Doc. No.: CLEJ-00351-3.03-09/01/90

SAMPLING PLAN

FINAL

FOR REMEDIAL INVESTIGATION/FEASIBILITY STUDY
AT
HADNOT POINT INDUSTRIAL AREA

AND

LIMITED SCOPE INVESTIGATIONS
AT
SITES 6, 48, AND 69

MARINE CORPS BASE CAMP LEJEUNE
NORTH CAROLINA

Prepared For:

NAVAL FACILITIES ENGINEERING COMMAND
ATLANTIC DIVISION

Prepared By:

ENVIRONMENTAL SCIENCE & ENGINEERING, INC.
RUTHERFORD, NEW JERSEY

ESE PROJECT NO. 49-02036

SEPTEMBER 1990

DOC NO: CLEJ-00351-303-09/01/90

FIELD SAMPLING PLAN

FINAL

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AT
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1.0 INTRODUCTION

This document presents the Field Sampling Plan (FSP) for the Remedial Investigation/Feasibility Study (RI/FS) at the Hadnot Point Industrial Area (HPIA) and the limited scope investigations at Sites 6, 48, and 69, located within the Marine Corps Base (MCB) Camp Lejeune.

The FSP presents the procedures to be used during the field investigations at these sites. Field procedures presented in this FSP were prepared in accordance with EPA and Navy guidelines, and the site-specific Health and Safety Plan (HASP).

1.1 SITE LOCATIONS AND DESCRIPTIONS

The four sites to be investigated are located within MCB Camp Lejeune. MCB Camp Lejeune is a training base for the Marine Corps, located in Onslow County, North Carolina (Figure 1-1).

The facility, which covers approximately 170 square miles, is bounded to the southeast by the Atlantic Ocean, to the west by U.S. 17, and to the northeast by State Road 24. The base is bisected by the New River estuary, which occupies approximately 30 square miles of the total area of the facility.

As a result of Marine operations and activities, substantial quantities of wastes that contain hazardous and toxic organic compounds have been generated at the base. This has resulted in the storage, disposal, and/or spillage of these wastes around the base. Several of the base's water supply wells have been shut down as a result of the presence of organic compounds, thus suggesting that some of the wastes may have entered the groundwater.

The four sites to be investigated are described below.

1.1.1 HADNOT POINT INDUSTRIAL AREA

The Hadnot Point Industrial Area (HPIA) of MCB Camp Lejeune is located on the east side of the New River. For the purposes of this investigation, HPIA is defined as that area bounded by Holcomb Blvd. to the west, Sneads Ferry Road to the north, Louis Street to the east, and the Main Service Road to the south (Figures 1-1 and 1-2).

The HPIA is comprised of approximately 75 buildings/facilities. These include maintenance shops, gas stations, administrative offices, commissaries, snack bars, warehouses, storage yards, and a dry cleaning facility. A steam plant and training facility occupy the southwest portion of HPIA. In addition, numerous underground storage tanks, stormwater drains, and oil/water separators are present.

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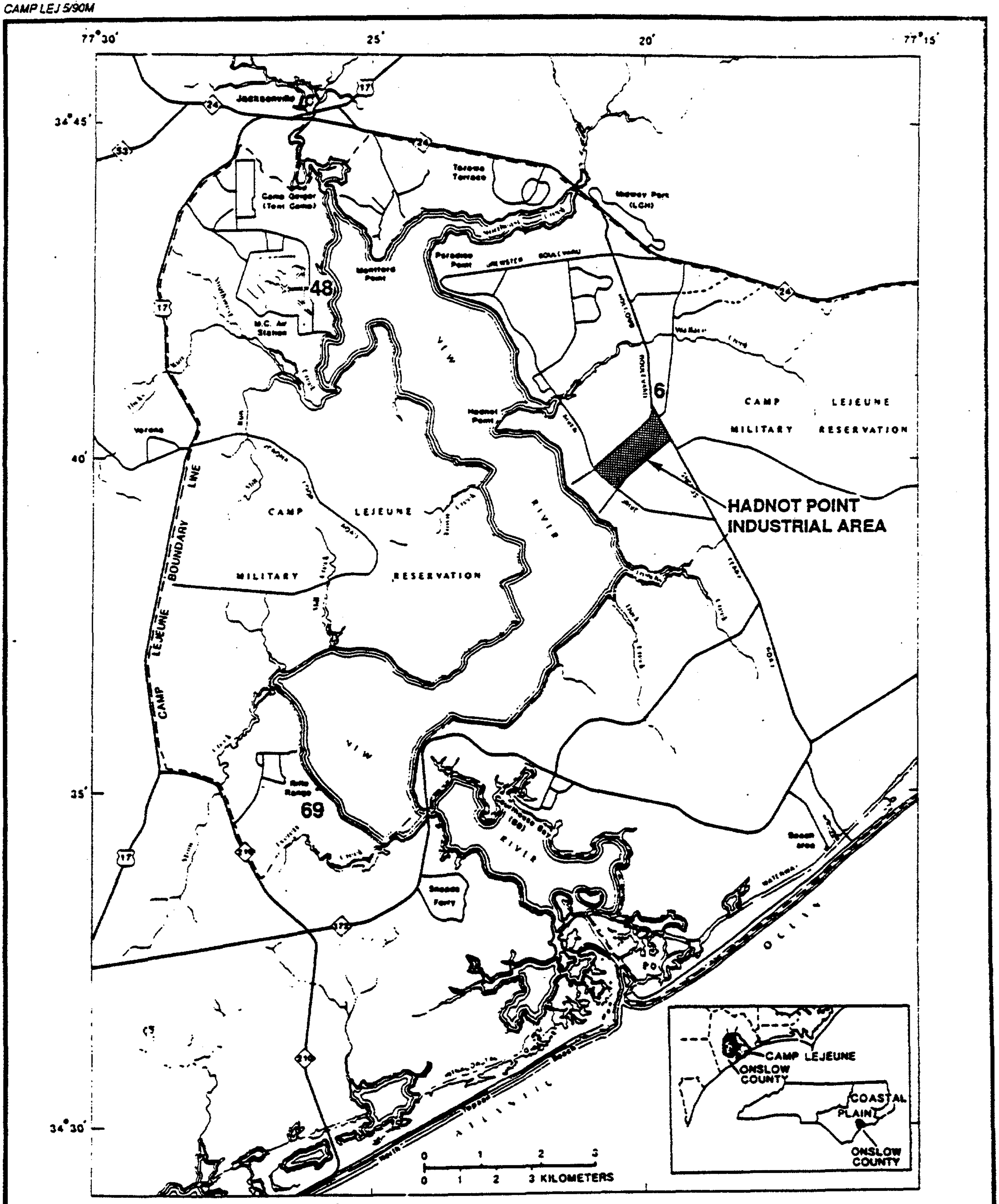

Base taken from Defense Mapping Agency Hydrographic Center, Camp Lejeune Special Map, 1:50,000

Figure 1-1
SITE LOCATIONS

SOURCE: HARNED *et al.*, 1989.

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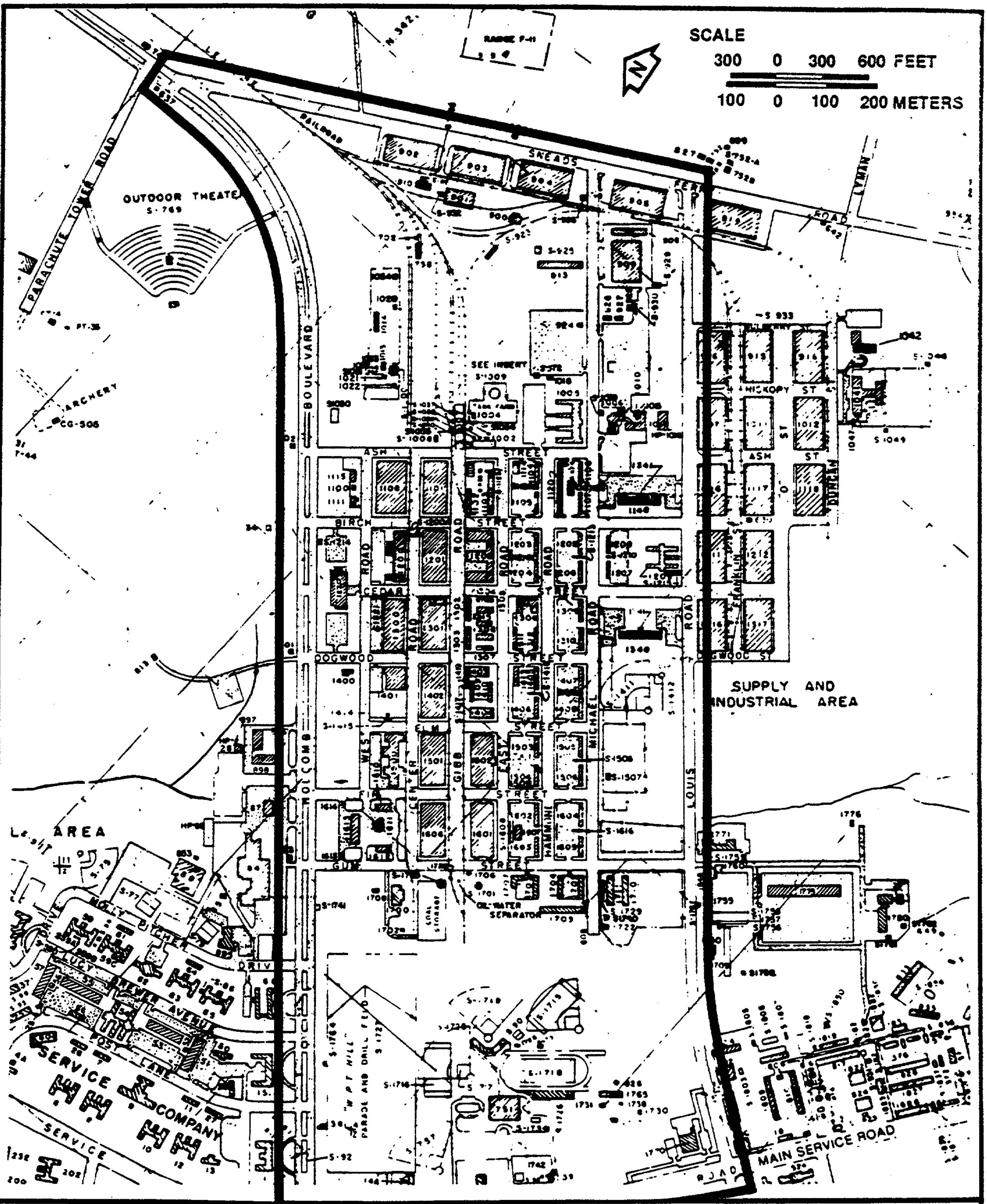

Figure 1-2
HADNOT POINT INDUSTRIAL AREA

SOURCE: CAMP LEJEUNE, 1987.

Department of the Navy Naval Facilities Engineering Command

MARINE CORPS BASE
CAMP LEJEUNE

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A transformer storage yard (Site 21) and a fuel tank farm (Site 22) are located within the northern portion of HPIA. These two areas of concern are not included in the proposed RI/FS scope of work. Sites 21 and 22 will be considered in separate studies at a later date.

1.1.2 SITE 6 - STORAGE LOTS 201 AND 203

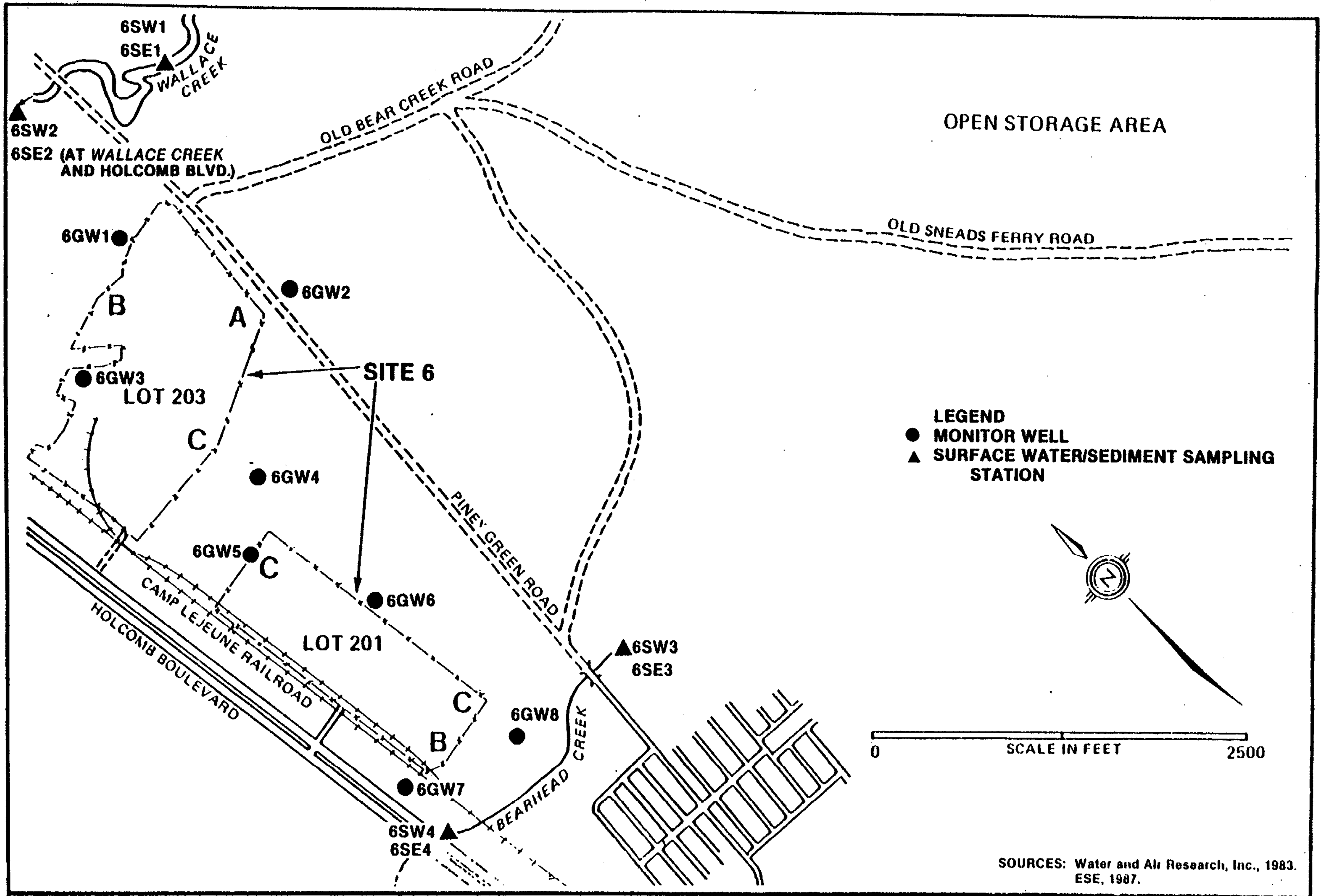
Site 6, located just north of HPIA, is comprised of Storage Lots 201 and 203. Storage Lots 201 and 203 are situated on Holcomb Boulevard between Wallace and Bearhead Creeks (Figures 1-1 and 1-3). Lots 201 and 203 are approximately 25 and 46 acres in size, respectively. These lots are used to store hazardous materials. The lot surfaces are relatively flat and unpaved. Surface soils have reportedly been moved about as a result of equipment movement and regrading (Water and Air Research, 1983).

1.1.3 SITE 48 - MCAS MERCURY DUMP

Site 48 is located on the west side of the New River Estuary, on Longstaff Road next to Building 804 (photo lab) (Figures 1-1 and 1-4). Metallic mercury was periodically drained from the delay lines of radar units and disposed of at Site 48. The actual disposal area is approximately 20,000 square feet and covers a 100-200 foot wide corridor which extends from the rear of Building 804 to the banks of the New River (Water and Air Research, 1983).

1.1.4 SITE 69 - RIFLE RANGE CHEMICAL DUMP

Site 69, the Rifle Range Chemical Dump, is west of the New River Estuary, and approximately 9000 feet east of the intersection of Range and Sneads Ferry Roads, north of Everett Creek (Figures 1-1 and 1-5). The site is an estimated six acres in size, containing approximately 93,000 cubic yards of material (Water and Air Research, 1983).



SOURCES: Water and Air Research, Inc., 1983.
ESE, 1987.

Figure 1-3
SITE 6
STORAGE LOTS 201 AND 203

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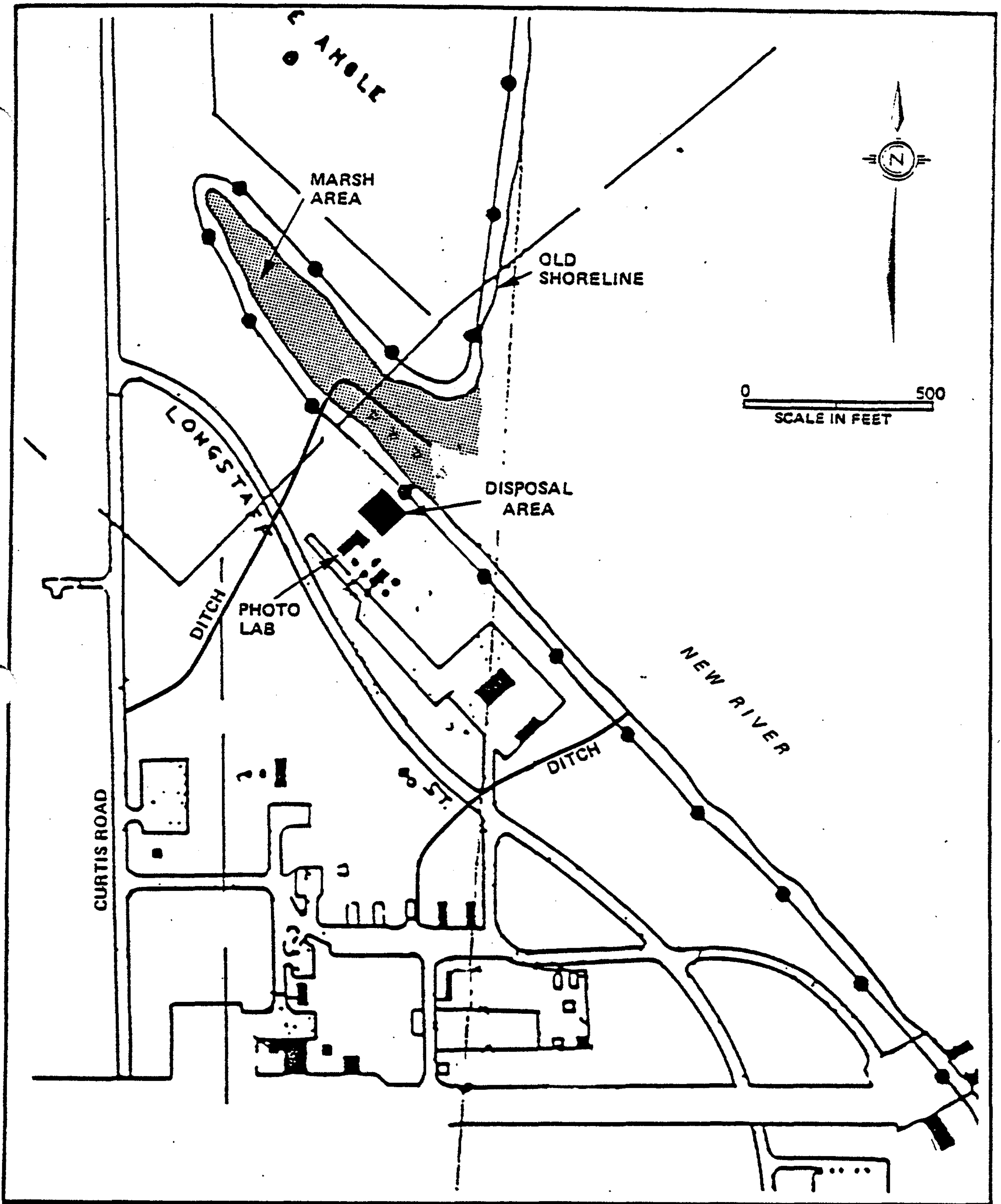

Figure 1-4
SITE 48
MCAS MERCURY DUMP

SOURCES: WATER AND AIR RESEARCH, INC., 1983; ESE, 1984.

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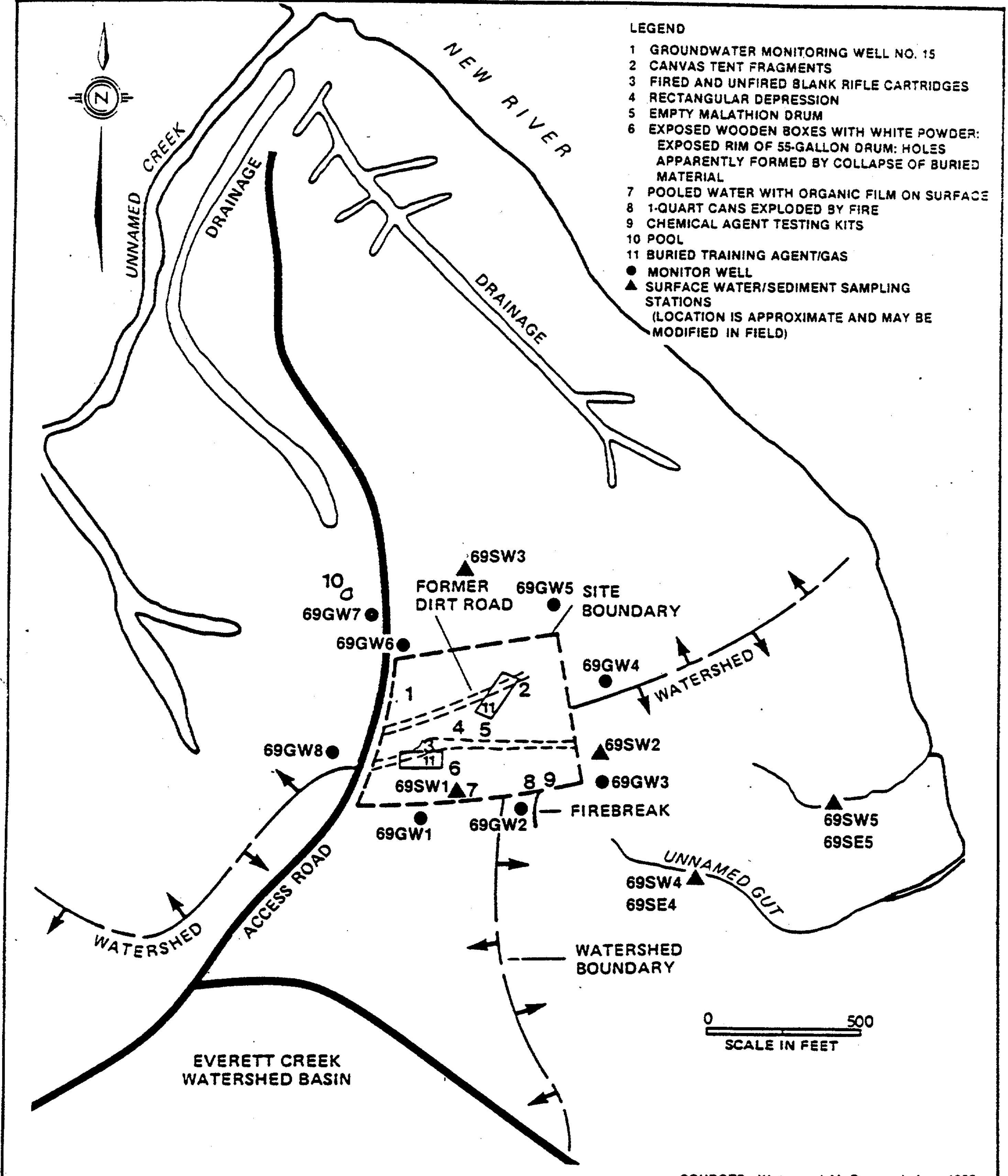

SOURCES: Water and Air Research, Inc., 1983.
ESE, 1987.

Figure 1-5
SITE 69
RIFLE RANGE CHEMICAL DUMP

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CAMP LEJEUNE

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2.0 GENERAL SITE OPERATIONS

2.1 BRIEF DESCRIPTION OF THE SAMPLING PROGRAM

The principal objectives of the HPIA field sampling program are:

- to collect additional data to facilitate the design of the selected remedial action for shallow groundwater;
- to collect data necessary to conduct a risk assessment and feasibility study for deep groundwater, and
- to collect data necessary to conduct a risk assessment and feasibility study for shallow soil contamination adjacent to Buildings 1602, 902, and 1202.

The principal objective of the field sampling programs at Sites 6, 48, and 69 is to collect additional data in order to move forward with the RI process at these sites.

The field sampling programs consist of groundwater, surface water, sediment, shallow soils, and fish tissue sampling. General site operations and field methods are presented in the following sections.

2.2 FIELD TEAM PERSONNEL AND RESPONSIBILITIES

The field team will consist of the following personnel:

Field Operations Leader (FOL) -- Responsible for the day-to-day management and supervision of the field investigation including scheduling of work, and ensuring that project-specific plans are in compliance with appropriate guidelines. The FOL will provide consultation and decision-making on issues pertaining to sampling activities including potential changes to the field program.

Site Geologist -- Responsible for overseeing sampling and monitoring well activities, ensuring that standard and approved drilling and monitoring well installation methods are followed and ensuring that pertinent drilling and testing information is obtained.

Project Hydrogeologist -- Responsible for planning and overseeing the groundwater investigations including determining the number of data points, wells, and reference measuring points needed to adequately define groundwater flow, obtaining accurate water level measurements to generate groundwater contour maps, and assessing

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the groundwater flow regime and subsurface conditions which could affect that flow regime.

Sampling Personnel -- Responsible for the proper collection, preservation, packaging, documentation, and initial chain-of-custody of samples until release to another party for storage or transport to the analytical laboratory.

Health and Safety Officer (HSO) -- Responsible for ensuring that field activities are conducted in accordance with the HASP. The HSO will have the authority to stop work if conditions exceed allowable limits and, as appropriate, will assume certain sampling responsibilities.

Health and Safety Officer Designee -- The project HSO may not be onsite at all times, therefore a sampling team member will be designated to monitor procedures and report inconsistencies, as they apply to the HASP, to the HSO.

Drilling Personnel -- Responsible for drilling permits and clearances and supplying all services (including labor), equipment, and material required to perform the drilling, testing, and well installation. The drilling personnel will also be responsible for the maintenance and quality control of required equipment and for following decontamination procedures specified in the FSP and HASP. Upon completion of the work, drilling personnel will be responsible for demobilizing all equipment, cleaning any materials deposited onsite during drilling operations, and properly backfilling any borings.

Surveying Subcontractor -- Responsible for establishing the locations and elevations of HPIA monitoring and water supply wells and plotting these locations on an existing topographic map. Required horizontal and vertical control are to the nearest 0.1 and 0.01 feet, respectively.

2.3 SAMPLE IDENTIFICATION SYSTEM

Each sample collected will be identified with an alphanumeric code. The code will indicate the site name/number, the matrix sampled, and the sample location (i.e. monitoring well or soil boring number). Soil borings will also contain a sequential letter which can be correlated to the sample depth.

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The site, matrix and sample location codes required for this field investigation are as follows:

- Site Codes:

  HP = Hadnot Point Industrial Area
  21 = Site 21
  22 = Site 22
  6 = Site 6
  48 = Site 48
  69 = Site 69

- Matrix Codes:

  GW = Groundwater
  SO = Soil
  SE = Sediment
  SW = Surface Water
  TI = Fish Tissue

- Sample Locations:

  GW#-# = monitoring well # - screen depth indicator*
  (*2 =intermediate, 3 = deep)

  SB# = soil boring #

The following can be used as a general guide for sample identification:

Site - Matrix - Well/Soil Boring - Depth Indicator

Some examples of sample identifications are as follows:

HPGW1-3 = groundwater sample collected from GW#1-3 (deep well) located at HPIA.

HPSO1-a = first (0-2 foot) soil sample collected from SB#1 located at HPIA.

6SE5 = sediment sample collected from Location #5 at Site 6.

2.4 ANALYTICAL PROGRAM

Table 2-1 presents a summary of the analytical program proposed at HPIA. Table 2-2 presents a summary of the analytical program proposed at Sites 6, 48, and 69. Sample container requirements, preservation

TABLE 2-1

HADNOT POINT INDUSTRIAL AREA
PROPOSED ANALYTICAL PROGRAM

	MATRIX(a)	FIELD SCREENING(b)	FULL TCL(c) + ketones(d)	TCL VOCs + ketones(d)	TCLP (metals)(e)	PESTICIDES /PCBs
GROUNDWATER:						
Existing Shallow Wells (30)	GW	30	30	-	-	-
Existing Deeper Wells (6)	GW	6	6	-	-	-
New Deeper Wells (8)	GW	8	8	-	-	-
Water Supply Wells (9)	GW	9	9	-	-	-
Duplicate Samples (f)	GW	-	5	3	-	-
TOTAL GROUNDWATER SAMPLES	GW	53	58	23	-	
SOIL:						
Soil Borings (30)	SO	90	9	81	81	81
Duplicate Samples (f)	SO	-	1	8	8	8
TOTAL SOIL SAMPLES	SO	90	10	90	90	90
BLANK SAMPLES (h):						
Equipment Blanks	AQ	-	25	8	8	8
Field Blanks	AQ	-	1	-	1	1
Trip Blanks	AQ	-	-	20	-	-
Drilling Mud Blank	SO	-	1	-	-	-
Deionized Water Blank	AQ	-	2	-	-	-
TOTAL BLANK SAMPLES	AQ	-	29	28	9	9

NOTES:
(a) GW = groundwater, SO = soil, AQ = aqueous
(b) Field screening for groundwater: pH, temperature, specific conductivity
Field screening for soils: HNu and/or OVM
(c) Full TCL = TCL VOCs, Extractables (includes BNAs, pesticides and PCBs), Metals and Cyanide
(d) ketones = methyl ethyl ketone and methyl isobutyl ketone
(e) TCLP = Toxicity Characteristic Leaching Procedure (metals only)
(f) Duplicate sample numbers based on a frequency of 10%
(g) Number of soil boring samples presented is approximate due to the variable depth to water (6-22 feet) at HPIA
(h) Equipment blank totals are approximate and based on 1/day/sampling procedure
Trip blank totals are approximate and based on 1/day of aqueous TCL VOC sampling
Deionized water blank totals are approximate and based on 1/lot (batch) of water.

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TABLE 2-2

SITES 6, 48, and 69
PROPOSED ANALYTICAL PROGRAM

	MATRIX(a)	FIELD SCREENING(b)	FULL TCL(c)	TCL VOCs	TCL METALS
SITE 6:					
Groundwater	GW	10	10	-	-
Surface Water	SW	2	2	-	-
Sediment	SE	2	2	-	-
TOTAL SAMPLES		14	14	-	-
SITE 48:					
Surface Water	SW	11	-	-	11
Sediment	SE	11	-	-	11
Fish Tissue	TI	-	-	-	11
TOTAL SAMPLES		22	-	-	33
SITE 69:					
Groundwater	GW	8	8	-	-
Surface Water	SW	7	7	-	-
Sediment	SE	7	7	-	-
Fish Tissue	TI	-	4	-	-
TOTAL SAMPLES		22	26	-	-
DUPLICATE SAMPLES(d):					
Groundwater	GW	2	2	-	-
Surface Water	SW	2	1	-	1
Sediment	SE	2	1	-	1
Fish Tissue	TI	-	1	-	-
TOTAL SAMPLES		6	5	-	2
BLANK SAMPLES(e):					
Equipment	AQ	16	13	-	3
Field	AQ	1	1	-	-
Trip	AQ	13	-	13	-
TOTAL SAMPLES		30	14	13	3

NOTES:
(a) GW = groundwater, SO = soil, SW = surface water, SE = sediment, TI = fish tissue, AQ = aqueous
(b) Field screening for groundwater and surface water: pH, temperature, specific conductivity
Field screening for soils and sediment: HNu and/or OVM
(c) Full TCL = TCL VOCs, Extractables (includes BNAs and pesticides/PCBs), Metals and Cyanide
(d) Duplicate sample numbers based on a frequency of 10%
(e) Equipment blank totals are approximate and based on 1/day/sampling procedure
Trip blank totals are approximate and based on 1/day of aqueous TCL VOC sampling

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requirements, holding times and analytical methods to be performed on each sample are specified in Table 2-3.

All samples collected during the field investigations will be analyzed at the ESE Laboratory. This laboratory fulfills all the requirements outlined in the "Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual" (EPA Region IV) and in the Navy's Quality Assurance Program (QAP), and has been pre-approved by the Navy.

Sample analysis will be conducted at DQO Level D ensuring that analytical methods comparable to EPA's CLP program will be used. DQO Level D correlates to EPA Level 4, and is required for sites that are on or about to be on the National Priorities List (NPL). CLP-type data packages will be generated by the lab for each sample.

2.5 SAMPLE PACKAGING AND SHIPPING

Each sample will be identified by affixing a pressure sensitive gummed label on each sample jar. Sample labels will reflect the following information: sample ID number, collection date, collection time, name of sampler, etc.

Samples will be packaged and shipped in accordance with the Navy's QA Plan requirements (NEESA 20.2 - 047B) as follows:

Shipping containers shall be secured using nylon strapping tape and custody seals to ensure that samples have not been disturbed during transport. The custody seals shall be placed on the containers so they cannot be opened without breaking the seal.

Samples shall be packed in shipping containers so as to guard against damage during shipment (e.g. bubble wrap, vermiculite). Samples which must be kept at 4°C shall be shipped in insulated containers with either freezer forms or ice. If ice is used, it shall be placed in a container so that the water will not fill the cooler as the ice melts. Fish tissue samples will be shipped with dry ice. The samples shall be shipped within 24 hours of collection to allow the laboratory to meet holding times. Shipping will be in accordance with Department of Transportation regulations.

Copies of the signed Chain-Of-Custody forms (Figure 2-1) shall be delivered with the sample packages. The originals shall remain on file.

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TABLE 2-3

SUMMARY OF ANALYTICAL METHODS, PRESERVATION AND HOLDING TIMES

MATRIX	SAMPLING DEVICE	ANALYSIS	SAMPLE CONTAINER	SAMPLE PRESERVATION	HOLDING TIME FROM COLLECTION	ANALYTICAL METHOD
Groundwater*/ surface water/ blanks	*stainless steel or teflon bailer	TCL VOCs +ketones (a)	3-60ml glass vials with teflon septum caps	HCL to pH<2 Cool to 4 C	14 days analyze	CLP-IFB-SOW (2/88)
	"	TCL BNAs, pesticides, and PCBs	2-1 liter amber glass	Cool to 4 C	7 days extract 40 days analyze	CLP-IFB-SOW (2/88)
	"	TCL Metals	1-1 liter polyethylene	HNO3 to pH<2 Cool to 4 C	6 months (Hg - 28 days)	CLP-IFB-SOW (7/87)
	"	Cyanide	1-1 liter polyethylene	NaOH to pH<2 Cool to 4 C	14 days analyze	CLP-IFB-SOW (7/87)
Soil	split-spoon	TCL VOCs +ketones (a)	1-60ml glass vial with teflon-lined cap	Cool to 4 C	14 days analyze	CLP-IFB-SOW (2/88)
	"	TCL BNAs, pesticides and PCBs	1-8oz glass	Cool to 4 C	14 days extract 40 days analyze	CLP-IFB-SOW (2/88)
	"	TCL Metals	1-8oz glass	Cool to 4 C	6 months	CLP-IFB-SOW (7/87)
	"	Cyanide	1-8oz glass	Cool to 4 C	14 days analyze	CLP-IFB-SOW (7/87)
	"	TCLP (metals only	1-16oz glass or plastic	Cool to 4 C	6 months	55 FCR 11798 (3/90)

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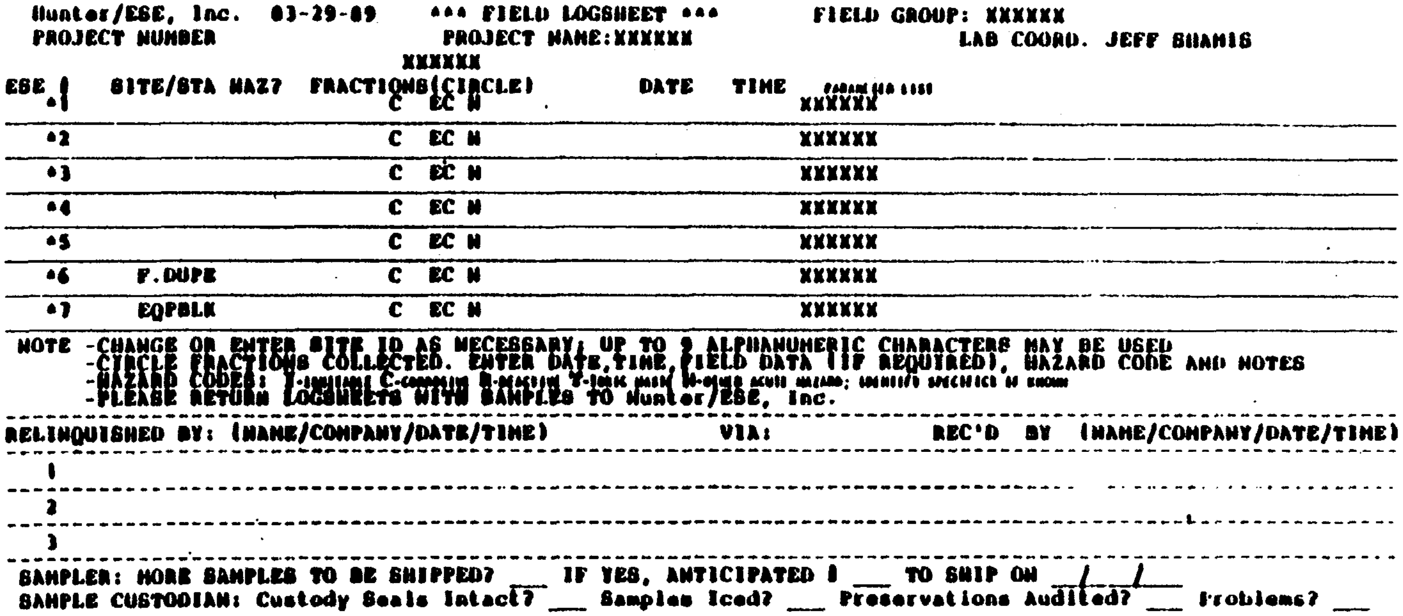
TABLE 2-3 cont'd

SUMMARY OF ANALYTICAL METHODS, PRESERVATION AND HOLDING TIMES

MATRIX	SAMPLING DEVICE	ANALYSIS	SAMPLE CONTAINER	SAMPLE PRESERVATION	HOLDING TIME FROM COLLECTION	ANALYTICAL METHOD
Sediment/ Drilling Mud	stainless steel scoop	TCL VOCs	1-60ml glass vial. with teflon-lined cap	Cool to 4 C	14 days analyze	(b)
	"	TCL BNAs, pesticides and PCBs	1-8oz glass	Cool to 4 C	14 days extract 40 days analyze	"
	"	TCL Metals	1-8oz glass	Cool to 4 C	6 months	"
	"	Cyanide	1-8oz glass	Cool to 4 C	14 days analyze	"
Fish Tissue	net/line	Full TCL	glass or foil and plastic (c) ~ 150 grams	Dry Ice	(d)	(b)
	"	TCL Metals	glass or plastic	"	"	"

NOTES: (a) ketones = methyl ethyl ketone and methyl isobutyl ketone
(b) USEPA Interim Methods for the Sampling and Analysis of Priority Pollutants in Sediments and Fish Tissue, 1980
(c) glass may be used for all fractions; foil for all fractions other than metals fraction; plastic for metals fraction only
(d) Soil holding times will be applied as guidelines only; holding times are not specified in the method.



Hunter/ESE, Inc. 03-29-89 *** FIELD LOGSHEET *** FIELD GROUP: XXXXXX
PROJECT NUMBER PROJECT NAME:XXXXXX LAB COORD. JEFF SHAMIS
XXXXXX

ESE #	SITE/STA	HAZ?	FRACTIONS(CIRCLE)	DATE	TIME	
*1			C EC N			XXXXXX
*2			C EC N			XXXXXX
*3			C EC N			XXXXXX
*4			C EC N			XXXXXX
*5			C EC N			XXXXXX
*6	F.DUPE		C EC N			XXXXXX
*7	EQPBLK		C EC N			XXXXXX

NOTE -CHANGE OR ENTER SITE ID AS NECESSARY; UP TO 9 ALPHANUMERIC CHARACTERS MAY BE USED
-CIRCLE FRACTIONS COLLECTED. ENTER DATE,TIME,FIELD DATA (IF REQUIRED), HAZARD CODE AND NOTES
-HAZARD CODES: [illegible]
-PLEASE RETURN LOGSHEETS WITH SAMPLES TO Hunter/ESE, Inc.

RELINQUISHED BY: (NAME/COMPANY/DATE/TIME)	VIA:	REC'D BY (NAME/COMPANY/DATE/TIME)
1		
2		
3		

SAMPLER: MORE SAMPLES TO BE SHIPPED? ___ IF YES, ANTICIPATED # ___ TO SHIP ON __/__/__
SAMPLE CUSTODIAN: Custody Seals Intact? ___ Samples Iced? ___ Preservations Audited? ___ Problems? ___

Figure 2-1
SAMPLE CHAIN-OF CUSTODY LOG SHEET

SOURCE: HUNTER/ESE, 1990.

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2.6 SAMPLE DOCUMENTATION

Each field team member will be required to maintain a field logbook to document all field activities at the site. The field logbook will be a bound, weatherproof notebook.

Entries will be made into the field logbook on a daily basis. Information to be noted in the field logbook include daily weather conditions, personnel on site, sample particulars such as sample number, sampling time, sampling method, sample description and name of sampler, field measurements and geologic and hydrologic data. Any deviations from procedures documented in the Sampling Plan will also be noted in the logbook.

In addition to logbook documentation, boring logs and monitoring well construction sheets will be generated once a boring or monitoring well are complete. Sampling data records will be filled out for each sample collected. Chain-of-custody forms will be filled out for all samples sent to a laboratory for analysis. Examples of each form are presented in Figures 2-1 through 2-4.

2.7 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

The QA/QC requirements for field activities are presented below.

2.7.1 FIELD INSTRUMENTATION CALIBRATION

Instruments which measure pH, temperature, specific conductivity and organic vapors will be used during the field investigation. Calibration and maintenance information for each instrument used at the site will be recorded on Calibration and Field Instrument Quality Assurance Record Forms (Figures 2-5 through 2-7) on a daily basis. Items such as instrument type, instrument I.D. number, calibration method and results, and name of person performing calibration will be noted.

2.7.2 QA/QC SAMPLE COLLECTION

The following blank samples will be included in the analytical program to ensure QA/QC of sampling practices.

Trip Blanks

A trip blank is an aliquot of deionized analyte-free water that is sealed in a sample bottle at the laboratory and accompanies the sample bottles to and from the field. A trip blank establishes a mechanism of control on sample bottle preparation, blank water quality and sample handling, including cross-contamination of samples during shipping.

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D20/LEG.F.BOR LOG 1/90M

FIELD BORING LOG			**BORING NO.** ___
Project No.	Project Name		Page ___ of ___
Contractor	Driller	Date started	completed
Method	Casing Size	HNU 11.7/10.2	Protection Level
Ground El.	Soil Drilled	▼ ___ below ground	Total Depth
Logged by	Checked by	Date	

Sample No.	Depth in Feet	Blows per 6"	Pen. Rec.	Description	HNU jar	Comments on Advance of Boring	Monitoring	
							HNU	LEL

Figure 2-2
FIELD BORING LOG

SOURCE: HUNTER/ESE, 1990.

DEPARTMENT OF THE NAVY NAVAL FACILITIES ENGINEERING COMMAND

MARINE CORPS BASE
CAMP LEJEUNE

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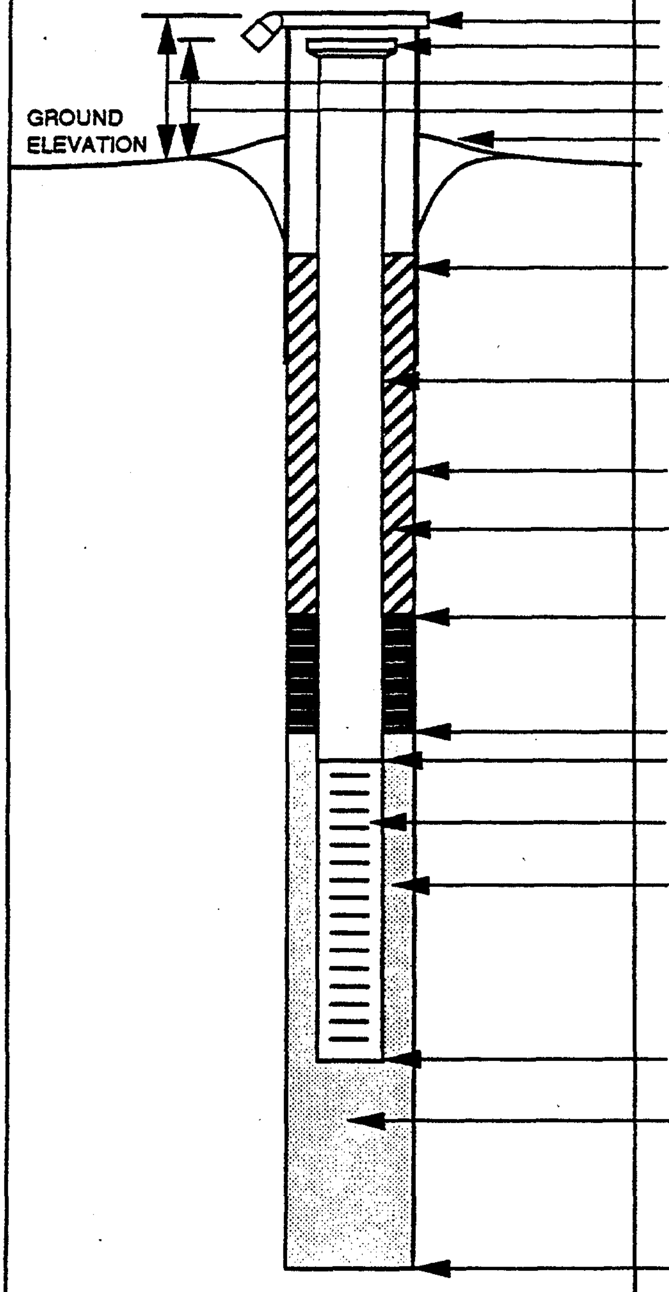
OVERBURDEN MONITORING WELL SHEET

WELL NO. ____

PROJECT ____
PROJECT NO. ____ BORING NO. ____
ELEVATION ____ DATE ____
FIELD GEOLOGIST ____

DRILLER ____
DRILLING METHOD ____
DEVELOPMENT METHOD ____



ELEVATION OF TOP OF SURFACE CASING: ____
ELEVATION OF TOP OF RISER PIPE: ____
STICK-UP TOP OF SURFACE CASING: ____
STICK-UP RISER PIPE: ____
TYPE OF SURFACE SEAL: ____

I.D. OF SURFACE CASING: ____
TYPE OF SURFACE CASING: ____

RISER PIPE I.D. ____
TYPE OF RISER PIPE: ____

BOREHOLE DIAMETER: ____

TYPE OF BACKFILL: ____

ELEVATION/DEPTH TOP OF SEAL: ____
TYPE OF SEAL: ____

DEPTH TOP OF SAND PACK: ____
ELEVATION/DEPTH TOP OF SCREEN: ____

TYPE OF SCREEN: ____
SLOT SIZE X LENGTH: ____
TYPE OF SAND PACK: ____

ELEVATION/DEPTH BOTTOM OF SCREEN: ____

ELEVATION/DEPTH BOTTOM OF SAND PACK: ____
TYPE OF BACKFILL BELOW OBSERVATION WELL: ____

ELEVATION/DEPTH OF HOLE: ____

Figure 2-3
MONITORING WELL CONSTRUCTION SHEET

SOURCE: HUNTER/ESE, 1990.

