITIONS

HCl - Hydrochloric Acid
H_2SO_4- Sulfuric Acid
HNO_3 - Nitric Acid
NaOH - Sodium Hydroxide

Normality (N) - Concentration of a solution expressed as equivalents per liter, where an equivalent is the amount of a substance containing one mole of replaceable hydrogen or its equivalent. Thus, a one molar solution of HCl, containing one mole of H, is "one-normal," while a one molar solution of H_2SO_4 containing two moles of H, is "two-normal."

4.0 RESPONSIBILITIES

Project Manager - The Project Manager is responsible for ensuring that project-specific plans are in accordance with these procedures, where applicable, or that other, approved procedures are developed. The Project Manager is responsible for development of documentation of procedures which deviate from those presented herein. The Project Manager is also responsible for proper certification of individuals responsible for transportation of samples of hazardous substances.

Field Team Leader - It is the responsibility of the Field Team Leader to ensure that these procedures are implemented in the field and to ensure that personnel performing sampling activities have been briefed and trained to execute these procedures. The Field Team Leader is responsible to ensure all samples and/or hazardous substances are properly identified, labeled, and packaged prior to transportation.

Sampling Personnel - It is the responsibility of the field sampling personnel to initiate sample preservation and handling. It is also the responsibility of the field sampling personnel to understand and adhere to the requirements for proper transportation of samples and/or hazardous substances.

5.0 PROCEDURES

The following procedures discuss sample containerization and preservation techniques that are to be followed when collecting environmental samples for laboratory analysis.

5.1 Sample Containers

For most samples and analytical parameters either glass or plastic containers are satisfactory. In general, if the analyte(s) to be measured is organic in nature, the container shall be made of glass. If the analyte(s) is inorganic, then glass or plastic containers may be used. Containers shall be kept out of direct sunlight (to minimize biological or photo-oxidation/photolysis of constituents) until they reach the analytical laboratory. The sample container shall have approximately five to ten percent air space ("ullage") to allow for expansion/vaporization if the sample is heated during transport (one liter of water at 4°C expands by 15 milliliters if heated to 130°F/55°C); however, head space for volatile organic analyses shall be omitted.

The analytical laboratory shall provide sample containers that have been certified clean according to USEPA procedures. Shipping containers for samples, consisting of sturdy ice chests, are to be provided by the laboratory.

Once opened, the sample container must be used at once for storage of a particular sample. Unused, but opened, containers are to be considered contaminated and must be discarded. Because of the potential for introduction of contamination, they cannot be reclosed and saved for later use. Likewise, any unused containers which appear contaminated upon receipt, or which are found to have loose caps or missing liners (if required for the container) shall be discarded.

General sample container, preservative, and holding time requirements are listed in Attachment A.

5.2 Preservation Techniques

The preservation techniques to be used for various analytes are listed in Attachment A. Reagents required for sample preservation will either be added to the sample containers by laboratory prior to their shipment to the field or added in the field using laboratory supplied preservatives. Some of the more commonly used sample preservation techniques include storage of sample at a temperature of 4°C, acidification of water samples, and storage of samples in dark (i.e. amber) containers to prevent the samples from being exposed to light.

All samples shall be stored at a temperature of 4°C. Additional preservation techniques shall be applied to water samples as follows:

- Water samples to be analyzed for volatile organics shall be acidified.
- Water samples to be analyzed for semivolatile organics shall be stored in dark containers.
- Water samples to be analyzed for pesticides/PCBs shall be stored in dark containers.
- Water samples to be analyzed for inorganic compounds shall be acidified.

These preservation techniques generally apply to samples of low-level contamination. The preservation techniques utilized for samples may vary. However, unless documented otherwise in the project plans, all samples shall be considered low concentration. All samples preserved with chemicals shall be clearly identified by indicating on the sample label that the sample is preserved.

5.3 Sample Holding Times

The elapsed time between sample collection and initiation of laboratory analyses is considered the holding time and must be within a prescribed time frame for each individual analysis to be performed. Sample holding times for routine sample collection are provided in Attachment A.

6.0 SAMPLE HANDLING AND TRANSPORTATION

After collection, the outside of all sample containers will be wiped clean with a damp paper towel; however sample handling should be minimized. Personnel should use extreme care to ensure that samples are not contaminated. If samples are placed in an ice chest, personnel should ensure that melted ice cannot cause sample containers to become submerged, as this may result in sample cross-contamination and loss of sample labels. Sealable plastic bags, (zipper-type bags), should be used when glass sample containers are placed in ice chests to prevent cross-contamination, if breakage should occur.

Samples may be hand delivered to the laboratory or they may be shipped by common carrier. Relevant regulations for the storage and shipping of samples are contained in 40 CFR 261.4(d). Parallel state regulations may also be relevant. Shipment of dangerous goods by air cargo is also regulated by the United Nations/International Civil Aviation Organization (UN/ICAO). The Dangerous Goods Regulations promulgated by the International Air Transport Association (IATA) meet or exceed DOT and UN/ICAO requirements and should be used for shipment of dangerous goods via air cargo. Standard procedure for shipping environmental samples are given in Attachment B.

7.0 REFERENCES

American Public Health Association, 1981. Standard Methods for the Examination of Water and Wastewater. 15th Edition. APHA, Washington, D.C.

USEPA, 1984. "Guidelines Establishing Test Procedures for the Analysis of Pollutants under Clean Water Act." Federal Register, Volume 49 (209), October 26, 1984, p. 43234.

USEPA, 1979. Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020. USEPA EMSL, Cincinnati, Ohio.

USEPA, Region IV, 1991. Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual. Athens, Georgia.

Protection of the Environment, Code of Federal Regulation, Title 40, Parts 260 to 299.

Transportation, Code of Federal Regulation, Title 49, Parts 100 to 177.

ATTACHMENT A

REQUIRED CONTAINER, PRESERVATION TECHNIQUES AND HOLDING TIMES

ATTACHMENT A

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

Parameter	Bottle Requirements	Preservation Requirements	Holding Time (1)	Analytical Method	Bottle Volume
Volatile Organic Compounds (VOA)	glass teflon lined cap	Cool to 4°C 1:1 HCl pH <2	10 days	CLP	2 x 40 ml
Semivolatile Organic Compounds (SVOA)	glass teflon lined cap	Cool to 4°C Dark	Extraction within 5 days Analyze 40 days	CLP	2 x 1 liter
PCB/Pesticides	glass teflon lined cap	Cool to 4°C Dark	Extraction within 5 days Analyze 40 days	CLP	2 x 1 liter
Cyanide	plastic/glass	NaOH to pH >12 Cool to 4°C	14 days	CLP EPA 335.2	1 x 1 liter
Metals (TAL)	plastic/glass	HNO_3 to pH <2	180 days except Mercury is 26 days	CLP	1 x 1 liter
Total Organic Carbon	glass, teflon lined cap	Cool to 4°C H_2SO_4 to pH <2	28 days	EPA 415.1	2 x 40 ml
Total Organic Halogen	plastic/glass	Cool to 4°C H_2SO_4 to pH <2	28 days	EPA 450.1	250 ml
Chloride	plastic/glass	none required	28 days	EPA 325.2/325.3	250 ml
Sulfate	plastic/glass	Cool to 4°C	28 days	EPA 375.4	250 ml
Alkalinity	plastic/glass	Cool to 4°C	14 days	EPA 310.1/310.2	250 ml
Gross alpha/gross beta	plastic/glass	HNO_3 to pH <2	6 months	9310	1 gallon
Chlorinated herbicides	glass, teflon lined cap	Cool to 4°C	14/28 days	EPA 515.1	1000 ml
Hardness	plastic/glass	HNO_3 to pH <2	6 months	EPA 130.2	150 ml

(1) Holding times for CLP methods are based on Validated Time of Sample Receipt as stated in CLP statement of work of February, 1991. Holding times for Non-CLP methods are based on time of sample collection.

Note: Verify this information with the laboratory that will perform the analyses.