MARINE CORPS BASE CAMP LEJEUNE

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GROUNDWATER FIELD SAMPLE DATA RECORD

PROJECT ______________________ JOB NO ______

STATION NO/LOCATION ______________________ DATE ______

SKETCH ON BACK YES ☐ NO ☐ PHOTOGRAPHS YES ☐ NO ☐ ROLL NO/EXPOSURE NO ______

FIELD DATA

TIME: START ______ AIR TEMP ______

END ______ WEATHER ______

WATER DEPTH ______ ☐ TOP WELL ☐ TOP CASING

WELL DEPTH ______ WELL MATERIAL ______

WELL DIAM. ______

WELL STICK-UP ______ WELL/CASING ______

SAMPLING EQUIPMENT USED ______________________ VOLUME PURGED ______

FIELD DATA COLLECTION ☐ IN SITU ☐ IN BOTTLE

VOA LEVEL(PPM) AMBIENT ______

SAMPLE LOCATION ______

HEADSPACE ______

SAMPLE PURGE DATA

@ ______ GAL	@ ______ GAL	@ ______ GAL	@ ______ GAL
TEMP ______ °C	TEMP ______ °C	TEMP ______ °C	TEMP ______ °C
SP COND ______ @25°C	SP. COND ______ @25°C	SP. COND ______ @25°C	SP. COND ______ @25°C
pH ______	pH ______	pH ______	pH ______
Eh ______	Eh ______	Eh ______	Eh ______

BOTTLE ID	LAB ID	VOL	MATERIAL	FILTERED	PRES./VOL.	ANALYSIS REQUESTED

REMARKS/OBSERVATIONS ______________________

SAMPLER ______________________

Figure 2-4
GROUNDWATER FIELD SAMPLE DATA RECORD

SOURCE: HUNTER/ESE, 1990.

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MARINE CORPS BASE
CAMP LEJEUNE

Doc No: CLEJ-00351-3.03-09/01/90

ENVIRONMENTAL SCIENCE & ENGINEERING
WATER RESOURCES DIVISION
pH Meter Calibration Form

Date ______________________

Project Number ______________________

Instrument Serial Number ______________________

Calibrator ______________________

Battery (Condition or Voltage) ______________________

Ambient Temperature ______________________

Standard Buffer Value	Initial Reading	Final Reading
7.00	________	________
4.00	________	________
10.00	________	________

Condensed Calibration Procedure:

1. Fill in ALL information at the top of the form.
2. Activate unit and perform battery check (on units without a battery check switch, mark as "O.K." if LOW BATTERY isn't displayed).
3. Inspect unit and probe for physical damage.
4. Triple Rinse with Deionized water then rinse with pH 7.00 buffer.
5. Put probe in enough pH 7.00 buffer to cover probe. When reading is stable record the "Initial Reading".
6. Adjust the CALIBRATE knob to get the unit to read exactly 7.00. Record the "Final Reading".
7. Triple Rinse with Deionized water then rinse with pH 4.00 or 10.00 buffer whichever is appropriate for the present application.
8. Put probe in enough pH buffer (same buffer as step 7) to cover probe. When the reading is stable record the "Initial Reading".
9. Adjust the SLOPE (TEMP. on some) knob to get the unit to read exactly the same as the buffer and record the "Final Reading".
10. Triple Rinse with Deionized water then rinse with pH buffer that has yet to be used.
11. Put probe in enough pH buffer (same buffer as step 10) to cover probe. When the reading is stable record the "Initial Reading" and the "Final Reading"
12. Make sure the unit is turned off and the probe disconnected. Then return the unit to its proper case.

Figure 2-5
pH METER CALIBRATION FORM

SOURCE: ESE, 1990.

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND

MARINE CORPS BASE
CAMP LEJEUNE

DOC NO: CLEJ-00351-3.03-09/01/90

ENVIRONMENTAL SCIENCE & ENGINEERING
WATER RESOURCES DIVISION
SCT Meter Calibration Form

Date ____________________

Project Number ____________________

Instrument Serial Number ____________________

Calibrator ____________________

Zero (unit off, Pass/Fail) ____________________

Redline (Pass/Fail) ____________________

Parameter	Standard	Reading
Temperature		______ C
Conductivity:		
High Conc. Stnd	______	______
Middle Conc. Stnd	______	______
Low Conc. Stnd	______	______
Salinity (if used):		
High Conc. Stnd	______	______
Middle Conc. Stnd	______	______
Low Conc. Stnd	______	______

Having performed a full calibration of this instrument, I certify that to the best of my knowledge this unit is completely operational and accurate. The only exceptions are those explicitly defined in the comments below.

Comments: ____________________

Signature ____________________ Date ____________________

Figure 2-6
CONDUCTIVITY METER
CALIBRATION FORM

SOURCE: ESE, 1990.

MARINE CORPS BASE
CAMP LEJEUNE

DOC NO: CLEJ-00351-3.03-09/01/96

CAMP LEJ 5/90M

PAGE ______ OF ______

FIELD INSTRUMENTATION QUALITY ASSURANCE RECORD

PROJECT ____________________ DATE ______________

JOB NO ______________

CALIBRATION DATA

EQUIPMENT I.D. ______________________________

ELECTRICAL, BATTERY VOLTAGE: ☐ OK ☐ REPLACE

TEMPERATURE PROBE CALIBRATED: ☐ YES ☐ NO DATE OF LAST CALIBRATION ______________

SPECIFIC CONDUCTIVITY PROBE/METER CALIBRATION:

CONDUCTIVITY STANDARD ________ umhos/cm ________ METER READING

________ umhos/cm ________ METER READING

________ umhos/cm ________ METER READING

pH/Eh PROBE CALIBRATION pH BUFFER ____ 4 ____ 7 ____ 10

Eh MILLIVOLT ____ 4 ____ 7 ____ 10

DISSOLVED OXYGEN METER CALIBRATION ______________

WINKLER CALIBRATION

AVERAGE WINKLER TITRATION VALUE ________ PPM METER CORRECTION ☐ YES ☐ NO

OTHER: ______________________________

____

SAMPLING EQUIPMENT/DECONTAMINATION RECORD

SAMPLING EQUIPMENT USED: ☐ ELECTRIC SUBMERSIBLE PUMP ☐ PERISTALTIC PUMP ☐ GRAVITY CORER

☐ BLADDER SUBMERSIBLE PUMP ☐ TEFLON/S.S. BAILER ☐ ______________

☐ ______________

DECONTAMINATION FLUIDS USED: ☐ DISTILLED WATER ☐ METHANOL ☐ ______________

☐ ISOPROPANOL ☐ TCP ☐ ______________

FILTRATION EQUIPMENT USED: ☐ VACUUM FILTRATION ACID-RINSED: ☐ YES ☐ NO

☐ PRESSURE FILTRATION FILTRATION BLANK PREPARED: ☐ YES ☐ NO

SAMPLER ______________________________

Figure 2-7
FIELD INSTRUMENTATION QUALITY ASSURANCE RECORD

SOURCE: HUNTER/ESE, 1990.

MARINE CORPS BASE CAMP LEJEUNE

Doc No: CLEJ-00351-3.03-09/01/90

Trip blanks should be handled, transported and analyzed in the same manner as the samples collected that day. Trip blanks are analyzed for volatile organics only and must accompany samples at a rate of 1/trip. Trip blanks are required for aqueous volatile sampling only.

Equipment Blanks (Equipment Rinsate Blanks)

An equipment blank is used to evaluate potential contamination from ambient air and sampling equipment on site. Equipment blanks are collected by passing deionized, analyte-free water through clean (decontaminated) sampling equipment and into sample jars. Equipment blanks are collected at a frequency of 1/day/sampling procedure. Equipment blanks are analyzed for the same parameters as the environmental samples.

Field Blanks (Potable Water Blanks)

A field blank is used to evaluate potential contamination from source water used for decontamination. At least one field blank is collected per event for the same parameters as the environmental samples.

Deionized Water Blanks

Quality assurance samples of the deionized water used for equipment decontamination and equipment blanks will be collected for analysis to confirm that the deionized water is contaminant-free. One deionized water blank will be collected per lot (batch) of deionized water supplied to the field team. These blank samples will be analyzed for the same compounds as the environmental samples, but will be shipped separately.

Drilling Mud Blanks

One sample of drilling mud used to drill intermediate and deep well boreholes will be collected for full TCL analysis during the field investigation. This sample will be collected directly into sample jars.

Duplicate Samples

A duplicate sample creates a mechanism for the evaluation of a laboratory's performance by allowing a comparison of analytical results of two samples collected from the same location. Duplicate samples are collected for each matrix sampled at a frequency of 10%.

Matrix spike and matrix spike duplicate (MS/MSD) analyses will be performed on all duplicate aqueous samples collected. MS/MSD samples require triple the normal sample volume which will require additional collection containers in most cases.

DOC NO: CLEJ-00351-303-09/01/90

3.0 FIELD INVESTIGATION AND SAMPLING

This section describes the field investigation and sampling activities to be conducted at HPIA and Sites 6, 48, and 69.

The field investigations will consist of the following activities:

1. Mobilization and Demobilization;
2. Monitoring Well Installation;
3. Groundwater Sampling and Water Level Monitoring;
4. Soil Sampling;
5. Surface Water and Sediment Sampling;
6. Fish (or Shellfish) Tissue Sampling, and
7. Surveying of HPIA wells.

3.1 MOBILIZATION AND DEMOBILIZATION

This subtask will consist of field personnel orientation, equipment mobilization, and the staking of sample locations.

Field team members will attend an orientation meeting to become familiar with the history of the site, health and safety requirements, and field procedures.

Equipment mobilization will entail the ordering and purchasing of all sampling equipment necessary for the field investigation. Locations for soil borings and monitoring well clusters will be staked at the start of the field investigation.

A survey of existing facilities equipped with floor drains and an evaluation of these facilities to serve as a decontamination area for heavy equipment will be performed during the mobilization phase of the field investigation. If a suitable decontamination area cannot be established from existing facilities, a decontamination pad will be constructed on site at this time.

Demobilization will consist of equipment demobilization, and will be performed at the completion of each phase of the field investigation, as necessary.

It is anticipated that the field investigations at HPIA and Sites 6, 48, and 69 will occur simultaneously or sequentially, thus requiring a single mobilization/demobilization effort for all field work proposed in this plan.

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3.2 MONITORING WELL INSTALLATION

Monitoring well installation will be performed at HPIA only. The monitoring well installation program is designed to obtain additional data on deep groundwater conditions downgradient of four areas of concern at HPIA.

Monitoring well clusters will be installed downgradient of Buildings 1602, 902, and 1202, and the Industrial Area Tank Farm (Site 22) (Figure 3-1).

The direction of horizontal groundwater flow within the deeper (>75 feet) portion of the aquifer below HPIA is not known at this time. The downgradient horizontal flow direction will be determined by water level measurements taken in existing deep wells at the site and, if available, water level data obtained from USGS files in Raleigh, N.C.

Four monitoring well clusters consisting of two wells each, for a total of 8 monitoring wells, will be installed during the field program. The wells will be screened at approximate depths of 75 and 150 feet. Exact screen depths will be determined in the field based on the permeability of the soils at these approximate depths. Proposed monitoring wells will be designated HPGW30-2 and HPGW30-3 through HPGW33-2 and HPGW33-3.

Monitoring wells will be drilled using the mud rotary method. Split-spoon samples will be collected every 5 feet in deep well borings for geologic characterization. Split-spoon samples will be collected at the proposed screen interval in all well borings to determine the most appropriate depth for effective screen placement.

Monitoring wells will be constructed of 4-inch Outer Diameter (O.D.), Schedule 40, flush-joint PVC screen and riser pipe. Screens will be 10 feet long with slots 0.010 inch (or of an appropriate size to retain approximately 90% of the filter pack).

Drill cuttings and fluids generated during the well installation process will be discharged to the ground surface in the immediate vicinity of the well.

The detailed procedure for monitoring well installation is presented below.

3.2.1 GENERAL MONITORING WELL INSTALLATION PROCEDURE

The following general procedure will be used to construct monitoring wells at HPIA. Figure 3-2 illustrates a typical monitoring well configuration.

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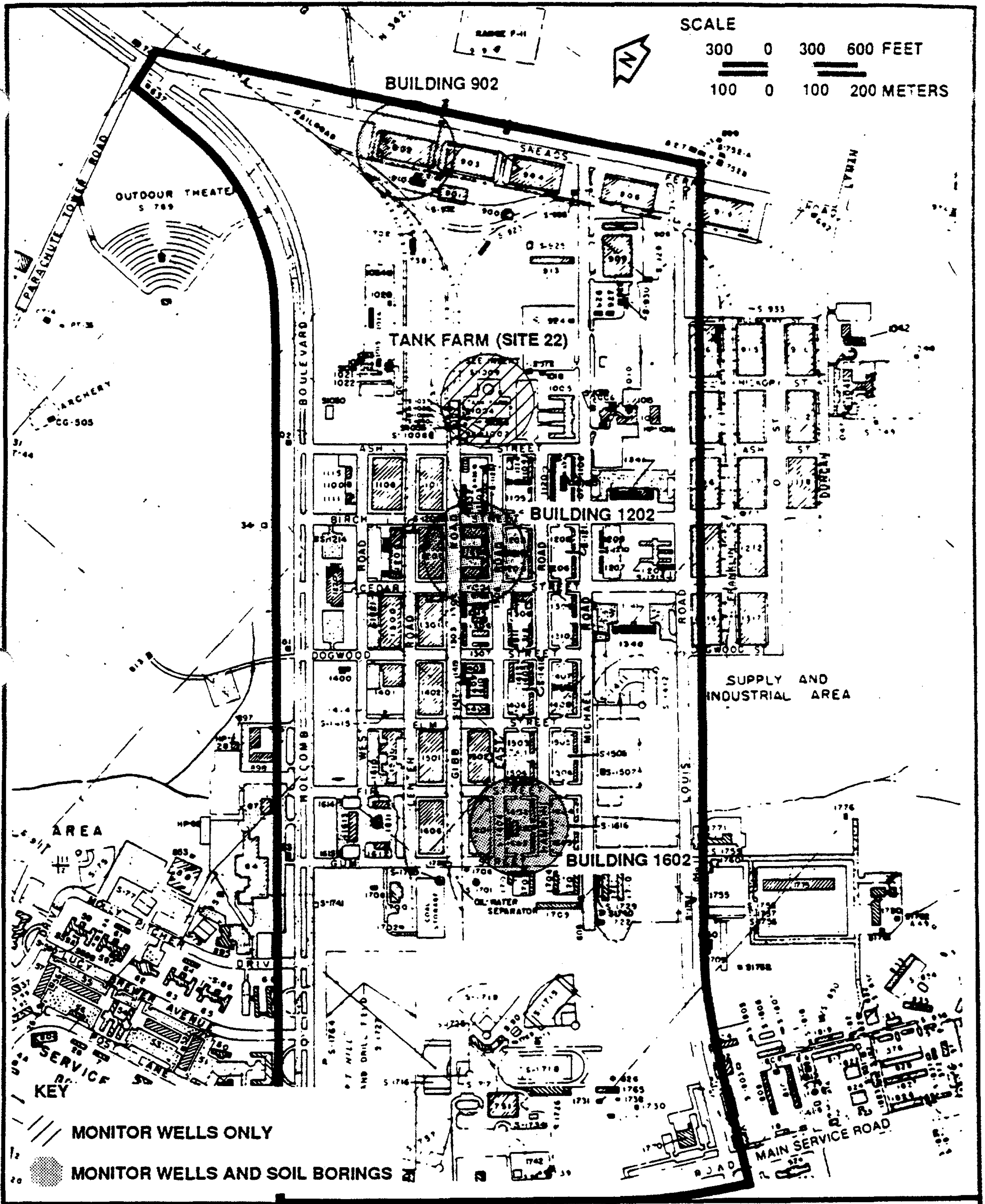

Figure 3-1
AREAS FOR INTERMEDIATE AND DEEP MONITORING WELLS AND SOIL BORINGS

SOURCE: CAMP LEJEUNE, 1987.

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CAMP LEJ 5/90M

D/19 LEGEUNE.WELL.2

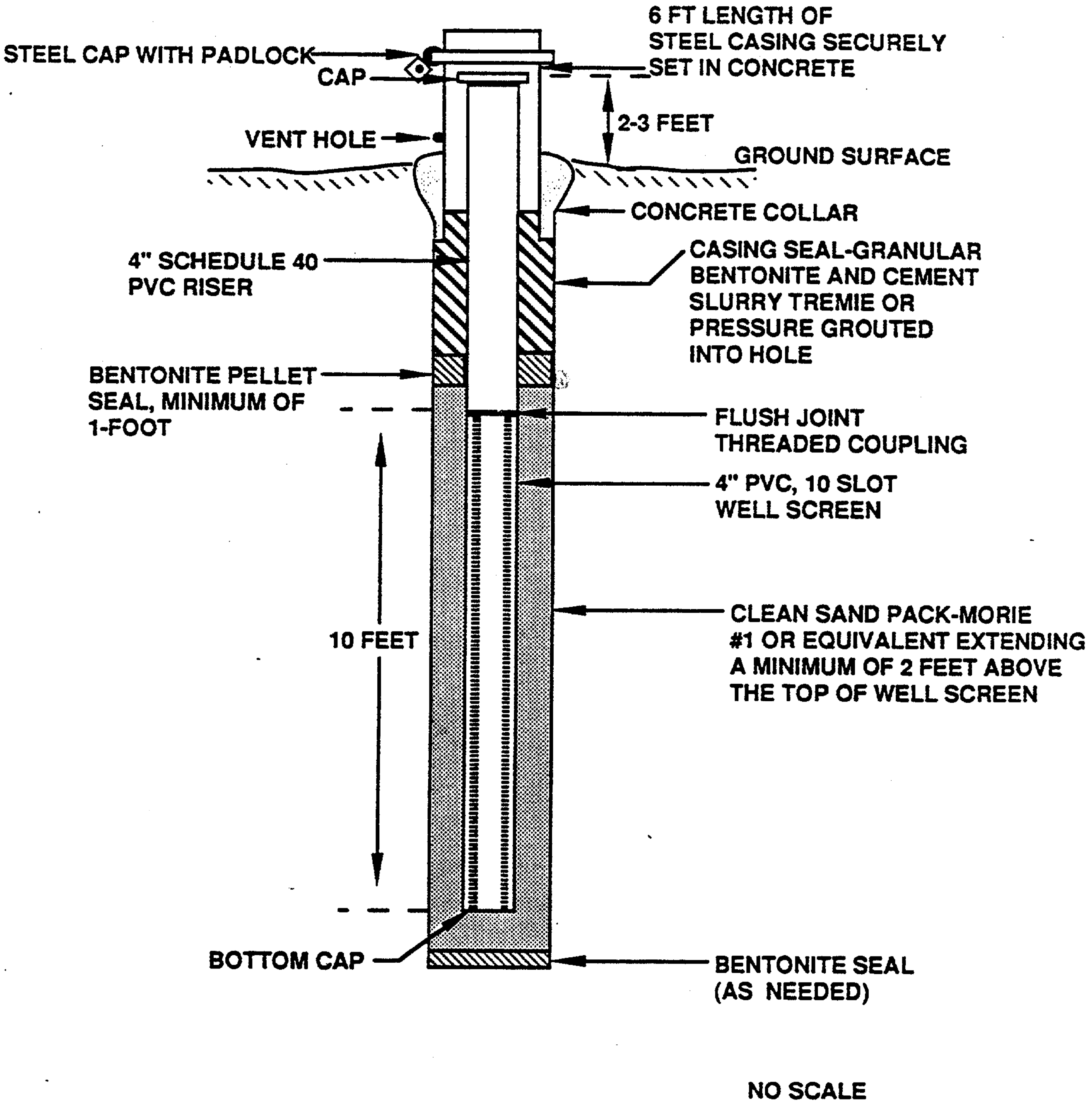

Figure 3-2
TYPICAL GROUNDWATER MONITORING WELL

SOURCE: HUNTER/ESE, 1990.

MARINE CORPS BASE
CAMP LEJEUNE

Doc NO: CLEJ-00351-3.03-09/01/90

1) Wear the appropriate health and safety equipment as outlined in the Health and Safety Plan.

2) Drill borehole to approximate depth specified using the mud rotary drilling method.

3) Collect soil samples, using a carbon steel split-spoon sampler, at 5-foot intervals in deep well borings for geologic characterization (see Section 3.4.1). Collect soil samples at the screened interval in all well borings and examine for permeability. Determine the optimum interval for screen placement based on permeability of soils.

4) Lower the decontaminated well screen and an appropriate length of riser pipe into the borehole so as to set the screen at the desired depth and allow the riser pipe to extend approximately 2-3 feet above the ground surface (if well not designated as a flush mount). The well screen and riser will be constructed of flush-joint, 4-inch O.D. PVC. The screen will have 0.010 inch slots (or be slotted at a size appropriate to retain approximately 90% of the filter pack).

5) Backfill the borehole and annular space from the bottom of the hole to approximately 2-3 feet above the well screen with a sand filter pack of appropriate size to retain most of the formation material. Install a 2-3 foot thick bentonite seal above the filter pack. Backfill the remainder of the annular space with a bentonite-cement grout installed with a tremie pipe.

6) Install a steel security casing with a locking steel cap at the top of each well. Security casings may be flush-mount, if warranted.

7) Construct a cement pad around the security casing contoured to slope away from the casing thereby directing surface runoff away from the well. Drill a drainage port through the base of the outer casing to prevent water containment in the annulus and reduce the risk of ice-expansion damage to the riser pipe and cement grout.

8) Following well installation and a sufficient time for the grout to cure, develop the well using the pump and surge method. Wells may be developed by bailing if recovery is poor. Monitor the effectiveness of the development by measuring pumping rates, water color, pH, and

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conductivity. Continue development until the water generated is visibly free of fines, as determined by the site geologist. Development water will be discharged to the ground surface in the immediate vicinity of the well.

9) Fill out the monitoring well construction sheet (See Figure 2-3).

3.3 GROUNDWATER SAMPLING AND WATER LEVEL MONITORING

Groundwater sampling will occur at HPIA, and Sites 6 and 69.

The objective of the groundwater sampling program at HPIA is to obtain water quality data for shallow and deep groundwater in order to facilitate remediation design for shallow groundwater and fill data gaps needed to conduct a risk assessment and feasibility study for deep groundwater. The objective of the groundwater sampling program at Sites 6, and 69 is to obtain current information on groundwater quality at these sites.

Thirty existing shallow wells, 8 newly installed intermediate and deep wells, 6 existing intermediate and deep wells, and 9 water supply wells at HPIA will be sampled during the field investigation. Figure 3-3 shows the locations of the existing wells to be sampled. The existing monitoring wells to be sampled include HPGW1 through HPGW26, HPGW29, 22GW1, 22GW2, and 21GW1. The water supply wells to be sampled include 601, 603, 642, 602, 608, 630, 634, 637, and 652.

Eight existing shallow monitoring wells (6GW1 through 6GW8) and 2 water supply wells (651 and 653) at Site 6, and eight existing shallow monitoring wells (69GW1 through 69GW8) at Site 69 will be sampled during the investigation. Figures 1-3 and 1-5 show the locations of the wells to be sampled at Sites 6 and 69, respectively.

A minimum stabilization period of 72 hours will be required prior to sampling the new wells. Three to five well volumes will be purged by pumping or bailing prior to sampling. Water quality parameters such as temperature, pH, and specific conductivity will be measured at the start of purging operations and after each purged well volume. Stabilization of these parameters from successive purged volumes indicates that the groundwater within the well is at equilibrium. Purge water will be discharged to the ground surface in the immediate vicinity of the well.

The wells will be sampled within three hours after water levels have recovered from purging. If a well is evacuated to dryness prior to the evacuation of 3 to 5 well volumes because of poor recovery, the well may be sampled as soon as a sufficient volume of water has entered the well. Groundwater samples will be obtained with dedicated PVC bailers in

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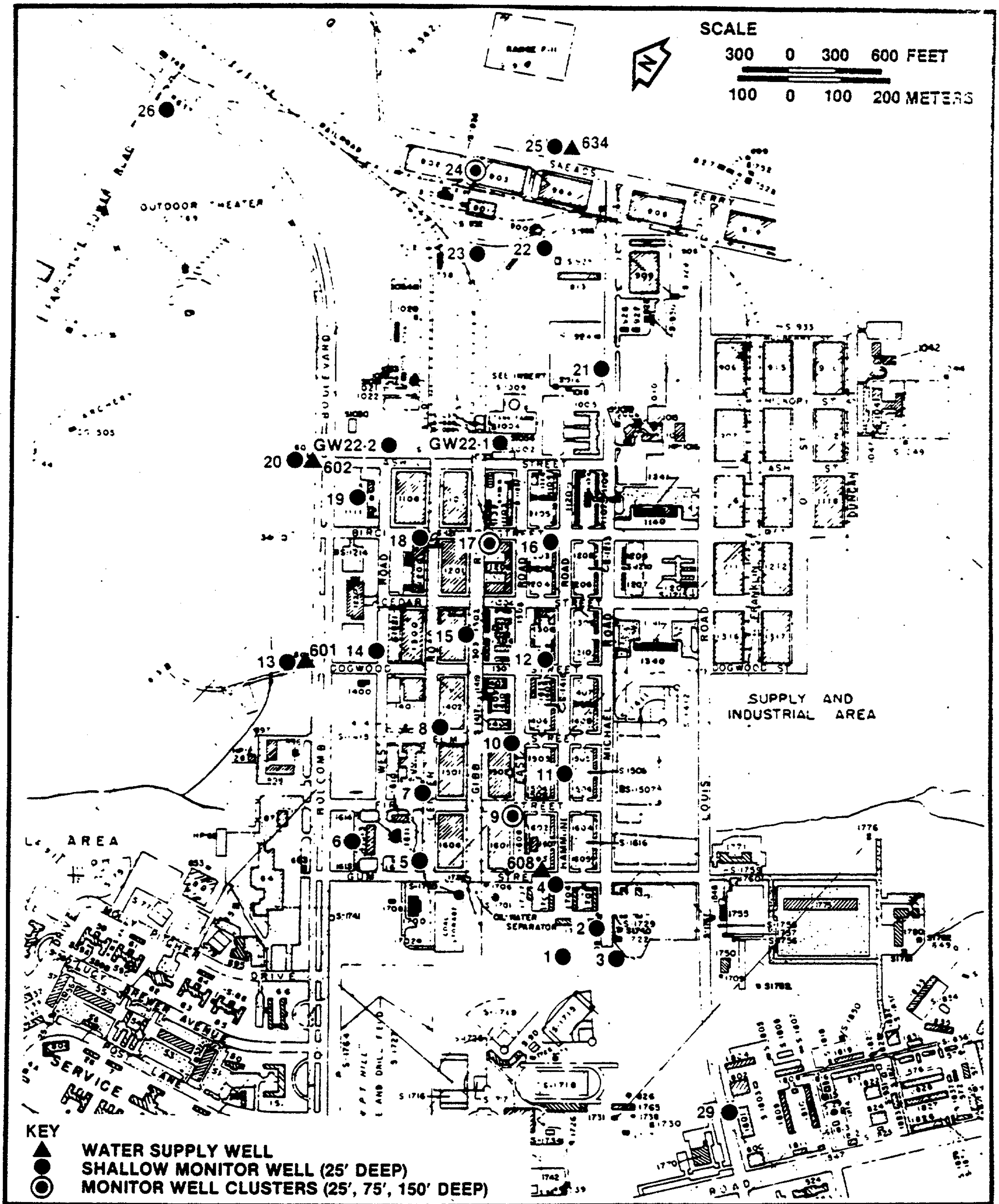

KEY

▲ WATER SUPPLY WELL

● SHALLOW MONITOR WELL (25′ DEEP)

◉ MONITOR WELL CLUSTERS (25′, 75′, 150′ DEEP)

Figure 3-3
MONITORING WELLS AND WATER SUPPLY WELLS AT HADNOT POINT INDUSTRIAL AREA
SOURCE: ESE, 1987.

MARINE CORPS BASE CAMP LEJEUNE

monitoring wells and through the permanent pumps in water supply wells. The bailer can be suspended from Teflon-coated stainless steel wire or a polypropylene monofilament line with a stainless steel leader. The leader must be of sufficient length to ensure that the rope will not come in contact with the groundwater being sampled.

All groundwater samples will be analyzed for full Target Compound List (TCL) parameters. Groundwater samples collected at HPIA will also be analyzed for methyl ethyl ketone (MEK) and methyl isobutyl ketone (MIBK).

A detailed monitoring well groundwater sampling procedure is presented in Section 3.3.1.

A minimum of two rounds of water level measurements will be taken at HPIA during the field investigation to determine horizontal and vertical groundwater flow gradients at this site. Water levels will be measured to the nearest 0.01 feet with an electronic water level indicator and/or a steel tape and chalk. Water level measurements will be recorded in the field logbook.

3.3.1 GROUNDWATER SAMPLING PROCEDURE

The following procedure will be used to obtain groundwater samples from monitoring and water supply wells.

1) Wear appropriate health and safety equipment as outlined in the Health and Safety Plan.

2) Visually examine the exterior of the well for signs of damage or tampering and record this information in the field logbook.

3) Unlock the security casing and remove the well cap.

4) Measure and record the ambient air and well head organic vapor concentrations using an HNu or OVM.

5) Measure and record the static water level in the well to the nearest 0.01 foot.

6) Calculate the volume of water in the well as follows:

   Volume (gals.) = $0.163 \times Tr^2$, where

   T = well depth (ft) - static water level (ft)
   r = well radius (inches)

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7) Purge 3 to 5 well volumes* of water from the well using one of the following pieces of decontaminated equipment:

   a) Dedicated PVC bailer;
   b) Submersible pump, and/or
   c) Suction pump (hose must be polyethylene and dedicated to an individual well).

   * If the well is slow to recover, evacuate the well to dryness.

8) Measure and record temperature, pH, and specific conductivity of each volume of well water purged.

9) After purging, remove purging equipment from the well, if not a permanent submersible pump, and allow static water level to recover to approximate original level.

10) Collect a sample from the well using a dedicated PVC bailer if a monitoring well, or the permanent pump if a water supply well. Measure and record temperature, pH, and specific conductance of sample. If possible, the time between purging and sampling should not exceed 3 hours.

11) Fill Volatile Organic Compound (VOC) sample bottles first, then fill all other required sample containers. Fill sample containers directly from the bailer.

12) Preserve all samples as required (See Table 2-3). If acidification of an aqueous sample for VOCs causes effervescence, preserve the remaining vials by cooling to 4° Celsius only. Note the occurrence of effervescence and the lack of preservation on the chain-of-custody form.

13) Replace well cap and lock outer steel casing.

14) Package samples according to QAP procedures (See Section 2.5). Cool analytical samples to 4° Celsius. Fill out sampling record forms, labels, chain-of-custody forms, and custody seals. Ship samples to the laboratory within 24 hours.

3.4 SHALLOW SOIL SAMPLING

The objective of the shallow soil sampling program is to evaluate the extent of shallow (above the water table) soil contamination at HPIA.

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Thirty soil borings are planned at HPIA, adjacent to Buildings 1602, 902, and 1202. Figure 3-1 presents the building locations. Figures 3-4 through 3-6 indicate approximate soil boring locations within each area.

Soil borings will extend to the water table, approximately 6-22 feet. Samples will be collected continuously. Hollow stem augers (6-1/4" inner diameter) with 3" O.D. carbon steel split-spoon samplers will be used to obtain the soil samples.

Three soil samples per boring will be sent to a laboratory for chemical analysis. Samples for analysis will be chosen based on field screening for VOCs using an HNu or OVM. Samples with the highest HNu/OVM readings will be sent to the laboratory for analysis.

Ten percent of all analytical samples (approximately 9) collected will be analyzed for full TCL parameters. The remaining 90% (approximately 81) will be analyzed for volatile organic compounds (VOCs) including xylene, MEK, MIBK, and Toxicity Characteristic Leaching Procedure (TCLP) (metals only). The split-spoons will be advanced in accordance with the Standard Penetration Test (ASTM D1586-74).

Upon completion of each boring, the soil cuttings will be returned to the borehole and the borehole will be grouted to ground surface with a cement-bentonite mixture.

Section 3.4.1 presents the detailed soil sampling procedure to be used during the field investigation.

3.4.1 SPLIT-SPOON SAMPLING PROCEDURE FOR SOIL BORINGS AND MONITORING WELLS

The following procedure will be used to obtain soil samples during the field investigation.

1) Wear appropriate health and safety equipment as outlined in the Health and Safety Plan.

2) Drill borehole to the desired sampling depth.

3) Drive a 3-inch O.D. carbon steel split-spoon sampler into the undisturbed soil to be sampled (2-inch O.D. spoons may be used for monitoring well borings). Drive the split-spoon with blows from a 300-lb hammer (140-lb hammer if 2-inch spoon) falling 30 inches until approximately 2 feet have been penetrated or 100 blows within a six-inch interval have been applied (Standard Penetration Test ASTM D 1586-74).

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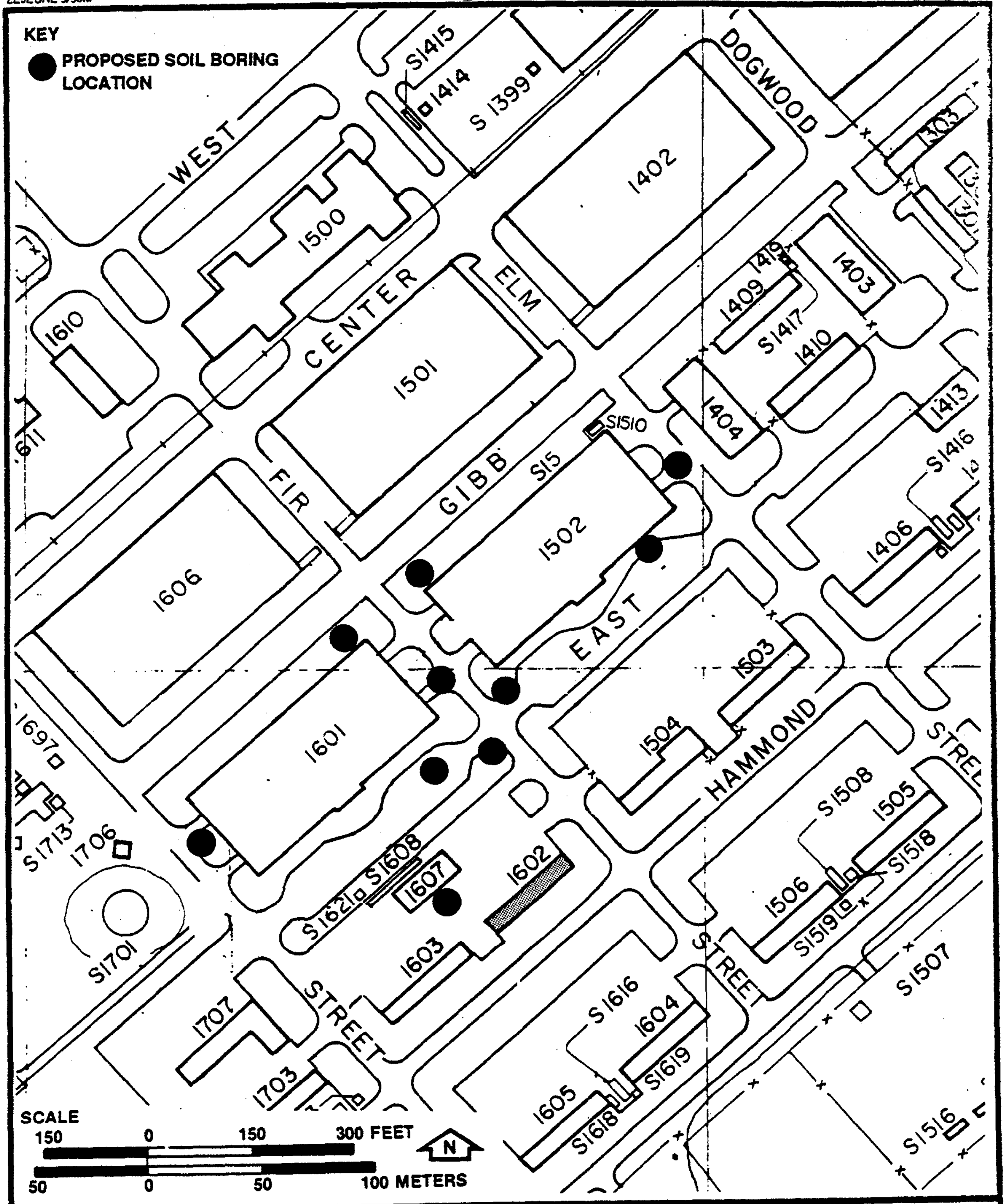

Figure 3-4
APPROXIMATE SOIL BORING LOCATIONS – BUILDING 1602

SOURCE: ESE, 1990.

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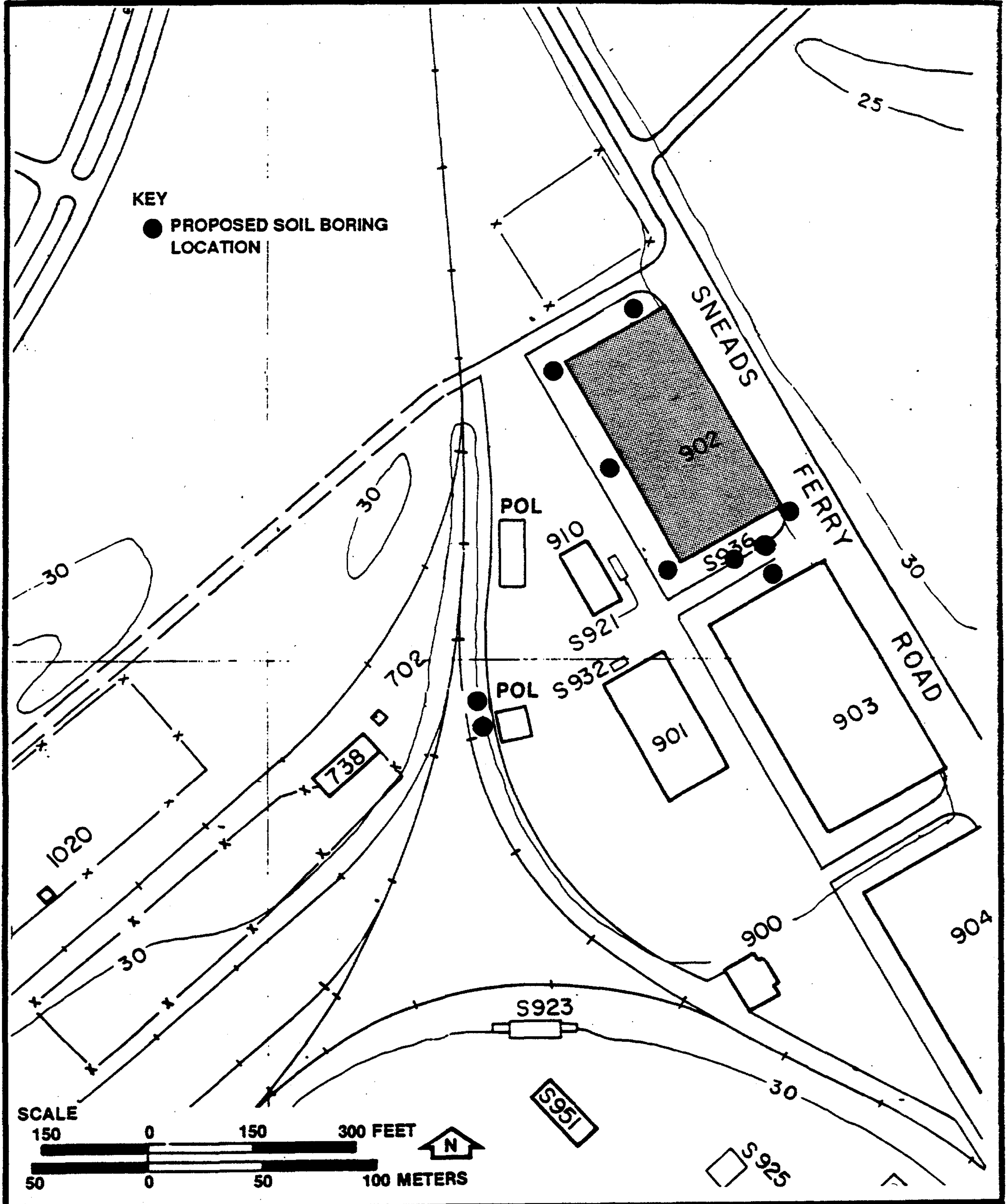

Figure 3-5
APPROXIMATE SOIL BORING LOCATIONS –
BUILDING 902

SOURCE: ESE, 1990.

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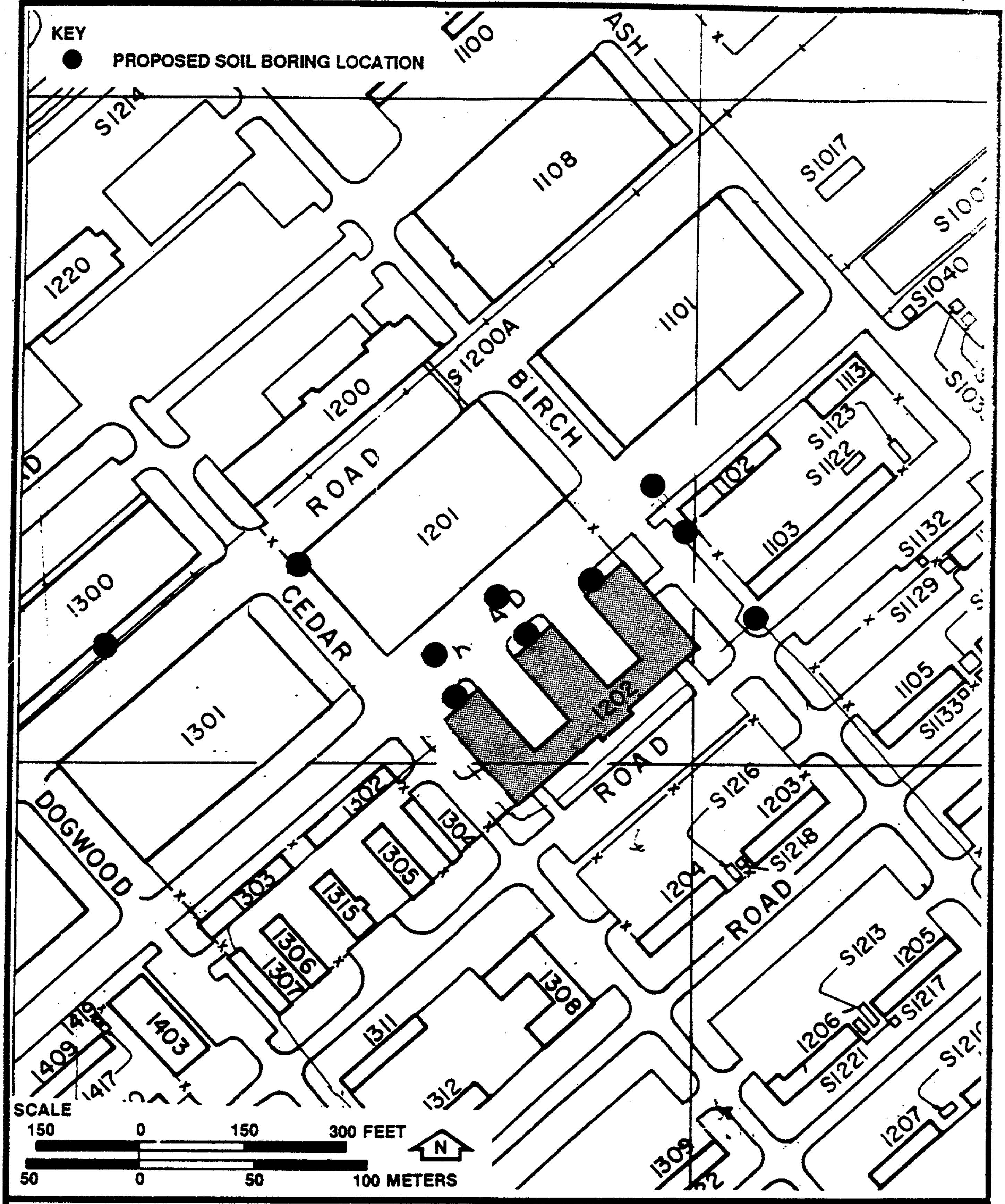

Figure 3-6
APPROXIMATE SOIL BORING LOCATIONS—BUILDING 1202

SOURCE: ESE, 1990.

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CAMP LEJEUNE**

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4) Record the number of blows required for each six inches of penetration or fraction thereof.

5) Bring the sampler to the surface and remove both ends and one half of the split-spoon so that the recovered soil rests in the remaining half of the barrel. Place the split-spoon on clean plastic sheeting. Collect VOC samples as discrete grab samples with a decontaminated spatula or spoon immediately after the split-spoon is opened. Screen the entire length of the core for volatile organics using an HNu or OVM. Record the readings, a geologic description of the soils including color, moisture, grain size (modified Unified Soil Classification System based on visual observance), etc. and approximate recovery of the soil sample in the field logbook.

6) Homogenize the recovered soil in a decontaminated stainless steel bowl or pan using a decontaminated stainless steel spoon or spatula. Fill appropriate sample jars using a stainless steel spoon or spatula.

7) Compare HNu and/or OVM readings from all samples collected from the boring and choose the three samples with the highest readings per boring for chemical analysis. Fill out labels, chain-of-custody forms, and custody seals for the analytical samples. Cool analytical samples on ice to 4° Celsius and package samples according to the QAP procedures. Ship the samples to the laboratory within 24 hours.

8) Discard soil samples not chosen for chemical analysis by returning soil from sample jars to the borehole and rinsing sample jars.

3.5 SURFACE WATER AND SEDIMENT SAMPLING

Surface water and sediment samples will each be collected at a number of sampling locations identified at Sites 6, 48, and 69.

At Site 6, surface water and sediment samples will be collected at upstream and downstream locations in Wallace Creek (Figure 1-3). At Site 48, 10 surface water/sediment samples will be collected in the marsh area north of Building 804 (Photo Lab) and one surface water/sediment sample will be collected at a background location (Figure 3-7). At site 69, a total of 7 surface water/sediment samples will be collected. One surface water and one sediment sample will be collected

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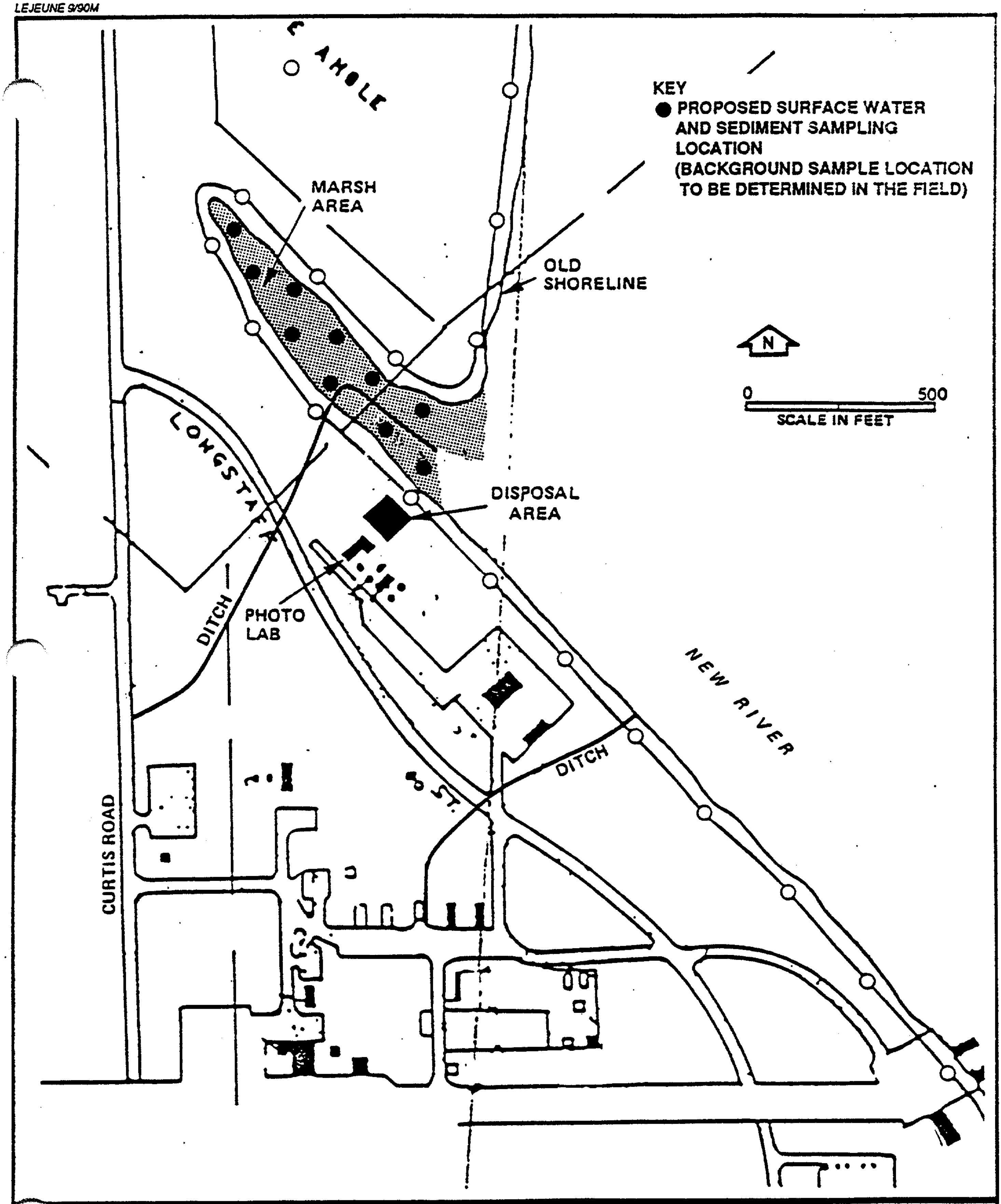

gure 3-7
APPROXIMATE SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS - SITE 48

SOURCES: WATER AND AIR RESEARCH, INC., 1983; ESE, 1990.

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CAMP LEJEUNE

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at each of the Round Two Report locations 69SW1, 69SW2, and 69SW3. Two surface water and two sediment samples will be collected at each location identified as 69SW4/69SE4 and 69SW5/69SE5 (Figure 1-5).

Surface water and sediment samples collected from Sites 6 and 69 will be analyzed for full TCL parameters. Surface water and sediment samples collected from Site 48 will be analyzed for TCL metals only.

Surface water samples will be collected directly into the sample jars. Sediment samples will be collected from the 0-6" depth interval with a decontaminated stainless steel scoop. VOC samples will be taken as discrete grab samples. The remainder of the sediment sample will be homogenized prior to filling sample jars for the other fractions.

3.6 FISH (OR SHELLFISH) TISSUE SAMPLING

Fish (or shellfish) tissue samples will be collected at Sites 48 and 69. An attempt will be made to collect bottom dwelling/feeding fish only.

At Site 48, tissue samples will be collected at each of the eleven surface water/sediment sample locations identified in Section 3.5 and Figure 3-7. At Site 69, tissue samples will be collected from 4 locations, two near 69SW4/69SE4 and two near 69SW5/69SE5 (Figure 1-5). If surface water bodies at these locations do not support substantial fish/shellfish populations, tissue samples will be collected from the nearest surface water body downstream of the particular site.

Fish samples will be collected with nets and/or fishing lines. A maximum of three hours per sampling location will be allotted for this effort. If a sample is not obtained within three hours, the sampling effort at that particular location will be aborted.

Fish samples will be filleted on site. Fish fillets will be placed in glass jars or plastic (metals fraction) and foil (other fractions). The samples will be packed in dry ice and forwarded to the laboratory.

The tissue samples from Site 48 will be analyzed for TCL metals only. The tissue samples from Site 69 will undergo full TCL analysis.

3.7 SURVEYING OF HPIA WELLS

Upon completion of the field operations*, HPIA monitoring and water supply well locations and elevations will be surveyed by a licensed surveyor and plotted on an existing topographic base map. Monitoring well elevations will include elevations for the ground surface as well as outer and inner casings.

Elevations and locations of existing monitoring wells will be required to process water level data for groundwater flow gradient determination.

* If USGS data fails to effectively determine the deep groundwater flow gradient at HPIA, existing well locations will be surveyed prior to initiation of monitoring well installation.

3.8 DECONTAMINATION

All equipment involved in field sampling will be decontaminated as required by the Quality Assurance Project Plan and the Health and Safety Plan.

Heavy equipment (e.g. drilling rigs, augers, and rods) will be steamcleaned prior to entering the site. Once onsite, heavy equipment will be steamcleaned prior to sampling, in between sampling locations, and prior to leaving the site. Gross contamination will be removed from drilling equipment with a brush when necessary. Well casings, screens, and riser pipes will be steamcleaned prior to installation. Steamcleaning will be conducted at a designated decontamination area.

Down-hole sampling equipment such as split-spoons and bailers, and equipment used to fill sample jars such as bowls, spatulas, scoops, and spoons, will be decontaminated according to the following procedure:

1) Phosphate-free soap(1) and potable water wash;
2) Potable water rinse;
3) 10% nitric acid(2) rinse if sampling for metals (use 1% for equipment other than stainless steel);
4) Deionized water rinse
5) Solvent(3) rinse (2 times);
6) Air dry;

(1) Liquinox or alconox
(2) Reagent-grade acid and deionized water
(3) Pesticide-grade only (e.g. isopropanol, acetone, methanol)

Extraneous contamination will be minimized by wrapping sampling equipment in aluminum foil when not in use, and changing the sampler's gloves prior to collection of each individual sample.

Probes on temperature, specific conductivity, and pH meters will be rinsed with deionized water in between samples.

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QUALITY ASSURANCE PROJECT PLAN

FINAL

FOR REMEDIAL INVESTIGATION/FEASIBILITY STUDY
AT
HADNOT POINT INDUSTRIAL AREA

AND

LIMITED SCOPE INVESTIGATIONS
AT
SITES 6, 48, AND 69

MARINE CORPS BASE CAMP LEJEUNE
NORTH CAROLINA

Prepared For:

NAVAL FACILITIES ENGINEERING COMMAND
ATLANTIC DIVISION

Prepared By:

ENVIRONMENTAL SCIENCE & ENGINEERING, INC.
RUTHERFORD, NEW JERSEY

ESE PROJECT NO. 49-02036

SEPTEMBER 1990

Doc No: CLEJ-00351-3.03-09/01/9

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LIST OF ACRONYMS

AAS	atomic absorption spectrophotometry
AIHA	American Industrial Hygiene Association
ASTM	American Society for Testing and Materials
BFB	bromofluorobenzene
BOD	biochemical oxygen demand
°C	degrees Celsius
CCC	calibration check compounds
CCV	continuing calibration verification
CLASS	Chemical Laboratory Analysis and Scheduling System
CLP	EPA Contract Laboratory Program
COD	chemical oxygen demand
D	detection limit
DBCP	1,2-dibromo-3-chloropropane
DFTPP	decafluorotriphenylphosphine
DHRS	Florida Department of Health and Rehabilitative Services
DI	deionized
DO	dissolved oxygen
DOT	U.S. Department of Transportation
DQOL	Data Quality Objective Level
ECD	electron capture detector
EDB	1,2-dibromoethane
ELAP	Environmental Laboratory Approval Program
EPA	U.S. Environmental Protection Agency
ESE	Environmental Science & Engineering, Inc.
eV	electronvolt
FID	flame ionization detector
FR	fraction code
FRN	frame reference number
FS	feasibility study

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LIST OF ACRONYMS
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ft	feet
g	gram
gal	gallon
GC/FID	GC employing flame ionization detection
GC	gas chromatography
GC/HPLC	gas chromatography/high performance liquid chromatography
GC/MS	gas chromatography/mass spectrophotometry
GC/MS/DS	gas chromatography/mass spectrophotometry/data system
HCl	hydrochloric acid
HNO_3	nitric acid
HPIA	Hadnot Point Industrial Area
HPLC	high performance liquid chromatography
H_2SO_4	sulfuric acid
HRS	Department of Health and Rehabilitative Services
ICAP	inductively coupled argon plasma
ICS	interference check solution
ICV	initial calibration verification
ID	identification
IR	infrared
KCl	potassium chloride
kg	kilogram
KOH	potassium hydroxide
L	liter
lb	pound
MBAS	Methylene Blue Active Substances
MCB	Marine Corps Base
MDL	method detection limits
MEK	methyl ethyl ketone
mg/kg	milligrams per kilogram

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LIST OF ACRONYMS
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MIBK	methyl isobutyl ketone
mL	milliliter
mm	millimeter
mm^2	square millimeters
MSC	matrix spike compound
NaOH	sodium hydroxide
$Na_2S_2O_3$	sodium thiosulfate
ng	nanogram
NIOSH	National Institute of Occupational Safety and Health
NIST	National Institute of Standards and Technology
NVLAP	National Voluntary Laboratory Accreditation Program
OD	outside diameter
PAT	Proficiency Analytical Testing Program
PCBs	polychlorinated biphenyls
PCP	pentachlorophenol
% RSD	percent relative standard deviation
PFS	prefield setup
PID	photoionization device
PNA	polynuclear aromatic hydrocarbon
ppb	parts per billion
psi	pounds per square inch
PVC	polyvinyl chloride
QA	quality assurance
QAPP	quality assurance project plan
QA/QC	quality assurance/quality control
QC	quality control
QCC	quality control check sample

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LIST OF ACRONYMS
(Continued, Page 4 of 4)

R	recovery
RCRA	Resource Conservation and Recovery Act
RF	response factor
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
RPD	relative percent difference
S	surrogate
SOPs	standard operating procedures
SOW	statement of work
STORET	storage and retrieval
TCLP	toxicity characteristics leaching procedure
TIC	tentatively identified compounds
TOC	total organic carbon
TOE	total organic extractables
TOX	total organic halide
TRPH	total recoverable petroleum hydrocarbons
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
μg/L	microgram per liter
UV	ultraviolet
VOC	volatile organic compound
YSI	Yellow Springs Instruments

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1.0 INTRODUCTION AND PROJECT DESCRIPTION

1.1 INTRODUCTION

This Quality Assurance Project Plan (QAPP) was prepared to support the project Work Plan for the remedial investigation/feasibility study (RI/FS) at the Hadnot Point Industrial Area (HPIA) and limited scope investigations at Sites 6, 48, and 69, located within the Marine Corps Base (MCB) Camp Lejeune.

The QAPP describes the organization activities and specific quality assurance/quality control (QA/QC) protocols for the work to be performed. All environmental monitoring and laboratory analyses conducted for this project must be performed in accordance with this QAPP.

1.2 SITE LOCATIONS AND DESCRIPTIONS

The four sites to be investigated are located within MCB Camp Lejeune, which is a training base for the Marine Corps, located in Onslow County, North Carolina (Figure 1-1). The facility, which covers approximately 170 square miles, is bounded to the southeast by the Atlantic Ocean, to the west by U.S. 17, and to the northeast by State Road 24. The base is bisected by the New River Estuary, which occupies approximately 30 square miles of the total area of the facility.

As a result of Marine operations and activities, substantial quantities of wastes that contain hazardous and toxic organic compounds have been generated at the base. This has resulted in the storage, disposal, and/or spillage of these wastes around the base. Several of the base's water supply wells have been shut down as a result of the presence of organic compounds, thus suggesting that some of the wastes may have entered the groundwater.

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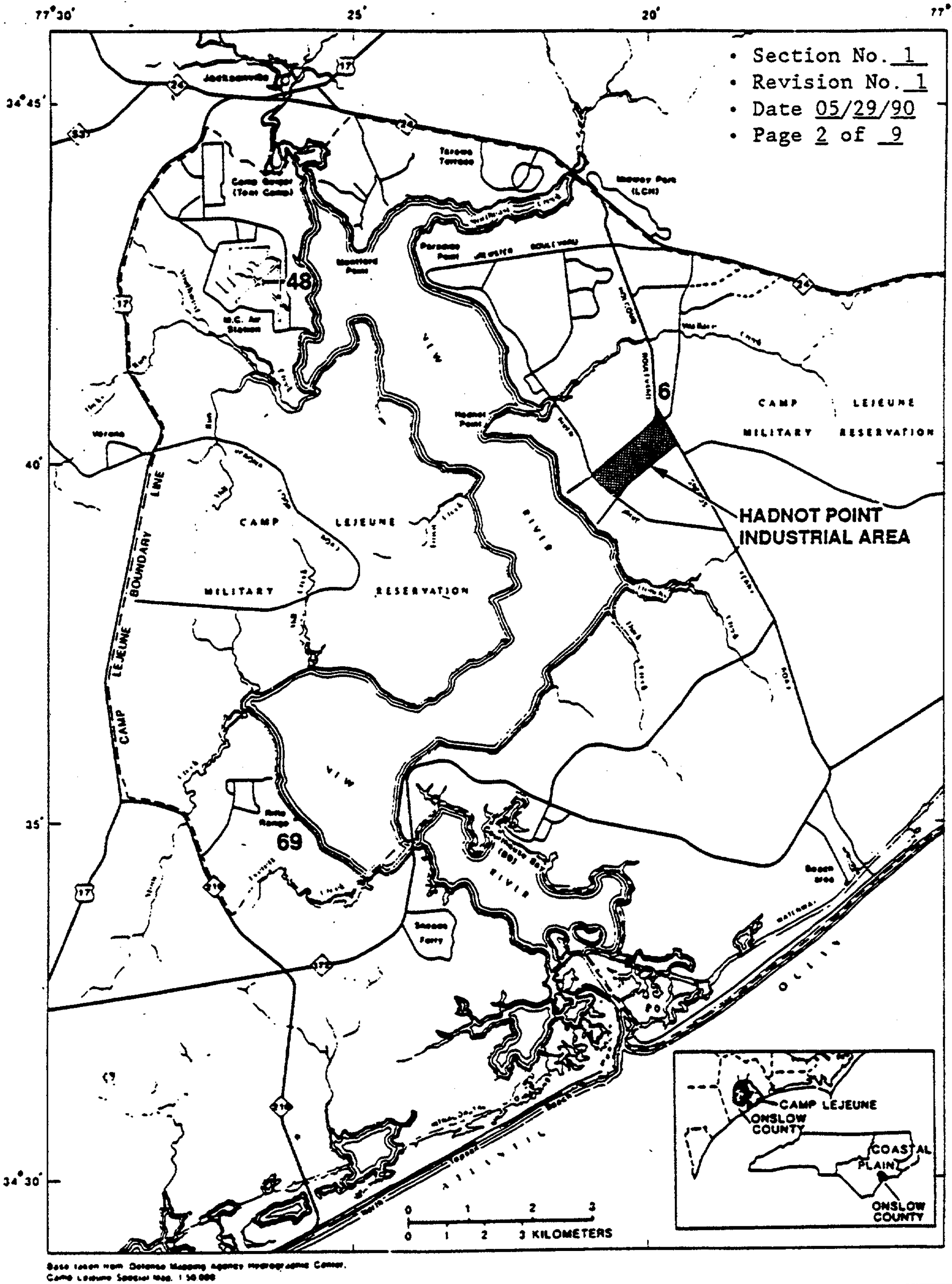

Base taken from Defense Mapping Agency Hydrographic Center, Camp Lejeune Special Map, 1:50,000

Figure 1-1
SITE LOCATIONS

SOURCE: HARNED *et al.*, 1989.

MARINE CORPS BASE CAMP LEJEUNE

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The four sites to be investigated are described in the following paragraphs.

1.2.1 HADNOT POINT INDUSTRIAL AREA

HPIA of MCB Camp Lejeune is located on the east side of the New River. For the purposes of this investigation, HPIA is defined as that area bounded by Holcomb Boulevard to the west, Sneads Ferry Road to the north, Louis Street to the east, and the Main Service Road to the south (Figures 1-1 and 1-2).

HPIA is comprised of approximately 75 buildings/facilities, including maintenance shops, gas stations, administrative offices, commissaries, snack bars, warehouses, storage yards, and a dry-cleaning facility. A steam plant and training facility occupy the southwest portion of HPIA. In addition, numerous underground storage tanks, stormwater drains, and oil/water separators are present.

A transformer storage yard (Site 21) and a fuel tank farm (Site 22) are located within the northern portion of HPIA. These two areas of concern are not included in the proposed RI/FS scope of work. Sites 21 and 22 will be considered in separate studies at a later date.

1.2.2 SITE 6--LOTS 201 AND 203

Site 6, located just north of HPIA, is comprised of Lots 201 and 203. Lots 201 and 203 are situated on Holcomb Boulevard between Wallace and Bearhead Creeks (Figures 1-1 and 1-3). Lots 201 and 203 are approximately 25 and 46 acres in size, respectively. These lots, used to store hazardous materials, have relatively flat and unpaved surfaces. Surface soils have reportedly been moved about as a result of equipment movement and regrading (ESE, 1990).

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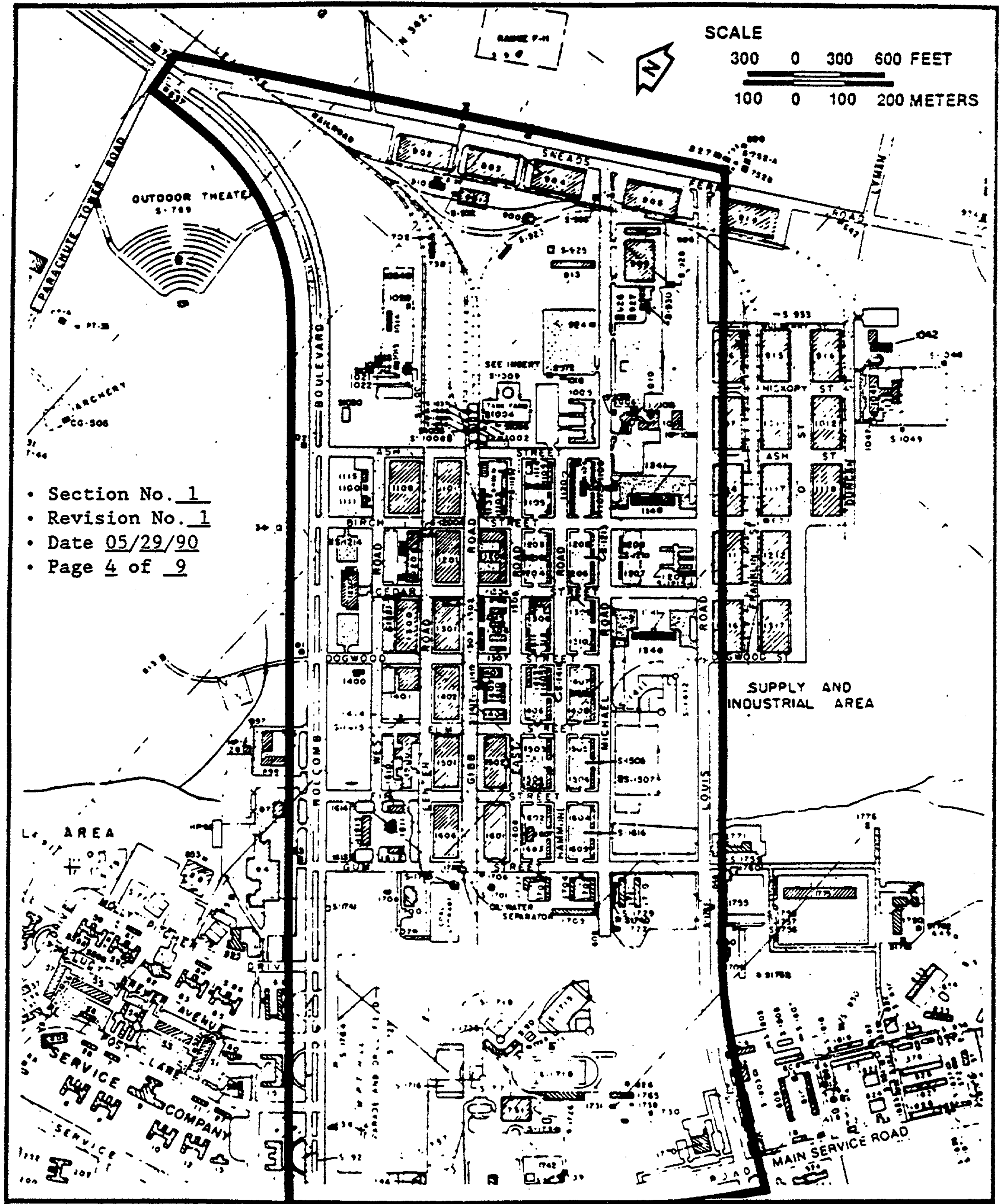

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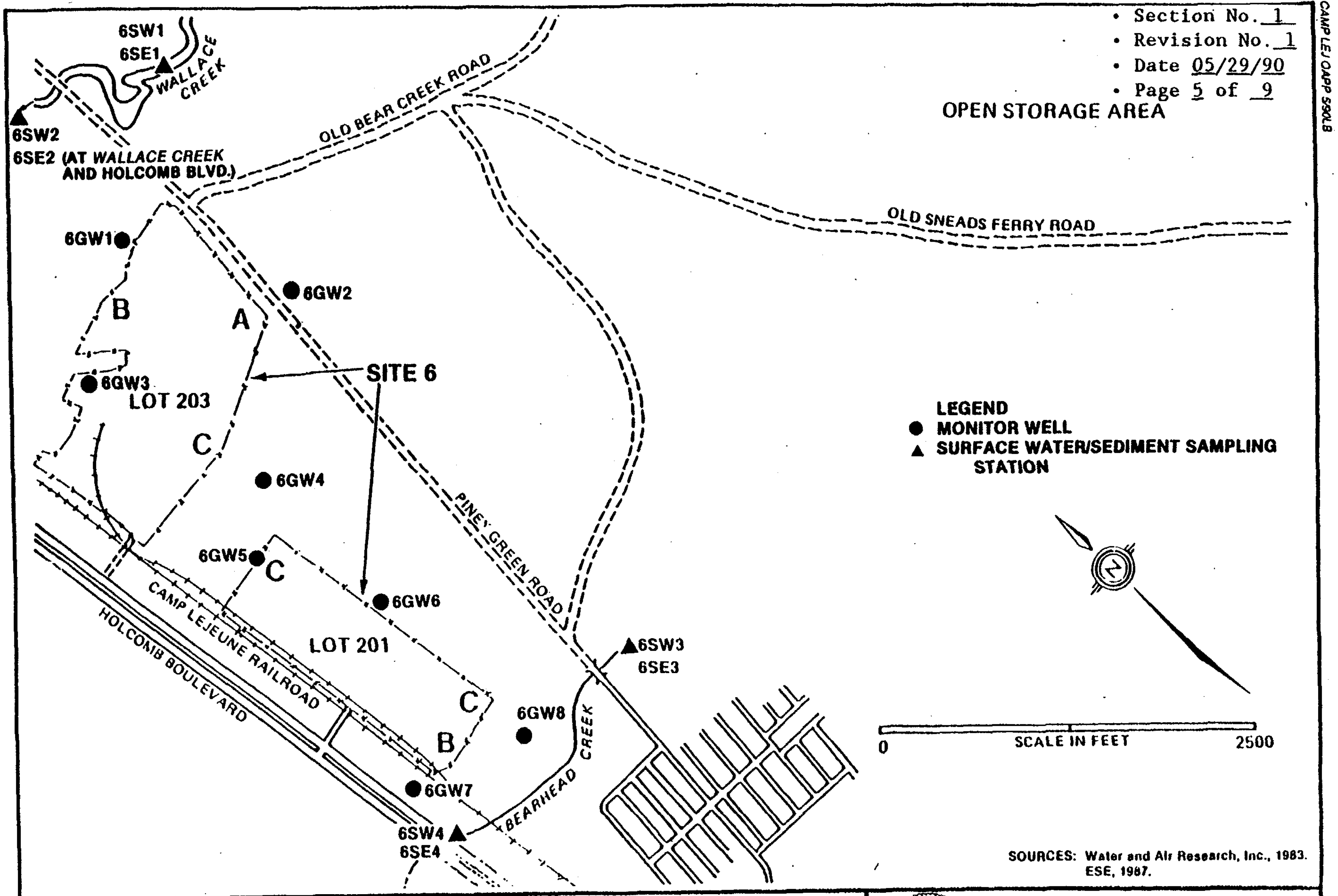
Figure 1-2
HADNOT POINT INDUSTRIAL AREA

SOURCE: CAMP LEJEUNE, 1987.

MARINE CORPS BASE
CAMP LEJEUNE



SOURCES: Water and Air Research, Inc., 1983.
ESE, 1987.

Figure 1-3
SITE 6
STORAGE LOTS 201 AND 203

MARINE CORPS BASE
CAMP LEJEUNE

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1.2.3 SITE 48--MCAS MERCURY DUMP

Site 48 is located on the west side of the New River Estuary, on Longstaff Road next to Building 804 (photography laboratory) (Figures 1-1 and 1-4). Metallic mercury was periodically drained from the delay lines of radar units and disposed of at Site 48. The actual disposal area is approximately 20,000 square feet and covers a 100- to 200-foot-(ft)-wide corridor which extends from the rear of Building 804 to the banks of the New River.

1.2.4 SITE 69--RIFLE RANGE CHEMICAL DUMP

Site 69, the Rifle Range Chemical Dump, is also west of the New River Estuary, approximately 9,000 ft east of the intersection of Range and Sneads Ferry Roads, north of Everett Creek (Figures 1-1 and 1-5). The site is an estimated 6 acres in size, containing approximately 93,000 cubic yards of material.

1.3 DESCRIPTION OF SAMPLING PROGRAM

The principal objectives of the HPIA field sampling program are as follows:

1. To collect additional data to facilitate the design of the selected remedial action for shallow groundwater;
2. To collect data necessary to conduct a risk assessment and feasibility study (FS) for deep groundwater; and
3. To collect data necessary to conduct a risk assessment and FS for shallow soil contamination adjacent to Buildings 1602, 902, and 1202.

The principal objective of the field sampling programs at Sites 6, 48, and 69 is to collect additional data to move forward with the remedial investigation (RI) process at these sites.

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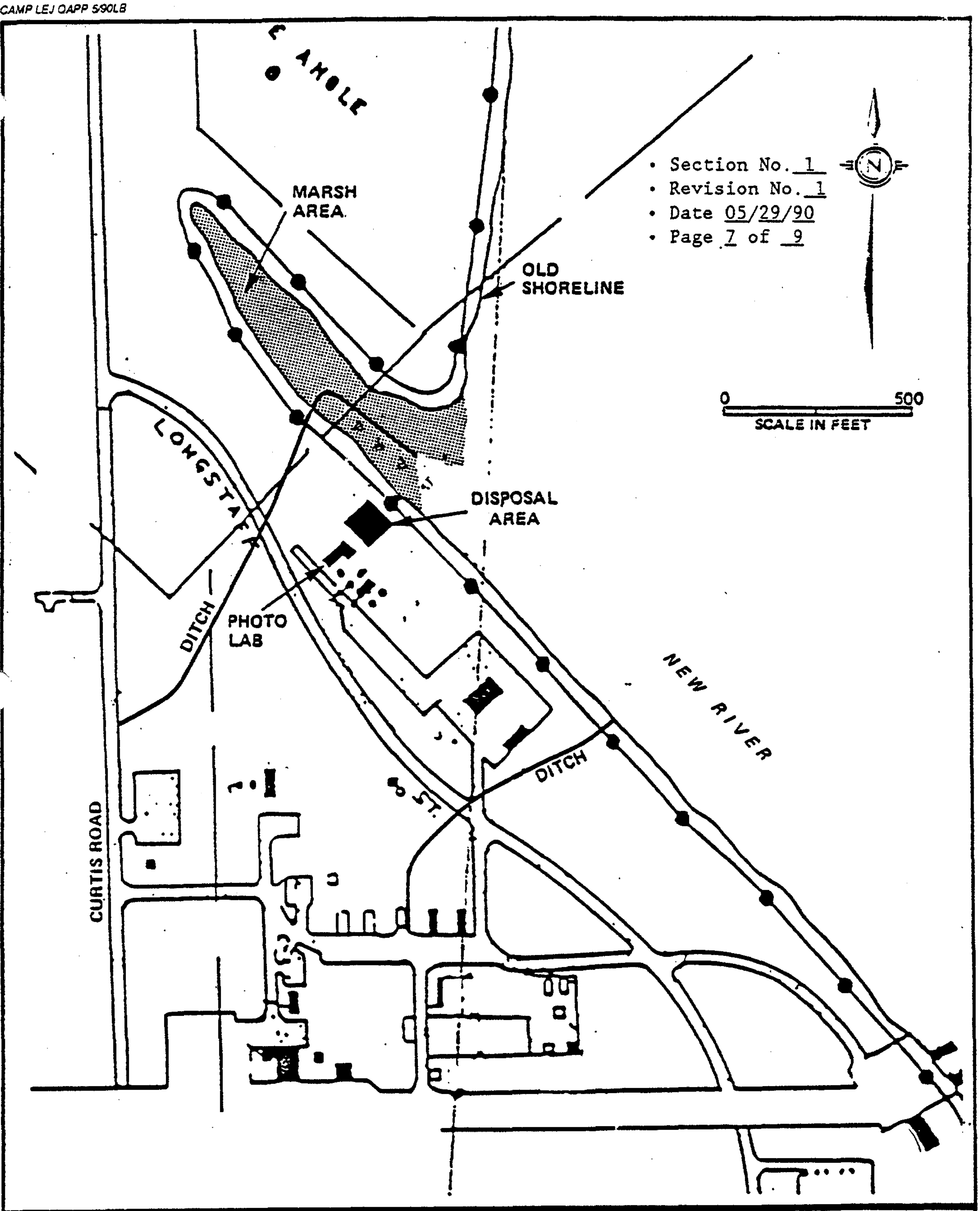

Figure 1-4
SITE 48
MCAS MERCURY DUMP

SOURCES: WATER AND AIR RESEARCH, INC., 1983; ESE, 1984.

MARINE CORPS BASE
CAMP LEJEUNE

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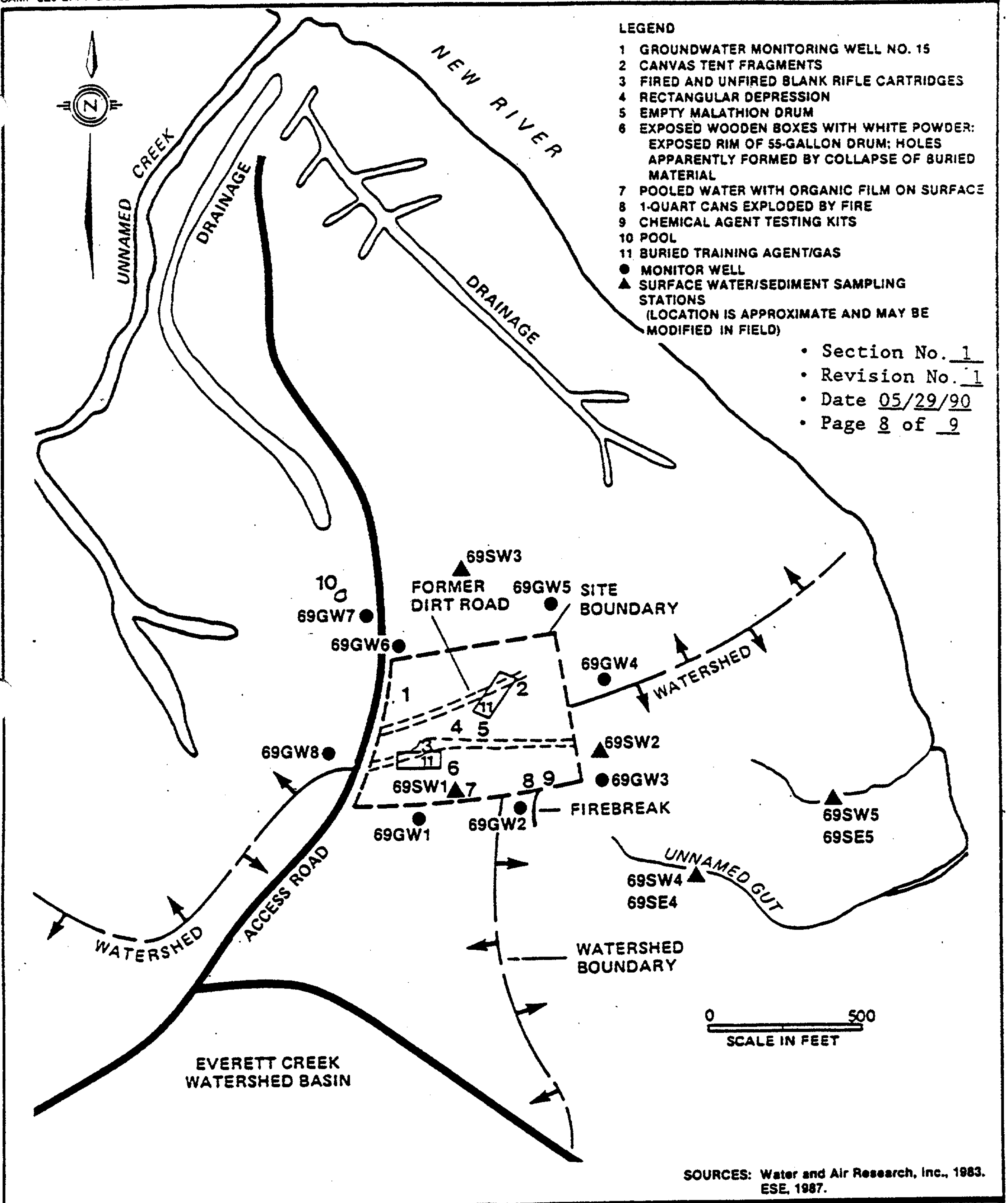

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SOURCES: Water and Air Research, Inc., 1983.
ESE, 1987.

Figure 1-5
SITE 69
RIFLE RANGE CHEMICAL DUMP

MARINE CORPS BASE
CAMP LEJEUNE

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The field sampling programs consist of groundwater, surface water, sediment, shallow soils, and fish tissue sampling. General site operations and field methods are presented in the following sections.

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2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

An organization chart showing discipline leaders for this project is presented in Figure 2-1.

The ESE Project Director is responsible for the appointment of the Project Manager, supervision of the manager in performance of project duties, and the provision of corporate support as needed. The ESE Project Manager is responsible for effective day-to-day management of the project staff as well as direct communication and liaison with the client. The Project Manager's responsibility to QA is to assure that all project quality control (QC) procedures are followed in the performance of the project and to provide additional authority when required to support the Project QA Supervisor.

The Chemistry Division Director is responsible for the overall management of the analytical laboratory, including the appointment and supervision of analytical section leaders, the project operations manager, the laboratory data manager, and the Laboratory QA/QC Supervisor within the division. He is responsible for approving all analytical procedures and associated QC procedures.

The Analytical Section Leaders are responsible for the overall management of their respective analytical sections (inorganic and organic), including the appointment and supervision of their department managers.

The Project Operations Manager is responsible for the overall management of the project operations within chemistry, including the appointment and supervision of the Laboratory Coordinators.

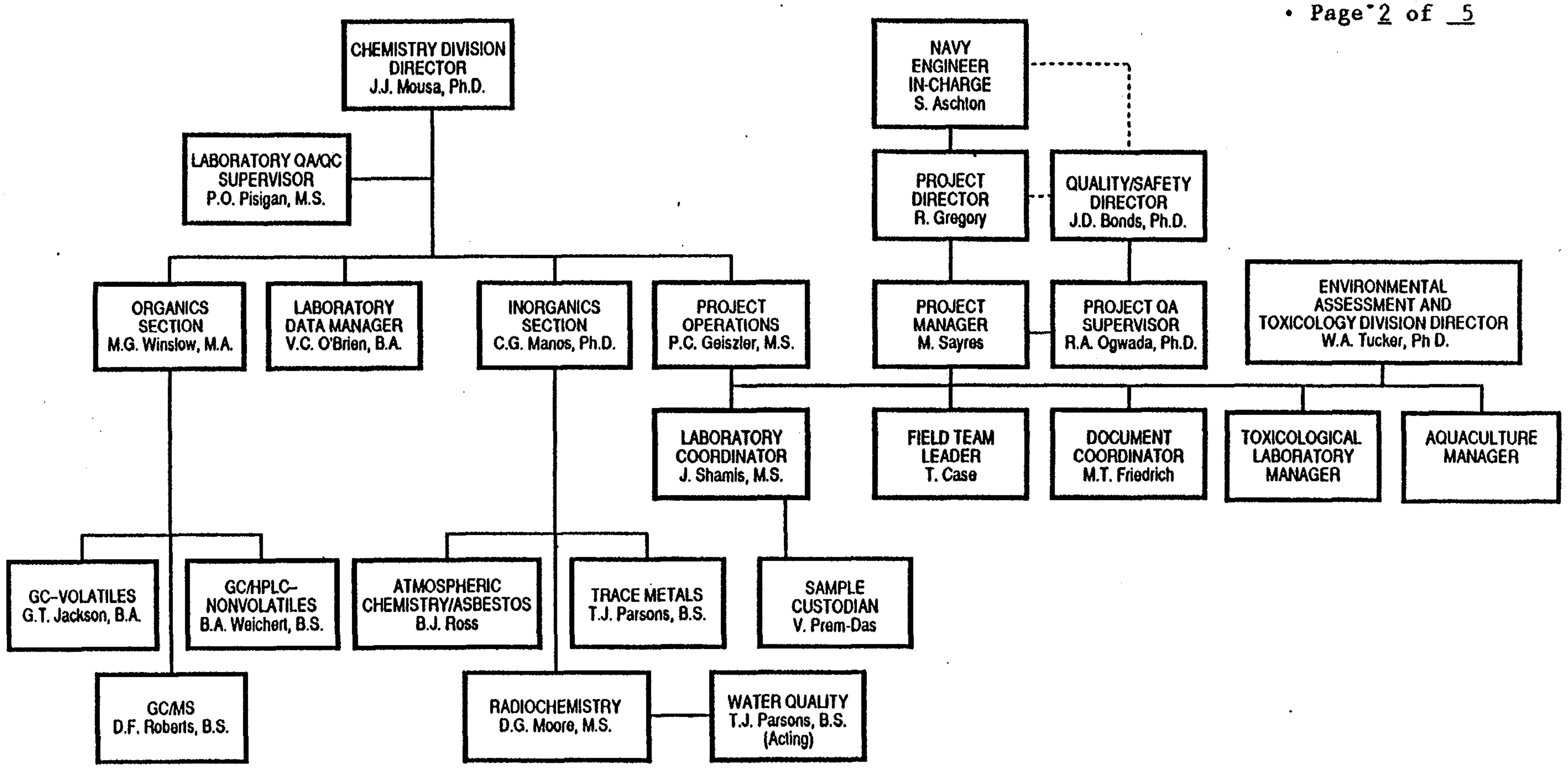

Figure 2-1
PROJECT ORGANIZATION

SOURCE: ESE, 1990.

MARINE CORPS BASE
CAMP LEJEUNE

CAMP LEJEUNE QAPP 5/90h

C2/CAP CJ QAPP 5.30h

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The Laboratory QA/QC Supervisor is responsible for coordinating the certification programs of the Chemistry Division. The Laboratory QA/QC Supervisor also performs data audits and validation and maintains QA records for inspection by ESE project management. The Laboratory QA/QC Supervisor provides guidance and coordination to resolve any QA/QC deficiencies rapidly and reviews precision, accuracy, and blind samples for some projects to assure completeness of the QC data.

The Laboratory Coordinator acts as liaison between field and laboratory operations and is responsible for the following:

1. Coordination of sample analyses to meet project or client objectives.
2. Preparation of analytical reports including coordination with the Laboratory QA/QC Supervisor and laboratory management to assure that the data are validated prior to release to the client.
3. Review of any QC deficiencies reported by the Department Manager.
4. Coordination of any data changes resulting from review by the Laboratory QA/QC Supervisor, Project QA Supervisor, and/or Project Manager.

The Laboratory Data Manager oversees ESE's computerized data management system and is responsible for the following:

1. Maintaining ESE's Chemical Laboratory Analysis and Scheduling System (CLASS) (refer to Section 8.1);
2. Approval of all changes made to CLASS; and
3. Storage of chain-of-custody logsheets, analytical batch folders for all departments in one central location, and all other computerized data.

The Field Team Leader and Analytical Departmental Managers are responsible for provision of consistent and accurate field or laboratory data and technical reports produced by analysts, project scientists or engineers, and sampling personnel under their supervision. These individuals are responsible to the Project Manager to assure that all personnel under their direction are knowledgeable of the QA/QC requirements of the project and that all QC and technical review procedures are followed and documentation is provided.

The Environmental Assessment and Toxicology Division Director is responsible for the overall management of the toxicology testing laboratory, including appointment of the toxicology laboratory manager and aquaculture manager. He is responsible for approving all test programs and associated QC procedures.

The ESE Quality/Safety Director appoints the Project QA Supervisor and is responsible for supervision of the Project QA Supervisor in performance of project duties. He maintains ESE's overall corporate QA program and interacts with the corporate officers, division managers, and client QA/QC personnel to correct problem situations as necessary. He reviews QA/QC reports to the Project Manager and the client.

The Project QA Supervisor ensures that specific QA and primary technical operations are coordinated efficiently for a specific project. The Project QA Supervisor is independent of the project team and is responsible for the following:

1. Approval of all QA/QC procedures used on the project;
2. Writing QA plans, which provides project-specific information;
3. Performance and/or system audits of laboratory, field, and engineering operations to assure compliance with the Project QA Plan;

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4. Notification of the Project Manager of any QC deficiencies discovered during audits;
5. Maintenance of all project QA records;
6. Independent review to assure the quality of all deliverables or outputs from the ESE project team to the client; and
7. Interaction and communication with client QA personnel.

It is the responsibility of all project personnel as well as the laboratory analysts, project scientists, and field team members to perform and document the required QA/QC procedures.

It is the responsibility of laboratory analysts to perform preliminary QC checks to ensure that each batch of data being generated passes all required QC criteria. Field team members must bring any unusual observation or analytical problem to the immediate attention of the Field Team Leader and the Project Manager.

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3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

Analyses performed will reference the U.S. Environmental Protection Agency (EPA) Contract Laboratory Program Statements of Work (CLP SOW) analytical procedures for analysis of water and soil/sediment unless otherwise specified (Tables 3-1 through 3-4). EPA precision and accuracy data and historic ESE data have been used as the basis for developing criteria for assessing laboratory method performance and the precision and accuracy of sample data (as noted). Specific compounds are used for controlling purposes in multianalyte methods; these compounds are identified in Tables 3-1 through 3-4. Laboratory method performance is evaluated using calibration checks, blanks, and QC check samples, and sample accuracy and precision is evaluated using matrix spike and matrix spike duplicate data. A minimum percent completeness (defined in Section 12.3) for each parameter is 90.
Methodology for Navy work is determined by the Data Quality Objective Level (DQOL) specified for each task. The methods referenced in this section are applicable to Level D. For Level D, EPA-CLP-Statements of Work (SOW) will be used in conformance with Navy's methodology and/or documentation requirements for this level.

The following is a brief explanation of the terms that appear in Tables 3-1 through 3-4. Items that are not applicable are denoted by NA.

Reference: The reference of the standard analytical methodology used for each procedure.

Precision: Evaluated based on the relative percent difference (RPD) of duplicate spikes. Both precision and RPD are defined in Section 12.1.

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Table 3-1. Summary of Precision and Accuracy Criteria for Metals and Cyanide Analysis

		Method Criterion*	
Parameter	Units	Precision (Max RPD)	Accuracy (Percent Recovery)
Aluminum, Total	µg/L	25	75-125
Aluminum, Sed/Soil	mg/kg-dry	N/A	N/A
Antimony, Total	µg/L	25	75-125
Antimony, Sed/Soil	mg/kg-dry	25	75-125
Arsenic, Total (R)	µg/L	25	75-125
Arsenic, Sed/Soil (R)	mg/kg-dry	25	75-125
Barium, Total (R)	µg/L	25	75-125
Barium, Sed/Soil (R)	mg/kg-dry	25	75-125
Beryllium, Total	µg/L	25	75-125
Beryllium, Sed/Soil	mg/kg-dry	25	75-125
Cadmium, Total (R)	µg/L	25	75-125
Cadmium, Sed/Soil (R)	mg/kg-dry	25	75-125
Calcium, Total	mg/L	25	75-125
Calcium, Sed/Soil	mg/kg-dry	NA	NA
Chromium, Total (R)	µg/L	25	75-125
Chromium, Sed/Soil (R)	mg/kg-dry	25	75-125
Cobalt, Total	µg/L	25	75-125
Cobalt, Sed/Soil	mg/kg-dry	25	75-125
Copper, Total	µg/L	25	75-125
Copper, Sed/Soil	mg/kg-dry	25	75-125
Iron, Total	µg/L	25	75-125
Iron, Sed/Soil	mg/kg-dry	NA	NA

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Table 3-1. Summary of Precision and Accuracy Criteria for Metals and Cyanide Analysis (Continued, Page 2 of 3)

		Method Criterion*	
Parameter	Units	Precision (Max RPD)	Accuracy (Percent Recovery)
Lead, Total (R)	µg/L	25	75-125
Lead, Sed/Soil (R)	mg/kg-dry	25	75-125
Magnesium, Total	mg/L	25	75-125
Magnesium, Sed/Soil	mg/kg-dry	NA	NA
Manganese, Total	mg/L	25	75-125
Manganese, Sed/Soil	mg/kg-dry	25	75-125
Mercury, Total (R)	µg/L	25	75-125
Mercury, Sed/Soil (R)	mg/kg-dry	25	75-125
Nickel, Total	µg/L	25	75-125
Nickel, Sed/Soil	mg/kg-dry	25	75-125
Potassium, Total	mg/L	NA	NA
Potassium, Sed/Soil	mg/kg-dry	NA	NA
Selenium, Total (R)	µg/L	25	75-125
Selenium, Sed/Soil (R)	mg/kg-dry	25	75-125
Silver, Total (R)	µg/L	25	75-125
Silver, Sed/Soil (R)	mg/kg-dry	25	75-125
Sodium, Total	mg/L	25	75-125
Sodium, Sed/Soil	mg/kg-dry	NA	NA
Thallium, Total	µg/L	25	75-125
Thallium, Sed/Soil	mg/kg-dry	25	75-125

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Table 3-1. Summary of Precision and Accuracy Criteria for Metals and Cyanide Analysis (Continued, Page 3 of 3)

Parameter	Units	Method Criterion*	
		Precision (Max RPD)	Accuracy (Percent Recovery)
Vanadium, Total	µg/L	25	75-125
Vanadium, Sed/Soil	mg/kg-dry	25	75-125
Zinc, Total	µg/L	25	75-125
Zinc, Sed/Soil	mg/kg-dry	25	75-125
Cyanide	mg/L	18	81-116
Cyanide, Sed/Soil	µg/g-dry	18	81-116
Moisture	% Wet Wt	20	NA
EP Toxicity Extraction⁺ (R)	mg/L	NA	NA

Note: CLP = EPA Contract Laboratory Program.
NA = not applicable.
N/A = spiking and recovery information is not available.
R = RCRA/TCLP parameter.
TCLP = toxicity characteristics leaching procedure.

All methodology is in accordance with EPA-CLP-SOW, 7/88, Statement of Work for Inorganic Analysis (or, for tissues, Interim Method for the Sampling and Analysis of Priority Pollutants in Sediments and Fish Tissue; EMSL, 8/77 (Rev. 10/80), incorporated into the CLP-SOW as applicable.)

Incorporation of historical criteria subject to revision.

*Reference for accuracy and precision criteria: for CLP analytes--EPA CLP SOW 7/88;
⁺EPA Method 1310. (EPA 1310-9071--Test Methods for Evaluating Solid Waste, EPA-SW-846, 3rd Edition, September 1986)

Source: ESE, 1990.