ATTACHMENT A (Continued)

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

Parameter	Bottle Requirements	Preservation Requirements	Holding Time (1)	Analytical Method	Bottle Volume
Volatile Organic Compounds (VOA)	glass teflon lined cap	Cool to 4°C	10 days	CLP	1 x 50 gm
Semivolatile Organic Compounds (SVOA)	glass teflon lined cap	Cool to 4°C	Extraction within 10 days Analyze 40 days	CLP	1 x 250 gm
PCB/Pesticides	glass teflon lined cap	Cool to 4°C	Extraction within 10 days Analyze 40 days	CLP	1 x 50 gm
Metals (TAL)	plastic/glass	Cool to 4°C	Mercury is 26 days 180 days	CLP	1 x 50 gm
Cyanide	plastic/glass	Cool to 4°C	14 days	CLP EPA 335.2M	1 x 50 gm

(1) Holding times for CLP methods are based on Validated Time of Sample Receipt as stated in CLP statement of work of February, 1991. Holding times for Non-CLP methods are based on time of sample collection.

Note: Verify this information with the laboratory that will perform the analyses.

ATTACHMENT B

SAMPLE SHIPPING PROCEDURES

ATTACHMENT B

SAMPLE SHIPPING PROCEDURES

Introduction

Samples collected during field investigations or in response to a hazardous materials incident must be classified by the project leader, prior to shipping by air, as either environmental or hazardous substances. The guidance for complying with U.S. DOT regulations in shipping environmental laboratory samples is given in the "National Guidance Package for Compliance with Department of Transportation Regulations in the Shipment of Environmental Laboratory Samples."

Pertinent regulations for the shipping of environmental samples is given in 40 CFR 261.4(d). Samples collected from process wastewater streams, drums, bulk storage tanks, soil, sediment, or water samples from areas suspected of being highly contaminated may require shipment as dangerous goods/hazardous substance. Regulations for packing, marking, labeling, and shipping of dangerous goods by air transport are promulgated by the United Nations International Civil Aviation Organization (UN/ICAO),which is equivalent to IATA.

Individuals responsible for transportation of environmental samples or dangerous goods/hazardous substances must be tested and certified by their employer. This is required by 49 CFR Part 172 Subpart H Docket HM-126 to assure the required qualifications for individuals offering materials for transportation.

Environmental samples shall be packed prior to shipment by commercial air carrier using the following procedures:

1. Select a sturdy cooler in good repair. Secure and tape the drain plug (inside and outside) with fiber or duct tape. Line the cooler with a large heavy duty plastic bag. This practice keeps the inside of the cooler clean and minimizes cleanup at the laboratory after samples are removed.
2. Allow sufficient headspace (ullage) in all bottles (except VOAs) to compensate for any pressure and temperature changes (approximately 10 percent of the volume of the container).

3. Be sure the lids on all bottles are tight (will not leak). In many regions custody seals are also applied to sample container lids. The reason for this practice is two-fold: to maintain integrity of samples and keep lid on the container should the lid loosen during shipment. Check with the appropriate regional procedures prior to field work. In many cases, the laboratory manager of the analytical lot to be used on a particular project can also provide this information.

4. It is good practice to wrap all glass containers in bubblewrap or other suitable packing material prior to placing in plastic bags.

5. Place all bottles in separate and appropriately sized polyethylene bags and seal the bags with tape (preferably plastic electrical tape, unless the bag is a zipper-type bag). Up to three VOA bottles, separately wrapped in bubblewrap, may be packed in one plastic bag.

6. Optionally, place three to six VOA vials in a quart metal can and then fill the can with vermiculite.

7. Place two to four inches of vermiculite (ground corn cob, or other inert packing material) in the bottom of the cooler and then place the bottles and cans in the cooler with sufficient space to allow for the addition of more vermiculite between the bottles and cans.

8. Put frozen "blue ice" (or ice that has been placed in properly sealed, double-bagged, heavy duty polyethylene bags) on top of and between the samples. Fill all remaining space between the bottles or cans with packing material. Fold and securely fasten the top of the large heavy duty plastic bag with tape (preferably electrical or duct).

9. Place the Chain-of-Custody Record and the Request for Analysis Form (if applicable) into a plastic bag, tape the bag to the inner side of the cooler lid, and then close the cooler and securely tape (preferably with fiber tape) the top of the cooler unit. Wrap the tape three to four times around each side of the cooler unit. Chain-of-custody seals should be affixed to the top and sides of the cooler within the securing tape so that the cooler cannot be opened without breaking the seal.

10. Each cooler (if multiple coolers) should have its own Chain-of-Custody Record reflecting the samples shipped in that cooler.

11. Label according to 40 CFR 261.4(d). The shipping containers should be marked "THIS END UP," and arrow labels which indicate the proper upward position of the container should be affixed to the container. A label containing the name and address of the shipper and laboratory shall be placed on the outside of the container. It is good practice to secure this label with clear plastic tape to prevent removal during shipment by blurring of important information should the label become wet. The commercial carrier is not required to sign the COC record as long as the custody seals remain intact and the COC record stays in the cooler. The only other documentation required is the completed airbill, which is secured to the top of the shipping container. Please note several coolers/shipping containers may be shipped under one airbill. However, each cooler must be labeled as "Cooler 1 of 3, Cooler 2 of 3, etc.", prior to shipping. Additionally it is good practice to label each COC form to correspond to each cooler (i.e., 1 of 3, 2 of 3, etc.).

APPENDIX N
CHAIN-OF-CUSTODY

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CHAIN-OF-CUSTODY

1.0 PURPOSE

The purpose of this SOP is to provide information on chain-of-custody procedures to be used to document sample handling.

2.0 SCOPE

This procedure describes the steps necessary for transferring samples through the use of Chain-of-Custody Records. A Chain-of-Custody Record is required, without exception, for the tracking and recording of samples collected for on-site or off-site analysis (chemical or geotechnical) during program activities (except wellhead samples taken for measurement of field parameters, SOP F101). Use of the Chain-of-Custody Record Form creates an accurate written record that can be used to trace the possession and handling of the sample from the moment of its collection through analysis. This procedure identifies the necessary custody records and describes their completion. This procedure does not take precedence over region-specific or site-specific requirements for chain-of-custody.

3.0 DEFINITIONS

Chain-of-Custody Record Form - A Chain-of-Custody Record Form is a printed two-part form that accompanies a sample or group of samples as custody of the sample(s) is transferred from one custodian to another custodian. One copy of the form must be retained in the project file.

Custodian - The person responsible for the custody of samples at a particular time, until custody is transferred to another person (and so documented), who then becomes custodian. A sample is under one's custody if:

- It is in one's actual possession.
- It is in one's view, after being in one's physical possession.
- It was in one's physical possession and then he/she locked it up to prevent tampering.
- It is in a designated and identified secure area.

Sample - A sample is physical evidence collected from a facility or the environment, which is representative of conditions at the point and time that it was collected.

4.0 RESPONSIBILITIES

Project Manager - The Project Manager is responsible for ensuring that project-specific plans are in accordance with these procedures, where applicable, or that other, approved procedures are developed. The Project Manager is responsible for development of documentation of procedures which deviate from those presented herein. The Project Manager is responsible for ensuring that chain-of-custody procedures are implemented. The Project Manager also is responsible for determining that custody procedures have been met by the analytical laboratory.

Field Team Leader - The Field Team Leader is responsible for determining that chain-of-custody procedures are implemented up to and including release to the shipper or laboratory. It is the responsibility of the Field Team Leader to ensure that these procedures are implemented in the field and to ensure that personnel performing sampling activities have been briefed and trained to execute these procedures.

Sampling Personnel - It is the responsibility of the field sampling personnel to initiate chain-of-custody procedures, and maintain custody of samples until they are relinquished to another custodian, the sample shipper, or to a common carrier.

5.0 PROCEDURES

The term "chain-of-custody" refers to procedures which ensure that evidence presented in a court of law is valid. The chain-of-custody procedures track the evidence from the time and place it is first obtained to the courtroom, as well as providing security for the evidence as it is moved and/or passed from the custody of one individual to another.