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Table 3-2. Analytes, Precision, and Accuracy Data for Volatile Organic Compounds, EPA-CLP-SOW (2/88)

	Aqueous		Solid	
Parameter	Precision (RPD)	Accuracy (%Recovery)	Precision (RPD)	Accuracy (%Recovery)
Acetone	N/A	N/A	N/A	N/A
Benzene*	11	76-127	21	66-142
Bromodichloromethane	20	35-155	30	35-155
Bromoform	20	45-169	30	45-169
Bromomethane	20	0-242	30	0-242
Carbon tetrachloride	20	70-140	30	70-140
Chlorobenzene*	13	75-130	21	60-133
2-Chloroethylvinyl ether	20	0-305	30	0-305
Chloroform	20	51-138	30	51-138
Chloromethane	20	0-273	30	0-273
Dibromochloromethane	20	53-149	30	53-149
Dichlorobenzene,tot.	20	18-190	30	18-190
1,1-Dichloroethane	20	59-155	30	59-155
1,2-Dichloroethane	20	49-155	30	49-155
1,1-Dichloroethylene*	14	61-145	22	59-172
trans-1,2-Dichloroethene	20	54-156	30	54-156
1,2-Dichloropropane	20	0-210	30	0-210
cis-1,3-Dichloropropene	20	0-227	30	0-227
trans-1,3-Dichloropropene	20	17-183	30	17-183

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Table 3-2. Analytes, Precision, and Accuracy Data for Volatile Organic Compounds, EPA-CLP-SOW (2/88) (Continued, Page 2 of 3)

	Aqueous		Solid	
Parameter	Precision (RPD)	Accuracy (%Recovery)	Precision (RPD)	Accuracy (%Recovery)
Ethylbenzene	20	37-162	30	37-162
Methylene chloride	20	0-221	30	0-221
Methyl ethyl ketone	N/A	N/A	N/A	N/A
Methyl isobutylketone	N/A	N/A	N/A	N/A
Styrene	N/A	N/A	N/A	N/A
1,1,2,2-Tetrachloroethane	20	46-157	30	46-157
Tetrachloroethene	20	64-148	30	64-148
Toluene*	13	76-125	21	59-139
1,1,1-Trichloroethane	20	52-162	30	52-162
1,1,2-Trichloroethane	20	52-150	30	52-150
Trichloroethene*	14	71-120	24	62-137
Trichlorofluoromethane	20	17-181	30	17-181
Vinyl chloride	20	0-251	30	0-251
Xylene, total	N/A	N/A	N/A	N/A
Toluene-D8+	NA	88-110	NA	81-117

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Table 3-2. Analytes, Precision, and Accuracy Data for Volatile Organic Compounds, EPA-CLP-SOW (2/88) (Continued, Page 3 of 3)

	Aqueous		Solid	
Parameter	Precision (RPD)	Accuracy (%Recovery)	Precision (RPD)	Accuracy (%Recovery)
4-Bromofluorobenzene+	NA	86-115	NA	74-121
1,2-Dichloroethane-D4+	NA	76-114	NA	70-121

Reference: Accuracy: EPA CLP SOW 2/88 for the controlling analytes. Precision: ESE (meets or exceeds the RPD criteria that can be calculated from the spiking and recovery information presented in the SW 8240 method) and CLP SOW 2/88 for controlling analytes.

For tissues: Interim Method for the Sampling and Analysis of Priority Pollutants in Sediments and Fish Tissue; EMSL, 8/77 (Rev. 10/80), Incorporated into the CLP-SOW as applicable.

Note: N/A = spiking and recovery information is not available.
NA = not applicable.
Incorporation of historical criteria subject to revision.

*Matrix spike and QC check sample compound.
+Surrogate; the surrogate is added to all environmental samples and quality control samples.

Source: ESE, 1990.

Doc No: CLEJ-00351-3.03-09/01/90

Table 3-3. Analytes, Precision, and Accuracy Data for Semivolatile Organic Compounds, EPA-CLP-SOW (2/88)

Parameter	Aqueous Precision (RPD)	Aqueous Accuracy (%Recovery)	Solid Precision (RPD)	Solid Accuracy (%Recovery)
Acenaphthene*	31	46-118	19	31-137
Acenaphthylene	30	33-146	50	33-146
Anthracene	30	27-133	50	27-133
Benzidine	N/A	N/A	N/A	N/A
Benzo(a)anthracene	30	33-143	50	33-143
Benzo(b)fluoranthene	30	24-159	50	24-159
Benzo(k)fluoranthene	30	11-162	50	11-162
Benzo(a)pyrene	30	17-163	50	17-163
Benzo(ghi)perylene	30	0-219	50	0-219
Butylbenzylphthalate	30	0-152	50	0-152
bis(2-Chloroethyl)ether	30	12-158	50	12-158
bis(2-Chloroethoxy)methane	30	33-184	50	33-184
bis(2-Ethylhexyl)phthalate	30	8-158	50	8-158
bis(2-Chloroisopropyl)ether	30	36-166	50	36-166
4-Bromophenylphenylether	30	53-127	50	53-127
2-Chloronaphthalene	30	60-118	50	60-118
2-Chlorophenol*	40	27-123	50	25-102
4-Chloro-3-methylphenol*	42	23-97	33	26-103
4-Chlorophenylphenylether	30	25-158	50	25-158

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Table 3-3. Analytes, Precision, and Accuracy Data for Semivolatile Organic Compounds, EPA-CLP-SOW (2/88) (Continued, Page 2 of 4)

Parameter	Aqueous Precision (RPD)	Aqueous Accuracy (%Recovery)	Solid Precision (RPD)	Solid Accuracy (%Recovery)
Chrysene	30	17-168	50	17-168
Dibenzo(a,h)anthracene	30	0-227	50	0-227
di-n-Butylphthalate	30	1-118	50	1-118
1,3,Dichlorobenzene	30	0-172	50	0-172
1,2-Dichlorobenzene	30	32-129	50	32-129
1,4-Dichlorobenzene*	28	36-97	27	28-104
3,3'-Dichlorobenzidine	30	0-262	50	0-262
2,4-Dichlorophenol	30	39-135	50	39-135
Diethylphthalate	30	0-114	50	0-114
2,4-Dimethylphenol	30	32-119	50	32-119
Dimethylpthalate	30	0-112	50	0-112
2,4-Dinitrophenol	30	0-191	50	0-191
2,4-Dinitrotoluene*	38	24-96	47	28-89
2,6-Dinitrotoluene	30	50-158	50	50-158
di-n-Octylphthalate	30	4-146	50	4-146
Fluoranthene	30	26-137	50	26-137
Fluorene	30	59-121	50	59-121
Hexachlorobenzene	30	0-152	50	0-152
Hexachlorobutadiene	30	24-116	50	24-116

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Table 3-3. Analytes, Precision, and Accuracy Data for Semivolatile Organic Compounds, EPA-CLP-SOW (2/88) (Continued, Page 3 of 4)

Parameter	Aqueous		Solid	
	Precision (RPD)	Accuracy (%Recovery)	Precision (RPD)	Accuracy (%Recovery)
Hexachlorocyclopentadiene	N/A	N/A	N/A	N/A
Hexachloroethane	30	40-113	50	40-113
Indeno(1,2,3-cd)pyrene	30	0-171	50	0-171
Isophorone	30	21-196	50	21-196
2-Methyl-4,6-dinitrophenol	30	0-181	50	0-181
Naphthalene	30	21-133	50	21-133
Nitrobenzene	30	35-180	50	35-180
2-Nitrophenol	30	29-182	50	29-182
4-Nitrophenol*	50	10-80	50	11-114
n-Nitrosodimethylamine	N/A	N/A	N/A	N/A
n-Nitrosodi-n-propylamine*	38	41-116	38	41-126
n-Nitrosodiphenylamine	30	85-115	50	85-115
Pentachlorophenol*	50	9-103	47	17-109
Phenanthrene	30	54-120	50	54-120
Phenol*	42	12-89	35	26-90
Pyrene*	31	26-127	36	35-142
1,2,4-Trichlorobenzene*	28	39-98	23	38-107
2,4,6-Trichlorophenol	30	37-144	50	37-144
2,3,7,8-TCDD	N/A	N/A	N/A	N/A

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Table 3-3. Analytes, Precision, and Accuracy Data for Semivolatile Organic Compounds, EPA-CLP-SOW (2/88) (Continued, Page 4 of 4)

Parameter	Aqueous		Solid	
	Precision (RPD)	Accuracy (%Recovery)	Precision (RPD)	Accuracy (%Recovery)
1-Methylnaphthalene	N/A	N/A	N/A	N/A
2-Methylnaphthalene	N/A	N/A	N/A	N/A
Methylnaphthalene, total	N/A	N/A	N/A	N/A
Nitrobenzene-D5+	NA	35-114	NA	23-120
2-Fluorobiphenyl+	NA	43-116	NA	30-115
p-Terphenyl-D4+	NA	33-141	NA	18-137
Phenol-D6+	NA	10-94	NA	24-113
2-Fluorophenol+	NA	21-100	NA	25-121
2,4,6-Tribromophenol+	NA	10-123	NA	19-122

Reference: Accuracy: EPA CLP SOW 2/88 for the controlling analytes. Precision: ESE (meets or exceeds the RPD criteria that can be calculated from the spiking and recovery information presented in the SW 8270 method) and CLP SOW 2/88 for controlling analytes.

For tissues: Interim Method for the Sampling and Analysis of Priority Pollutants in Sediments and Fish Tissue; EMSL, 8/77 (Rev. 10/80), Incorporated into the CLP-/SOW as applicable.

Note: N/A = spiking and recovery information is not available.
NA = not applicable.

Incorporation of historical criteria subject to revision.

*Matrix spike and QC check sample compound.
+Surrogate; the surrogate is added to all environmental samples and quality control samples.

Source: ESE, 1990.

Table 3-4. Analytes, Precision, and Accuracy Data for Organochlorine Pesticides and PCBs, EPA-CLP-SOW (2/88)

Parameter	Aqueous Precision (RPD)	Aqueous Accuracy (%Recovery)	Solid Precision (RPD)	Solid Accuracy (%Recovery)
Aldrin*	30	40-120	50	34-132
BHC,A	30	37-134	50	37-134
BHC,B	30	17-147	50	17-147
BHC,D	30	19-140	50	19-140
BHC,G(lindane)* (R)	15	56-123	50	46-127
Chlordane	30	45-119	50	45-119
DDD,PP'	30	31-141	50	31-141
DDE,PP'	30	30-145	50	30-145
DDT,PP'*	27	38-127	50	23-134
Dieldrin*	18	52-126	38	31-134
Endosulfan,A	30	45-153	50	45-153
Endosulfan,B	30	0-202	50	0-202
Endosulfan sulfate	30	26-144	50	26-144
Endrin* (R)	21	56-121	50	42-139
Endrin ketone	N/A	N/A	N/A	N/A
Heptachlor*	20	40-131	31	35-130
Heptachlor epoxide	30	37-142	50	37-142
Methoxychlor (R)	N/A	N/A	N/A	N/A
Toxaphene (R)	30	41-126	50	41-126

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Table 3-4. Analytes, Precision, and Accuracy Data for Organochlorine Pesticides and PCBs, EPA-CLP-SOW (2/88) (Continued, Page 2 of 2)

	Aqueous		Solid	
Parameter	Precision (RPD)	Accuracy (%Recovery)	Precision (RPD)	Accuracy (%Recovery)
PCB-1016	30	50-114	50	50-114
PCB-1221	30	15-178	50	15-178
PCB-1232	30	10-215	50	10-215
PCB-1242	30	39-150	50	39-150
PCB 1248	30	38-158	50	38-158
PCB-1254	30	29-131	50	29-131
PCB-1260	30	8-127	50	8-127
Dibutylchlorendate$^+$	NA	24-154	NA	20-150

Reference: Accuracy: EPA CLP SOW 2/88 for the controlling analytes. Precision: ESE (meets or exceeds the RPD criteria that can be calculated from the spiking and recovery information presented in the SW 8080 method) and CLP SOW 2/88 for controlling analytes.

For tissues: Interim Method for the Sampling and Analysis of Priority Pollutants in Sediments and Fish Tissue; EMSL, 8/77 (Rev. 10/80), Incorporated into the CLP-/SOW as applicable.

Note: N/A = spiking and recovery information is not available.
NA = not applicable.

Incorporation of historical criteria subject to revision.

*Matrix spike and QC check sample compound.
$^+$Surrogate; the surrogate is added to all environmental samples and quality control samples.

Source: ESE, 1990.

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Accuracy: Evaluated based on the percent recovery of each spike (see Section 12.2 for definition).

Units: Volume in liters (L) [e.g., micrograms per liter (μg/L)] indicates a water matrix; control spikes are added to either sample matrices or to organic-free laboratory water. Mass in kilograms (kg) [e.g., milligrams per kilogram (mg/kg)] indicates a soil/sediment matrix; control spikes are added to sample matrices, soil, or blank water, depending on the analytical procedure.

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4.0 SAMPLING PROCEDURES

The sampling procedures described in this manual are considered to be ESE's field sampling standard operating procedures (SOPs). The procedures are based on the following sources:

1. EPA's SOP and QA Manual for Region IV (EPA, 1986);
2. EPA's Procedures For Handling and Chemical Analysis of Sediment and Water Samples (EPA, 1981); and
3. ESE division managers and regional office managers.

Critical objectives for each field team member are to:

1. Collect a sample that is representative of the matrix being sampled, and
2. Maintain sample integrity from the time of sample collection to receipt by the laboratory (see Section 5.0).

All field notes will be recorded in indelible ink on standard forms. These forms will be developed by each ESE division/regional office and covered and bound. A sufficient supply of blank paper also will be added to record notes not included in the forms. Each division has the flexibility to develop its own forms, subject to approval by the QA Division, as long as enough information is included to document sufficiently field procedures and data. All forms must provide a place for the field team member to sign and date the entries. Examples of recommended forms are provided in Appendix A.

Two calibration forms are standard for corporate use and must be employed by all divisions/regional offices (see Section 6.0, Figures 6-1 and 6-2).

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All field notes must be reviewed by the Field Team Leader, and approval must be documented by either signing each field page or completing a daily field trip log (see Figure 4-1) and stating the notes were reviewed. The review must be completed during the field site visit, preferably daily, to assure that timely corrective actions can be implemented, if necessary. As a minimum, documentation and validity of the following items should be verified:

1. Proper recording of correct site designation and sample numbers,
2. Date and time (24-hour system recordings), and
3. Complete entries on each form (no blank spaces).

4.1 PREFIELD ACTIVITY

Corporate policy dictates that prefield briefing meetings/conference calls be held prior to any field investigations involving the collection of laboratory samples. These meetings are intended to assure that all necessary departments are aware of the field activity and can plan accordingly.

Within corporate headquarters (Gainesville), the Project Manager and/or Field Team Leader must schedule a meeting with at least the Laboratory Coordinator and Project QA Supervisor. Regional office personnel must initiate a conference call with the appropriate laboratory coordinator (regional laboratory or Gainesville) and Project QA Supervisor.

A Field Trip Plan Approval Form (see Figure 4-2) is filled out, and approval is documented by the signatures of the personnel on the form. For regional offices, the date of the conference call is placed on the signature line.

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WATER RESOURCES DAILY FIELD TRIP LOG

Sub/Project Number and Title: ____________________

Date: ________ ____ ____ ____ Page ______ of ______
Day of Wk. Mo. Day Year

Purpose of Trip: ____________________

Field Team Members: __________ __________
(Names and Initials) __________ __________
__________ __________

Contacts: __________ __________

Work Completed This Date: ____________________

Work Remaining To Be Done: ____________________

Team Leader Signature: ______________ Date: __________

Route To (In Order Listed): 1) Group Leader ________, 2) Dept. Manager _____
3) ☐ Other ________, 4) Dept. File

cc: Sub/Project Manager, Author (Team Leader), Project File

Figure 4-1
DAILY LOG FORM

SOURCE: ESE, 1990.

MARINE CORPS BASE
CAMP LEJEUNE

Doc No: CLEJ-00351-303-09/01/90

Project No. ____________

FIELD TRIP PLAN APPROVAL FORM

Project Name: ____________________________

Field Trip Site: ____________________________

Field Trip Responsibility (Subproj. or Proj. Mngr.) ____________________

Field Team Leader: ____________________________

Laboratory Coordinator: ____________________________

Field Team Members:

____________________ ____________________

____________________ ____________________

____________________ ____________________

____________________ ____________________

SCHEDULING INFORMATION:

Field Trip Briefing Mtg ____________ (Date) ____________ (Time)

Departure ESE ____________ (Date) ____________ (Time)

Site Arrival ____________ (Date) ____________ (Time)

Site Departure ____________ (Date) ____________ (Time)

Arrive ESE ____________ (Date) ____________ (Time)

PLANNING INFORMATION:

The following information must be attached (check to indicate):

____________ Sampling and Shipping Schedule; Lab/Field Contacts Established

____________ Sampling Location Layout

____________ Samples to be Collected and Fraction

____________ List of all Parameters to be Measured On-Site

____________ List of Field Equipment Requested

APPROVALS:

____________________ ____________________

Laboratory Coordinator (Date) Proj. or Subproj. Manager (Date)

____________________ ____________________

Field Team Leader (Date) QA Manager (Date)

REMARKS: ____________________________

____

____

____

____

cc: Project Director / Project Manager

Signature ____________________ Date ____________

Figure 4-2
FIELD TRIP APPROVAL FORM

SOURCE: ESE, 1990.

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND

MARINE CORPS BASE
CAMP LEJEUNE

Doc. No: CLEJ-00351-303-09/01/90

4.2 SPECIAL REQUIREMENTS FOR PRIORITY POLLUTANT SAMPLING

Priority pollutant samples (or any trace contaminant samples) will be analyzed in the parts-per-billion (ppb) range for many compounds; therefore, extreme care must be exercised to prevent contamination of samples. When volatile organic compounds (VOCs) are included for analysis, field team members must use caution to assure that the samples are not exposed to the atmosphere unnecessarily.

The following precautions should be taken when sampling for all trace contaminants:

1. A clean pair of new, disposable gloves are worn for each new sampling station.
2. Sampling must be performed in such a manner that any material or liquid being collected that contacts the gloves (and/or any external surface of the sample container) does not contaminate the sample.
3. When possible, samples should be collected from stations that are least contaminated (i.e., background) followed by stations in increasing order of contamination.
4. When possible, in sampling surface waters, the water sample should be taken before sediment samples are collected or flow measurements are performed, working from downstream to upstream.

When sampling for the presence of organic or pesticide parameters, the following additional precautions will be taken:

1. All sample bottles and equipment must be kept away from fuels and solvents. When possible, gasoline (used in generators) should be transported in a different vehicle from bailers, sample bottles, purging pumps, water sampling bottles, etc. If

possible, one person should be designated to handle samples and another to work generators and gas the truck. If it is not feasible, disposable gloves should be worn for each activity and then disposed of. Care must be taken not to spill any fuels on clothing.

2. All sampling equipment should be made of Teflon®, glass, or stainless steel that is decontaminated according to Section 4.5. Other materials, such as plastic, may contaminant samples with phthalate esters that interfere with many analyses. Use of a polyvinyl chloride (PVC) bailer constructed as in Section 4.7.6 and dedicated to an individual well may be proposed in site-specific Quality Assurance Plan Supplements for certain monitoring efforts. Use of PVC bailers to sample wells with suspected low contaminant levels (relative to the quantitation limits of the analytical methods proposed) will not usually be considered acceptable. Supporting data, such as historical contaminant level data from a particular site, should be provided with any site-specific proposal for use of PVC bailers. Approval for use of PVC bailers must be granted prior to sampling.
3. Volatile water samples must be taken so that no air passes through the sample (to prevent volatiles from being stripped from the samples); the bottles should be filled by slowly running the sample down the side of the bottle until there is a convex meniscus over the neck of the bottle; the Teflon® side of the septum (in cap) should be positioned against the meniscus and the cap screwed on tightly; the sample should be inverted and the bottle lightly tapped. The absence of an air bubble indicates a successful seal; if a bubble is evident, the

cap should be removed, more sample added, and the bottle resealed.

4. Extra Teflon® seals should be available because the seals are difficult to handle and might be dropped. Dropped seals should be considered contaminated and should not be reused. When replacing seals or if seals become flipped, care must be taken to assure that the Teflon® seal faces down.
5. Volatile soil samples should be collected with as little air space as possible to prevent loss to the headspace. Appropriate sample containers are listed in Table 4-1.
6. Volatile compounds (including inorganics such as sulfide, chlorine, etc.) should not be composited due to the potential for loss when homogenizing the sample.
7. Oil and grease fractions should not be composited due to the possible loss of compounds on intermediate sample containers.

4.3 SAMPLING CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES

For field sampling, the Field Team Leader is responsible for proper sampling, labeling of samples, preservation, and shipment of samples to the laboratory to meet required holding times. For toxicity testing, the study director is responsible for proper sampling, labeling of samples, preservation, and shipment of samples to the laboratory to meet required holding times. Sample containers for toxicity testing are provided by the laboratory and are selected based on the chemical nature of the toxicant. Table 4-1 identifies the proper containers, preservation techniques, and maximum holding times established by EPA (40 CFR, Part 136). The maximum holding times in Table 4-1 apply to water and soils. The validity of samples that exceed the goals by a significant length of time will be determined by the ESE Chemistry Division Manager on a case-by-case basis.

Table 4-1. Summary of Analytical Methods, Preservation, and Holding Times

Matrix	Sampling Device	Analysis	Sample Container	Sample Preservation	Holding Time from Collection	Analytical Method
Groundwater/ surface water/ blanks	Stainless steel or Teflon® bailer	TCL VOCs ketones(a)	3 60-mL glass vials with Teflon® septum	HCl to pH<2 Cool to 4°C	14 days analyze	CLP-IFB-SOW (2/88)
	Stainless steel or Teflon® bailer	TCL BNAs, pesticides, and PCBs	2 1-L amber glass, Teflon®-lined cap	Cool to 4°C	7 days extract 40 days analyze	CLP-IFB-SOW (2/88)
	Stainless steel or Teflon® bailer	TCL metals	1 1-L polyethylene	HNO_3 to pH<2 Cool to 4°C	6 months (Hg - 28 days)	CLP-IFB-SOW (7/87)
	Stainless steel or Teflon® bailer	Cyanide	1 1-L polyethylene	NaOH to pH<2 Cool to 4°C	14 days analyze	CLP-IFB-SOW (7/87)
Soil	Split-spoon	TCL VOCs Ketones(a)	1 60-mL glass vial with Teflon®-lined cap	Cool to 4°C	14 days analyze	CLP-IFB-SOW (2/88)
	Split-spoon	TCL BNAs, pesticides, and PCBs	1 8-oz glass with Teflon®-lined cap	Cool to 4°C	14 days extract 40 days analyze	CLP-IFB-SOW (2/88)

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Table 4-1. Summary of Analytical Methods, Preservation, and Holding Times (Continued, Page 2 of 3)

Matrix	Sampling Device	Analysis	Sample Container	Sample Preservation	Holding Time from Collection	Analytical Method
	Split-spoon	TCL metals	1 8-oz glass with Teflon®-lined cap	Cool to 4°C	6 months	CLP-IFB-SOW (7/87)
		Mercury	1 8-oz glass with Teflon®-lined cap	Cool to 4°C	28 days	
	Split-spoon	Cyanide	1 8-oz glass with Teflon®-lined cap	Cool to 4°C	14 days analyze	CLP-IFB-SOW (7/87)
	Split-spoon	TCLP (metals only)	1 16 oz. glass or plastic	Cool to 4°C	6 months	CLP-IFB-SOW (7/87)
Sediment	Stainless steel scoop	TCL VOCs	1 60-mL glass vial with Teflon®-lined cap	Cool to 4°C	14 days analyze	(b)
	Stainless steel scoop	TCL BNAs, pesticides, and PCBs	1 8-oz glass with Teflon®-lined cap	Cool to 4°C	14 days extract 40 days analyze	(b)
	Stainless steel scoop	TCL metals	1 8-oz glass with Teflon®-lined cap	Cool to 4°C	6 months	(b)

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Table 4-1. Summary of Analytical Methods, Preservation, and Holding Times (Continued, Page 3 of 3)

Matrix	Sampling Device	Analysis	Sample Container	Sample Preservation	Holding Time from Collection	Analytical Method
Fish Tissue	Stainless steel scoop	Mercury	1 8-oz glass with Teflon®-lined cap	Cool to 4°C	28 days	(b)
	Stainless steel scoop	Cyanide	1 8-oz glass with Teflon®-lined cap	Cool to 4°C	14 days analyze	(b)
	Net/line	Full TCL	Glass or foil and plastic(c) approximately 150 g	Dry ice	(d)	(b)
	Net/line	TCL metals	Glass or plastic	Dry ice	(d)	(b)
		Mercury	Glass or plastic	Dry ice	28 days	(b)

Note: (a)ketones = methyl ethyl ketone and methyl isoburtyl ketone.
(b)EPA Interim Methods for the Sampling and Analysis of Priority Pollutants in Sediments and Fish Tissue, 1980.
(c)Glass may be used for all fractions; foil for all fractions other than metals fraction; plastic for metals fraction only.
(d)Soil holding times will be applied as guidelines only; holding times are not specified in the method.

BNA = base/neutral/acid.
°C = degrees Celsius.
g = gram.
HCl = hydrochloric acid.
mL = milliliter.
NaOH = sodium hydroxide.
oz = ounce.
PCB = polychlorinated biphenyl.
TCLP = Toxicity Characteristic Leaching Procedure
TCL = Targeted Compound List.

Source: ESE, 1990.

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For the small number of cases where a sample is known to contain or is suspected of containing residual chlorine, the sampler is required to ensure that sodium thiosulfate (crystals or liquid) is added to organic fractions prior to completely filling the appropriate fractions (see Table 4-1).

Trial preservation may be necessary for concentrated hazardous/ industrial wastes to assure adequate preservation, and if reactions are suspected, the volume of preservation added should be recorded in the field notes. For example, acidification of some wastes may liberate toxic gases (e.g., cyanide gas) or result in foaming. In such cases, preservation should be omitted, samples should be shipped to the laboratory as soon as possible, and appropriate comments must be included on the sample logsheet. The volume of preservative added to extreme-pH or highly buffered samples should not exceed 5 percent of the original sample volume.

With hazardous samples it may be necessary to rinse the outer portion of sample containers with deionized (DI) water prior to packaging for shipment. The latest U.S. Department of Transportation (DOT) procedures for shipment of environmental samples will be used in all cases. The quantity of acids or bases added as preservatives generally should not exceed 0.15 percent by weight, or the samples must be shipped as corrosives.

The quality of the preservation techniques and sampling containers are verified by running equipment blanks as described in Section 4.4.

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4.4 SAMPLE BLANKS AND BLIND DUPLICATES

Three types of sample blanks will be processed: trip blanks, field blanks, and equipment blanks. Field and equipment blank totals are approximate and based on 1-day sampling procedures. Trip blank totals are also approximate and are based on 1 day of aqueous TCL VOC sampling (see Table 4-2).

Trip blanks for purgeable compounds consist of sample bottles filled in the laboratory with organic-free water (see Section 4.5) and any applicable preservatives or additives. They are sent to the sampling location with sampling kits and are returned unopened from the sampling location with the samples. These blanks should be included for shipping and analysis with every cooler of purgeable samples shipped from the field. Trip blanks will be composed for VOC only for water samples.

Field blanks are composed in the field, onsite, by filling sample containers (appropriate for the parameter group) using fresh, ultra-pure water from the laboratory. Preservatives or additives are added if necessary, and the blank sample container is then sealed. The field blank is then grouped/transported/stored with the real samples collected for the same parameter group. Field blanks will not be composed for soil samples.

Equipment blanks will be processed after field decontamination by rinsing decontaminated sampling equipment (bailers, pump tubing, etc.) with ultra-pure water obtained from the laboratory. The rinse water is collected in sample bottles, preserved, and handled in the same manner as the samples. An equipment blank may be prepared for each parameter group sampled where a particular piece of sampling equipment was employed for sample collection and subsequently

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Table 4-2. Field QC Samples for Navy Sampling Events

Type of Sample	Level D Metal	Organic
Trip Blank*	NA+	1/cooler
Equipment Rinseate**	1/day	1/day
Field Blank	1/event++	1/event++
Field Dupes***	10%	10%

*For volatiles only.
+NA-not applicable.
**Equipment rinseate samples are collected daily.
++One per source per event for all levels and analytes.
***Field Dupes-Field Duplicates; must be taken from the same sample which will become the laboratory matrix/spike duplicate for organics or for the sample used as a duplicate in inorganics analysis.

Source: Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program, NEESA 20.2-047B, June 1988.

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decontaminated in the field for use in additional sampling. Equipment blanks are required for water, soil, and sediment samples.

Duplicate sample numbers for this project are based on a frequency of 10 percent (see Table 4-2). Each duplicate kit will be sent to the field with label and logsheet IDs of "FD#"; field personnel will add to this ID the lab sequence number of the sample being duplicated only on the logsheet; the bottle labels and the lab sequence numbers which the analysts access via ESE LIMS will not correlate the duplicate with the labeled environmental samples. It is critical for the field team to record the sample number and site identification in the field notes; also, great care must be taken in collecting duplicates to assure that both samples represent the matrix being sampled.

4.5 LABORATORY CLEANING PROCEDURES AND SAMPLING EQUIPMENT DECONTAMINATION

4.5.1 LABORATORY CLEANING PROCEDURES

ESE will use commercially cleaned sample containers whenever possible (except as noted). Table 4-3 summarizes the application of these cleaning procedures. Any containers prepared in-house (when necessary) will meet these or equivalent specifications. Sample-kit containers are stored in clean, dust-free areas segregated from the analytical laboratory and solvent/reagent storage areas. Occasional audits of containers to document freedom from contaminants will be performed to supplement the various blanks that are frequently and routinely analyzed to provide similar QC data.

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Table 4-3. Sample Container Cleaning Procedures Within the Laboratory

Analysis/Parameter	Container Type	Matrix	Fraction Code	Cleaning Protocol*
Organic extractables include GC, HPLC, GC/MS, and Total Phenols Analyses	Glass jar with Teflon®-lined cap	Water	MS, EC, HB, UP, NP, LC, W, Z	A
	Glass jar with Teflon®-lined cap	Soil/ Sediment/ Tissue	SS	A
Organic purgeables including GC and GC/MS Analyses, TOX, Aldicarb	Glass septum vial with Teflon®-lined septum	Water	V, VP, ED, AL, XP	B
	Wide-mouth glass jar with Teflon®-lined cap	Soil/Tissue	SV	B
Metals	Linear polyethylene cubitainer with polyethylene cap	Water	N	C
	Glass jar with Teflon®-lined cap (or new plastic)	Soil/ Sediment/ Tissue	SS	A
Inorganics include total cyanide, alkalinity, acidity, residues, BOD, color, MBAS, COD, TOC, chloride, turbidity, sulfate, bromide, sulfide, fluoride, nutrients, and radionuclides	Linear polyethylene cubitainer with polyethylene cap	Water	C, B, S, H, R	D*
	Glass jar with Teflon®-lined cap (or new plastic)	Soil/Tissue	SS	A

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Table 4-3. Sample Container Cleaning Procedures With the Laboratory (Continued, Page 2 of 2)

Analysis/Parameter	Container Type	Matrix	Fraction Code	Cleaning Protocol*
Oil and grease (O&G), odor	Glass jar with Teflon®-lined cap	Water	O,OD	A
Oil and grease (O&G)	Glass jar with Teflon®-lined cap	Soil/ Sediment	SS	A
Bacteriologicals	Plastic Whirlpak or equivalent	Water	M	E

Note: GC/MS = gas chromatography/mass spectrography.
GC/HPLC = gas chromatography/high performance liquid chromatography.
Glass = amber for all organic water analyses.
TOX = total organic halide.

*Cleaning Protocol A	B	C	D	E	Specifications
X	X	X			Wash with hot tap water using laboratory-grade, nonphosphate detergent.
X	X	X			Rinse 3 times with tap water.
X		X			Rinse with 1:1 nitric acid (reagent-grade nitric acid diluted with ASTM Type 1 deionized water).
X	X	X			Rinse 3 times with ASTM Type 1 deionized water.
X					Rinse with pesticide-grade methylene chloride using 20 mL per 64-oz bottle, 10 mL per 32- or 16-oz bottle, or 5 mL per 8- or 4-oz bottle. Methylene chloride is used as organics rinse.
X	X				Oven dry, using a forced air oven, at 105° to 125°C for 1 hour.
		X			Invert and air dry in contaminant-free environment.
			X		No cleaning required; use new cubitainers (only).
				X	Use sterile, prepackaged plastic container or equivalent for subcontracted work.

Source: ESE, 1989.

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DI water is defined as ESE water that has been treated by passing it through a standard resin column and an activated carbon unit. The water contains no detectable (ESE's routine detection limits) heavy metals or inorganic compounds of analytical interest and is relatively free of organic compounds. The water is acceptable for the initial rinsing of laboratory glassware and field equipment. Ultra-pure water, used for equipment and field blanks, is defined as ESE water that has been additionally treated through a Milli-Q treatment system and contains no organic compounds of analytical interest above ESE's routine detection limits. Organic-free water, used for trip blanks (refer to Section 4.4), is prepared by purging American Society for Testing and Materials (ASTM) Type 2 water at 60°C for 24 hours with Grade 6 helium.

DI water other than ESE treated water may be used if it is of documented equivalent quality. Use of commercially "deionized" or "distilled" water is discouraged because it often contains phthalate esters.

4.5.2 SAMPLING EQUIPMENT DECONTAMINATION

Sampling equipment to be used by field sampling teams may be decontaminated prior to mobilization to the sampling site or in the field. When possible, field equipment should be decontaminated prior to mobilization. In either case, the decontamination procedure listed in this section will be utilized. Sampling equipment that cannot be efficiently decontaminated with this procedure, due to heavy organic contamination, will be discarded.

A major concern in decontamination of sampling equipment has been the choice of solvent. The standard ESE decontamination solvent shall be pesticide-grade isopropanol. If a more polar solvent is required for a particular investigation, pesticide-grade methanol may be used if

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written safety procedures covering the handling and use of methanol have been approved by the Safety Officer and included in the work plan or project QA form. Use of other solvents, such as acetone, hexane, and petroleum ether, must be approved by the Project QA Supervisor. Use of acetone is generally discouraged because residues of acetone may be detected in samples being analyzed for acetone. Hexane and petroleum ether are not miscible with water and, therefore, are effective only if the equipment is dry. The use of any solvent other than pesticide-grade isopropanol for sampling equipment decontamination must be justified, and its use must be documented. Disposal of solvent rinses must be performed in an approved manner (evaporated onsite or containerized for disposal through a disposal contract depending on the volume). The following sampling equipment decontamination procedures are for sampling equipment that contacts sample matrices:

1. Organic compounds and trace metal analyses:
   a. Clean with Liquinox® and tap water (a higher grade of water always may be substituted for tap water) using a brush if necessary to remove particulate matter and surface films.
   b. Rinse thoroughly with tap water.
   c. Rinse thoroughly with 10 percent nitric acid (HNO_3).
   d. Rinse thoroughly with DI water.
   e. Rinse twice with pesticide-grade isopropanol.
   f. Allow to air-dry.
   g. For overnight storage, wrap in new aluminum foil, if appropriate, to prevent contamination.
2. Groundwater purging and monitoring equipment:
   a. Rinse elevation tapes and slugs (slug testing) with tap water followed by DI water, place in a polyethylene bag to prevent contamination during storage or transit.

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   b. Rinse the downhole well tubing, hoses, drop pipes, and submersible pumps with copious amounts of tap water followed by DI water.
   c. If the inside of the tubing/hoses cannot be rinsed adequately, tap water and DI water should be pumped through the tubing.
3. Drilling tools:
   a. All drilling equipment will be steam-cleaned prior to shipment to a site.
   b. Between borings, drilling tools will be steam-cleaned using tap water to remove traces of soil, rock, or other contaminants. In addition, downhole tools will be rinsed with DI water followed by pesticide-grade isopropanol and air-dried.
4. Classic water quality parameters requiring water sampling bottles, BOD samplers, grabs, etc.:
   a. Remove deposits of material/sediment with a brush if necessary.
   b. Rinse with DI water.
   c. Rinse with water from the next sampling location.
5. ISCO Automatic samplers--Follow EPA's standard cleaning procedures for automatic sampling equipment (Appendix B).
6. Field filtration assembly for filtering samples in the field to determine the dissolved fraction of organic compounds and/or metal analyses:
   a. Wash filtration apparatus (filter holder and filtrate flask) with Liquinox® and tap water.
   b. Rinse thoroughly with DI water.
   c. Rinse with 0.5-percent nitric acid solution.

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d. Rinse thoroughly with tap water.
e. Rinse thoroughly with DI water.
f. Rinse twice with pesticide-grade isopropanol.
g. Allow to air-dry.
h. Rinse with tap water immediately after filtering the sample.

4.6 SURFACE WATER AND SEDIMENT SAMPLING

4.6.1 SAMPLING LOCATION

Generally, sediment samples are collected in the same location as surface water samples. Surface water and sediment samples will be collected at a number of sampling locations identified at Sites 6, 48, and 69. At Site 6, two surface water/sediment samples will be collected in Wallace Creek near those locations used in the Second Round Verification Study (see Figure 1-3). At Site 48, 10 surface water/sediment samples will be collected in the marsh area north of Building 804 (photography laboratory) (see Figure 1-4), and one surface water/sediment sample will be collected at a background location. At Site 69, a total of seven surface water/sediment samples will be collected at each of the Round Two Report locations (69SW1, 69SW2, and 69SW3). Two surface water/ sediment samples will be collected at each location identified as 69SW4/69SE4 and 69SW5/69SE5 (see Figure 1-5). The total number of samples to be collected is presented in Tables 4-4 and 4-5.

Surface water and sediment samples collected from Sites 6 and 69 will be analyzed for full TCL parameters. Surface water and sediment samples collected from Site 48 will be analyzed for TCL metals only.

Table 4-4. HPIA Proposed Analytical Program

	Matrix[a]	Field Screening[b]	Full TCL[c] Ketones[d]	TCL VOCs Ketones[d]	TCLP (Metals)[e]	Pesticides /PCBs
1. GROUNDWATER						
Existing shallow wells (30)	GW	30	30	--	--	--
Existing deeper wells (6)	GW	6	6	--	--	--
New deeper wells (8)	GW	8	8	--	--	--
Water supply wells (9)	GW	9	9	--	--	--
Duplicate samples[f]	GW	--	5	--	--	--
TOTAL Groundwater Samples	GW	53	58	--	--	--
2. SOIL						
Soil borings (30)	SO	90	9	81	81	81
Duplicate samples[f]	SO	--	1	8	8	8
TOTAL Soil Samples	SO	90	10	89	89	89
3. BLANK SAMPLES[g]						
Equipment blanks	AQ	--	25	8	8	8
Field blanks	AQ	--	1	--	--	--
Trip blanks	AQ	--	--	20	--	--
TOTAL Blank Samples	AQ	--	26	28	8	8

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Table 4-4. HPIA Proposed Analytical Program (Continued, Page 2 of 2)

Note: [a]GW = groundwater, SO = soil, AQ = aqueous.
[b]Field screening for groundwater: pH, temperature, specific conductivity.
Field screening for soils: HNU and/or DVM.
[c]Full TCL = TCL VOCs, extractables (includes BNAs, pesticides, and PCBs), metals, and cyanide.
[d]Ketones = methyl ethyl ketone and methyl isobutyl ketone.
[e]TCLP = Toxicity Characteristic Leaching Procedure (metals only)
[f]Duplicate sample numbers based on a frequency of 10 percent.
[g]Number of soil boring samples presented is approximate due to the variable depth to water (6 to 22 ft) at HPIA.
[h]Equipment blank totals are approximate and based on 1/day/sampling procedure.
Trip blank totals are approximate and based on 1/day of aqueous TCL VOC sampling.

Source: ESE, 1990.

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Table 4-5. Sites 6, 48, and 69, HPIA Proposed Analytical Program

	Matrix[a]	Field Screening[b]	Full TCL[c]	TCL VOCs	TCL Metals
1. SITE 6					
Groundwater	GW	10	10	--	--
Surface Water	SW	2	2	--	--
Sediment	SE	2	2	--	--
TOTAL SAMPLES		14	14	--	--
2. SITE 48					
Surface Water	SW	11	--	--	11
Sediment	SE	11	--	--	11
Fish Tissue	TI	--	--	--	11
TOTAL SAMPLES		22	--	--	33
3. SITE 69					
Groundwater	GW	8	8	--	--
Surface Water	SW	7	7	--	--
Sediment	SE	7	7	--	--
Fish Tissue	TI	--	4	--	--
TOTAL SAMPLES		22	26	--	--

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Table 4-5. Sites 6, 48, and 49, HPIA Proposed Analytical Program (Continued, Page 2 of 3)

	Matrix[a]	Field Screening[b]	Full TCL[c]	TCL VOCs	TCL Metals
4. DUPLICATE SAMPLES[d]					
Groundwater	GW	2	2	--	--
Surface Water	SW	2	1	--	1
Sediment	SE	2	1	--	1
Fish Tissue	TI	1	1	--	--
TOTAL SAMPLES		7	5		2
5. BLANK SAMPLES[e]					
Equipment	AQ	16	13	--	3
Field	AQ	1	1	--	--
Trip	AQ	13	--	13	--
TOTAL SAMPLES		30	14	13	3

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Table 4-5. Sites 6, 48, and 69, HPIA Proposed Analytical Program (Continued, Page 3 of 3)

Note: [a]GW = groundwater, SW = soil, AQ = aqueous.
[b]Field screening for groundwater: pH, temperature, specific conductivity.
Field screening for soils: HNU and/or OVM.
[c]Full TCL = TCL VOCs, extractables (includes BNAs, pesticides, and PCBs), metals, and cyanide.
[d]Duplicate sample numbers based on a frequency of 10 percent.
[e]Equipment blank totals are approximate and based on 1/day/sampling procedure.
Trip blank totals are approximate and based on 1/day of aqueous TCL VOC sampling.

Source: ESE, 1990.

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Surface water samples will be collected directly into the sample jars. Sediment samples will be collected from the 0- to 6-ft depth interval with a decontaminated stainless steel scoop. VOC samples will be taken as discrete grab samples. The remainder of the sediment sample will be homogenized prior to filling sample jars for the other fractions.

4.6.2 SAMPLING PROCEDURE

The work plan also will provide a detailed description of the sampling techniques to be employed. This QA Plan addresses the QC aspects of surface water sampling.

1. Rivers, streams, and creeks:
    a. Each field sampler must understand the reason for collecting the samples to assure that representative samples are collected. Sufficient field observations (stream stage, unexpected confluent tributaries, beaver dams, etc.) should be made to aid in interpreting the analytical data.
    b. Unless otherwise specified in the work plan, grab samples will be collected at midstream and middepth where lateral mixing is complete, whenever possible.
    c. Unless otherwise specified in the work plan, the surface (air-water interface) will not be sampled.
    d. Care must always be taken not to stir up sediments (by wading, sediment sampling, etc.) prior to or during sampling.
    e. When wading to collect a sample, the sampler should approach the station from downstream and collection should be made upstream of the sampler's body.
    f. Unless otherwise specified in the work plan, samples must be taken in areas of the stream where good vertical and

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horizontal mixing occurs (good current velocity and turbulence).

g. Samples should be taken upstream of culverts (culverts tend to trap materials and debris moving downstream).

h. At small bridges, it may be necessary to move upstream when sampling to avoid garbage and debris commonly thrown off bridges by local residents.

i. When sampling downstream of an effluent discharge, the sampler must be aware of the location of the mixing zone and where samples are to be taken relative to the mixing zone (specified in the work plan).

j. Near the confluence of two streams, samples must be collected at a sufficient distance downstream to assure adequate mixing and at a sufficient distance upstream to avoid backwater from the other stream.

2. Lakes, ponds, and impoundments:
   a. Vertical and horizontal sampling locations will be specified in the work plan.
   b. Wading to collect samples is not recommended as disturbed sediments may enter the overlying water column to be sampled.
   c. When boats are used to sample lakes, care must be taken that no oil or gasoline leakage from the boat motor (if used) affects the water being sampled.
3. Sediment:
   a. If surface water samples need to be collected at the station, collect the water samples first, as sediment sampling temporarily disturbs the water column above.
   b. Care must be taken to assure that the sediment sample is as representative of the streambed as possible.

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c. A ponar grab or corer is recommended for sediment sampling. Stainless steel scoops or trowels are effective in shallow waters. A corer with a glass or Teflon® liner is preferred for priority pollutant analysis due to the reduced potential for contamination.

d. The water depth at each sediment sampling location should be measured and recorded as well as the depth/interval of the sediment sample.

e. Equipment must be decontaminated between sampling stations according to Section 4.5.2.

4.7 GROUNDWATER SAMPLING

4.7.1 GROUNDWATER SAMPLING LOCATIONS

Groundwater sampling will occur at HPIA and Sites 6 and 69. The objective of the groundwater sampling program at HPIA is to obtain water quality data for shallow and deep groundwater to facilitate remediation design for shallow groundwater and fill gaps needed to conduct a risk assessment and FS for deep groundwater. The total number of groundwater samples to be collected is presented in Tables 4-4 and 4-5.

Thirty existing shallow wells, eight newly installed intermediate and deep wells, six existing intermediate and deep wells, and nine water supply wells at HPIA will be sampled during the field investigation. Figure 4-3 shows the location of the existing wells to be sampled. The monitor wells to be sampled include HPGW1 through HPGW26, HPGW29, 22GW1, 22GW2, and 21GW1. The water supply wells to be sampled include 601, 603, 642, 602, 608, 630, 634, 637, and 652.

Eight existing shallow monitor wells (6GW1 through 6GW8) and two water supply wells (651 and 653) at Site 6, and eight existing shallow monitor

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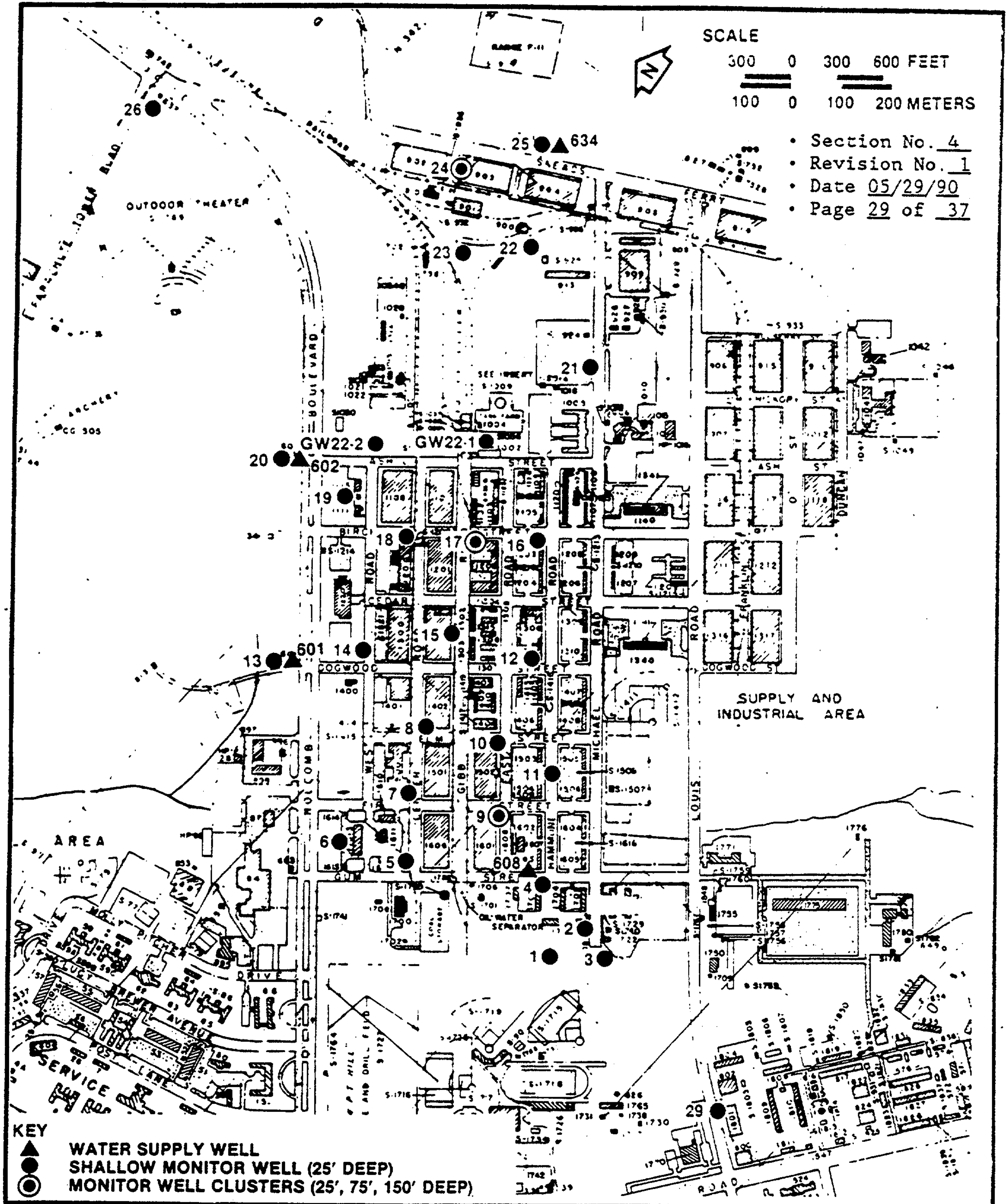

Figure 4-3
MONITOR WELLS AND WATER SUPPLY WELLS AT HADNOT POINT INDUSTRIAL AREA

SOURCE: ESE, 1987.

MARINE CORPS BASE CAMP LEJEUNE

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wells (69GW1 through 69GW8) at Site 69 will be sampled during the investigation. Figures 1-3 and 1-5 show the locations of the wells to be sampled.

All groundwater samples will be analyzed for full TCL parameters. Groundwater samples collected at HPIA will also be analyzed for methyl ethyl ketone (MEK) and methyl isobutyl ketone (MIBK).

A detailed monitor well groundwater sampling procedure is presented in Section 4.7.2.

A minimum of two rounds of water-level measurements will be taken at HPIA during the field investigation to determine horizontal and vertical groundwater flow gradients to this site. Water levels will be measured to the nearest 0.01 ft with an electronic water-level indicator and/or a steel tape and chalk. Water-level measurements will be recorded in the field logbook.

4.7.2 GROUNDWATER SAMPLING PROCEDURE

Procedures used to install and develop monitor wells are detailed in the project work plan. All drilling will be conducted under the supervision of a ESE geologist. Water for drilling test borings and installing wells will be obtained from an uncontaminated, nonchlorinated source. When the quality of the water has not been predetermined, a sample of the drilling water or mud must be taken for analysis prior to drilling to assure that it is free from contaminants of interest.

The following procedures will be used in the collection of groundwater samples:

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1. Groundwater samples will not be collected until at least 5 days have elapsed since the wells were developed (wells must be allowed to reach equilibrium).
2. Appropriate health and safety equipment, as outlined in the Health and Safety Plan, will be worn.
3. The exterior of the well will be visually examined for signs of damage or tampering and this information will be recorded in the field logbook.
4. The security casing will be unlocked and the well cap will be removed.
5. The ambient air and well head organic vapor concentrations will be measured and recorded using an HNU or OVM.
6. Immediately prior to collecting a sample, the static water level below the top of the well casing will be measured to the nearest 0.01 ft and recorded in the field notebook.
7. Whenever feasible, wells expected to be uncontaminated will be sampled first, followed by wells with increasing levels of contamination.
8. Prior to collecting a sample, the volume of water in the screen, well casing, and saturated annulus will be purged three to five times. Purging may be accomplished by:
    a. Manual bailing with a decontaminated Teflon® bailer,
    b. Use of a decontaminated Teflon® or stainless steel drop pipe with a motor-driven centrifugal lift pump,
    c. Use of dedicated PVC drop pipe is allowed if it has been installed in the well for at least 5 days prior to sampling, or
    d. Use of a decontaminated submersible pump.

    If well yield is sufficient, additional well volumes may be removed until the temperature, specific conductance, and pH of the well have stabilized. Wells that recharge extremely slowly will be purged dry, allowed to recharge, and purged again. If excessive time is required to purge 3 volumes, the client (Navy Engineer-in-Charge) will be notified and it may be agreed to purge a lesser volume. The amount of fluid purged will be measured and recorded.

9. The standard ESE well sampling technique is by a precleaned Teflon® bailer. PVC bailers may be utilized only with prior approval (from the client). Cross-contamination potential between wells is reduced by using a new bailer for each well; after sampling, the bailer is either decontaminated or is dedicated to the well (normally hanging in the well).
10. All sampling equipment will be kept off contaminated soil to prevent cross contamination of the samples (e.g., equipment may be placed on disposable polyethylene plastic sheeting).
11. The bailer will be rinsed once with well water (first bail is discarded) prior to collecting a sample.
12. VOC sample bottles will be filled first, then all other required sample containers. Sample containers will be filled directly from the bailer.
13. All samples will be preserved as required (see Table 2-3). If acidification of an aqueous sample for volatiles (VOCs) causes effervescence, the remaining vials will be preserved by cooling to 4°C only. Occurrence of effervescence and the lack of preservation will be noted on the chain-of-custody form.
14. The well cap will be replaced and the outer steel casing will be locked.
15. Samples will be packaged according to QAPP procedures (see Section 2.5). Analytical samples will be cooled to 4°C. Sampling record forms, labels, chain-of-custody forms, and

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custody seals will be filled out. Samples will be shipped to the laboratory within 24 hours.

4.8 SOIL SAMPLING

4.8.1 SHALLOW SOIL SAMPLING LOCATIONS

The objective of the shallow soil sampling program is to evaluate the extent of shallow (above the water table) soil contamination at HPIA. Thirty soil borings are planned adjacent to Building 1602, 902, and 1202. Figure 4-4 presents the building locations. The total number of soil samples to be collected is presented in Tables 4-4 and 4-5.

Soil borings will extend to the water table, approximately 6 to 22 ft. Samples will be collected continuously. Hollow-stem augers (6 1/4-inch inner diameter) with 3-inch outside diameter (OD) carbon steel split-spoon samplers will be used to obtain the soil samples.

Ten percent of all samples collected (approximately nine) will be analyzed for full TCL parameters. The remaining 90 percent (approximately 81) will be analyzed for VOCs, including xylene, MEK, MIBK, and EP toxicity (RCRA metals only). The split spoons will be advanced in accordance with the Standard Penetration Test (ASTM D1586-74).

Upon completion of each boring, the borehole will be grouted with a cement-bentonite mixture. Borehole cuttings will be containerized in 55-gallon (gal) drums. The drums will be transported to a secure area by Camp Lejeune personnel. Samples of the cuttings will be composited and analyzed for the entire TCL and EP toxicity metals.

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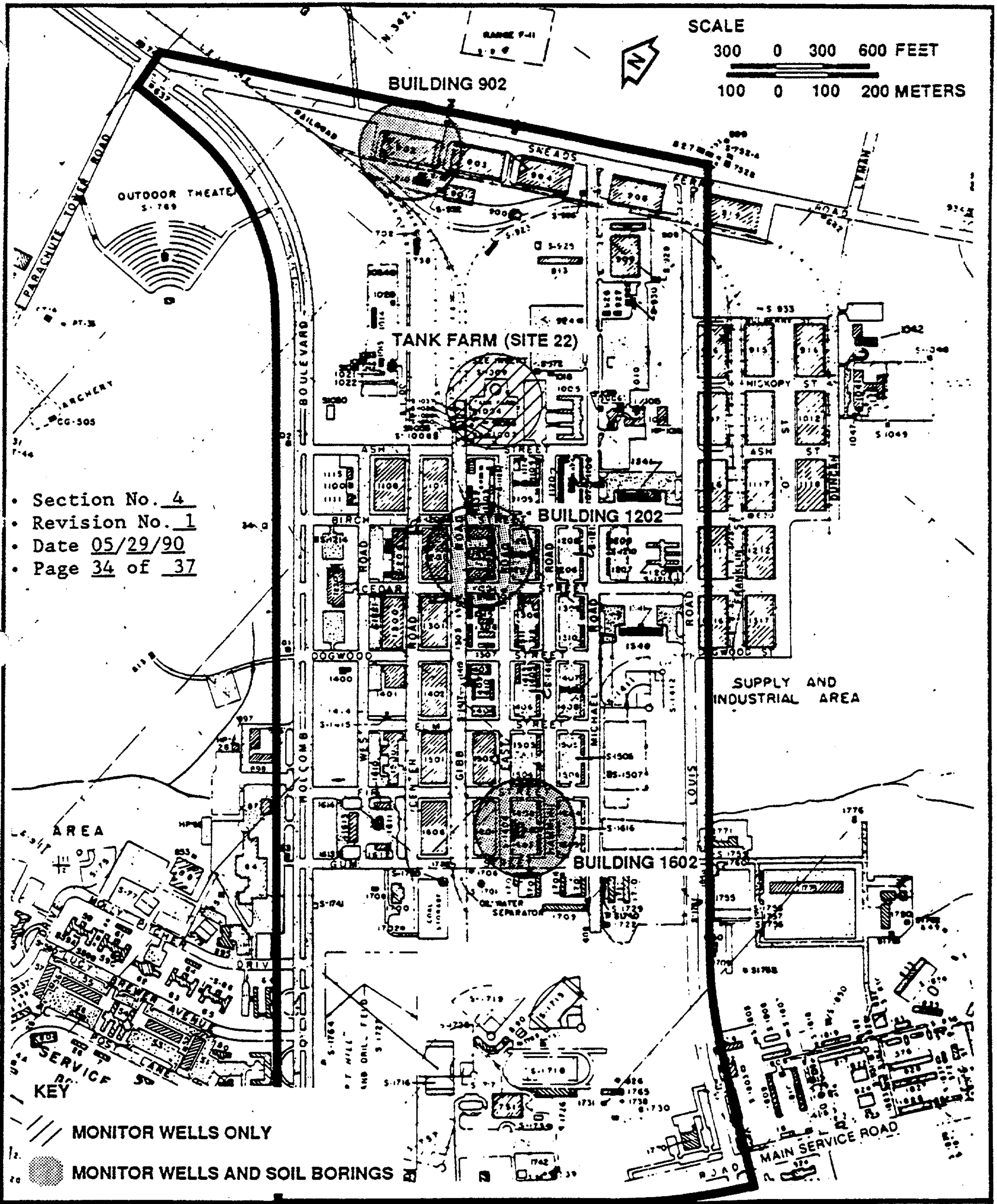

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Figure 4-4
AREAS FOR INTERMEDIATE AND DEEP MONITOR WELLS AND SOIL BORINGS

SOURCE: CAMP LEJEUNE, 1987.

MARINE CORPS BASE
CAMP LEJEUNE

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Section 4.9.2 presents the detailed soil sampling procedure to be used during the field investigation.

4.8.2 SPLIT-SPOON SAMPLING PROCEDURE FOR SOIL BORINGS AND MONITOR WELLS

The following procedure will be used to obtain soil samples during the field investigation.

1. Wear appropriate health and safety equipment as outlined in the Health and Safety Plan.
2. Drill borehole to the desired sampling depth.
3. Drive a 3-inch OD carbon steel split-spoon sampler into the undisturbed soil to be sampled (2-inch OD spoons may be used for monitoring well borings). Drive the split spoon with blows from a 300-pound (lb) hammer (140-lb hammer if 2-inch spoon) falling 30 inches until approximately 2 ft have been penetrated or 100 blows within a 6-inch interval have been applied (Standard Penetration Test, ASTM D 1586-74).
4. Record the number of blows required for each 6 inches of penetration or fraction thereof.
5. Bring the sampler to the surface and remove both ends and one-half of the split spoon so that the recovered soil rests in the remaining half of the barrel. Place the split spoon on clean plastic sheeting. Collect VOC samples as discrete grab samples with a decontaminated spatula or spoon immediately after the split spoon is open. Samples will be transferred to glass Mason® jars. The container should be filled, leaving as little headspace as possible. Screen the entire length of the core for volatile organics using an HNU or OVM. Record the readings, a geologic description of the soils including color, moisture, grain size (modified Unified Soil Classification

System based on visual observance), etc., and approximate recovery of the recovered soil in the field logbook.

6. Homogenize the recovered soil in a decontaminated stainless steel bowl or pan using a decontaminated stainless steel spoon or spatula. Fill appropriate sample jars using a stainless steel spoon or spatula.
7. Fill out labels, chain-of-custody forms, and custody seals. Cool analytical samples on ice to 4°C and package samples according to the QAPP procedures. Ship the samples to the laboratory within 24 hours.

4.9 HAZARDOUS AIR AND HEADSPACE SCREENING

The most common ESE air screening tools are portable photoionization detection devices (PIDs). They are used to detect aromatic hydrocarbons but will not detect most inorganic compounds. These devices must be calibrated according to the directions in Section 6.0. If the instrument is used for screening, an action level must be specified in the project work plan or project QA plan form. The action level is a measured concentration value, which, when reached or exceeded, requires specific action to be taken, such as collecting a sample for laboratory analysis and/or increasing the level of respiratory protection.

Care must be taken when using these devices near water or soil samples. Excessive moisture or soil particles drawn into the probe will disable the unit. Preventive maintenance procedures are specified in Section 11.0.

Additional air screening tools include flame ionization detector devices, which detect methane as well as the compounds detected by the

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PIDs, and specific compound detection tubes, which provide visible color changes within a glass tube in the presence of the target compound.

4.10 FISH TISSUE SAMPLING

Fish (or shellfish) tissue samples will be collected at Sites 48 and 69. At Site 48, fish tissue samples will be collected at each of the 11 surface water/sediment samples identified in Section 3.5. At Site 69, fish tissue samples will be collected from four locations, two near 69SW4/69SE4 and two near 69SW5/69SE5. If surface water bodies at these locations do not support substantial fish/shellfish populations, fish tissue samples will be collected from the nearest surface water body downstream of the particular site.

Fish samples will be collected with nets and/or fishing lines. A maximum of 3 hours per sampling location will be allotted for this effort. If a sample is not obtained within 3 hours, the sampling effort at that particular location will be stopped.

Fish samples will be filleted onsite. Fish fillets will be placed in glass jars, or in plastic (metals fraction) or foil (other fractions). The samples will be packed in dry ice and forwarded to the laboratory.

The fish tissue samples from Site 48 will be analyzed for TCL metals only. The tissue samples from Site 69 will undergo full TCL analysis.

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5.0 SAMPLE CUSTODY

The primary objective of sample custody is to create an accurate written verified record that can be used to trace the possession and handling of the samples from the moment of collection until receipt by the laboratory. Adequate sample custody will be achieved by means of approved field and analytical documentation.

A sample for this project is defined to be in someone's custody if:

1. It is in one's actual physical possession;
2. It is in one's view, after being in one's physical possession;
3. It is in one's physical possession and then locked or otherwise sealed so that tampering will be evident; or
4. It is kept in a secure area, restricted to authorized personnel only.

5.1 FIELD SAMPLE DOCUMENTATION

Field procedures will be designed to minimize sample handling and transfers. During sampling, the field crews will record the following information in field notebooks using indelible ink (Section 4.0);

1. The unique sample number as obtained from the sample label,
2. Source of sample (including name, location, and sample type),
3. Date and time of sample collection,
4. Preservatives used,
5. Name(s) of collector(s), and
6. Field data (pH, temperature, and specific conductance).

Each sample is identified by affixing the pressure-sensitive gummed label produced by the laboratory data management prefield setup (PFS) program. Each label has a unique combination of field group name and sequence number, a standardized sample preservation code (Figure 5-1),

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ESE KEY TO FRACTION CODES

	CODE	PRESERVATIVE	CONTAINER	ANALYSIS-TYPE	HOLDING-TIMES
AIR:	AA	4-Deg-C	Various	Various	
	AO	Exclude Light	Sorbent	Organic	14 Days
	AV	Exclude Light	Charcoal	Volatiles	14 Days
	FL	Keep Upright	Cassette	Various	Various
SOILS:	SS	4-Deg-C	G, 500 mL	All excl. Vol.	7-28 Days
	SV	4-Deg-C	G, 60 mL	Volatiles	7-14 Days
WATER:	AL	4-Deg-C(T)	G,2x60 mL*	Aldicarb	14 Days
	B	4-Deg-C;NaOH,pH>12	P, 1-4 L	Cyanides	14 Days
	C	4-Deg-C	P, 1-4 L	Var.Inorganic	1-28 Days
	CL	4-Deg-C	G, 1-4 L	Chlorophyll	1 Day
		(Pref'd Filtered & Frozen at <0-Deg-C)			
	EC	4-Deg-C(T)g	G, 1 L	Chlor'd Pests	7 Days
	ED	4-Deg-C(T)	G,2x60 mL*	EDB, DBCP	14 Days
	FI	4-Deg-C(T)	G, 1 L	GC/FI Organic	7 Days
	FM	Formaldehyde	P/G,500mL	"Quats"	28 Days
	FP	4-Deg-C(T)	G,3x60 mL*	GC/FP Organic	14 Days
	H	Zn-Acet;NaOH,pH>10	P, 1 L	Sulfides	7 Days
	HB	4-Deg-C(T)	G, 1 L	Chlor'd Herbs	7 Days
	LC	4-Deg-C	G, 1 L	HPLC Organics	7 Days
	M	4-Deg-C(T)	P, 250 mL	Bacteriologic	1 Day
	MS	4-Deg-C(T)	G, 1 L	GCMS Extr.Org.	7 Days
	N	HNO_3,pH<2	P, 1 L	Metals	28-180 Days
	NP	4-Deg-C	G, 1 L	GC/NP Organic	7 Days
	O	4-Deg-C;H_2SO_4,pH<2	G, 1 L	Oil&Grease,TRPH	28 Days
	OD	4-Deg-C	G, 1 L	Odor	2 Days
	R	HNO_3,pH<2	P, 1-4 L	Radionuclides	180 Days
	S	4-Deg-C;H_2SO_4,pH<2	P, 1 L	Nutrients	28 Days
	(UP)	4-Deg-C(T)	G, 1 L	Pest(Antiq'd)	7 Days
	V	4-Deg-C(T)	G,3x60 mL*	Halogen, Vols	14 Days
	VP	4-Deg-C;HCL,pH<2(T)	G,3x60 mL*	Aromatic Vols	14 Days
	(W)	4-Deg-C(T)	G, 1 L	Orgs(Antiq'd)	7 Days
	X	4-Deg-C(S)	G,2x250mL*	TOX(USATHAMA)	7 Days
	XP	4-Deg-C;H_2SO_4,pH<2(S)	G,2x250mL*	TOX	7 Days
	Z	4-Deg-C;H_2SO_4,pH<2	G, 1 L	Total Phenols	28 Days
OTHER:	F	-20-Deg-C	Various	Frozen Sample	Various
	OL	None	G,10-100mL	Organic-Oil	14 Days
	TS	-20-Deg-C	Various	Frozen Tissue	Various

FOOTNOTES:
(T) - Add Sodium Thiosulfate ($Na_2S_2O_3$) If Res.Cl Present (0.25g/L)
(S) - Add Sodium Sulfite (Na_2SO_3) If Res.Cl Present (0.1M, 1 mL/L).
* - Volatiles Bottles (VOAs) With Teflon-Lined Rubber Septa.

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- Date 05/20/90
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INSTRUCTIONS FOR SAMPLING AND SHIPPING

-Plastic (P) Containers May Be Rinsed With Sample; Do Not rinse Glass (G)
-Fill Completely, Especially For Volatiles (Fill These Slowly; Achieve Positive Meniscus; Cap; Invert; Check for Air Bubbles; Top Off If Needed.
-Preserve With Reagents Provided As Instructed Above (VP's Are Pre-Preserved)
-Fill-out Logsheet/Chain-of-Custody. Indicate: Sample Number (*) and Fractions Collected; Dates/Times of Collection & Shipment; Appropriate Field Notes; Be Sure To Sign Bottom of Each Page Where and As Indicated.
-Ship With Bagged Ice in Ice-chest By Express Carrier To Lab Coordinator's Attention.

Figure 5-1
STANDARDIZED SAMPLE PRESERVATION CODES

SOURCE: ESE, 1990.

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and the station identification (ID). Each label also has spaces for the field team to write in the date and time of sample collection, sampler's signature, and a new station ID if different than the original station ID. New station IDs may be necessary due to changes in field and/or sampling conditions that require substitution of sampling stations. All changes in station ID are clearly noted in permanent ink on the sample label and logsheet and must be approved by the Field Team Leader.

The sample container that was cleaned in accordance to Table 4-2 is then placed in a transportation case along with logsheets produced by the PFS program (see Figure 5-2). Each collected sample fraction contained in the transportation case is specified on the logsheet by circling the appropriate fraction code. Other field information such as sample type, sample collection time and date, new station code (if different from tentative station ID), and field analysis results (e.g., pH, temperature) also are entered onto the logsheet. The method of shipment is entered on the bottom of the logsheet, and the sampler signs and dates the logsheet. The logsheet is placed in a waterproof container and sealed in the transportation case along with the samples to which it applies. Evidence tape will be applied to ensure integrity of the shipment. The transportation seal or lock will not be opened until the samples arrive in the analytical laboratory and are checked in by the sample custodian. The Field Team Leader will alert the Laboratory Coordinator to pertinent shipping information at the end of each sampling day.

5.2 LABORATORY SAMPLE DOCUMENTATION

Upon arrival in the laboratory, samples will be checked in by the sample custodian. All samples contained in the shipment will be compared to the logsheet(s) to assure that all samples designated on the logsheet have been received. Any changes in station ID from the originally established station ID are noted. The sample custodian will note any

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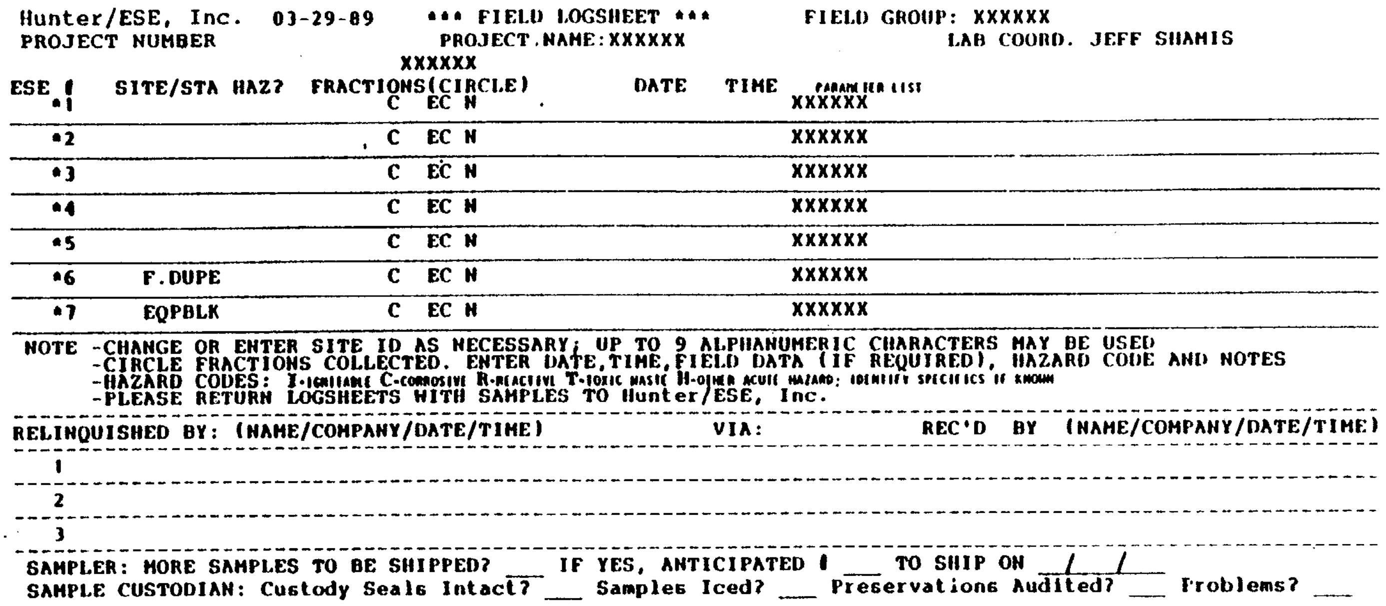

Hunter/ESE, Inc. 03-29-89 *** FIELD LOGSHEET *** FIELD GROUP: XXXXXX
PROJECT NUMBER PROJECT.NAME:XXXXXX LAB COORD. JEFF SHAMIS
XXXXXX

ESE #	SITE/STA	HAZ?	FRACTIONS(CIRCLE)	DATE	TIME	PARAMETER LIST
*1			C EC N			XXXXXX
*2			C EC N			XXXXXX
*3			C EC N			XXXXXX
*4			C EC N			XXXXXX
*5			C EC N			XXXXXX
*6	F.DUPE		C EC N			XXXXXX
*7	EQPBLK		C EC N			XXXXXX

NOTE -CHANGE OR ENTER SITE ID AS NECESSARY; UP TO 9 ALPHANUMERIC CHARACTERS MAY BE USED
-CIRCLE FRACTIONS COLLECTED. ENTER DATE,TIME,FIELD DATA (IF REQUIRED), HAZARD CODE AND NOTES
-HAZARD CODES: I-IGNITABLE C-CORROSIVE R-REACTIVE T-TOXIC WASTE H-OTHER ACUTE HAZARD; IDENTIFY SPECIFICS IF KNOWN
-PLEASE RETURN LOGSHEETS WITH SAMPLES TO Hunter/ESE, Inc.

RELINQUISHED BY: (NAME/COMPANY/DATE/TIME)	VIA:	REC'D BY (NAME/COMPANY/DATE/TIME)
1		
2		
3		

SAMPLER: MORE SAMPLES TO BE SHIPPED? ___ IF YES, ANTICIPATED # ___ TO SHIP ON __/__/__
SAMPLE CUSTODIAN: Custody Seals Intact? ___ Samples Iced? ___ Preservations Audited? ___ Problems? ___

Figure 5-2
SAMPLE CHAIN-OF-CUSTODY LOGSHEET

SOURCE: ESE, 1990.

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special remarks concerning the shipment, evaluate evidence tape, perform radiologic screening, indicate an analysis due date, and deliver the logsheet to Information Services.

Samples are placed in appropriate storage areas and group leaders or department managers notified. Access to samples is limited to authorized personnel, and a sample checkout list is maintained. Samples remain in storage until it becomes unnecessary to retain them, at which time their disposition is noted.

5.3 DOCUMENT CONTROL AND REVIEW

Document control includes the maintenance of project files. All project files will be maintained by the Project Manager. All documents will be kept in project files. Project personnel may keep their own files; however, all official and original documents will be placed in the official project file.

All laboratory records, including chromatograms or strip charts, batch reports, logsheets, data reduction sheets, and computerized worksheets are kept in a batch folder filed in the central filing system maintained by Information Services. Field logs are maintained by the Field Team Leader in a project field file.

The Project QA Supervisor will maintain a project QA file independently. At the end of the project, the QA project file may be turned over to the Project Manager. The following documents will be placed in the QA project file:

1. QA records maintained throughout the investigation;
2. Documentation of QA system and performance audits;
3. Documentation of all unusual findings or observations;
4. Documentation of all QA corrective actions;

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5. All official QA correspondence received or issued relating to the investigation, including records of telephone calls;
6. One copy of all QA deliverable review sheets; and
7. Any other QA documents related to the project or followup activities related to the investigation.

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6.0 CALIBRATION CONTROLS AND FREQUENCY

Calibration procedures establish the relationship between a calibration standard(s) and the measurement of that standard by an instrument or analytical procedure. At a minimum, calibration is required (1) when an analytical method is first set up, (2) prior to the analysis of any lot or batch of samples, (3) when the instrument detector has been subject to major maintenance, or (4) when the instrument fails the calibration QC checks.

Calibration standards should be prepared from materials of known purity or accuracy. Certified reference standards traceable to National Institute of Standards and Technology (NIST) or EPA primary standards should be used to prepare stock standard solutions where available. Preparation of standards must be documented as discussed in Section 8.0.

Specific calibration requirements for major classes of analytical procedures are described in the following sections.

6.1 FIELD INSTRUMENTS

All field geophysical and analytical equipment will be calibrated immediately prior to use in the field. The calibration procedures will follow standard manufacturers' instructions or ESE SOPs to assure that the equipment is functioning within tolerances established by the manufacturer and within control limits required by the project. The Field Team leader will ensure that a copy of each instrument manual is available to the project team while in the field. A record of the instrument calibration will be maintained by the Field Team Leader, and these records are subject to audit by the QA Supervisor.

The calibration frequencies listed in this section are the minimum required under ideal conditions. More frequent calibrations should be

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performed if readings are erratic or if the instrument experiences harsh conditions such as shock, rain, or temperature extremes. All calibrations will be recorded in the field notebook on standard field calibration forms (Figures 6-1 and 6-2).

6.1.1 pH METER

Calibration is performed at the start of each sampling day using NIST-traceable standard buffer solutions that bracket the pH range expected in the samples. Calibration knobs are used to set the meter to read the value of the standard. The meter is then checked during the sampling period, using at least one standard, at a frequency that results in little or no calibration adjustment. If the reading varies more than one-tenth of a unit between calibration checks, the frequency of the checks must be increased.

6.1.2 CONDUCTIVITY METER

Calibration is performed at the start of each sampling day using potassium chloride (KCl) standard solutions prepared in the ESE laboratory prior to each field trip. The analyst preparing the solutions verifies the standard solution versus a laboratory conductivity bridge. The levels of the standards are selected to bracket the range of values expected in the samples. If the unit has a calibration adjustment (e.g., knobs, screws), the meter is calibrated in the same manner as the pH meter. Adjustments are generally not made on meters that lack a designated calibration knob. The meter must read within 10 percent of the standard. If the calibration indicates the meter is out of control, a backup unit should be employed; if one is not available, the data will be flagged to note the percent difference between the meter and standard. Readings from

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Conductivity Meter Calibration Form

Project: ____________ Date: ____________

Meter: ____________ Standards Temp.: ____________

Is meter temperature compensated? ___ Yes ___ No

Manual Correction to 25°C

$$C_{25} = \frac{CK}{1 + .0191(t - 25)}$$ where,

C = meter reading.(uncompensated)
t = solution temperature (°C)
K = Cell constant = 1 (most probes)

Time: ____________ Signature: ____________

Standard (umhos/cm)	Meter Reading	Meter Reading @ 25°C	% Error* $\frac{\text{Std-Meter @ 25°C}}{\text{Std (100)}}$
1.)			
2.)			
3.)			

Time: ____________ Signature: ____________

Standard (umhos/cm)	Meter Reading	Meter Reading @ 25°C	% Error* $\frac{\text{Std-Meter @ 25°C}}{\text{Std (100)}}$
1.)			
2.)			
3.)			

Time: ____________ Signature: ____________

Standard (umhos/cm)	Meter Reading	Meter Reading @ 25°C	% Error* $\frac{\text{Std-Meter @ 25°C}}{\text{Std (100)}}$
1.)			
2.)			
3.)			

*Should be less than 10.

Signature: ____________
Field Team Leader

Figure 6-1
CONDUCTIVITY METER CALIBRATION

SOURCE: ESE, 1990.

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pH Meter Calibration Form

Project: ______________________ Date: ______________________

Meter: ______________________

			Buffer Solution					
	Time (24 hour system)	Meter Reading	7			Buffer Temp. °C	% Slope	Operator
Initial Calibration		Unadjusted						
		Adjusted						
Intermediate Calibration		Unadjusted						
		Adjusted						
		Unadjusted						
		Adjusted						
		Unadjusted						
		Adjusted						
		Unadjusted						
		Adjusted						
		Unadjusted						
		Adjusted						
		Unadjusted						
		Adjusted						
		Unadjusted						
		Adjusted						
Final Calibration		Unadjusted						
		Adjusted						

Intermediate checks may be made with one buffer (unadjusted reading), if readings are within one unit of the standard no calibration adjustment is made, if greater than 0.1 a complete calibration is necessary (adjusted readings), if greater than 0.2 increase frequency of intrmediate checks.

Signature: ______________________

Field Team Leader

Figure 6-2
pH METER CALIBRATION FORM

SOURCE: ESE, 1990.

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conductivity meters lacking calibration adjustments are normally stable; thus, calibration checks are usually limited to checks at the beginning and end of the sampling day.

6.1.3 TEMPERATURE METER

Temperature is measured using a thermistor built into the conductivity meter. The readings will be checked at least once per field trip using a transfer standard thermometer.

6.1.4 PHOTOIONIZATION AND FLAME IONIZATION DETECTION DEVICES

Calibration of these devices will be performed at the start of each day of use using a standard calibration gas. Additional calibrations will be made if the unit experiences abnormal perturbations or readings become erratic. Results of the calibrations will be recorded in a calibration log that accompanies each instrument

6.2 LABORATORY INSTRUMENTS

Calibration criteria will be required for analytical operations. Each instrument will be calibrated in a manner consistent with EPA calibration protocols and/or ESE SOPs. Calibration will be documented in a parameter notebook or the analyst's notebook.

Specific calibration requirements for major classes of analytical procedures are described in Subsections 6.2.1 through 6.2.5.

6.2.1 GAS CHROMATOGRAPH/HIGH PRESSURE LIQUID CHROMATOGRAPH (GC-NONVOLATILES/HPLC) CALIBRATION

Standard Curve Calibration--Initial calibration standard solutions will be prepared by sequential dilution of a single stock standard solution to cover the analytical working range of the method. These may be either composite standards of more than one analyte or single-analyte solutions. The concentrations will be adjusted to take into account the

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instrumental and method detection limit. A minimum of three initial calibration standard concentrations covering the working range and a blank will be prepared and analyzed. The initial calibration standards and the blank will be analyzed before starting an analytical run. At least one calibration standard will be analyzed at the beginning of every analytical run and repeated at the end of the run. In addition, during extended runs covering more than a 12-hour period, this same continuing calibration standard should be analyzed midway through the sample run to assure constant instrument response, or at maximum intervals of every ten samples.

The initial calibration curve will be produced by plotting the standard response for each standard versus the concentration of each standard from the initial calibration run. The concentrations of the standards may be expressed in units of mass injected, or in terms of the concentration of the standard solution, if the injection volume is constant for standards and samples. QC evaluation criteria for initial calibration, recalibration, and continuing calibrations are as follows:

1. The initial calibration curve and the subsequent recalibrations possess a minimum of three points and a blank;
2. The correlation coefficient of the curve is 0.995 or greater;
3. Continuing calibrations standards are within 20 percent of the same initial calibration standard (detectors that normally show greater than 20-percent drift during a normal run will require more frequent calibrations during the run); and
4. The calibration curve brackets the response for all samples.

Failure to meet Criteria 1 and 2 usually will require rerunning the standard curve, with new standards if necessary, and reanalysis of the analytical batch. Failure to meet Criteria 3 may require rerunning the calibration curve and reanalysis of all samples with detectable levels

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of analytes, or an explanation should be provided for acceptance of the data.

The concentration (or amount) of the injected sample will be obtained by entering the response for the sample into the initial calibration curve equation and determining the sample concentration after all appropriate extract and sample dilution factors have been applied.

Single-Point Calibration--This procedure will utilize a single standard concentration to calculate a response factor which allows daily sample concentrations to be calculated. Single-point calibration should be used only with Division Manager approval, and limited to selected chromatographic methods where the analysis of a complete standard curve for each analyte with each instrumental run is impractical due to run time or other technical considerations. Prior to use of this procedure at least one initial standard curve for each analyte must be run. Response factors for single calibration must be within 35 percent of the equivalent standard response factor obtained during initial calibration. Continuing calibration standards will be run throughout the analysis.

6.2.2 GAS CHROMATOGRAPH/MASS SPECTROMETER (GC/MS) TUNING AND CALIBRATION

GC/MS Tuning--Daily instrument tuning will be practiced to assure that the instrument is calibrated and in proper working condition. The GC/MS will be tuned daily with decafluorotriphenylphosphine (DFTPP) for nonvolatiles analysis and bromofluorobenzene (BFB) for volatiles analysis. The mass intensity specifications for BFB and DFTPP are contained in Table 6-1.

Table 6-1. Mass Intensity Specifications for DFTPP and BFB

Key Ions	Ion Abundance Criterion
For DFTPP*	
51	30 to 60 percent of mass 198
68	Less than 2 percent of mass 69
70	Less than 2 percent of mass 69
127	40 to 60 percent of mass 198
197	Less than 1 percent of mass 198
198	Base peak, 100-percent relative abundance
199	5 to 9 percent of mass 198
275	10 to 30 percent of mass 198
365	Greater than 1 percent of mass 198
441	Present but less than mass 443
442	Greater than 40 percent of mass 198
443	17 to 23 percent of mass 442
For BFB*	
50	15 to 40 percent of mass 95
75	30 to 60 percent of mass 95
95	Base peak, 100-percent relative abundance
96	5 to 9 percent of mass 95
173	Less than 2 percent of mass 174
174	Greater than 50 percent of mass 95
175	5 to 9 percent of mass 174
176	Greater than 95 percent but less than 101 percent of mass 174
177	5 to 9 percent of mass 176

*Reference: Test Methods for Evaluating Solid Waste, EPA-SW-846, 3rd Edition, November 1986.

Source: ESE, 1989.

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GC/MS Calibration--Relative response factors for the individual compounds will be determined as follows:

$$RF = \frac{A_c/Q_c}{A_{is}/Q_s} = \frac{A_c}{A_{is}} \frac{Q_s}{Q_c}$$

where:
A = integrated area taken from the extracted ion current profile,
Q = quantity of material,
c = compound,
is = internal standard, and
s = standard.

Initial calibration, using a minimum of five levels of the compound, will be used to determine the instrument linearity. The average response factor (RF) will be calculated for each compound. The percent relative standard deviation (% RSD) will be calculated for each calibration check compound (CCC). The percent RSD of the CCCs in the initial calibration must be ≤35 percent.

A 1-point calibration will be used daily for all subsequent analysis. The RFs of the calibration check compounds in this daily calibration standard should be ≤25 percent difference from the average RFs in the initial calibration. Failure to meet this criterion may require rerunning the calibration curve and re-analysis of samples with detectable levels of analytes, or an explanation should be provided for the acceptance of data. The RFs in the daily calibration standard will also be used for quantitation of samples.

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6.2.3 TRACE METALS ANALYSIS CALIBRATION

Atomic Absorption Spectrophotometry (AAS) Standard Curve Calibration--Working standard solutions will be prepared to cover the analytical working range of the method; these solutions may be either composite standards of more than one metal or single-metal solutions. The standard concentrations will be adjusted to take into account the instrument and method, upper and lower limits of linearity, and the instrumental detection limit. A minimum of three standard concentrations covering the working range and a blank will be prepared and analyzed. The working standards and the blank will be analyzed at the beginning of the analytical run, and at least one midlevel standard will be analyzed at the middle if there are more than 10 samples and at the end of the run to check for constant instrument response.

The calibration is verified by the analysis of the initial calibration verification (ICV) solution. The ICV is an independent standard, prepared from different stock solutions than those used to prepare the calibration standards. Typically an EPA or NIST reference is used as the ICV and is prepared according to the supplier's instructions.

The working curve will be produced by plotting the standard response for each standard versus the concentration of each standard from the initial calibration run. QC evaluation criteria for working curves are as follows:

1. The working curve possesses a minimum of three points and a blank;
2. The correlation coefficient of the line is 0.995 or greater;
3. The response for the midlevel standard analyzed at the middle of the run (for more than 10 samples) and at the end of the run is within 20 percent of true value;
4. The ICV is within 10 percent of the element's true value; and
5. The calibration curve brackets the response for all samples.

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Failure to meet Criteria 1, 2, and 4 may require rerunning the standard curve, with new standards if necessary, and reanalysis of the analytical batch. Failure to meet Criterion 3 may require reanalysis of all samples with detectable levels of analytes, or an explanation should be provided for acceptance of the data.

The concentration of the sample is obtained by entering the response for the sample into the working curve equation and determining the sample concentration after all appropriate digestate and sample dilution factors have been applied.

Inductively Coupled Argon Plasma (ICAP) Single Point Calibration--This procedure utilizes a single standard concentration for each element to obtain an instrument response (emission counts). A second single point, emission counts obtained obtained when aspirating a blank solution, is used in conjunction with the standard to calibrate the instrument in concentration units.

The calibration is verified by the analysis of an ICV solution, which is an independent standard prepared from different stock solutions than those used to prepare the calibration standards. The elemental concentrations of the calibration verification solution must be within the calibration range of the instrument and at concentrations other than those used for instrument calibration.

A multi-element interference check solution (ICS) and a method blank are analyzed each day prior to analyzing the samples. The ICS is used to verify the correction of spectroscopic interference caused by emissions adjacent to analyte emission lines.

The CCV solution is analyzed at the middle of the run, if there are more than 10 samples, and at the end of the run to document constant instrument response. This solution contains one-half the concentration of each element present in the calibration standards. This solution may be prepared by dilution of an aliquot of the calibration standard or prepared as a separate solution in a manner analogous to the calibration standard preparation procedure.

QC evaluation criteria for the instrument calibration standard follow:

1. A calibration standard and a calibration blank are employed;
2. All the values for the ICV are within 10 percent of each element's true value;
3. Values for the ICS are 20 percent of each element's true value; and
4. The measured concentration of the elements in the CCV solution, for which calibration was performed, are within 20 percent of their respective true values.

Failure to meet Criterion 1, 2, or 3 may require recalibration of the instrument, reverification of the calibration, and reanalysis of the samples. Failure to meet Criterion 4 may require reanalysis of the CCV. If the next CCV is still outside the criteria, it may require recalibration of the instrument, reverification of calibration, and reanalysis of the samples, or an explanation should be provided for the acceptance of the data.

6.2.4 GRAVIMETRIC METHODS CALIBRATION

The analytical balances are calibrated semiannually by the proper service personnel. The semiannual calibration is documented by a tag on the instrument. A set of NIST-certified weights are used to check the calibration daily. This check is performed by the designated technician. Results are recorded in the instrument notebook.

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7.0 STANDARD ANALYTICAL PROCEDURES

7.1 DETECTION LIMITS AND ACCEPTANCE CRITERIA

Soil, groundwater, and surface water analyses performed for this project (see Tables 4-4 and 4-5) will use standard EPA analytical procedures. EPA and historical ESE precision and accuracy data will be used as the basis for developing acceptance criteria for assessing the precision and accuracy of the generated data. Criteria to be used in this project are given in Tables 3-1 through 3-4. A minimum percent completeness (defined in Section 5.3) for each parameter is 90.

Detection limits to be utilized for this project are presented in Tables 7-1 to 7-4. The reported detection limit for a method will be subject to the judgment of the analyst and the department manager and should take into account background levels, instrument baseline noise, spiking recoveries, and the lowest calibration standards analyzed.

These are EPA-CLP Contract Required Detection Limits (CRDLs). They are either specified in the applicable SOWs (organics), or calculated as specified in the SOWs (inorganics). These limits are integral to the documentation process of DQO Level D specified for this project.

7.2 GLASSWARE CLEANING PROCEDURES (CHEMISTRY DIVISION)

Dirty glasswares are drained of solvents and rinsed with tap water, if soils or other residues are still remaining, before they are submitted to the ESE washroom for cleaning. Glasswares from the Metals Department are always rinsed with tap water prior to submittal to the washroom.

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Table 7-1. Limit of Detection for Metals

Compound	Waters (µg/L)	Solids (mg/kg)
ICAP Method		
Aluminum	117.5	12
Antimony	54.6	5.5
Arsenic	110.1*	11*
Barium	1.8	0.2
Beryllium	1.9	0.2
Boron	10.6*	1*
Cadmium	4.0	0.4
Calcium	23.7	2.4
Chromium	7.1	0.7
Cobalt	19.1	1.9
Copper	8.6	0.9
Iron	61.6	6.2
Lead	44.7*	4.5*
Magnesium	52.2	5.2
Manganese	2.1	0.2
Molybdenum	32.5*	3.3*
Nickel	26.0	2.6
Potassium	563.0	56
Selenium	159.0*	16*
Silver	8.8	0.9
Sodium	157.0	16
Thallium	160.0	16
Vanadium	13.4	1.3
Zinc	4.5	0.5
GFAA Method		
Arsenic	2.3	0.2
Lead	1.4	0.2
Selenium	1.8	0.2
CVAA Method		
Mercury	0.2	0.02

*Detection limits determined using ESE LOD, all others determined using EPA-CLP CRDL.

Source: ESE, 1990.

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Table 7-2. Method Detection Limits for Volatile Organic Compounds

		Quantitation Limits**	
Volatiles	CAS Number	Water ug/L	Low Soil/Sediment[a] ug/Kg
1. Chloromethane	74-87-3	10	10
2. Bromomethane	74-83-9	10	10
3. Vinyl Chloride	75-01-4	10	10
4. Chloroethane	75-00-3	10	10
5. Methylene Chloride	75-09-2	5	5
6. Acetone	67-64-1	10	10
7. Carbon Disulfide	75-15-0	5	5
8. 1,1-Dichloroethene	75-35-4	5	5
9. 1,1-Dichloroethane	75-34-3	5	5
10. 1,2-Dichloroethene (total)	540-59-0	5	5
11. Chloroform	67-66-3	5	5
12. 1,2-Dichloroethane	107-06-2	5	5
13. 2-Butanone	78-93-3	10	10
14. 1,1,1-Trichloroethane	71-55-6	5	5
15. Carbon Tetrachloride	56-23-5	5	5
16. Vinyl Acetate	108-05-4	10	10
17. Bromodichloromethane	75-27-4	5	5
18. 1,2-Dichloropropane	78-87-5	5	5
19. cis-1,3-Dichloropropene	10061-01-5	5	5
20. Trichloroethene	79-01-6	5	5
21. Dibromochloromethane	124-48-1	5	5
22. 1,1,2-Trichloroethane	79-00-5	5	5
23. Benzene	71-43-2	5	5
24. trans-1,3-Dichloropropene	10061-02-6	5	5
25. Bromoform	75-25-2	5	5
26. 4-Methyl-2-pentanone	108-10-1	10	10
27. 2-Hexanone	591-78-6	10	10
28. Tetrachloroethene	127-18-4	5	5
29. Toluene	108-88-3	5	5
30. 1,1,2,2-Tetrachloroethane	79-34-5	5	5

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Table 7-2. Method Detection Limits for Volatile Organic Compounds
(Continued, Page 2 of 2)

Volatiles	CAS Number	Quantitation Limits** Water ug/L	Quantitation Limits** Low Soil/Sediment[a] ug/Kg
31. Chlorobenzene	108-90-7	5	5
32. Ethyl Benzene	100-41-4	5	5
33. Styrene	100-42-5	5	5
34. Xylenes (Total)	1330-20-7	5	5

---

[a] Medium Soil/Sediment Contract Required Quantitation Limits (CRQL) for Volatile TCL Compounds are 125 times the individual Low Soil/Sediment CRQL.

* Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable.

** Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis as required by the contract, will be higher.

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Table 7-3. Detection Limits for Semivolatile Organic Compounds

Semivolatiles	CAS Number	Quantitation Limits** Water ug/L	Low Soil/Sediment^b ug/Kg
35. Phenol	108-95-2	10	330
36. bis(2-Chloroethyl) ether	111-44-4	10	330
37. 2-Chlorophenol	95-57-8	10	330
38. 1,3-Dichlorobenzene	541-73-1	10	330
39. 1,4-Dichlorobenzene	106-46-7	10	330
40. Benzyl alcohol	100-51-6	10	330
41. 1,2-Dichlorobenzene	95-50-1	10	330
42. 2-Methylphenol	95-48-7	10	330
43. bis(2-Chloroisopropyl) ether	108-60-1	10	330
44. 4-Methylphenol	106-44-5	10	330
45. N-Nitroso-di-n-dipropylamine	621-64-7	10	330
46. Hexachloroethane	67-72-1	10	330
47. Nitrobenzene	98-95-3	10	330
48. Isophorone	78-59-1	10	330
49. 2-Nitrophenol	88-75-5	10	330
50. 2,4-Dimethylphenol	105-67-9	10	330
51. Benzoic acid	65-85-0	50	1600
52. bis(2-Chloroethoxy) methane	111-91-1	10	330
53 2,4-Dichlorophenol	120-83-2	10	330
54. 1,2,4-Trichlorobenzene	120-82-1	10	330
55. Naphthalene	91-20-3	10	330
56. 4-Chloroaniline	106-47-8	10	330
57. Hexachlorobutadiene	87-68-3	10	330
58. 4-Chloro-3-methylphenol (para-chloro-meta-cresol)	59-50-7	10	330
59. 2-Methylnaphthalene	91-57-6	10	330
60. Hexachlorocyclopentadiene	77-47-4	10	330
61. 2,4,6-Trichlorophenol	88-06-2	10	330
62. 2,4,5-Trichlorophenol	95-95-4	50	1600
63. 2-Chloronaphthalene	91-58-7	10	330
64. 2-Nitroaniline	88-74-4	50	1600
65. Dimethylphthalate	131-11-3	10	330
66. Acenaphthylene	208-96-8	10	330
67. 2,6-Dinitrotoluene	606-20-2	10	330
68. 3-Nitroaniline	99-09-2	50	1600
69. Acenaphthene	83-32-9	10	330

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Table 7-3. Detection Limits for Semivolatile Organic Compounds
(Continued, Page 2 of 2)

Semivolatiles	CAS Number	Quantitation Limits** Water ug/L	 Low Soil/Sediment^{b} ug/Kg
70. 2,4-Dinitrophenol	51-28-5	50	1600
71. 4-Nitrophenol	100-02-7	50	1600
72. Dibenzofuran	132-64-9	10	330
73. 2,4-Dinitrotoluene	121-14-2	10	330
74. Diethylphthalate	84-66-2	10	330
75. 4-Chlorophenyl-phenyl ether	7005-72-3	10	330
76. Fluorene	86-73-7	10	330
77. 4-Nitroaniline	100-01-6	50	1600
78. 4,6-Dinitro-2-methylphenol	534-52-1	50	1600
79. N-nitrosodiphenylamine	86-30-6	10	330
80. 4-Bromophenyl-phenylether	101-55-3	10	330
81. Hexachlorobenzene	118-74-1	10	330
82. Pentachlorophenol	87-86-5	50	1600
83. Phenanthrene	85-01-8	10	330
84. Anthracene	120-12-7	10	330
85. Di-n-butylphthalate	84-74-2	10	330
86. Fluoranthene	206-44-0	10	330
87. Pyrene	129-00-0	10	330
88. Butylbenzylphthalate	85-68-7	10	330
89. 3,3'-Dichlorobenzidine	91-94-1	20	660
90. Benzo(a)anthracene	56-55-3	10	330
91. Chrysene	218-01-9	10	330
92. bis(2-Ethylhexyl)phthalate	117-81-7	10	330
93. Di-n-octylphthalate	117-84-0	10	330
94. Benzo(b)fluoranthene	205-99-2	10	330
95. Benzo(k)fluoranthene	207-08-9	10	330
96. Benzo(a)pyrene	50-32-8	10	330
97. Indeno(1,2,3-cd)pyrene	193-39-5	10	330
98. Dibenz(a,h)anthracene	53-70-3	10	330
99. Benzo(g,h,i)perylene	191-24-2	10	330

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[b] Medium Soil/Sediment Contract Required Quantitation Limits (CRQL) for SemiVolatile TCL Compounds are 60 times the individual Low Soil/Sediment CRQL.

* Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable.

** Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis as required by the contract, will be higher.

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Table 7-4. Detection Limits for Organochlorine Pesticides and PCBs

Pesticides/PCBs	CAS Number	Quantitation Limits** Water ug/L	Low Soil/Sediment[c] ug/Kg
100. alpha-BHC	319-84-6	0.05	8.0
101. beta-BHC	319-85-7	0.05	8.0
102. delta-BHC	319-86-8	0.05	8.0
103. gamma-BHC (Lindane)	58-89-9	0.05	8.0
104. Heptachlor	76-44-8	0.05	8.0
105. Aldrin	309-00-2	0.05	8.0
106. Heptachlor epoxide	1024-57-3	0.05	8.0
107. Endosulfan I	959-98-8	0.05	8.0
108. Dieldrin	60-57-1	0.10	16.0
109. 4,4'-DDE	72-55-9	0.10	16.0
110. Endrin	72-20-8	0.10	16.0
111. Endosulfan II	33213-65-9	0.10	16.0
112. 4,4'-DDD	72-54-8	0.10	16.0
113. Endosulfan sulfate	1031-07-8	0.10	16.0
114. 4,4'-DDT	50-29-3	0.10	16.0
115. Methoxychlor	72-43-5	0.5	80.0
116. Endrin ketone	53494-70-5	0.10	16.0
117. alpha-Chlordane	5103-71-9	0.5	80.0
118. gamma-Chlordane	5103-74-2	0.5	80.0
119. Toxaphene	8001-35-2	1.0	160.0
120. Aroclor-1016	12674-11-2	0.5	80.0
121. Aroclor-1221	11104-28-2	0.5	80.0
122. Aroclor-1232	11141-16-5	0.5	80.0
123. Aroclor-1242	53469-21-9	0.5	80.0
124. Aroclor-1248	12672-29-6	0.5	80.0
125. Aroclor-1254	11097-69-1	1.0	160.0
126. Aroclor-1260	11096-82-5	1.0	160.0

---

[c] Medium Soil/Sediment Contract Required Quantitation Limits (CRQL) for Pesticide/PCB TCL compounds are 15 times the individual Low Soil/Sediment CRQL.

* Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable.

** Quantitation limits listed for soil/sediment are based on wet weight. The quantitation Limits calculated by the laboratory for soil/sediment, calculated on dry weight basis as required by the contract, will be higher.

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A completed Glassware Washing Request Form (Figure 7-1) must accompany each box of glasswares brought to the ESE washroom. All laboratory glasswares (i.e., volumetric flasks, separatory funnels, extraction tubes, beakers, graduated cylinders, and others) are cleaned according to the analysis/parameter group listed in Table 7-5. These cleaning procedures are subject to change depending on the requirements of the projects. The washroom personnel perform the cleaning procedures 1 through 4 listed in the table, unless otherwise directed in writing by the analyst via the Glassware Washing Request Form. Cleaned glassware for organic analyses are placed in boxes lined with fresh aluminum foil. The form is then initialled, dated, and the type of cleaning procedures performed specified by the washroom personnel. The remaining cleaning procedures are performed by the analyst.

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GLASSWARE WASHING REQUEST FORM

TO BE DONE

☐ Normal Wash 1) Hot soapy tap water wash
2) Tap water rinse
3) DI rinse

☐ Rinse with DI only!

☐ Other ______________ (be specific)
____
____
____

SOLVENT RINSE

☐ Acetone

☐ Other ______________________
____
____

NEEDED BY: ______________________
Date and Time

SPECIAL INSTRUCTIONS: ______________
____
____
____

REQUESTED BY: ______________________

THE FOLLOWING HAS BEEN COMPLETED

☐ Normal Wash

☐ Rinse with DI only!

☐ Other ______________________
____
____
____

SOLVENT RINSE

☐ Acetone

☐ Other ______________________
____
____

COMPLETED BY ______________________

DATE ______________________

Figure 7-1
GLASSWARE WASHING
REQUEST FORM

SOURCE: ESE, 1990.

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CAMP LEJEUNE

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Table 7-5. Glassware Cleaning Procedures

Analysis/Parameter	Cleaning Protocol*
Extractable Organics	1,2,3,4,5,6
Purgeable Organics	1,2,3,4,7,9
HPLC Analyses	1,2,3,4,5,8
Trace Metals	1,2,3,4,10

Note: HPLC = High Pressure Liquid Chromatography.

*Cleaning Procedures

1. Remove all labels using sponge or acetone.
2. Wash with hot soapy water (use Liquinox® soap only) using brushes to scrub inside of glasswares, stopcocks, and other small pieces, if possible.
3. Rinse three times with hot tap water.
4. Rinse three times with DI water.
5. Rinse thoroughly with reagent-grade acetone.
6. Rinse with reagent-grade methylene chloride.
7. Rinse with reagent-grade methanol.
8. Rinse with acetonitrile and methanol prior to use, if needed.
9. Bake at 80°C for 3 to 4 hours.
10. Acid rinse with dilute HNO_3 and then with deionized water prior to use.

Source: ESE, 1990.

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8.0 DATA REDUCTION, VALIDATION, AND REPORTING

8.1 DATA REDUCTION AND REPORTING

Data transfer and reduction are essential functions in summarizing information to support conclusions. It is essential that these processes are performed accurately and, in the case of data reduction, accepted statistical techniques are used. ESE will use its in-house-developed CLASS for data management.

If available, example calculations should be included with the analytical method to facilitate review. The entry of input data and calculations should be checked and the signature/initials of the Data Technician and Reviewer(s) should accompany all data transfers with and without reduction.

The data flow scheme for CLASS is presented in Figure 8-1. An example data output form is shown in Figure 8-2. Reporting will include standard curves, QC data, and sample data. Reports equivalent to EPA-CLP-SOW format will be provided for all Level D results as applicable.

For routine analyses performed at the ESE laboratory, sample response data information will be entered into CLASS by the analyst or other designated individual(s). The computer calculates the following:

1. Linear or quadratic regression line for standards,
2. Coefficients of variation for replicates,
3. Spiked recoveries,
4. Reference sample concentrations, and
5. Sample concentrations.

Linear or quadratic equations will be used to calculate final data for laboratory analyses requiring a calibration curve:

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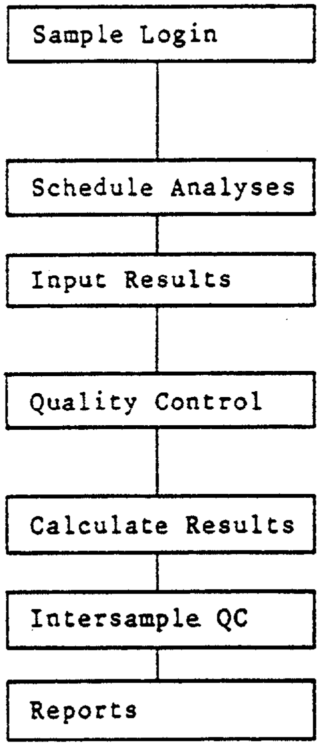

Sample Login

--activate samples
--set permanent station codes
--store collection time and date
--store field data

Schedule Analyses

--list of samples available for each parameter sorted by due date

Input Results

--reserve analysis
--input calibration, quality control and sample data

Quality Control

--calculate calibration curve, spike recovery, replicate and reference sample quality control

Calculate Results

--calculate and store final sample concentrations

Intersample QC

--check for data inconsistencies
--perform interparameter calculations

Reports

--produce reports of sample data, quality control, and statistical analyses

Figure 8-1
FLOWCHART OF THE CLASS PROGRAM

SOURCE: ESE, 1990.

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```
Hunter/ESE, Inc.                      DATE 03/23/89 STATUS :FINAL
PROJECT NUMBER 99999 0000             PROJECT NAME    EXAMPLE PROJECT
FIELD GROUP    XXXXXX                 PROJECT MANAGER J.D. HUNTER
               ALL                    LAB COORDINATOR J.D. HUNTER

                                                SAMPLE ID/#

                                            MW-1      MW-2      MW-3
  PARAMETERS                  STORET      XXXXXX    XXXXXX    XXXXXX
              UNITS           METHOD           1         2         3

  DATE                                  12/26/88  12/26/88  12/26/88
  TIME                                     11:35     12:30     14:20