Chain-of-custody procedures, recordkeeping, and documentation are an important part of the management control of samples. Regulatory agencies must be able to provide the chain-of-possession and custody of any samples that are offered for evidence, or that form the basis of analytical test results introduced as evidence. Written procedures must be available and followed whenever evidence samples are collected, transferred, stored, analyzed, or destroyed.

5.1 Sample Identification

The method of identification of a sample depends on the type of measurement or analysis performed. When in-situ measurements are made, the data are recorded directly in bound logbooks or other field data records with identifying information.

Information which shall be recorded in the field logbook, when in-situ measurements or samples for laboratory analysis are collected, includes:

- Field Sampler(s);
- CTO Number;
- Project Sample Number;
- Sample location or sampling station number;
- Date and time of sample collection and/or measurement;
- Field observations;
- Equipment used to collect samples and measurements; and,
- Calibration data for equipment used.

Measurements and observations shall be recorded using waterproof ink.

5.1.1 Sample Label

Samples, other than in-situ measurements, are removed and transported from the sample location to a laboratory or other location for analysis. Before removal, however, a sample is often divided into portions, depending upon the analyses to be performed. Each portion is preserved in accordance with the Sampling and Analysis Plan. Each sample container is identified by a sample label (see Attachment A). Sample labels are provided, along with sample containers, by the analytical laboratory. The information recorded on the sample label includes:

- Project or Contract Task Order (CTO) Number.

- Station Location - The unique sample number identifying this sample.

- Date - A six-digit number indicating the day, month, and year of sample collection (e.g., 12/21/85).

- Time - A four-digit number indicating the 24-hour time of collection (for example: 0954 is 9:54 am., and 1629 is 4:29 p.m.).

- Medium - Water, soil, sediment, sludge, waste, etc.

- Sample Type - Grab or composite.
- Preservation - Type and quantity of preservation added.
- Analysis - VOA, BNAs, PCBs, pesticides, metals, cyanide, other.
- Sampled By - Printed name of the sampler.
- Remarks - Any pertinent additional information.

Using only the work assignment number of the sample label maintains the anonymity of sites. This may be necessary, even to the extent of preventing the laboratory performing the analysis from knowing the identity of the site (e.g., if the laboratory is part of an organization that has performed previous work on the site).

5.2 Chain-of-Custody Procedures

After collection, separation, identification, and preservation, the sample is maintained under chain-of-custody procedures until it is in the custody of the analytical laboratory and has been stored or disposed.

5.2.1 Field Custody Procedures

- Samples are collected as described in the site Sampling and Analysis Plan. Care must be taken to record precisely the sample location and to ensure that the sample number on the label matches the Chain-of-Custody Record exactly.
- The person undertaking the actual sampling in the field is responsible for the care and custody of the samples collected until they are properly transferred or dispatched.
- When photographs are taken of the sampling as part of the documentation procedure, the name of the photographer, date, time, site location, and site description are entered sequentially in the site logbook as photos are taken. Once developed, the photographic prints shall be serially numbered, corresponding to the logbook descriptions; photographs will be stored in the project files. It is good practice to identify sample locations in photographs by including an easily read sign with the appropriate sample/location number.
- Sample labels shall be completed for each sample, using waterproof ink unless prohibited by weather conditions, e.g., a logbook notation would explain that a pencil was used to fill out the sample label if the pen would not function in freezing weather.

5.2.2 Transfer of Custody and Shipment

Samples are accompanied by a Chain-of-Custody Record Form. A Chain-of-Custody Record Form example is shown in Attachment B. When transferring the possession of samples, the individual(s) relinquishing and receiving will sign, date, and note the time on the Record. This Record documents sample custody transfer from the sampler, often through another person, to the analyst in the laboratory. The Chain-of-Custody Record is filled out as given below.

- Enter header information (CTO number, samplers, and project name).
- Enter sample specific information (sample number, media, sample analysis required and analytical method, grab or composite, number and type of sample containers, and date/time sample was collected).
- Sign, date, and enter the time under "Relinquished by" entry.
- Have the person receiving the sample sign the "Received by" entry. If shipping samples by a common carrier, print the carrier to be used in this space (i.e., Federal Express).
- If a carrier is used, enter the airbill number under "Remarks," in the bottom right corner;
- Place the original (top, signed copy) of the Chain-of-Custody Record Form in a plastic zipper-type bag or other appropriate sample shipping package. Retain the copy with field records.
- Sign and date the custody seal, a 1- by 3-inch white paper label with black lettering and an adhesive backing. Attachment C is an example of a custody seal. The custody seal is part of the chain-of-custody process and is used to prevent tampering with samples after they have been collected in the field. Custody seals shall be provided by the analytical laboratory.
- Place the seal across the shipping container opening so that it would be broken if the container was to be opened.
- Complete other carrier-required shipping papers.

The custody record is completed using waterproof ink. Any corrections are made by drawing a line through and initialing and dating the change, then entering the correct information. Erasures are not permitted.

Common carriers will usually not accept responsibility for handling Chain-of-Custody Record Forms; this necessitates packing the record in the shipping container (enclosed with other documentation in a plastic zipper-type bag). As long as custody forms are sealed inside the shipping container and the custody seals are intact, commercial carriers are not required to sign the custody form.

The laboratory representative who accepts the incoming sample shipment signs and dates the Chain-of-Custody Record, completing the sample transfer process. It is then the laboratory's responsibility to maintain internal logbooks and custody records throughout sample preparation and analysis.

6.0 QUALITY ASSURANCE RECORDS

Once samples have been packaged and shipped, the COC copy and airbill receipt becomes part of the Quality Assurance Record.

7.0 REFERENCES

1. USEPA. User's Guide to the Contract Laboratory Program. Office of Emergency and Remedial Response, Washington, D.C. (EPA/540/P-91/002), January 1991.

ATTACHMENT A

EXAMPLE SAMPLE LABEL

ATTACHMENT A

EXAMPLE SAMPLE LABEL

Baker

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

Project: 19026-SRN CTO No.: 0026

Sample Description: Groundwater

Date: 09/17/92 Sampler: ABC

Time: 0944

Analysis: TAL Metals (CAP) Preservation: HNO_3

Project Sample No.: CAX-GW-04

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

ATTACHMENT B

EXAMPLE CHAIN-OF-CUSTODY RECORD

Baker

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

CHAIN-OF-CUSTODY RECORD

PROJECT NO.:			SITE NAME:			NO. OF CONTAINERS							REMARKS
SAMPLERS (SIGNATURE):													
STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION								

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

ATTACHMENT C

EXAMPLE CUSTODY SEAL

ATTACHMENT C

EXAMPLE CUSTODY SEAL

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

APPENDIX O
FIELD LOGBOOK

FIELD LOGBOOK
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FIELD LOGBOOK

1.0 PURPOSE

This SOP describes the process for maintaining a field logbook.

2.0 SCOPE

The field logbook is a document which records all major on-site activities conducted during a field investigation. At a minimum, the following activities/events shall be recorded in the field logbook by each member of the field crew.

- Arrival/departure of site workers and visitors
- Arrival/departure of equipment
- Sample pickup (sample numbers, carrier, time)
- Sampling activities
- Start or completion of boreholes, monitoring wells, or sampling activities
- Health and safety issues

The field logbook is initiated upon arrival at the site for the start of the first on-site activity. Entries are made every day that on-site activities take place. At least one field logbook shall be maintained per site.

The field logbook becomes part of the permanent site file. Because information contained in the field logbook may be admitted as evidence in legal proceedings, it is critical that this document is properly maintained.

3.0 DEFINITIONS

<u>Field logbook</u> - The field logbook is a bound notebook with consecutively numbered pages. Upon entry of data, the logbook requires the signature of the responsible data/information recorder.

4.0 RESPONSIBILITIES

The Field Team Leader is responsible for maintaining a master field logbook for the duration of on-site activities. Each member of the sampling crew is responsible for maintaining a complete and accurate record of site activities for the duration of the project.

5.0 PROCEDURES

The following sections discuss some of the information which must be recorded in the field logbook. In general, a record of all events and activities, as well as other potentially important information shall be recorded by each member of the field team.

5.1 Cover

The inside cover or title page of each field logbook shall contain the following information:

- Contract Task Order Number
- Project name and location
- Name of Field Team Leader
- Baker's address and telephone number
- Start date
- If several logbooks are required, a sequential field logbook number

It is good practice to list important phone numbers and points of contact here.

5.2 Daily Entries

Daily entries into the logbook may contain a variety of information. At the beginning of each day the following information must be recorded by each team member.

- Date
- Start time
- Weather
- All field personnel present
- All visitors present
- Other pertinent information (i.e., planned activities, schedule changes, expected visitors, and equipment changes)

During the day, an ongoing record of all site activities should be written in the logbook. The master logbook kept by the field team leader need not duplicate that recorded in other field logbooks, but should summarize the information in other books and, where appropriate, reference the page numbers of other logbooks where detailed information pertaining to a subject may be found.

Some specific information which must be recorded in the logbook includes:

- Equipment used, equipment numbers, calibration, field servicing
- Field measurements
- Sample numbers, media, bottle size, preservatives, collection methods, and time
- Test boring and monitoring well construction information, including boring/well number and location
- Sketches for each sample location including appropriate measurements if required.
- Photograph log
- Drum log
- Other pertinent information

All entries should be made in indelible ink; all pages numbered consecutively; and all pages must be signed or initialed and dated by the responsible field personnel completing the log. No erasures are permitted. If an incorrect entry is made, the entry shall be crossed out with a single line, initialed, and dated.

5.3 Photographs

If photographs are permitted at a site, the record shall be maintained in the field logbook. When movies, slides or photographs are taken of any site location, they are numbered or cross-referenced to correspond to logbook entries. The name of the photographer, date, time, site location, site description, direction of view and weather conditions are entered in the logbook as the photographs are taken. Special lenses, film, or other image-enhancement techniques also must be noted in the field logbook. Once processed, photographs shall be serially numbered and labeled corresponding to the field logbook entries. Note that it may not be permitted to take photographs at all Activities; permission must be obtained from the LANTDIV EIC and the Activity responsible individual.

6.0 QUALITY ASSURANCE RECORDS

Once on-site activities have been completed, the field logbook shall be considered a quality assurance record.

7.0 REFERENCES

None.

FINAL

SOLID WASTE MANAGEMENT UNIT (SWMU) CONFIRMATORY SAMPLING QUALITY ASSURANCE PROJECT PLAN

MCB CAMP LEJEUNE, NORTH CAROLINA

CONTRACT TASK ORDER 0371

AUGUST 21, 1997

Prepared for:

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

Under the:

LANTDIV CLEAN Program
Contract N62470-89-D-4814

Prepared by:

BAKER ENVIRONMENTAL, INC.
Coraopolis, Pennsylvania

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1.0 INTRODUCTION

This Quality Assurance Project Plan (QAPP) has been developed for the field investigation of 62 solid waste management units (SWMUs) at Marine Corps Base (MCB), Camp Lejeune, North Carolina. The preparation of this QAPP, and other related project plans, is being performed under the Navy CLEAN Contract No. N62470-89-D-4814, Contract Task Order 0371. Baker Environmental, Inc. (Baker) is the prime contractor for the implementation of this project.

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

2.0 SCOPE OF QUALITY ASSURANCE PROJECT PLAN

This QAPP addresses sample collection and analysis to be conducted for the field investigation of 62 SWMUs at MCB, Camp Lejeune, North Carolina. The QAPP has been developed for the Department of the Navy (DON) in accordance with U.S. Environmental Protection Agency (USEPA) guidelines. Contractors will follow QA/QC practices and procedures, including chain-of-custody procedures, while conducting all sample collection and analysis activities.

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

1. The use of a NFESC-certified analytical laboratory;

2. The use of accepted analytical methods for the samples discussed in the FSAP. Analysis of samples for hazardous constituents parameters will be performed using the following documents:

    - "Methods for Chemical Analysis of Water and Waste," USEPA, 1979, Revised March 1983

    - "Environmental Protection Agency Regulations on Test Procedures for Analysis of Pollutants," USEPA, 40 CFR 136

    - "Test Methods for Evaluating Solid Waste," USEPA, November 1986, 3rd Edition

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

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

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

3.0 PROJECT DESCRIPTION

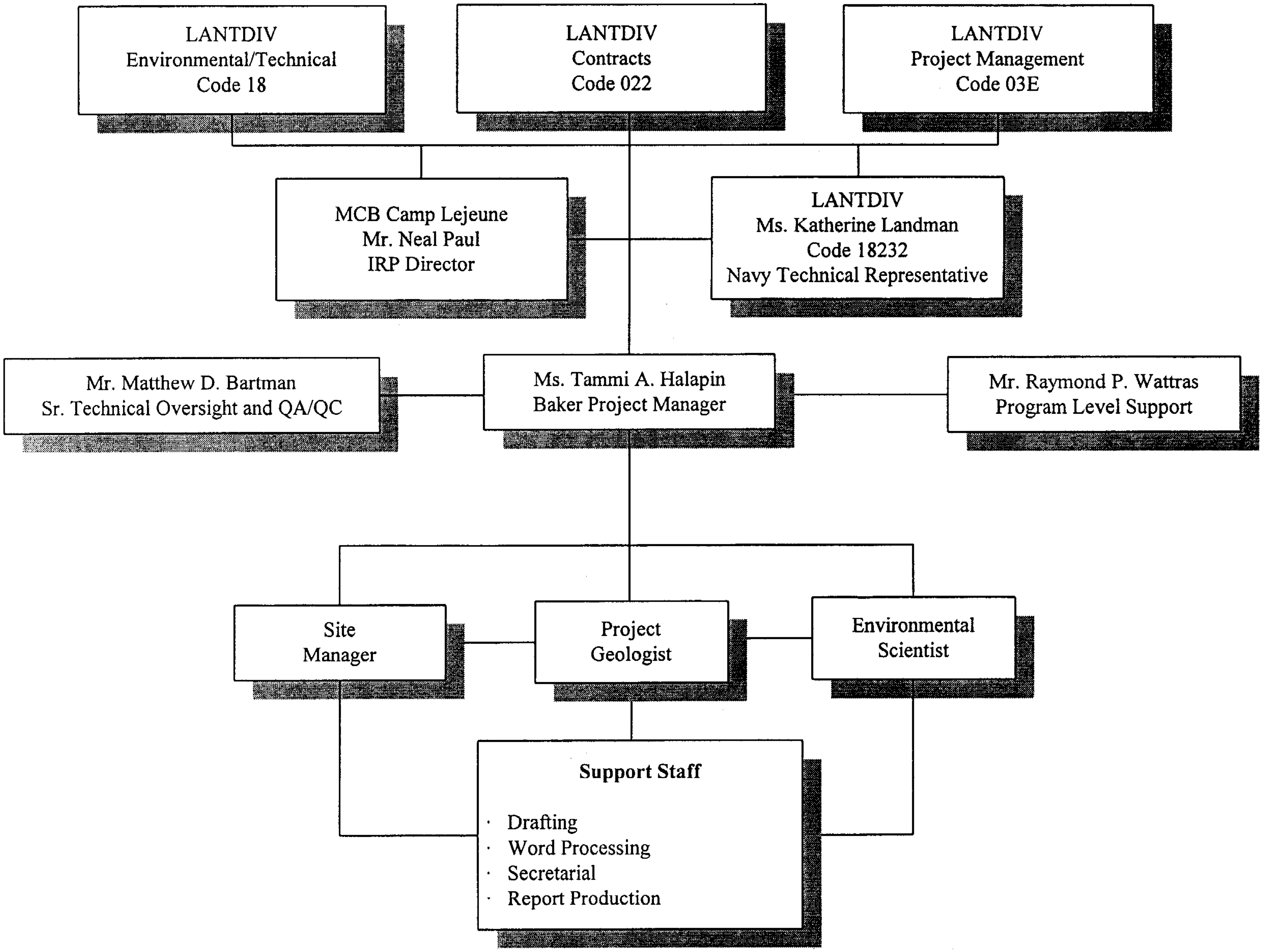
An introduction to the confirmatory sampling investigation, describing the project objectives and scope, is presented in Sections 3.0 and 4.0 of the SWMU Confirmatory Sampling Work Plan. A detailed description of the field investigations, including the sampling locations and frequency proposed for each SWMU, is presented in Section 5.0 of the Work Plan. Sampling procedures are presented in the FSAP.