  CHROMIUM,(+6)                 1032       <2.50      10.4     <2.50
              UG/L                 I
  PCB-1016                     34671      <0.118    <0.118    <0.118
              UG/L                EC
  PCB-1221                     39488      <0.118    <0.118    <0.118
              UG/L                EC
  PCB-1232                     39492      <0.118    <0.118    <0.118
              UG/L                EC
  PCB-1242                     39496      <0.118    <0.118    <0.118
              UG/L                EC
  PCB 1248                     39500      <0.118    <0.118    <0.118
              UG/L                EC
  PCB-1254                     39504      <0.118    <0.118    <0.118
              UG/L                EC
  PCB-1260                     39508      <0.118    <0.118    <0.118
              UG/L                EC
  ARSENIC,TOTAL                 1002        16.1       6.8       5.9
              UG/L              GFAA
  BARIUM,TOTAL                  1007        70.3       124      20.1
              UG/L              ICAP
  COPPER,TOTAL                  1042        11.2      29.8       6.0
              UG/L              ICAP
  CHROMIUM,TOTAL                1034        17.0      90.0      <6.8
              UG/L              ICAP
  LEAD,TOTAL                    1051         5.7      39.0       1.4
              UG/L              GFAA
  MERCURY,TOTAL                71900        <0.2       0.4      <0.2
              UG/L              CVAA
  SELENIUM,TOTAL                1147        <2.0      <2.0      <2.0
              UG/L              GFAA
  SILVER,TOTAL                  1077        <5.7      <5.7      <5.7
              UG/L              ICAP
  ZINC,TOTAL                    1092        16.3      49.4       4.2
              UG/L              ICAP
```

Figure 8-2
FINAL RESULTS OUTPUT FROM THE DATA PROGRAM

SOURCE: ESE, 1990.

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$$\text{Concentration} = \text{Intercept} + M\,(\text{Response}) + M2\,(\text{Response})^2$$

The equation used to calculate final data is dependent on the linearity of the standard curve and method of analysis.

Purgeable organics by GC/MS are calculated as follows:

$$\text{Concentration (ug/L)} = \frac{(A_{sa})\quad(Q_{is})}{(RF)(A_{is})(PV)}$$

where: A_{sa} = area from the extracted ion profile of the primary characteristics ion for the target analyte in the sample,

Q_{is} = quantity of the internal standard [nanograms (ng)],

RF = response factor (see Section 6.2.3),

A_{is} = area from the extracted ion profile of the primary characteristic ion of the internal standard in the sample, and

PV = purge volume (mL).

Acid and base/neutral extractables are calculated as follows:

$$\text{Concentration (ug/L)} = \frac{(A_{sa})(Q_{is})}{(A_{is})\ (RF)} \times \frac{1}{FE} \times \frac{1}{\text{volume}} \times DF$$

where: A_{sa} = area from the extracted ion profile of the primary characteristic ion for the target analyte in the sample;

A_{is} = area from the extracted ion profile of the primary characteristic ion of the internal standard in the sample;

Q_{is} = quantity of the internal standard (ng);

RF = response factor (see Section 6.2);

FE = fraction extract analyzed = $\frac{\text{Volume injected (uL)}}{\text{extract volume (uL)}}$;

volume = volume of extracted sample (mL); and

DF = dilution factor = $\frac{\text{final extract volume for injection (mL)}}{\text{extract volume prior to dilution (mL)}}$

QC acceptance criteria (Section 3.0) for the relative percent difference of replicate spike recoveries and for the range of acceptable recoveries will be stored in the computer data management files for each storage and retrieval (STORET) number/method code combination. If the samples in a sample lot do not pass all the QC checks (Section 9.0), then the results reported in all samples processed in the same sample set may be considered as suspect and the analyses may need to be repeated.

Completed batch folders will be stored in a central location arranged by departments and numerically by batch number. Strip charts and copies of parameter notebooks will be stored in the batch folders.

When the data set is complete for each sampling effort, the computer can be used to organize the information in the field group in a variety of formats. The final reports are generated and reviewed by the Laboratory Coordinator.

8.2 DOCUMENTATION OF RAW DATA

8.2.1 GC/HPLC

Prior to analysis, the analyst must obtain a file folder and all applicable logsheets and data sheets.

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Extraction Logsheet--An extraction logsheet, filled out by the analyst performing the sample extraction, will accompany each lot of samples throughout analysis. This sheet will include at least the following data:

1. Project name and number,
2. Extractor's initials,
3. Type of sample matrix,
4. Field group name;
5. Sample numbers,
6. Date extracted,
7. Analyte group [e.g., pentachlorophenol (PCP), PNAs, pesticides, and PCBs],
8. Initial volume or wet weight of sample extracted,
9. Initial/final pH (water sample),
10. Extracting solvent,
11. Final volume/solvent,
12. Date of cleanup (if required),
13. Notes and comments affecting the extraction procedure, and
14. Appearance of each sample.

After extraction is complete, extraction logsheets will be filed in the batch folder and accompany the extracted samples to the instrumental analyst. Each extract vial will be properly labeled. Each label will contain the following information:

1. Project name,
2. Sample number,
3. Extraction concentration factor,
4. Date extracted,
5. Extractor's initials, and
6. Field group.

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Instrument Logbooks--During analysis, the following information will be recorded in the instrument notebook:

1. A log of the types of analyses run on the instrument, to include:
    a. Column conditions and temperature zones,
    b. Sample numbers or other identification of samples,
    c. Reference to a method describing the analysis,
    d. Analysis date,
    e. Detector used [e.g., flame ionization detector (FID), electron capture detector (ECD)], and
    f. Detector conditions.
2. Service records are kept in a separate maintenance log.

Chromatograms--At the time of analysis, the analyst will include on the chromatogram the following information:

1. Date and time of analysis,
2. Analyst's initials,
3. Instrument used,
4. Project name or number,
5. Field group name,
6. Sample number and other identification for each chromatogram, and
7. Concentration/dilution factor for each sample.

The chromatograms, extraction logsheet, and copies of instrument logbooks will be placed in the batch file folder.

Chromatographic Logsheets--For each analysis, the analyst will record all pertinent information on a standard curve data sheet and chromatographic data logsheet. The standard curve data sheet lists the standards, their concentrations, and the respective responses. The

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chromatographic data sheet lists the samples in order of injection and the factors needed for calculating the concentrations. A sample calculation using calculated response factors will appear on the back of the chromatographic data sheet if responses are calculated manually.

After the analysis and data reduction are complete, the chromatograms and worksheets will be stored in the batch file folder and the data entered in the CLASS system. The folder will be turned in to Data Information Services to be stored in each department's designated filing location.

Standards--Prior to analysis, stock standard solutions and working solutions covering the working range of the method will be prepared. Procedures used in preparing the standards will be recorded in the standards preparation notebook. The following information must be recorded:

1. Reference standard source,
2. Lot number,
3. Date of preparation,
4. Analyst's name or initials,
5. Actual weight measured,
6. Volumetric flask volume,
7. Calculated concentration,
8. Solvent,
9. Dilutions, and
10. Expiration date.

Immediately after an analytical standard has been prepared, the standard will be transferred to an amber glass vial or bottle and properly labeled. Standards should be refrigerated when not in immediate use.

8.2.2 GC/MS

Prior to analysis, the extracting analyst must obtain a batch file folder and all applicable data sheets and logsheets.

Extraction Logsheet--Once a batch has been established, the sample extraction and analysis procedure begins. A GC/MS extraction logsheet, filled out by the analyst performing the sample extraction, will accompany the batch throughout analysis. This sheet will include at least the following data:

1. Project name and number,
2. Analyst's initials,
3. Type of sample matrix,
4. Field group name,
5. Sample numbers,
6. Date extracted,
7. Analyte group (i.e., acids, base/neutrals),
8. Initial volume or wet weight of sample extracted,
9. Initial/final pH,
10. Extract solvent,
11. Final volume/solvent,
12. Date of cleanup, and
13. Notes and comments affecting the extraction procedure.

After extraction, extraction logsheets will be filed in the batch file folder and accompany the extracted samples to the instrument analyst. The extract vial will be properly labeled. The label will contain the following information:

1. Project name,
2. Sample number,
3. Extraction concentration factor and solvent used,
4. Date extracted,

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5. Extractor's initials, and
6. Field group.

Sample Screening--Sample extracts may be screened by GC employing flame ionization detection (GC/FID) prior to GC/MS analysis to permit dilution of extracts (as required) to concentration levels compatible with the GC/MS instrument and column capabilities.

Spectral Data and GC/MS Computer Quantitation Report--The quantitative sample and standard data generated by the GC/MS data system and all mass spectral information will be labeled according to standard procedures and placed in the batch file folder. Manual data reduction sheets also will be placed in this folder.

Standards--Prior to analysis, stock standard solutions and working solutions covering the working range of the instrument are prepared. Procedures used in preparing the standards must be recorded in the preparer's laboratory notebook. The following information will be recorded:

1. Reference standard source,
2. Lot number,
3. Date of preparation,
4. Analyst's name or initials,
5. Actual weight (or volume) measured,
6. Volumetric flask volume,
7. Calculated concentration,
8. Solvent, and
9. Dilutions.

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The analytical standard will be transferred immediately to a properly labeled glass amber bottle or vial after preparation. Standards should be refrigerated when not in use.

GC/MS Instrument Logbooks--Whenever the GC/MS is used for sample analysis, the appropriate information will be recorded in an instrument logbook.

Compound Identification--Compound identification will be made in terms of the full-scan mass spectrum generally obtained in the electron impact mode at 70 electronvolts (eV). Compound identification will require the presence of all significant major ions at the appropriate relative abundance as obtained with an authentic compound or reference spectrum from a reputable literature source. The selection of significant ions is strongly compound dependent, and because of this and other considerations, the identification of compounds will entail considerable professional judgment and experience.

The most convincing evidence for compound identification is comparison of spectrum with that of an authentic compound obtained under identical operation conditions. When this is not possible due to compound availability, computer identification or manual library search will be used.

When no tentative matches are found in the library, identification will be based on application of known fragmentation patterns, empirical correlations, and isotope abundance data. All data reported as a result of library searches will be reported as tentatively identified compounds (TICs).

Compound Quantification--The technique of extracted ion current profiles will be employed for the preliminary qualitative searching and for quantification of individual compounds. Appropriate internal standards will be employed to permit quantification in terms of the relative response to these internal standards. Concentration calculations and data reduction procedures are given in Section 8.1.

Spiking with Internal Standards--All samples will be spiked with quantitation standards just prior to the GC/MS analysis (Section 9.2). Appropriate internal standards will be selected for the remaining categories.

GC/MS Instrumental Detection Limits--The instrumental detection limit refers to the least quantity of material required to provide a total mass spectrum of sufficient quantity to permit compound identification. The mass spectrum must contain all major ions with the appropriate relative abundance within 35 percent of either an authentic compound analyzed under identical conditions or an appropriate reference spectrum from the literature.

Data Management--Output from the gas chromatography/mass spectrophotometry/data system (GC/MS/DS) is variable, depending on the project. However, all raw data such as mass chromatograms will be stored on magnetic tape. The final results are transmitted to CLASS by project and sample number. The calculation results, which are the Quantification reports, will be kept in the GC/MS room by these same identifiers. The frame reference number (FRN) is obtained from the Quantification reports. All magnetic tapes are kept in sequential order with respect to the FRN. By following this sequence, it is possible to obtain all raw data for a particular sample number. The GC/MS computer generates a data file that is transmitted to CLASS. The data

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information center will read the transmitted data and generate a batch report. The batch is returned to the analyst for review. The batch folder, containing the Quantification report, batch report, and copies of logsheets, is stored in the central filing location.

8.2.3 TRACE METALS

Strip Charts--At the time of analysis (currently only applicable to mercury by cold vapor), the following information will be recorded on the strip chart:

1. Analyst's name, initials, or employee number;
2. Date of analysis;
3. Instrument/method used;
4. Element of interest;
5. Instrument conditions;
6. Sample matrix; and
7. Comments.

During analysis, the analyst will indicate on the strip chart sample numbers, QC samples, blanks, and standards.

After the data have been reduced and recorded in the instrument notebook, the strip charts are placed in a batch file folder together with the copies of the digestion logsheet, copies of the instrument logbook, and reduction sheets. These data are entered manually or automatically uploaded to the CLASS system to generate a uniquely numbered batch. The analyst reviews the data and validates the correct transcription of data into CLASS. Then, the batch is signed and submitted to Data Information Services to be stored in the central filing system.

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For ICAP, the ICAP computer produces a data file that is evaluated and transmitted to CLASS. The data information center reads the file and generates a batch. The batch is returned to the analyst for review. The batch, the data file, and copies of logsheets are placed in the batch folder and stored in the central filing location.

Laboratory Notebooks--Each instrument will have its own laboratory notebook. After each analysis, the analyst will record in the notebook the following information:

1. Problems encountered during the digestion/analysis,
2. Comments about the samples and/or analytical procedure,
3. Instrument used,
4. Method used (GFAA, CVAA, ICAP),
5. Date of analysis,
6. Analyst(s),
7. Element,
8. Sample matrix,
9. Instrument conditions,
10. Sample numbers,
11. QC data,
12. Raw data, and
13. Blank subtracted responses.

Standards--Stock standard solutions are purchased from vendors. These stock solutions are certified by the vendor for purity and concentration.

Volumetric dilutions are made from the stock solution to obtain working solutions. Serial dilutions are then made from the working solutions to obtain working standards to be used to generate standard curves.

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Working standard solution are stored in a volumetric flasks and properly labeled with the following information:

1. Preparer's name or initials,
2. Date of preparation,
3. Element(s), and
4. Concentration.

8.3 DATA REVIEW/VALIDATION

Unless otherwise specified by the client, the following procedures for review/validation of data are employed. Data review is initiated by the bench analyst upon conversion of raw data into reportable data. The bench analyst reviews preliminary data, holding times and precision, accuracy, and calibration checks. The analyst provides explanation and/or corrective action for any method control parameters which are outside criteria and signs the analytical batch when satisfied with the data.

The analyst's supervisor or a designated reviewer also reviews the analytical batch and any explanations or corrective actions provided by the analyst. If the supervisor or his designee is not satisfied with the explanations or corrective actions, an additional explanation or corrective action is provided in the batch. The supervisor or his designee signs the analytical batch when satisfied with the data.

The Laboratory Coordinator reviews analytical data batches that have explanations and corrective actions and signs the analytical batch when satisfied with the data. The Laboratory Coordinator also reviews all final data reports for inconsistencies and completeness prior to releasing the reports to the client; qualification of data and/or QC/QA summaries are provided as appropriate.

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The Laboratory QA/QC Supervisor performs quarterly audits to check that the required quality control procedures are being followed. This procedure entails random review of analytical batches to see that the QC designated for the analysis is being consistently performed. A record of this audit is maintained by the Laboratory QA/QC Supervisor. The Laboratory QA/QC Supervisor also initiates and follows up on corrective actions to resolve QC problems.

The minimum QA/QC data that should be included in the data batch are the following:

1. Sample data (matrix, date of extraction, and date of analysis);
2. Parameter, result, and test method identification;
3. Sample-specific detection limits for each parameter; and
4. Results of laboratory control data, method blanks, spikes, and replicates (if required).

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9.0 INTERNAL QUALITY CONTROL CHECKS

9.1 GENERAL QUALITY CONTROL REQUIREMENTS

Analytical QC procedures are those steps taken by the laboratory in day-to-day activities to achieve the desired accuracy, precision, reliability, and comparability of analytical data. Each analytical chemistry department manager and analyst is responsible for performing the analysis in accordance with the defined quality control practices outlined in this manual.

For all analyses performed by ESE, the QC checks described in this section are mandatory unless overridden by the CLP-SOW. Table 9-1 summarizes minimum QC sample requirements. Section 12.0 describes precision and accuracy calculations used to control samples. Sections 3.0 and 6.0 contain QC evaluation criteria for laboratory methods and calibrations.

For QC purposes, the number of samples extracted and/or prepared for instrumental analysis as one group in one 24-hour period will constitute one lot. The number and type of QC samples specified in Section 9.0 will apply to this lot of samples. For example, a group of samples that are extracted on the same day and (if required) undergo concentration and clean-up procedures on subsequent days would be considered one lot for QC purposes. Also a set of samples that are extracted over several days in a 1-week period may be considered one lot as long as the minimum number of QC samples specified in Table 9-1 is also extracted. In this case QC samples should be spread over several days.

Table 9-1. Minimum QC Sample Requirements for Organics and Metals Analysis

Sample Lot	Sample Matrix* Spike	Sample Matrix* Replicate Spike	Standard Matrix Spike$^+$ (QC Check Sample)	Surrogate	Method Blank	Filter Blank (as required)
EACH LOT OF 5 TO 20 SAMPLES**						
All analysis (except GC/MS, organochlorine pesticides, and PCBs)	1	1	1	--	1	1
GC/MS, organochlorine, pesticides and PCBs	1	1	1	All samples spiked	1	1
EACH LOT OF 1 TO 4 SAMPLES						
All analyses (except GC/MS, organochlorine, pesticides, and PCBs)	1^{++}	--	1	--	1	1

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Table 9-1. Minimum QC Sample Requirements for Organics and Metals Analysis (Continued, Page 2 of 2)

	Sample Matrix*		Standard Matrix Spike⁺			
Sample Lot	Spike	Replicate Spike	(QC Check Sample)	Surrogate	Method Blank	Filter Blank (as required)
GC/MS, organochlorine, pesticides, and PCBs	--	--	1	All samples spiked	1	1

Note: -- = not applicable for this analysis.

*Sample Matrix Spike is a spike into a sample matrix which is carried through sample digestion or extraction to sample analysis.

⁺Standard Matrix Spike is a spike into a blank matrix which is carried through sample digestion or extraction to sample analysis. The blank matrix is a reagent blank for aqueous samples and a standard soil for solid matrix, if available; if standard soil is not available, spiking is done on a reagent blank. This spike is also called a QC check sample because the standards used to prepare the spiking solution are from a different source from those used for the calibration standards.

**A sample lot containing 5 to 20 samples may be processed as several smaller analytical batches. An analytical batch should contain at a minimum a check sample and a method blank or filter blank. For GC/MS, pesticides, and PCBs, besides the QC check sample and method blank, the surrogates should also be included in a batch.

⁺⁺The sample matrix spike QC requirement for each lot of one to four samples can be replaced by surrogate spiked into the samples.

Source: ESE, 1989.

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For analyses where no sample extraction or preparation is required, the number of samples that can be analyzed as one set during a 24-hour period will determine the number of samples per lot for QC purposes.

The QA Supervisor may insert into the batch either a spiked sample or a duplicate of a previously analyzed sample for QC purposes. The QA Supervisor will monitor the results of this sample to ensure that the analysis meets QA criteria for the project.

Spikes will be placed into sample matrices for organics and metals analyses. Samples will be split into duplicates, spiked, and analyzed. The relative-percent difference between the spike and the replicate spike will be used to assess analytical precision. Selection of the sample to be split and spiked may be made by the client or by the laboratory.

It is ESE's policy to control sample analyses on those QC criteria that are actually under the control of the technicians and analysts performing the analytical procedure. Therefore, emphasis is placed on calibration, method blanks, and QC check sample (standard matrix spike) results. When these are within criteria, method performance is documented. Sample matrix spikes will be reported and evaluated for precision and accuracy, but not necessarily used for method control. A sample matrix spike that has recoveries outside of criteria limits will be evaluated against other available QC data within that batch in order to determine if the method is in control. Failure of a sample matrix spike to achieve the acceptance criteria when a QC check sample in the same batch has acceptable recoveries often only documents that the method employed is not applicable to that particular matrix, not that the method is out of control.

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In the following subsections, those criteria marked with an asterisk (*) will be used to control the sample analysis. Precision and spike recovery checks are discussed in further detail in Section 12. In addition to the QC samples specified in the following subsections, field QC blanks must be prepared and analyzed as described in Section 4.4.

9.2 GAS CHROMATOGRAPHY/MASS SPECTROMETRY MINIMUM QUALITY CONTROL

For GC/MS analyses of 5 to 20 samples, the following minimum QC checks will apply:

1. All samples spiked with surrogates.
2. At least one spike in sample matrix (MS) with selected actual analytes and surrogates will be analyzed.
3. At least one duplicate spike in sample matrix (MSD) with selected actual analytes and surrogates will be analyzed.

*4. At least one QC check sample spike in blank matrix will be analyzed (spiked with surrogates and selected analytes).

*5. At least one method blank will be analyzed (spiked with surrogates).

*6. One calibration standard will be run and a daily response factor within 35 percent of initial calibration response factor for selected calibration check compounds.

*7. Instrument tuning protocols will be performed and will be within criteria prior to analysis.

Note: An MS and MSD may not be performed for every analytical batch but will be performed at a rate of one MS and one MSD per 20 environmental samples.

For GC/MS analyses of less than five samples, the following minimum QC will apply:

1. All samples will be spiked with surrogates.

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*2. At least one QC check sample spike in blank matrix with selected actual analytes and surrogates will be analyzed.
*3. At least one method blank will be analyzed.
*4. One calibration standard will be run and a daily response factor will be within 35 percent of initial calibration response factor for selected calibration check compounds.
*5. Instrument tuning protocols will be performed and will be within criteria prior to analysis.

9.3 GAS CHROMATOGRAPHY MINIMUM QUALITY CONTROL

For GC-nonvolatiles and HPLC analyses of 5 to 20 samples, the following minimum requirements will apply:

1. All samples spiked with surrogate (dibutyl-chlorendate) for organochlorine pesticides and PCBs analysis only.
2. At least one spike in sample matrix (MS) with selected analytes will be analyzed.
3. At least one duplicate spike in sample matrix (MSD) with selected analytes will be analyzed.

*4. At least one QC check sample (a spike with selected analytes into a blank matrix) will be analyzed. (Note that a surrogate will be added for PCBs only).
*5. At least one method blank will be analyzed.
*6. At least three standards will be run for a standard curve.
*7. Correlation coefficient of the standard curve will be equal to or greater than 0.995.
*8. Samples will be within concentration range of standards.

9. Midlevel calibration standard repeated at the middle of run (if run covered more than a 12-hour period) and at the end of run must be within 20 percent of initial response.

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10. Detection limits for each parameter will be determined and checked to ensure they meet limits specified for the field group.

Note: An MS and MSD may not be performed for every analytical batch but will be performed at a rate of one MS and one MSD per 20 environmental samples.

For GC-nonvolatiles and HPLC analyses of less than five samples, the following minimum requirements will apply:

1. All samples spiked with surrogate (dibutyl-chlorendate) for organochlorine pesticides and PCBs only.
*2. At least one QC check sample (a spike with selected analytes into a blank matrix) will be analyzed. (Note that a surrogate will be added for organochlorine pesticides and PCBs only).
3. At least one spike in the sample matrix for methods with no surrogates.
*4. At least one method blank will be analyzed.
*5. At least three standards will be run for a standard curve.
*6. Correlation coefficient of the standard curve will be equal to or greater than 0.995.
*7. Samples will be within concentration range of standards.
8. Mid-level calibration standard repeated at the end of run and response of control analytes must be within 20 percent of initial response.
9. Detection limits for each parameter will be determined and checked to ensure they meet limits specified for the field group.

For GC-volatiles analyses of 5 to 20 samples, the following minimum requirements will apply:

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1. At least one spike in sample matrix (MS) with selected analytes will be analyzed.
2. At least one duplicate spike in sample matrix (MSD) with selected analytes will be analyzed.

*3. At least one QC check sample spike in blank matrix will be analyzed (spiked with selected analytes).

*4. At least one method blank will be analyzed.

*5. At least three standards will be run for a standard curve.

*6. Correlation coefficient of the standard curve will be equal to or greater than 0.995.

*7. Samples will be within concentration range of standards.

8. Midlevel calibration standard repeated during the run and response of control analytes must be within 20 percent of initial response.
9. Detection limits for each parameter will be determined and checked to ensure they meet limits specified for the field group.

Note: An MS and MSD may not be performed for every analytical batch but will be performed at a rate of one MS and one MSD per 20 environmental samples.

For GC-volatiles analyses of less than five samples, the following minimum requirements will apply:

*1. At least one QC check sample spike in blank matrix will be analyzed (spiked with selected analytes).

2. At least one sample matrix spike.

*3. At least one method blank will be analyzed.

*4. At least three standards will be run for a standard curve.

*5. Correlation coefficient will be equal to or greater than 0.995.

*6. Samples will be within concentration range of standards.

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7. Midlevel calibration standard repeated during the run and response of control analytes must be within 20 percent of initial response.
8. Detection limits for each parameter will be determined and checked to ensure they meet limits specified for the field group.

9.4 TRACE METALS--ATOMIC ABSORPTION AND INDUCTIVELY COUPLED PLASMA (ICAP) SPECTROSCOPY MINIMUM QUALITY CONTROL

For each lot of 5 to 20 samples analyzed by AAS, the following QC checks will apply:

1. At least one spike in sample matrix (MS) will be analyzed.
2. At least one duplicate spike in sample matrix (MSD) will be analyzed.

*3. At least one QC check sample spike in blank matrix will be analyzed (spiked with control analytes).

*4. At least one method blank will be analyzed.

*5. At least three standards will be analyzed for a standard curve.

*6. Correlation coefficient of the standard curve will be equal to or greater than 0.995.

*7. Samples will be within concentration range of the standards.

8. A midlevel standard will be reanalyzed at the middle of the run (if there are more than 10 samples) and at the end of a run, and its response will be within 20 percent of true value.
9. At least one filter blank will be analyzed with all filtered samples.
10. Detection limits for analytes will be determined and checked to ensure they meet limits specified for the field group.

Note: An MS and MSD may not be performed for every analytical batch but will be performed at a rate of one MS and one MSD per 20 environmental samples.

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For each lot of 5 to 20 samples analyzed by ICAP, the following QC checks will apply:

1. At least one spike in sample matrix (MS) with selected analytes will be analyzed.
2. At least one duplicate spike in sample matrix (MSD) with selected analytes will be analyzed.

*3. At least one QC check sample spike in blank matrix will be analyzed (spiked with selected analytes).

*4. At least one method blank will be analyzed.

5. At least one interference check standard will be analyzed.

*6. At least one calibration standard will be analyzed.

*7. Samples will be within concentration range of the instrument.

8. A calibration standard will be reanalyzed at the middle of the run (if there are more than 10 samples) and at the end of a run, and the responses of the calibration check analytes will be within 20 percent of true values.
9. At least one filter blank will be analyzed with all filtered samples.
10. Detection limits for analytes will be determined and checked to ensure they meet limits specified for the field group.

Note: An MS and MSD may not be performed for every analytical batch but will be performed at a rate of one MS and one MSD per 20 environmental samples.

For less than five samples analyzed by AAS, the following QC checks will apply:

*1. At least one QC check sample spike in blank matrix will be analyzed (spiked with all analytes).

2. At least one sample matrix spike.

*3. At least one method blank will be analyzed.

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*4. At least three standards will be analyzed for a standard curve.
*5. Correlation coefficient of the standard curve will be equal to or greater than 0.995.
*6. Samples will be within concentration range of the standards.
7. A midlevel standard reanalyzed at the end of a run and its response will be within 20 percent of true value.
8. At least one filter blank will be analyzed with all filtered samples.
9. Detection limits for analytes will be determined and checked to ensure they meet limits specified for the field group.

For each lot less than five samples analyzed by ICAP, the following QC checks will apply:

*1. At least one QC check sample spike in blank matrix will be analyzed (spiked with selected analytes).
2. At least one sample matrix spike.
*3. At least one method blank will be analyzed.
*4. At least one interference check standard will be analyzed.
*5. At least one calibration standard will be analyzed.
*6. Samples will be within concentration range of the instrument.
7. A standard will be reanalyzed at the end of a run, and the response of the analytes will be within 20 percent of true value.
8. At least one filter blank will be analyzed with all filtered samples.
9. Detection limits for analytes will be determined and checked to ensure they meet limits specified for the field group.

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10.0 PERFORMANCE AND SYSTEM AUDITS

Two types of audit procedures will be used to assess and document performance of project staff: system audits and performance audits. These are performed at frequent intervals under the direction of the Project QA Supervisor. These audits form one of the bases for corrective action requirements and constitute a permanent record of the conformance of measurement systems to QA requirements.

System audits are inspections of training status, records, QC data, calibrations, and conformance to standard operating procedures without the analysis of check samples. System audits will be performed quarterly on laboratory, office, and field operations.

The system audit protocol is summarized as follows:

1. Field Operations--The Project QA Supervisor will review:
   a. Field notebooks, logsheets, bench sheets, tracking forms, and report any inconsistencies and/or omissions;
   b. Field sampling plans; and
   c. Sample site briefing package.
2. Laboratory Operations--The Project QA Supervisor will review:
   a. Parameter and/or laboratory notebooks;
   b. Instrument logbooks;
   c. Sample log-in, dispensing, and labeling for analysis;
   d. Updating of QC criteria for spike recoveries.

   In addition, the Project QA Supervisor may monitor analyses randomly to assure adherence to approved analytical methods.
3. Final Reports--The Project QA Supervisor may review all final reports and deliverables to the client.

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The results of these interlaboratory studies may be evaluated by the Project QA Supervisor as part of the performance audits.

ESE is participating in the following proficiency programs:

1. National Institute of Occupational Safety and Health (NIOSH) through its Proficiency Analytical Testing Program (PAT),
2. NIST proficiency testing program under the National Voluntary Laboratory Accreditation Program (NVLAP) for bulk asbestos,
3. EPA Water Pollution and Water Supply proficiency programs,
4. EPA Radiochemistry Intercomparison Study and Blind Performance Samples,
5. State of New York through its Environmental Laboratory Approval Program (ELAP) for public drinking water and environmental samples categories,
6. State of California Department of Health, and
7. U.S. Army Corps of Engineers.

The licenses, accreditations, and certifications held by the Gainesville analytical laboratory are the following:

1. American Industrial Hygiene Association (AIHA),
2. NIST for bulk asbestos,
3. State of Florida Department of Health and Rehabilitative Services (HRS) for environmental and drinking water analyses,
4. New York Department of Health,
5. New Jersey Department of Environmental Protection,
6. South Carolina Department of Health and Environmental Control,
7. EPA CLP--both organics and inorganics,
8. State of Florida HRS for Radiochemistry,
9. State of California Department of Health Services for hazardous waste testing analyses,

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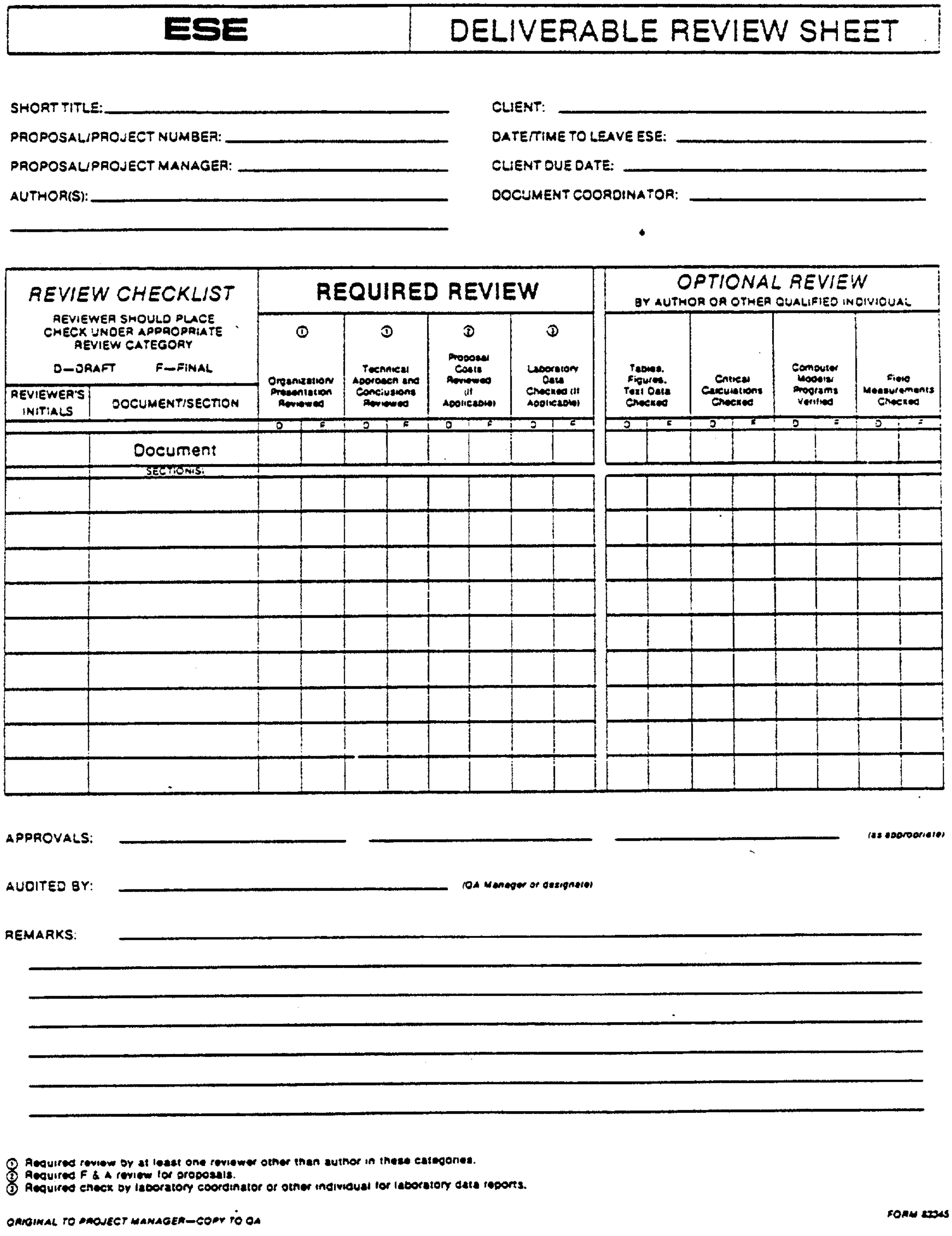
10. State of Tennessee Department of Health and Environment for drinking water analyses,
11. U.S. Army Corps of Engineers, and
12. U.S. Navy.

Peer review of all deliverable reports and data will be performed by technically qualified individuals from each major discipline represented in the deliverable. Figure 10-1 is a sample Deliverable Review Sheet.



ESE | DELIVERABLE REVIEW SHEET

SHORT TITLE: ____________________

PROPOSAL/PROJECT NUMBER: ____________________

PROPOSAL/PROJECT MANAGER: ____________________

AUTHOR(S): ____________________

CLIENT: ____________________

DATE/TIME TO LEAVE ESE: ____________________

CLIENT DUE DATE: ____________________

DOCUMENT COORDINATOR: ____________________

REVIEW CHECKLIST REVIEWER SHOULD PLACE CHECK UNDER APPROPRIATE REVIEW CATEGORY D—DRAFT F—FINAL		**REQUIRED REVIEW**								*OPTIONAL REVIEW* BY AUTHOR OR OTHER QUALIFIED INDIVIDUAL							
REVIEWER'S INITIALS	DOCUMENT/SECTION	① Organization/ Presentation Reviewed		① Technical Approach and Conclusions Reviewed		② Proposal Costs Reviewed (If Applicable)		③ Laboratory Data Checked (If Applicable)		Tables, Figures, Text Data Checked		Critical Calculations Checked		Computer Models/ Programs Verified		Field Measurements Checked	
		D	F	D	F	D	F	D	F	D	F	D	F	D	F	D	F
	Document																
	SECTION(S):																

APPROVALS: ____________ ____________ ____________ (as appropriate)

AUDITED BY: ____________ (QA Manager or designate)

REMARKS: ____________________

① Required review by at least one reviewer other than author in these categories.
② Required F & A review for proposals.
③ Required check by laboratory coordinator or other individual for laboratory data reports.

ORIGINAL TO PROJECT MANAGER—COPY TO QA

FORM 83345

Figure 10-1
DELIVERABLE REVIEW SHEET

SOURCE: ESE, 1990.

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11.0 PREVENTIVE MAINTENANCE

To minimize the occurrence of instrument failure and other system malfunction, a preventive maintenance program for field and laboratory instruments has been implemented. The preventive maintenance performed for each major piece of field and analytical equipment is listed next.

11.1 SALINITY/CONDUCTIVITY/TEMPERATURE METER AND PROBE

Preventive maintenance protocol for the Yellow Springs Instruments (YSI) meter and probe involves red lining the meter to check the condition of the batteries. Probe preventive maintenance involves verification of temperature readings using a mercury thermometer and verification that the probe does not need cleaning. A fouled probe is discovered by measuring a standard on the X100 and X10 ranges, then depressing the CELL TEST button. If the meter reading falls more than 2 percent, the probe is fouled and will be cleaned. Replacement membranes will be available.

11.2 pH METERS AND COMBINATION pH ELECTRODES

Preventive maintenance for the pH meter and electrodes primarily involves the proper care of the electrode. Electrodes are stored in a 1:1 solution of pH = 7 buffer and DI water. The hole to add internal filling solution must be plugged at all times to prevent evaporation of the solution when the electrode is not in use. When the internal filling solution has dried out, the chamber will be rinsed with deionized water before the filling solution is replaced. This step prevents clogging of the probe and poor (<100 percent) slope adjustments when calibrating the electrode. Whenever slope readings are deteriorating or a low ionic strength sample gives erroneous readings, the electrode will be treated with 1N potassium hydroxide (KOH) and 1N HCl.

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Spare parts such as a replacement probe and fresh buffer solutions will be available for the system at all times.

11.3 CONDUCTIVITY BRIDGE AND CELL

Preventive maintenance for the Beckman conductivity bridge involves keeping the rechargeable battery fully charged. Care for the conductivity cell involves storage in a deionized water. Replatinization of the conductivity cell is performed according to Standard Methods (Page 74) only when the cell response becomes erratic, a sharp endpoint cannot be obtained, or when inspection shows that any of the platinum black has flaked off.

11.4 GAS CHROMATOGRAPHS

GC septa will be replaced as needed. Frequent injections will require replacement daily. To prevent contaminants from reaching the detector or columns, carrier and detector gases will be changed when the supply of gas in the cylinder falls below 100 pounds per square inch (psi). Molecular sieves and oxygen traps used in the gas lines will be replaced regularly. GC detectors will be periodically removed and cleaned to remove accumulations that can affect instrument performance.

Instrument calibration curves will be monitored and compared to historical performance. Excessive noise, low response, and poor precision indicate a dirty detector; more frequent detector cleanings may be required. Spare columns, packing materials, instrument cables, and printed circuit boards will be available in case of breakage or malfunction to minimize instrument downtime.

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11.5 GAS CHROMATOGRAPH/MASS SPECTROMETER

All routine preventive maintenance performed for gas chromatographs also will be performed for the GC/MS equipment. In addition, the ionizing source will be periodically dismantled, thoroughly cleaned, and reassembled to prevent serious sensitivity problems. Calibration with selected mass standards will be performed daily to ensure that instrument performance has not deteriorated. The failure to achieve calibration will require source cleaning. Spare parts and equipment will be available for the system components most likely to experience failure. Routine maintenance by the manufacturers' representatives will be performed annually.

11.6 ANALYTICAL BALANCE

Analytical balances will be cleaned and calibrated semiannually by manufacturers' representatives. The accuracy of analytical balances will be checked daily using standard weights. It is imperative that the balance logbooks be maintained daily.

11.7 INDUCTIVELY COUPLED ARGON PLASMA

Routine maintenance on the ICAP system by the manufacturer's representatives is performed annually. In addition, a quarterly service contract is maintained on the minicomputer. Periodically, the analyst will dismantle, clean, and reassemble the torch and nebulizer to prevent serious sensitivity problems. Calibration with selected standards will be performed daily to ensure that the instrument performance has not deteriorated. Failure to achieve standardization could require cleaning, including changing the tubing of the sample delivery system.

Spare parts are available for the system components most likely to experience failure.

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11.8 ATOMIC ABSORPTION

Routine preventative maintenance on the atomic absorption systems primarily consists of keeping components clean (to prevent acid corrosion), replacing expendables, and monitoring instrument response. Instrumental response is compared to historical data and the manufacturers' performance specifications to verify instrument sensitivity. Sample cells (e.g., graphite furnace, hydride cell, and burner/spray chamber) are cleaned periodically to prevent serious contamination. Sufficient stock of spare parts and expendables is maintained at all times to ensure continuous operation. Manufacturers' service representatives inspect instrument optics and other components at least once per year.

11.9 PORTABLE ORGANIC VAPOR DETECTION EQUIPMENT

Preventive maintenance of portable organic vapor detection equipment consists of cleaning the exterior of the equipment after use with a solution of mild detergent and rising with tap water. Care should be taken not to flood the equipment, gentle wiping of the exterior is usually sufficient. No organic solvents are to be used. Care must be taken to prevent ingestion of water or foreign solid material into the inlets of these devices during use and cleaning. Batteries must be recharged at the intervals recommended. Deep discharge of the batteries should be avoided to maximize battery service life. Procedures to be followed for these preventive maintenance activities are found in the instrument manuals supplied with this equipment.

11.10 INSTRUMENT FAILURE

In the event of instrument failure, every effort will be made to analyze samples within holding times by alternate means. The Project Manager will be advised of any required changes in methodology or location; the Project Manager should then notify the U.S. Navy Project Officer.

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12.0 PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

12.1 PRECISION

Precision is a measure of agreement among measurements performed using the same test procedure. Precision will be assessed for applicable parameters by calculating the RPD of two duplicate spike samples as follows:

$$RPD = \frac{|R_1 - R_2|}{(R_1 + R_2)/2} \times 100$$

where: R_1 and R_2 = concentration of Replicate Spikes 1 and 2, respectively.

This calculated RPD value is compared to the maximum value considered acceptable for this project (refer to Section 3.0). The values given in Section 3.0 are precision objectives for this project and are based on EPA criteria (for water samples) or historical ESE data (for solid samples) from replicate measurements. These maximum values represent the upper control limit for the analysis of the QC check samples. Since an absolute value is used for the difference between R_1 and R_2, there is no lower control limit.

12.2 ACCURACY

Accuracy is the degree of agreement between a sample's target value (known concentration) and the actual measured value. Accuracy for this project is measured by calculating the percent recovery (R) of known levels of spike compounds into appropriate sample matrices. Percent recovery is calculated as follows:

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$$R = \frac{100 \times [(\text{Spike Sample Conc.})(\text{Sample + Spike Vol.}) - (\text{Sample Vol.})(\text{Sample Conc.})]}{(\text{Spike Conc.})(\text{Spike Volume})}$$

The following equation is an example of how this would be calculated:

1 mL of spike with concentration of 100 ppb

10 mL of sample with concentration of 10 ppb

spiked sample concentration of 20 ppb

$$= 100 \times \frac{(20)(11) - (10)(10)}{(1)(100)} = 100 \times \frac{120}{100} = 120 \text{ percent}$$

Each calculated R value is compared to the accuracy criteria listed in Section 3.0. The accuracy ranges provided in Section 3.0 are based on the mean accuracy measured or expected (based on EPA data) for each parameter plus or minus three standard deviations of the mean.

If RPD or R values do not meet acceptance criteria for QC check samples as specified in Section 3.0, results reported in all samples processed as part of the same set may be labeled as suspect, and the analysis may need to be repeated. The QA Supervisor will be notified and the necessary corrective action implemented.

12.2.1 CONTROL CHARTS OF ACCURACY

Control charts will be maintained for standard laboratory spike samples for Navy and other specified programs. Initial control charts are prepared using historical ESE data, or are derived from published EPA method data if sufficient inhouse data are unavailable.

The formulas used to establish and maintain control charts for standard laboratory spike QC samples are as follows:

$USL_{\bar{x}} = \bar{\bar{X}} + 3SD$
$UWL_{\bar{x}} = \bar{\bar{X}} + 2SD$
$LWL_{\bar{x}} = \bar{\bar{X}} - 2SD$
$LCL_{\bar{x}} = \bar{\bar{X}} - 3SD$

where: $\bar{\bar{X}}$ = mean of the recoveries of the laboratory spikes
SD = Standard Deviation of the mean
UCL = Upper Control Limit
UWL = Upper Warning Limit
LWL = Lower Warning Limit
LCL = Lower Control Limit

All recoveries will be plotted on the appropriate matrix-specific control charts.

12.2.2 OUT-OF-CONTROL SITUATIONS

An out-of-control situation for accuracy control charts may be indicated by the following:

1. Any one point plots outside the control limits.
2. Any eight consecutive points plot on the same side of the mean.
3. Any six consecutive points trend in the same direction.
4. A cyclical pattern is evident.
5. Any three consecutive points plot within the control limits but outside the warning limits.

The occurrence of any of these events will be investigated; corrective actions will be taken as required to return the system to a state of statistical control. All corrective actions will be documented.

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12.3 COMPLETENESS

Completeness is defined by EPA (1980) as "a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct normal conditions." A completeness of at least 90 percent for each parameter is the objective for this project. Following completion of the analytical testing, percent completeness will be calculated as follows:

$$\text{Completeness (\%) for parameter } y = \frac{\text{\# of valid y values reported}}{\text{\# of samples collected for analysis of y}} \times 100$$

If completeness is less than 90 percent for any parameter(s), the Project Manager will be notified immediately. The Project Manager is responsible for determining if resampling will be necessary to meet project objectives and will inform the QA Supervisor and Laboratory Coordinator of the decision.

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13.0 CORRECTIVE ACTION

Corrective action is necessary when any measurement system fails to follow this QA Plan. Items that may need corrective action range from a minor problem of a field team member failing to sign a field form to a major problem of an analyst using an improper analytical method. For this reason, corrective action protocols must be flexible.

In general, items needing corrective action fall into three "correction" categories: short-term, long-term, and QC; each item requires different action.

<u>Short-Term Corrective Actions</u>--These actions consist of minor and major problems that can be corrected immediately. Examples include failure to date or sign a standard form, incorrectly preserving sample, and errors in data entry. Corrective action is initiated by verbally calling attention to the problem followed by written notification.

<u>Long-Term Corrective Actions</u>--The actions consist of minor and major problems that require a series of actions to resolve the problem. The actions to be taken are coordinated by the Project QA Supervisor or Laboratory QA/QC Supervisor, and a QA corrective action and routing form (Figure 13-1) is used to track the action. An example of this type of corrective action is as follows:

> Problem--A field team member fails to calibrate a photoionization instrument in the field prior to use.
>
> Corrective Action--The problem is identified by the person originating the corrective action, responsibility is assigned to an appropriate person (may be someone other than person failing to

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QUALITY ASSURANCE CORRECTIVE ACTION REQUEST AND ROUTING FORM

1. Identification of a Problem: CA#

Originator: Date:

Nature of Problem:

2. Determination of Required Action:

Responsibility Assigned to: Due Date:

Recommended Action:

3. Implementation of Required Action:

Responsibility Assigned to: Due Date:

4. Assuring Effectiveness of Action:

Responsibility Assigned to: Due Date:

Procedure to Assure Effectiveness:

Figure 13-1
QUALITY ASSURANCE CORRECTIVE ACTION REQUEST AND ROUTING FORM

SOURCE: ESE, 1990.

MARINE CORPS BASE
CAMP LEJEUNE

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calibrate the instrument), an appropriate standard gas is selected, the gas is ordered, receipt of the shipment gas is verified that the order is filled properly, training of field members in the use of the gas is required, and the instrument is calibrated in the field during the next field trip. The QA Supervisor audits this process to assure that it is completed in an expeditious manner.

Quality Control Corrective Action--Consists of corrective action following a failure to meet QC criteria specified in this QA Plan and the analytical methods. Actions taken consist of two types: those resolved within each analytical department and those resolved outside the department. Examples outlining the differences between these two types of corrective action are as follows:

WITHIN DEPARTMENT ACTION

QC Failure	Department Action
Tuning results for GC/MS fail criteria in Methods 8240 and 8270	Analyst re-tunes instrument
Standard curve correlation coefficient is less than 0.995	Analyst investigates problem and reruns curve and samples
Sample response falls outside calibration curve	Analyst dilutes sample into range of curve

OUTSIDE DEPARTMENT ACTION

QC Failure	Department Action
Holding times are exceeded	Project Manager, Laboratory Coordinator, and QA Supervisor are notified; resampling may be necessary

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Corrective actions may be initiated for each measurement system (individual disciplines) by subproject managers or other responsible individuals such as the Laboratory QA/QC Supervisor, Department Manager, or Division Manager. The Project QA Supervisor, Laboratory QA/QC Supervisor, Analytical Section Manager, or Division Manager will be responsible for approving the corrective action.

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14.0 QA REPORTS TO MANAGEMENT

QA activities are reported to management by the Project QA Supervisor in three ways:

1. Verbal notification of significant deficiencies immediately upon discovering the problem,
2. Writtern interim QA reports, and
3. Written final QA reports.

A final QA report will be prepared for each project. Interim reports will be prepared at the request of the Project Manager. The contents of both interim and final QA reports will be similar, except the final report will include a summary of the interim reports.

The following items will be addressed in the reports:

1. An assessment of the precision and accuracy data associated with sample data generated during the report period, and
2. Results of any QA audits performed during the report period.

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15.0 RESUMES OF KEY PERSONNEL

Following are the resumes of key individuals involved in the QA/QC process.

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JOHN D. BONDS, Ph.D.
Quality Assurance Program Manager

SPECIALIZATION

Project Management, Atmospheric Chemistry, Water Chemistry, Industrial Hygiene, Quality Assurance/Quality Control, Hazardous Waste, RI/FS

RECENT EXPERIENCE

Preparation of Quality Assurance Guidelines for EPA Project Officers, Project Manager--Preparation of QA guidelines for use by EPA project officers in selecting contractors for projects requiring sampling and analysis. Also included guidelines for quality assurance audits of the field sampling and analysis portion of any awarded contract. EPA publication 600/9-79-046 entitled Quality Assurance Guidelines for IERL-Ci Project Officers was produced under this project.

Air Compliance Testing of Industrial Sources, Project Manager--Various projects involving compliance testing at petroleum refineries, Kraft pulp mills, power plants, iron and aluminum smelting operations, and various other industries. Power industry clients include Tampa Electric Company, Florida Power Corporation, Florida Power & Light (Martin County), and Gulf Power Company.

Siting Studies, Team Leader--Seminole Electric and FPC in Gulf County.

Development of Remedial Action Plan, Project Manager--Remedial action alternatives were evaluated in a contract for USATHAMA to select the most cost-effective alternative for cleanup of a transformer/ capacitor burial. Developed remedial action plan. Participated in public meeting to provide technical expertise on PCB contamination.

Initial Assessment for Hazardous Wastes at Army Installations, Team Leader--Comprehensive study at 48 Army installations to determine both past and present history with respect to the use of hazardous substances, quantities used, disposal methods, and disposal sites. Also included an assessment of safety practices and compliance with regulations. Provide technical expertise at public meetings.

Initial Assessment Studies for the United States Air Force, Team Leader--Comprehensive studies at two Air Force bases to determine both past and present history with regard to the use and disposal of toxic and hazardous materials. Conducted in accordance with the Department of Defense Installation Restoration Program policies.

Initial Assessment Studies for the Naval Energy and Environmental Support Activity, Team Leader--Evaluated two Naval installations with regard to past hazardous waste generation, storage, treatment, and disposal practices. Investigations included records review, aerial and ground site surveys, employee interviews, and limited sampling and analysis including geophysical techniques. Determined extent of contamination at former disposal/spill sites, potential for contaminant migration, and potential effects on human health and the environment.

Phase II Confirmation Studies to Determine the Presence and Migration of Hazardous Wastes from Military Installations, Team Leader--Five comprehensive field studies to determine the actual sites where hazardous substances were used, their current concentrations in soils, surface waters and groundwater, and an assessment of the quantities which may migrate from the installation. The study also included recommendations for decontamination operations.

Determination of Hazardous Chemicals in Landfills, Project Manager-Several studies in which field sampling techniques and laboratory methods were developed to determine the existence and concentrations of explosive gases generated by landfill operations, priority pollutants escaping to the atmosphere, and contaminating the groundwater.

Ambient Air Monitoring, Project Manager--Various projects to determine ambient air concentrations of sulfur oxides, particulates, nitrogen oxides, carbon monoxide, photochemical oxidants, priority pollutant organics, and hydrocarbons.

EDUCATION

Ph.D.	1969	Analytical Chemistry	University of Alabama
B.S.	1963	Chemistry	University of Alabama

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TIMOTHY D. CASE

63 Third Street Apt. G-2
Clifton, NJ 07011
Ph: 201/614-1736

Date of Birth: October 7, 1959
Excellent Health 5' 10" 165 lbs.
Maritial Status: Single

CAREER OBJECTIVE: Sales position with a company specializing in service to the environmental industry.

PROFESSIONAL AND WORK EXPERIENCE:

HUNTER ENVIRONMENTAL SERVICES: Rutherford, NJ (March, 1989 - Present)
Position: Staff Geologist - Hazardous Waste Specialist

Responsibilities and Accomplishments:

- Meet with clients and prepare proposals/bids for potential environmental services. This includes subcontracting of certain services and costing.

- Author of the Part B Contingency Plan for the hazardous waste incinerators and storage facility at the Pfizer facility in Groton, CT. The Pfizer facility is a major research and production chemical facility.

- Field Operations Leader (FOL) for RI/FS at Bioclinical Laboratories (Bohemia, Long Island, NY) $1.3 million Superfund Site - Responsible for day-to-day review of the field activities performed onsite, overall management and coordination of the field work, supervision and scheduling of work, and ensuring that project-specific plans and the implementation of field investigations are in compliance with appropriate guidelines. The documentation of the field effort/results at the conclusion of the RI/FS is also the responsibility of the FOL.

- Perform environmental site audits/assessments, UST removal/ management projects, aquifer pump tests, supervision of soil boring/monitor well installations, and sampling of soil, air, water, and waste for various projects.

- Prepare comprehensive and technical reports pertaining to the tasks identified above.

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY: Peoria, IL (June, 1987 -Present)
Position: Environmental Protection Specialist - Div. of Land Poll. Control

Responsibilities and Accomplishments:

- Conduct field inspections at solid/liquid waste management facilities. These facilities include solid waste landfills, hazardous waste generators, hazardous waste storage and/or treatment facilities, and hazardous waste landfills.

- Regional Groundwater Coordinator - conduct Comprehensive Groundwater Monitoring Evaluations (CME) at RCRA facilities requiring groundwater monitoring.

- Prepare comprehensive and technical reports pertaining to the Environmental Protection Act, RCRA and the Illinois Pollution Control Board's Waste Disposal Regulations.

- Collect any necessary waste, soil, and/or water samples using approved methods.

DAILY ANALYTICAL LABORATORIES: Peoria, IL (November, 1986 - June, 1987)
Position: Staff Chemist

Responsibilities:
- Soil, surface and groundwater sampling.
- Asbestos field inspections, sampling and analysis.
- Key operator for total organic carbon and halogen instruments.

MARKETING-DIRECT SALES: Peoria, IL (June, 1983 - November, 1986)
Position: Sales representative/branch manager

Responsibilities: Sales representative for various companies marketing energy saving products and equipment. As a branch manager, duties included direct sales, recruiting and training of personnel, processing orders, collections and payroll.

EDUCATION:

WESTERN ILLINOIS UNIVERSITY: Macomb, IL
Bachelor of Science: May, 1983
Major: Geology Minor: Geography

CONTINUING EDUCATION and PROFESSIONAL DEVELOPMENT:

- Conducting Environmental Site Audits - Hunter Environmental Services, September 8, 1989, Rutherford, NJ
- Project Management Training Course - Practice Management Associates, Ltd., July 7-8, 1989, Greenville, NC
- Annual Refresher Course on Health and Safety for Hazardous Waste Site Investigation Personnel - New York/New Jersey Hazardous Materials Worker Training Center, May 17, 1989
- Sanitary Landfill Design Course - University of Wisconsin - College of Engineering, February 22-24, 1989
- Land Disposal Restrictions Training Course - USEPA, December 6-7, 1988, Chicago, IL
- Introduction to Lotus 1-2-3 - Bradley University, September 30 and October 7, 1988
- RCRA Groundwater Monitoring Training Course (Use of the Technical Enforcement Guidance Document and Compliance Order Guide) USEPA, October 3-5, 1988, Washington, DC
- Training Course - Hazardous Waste Landfill Design, Construction and Closure - USEPA, July 14-15, 1989, Chicago, IL
- Seminar - How to be an Effective Witness - IEPA (Legal Division), xxxxx, 1988, Springfield, IL
- Basic Training in Hazardous Site Operations - IEPA, March 21-26. 1989, Springfield, Il

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MARTHA T. FRIEDRICH

Areas of Specialization

Technical Writing and Editing, Document Coordination, Writing and Editing of Manuals, and Preparation of Technical Reports

Experience

Technical Writer/Editor, Publications and Communications Division, Environmental Science & Engineering, Inc. (ESE), Gainesville, Florida, 1989 to present.

U.S. Army Corps of Engineers (USACE), Savanna Army Depot Activity, Technical Editor and Document Coordinator--Responsibilities included technical editing and document coordination of a RCRA permit application for an Army ordnance depot for treatment and storage of hazardous waste for USACE. Specific duties included editing text, coordinating graphics, formatting and interfacing sections, and supervising word processing, printing, binding, and distribution of both draft and final documents.

Equal Employment Opportunity Manual, Technical Editor and Document Coordinator--Responsible for editing and coordinating manual to address government requirements for Affirmative Action and company goals and objectives. Specific duties included meetings with Human Resources Division to ensure completeness of response, updating and interfacing Personnel Policies and Procedures, arrangement of graphics, and sectional compilation of the manual. Supervised word processing, graphics production, printing, binding, and distribution.

Proposal Preparation and Summary Report, Westinghouse Electric Company (WEC), Technical Editor/Document Coordinator--Served as editor for the regulatory requirements section of a proposal being developed by WEC wherein ESE provided information concerning power plant licensing and permitting and evaluation of proposed power plant sites. Text submitted contained numerous tables to be formatted and edited. A summary report to WEC followed. Specific duties included supervision of word processing, graphics, printing, binding, and distribution.

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Management and Storage of Surface Waters (MSSW) Permit Application, Sabal Hammocks Development Company, Technical Editor and Document Coordinator--Edited and coordinated technical information required in support of an MSSW permit, including formatting and interfacing numerous tables, figures, maps, and appendices. Responsible for supervision of word processing, graphics, printing, binding, and distribution.

Toxicity Test Reports, American Petroleum Institute (API), Technical Editor and Document Coordinator--Edited report, formatted extensive tables, compiled 27 appendices, and supervised printing, binding, and distribution, all with a short turnaround time.

Technical Report, The Clorox Company, Technical Editor and Document Coordinator--Responsible for editing a highly technical report on the hydrolysis of NOGPS studied in aqueous media. The report presented biological and analytical procedures followed and data generated and involved complex equations and tables to be formatted and inserted. Duties also included supervision of word processing, graphics, printing, binding, and distribution.

Technical Writer/Editor, Environmental Services and Permitting, Inc., Alachua, Florida, 1988 to 1989.

Proposals, Manager, Word Processing and Graphics and Technical Editor--Responsible for coordination of writers, technicians, and support staff in production of proposal documents. Specific duties included project initiation meetings, supervision of word processing and graphics personnel and work assignments, editing, and coordination of printing, binding, and distribution.

Technical Reports/Progress Reports, Manager, Word Processing and Graphics and Technical Editor--Responsible for editing, supervision of word processing and graphics personnel and work assignments, and coordination of printing and binding.

Technical Writer/Editor, Informed Technology, Inc., Bowie, Maryland, 1986 to 1988

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Security System User's Manual, Technical Writer/Editor--Responsible for initiating writing of manual to accompany privately developed and marketed software package. The process included learning to use the software program while concurrently developing and formatting the manual.

Various Proposal Efforts, Technical Editor--Supervised production of proposals. Specific duties involved editing, coordinating text, and assuring adherence to federal regulations.

Education

B.A.	1959	English	University of North Carolina

Associations and Certifications

Society for Technical Communication

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PAUL C. GEISZLER, M.S.
Senior Scientist

SPECIALIZATION

Priority Pollutant and NPDES Analyses, Gas Chromatography/Mass Spectrometry, Petroleum Hydrocarbon Analysis, Environmental Chemistry

RECENT EXPERIENCE

RI/FS at Rocky Mountain Arsenal, Laboratory Manager--Includes multi-phase analyses at two laboratories for three-year intensive effort. Established methods certifications, developed analytical program, produced data, and summarized results. Included interactions with subcontractor lab.

RI/FS Projects at Multiple Army Sites Under USATHAMA Remedial Action Technical Support Contract, Laboratory Manager--Sites includes Sharpe AD, CA; Letterkenny, PA; West Virginia Ordnance Works, WV; Anniston AD, AL; and Tobyhanna AD, PA.

RI/FS at Multiple Navy Facilities NAVFAC, Laboratory Manager--Sites included Camp LeJeune, NC; Charleston Naval Shipyard; Charleston Naval Weapons Station, SC; Roosevelt Roads, PR.

Military Installations, USATHAMA, Laboratory Project Manager--Numerous projects including Phoenix Military Reservation, Lexington, Bluegrass, and Gateway installations. Projects involved certification of several methods, preparation and coordination of sampling events, and chemical analyses of samples.

Environmental Assessment of Toxic and Hazardous Waste Handling Practices at Naval Installations, Project Chemist--Responsible for conducting onsite environmental surveys which assess current and past waste activities at military installations. Hazardous and toxic waste management is emphasized.

Naval Energy and Support Activity Record Search, Team Member--In charge of chemistry and ecology initial assessment at the Naval Supply Center-Craney Island, Portsmouth, Virginia. In charge of chemistry and ecology at Sewells Point Naval Complex, Norfolk, Virginia.

EDUCATION

M.S.	1976	Chemistry/Biology	University of Southern Mississippi
B.S.	1972	Biology/Chemistry	Southern Illinois University

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ROBERT G. GREGORY, M.S.

Areas of Specialization

Geology, Hydrology, Geotechnical Exploration, Waste Management

Experience

Staff Geologist, Program Operations, Hunter/ESE, Inc., Gainesville, Florida, 1978 to present.

Project Manager, Hydrogeologic Study and Permitting Program, Three Sanitary Landfills at Ft. Stewart Army Installation, Hinesville, Georgia--Tasks include well drilling, soil borings, water quality sampling and analysis, laboratory soils analysis, and engineering to ensure that landfills comply with RCRA guidelines.

Field Geohydrologist, Geologic and Geohydrologic Environmental Assessment, Army Facilities, USATHAMA--Responsible for identifying site deficiencies, ground water contamination potential, and corrective measures to mitigate pollutant transport in a multi-year study. Sites included Fort Knox, Kentucky; Lima Army Tank Center, Ohio; Ft. Gillem, Georgia; and Red River Army Depot, Texas.

Discipline Manager (Geotechnical), Siting Study, 440-MW Coal-Fired Electric Power Generating Facility, Southern Illinois Power Cooperative--Study area included Southern Illinois, and a two-county fringe area of Missouri, Kentucky, and Indiana. Tasks included assessment of geologic hazards (seismic risk, foundation stability) and site suitability.

Discipline Manager (Geotechnical), Siting Study, 650-MW Coal-Fired Electric Power Generating Facility, Soyland Power Cooperative--Study area included the entire state of Illinois. Tasks included assessment of geologic hazards (seismic risk, foundation stability) and site suitability.

Project Manager, Multidisciplinary Study in the Land Pebble Phosphate District of Central Florida, Major Phosphate Mining Company--Project evaluated the interrelationships among mining activities, surface water impoundments, stream relocations, and large-scale pumping of the Floridan Aquifer and the affects of these events upon the near-surface hydrology of the area through time.

Technical Field Supervisor, Supervised Pump Tests on the Site of a Planned 1600 MW Net Coal-Fired Power Plant, Gulf County, Florida, Florida Power Corporation--Pump tests performed on deep and shallow water table aquifers and the deep confined Floridan aquifer.

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Remedial Investigation/Feasibility Study (RI/FS), Tobyhanna Army Depot, Tobyhanna, PA, Project Manager--RI/FS to determine source of observed offpost of potable aquifer by organic solvents. RI consisted of review of aerial imagery, performance of geophysical survey, soil gas survey, soil trenching operation, monitor well installation, sampling and flow testing, and sampling of ground water, surface water, soil, and sediment. Risk assessment conducted to quantify the risk to receptor populations resulting from ingestion of measured contamination. FS element to develop specific ranking of appropriate remedial technologies to meet standards developed in the risk assessment.

Ground Water Contaminant Assessment, Phoenix Military Reservation, Jacksonville, Maryland, Project Manager--Geohydrologic and ground water quality assessment to evaluate the potential for migration of organic solvents from a near-surface source toward the potable ground water aquifer contained within the fractured metamorphic bedrock of the Maryland Piedmont geologic province. The preferred migration pathways within the fractured bedrock were identified by the geotechnical and sampling/analysis programs which consisted of soil sampling, bedrock coring, monitor well installation, soil gas investigations, potable well sampling, and analytical chemistry.

Remedial Action Alternatives Analysis, Phoenix Military Reservation, Jacksonville, Maryland, Project Manager--Conducted a focused feasibility study to determine the options for ultimate disposition of Phoenix Military Reservation, an abandoned NIKE missile facility. Field efforts included the development of a reliable technique to sample and analyze soil samples for volatile organic compounds and an active soil gas survey to determine the extent of the contaminant source. Extensive cost analyses of remedial options were tabulated and final recommendations for disposition were formulated.

Ground Water Contamination Assessment, Fort Detrick, Frederick, Maryland, Project Manager--Performed a hydrogeologic and water quality study for the U.S. Army Biomedical Research and Development Laboratory to assess potential contamination of shallow ground water by past solid water disposal practices. Additionally, ongoing RCRA closure permitting process was supported by the investigation.

Ground Water Contamination Assessment, Fort Belvoir, Virginia, Project Manager--Conducted a hydrogeologic and water quality study to assess potential for ground water contamination by spilled fuel (diesel, JP-4, JP-5) and waste solvents. Past solid and liquid disposal practices resulted in contamination of both the soil and

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underlying fractured metamorphic bedrock. Migration via surface discharges into the drainage network, ultimately reaching the Potomac River, was investigated. Direct ground water discharge into the Potomac River also was studied.