4.0 PROJECT ORGANIZATION

Technical performance of the SWMU investigation and key personnel responsible for quality assurance throughout its duration are described in Section 6.0 of the SWMU Confirmatory Sampling Work Plan. The contractor will utilize subcontractors to perform laboratory analysis, drilling, and temporary monitoring well installation. Specific subcontractors have not yet been identified. Figure 4-1 shows the project organization, lines of authority, and support personnel/organizations.

FIGURE 4-1

PROJECT ORGANIZATION
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO-0371
MCB CAMP LEJEUNE, NORTH CAROLINA



5.0 QUALITY ASSURANCE OBJECTIVES FOR DATA MEASUREMENT

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

5.1 Project Quality Assurance Objectives

The following is a list of QA objectives which will be implemented for the 62 SWMUs.

- Obtain scientific data of a quality sufficient to meet scientific and legal scrutiny.
- Gather/develop data in accordance with procedures appropriate for its intended use.
- Ensure that data is of acceptable precision, accuracy, completeness, representativeness, and comparability as required by the project.

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

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

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

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

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

- "Methods for Chemical Analysis of Water and Waste," USEPA, 1979, Revised March 1983
- "Environmental Protection Agency Regulations on Test Procedures for Analysis of Pollutants," USEPA, 40 CFR 136

- "Test Methods for Evaluating Solid Waste," USEPA SW846, November 1986, 3rd Edition

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

- "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans," USEPA, (QAMS 005/80).

5.2 Data Quality Objectives

Data quality objectives (DQOs) are qualitative or quantitative statements developed by the data users to specify the quality of data needed from a particular data collection activity to support a specific decision. The DQOs are expressed in terms of precision, accuracy, representativeness, completeness, and comparability. Definitions for these terms, as well as for the more general term uncertainty, are given in Table 5-1. The Project Manager, in conjunction with the Navy Environmental Technical Representative (NTR), is responsible for defining the DQOs. The intended use of the data, analytical measurements, and the availability of resources are integral in development of DQOs. DQOs define the level of uncertainty in the data that is acceptable for each specific activity during the investigation. This uncertainty includes both field sampling error and analytical instrument error. Ideally, zero uncertainty is the goal; however, the variables associated with sampling and analysis contribute to a degree of uncertainty in any data generated. It is an overall program objective to keep the total uncertainty within an acceptable range, so as not to hinder the intended use of the data. To achieve this objective, specific data quality requirements such as detection limits, criteria for accuracy and precision, sample representativeness, data comparability, and data completeness have been specified.

The data collected from the confirmatory sampling effort will be used:

- To evaluate the presence or absence of contamination resulting from previous and current activities at the SWMUs.

- To monitor health and safety conditions during field activities.

All samples for characterizing the site will be analyzed and reported by the laboratory as Level III data (NFESC Level C). Field parameters including temperature (aqueous only) and specific conductance will be Level I (NFESC Level A) data quality.

TABLE 5-1

DEFINITIONS OF DATA QUALITY INDICATORS
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO-0371
MCB CAMP LEJEUNE, NORTH CAROLINA

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

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

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

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

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

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

6.0 SAMPLE AND DOCUMENT CUSTODY PROCEDURES

Descriptions of the procedures to be used for sampling the environmental media at each SWMU are provided in the FSAP. The number of samples, sampling locations, and sampling rationale by media also are presented in Section 5.0 of the Work Plan.

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

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

6.1 Sampling Handling

New polyethylene or glass bottles containing the proper preservatives will be provided by the laboratory for sample collection. In addition to the chemical preservatives, samples will be stored on ice at 4°C in a waterproof metal or sturdy plastic cooler, if required (see Tables 6-1 through 6-2 for summaries of containers, preservation, and holding times for water and solids, respectively).

6.2 Chain-of-Custody Procedures

6.2.1 Field Chain-of-Custody Procedures

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

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

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

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

TABLE 6-1

SUMMARY OF CONTAINERS, PRESERVATION, AND HOLDING TIMES FOR AQUEOUS SAMPLES
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO-371
MCB CAMP LEJEUNE, NORTH CAROLINA

Parameter	Container	Preservation	Holding Time
TCL Volatiles - EPA Methods 8240 and/or 8020	Two 40-mL vials with teflon septum caps	Cool, 4°C HCl pH <2	14 days (7 days if unpreserved)
TCL Semivolatiles - EPA Method 8270	1-liter amber glass bottle with teflon caps	Cool, 4°C	7 days to extraction; 40 days from extraction to analysis
TCL Pesticides/PCBs - EPA Method 8080	1-liter amber glass bottle with teflon caps	Cool, 4°C	7 days to extraction; 40 days after extraction for analysis
TAL Metals	1-500 ml polyethylene bottle	HNO_3 pH<2	6 months; Mercury 28 days

Notes:

TAL - Target Analyte List
TCL - Target Contaminant List

TABLE 6-2

SUMMARY OF CONTAINERS, PRESERVATION, AND HOLDING TIMES FOR SOLID SAMPLES
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO-371
MCB CAMP LEJEUNE, NORTH CAROLINA

Parameter	Container	Preservation	Holding Time
TCL Volatiles - EPA Methods 8240 and/or 8020	One 4-ounce wide-mouth glass jars	Cool, 4°C	10 days
TCL Semivolatiles - EPA Method 8270	One 8-ounce wide-mouth glass jar	Cool, 4°C	7 days to extraction; 40 days from extraction to analysis
TCL Pesticides/PCBs - EPA Method 8080	One 8-ounce wide-mouth glass jar	Cool, 4°C	7 days to extraction; 40 days after extraction for analysis
TAL Metals	One 8-ounce wide-mouth glass jar	Cool, 4°C	6 months; Mercury, 28 days
Corrosivity	One 4-ounce wide-mouth glass jar	Cool, 4°C	10 days
Ignitability	One 4-ounce wide-mouth glass jar	Cool, 4°C	14 days
Reactivity	One 4-ounce wide-mouth glass jar	Cool, 4°C	10 days

Notes:

TAL - Target Analyte List
TCL - Target Contaminant List
TCLP - Toxicity Characteristic Leaching Procedure

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

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

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

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

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

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

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

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

6.2.2 Laboratory Chain-of-Custody Procedures

Upon sample receipt of the samples, the laboratory will preform the following steps:

- Samples will be received and unpacked in the laboratory where the staff checks for bottle integrity (loose caps, broken bottles, etc.).
- Samples will be verified with incoming paperwork (packing slip, etc.) by type of bottle and stabilizer. The paperwork must be either signed or initialed.
- Information concerning the sample (from the sampling record, Chain-of-Custody, and observation) will be recorded along with parameters to be analyzed, date of sampling, and date the sample is received in the laboratory.
- Samples will be placed in an appropriate secured storage area until analysis.
- When analysis is complete, samples will be stored for a 30-day period unless otherwise specified.

If collected samples arrive without a chain-of-custody record or an incorrect chain-of-custody record, the following steps will be taken:

- The laboratory will prepare a nonconformance form stating the problem.
- The Site Supervisor and Project Manager will be notified.
- If the missing information cannot be provided by the field staff, the samples affected will not be analyzed.

Primary considerations for sample storage are:

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

6.3 Document Custody Procedures

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

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

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

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

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

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

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

7.0 CALIBRATION PROCEDURES AND FREQUENCY

The following section describes calibration procedures and frequency.

7.1 Field Instruments

Two field instruments may be used for health and safety monitoring: the O_2/LEL meter, and the HNu System portable photoionizer. These instruments will be calibrated on site daily according to the manufacturer's instructions in addition to the factory calibration it will receive prior to the start of site sampling. The calibration standards will be recorded in the field log book.

A pH meter and a conductivity meter will be used to analyze groundwater and surface water samples. Procedures from "Test Methods for Evaluating Solid Waste," USEPA, SW846, November 1986, 3rd Edition will be used to calibrate these meters. Specific procedures for the calibration of water quality instruments are presented in the FSAP.

7.2 Laboratory Instruments

The laboratory's procedures for calibration and related quality control measures will be conducted according to the protocols presented in the following documents:

- "Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater," USEPA, July 1982
- "Methods for Chemical Analysis of Water and Waste," USEPA, 1979, Revised March 1983
- "Environmental Protection Agency Regulations on Test Procedures for Analysis of Pollutants," USEPA, 40 CFR 136
- "Test Methods for Evaluating Solid Waste," USEPA SW846, November 1986, 3rd Edition
- "Hazardous Waste Management System; Identification and Listing of Hazardous Waste; Toxicity Characteristics Revisions; Final Rule," USEPA, 52 FR 26886

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

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

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

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

7.2.1 Method Calibration

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

7.2.2 GC/MS System Calibration Procedure

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

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

7.2.2.1 Tuning and Mass Calibration

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

A GC/MS system used for organic compound analysis will be tuned to meet the criteria specified for BFB analysis (volatile compounds) or DFTPP (semivolatile compounds) for an injection of 50 nanograms (ng) of BFB or DFTPP. The analysis must be performed separately from standard or blank analysis. These criteria will be demonstrated every 12 hours of operation. Professional judgment must be used to determine whether background subtraction is required to eliminate column bleed or instrument background (i.e., noise). Calibration documentation will be in the form of a bar graph spectrum and a mass listing.

7.2.2.2 GC/MS System Calibration

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

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

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

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

7.2.3 GC System Calibration Procedure for Pesticides/PCBs

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

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

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

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

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

The relative percent difference of the calculated amount and the true amount for each of the single component pesticides and surrogates in both of the PEMs must be less than or equivalent to 25 percent.

At least one chromatogram between any two adjacent peaks in the midpoint concentrations of Individual Standard Mixtures A and B in the initial calibration must be greater than or equal to 90 percent.

7.2.4 System Calibration Procedure for Metals Analysis

This section outlines the requirements for the calibration of atomic absorption (AA) systems for the determination of metals. The following will be performed in support of these requirements:

- Documentation of standard response
- Correlation coefficient monitoring

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

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

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

7.2.4.1 Correlation Coefficient Calculation

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

7.2.4.2 Calibration Verification

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

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

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

7.2.5 System Calibration Procedure for Inorganic Analyses

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

- Documentation of standard response
- Correlation coefficient monitoring

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

7.2.5.1 Correlation Coefficient Calculation

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

7.2.5.2 Calibration Verification

The initial calibration curve will be verified on each working day by the measurement of two calibration standards.

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

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

7.2.6 Periodic Calibration

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

- Balances will be calibrated weekly with class S weights.

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

- The temperatures of the refrigerators will be recorded daily.

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

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

The following equipment must maintain the following temperatures:

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

8.0 ANALYTICAL PROCEDURES

This section discusses analytical procedures.

8.1 Field Analysis

O_2/LEL and HNu PI-101 meters will be used to analyze ambient air for health and safety monitoring, as well as to screen soil during the soil sampling. The O_2/LEL meter detects explosive gases that may be present (i.e., methane). The HNu PI-101 detects total organic vapor. These instruments will be operated in accordance with the manufacturer's instructions.

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

8.2 Laboratory Analysis

The samples that will be collected during the investigation will be analyzed for constituents listed in Tables 8-1 through 8-4. Parameters will be analyzed using USEPA methods as noted in Tables 8-1 through 8-4. Compounds and the corresponding method performance limits also are listed in these tables.

TABLE 8-1

METHOD PERFORMANCE LIMITS
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO-371
MCB CAMP LEJEUNE, NORTH CAROLINA

Compound	Water PQL (µg/L)	Soil/Sediment PQL (µg/kg)	Method
Volatiles			Method 8240
Benzene	20	20	
Chlorobenzene	20	20	
1,4-Dichlorobenzene	30	30	
1,3-Dichlorobenzene	40	40	
1,2-Dichlorobenzene	40	40	
Ethyl Benzene	20	20	
Toluene	20	20	
Chloromethane	10	10	
Bromomethane	10	10	
Vinyl Chloride	10	10	
Chloroethane	10	10	
Methylene Chloride	5	5	
Acetone	100	100	
Carbon Disulfide	5	5	
1,1 -Dichloroethene	5	5	
1,1 -Dichloroethane	5	5	
1,2 -Dichloroethene	5	5	
Chloroform	5	5	
1,2 -Dichloroethane	5	5	
2-Butanone	100	100	
1,1,1-Trichloroethane	5	5	
Carbon Tetrachloride	5	5	
Vinyl Acetate	50	50	
Bromodichloromethane	5	5	
1,1,2,2-Tetrachloroethane	5	5	
1,2-Dichloropropane	5	5	
trans-1,3-Dichloropropene	5	5	
Trichloroethene	5	5	
Dibromochloromethane	5	5	
1,1,2-Trichloroethane	5	5	
Benzene	5	5	
cis-1,3-Dichloropropene	5	5	
2-Chloroethyl Vinyl Ether	10	10	
Bromofrom	5	5	
2-Hexanone	50	50	
4-Methyl-2-pentanone	50	50	

TABLE 8-1 (Continued)

METHOD PERFORMANCE LIMITS
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO-371
MCB CAMP LEJEUNE, NORTH CAROLINA

Compound	Water PQL (µg/L)	Soil/Sediment PQL (µg/kg)	Method
Volatiles (continued): Tetrachloroethene	5	5	**Method 8240**
Toluene	5	5	
Chlorobenzene	5	5	
Ethyl Benzene	5	5	
Styrene	5	5	
Total Xylenes	5	5	
Semivolatiles Phenol	10	660	**Method 8270**
bis(2-Chloroethyl)ether	10	660	
2-Chlorophenol	10	660	
1,3-Dichlorobenzene	10	660	
1,4-Dichlorobenzene	10	660	
Benzyl alcohol	20	1300	
1,2-Dichlorobenzene	10	660	
2-Methylphenol	10	660	
bis(2-Chloroisopropyl)ether	10	660	
4-Methylphenol	10	660	
N-Nitroso-di-n-dipropylamine	10	660	
Hexachloroethane	10	660	
Nitrobenzene	10	660	
Isophorone	10	660	
2-Nitrophenol	10	660	
2,4-Dimethylphenol	10	660	
Benzoic acid	50	3,300	
bis(2-Chloroethoxyl)methane	10	660	
2,4-Dichlorophenol	10	660	
1,2,4-Trichlorobenzene	10	660	
Naphthalene	10	660	
4-Chloroaniline	20	1,300	
Hexachlorobutadiene	10	660	
4-Chloro-3-methylphenol (para-chloro-meta-cresol)	20	1,300	
2-Methylnaphthalene	10	660	
Hexachlorocyclopentadiene	10	660	

TABLE 8-1 (Continued)

METHOD PERFORMANCE LIMITS
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO-371
MCB CAMP LEJEUNE, NORTH CAROLINA

Compound	Water PQL (µg/L)	Soil/Sediment PQL (µg/kg)	Method
Semivolatiles (continued) 2,4,6-Trichlorophenol	10	660	Method 8270
2,4,5-Trichlorophenol	10	660	
2-Chloronaphthalene	10	660	
2-Nitroaniline	50	3,300	
Dimethylphthalate	10	660	
Acenaphthylene	10	660	
Acenaphthene	10	660	
2,4-Dinitrophenol	50	3300	
4-Nitrophenol	50	3300	
Dibenzofuran	10	660	
2,4-Dinitrotoluene	10	660	
2,6-Dinitrotoluene	10	660	
Diethylphthalate	10	660	
4-Chlorophenyl phenyl ether	10	660	
Fluorene	10	660	
4-Nitroaniline	50	3300	
4,6-Dinitro-2-methylphenol	50	3300	
N-Nitrosodiphenylamine	10	660	
4-Bromophenyl phenyl ether	10	660	
Hexachlorobenzene	10	660	
Pentachlorophenol	50	3300	
Phenanthrene	10	660	
Anthracene	10	660	
Di-n-butylphthalate	10	660	
Fluoranthene	10	660	
Pyrene	10	660	
Butyl benzyl phthalate	10	660	
3,3'-Dichlorobenzidine	20	1300	
Benzo(a)anthracene	10	660	
bis(2-ethylhexyl)phthalate	10	660	
Chrysene	10	660	
Di-n-octyl phthalate	10	660	
Benzo(b)fluoranthene	10	660	
Benzo(k)fluoranthene	10	660	

TABLE 8-1 (Continued)

METHOD PERFORMANCE LIMITS
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO-371
MCB CAMP LEJEUNE, NORTH CAROLINA

Compound	Water PQL (µg/L)	Soil/Sediment PQL (µg/kg)	Method
Semivolatiles (continued)			Method 8270
Benzo(a)pyrene	10	660	
Indeno(1,2,3-cdpyrene	10	660	
Dibenz(a,h)anthracene	10	660	
Benzo(g,h,i)perylene	10	660	
Pesticides/PCBs			Method 8080
alpha-BHC	0.03	2.01	
beta-BHC	0.06	4.02	
delta-BHC	0.09	6.03	
gamma-BHC (Lindane)	0.04	2.68	
Heptachlor	0.03	2.01	
Aldrin	0.04	2.68	
Heptachlor epoxide	0.83	55.61	
Endosulfan I	0.14	9.38	
Dieldrin	0.02	1.34	
4,4'-DDE	0.11	7.37	
Endrin	0.06	4.02	
Endosulfan II	0.04	2.68	
4,4'-DDD	0.11	7.37	
Endosulfan sulfate	0.66	44.22	
4,4'-DDT	0.12	8.04	
Methoxychlor	1.76	117.92	
Endrin ketone	0.06	4.02	
Endrin aldehydre	0.23	15.41	
Chlordane (technical)	0.14	9.38	
Toxaphene	2.4	160.8	
Aroclor-1016	ND	ND	
Aroclor-1221	ND	ND	
Aroclor-1232	ND	ND	
Aroclor-1242	0.65	43.55	
Aroclor-1248	ND	ND	
Aroclor-1254	ND	ND	
Aroclor-1260	ND	ND	

Notes:

PQL = Practical Quantitation Limit

TABLE 8-2

INORGANIC METHOD PERFORMANCE LIMITS
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO-371
MCB CAMP LEJEUNE, NORTH CAROLINA

Analyte	Method Number(2,3,4)	IDL(1) (µg/L)	Method Description
Metals			
Aluminum	7010		Atomic Absorption, Direct Aspiration
Antimony	7040 7041	20 3	Atomic Absorption, Direct Aspiration Atomic Absorption, Furnace Technique
Arsenic	7060 7061	1 2	Atomic Absorption, Furnace Technique Atomic Absorption, Direct Aspiration
Barium	7080		Atomic Absorption, Direct Aspiration
Beryllium	7090 7091	5 0.2	Atomic Absorption, Direct Aspiration Atomic Absorption, Furnace Technique
Cadmium	7130 7130	5 0.1	Atomic Absorption, Direct Aspiration Atomic Absorption, Furnace Technique
Calcium	7140	10	Atomic Absorption, Direct Aspiration
Chromium	7190 7191	10	Atomic Absorption, Direct Aspiration Atomic Absorption, Furnace Technique
Cobalt	7200 7201	50 1	Atomic Absorption, Direct Aspiration Atomic Absorption, Furnace Technique
Copper	7210	20	Atomic Absorption, Direct Aspiration
Iron	7380	30	Atomic Absorption, Direct Aspiration
Lead	7420 7421	100 1	Atomic Absorption, Direct Aspiration Atomic Absorption, Furnace Technique
Magnesium	7450	1	Atomic Absorption, Direct Aspiration
Manganese	7460	10	Atomic Absorption, Direct Aspiration
Mercury	7470 7471	0.2	Water by manual cold vapor technique Soil/sediment by manual cold vapor technique
Nickel	7520	40	Atomic Absorption, Direct Aspiration
Potassium	7610	10	Atomic Absorption, Direct Aspiration
Selenium	7740 7741	2	Atomic Absorption, Furnace Technique Atomic Absorption, Gaseous Hydride
Silver	7760	10	Atomic Absorption, Direct Aspiration
Sodium	7770	2	Atomic Absorption, Direct Aspiration
Thallium	7840 7841	100 1	Atomic Absorption, Direct Aspiration Atomic Absorption, Furnace Technique

TABLE 8-2 (Continued)

INORGANIC METHOD PERFORMANCE LIMITS
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO-371
MCB CAMP LEJEUNE, NORTH CAROLINA

Analyte	Method Number[2,3,4]	IDL[1] (μg/L)	Method Description
Vanadium	7910 7911	200 4	Atomic Absorption, Direct Aspiration Atomic Absorption, Furnace Technique
Zinc	7950	5	Atomic Absorption, Direct Aspiration

Notes:

(1) Methods taken from "Test Methods for Evaluating Solid Waste," USEPA SW846, November 1986, 3rd Edition.

IDL = Instrument Detection Limit

TABLE 8-3

TCLP METHOD PERFORMANCE LIMITS
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO-371
MCB CAMP LEJEUNE, NORTH CAROLINA

Parameter	Aqueous PQL(1) (µg/l)	Solid PQL(1) (µg/kg)	Method
TCLP Volatiles Benzene	5	10	EPA Method 3550/ EPA Method 8240
Carbon Tetrachloride	5	5	
Chloroform	5	5	
1,2-Dichloroethane	5	5	
1,1-Dichloroethylene	5	5	
Methyl ethyl ketone	N/A	NA	
Tetrachloroethylene	5	5	
Trichloroethylene	5	5	
Vinyl Chloride	10	10	
TCLP Semivolatiles o-Cresol	10	660	EPA Method 3550/ EPA Method 8270
m-Cresol	10	660	
p-Cresol	10	660	
Cresol	10	660	
1,4-Dichlorobenzene	10	660	
2,4-Dinitrotoluene	10	660	
Hexachlorobenzene	10	660	
Hexachlorobutadiene	10	660	
Hexachloroethane	10	660	
Nitrobenzene	10	660	
Pentachlorphenol	50	3300	
Pyridine	50	660	
2,4,5-Trichlorophenol	10	660	
2,4,6-Trichlorophenol	10	660	

TABLE 8-3 (Continued)

TCLP METHOD PERFORMANCE LIMITS
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO-371
MCB CAMP LEJEUNE, NORTH CAROLINA

Parameter	Aqueous PQL⁽¹⁾ (µg/l)	Solid PQL⁽¹⁾ (µg/kg)	Method
TCLP Pesticides Chlordane	0.14	9.4	EPA Method 3550/ EPA Method 8240
Endrin	0.06	4.0	
Heptachlor (and its hydroxide)	0.03	20	
Lindane	0.04	2.7	
Methyoxychlor	1.8	120	
Toxaphene	2.4	160	
TCLP Herbicides 2,4-D	12	240	EPA Method 8150
2,4,5-TP Silvex	1.7	34	

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

Notes:

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

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

TABLE 8-4

RCRA/ENGINEERING PARAMETER METHOD PERFORMANCE LIMITS
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO-371
MCB CAMP LEJEUNE, NORTH CAROLINA

Parameter	Aqueous Performance Limit	Solid Performance Limit	Method
RCRA pH/Corrosivity	N/A	N/A	SW-846 9010
Ignitability	N/A	N/A	SW-846 1010
Reactive Cyanide	10 mg/l(1)	10 mg/l	SW-846 9012
Reactive Sulfide	50 mg/l(1)	50 mg/kg(1)	SW-846 9030

Notes:

(1) Performance Limit, taken from "Test Methods for Evaluating Sold Waste," USEPA, November 1986.

N/A - Not Applicable

9.0 DATA REDUCTION, VALIDATION AND REPORTING

The following section presents data reduction, validation, and reporting procedures.

9.1 Field Data Procedures

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

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

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

9.2 Laboratory Data Procedures

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

9.2.1 Laboratory Data Validation

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

Data processing will be checked by an individual other than the analyst who performed the data processing. The checker will review the data for the following:

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

The checking process will be sufficient thorough enough to verify the results.

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

9.2.2 Analytical Reports

The items listed below will be required of analytical reports.

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

10.0 INTERNAL QUALITY CONTROL CHECKS

The following section describes internal QC checks that will be implemented.

10.1 Field Quality Control Checks

Four types of field quality assurance/quality control samples will be submitted to the laboratory: trip blanks, equipment rinsates, field blanks, and field duplicates. A breakdown by type of sample with which the QC samples will be submitted to the laboratory is listed on Table 10-1. The number of environmental and QC samples to be submitted for analysis is presented in the Work Plan and/or FSAP.

10.1.1 Field Blanks

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

10.1.2 Trip Blank

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

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

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

10.1.3 Field Duplicates

Duplicates for soil samples, with the exception of the samples for VOC analysis, will be collected, homogenized, and split. VOC samples will not be mixed, but select segments of the soil will be taken from the length of the core and placed in 4-ounce glass jars. Cores may be sealed and shipped to the laboratory for subsampling if the project deems this appropriate. The duplicate for water samples should be collected simultaneously. Field duplicates should be collected at a frequency of 10 percent per sample matrix. All the duplicates should be sent to the primary laboratory responsible for analysis. The same samples used for field duplicates shall be split by the laboratory and used by the laboratory as the laboratory duplicate or matrix spike. This means that for the duplicate sample, there will be analyses of the normal sample, the field duplicate, and the laboratory matrix spike/duplicate.

TABLE 10-1

QA/QC SAMPLE FREQUENCY
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO-371
MCB CAMP LEJEUNE, NORTH CAROLINA

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

Notes:

(1) Not Applicable

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

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

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

10.1.4 Equipment Rinsates

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

10.2 Laboratory Quality Control Checks

This section provides descriptions of the laboratory QC checks to be implemented.

10.2.1 Method Blanks

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

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

10.2.2 Replicate Sample Analysis

Replicate sample analysis will be performed to demonstrate the precision of an analysis. An interlaboratory replicate sample is initiated by the analyst prior to sample preparation and carried through the entire analytical procedure. The frequency of interlaboratory replicate analysis for each analyte is summarized in Table 10-2.

10.2.3 Spike Analysis

Spike analysis will be performed to demonstrate the accuracy of an analysis. The analyst initiates the spike prior to sample preparation and analysis by adding a known amount of analyte(s) to a sample. The spike sample is carried through the entire analytical procedure. The frequency of spike analysis for each analyte(s) is summarized in Table 10-2.

TABLE 10-2

QC ANALYSIS FREQUENCY
SWMU CONFIRMATORY SAMPLING WORK PLAN, CTO-371
MCB CAMP LEJEUNE, NORTH CAROLINA

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

10.2.4 Surrogate Standards

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

10.2.5 Internal Standards

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

10.2.6 Matrix Spikes and Matrix Spike Duplicates

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

10.3 Laboratory Control Limits

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

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

10.3.1 Method Blanks

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

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

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

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

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

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

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

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

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

10.3.2 Surrogate Standards

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

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

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

Corrective action will include steps listed below:

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

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

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

- Recovery of any one surrogate compounds in the volatile fraction is outside the surrogate spike recovery limits;
- Recovery of any one surrogate compound in either semivolatile fraction is below ten percent; or
- Recoveries of two or more surrogate compounds in either semivolatile fraction are outside surrogate spike recovery limits.

11.0 PREVENTIVE MAINTENANCE

The following section outlines preventive maintenance.

11.1 Field Maintenance

The O_2/LEL meter and the HNu PI-101 are to be used in site characterization and will be maintained as described by the manufacturer's instructions. The pH and specific conductance meters to be used during sampling will be maintained according to Baker's Standard Operating Procedure (SOP) F201. A full set of SOPs will be maintained in the field trailer.

11.2 Laboratory Maintenance

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

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

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

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

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

12.0 DATA MEASUREMENT ASSESSMENT PROCEDURES

The following section outlines data measurement assessment procedures.

12.1 Overall Project Assessment

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

12.2 Field Quality Assessment

To assure that all field data are collected accurately and correctly, specific written instructions will be issued to all personnel involved in field data acquisition by the Project Manager. The evaluation (data review) of field blanks, and other field QC samples will provide definitive indications of the data quality. If a problem that can be isolated arises, corrective actions can be instituted for future field efforts.

12.3 Laboratory Data Quality Assessment

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

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

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

- Trip Blank Evaluation - Trip blank results will be evaluated for high readings similar to the method blanks described above. If high trip blank readings are encountered (i.e. a value sufficient to result in a difference in sample values, if not corrected, greater than or equal to the smallest significant digit known to be valid), procedures for sample collection, shipment, and laboratory analysis are reviewed. If both the method and the trip blanks exhibit significant background contamination, the source of contamination is probably within the laboratory. Ambient air in the laboratory and reagents will be checked as possible sources of contamination.

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

- Duplicate Sample Analyses - Duplicate sample analyses will be used to determine the precision of the analytical method for the sample matrix. Two types of duplicate samples will be analyzed for this project, field, and laboratory. Duplicate results will be used to calculate precision as defined by the relative percent difference (RPD). If laboratory duplicate values exceeds the control limit, the sample set may be reanalyzed for the parameter in question. Precision limits will be updated periodically following review of data.

- Reference Sample Analyses - The results of reference sample analysis will be compared with true values, and the percent recovery of the reference sample will be calculated. If correction is required (excessive or inadequate percent recovery), the reference sample must be reanalyzed to demonstrate that the corrective action has been successful.

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

- Matrix Spike Analyses - The observed recovery of spike versus theoretical spike recovery will be used to calculate accuracy as defined by the percent recovery. If the accuracy value exceeds the control limit for the given parameter, the appropriate laboratory personnel notified and corrective action will be taken before the sample set is reanalyzed for the parameter in question.

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

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

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

13.0 CORRECTIVE ACTION

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

The following personnel will be responsible for detecting and reporting nonconformances:

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

13.1 Limits of Operation

The limits of operation that are used to identify nonconformances will be established by the contents of the Work Plan, QAPP, and FSAP. Interlaboratory control limits produced by statistical analyses will also be considered as limits of operation.

13.2 Corrective Action

Nonconformances will be identified and communicated to Baker to avoid delays with respect to project schedules and prevent the submission of non-valid data. Documentation will include the following:

- Personnel identifying the nonconformance(s) will be identified.
- The nonconformance(s) will be described and communicated to the Baker Project Manager.
- For serious nonconformances, the site supervisor will have the authority to initiate corrective action.
- For less serious nonconformances, corrective action will be decided upon and signatures will be obtained prior to implementation of corrective action.
- All nonconformances and corrective actions will be documented and reside with the Baker Activity Coordinator. This documentation will be available to LANTDIV.

The Baker Project Manager and Activity Coordinator will be notified of laboratory or field nonconformances and corrective actions taken if:

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

If the nonconformance(s) are serious and corrective action cannot resolve the problem(s), NFESC Contract Representatives (NCRs) and the LANTDIV NTR may be notified by Baker.

14.0 QUALITY ASSURANCE REPORTING PROCEDURES

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

The Project Manager will keep in contact with the LANTDIV NTR through informal, verbal reports during the project as well as through monthly progress reports.