Ground Water Treatment Feasibility Study, Letterkenny Army Depot, Chambersburg, Pennsylvania, Senior Geohydrologist--Study to evaluate the geotechnical and chemical engineering feasibility of ground water extraction and treatment from a fractured bedrock terrain. An extensive multi-instrument geophysical survey was conducted to evaluate the ability of geophysical techniques to detect faults and fractures in the bedrock to assist in placement of effective extraction wells. Aquifer testing was conducted to provide data utilized in ground water modeling efforts (contaminant transport).

Environmental Survey of Fort Gillem, Georgia, Senior Geohydrologist-Performed a geohydrologic and water quality investigation to determine the existence and potential migration of waste oils and solvents from land disposal operations and fluid discharges to the residual soils (saprolite) overlying the fractured igneous and metamorphic terrain of the Georgia Piedmont Province. Interrelation of surface drainage network to saprolite and bedrock water-bearing zones was investigated.

Remedial Investigation (RI), Louisiana Army Ammunition Plant, Doyline, Louisiana, Project Manager--Investigation integrating existing ground water, surface water, and soil chemistry data with new data to prepare a complete RI document. Four disposal areas which received waste nitroaromatic compounds were investigated to determine the extent of the contamination and the potential for migration. Multi-depth well clusters were installed, an extensive well testing program (slug test) was completed, and a comprehensive well sampling program was conducted.

Geohydrological Investigation and Evaluation, Defense Depot, Ogden, Utah, Project Manager--Managed geophysical surveys, soil gas sampling and analysis, evaluation of aerial photographs, a soil boring program, monitor well installations, ground water and soil sampling, and aquifer testing to evaluate extent of environmental contamination at six sites by waste solvents, POL, herbicides, pesticides, chemical agents, and heavy metals resulting from past operations. Site consisted of alluvial and riverine deposits derived from adjacent Wasatch Mountains.

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Phase II Verification and Characterization Step Survey, Marine Corps Base, Camp Lejeune, North Carolina, Project Manager--A multi-step confirmatory survey is being conducted to determine the source and extent of contamination at 23 discrete study areas within Camp LeJeune. Work elements include record searches, HRS rankings soil gas surveys, geophysical surveys, potable well sampling, soil sampling, surface water and sediment sampling, tissue sampling, monitor well installations, aquifer testing, and health risk assessments. A feasibility study for ground water remediation of the deep potable aquifer is being conducted. Target analytes include VOA, metals, POL, herbicides, pesticides, ordnance compounds, TCDD, and EDB.

Environmental Survey, Fort Wingate Depot Activity, Gallup, New Mexico, Site Geologist--Study consisted of the development and implementation of a ground water, surface water, sediment, and soil sampling network to evaluate the effects of past munitions washing activities and ongoing munitions storage and demolition activities. Site located on alluvial fans originating in Zuni Mountains located at the southern installation boundary.

Remedial Investigation, Air Force Plant No. 6, Marietta, Georgia, Senior Geohydrologist--Work efforts included management and design of the field data collection efforts, designed to provide contaminant assessment data for several former landfill areas. Specific efforts included installation of monitor wells, soil sampling and analysis, geophysical surveys, ground and surface water sampling and analysis, and an OVA soil gas survey. Site located in rolling hills composed of decayed igneous and metamorphic bedrock. Aquifers of concern included shallow zone in residual soils and underlying fractured bedrock aquifer.

Remedial Investigation, Dobbins Air Force Base, Marietta, Georgia, Senior Geohydrologist--Management and design of field data collection programs. Field efforts included installation of monitor wells, soil sampling and analysis, geophysical surveys, ground water and surface water sampling, and sediment sampling and analysis. Study areas consisted of former landfill areas located in residual soils overlying metamorphic bedrock terrain.

RCRA/Solid Waste Disposal Project,-Project Manager--Hydrogeologic study and permitting program for three sanitary landfills at Ft. Stewart Army Installation, Hinesville, Georgia. Tasks include well drilling, soil borings, water quality sampling and analysis,

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laboratory soils analysis, and engineering to ensure that landfills comply with RCRA guidelines.

Task Manager, Base-Line Leachate-Monitoring Program--Supervised installation and development of 19 monitor wells for the proposed ash-storage area at Florida Power Corporation's Crystal River Units 4 and 5.

Field Geologist, Hydrogeologic Study of a 130-Square-Mile Area, Collier County, Florida--Duties included field inspection of well drilling operations, final well site and depth selection, well testing procedures, subsurface sampling (strata and water), percolation tests and pump tests in a 130 well program.

Site Manager, Hydrogeologic and Water Quality Study, Fort Wingate Depot Activity, Gallup, New Mexico--Tasks included the development of a ground water, surface water, sediment, and soils sampling network to evaluate the effects of past munition washing activities and ongoing munitions storage and demolition activities.

Geologist, Caribbean Soil Engineers, Inc., July 1978 to September 1978.

Field geologist, foundation boring investigations for condominium and office park projects on St. Thomas and St. Croix, U.S.V.I., and Curacao, N.A., in the West Indies. Tasks included placement of borings, subsurface sampling, and laboratory analysis.

Field geologist, offshore drilling in Willemsted Harbor, Curacao, N.A. Project involved assessment of quantity of igneous rock available as fill for a container offloading facility.

Graduate Research Assistant, University of Florida, Gainesville, Florida, 1975 to 1978.

Conducted field and laboratory work associated with a reconnaissance geothermal survey of Alabama, Georgia, South Carolina, North Carolina, Eastern Tennessee, and Southern Virginia.

Education

M.S.	1978	Geology	University of Florida
B.S.	1975	Geology	University of Florida

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Publications

Gregory, Robert G. 1978. A Geothermal Study of Alabama, Georgia, and South Carolina. In: Master's Thesis, University of Florida, Gainesville, Florida.

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GLENN T. JACKSON, B.A.
Associate Scientist

SPECIALIZATION

Gas Chromatography, Volatiles Analysis, Pesticide and PCB Residue Analysis, Trace Organic Methods Development, Soil Gas Analysis, Specific Detectors in Gas Chromatography

RECENT EXPERIENCE

Management--Department Manager, GC-Volatiles. Responsible for all departmental, technical, and administrative operations for the GC-Volatiles Department, and responsible for the analysis of volatile organic compounds in various environmental media.

Soil Gas Analysis, Sharpe Army Depot, Stockton, CA, Project Chemist--Responsible for onsite setup and operation of Photovac GCs for soil gases analysis and headspace analysis of waste plant water samples.

Quadrex PCB Cleanup, FAA, Nashua, NH, Project Chemist--Responsible for onsite setup and analysis of PCBs in transformers, capacitors, surfaces, and air during Quadrex cleanup procedure.

USATHAMA Air Stripper, Sharpe Army Depot, Stockton, CA, Project Chemist--Responsible for onsite setup and analysis of volatiles during operation of ESE's air stripper.

Carbon Adsorption Study, Ciba-Geigy Field Study Plan, Phase III, St. Gabriel, Louisiana, Project Chemist--Responsible for onsite setup and operation of DMCAT, and analysis to validate DMCAT technology using a full-scale system.

USATHAMA Air Stripper, Chemist--Involved the study of DMCAT to predict removal of volatiles and organic pesticides from artificial wastewater using ESE's pilot plant.

Florida, Project Chemist--Work performed to verify analysis of DMMP for Brunswick Corporation, which included an onsite visit to observe stimulant generator operation and make recommendations.

Air Quality Monitoring, USBI, Cape Kennedy, Florida, Team Member--Onsite air monitoring and GC analysis for volatiles due to insulation spraying operation.

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Laboratory Construction--Supervised construction, setup, and operation of ESE's expanded GC Volatiles lab.

Laboratory Construction--Supervised construction, setup, and operation of ESE's original GC Volatiles lab.

Volatiles Certifications, Project Chemist--Responsible for method development and certification for various volatiles analysis in soils and waters for USATHAMA projects.

EDB Certification, Project Chemist--Responsible for method development and certification for EDB analysis.

EDUCATION

B.A.	1972	Chemistry/English	University of South Florida

REGISTRATIONS AND CERTIFICATIONS

Certified, Employee Development Course in Hazardous Materials and Site Investigations

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CHARLES G. MANOS, JR., PH.D.
Staff Scientist

SPECIALIZATION

Inorganic Analytical Chemistry, Soil Chemistry, Clay Mineral Chemistry, Quality Assurance, Mathematical Modeling, Surface Chemistry

RECENT EXPERIENCE

Contract Laboratory Program, Environmental Protection Agency, Project Manager--Responsible for laboratory methods, reporting requirements, and quality assurance.

Gaseous Hydrocarbons in Soils, Environmental Protection Agency, Task Manager and Principal Investigator--Project modeling diffusion, adsorption, and migration of volatile organic compounds in soils.

Studying Deposition Mechanisms of Fuel-Bound Contaminants, U.S. Department of Energy, Research Chemist--Principal Investigator studying deposition mechanisms of fuel-bound contaminants in coal-fired gas turbines. Responsible for design and implementation of experiments measuring effect of individual coal minerals and elements on deposition using laser-induced fluorescence and fiber optic atomic absorption.

Environmental Protection Agency Contract Laboratory Program, Radian Corporation, Senior Scientist/Engineer--Project Manager/Quality Assurance Officer for Radian's involvement in the U.S. EPA's Contract Laboratory Program. Project Manager and Task Leader for Radian contracts with the U.S. Department of Energy concerning development of new fuel forms from coal, and U.S. EPA project modeling diffusion, adsorption, and migration of volatile organic compounds in soils. Similar involvement with other projects that included work with clay liners, hazardous waste sites, and matrix-specific methods development for environmental analyses.

Environmental Protection Agency Contract Laboratory Program, Toxicon Laboratories, Inc., Manager, Inorganic Chemistry Division, Project Manager and Quality Assurance Officer--Supervised operation of all inorganic analyses including classical parameters, graphite furnace atomic absorption, and inductively coupled plasma emission spectrophotometers for Toxicon's involvement in the U.S. EPA's Contract Laboratory Program. Prepared and maintained budgets for laboratory and projects.

EDUCATION

Ph.D.	1982	Soil Chemistry/ Clay Mineralogy	Michigan State University
M.S.	1978	Mathematics	University of Florida
B.S.	1974	Chemistry	University of Florida

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DANIEL G. MOORE, M.S.

SPECIALIZATION

Trace Metal Analysis Techniques for Sediment, Biota and Natural Waters Using Flame, Flameless (Graphite Furnace) and Hydride Atomic Adsorption Spectroscopy; Neutron Activation Analysis Techniques; IC, HPLE and GC Analysis Techniques; IF, UV and ICP Spectrophotometry Techniques; Volumetric and Gravimetric Analysis Techniques; Computer Skills Including Pascal, Fortran and Basic on the VAX, HP 85/87 and Macintosh; Radium Geochemistry and Trace Metal Geochemistry Within River/Ocean Mixing Regions; Uranium Series Nuclides in Groundwater and River Water, Concerning Both Authogenic and Anthropogenic Sources; Low Level Alpha Counting System Design

RECENT EXPERIENCE

Radiochemistry and Water Quality at Hunter/ESE, Department Manager--Supervises seven analysts and technicians. Responsible for measurements of a broad range of Radiochemical parameters including, but not limited to, gross alpha, gross beta, Radium-226, Radium-228, gross Uranium and photo emitters in a variety of environmental samples.

Department of Oceanography at Texas A&M University, Research Associate--Studies the behavior of Radium-226 in the river/ocean mixing zone of the Mississippi River. Performed trace analyses for the NOAA Status and Trends Project (Gulf of Mexico. Twenty-one days at sea participating in the T.T.O Ra/Rn Inter-calibration Cruise measuring Pu-239, U-234, RA-226, and Pb-210. Built and maintained a four channel alpha scintillation detector system for the analysis of Radon-222. Operated and maintained the alpha spectroscopy system used by the laboratory for the analysis of Pu, U, Th, and Pb in sediment and water samples.

Department of Chemistry at Texas A&M, Graduate Teaching Assistant--Taught freshman Chemistry laboratories.

Park Employee IV--Handled all aspects of park operations for the Texas Parks and Wildlife Department at Galveston Island State Park.

EDUCATION

M.S.	1986	Oceanography (Chemical)	Texas A&M University
B.S.	1981	Marine Biology	Texas A&M University

ASSOCIATIONS

American Geophysical Union
Sigma XI

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03/13/89

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JOHN J. MOUSA, Ph.D
Senior Chemist
Chemistry Division Manager

SPECIALIZATION

Environmental Sampling and Analysis, Analytical Chemistry, Water Quality Assessment, Environmental Fate and Assessment Studies, Trace Organic Residue Analysis, Gas Chromatography and High-Pressure Liquid Chromatography

RECENT EXPERIENCE

Division Manager of Chemistry Division for ESE--Supervised and administered a staff of more than 80 chemists and technicians involved in chemical analysis of environmental and hazardous waste samples for inorganic and organic parameters, and in methods development and applied research and development.

Environmental Contamination Study of Letterkenny Army Depot, Project Manager--Exploration survey of groundwater contaminant migration at a U.S. Army installation in Pennsylvania. Included the emplacement of monitor wells and the long-term monitoring for pollutants. Responsible for cost, schedule, quality control, and report.

U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) Analytical Methods Development, Project Manager/Principal Investigator--Responsible for developing 15 new analytical methods for explosives and munition-related compounds in soils, sediments, and aqueous matrices samples, and for developing a qualitative scan for polynuclear aromatics using HPLC. Methods involved extraction, extensive cleanup, and trace analysis.

Methods Development and Contaminant Analysis, Subproject Manager/ Laboratory Supervisor--Methods development and analysis of soils, sediments, ground and surface water samples for trace level munitions and munitions degradation products, inorganics, and trace metals on various U.S. Army projects, including Alabama Army Ammunition Plant, Savanna Depot, Ft. Wingate and Navajo Depot activities.

EPA Effluent Guidelines BAT Review--Pesticides Industry, Subproject Manager Senior Chemist--Supervised the review and technical evaluation of pesticide and priority pollutant analytical methods and quality control data for the pesticide industry and coordinated the development of priority pollutant process chemistry profiles. Supervised the selection of non-conventional pesticide methods for compliance monitoring.

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Analysis of Polybrominated Biphenyls (PBBs) in Tissue, Soils, and Water, Project Chemist/Senior Chemist--Developed extraction and cleanup procedures using sonication and Florisil and silica gel columns for analysis of PBB in complex matrices.

Residue Analysis, Senior Chemist--Responsible for the analysis of aliphatic and aromatic hydrocarbon residues in fish and other marine tissue. Analyzed shrimp for hydrocarbon residues.

Groundwater Contamination Study, Project Manager/Principal Investigator--USATHAMA project to assess magnitude of groundwater and surface water contamination with volatile chlorinated hydrocarbons of Letterkenny Army Depot.

Environmental Contamination Assessment of Army Munitions Manufacturing and Storage Facilities, Laboratory Manager/Subproject Manager--Managed laboratory analyses for seven environmental assessment studies conducted for USATHAMA. Work involved methods development certification and trace organics analysis in water, soil, and sediment samples.

Superfund Site Feasibility Study at Sapp Battery Recycling Center, Cottondale, FL, Quality Assurance Manager--Project conducted for Florida Department of Environmental Regulation. Prepared QA plan and performed QA/QC duties for field sampling, analysis, and report preparation.

Remedial Investigations and Feasibility Studies at 22 State Sites, Quality Assurance Manager--Project for Florida Department of Environmental Regulation. Prepared QA plans and performed QA/QC duties for field sampling, analysis, and report preparation.

Remedial Investigation and Feasibility Study for the French Limited and Sikes Pit Abandoned Waste Disposal Sites, Quality Assurance Manager--Prepared QA plans and performed quality assurance/quality control duties for field sampling, analysis, and report preparation.

Sampling and Analysis of Boundary Monitoring Wells, Project Manager--Sampling and analysis of groundwater for trace organics and inorganics at industrial explosives manufacturing facility. Supervised methods documentation and analysis.

Analytical Methods Development for Hazardous Compounds in Water and Soil, Project Manager--Development of analytical methods for seven organic compounds at part-per-billion and part-million level in water and soil. Includes development of HPLC screening method for organics in water. Compounds include hazardous munitions and related degradation products.

EDUCATION

Ph.D.	1973	Analytical Chemistry	University of Florida
B.S.	1970	Chemistry	University of Florida (Summa Cum Laude)

ASSOCIATIONS

American Chemical Society
Society of Environmental Toxicology and Chemistry (SETAC)
American Society for Testing and Materials (ASTM)
Phi Kappa Phi--Honor Society

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VIRGINIA C. O'BRIEN, B.A.
Department Manager, Chemistry Information Services

SPECIALIZATION

Project Coordination, Database Management, Data Retrieval

RECENT EXPERIENCE

National Dry Deposition Network (NDDN), EPA-RTP, Department Data Manager--Responsible for supervision and coordination of all chemical data for CLASS system.

Contamination Assessments, United States Army Toxic and Hazardous Materials Agency (USATHAMA), Subproject Manager--Responsible for managing chemical and geotechnical data for work performed for Rocky Mountain Arsenal, West Virginia Ordnance Works, Letterkenny Army Depot, Sharpe Army Depot, and Vint Hill Farms. Responsible for storage, handling, retrieving, formatting, and transferring data for hazardous waste projects for military installations using ESE's PRIME 750, ESE's Chemistry Novell PC Network, and USATHAMA's Univac computers.

Florida Acid Deposition Study, Laboratory Data Coordinator--Six year statewide study of rain water and air samples. Supervise and coordinate personnel entering chemical and field data into CLASS. Assisted in developing computer programs for quality control and quality assurance checks.

EPA-EGD Pesticide Study, Laboratory Data Coordinator--Coordinated input, storage, retrieval, and transfer of pesticide data base to University of Florida computer.

Florida Institute of Phosphate Research, Laboratory Data Coordinator--Extensive study of limnological characteristics of 16 natural and manmade lakes. Organized and maintained extensive database for chemical and biological data.

EPA Holding Time Study, Data Coordinator--Coordinated laboratory data and assisted in performing statistical analyses.

Douglas Aircraft Co., Long Beach, California, Mathematician--Work included making calculations and charts for pilot handbooks.

Convair, San Diego, California, Engineering Aide--Read oscillographs, telemetry, graphed film results read from airborne cameras.

EDUCATION

B.A.	1955	Mathematics/Business Administration Magna Cum Laude	Vanderbilt University

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RICHARD A. OGWADA, Ph.D.

Areas of Specialization

Quality Assurance (QA), Environmental Chemistry, Soil Physical Chemistry Experience

Experience

QA Scientist, QA and Health and Safety Division, Environmental Science & Engineering, Inc. (ESE), Gainesville, Florida, 1988 to present.

Environmental Testing, QA Supervisor--Responsible for preparation of project QA procedures, field and laboratory systems and performance audits, data review, and preparation of QA reports. Responsible for the coordination of certification requirements of various agencies.

Environmental Testing for U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), Project QA Supervisor---Responsible for project chemical data acquisition audits for Alabama Army Ammunition Plant, Louisiana Army Ammunition Plant, Tobyhanna, Ft. Dix, Lonestar, Sharpe, Phoenix, Letterkenny Army Depot, and Rocky Mountain Arsenal.

Environmental Testing for Air Force, Project QA Supervisor--Responsible for project chemical data acquisition audits for Maxwell, Keesler, Cape Canaveral, and Patrick Air Force Base.

Environmental Testing for the Corps of Engineers, Project QA Supervisor--Several projects including Fort Pickett, Ft. Benning, Ft. Stewart, Seneca Army Depot and Watervliet. Responsible for the development of QA procedures and auditing field and laboratory operations.

Disappearance Study of Soil Applied (EDB) Ethylene Dibromide (for Industrial Client), Project Soil Scientist and Task Manager--Responsible for experimental design and execution of the study.

Technical Manuscripts Reviewer--Invitational reviewer of several manuscripts for Soil Science Society of America Journal and Soil Science.

Study Phosphorus Retention and Transport in Soils of Lake Okeechobee Watershed in Florida, University of Florida--Research aimed to protect Lake Okeechobee from phosphorus-loading from dairy and waste water application activities in the basin. Research provided phosphate-soil interactions information for overall modeling effort undertaken to quantify the fate of phosphorus in the basin. This included characterization of the soil profiles with phosphate sorption parameters.

Study Retention and Transport of Selected Volatile Organic Constituents of Jet Fuels on Soils From Gas-and Solution-Phases, University of Florida, Department of Soil Science--Developed gas chromatographic and GC-headspace techniques to characterize sorption of volatile organic chemicals on soils and aquifer materials. Other duties included managing the day-to-day research activities of the project, including writing monthly research progress reports and budgets. The project was sponsored by the Tyndall Air Force Base.

Study Transport and Sorption of Potassium Fertilizer in Soils, University of Delaware--Developed kinetic methodologies to quantitate ion sorption thermodynamic parameters. Gained experience in Atomic Absorption Spectrophotometry, X-ray Diffraction, Potentiometric and Conductometric Titration Analyses, and Kinetic Analyses.

Assisted in Field Studies Involving Corn Response to Native and Fertilizer Potassium Applications on Delaware Soils--This resulted in extensive field experience in field plot design, soil and tissue sampling and analyses.

Teaching and Research Presentation--Assisted in the laboratory lecture of General Soils course (University of Florida) and Advanced Soil Physical Chemistry course. Presented seven technical papers to professional meetings.

Study of Selected Aquatic Plants to Remove Nutrients from Wastewaters of Lake Apopka Watershed, University of Florida--Organic soils of Lake Apopka basin are intensively used for vegetable production. The research was aimed to evaluate aquatic plants with high growth rates and their potentials to remove nutrients from flood-waters before pumping into Lake Apopka. Gained extensive experience in soil and water sampling techniques, and use of mass spectrometer for stable nitrogen isotope analysis.

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Education

Ph.D.	1986	Soil Physical Chemistry	University of Delaware
M.Sc.	1983	Soil Science	University of Florida
B.Sc.	1980	Agriculture, Soil Science	University of Florida

Associations and Certifications

Member of American Society of Agronomy
Member of Soil Science Society of America

Publications

Ogwada, R.A., Reddy, K.R., and Graetz, D.A. 1984. Effects of Aeration and Temperature on Nutrient Regeneration from Selected Aquatic Macrophytes. Journal of Environmental Quality, 13:239-243.

Ogwada, R.A., and Sparks, D.L. 1986. Use of Mole or Equivalent Fraction in Determining Thermodynamic Parameters for Potassium Exchange in Soils. Soil Science, 141:268-273.

Ogwada, R.A., and Sparks, D.L. 1986. A Critical Evaluation on the Use of Kinetics for Determining Thermodynamics of Ion Exchange in Soils. Soil Science Society American Journal, 50:300-305.

Ogwada, R.A., and Sparks, D.L. 1986. Kinetics of Ion Exchange on Clay Minerals and Soil: Evaluation of Methods. Soil Science Society American Journal, 50:1158-1162.

Ogwada, R.A., and Sparks, D.L. 1986. Kinetics of Ion Exchange on Clay Minerals and Soil: Elucidation of Rate Limiting Steps. Soil Science Society American Journal, 50:1162-1164.

Lee, L.S., Rao, P.S.C., Brusseau, M.L., and Ogwada, R.A. 1989. Nonequilibrium Sorption of Organic Contaminants During Flow Through Columns of Aquifer Materials. Environmental Toxicology and Chemistry, 7:779-793.

Rao, P.S.C., Ogwada, R.A., and Rhue, R.D. 1989. Use of Chromatographic and GC-Headspace Techniques to Characterize Sorption of Volatile Organic Contaminants on Soils and Aquifer Materials. Environmental Toxicology and Chemistry (in review).

Ogwada, R.A., Graetz, D.A., and Reddy, K.R. 1990. Phosphorus Dynamics in Soils of the Lake Okeechobee Watershed. I. Characterization of Phosphate Retention. Soil Science Society American Journal (in review).

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TIMOTHY J. PARSONS
Department Manager, Atomic Spectroscopy

SPECIALIZATION

Metals Analysis of Water, Wastewater, Soils, and Sediments. Utilizing ICP, Furnace, Cold-Vapor, and Flame Spectroscopy.

RECENT EXPERIENCE

EPA Contract Laboratory Program--Currently coordinating laboratory analyses of water, soils, and sediments for the assessment of metals contamination. Project involves the collection and reporting of data within the guidelines of CLP protocol.

Illinois EPA Contract Laboratory Program, Group Leader--Project involved getting documentation and analysis procedures within Illinois EPA guidelines and the analysis of performance evaluation samples. Once completed, the laboratory qualified for the Contract Laboratory Program and received samples for metals analysis on a routine basis.

Cilco Ground Water Analysis, Group Leader--Quarterly metals analysis of ground water in order to assess contamination that could result from area landfill leaching.

EDUCATION

B.S.	1983	Chemistry	Illinois State University

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PORTIA O. PISIGAN, M.S.
Associate Scientist

SPECIALIZATION

Data Review, Data Validations, Systems Audits, Quality Assurance/Quality Control (QA/QC) Plans. Organic Analytical Chemistry, Gas Chromatography, Analysis of Volatile Organohalogens and Aromatics, Pesticides and Polychlorinated Biphenyls, Soil Gas Analysis, Water Quality Assessment

RECENT EXPERIENCE

Laboratory Quality Assurance Supervisor, Hunter/ESE--Ms. Pisigan is responsible for laboratory quality assurance procedures, audits and documentation. She is also responsible for coordinating certifications and performance samples. Ms. Pisigan coordinates the introduction of performance evaluation (PE) samples that are required for Hunter/ESE's numerous certification programs. She performs both system and performance audits of the laboratory's procedures and QC data.

Quality Assurance Supervisor for U.S. Army Toxic and hazardous Materials Agency--Responsible for the implementation and monitoring of the USATHAMA QA plan and help in auditing of field and laboratory operations.

Quality Assurance Supervisor for U.S. Air Force Occupational and Environmental Health Laboratory (USAOEHL)--Responsible for laboratory QA procedures and updates of QC requirements for USAFOEHL major analytical programs.

Project Quality Assurance Coordinator for Hickam Air Force Base, Hickam POL Air Force Base, and Wheeler Air Force Base--Responsible for the implementation of the project QA plan.

Water and Soils Analysis for Volatile Organics, Rocky Mountain Arsenal, Denver, Colorado, Project Chemist--Responsible for the analysis of organohalogens and purgeable aromatics by gas chromatography using the Hall Electrolytic Detector and the Photoionization Detector.

Analysis of Volatile Organics, Sharpe Army Depot, Stockton, California, Project Chemist--Responsible for gas chromatographic analysis of organic volatiles using USATHAMA methods.

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Analysis of Water and Soils for Volatile Organics, General Development Utilities, Monroe Automotive, Martin Marietta, Law Engineering, SOHIO Terminal Monitoring, AMAX, AMOCO, and Shell Oil Terminals, Project Analyst--Responsible for the extraction and analysis of volatile priority pollutants in water and soil. Gas chromatographic analyses were performed based on EPA Methods 601 and 602.

Water Analysis for EDB and DBCP, RAKA Pilot Plant, Project Chemist--Conducted extractions and analysis of ethylenedibromide (EDB) and dibromochloropropane (DBCP) using a gas chromatograph equipped with an electron capture detector.

Monitoring of EDB in Waters, SOHIO Monitoring Terminals, AMOCO, City of Sanford, AMAX, and Champion International, Project Chemist--Responsible for the extractions and analysis of water samples for EDB using electron capture gas chromatography.

THM Analysis, Mote-Marine Laboratory, Project Chemist--Extracted and analyzed trihalomethanes (THMs) in water samples using a gas chromatograph equipped with electron capture detector.

EDUCATION

M.S.	1982	Environmental Chemistry	University of Florida
B.S.	1977	Chemistry	University of the Phillipines

REGISTRATIONS AND CERTIFICATIONS

Hazardous Waste Safety Training

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VINCE PREM-DAS
Shipping and Receiving

SHIPPING AND RECEIVING EXPERIENCE

Mr. Prem-Das is responsible for sample check-in upon arrival at laboratory, audit of sample preservations, delivery of samples to appropriate department's storage areas, and delivery of chain-of-custody forms to data management for sample login. For specific project, sample custodian is responsible for subsampling, compositing, or homogenizing environmental samples prior to analysis.

- RI/FS at Multiple USAF Facilities in Accordance with CERCLA and SARA, Shipping and Receiving. These programs are being conducted at Keesler AFB, MS; Dobbins AFB, GA; Patrick AFB, FL; and Plant 78, UT.
- Installation Restoration Phase II of Various USAF Installations, Shipping and Receiving. The Phase II studies for Dobbins AFB, GA; Lockheed Plant 6, GA; and Maxwell AFB, AL will include evaluation of hazardous waste disposal sites and analysis for metals, trace organics, and POL contamination.
- RI/FS at Various Civilian and Military Installations Identified under DERA, through EPA or State programs for US Army COE, Shipping and Receiving. Sites include Webb AFB and Schilling AFB, KS.

EDUCATION

Currently pursuing an A.S. degree in pre-engineering at the University of Florida

ASSOCIATIONS

American Institute of Aeronautics and Astronautics
Black Student Engineers

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DWIGHT F. ROBERTS, B.S.
Senior Associate Chemist

SPECIALIZATION
Gas Chromatography/Mass Spectrometry (GC/MS), High Performance Liquid Chromatography (HPLC), Analytical Organic Chemistry

RECENT EXPERIENCE
Management--Department Manager, GC/MS. Responsible for all departmental, technical, and administrative operations of 12 chemists and technicians performing GC/MS analysis of volatile and semi-volatile compounds in various environmental media. The department currently utilizes five Hewlett-Packard GC/MS units and two Finnigan Incos 50s.

Rocky Mountain Arsenal, Analysis Group Leader--Responsible for semi-volatiles analysis and extensive QA/QC for 900 environmental samples. Performed unknown searches for all chromatograms and provided mass-spectral identifications of non-target compounds.

Environmental Survey Analysis for Trace Organics in Groundwater, Soils, and Sediments from Various U.S. Army Installations, Task Manager--Environmental monitoring of previous U.S. Army munitions facilities for chemical characterization of representative sites, specifically explosives, and EPA non-volatile priority pollutants. Involved with sample preparation, screening of extracts by GC-FID, and analysis by capillary GC/MS.

Confirmation of Chlorinated Phenols and Chlorinated Dioxins--Project involved the selection ion monitoring of specific ions indicative of polychlorinated phenols and polychlorinated dioxins.

Quantitative Analysis of PCBs and Pesticides Residues--Project involved conducting analysis by GC-ECD according to EPA protocol for EPA Effluent Guidelines Division to establish guidelines for gum and wood industries.

Miscellaneous NPDES Permit Monitoring, Laboratory Coordinator--Various utility companies and industries need to monitor for many pollutants so that elimination and/or control can be instituted. Sample preparation and analysis by capillary GC/MS for non-volatile priority pollutants including PCBs and pesticides.

EPA Screen Sampling and Analysis for Organic Chemicals in Related Industries, Laboratory Coordinator--Documentation, organization, and implementation for quality control. Sample preparation and instrumental analysis for non-volatile organic priority pollutants by capillary GC/MS for establishment of industrial effluent guidelines.

Champion International Corporation Consultation, Laboratory Consultant--Training and consultation for Champion analytical personnel

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Champion International Corporation Consultation, Laboratory Consultant--Training and consultation for Champion analytical personnel for capillary GC/MS analysis of EPA priority pollutants, NPDES monitoring, and instrumental training and troubleshooting.

Synthetic Organic Chemicals in Drinking Water for Various Residential Municipalities, Task Manager--Monitoring of drinking water for trace levels of chemicals by capillary GC/MS per Safe Drinking Water Act.

GC/MS Experience--Ten years experience in GC/MS maintenance and operation. Supervisor of 10 chemists performing GC/MS analysis of environmental samples.

HPLC Experience--Method development and quantitative analysis of trianzines, PNAs, and various pesticides by HPLC using fixed UV, variable UV, fluorescence, refractive index, and electrochemical detectors in reverse and normal phase.

EDUCATION

B.S.	1973	Chemistry	University of Florida

ASSOCIATIONS

American Society for Mass Spectrometry
American Chemical Society

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BARBARA J. ROSS
Department Manager
Inorganic Analytical Chemistry

SPECIALIZATION

Chemical Analysis of Water, Air, Soil, and Sediment by Wet Chemical and Instrumental Techniques; Clinical Chemistry, Hematology, Immunohematology, and Radio Immunoassay of Body Fluids; Microscopic Analysis of Air and Bulk Materials Samples for Asbestos Using Phase-Contrast and Polarized Light Techniques.

RECENT EXPERIENCE

EPA National Dry Deposition Network (NDDN)--Supervision of sample preparation and analysis of air samples for selected anions for the purpose of assessing the contribution of dry deposition to atmospheric acidity.

Florida Acid Deposition Study--Coordination and supervision of chemical analysis of wet deposition samples for selected parameters contributing to acid rain.

U.S. Army Toxic and Hazardous Materials Agency (USATHAMA)--Supervision of chemical analysis of water and soil for Cl, F, and S04 by ion chromatography and by automated cadmium reduction.

Veteran's Administration Hospital, Gainesville, Florida, Project Chemist--Responsible for area sampling and personal monitoring for asbestos and identification of asbestos by polarized light microscopy and asbestos fiber counting by phase contrast microscopy.

Florida State University System (SUS) Asbestos Surveys, Project Chemist--Survey of nine universities, including onsite collection of friable material samples and analysis by phase contrast and polarized light microscopy.

EPA-Development of Preservation Techniques and the Establishment of Maximum Holding Times for NPDES and SWDA Inorganic Constituents, Project Chemist--Supervision of analysis of various short holding time parameters to determine feasibility of extending present holding time criteria.

Florida Institute of Phosophate Research (FIPR)--Chemical analysis of surface water for selected parameters by autoanalyzer to aide in the assessment of a variety of limnological characteristics in 16 natural and reclaimed lakes.

Tampa Electric Co., (TECO), EIS--Coordination and supervision of a wide variety of chemical parameters as part of a baseline study for a proposed power generating facility.

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EPA-EGD, Mission Contract for Wood Products and Fibers Branch, Project Chemist--Supervised sample preparation and analysis for various inorganic parameters of environmental interest.

EPA-EGD, BAT Review of Printing and Publishing Industry, Project Chemist--Responsible for analysis of nutrient parameters on wastewater and sludge samples.

U.S. Army Toxic and Hazardous Materials Agency, Project Chemist--Responsible for the preparation and analysis of water, soil and sediment samples for nitrocellulose and nutrient parameters of environmental interest.

Florida Power and Light, Statewide Ambient Monitoring Network--Supervision of chemical and gravimetric analysis of S02, N02, and TSP in ambient air.

U.S. Army Corps of Engineers, Mobile, Alabama, Project Chemist--Responsible for sample preparation and analysis of water and soils for various inorganic parameters of environmental interest.

REGISTRATIONS AND CERTIFICATIONS

Certified Laboratory Technician
Certified in Microscopical Identification of Asbestos
Hazardous Waste Safety Training, 1986

ASSOCIATIONS

American Society of Clinical Pathologists
Charter Member, Florida Society of Environmental Analysts

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MINDY SAYRES
Senior Geologist

PROFESSIONAL QUALIFICATIONS:

Ms. Sayres has participated in a wide range of geologic and geotechnical projects in both industry and the academic community. Specific project experience includes task leader and field operations leader for remedial investigations of Superfund sites, supervision of monitoring well installation and subsequent chemical sampling at hazardous waste sites, hydrogeologic evaluation for the siting of a high-level nuclear waste repository, rock excavation inspection and geologic field mapping and analysis.

Her experience includes:

- Design and development of site assessment work plans and field sampling plans
- Supervision of field investigations involving soil gas, soil, sediment, groundwater, surface water and wipe sampling, monitoring well installation and aquifer testing.
- Development of subcontractor bid specifications, technical evaluation of bids and negotiation and management of vendor contracts.
- Preparation of Remedial Investigation reports and proposals.
- Participation in siting studies for a high level nuclear waste repository in crystalline rocks in the Northeast, and the Supercollider in New York State.
- Rock excavation inspection, seismograph monitoring for rock blasting and pile driving, pre-construction surveys and compacted fill inspection/density testing.

EMPLOYMENT:

January 1990 - Present	Sr. Geologist/Project Manager Hunter Environmental Services Rutherford, NJ
November 1986 - January 1990	Senior Geologist Ebasco Environmental Lyndhurst, NJ

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January 1986 - November 1986	Senior Staff Geologist Woodward-Clyde Consultants Wayne, NJ
June 1984 - August 1984	Field Geologist Maine Geological Survey Augusta, ME

EDUCATION:

M.A., Geology, Queens College of CUNY - 1986
B.A., Geology, State University of New York at Oneonta - 1979

SPECIAL TRAINING:

Certification of Completion of REM III Health and Safety Training Course - NUS, Pittsburg, PA - 1986

PROFESSIONAL AFFILIATIONS:

Geological Society of America
Sigma Xi

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JEFF D. SHAMIS, M.S.
Laboratory Coordinator

SPECIALIZATION

Project Management, Project Coordination, Inorganic Quantitative Analysis, Pesticide Residue Sample Preparation, Technical Assistance in Methods Development

RECENT EXPERIENCE

Hazardous Site Assessments, Koppers Co., Inc., Task Manager-Coordinating a succession of analytical studies of support of hazardous site assessments throughout the United States. Includes development of scopes and QA/QC objectives with client and state regulatory agencies.

Groundwater Contamination Projects, Alachua County, Project Coordinator--Coordinating analytical support of engineering studies to evaluate groundwater contamination by county landfills and by gasoline service stations.

Sewer Discharge Evaluation Study, Detroit Water and Sewer Department, Task Manager--Coordinating analytical support for bioassay, waste treatment technology, and the ecology disciplines in this study evaluating the largest municipal sewage discharge in the world.

Municipal SOC Program, Project Manager--Supervised and coordinated analytical program to satisfy latest DER requirements for VOC and SOC determinations.

Drinking Water Analysis, Project Manager--Supervised and coordinated routine requests for analysis to comply. with state primary and secondary standards by individuals and municipal water treatment plants.

Wastewater Characterization, PRASA Project Coordinator--Assisted in scope development and coordinated laboratory analyses of wastewater characterization samples for Puerto Rico Aqueduct and Sewer Authority in compliance with Puerto Rico EQB requirements.

Priority Pollutant Analysis, Reynolds, Project Coordinator--Coordinated laboratory analyses for priority pollutant analysis of samples from a site with suspected contamination.

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Analytical Analysis, Manatee County Division of Water Treatment, Project Manager--Supervised and coordinated the quarterly analysis of samples from surface water impoundments for trace metal, inorganic, organic, and radiological parameters.

Groundwater Monitoring Program, Valley Steel Product, Subproject Manager--Coordinating laboratory analyses for monthly groundwater monitoring program in compliance with RCRA regulations.

EDUCATION

M.S.	1977	Forestry	University of Florida
B.S.	1975	Natural Resources	Cornell University

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WILLIAM A. TUCKER, Ph.D.

Areas of Specialization

Environmental Modeling, Hazardous Waste Management, Risk Assessment

Experience

Manager, Environmental Assessment and Toxicology Division, Environmental Science & Engineering, Inc. (ESE), Gainesville, Florida; 1986 to present. Director, Environmental Sciences, Water Resources Division, 1985 to 1986; Department Manager, Water Quality/Modeling and Analysis, 1983 to 1985.

Bioaccumulation of Chlorobenzenes in an Estuarine Fishery, Project Manager--Responsible for major long term field biomonitoring survey of water quality and uptake of chlorobenzenes by fish and shellfish in a Gulf Coast estuarine fishery; also responsible for data interpretation (development of conceptual model for bioaccumulation and input bioaccumulation factors) in support of a computerized model to be used in remedial decision-making process.

Peer Review of U.S. Environmental Protection Agency (EPA) National Research Strategy for Comparative Risk Assessment of Alternative Fuels, Peer Reviewer--Invited participant in 3-day workshop to evaluate EPA's proposed national research strategy to support comparative assessment of health and environmental risks associated with potential shift to alternative fuels for vehicles such as methanol, ethanol, compressed natural gas, and hydrogen; member of ecological risk assessment panel.

Health Risks Associated with Well Field Contamination, Project Manager--Responsibilities included overseeing site data collection and related litigation technical support for southeastern United States site contaminated by chlorinated hydrocarbons; preparing to testify on contaminant migration and magnitude and duration of residents' exposure to contamination.

Rocky Mountain Arsenal (RMA) Feasibility Study, Task Manager (Endangerment Assessment)--Managing the endangerment assessment for the offpost operable unit where groundwater is contaminated by pesticides and by-products of chemical agent production. Offpost operable unit comprises approximately 25 square miles north and northwest of RMA. In predominantly agricultural use today, the area's population is growing

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rapidly due to its location at Denver's urban fringe. Priority chemicals affecting groundwater and/or, to a lesser extent, surface water include: aldrin, arsenic, benzene, cadmium, chloroform, CPMSO, DBCP, 1,2-dichloroethane, dieldrin, DIMP, and tetrachloroethylene. Potential exposure of humans, livestock, aquatic biota, and terrestrial wildlife has been assessed.

RMA Litigation Support, Denver, Colorado, Task Manager--Provided technical support to U.S. Army/Department of Justice litigation team in $1.5 billion suit against Shell Chemical Company. Member of interagency working group (EPA, DOJ, DOD) responsible for evaluation and recommendation for exposure and risk assessment methodology for evaluating site remediation.

RMA Offpost Contamination Assessment Plan, Denver, Colorado, Team Member--Responsible for groundwater quality, contaminant fate exposure, and risk assessment portions of planning document for major data collection and assessment program.

Benzene Exposure Assessment, American Petroleum Institute, Project Manager--To assess the risks associated with benzene in Florida groundwater as a result of leaking underground storage tanks, ESE participated in a multicontractor study supported by the American Petroleum Institute. ESE's scope focused on exposure assessment and included a review of ambient concentrations of benzene in air; groundwater, surface water, and drinking water; and foods. A critique of sampling and analysis methods for benzene in water was prepared. The major effort under the contract was the development, validation, and application of the Underground Leak Transport Assessment model (ULTRA). ULTRA simulated benzene in soils and groundwater resulting from underground gasoline leaks. The model was validated by applying it to reproduce observed benzene concentrations in soils and groundwater at two documented leak sites in Florida. The model was there applied to 10 hypothetical release scenarios encompassing a range of representative Florida groundwater aquifers. The model accounts for migration, volatilization, adsorption, and degradation of benzene.

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Persistence of Contaminants in Soil, Project Manager--Estimated the persistence of a variety of organic chemicals and petroleum products in soils at four industrial facilities in New Jersey.

Migration of Gasoline from a Tank Leak in South Dakota, Task Manager--Evaluated the rate of migration of floating product on the water table in a sand and gravel aquifer for a major insurance company.

Fate and Transport Assessment for Gasoline Leak, Titusville, Florida, Project Manager--Applied ULTRA to evaluate remedial alternatives for leak incident affecting municipal water supply well. Related project activities included surveying and sampling and analysis of air stripper influent and effluent and monitor wells. Model application results presented at conference in 1987.

Exposure Assessment, Letterkenny Army Depot, Pennsylvania--Estimated inhalation exposure resulting from volatilization of chlorinated solvents from soils and surface waters, including estimate of swimmer inhalation exposure. Applied state-of-the-art theory of environmental and chemical factors affecting volatilization.

Expert Testimony on Potential Risks Posed by Gasoline Leak, San Antonio, Texas--Evaluated potential explosive and chemical exposure risks; deposed twice.

Abandoned Coal Gasification Plant RI/FS, Project Manager--Managed field and laboratory investigations and engineering studies on behalf of the present owner, a paper recycler, in response to a State of Florida enforcement action.

Anniston Army Depot Feasibility Study, Task Manager (Endangerment Assessment)--Managed the EA for a National Priorities List site in Alabama where TCE has been detected in Cold Water Spring, the principal community water supply.

Florida Acid Deposition Study (FADS) Peer Review, Project Manager--Managed and participated in the presentation of the findings of a 4-year, multimillion dollar research program to a peer review panel of nationally

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prominent acid deposition researchers. The panel was convened by the Florida Department of Environmental Regulation and its deliberations were in the format of a public meeting. FADS was funded by the Florida Electric Power Coordinating Group.

EPA/Office of Solid Waste Land Disposal Restrictions Rule Support, Project Manager--Developed models for estimating air releases from RCRA disposal facilities (TSDFs) to be used in determining waste-specific land disposal prohibitions.

West Virginia Ordnance Works, RI/FS, Task Manager-Responsible for performance of endangerment assessment for former Army installation contaminated by nitroaromatics. Site is currently a wildlife management area used extensively by hunters and fishermen. Investigated potential for contamination of water supply of more than 6,000 residents. Principal author of two Endangerment Assessment reports. Records of decision have been completed for both operable units and remediation is underway.

Metal Plating Facility, Project Staff--Responsible for exposure and risk assessment and development of site-specific water quality standards pursuant to cleanup of historical contamination and permitting of RCRA landfill.

Assessment of Potential Indirect Health Effects of Acid Rain-Performed literature assessment and critique for Peabody Coal.

Abandoned Wood Processing Preserving Plant, Risk Assessment, Task Manager--Developed site-specific soil contaminant clean-up standards for site contaminated by polynuclear aromatic hydrocarbons. Reviewed relevant information on health and environmental effects. Summarized potential for migration to adjacent surface waters used as drinking water supply. Also applied geostatistical techniques (kriging) to interpolate between soil sampling locations and to establish confidence bounds on volume of soils above recommended site-specific standards. Risk assessment report was the basis for negotiated consent decree between client and State of Florida requiring limited source removal and continued monitoring.

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Evaluation of Critical Parameters Affecting Contaminant Migration Through Soils for USATHAMA, Project Manager--Conducted literature survey and designed experimental program to determine critical soil properties affecting adsorption of TNT, RDX, and nitroguanidine. Developed statistical and modeling techniques to interpret experimental results.

Herbicide Use in Utility Rights-of-Way, Atlantic City Electric, Team Member--Applied PRZM to evaluate the proposed use of picloram and 2,4-D in Atlantic City Electric ROWs through the New Jersey Pine Barrens. Reviewed climatologic and soils data to realistically simulate the range of conditions affecting percolation.

Effects of Feedlot Operation on Groundwater Quality, Project Director--Identified sources of nitrate contamination in vicinity of major cattle feedlot. Program includes field data collection and modeling of fertilizer and livestock waste constituents through soils.

Groundwater Contamination Investigation, Team Member-Interpreted soils and shallow groundwater quality data to estimate the probable location, size, and date of a major spill of industrial solvents, based on existing contamination fingerprints. Considered buoyancy, adsorption, volatilization, and capillary effects controlling migration of a complex solvent mixture in soils and groundwater.

Superfund Remedial Feasibility Study, Superfund Site, Project Team Member--Used models to identify preferred remedial action, strategy (number of wells, well placement, pumping rates, required duration of pumping and treatment) to address shallow aquifer contamination by numerous organics at Superfund site.

Remedial Pumping System Design, Project Scientist--Used PLASM to design/optimize a remedial pumping well network.

Superfund Remedial Feasibility Study, Task Manager--Responsible for risk assessment-based evaluation of alternatives for the Sapp Battery Salvage Site in northwestern Florida. Site exhibits aquifer contamination by sulfuric acid and heavy metals, and soils contamination by lead and other heavy metals.

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Thermal Mixing Zone Validation Study Assessment, Project--Applied sophisticated hydraulic/thermal plume computer model to determine thermal mixing zone boundaries for 1700 MW coal-fired power plant discharging once through cooling water to Tampa Bay. Prepared plan of study (POS) and participated in POS negotiations. Results presented to Florida Department of Environmental Regulation and EPA Region IV on behalf of Tampa Electric Company, resulting in agency approval to increase capacity by 425 MW.

Southwest Florida Shelf Benthic Communities Study, Task Manager--Responsible for analysis and interpretation of physical oceanographic and sediment data.

North Aleutian Shelf Environmental Characterization, Project Director--Physical oceanographic study of large tidal lagoon and adjacent coastal zone. Providing technical guidance and developing conceptual model of coastal zone sediment, nutrient, and carbon fluxes.

RI/FS, Discipline Manager-Responsible for exposure and risk assessment activities under contract to conduct multi-site inactive hazardous waste site investigations.

Land Application of Wastewater, Task Manager--Calibrated and applied PLASM in two projects to determine percolation pond treatment capacities.

Staff Consultant, Hazardous Waste Management Section, Arthur D. Little, Inc., Cambridge, Mass., 1976-1983.

Development of Installation Restoration Cost/Benefit/Risk Model, Subtask Manager--Developed coupled surface water/groundwater model used by U.S. Army Toxic and Hazardous Materials Agency to evaluate cleanup plans at hazardous waste disposal sites; subsequently applied model to Rocky Mountain Arsenal; modified finite element model to account for adsorption/degradation; developed unsaturated zone flow and mass transport model; developed Markov process precipitation time series synthesizer.

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Risk Assessments Toxic Pollutants--Participated in a variety of risk assessments on local, regional, and national scale. Responsible for air- and/or water-borne pollutants fate analyses. Applied air to surface pathway methodology in assessment of polynuclear aromatic hydrocarbons, and applied EXAMS to toxicant discharges to Kanawha and Ouachita Rivers.

Evaluation of Contaminant Impacts of Estuaries, Project Scientist--Evaluated effects of refinery effluents on several American estuaries; also evaluated effects of proposed port expansion in Winyah Bay, SC.

Multimedia Model Development, EPA, Task Manager--Developed water compartment logic for comprehensive multimedia model for toxic substances.

Technical Assistance in Environmental Litigation--Interpreted surface water and groundwater flow and quality data to client's lawyers re several controversial hazardous waste disposal sites in Niagara Falls. Interpretation emphasized potential effects of leachate on Niagara River and effectiveness of containment plans.

Air to Surface Pathway Evaluation Methodology, EPA, Project Manager--Work conducted for EPA's Office of Water Regulation and Standards. Involved development of methods to estimate dry and wet deposition rates of toxic chemicals (organics and heavy metals). Project led to two referred papers and was incorporated into ALWAS user guidance.

Development of Air, Land, and Water Analysis System, EPA Office of Research and Development, Program Manager--Developed a watershed model which simulates the effects of all sources of contaminants in a watershed, whether derived from atmospheric fallout, runoff, point sources or leachate. ALWAS couples an air quality model with EPA's NPS and EXAMS.

Water Supply Wells, Acton, Massachusetts, Subtask Manager-Reviewed model study performed by Camp, Dresser, & McKee for EPA, Region I.

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Environmental Model Catalogue, Project Scientist--Critically reviewed watershed models and prepared chapter of Enviro-HC: Watershed Models.

Study Effects of Utility Waste Disposal Practices, EPA, Team Scientist--Participated in the design of a nationwide field study of utility waste disposal practices conducted for the EPA Office of Solid Waste. Interpreted all field data pertaining to ground and surface water quality, and was responsible for predicting future contamination levels at six sites nationwide.

Risk Assessment-Based Evaluation of Alternative Remedial Plans for Contaminated Soils and Sediments, Subtask Manager--Responsible for evaluation of contaminant migration through surface waters, soils, and groundwater at a site contaminated by dioxins and chlorinated benzenes in Niagara Falls. Used Monte Carlo techniques to estimate uncertainty in contaminant migration potential considering uncertainty in available data.

Remedial Action Handbook (Superfund), EPA, Project Manager--Described groundwater control techniques in an EPA handbook for remedial action at Superfund sites.

Design of Large Scale Field Experiment of Ammonia Spills, Team Member--Determined siting and sensitivity specifications for monitoring instrumentation based on dispersion estimates.

Air Quality Model for Youngstown, Ohio, Assistant Project Manager--Calibrated the CDM model for SO_2 in Youngstown after EPA had failed in attempts to do so. Used calibrated model to develop alternative control strategy which was subsequently adopted by EPA.

Environmental Impact Statement, Major Integrated Steel Mill, Project Scientist--Responsible for water quality prediction for steel mill proposed to discharge to Lake Erie. Developed and applied PTPLUME model for dispersion in coastal zone of large lakes and oceans.

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Education

Ph.D.	1976	Ocean Science	University of Michigan
M.S.	1974	Ocean Science	University of Michigan
B.S.	1970	Physics	West Virginia University

Associations

Hazardous Materials Control Research Institute

Selected Publications

Tucker, W.A. and F.L. Hearne. 1989. Risk Assessment: Tools for Reducing Liability from Underground Storage Tanks. Proceedings of the 1989 Oil Spill Conference, American Petroleum Institute Publication No. 4479, pp. 1-12.

Kountzman, J.A. and W.A. Tucker. 1989. Multimedia Transport and Exposure Analysis of Contamination from an NPL Site. Proceedings of the 6th National Conference on Hazardous Wastes and Hazardous Materials, Hazardous Materials Control Research Institute, pp. 171-175.

Tucker, W.A., M.W. Kemblowski, and D.E. Draney. 1989. Technological Limits of Groundwater Remediation: A Statistical Evaluation Method. Proceedings of the Conference on Petroleum Hydrocarbons and Organic Chemicals in Groundwater, National Water Well Association, pp. 249-264.

Denahan, S.A., B.J. Denahan, W.G. Elliott, W.A. Tucker, M.G. Winslow, and S.R. Boyes. 1989. Relationships between Chemical Screening Methodologies for Petroleum Contaminated Soils, Theory and Practice, presented at the 4th Conference on Petroleum Contaminated Soils, September 25-28, Amherst Massachusetts.

Doc No : CLEJ-00351-3.03-09/01/90

Tucker, W.A., Morgan, R.C., Chandler, A.B., Kountzman, J.A., and Kosalwat, P. 1988. Using ACLs to Establish Remedial Design Goals. Accepted for presentation at Hazardous Materials Control Research Institute's Fifth National Conference and Exhibition, Las Vegas, Nevada, April 19-21.

Tucker W.A., Huang, C.T., and Stanforth, M.T. 1987. Application of ULTRA to a Product Loss near a Municipal Well Field. Presented at National Water Well Association's Conference on Petroleum Hydrocarbons and Organic Contaminants in Groundwater Prevention, Detection, and Restoration, Houston, Texas, November 1987.

Tucker, W.A. Poppell, C.F., and Kraus, D.L. 1987. West Virginia Ordnance Works Endangerment Assessment for the Acids Area/Yellow Water Reservoir, Red Water Reservoirs, and the Pond 13/Wet Well Area, Draft Final Report. Prepared for U.S. Army Toxic and Hazardous Materials Agency, Aberdeen Proving Ground, Maryland. Contract No. DAAK11-83-D-0007.

Tucker, W.A. and Hedden, K.F. 1986. The Air, Land, Water Analysis System (ALWAS) Multi-Media Pathways of Organic Pollutants in Freshwater Systems, Journal of Environmental Science and Health, A21(5), 449-481.

Tucker, W.A., and Poppell, C.F. 1986. Method for Determining Acceptable Levels of Residual Soil Contamination. Presented at HMCRI's 3rd National Conference and Exhibition on Hazardous Wastes and Hazardous Materials, Atlanta, GA, March 4-6, 1986.

Tucker, W.A., Gensheimer, G.J., and Poppell, C.F. 1986. Endangerment Assessment for the West Virginia Ordnance Works. Presented at the Annual Convention of the American Society of Civil Engineers, Boston, MA, Oct. 29-31, 1986.

Doc No: CLEJ-00351-3.03-09/01/90

Tucker, W.A., Huang, C.T., Bral, J.M., and Dickinson, R.E. 1986. Development and Validation of the Underground Leak Transport Assessment Model (ULTRA). Presented at National Water Well Association's 5th Annual Conference on Petroleum Hydrocarbons and Organic Chemicals in Groundwater, Houston, TX, Nov. 12-14, 1986.

McCann, R.C., Edgerton, E.S., Kosky, K.F., and Tucker, W.A. 1986. Relationships of Sources to Acid Deposition in Florida, Section 3.0 of Florida Acid Deposition Study Final Report, Florida Electric Power Coordinating Group, Tampa, FL.

Edgerton, E.S., Pollman, C. D., Tucker, W.A., and Kosky, K.F. 1986. Integration of Programs, Section 5.0 of Florida Acid Deposition Study Final Report, Florida Electric Power Coordinating Group, Tampa, FL.

Kosky, K. F., Pollman, C.D., Edgerton, E. S., McCann, R. C., and Tucker, W.A. Conclusions, Section 6.0 of Florida Acid Deposition Study Final Report, Florida Electric Power Coordinating Group, Tampa, FL.

Tucker, W.A., Poppell, C.F., and Gensheimer, G.J. 1986. West Virginia Ordnance Works: Endangerment Assessment for Sewerlines, the TNT Manufacturing Area, and the Burning Grounds. Prepared for U.S. Army Toxic and Hazardous Materials Agency, Installation Restoration Division, Contract No. DAAK11-83-D-0007.

Powell, D.H., and Tucker, W.A. 1986. Non-Drinking Water Exposure, Section 2-4 of Benzene in Florida Groundwater: An Assessment of the Significance to Human Health, American Petroleum Institute, Wash., DC.

Schulze, R.L., and Tucker, W.A. 1986. Drinking Water Use Patterns, Section 2-5 of Benzene in Florida Groundwater: An Assessment of the Significance to Human Health, American Petroleum Institute, Wash., DC.

Tucker, W.A., Huang, C.T., and Dickinson, R.E. 1986. Modeling Transport of Benzene in the Subsurface, Section 3-1 of Benzene in Florida Groundwater: An Assessment of the Significance to Human Health, American Petroleum Institute, Wash., DC.

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Tucker, W.A., Huang, C.T., and Bral, J.M. 1986. Validation of Transport Model, Section 3-2 of Benzene in Florida Groundwater: An Assessment of the Significance to Human Health, American Petroleum Institute, Wash., DC.

Tucker, W.A., Huang, C.T., and Bral, J.M. 1986. Application of the Model to Illustrative Settings, Section 3-3 of Benzene in Florida Groundwater: An Assessment of the Significance to Human Health, American Petroleum Institute, Wash., DC.

Tucker, W.A., Dose, E.V., and Gensheimer, G.J., et al. 1985. Evaluation of Critical Parameters Affecting Contaminant Migration Through Soils, Presented at the National Environmental Engineering Conference of the American Society of Civil Engineers, Boston, July 1-3, 1985; also DOD report of same title, Report No. AMXTH-TE-TR-85030.

Tucker, W.A., Gensheimer, G.J., and Dickinson, R.F. 1984. Coping with Uncertainty in Evaluating Alternative Remedial Actions. The 5th National Conference on Management of Uncontrolled Hazardous Waste Sites, Washington, D.C., November 7-9, 1985.

Bonazountas, M., Goutsou, M., Bouloutas, E., Vamvakeridouu, L., and Tucker, W.A.. 1984. Dynamic Policies for Emission Reductions When Controlling Air Quality. Specialty Conference on Environmental Engineering (ASCE) June 25-27, 1984, Los Angeles, CA.

Tucker, W.A., Eschenroeder, A.Q., and Magill, G.C. 1984. Air Land Water Analysis System (ALWAS): A Multi-Media Model for Toxic Substances. EPA-600/53-84-052.

Tucker, W.A., and Preston, A.L. 1984. Procedures for Estimating Atmospheric Deposition Properties of Organic Chemicals. Water, Air, and Soil Pollution, 21:247-260.

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Tucker, W.A., Lyman, W.J., and Preston, A.L. 1983. Estimation of the Dry Deposition Velocity and Scavenging Ratio for Organic Chemicals. In: Precipitation Scavenging, Dry Deposition, and Resuspension: Volume 2: Dry Deposition and Resuspension. Coord. Pruppacher, H.R., Semonin, R.G., and Slinn, W.G.N., Elsevier, N.Y. 1462 pp.

Tucker, W.A. 1982. The Air, Land, Water Analysis System (ALWAS), Multi-Media Pathways of Toxic Pollutants in Freshwater Systems. Presented at the American Society of Civil Engineers, National Convention, Las Vegas, Nevada, April 26-30, 1982.

Mulkey, L.F., Hedden, K.F., and Tucker, W.A. 1982. Application of Multi-Media Exposure Assessment to Drinking Water. Environmental Monitoring and Assessment, 2:57-69.

Tucker, W.A., and Nelken, L.H. 1982. Diffusion Coefficients in Air and Water. In: Handbook of Chemical Property Estimation Methods, Chapter 17, Lyman, W.J., Reehl, W.F., and Rosenblatt, D.H., Editors. McGraw-Hall, New York.

Tucker, W.A. 1982. Surface Heat Fluxes from Lake Ontario: Further Verification of Lake Thermal Model. Water Resources Research, 18:77-82.

Tucker, W.A. 1982. Watershed Modeling. Appendix WS to Enviro-HC: Environmental Mathematical Pollutant Fate Modeling Handbook/ Catalogue. Report to EPA., Office of Policy Resource Management, Contract 68-01-5146.

Aravamudan, K.S., Raj, R.K., Ostlund, J., Newman, F., and Tucker, W.A. 1982. Break-Up of Oil on Rough Seas--Simplified Models and Step-by-Step Calculations. Report No. CG-D-28-82 (U.S. Coast Guard).

Tucker, W.A., and Preston, A.L. 1981. Air-to-Surface Pathway Evaluation Methodology. Report to EPA, Office of Water Regulation and Standards, under Contract 68-01-5949.

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Aravamudan, K., Bonazountas, M., Eschenroeder, A., Gilbert, D., Nelson, L., Scow, K., Thomas, R., Tucker, W., and Unger, C. 1981. An Environmental Partitioning Model for Risk Assessment of Chemicals, Prepared for the EPA Office of Toxic Substances under Contract 68-01-3857.

Fiksel, J., Cooper, C., Eschenroeder, A., Goyer, M., Perwak, J., Scow, K., Thomas, R., Tucker, W., and Wood, M. 1981. An Exposure and Risk Assessment for Cyanide. Report to EPA, Office of Water Regulation and Standards, Contract 68-01-5949.

Cooper, C.B., Bysshe, S., Nelken, L., Scow, K., and Tucker, W.A. 1979. Risk Assessments of Priority Pollutants: Cadmium. ADl Draft Report to EPA, Monitoring and Data Support Division, 401 M Street, S.W., Washington, D.C. 20460. Contract 68-01-3857, Task Order No. 11, C-81099-71.

Bonazountas, M., Hawes, W., and Tucker, W.A. 1979. A Heuristic Unsaturated Flow/Quality Soil Zone Model. Presented at AGU Spring Meeting and abstracted EOS, Trans. AGU, 60.

Santhanam, C.J., Lunt, R.R., Cooper, C.B., Kleinschmidt, D.E., Bodek, L., Tucker, W.A (Arthur D. Little, Inc.), and Ullrich, C.R. (University of Louisville).. 1979. Waste and Water Management for Conventional Coal Combustion Assessment Report-1979, Volumes 1-5, EPA-600/7-80-012 (a-e).

Tucker, W.A. 1978. Turbulent Mixing by Breaking Waves: The Wave-Mixed Layer. Presented at Second Conference of Atmospheric and Oceanic Waves and Stability of the American Meteorological Society, October 23-6, 1978, Boston, MA.

Tucker, W.A., and Green, A.W. 1977. A Time-Dependent Model of the Lake-Averaged Vertical Temperature Distribution of Lakes. Limnology and Oceanography, 22:687-699.

Tucker, W.A. 1976. Thermal Structure of Lakes. Doctoral Dissertation, University of Michigan, University Microfilms, Ann Arbor, Michigan.

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Tucker, W.A., and Green, A.W. 1975. Thermocline Formation in Large and Small Lakes. Proceedings of the Symposium on Modeling of Transport Mechanisms in Oceans and Lakes, Canada Centre for Inland Waters, Burlington, Ont.

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BRAD A. WEICHERT, B.S.
Senior Associate Scientist

SPECIALIZATION

Gas Chromatography, Pesticide Analysis, Trace Organics Method Development

RECENT EXPERIENCE

Department Manager-GC Non-Volatiles Department--Supervises routine analysis of pesticides, PCBs, petroleum hydrocarbons, phenols, and industrial hygiene samples by gas chromatography.

United States Environmental Protection Agency Contract Laboratory Program (EPA CLP)--Managing the analysis of pesticides using CLP protocols, project quality assurance review, data package submission and technical liaison.

United States Air Force Office of Environmental Health Laboratories, USAFOEHL--Responsible for the management of the analysis of environmental samples for pesticides and herbicides using EPA methodologies including SW 846 and CLP protocols.

Institute of Food and Agricultural Sciences (IFAS) Site Investigation, Florida DER, Group Leader--Analyzed water and soil for organochlorine, organophosphorus pesticides, and herbicides.

Soil Gas Analysis (LUST Program)--Development of field capability for analysis of soil gas (volatile organic compounds) by portable gas chromatography.

Effects of Run-off on Tropical Marine Bays, Caribbean Research Institute, St. Thomas, U.S. Virgin Islands, Program Assistant--Studied effects of run-off on tropical marine bays and nearshore fisheries. Work conducted for office of Water Research and Technology.

Mote Marine Laboratory, Sarasota, Florida, Research Associate--Researched hydrocarbons in sediment and organisms of commercial importance from Charlotte Harbor, Florida. Work performed for the Florida Department of Natural Resources.

Graduate School of Oceanography, Florida Institute of Technology, Melbourne, Florida, Research Associate, Instructor--Instrumental analysis of seawater, saline water analysis.

Department of Oceanography, Florida Institute of Technology, Melbourne, Florida, Research Associate--Studied fate of organic components of drilling fluid released into the marine environment - joint National Oceanic and Atmospheric Administration and Environmental Protection Agency project. Performed petroleum hydrocarbon analysis of surficial sediment from the West Florida Shelf for the Bureau of Land Management.

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Research and Sea Experience--

- o Operation and maintenance of analytical instruments including but not limited to GC/ECD/FID/NPD/HECD, Flame/flamess AA, HPLC/UV/VIS/Fluorescence.
- o Extensive experience with gas chromatographic systems equipped with both packed columns and capillary columns supported with data handling systems.
- o Wide range of experience in high performance liquid chromatography using normal and reverse phase high performance liquid chromatography and high performance size exclusion chromatography of aqueous soluble polymers.
- o Obtained clean environmental samples and laboratory procedures for trace organic analysis.
- o Development of procedures for the recovery of dissolved and particulate trace organics from large volumes of seawater.
- o Numerous colormetric, titrametric, and electrometric procedures for seawater analysis.
- o Spent 70 days at sea conducting oceanographic research aboard the RVs GYRE, KELEZ, RESEARCHER, and COLUMBUS ISELIN.

EDUCATION

B.S.	1979	Chemical Oceanography	Florida Institute of Technology

ASSOCIATIONS

American Association for the Advancement of Science
American Chemical Society
American Geophysical Union

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MICHAEL G. WINSLOW, B.S., M.A.
Organic Analytical Chemist

SPECIALIZATION

Operation of Field Analytical Organic Laboratories, Gas Chromatography, Pesticide Residue Analysis, Trace Organic Methods Development, Specific Detectors in Gas Chromatography

RECENT EXPERIENCE

USATHAMA Methods Development, Supervisor--Supervised the development validation of numerous gas chromatographic methods for the analysis in soils and waters of organochlorine pesticides, PCBs, purgeable halocarbons, purgeable aromatics, organosulfur, and organophosphorous compounds in response to the contamination assessment of Rocky Mountain Arsenal.

USATHAMA Groundwater Aeration and Ion, Laboratory Coordinator--Analytical support for pilot study of a treatment system for contaminated groundwater.

Management--Section Manager, Organic Analytical Chemistry. Responsible for all administrative, technical, and marketing operations of four departments currently comprising 40 chemists and technicians: GC/MS, GC volatiles, GC non-volatiles, GC-HPLC.

Wastewater Treatment, Laboratory Coordinator--Analytical support for the optimization of granular activated carbon treatment of pesticides-manufacturing wastewaters.

Mobile Field Laboratory Operation, Laboratory Supervisor--Managed and operated mobile laboratories at more than ten sites including industrial process plants, hazardous waste treatment facilities, spill response areas, and pilot plant support.

Pesticide/PCB Residue Analysis, Project Chemist--Work included complex-clean-up and gas chromatography and interpretation. Responsibilities included hazardous waste sampling, analysis, data handling, and reporting of pesticide/PCB values for all types of environmental media. Extensive involvement in the extraction and analysis of trihalomethanes, volatiles, phenols, nitrosamines, and other priority pollutants in soils, wastewaters, and biota.

EDUCATION

M.A.	1977	German	University of Florida
B.S.	1967	Chemistry	University of Florida

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03/24/88

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U.S. Environmental Protection Agency (EPA). 1987. Measurement of N-Methyl Carbamoyloximes and N-Methyl Carbamates in Water by Direct Aqueous Injection HPLC with Post Column Derivatization. EPA, EMSL, Cincinnati, OH.

U.S. Environmental Protection Agency (EPA). 1988a. Analysis of Organohalide Pesticides and Arochlors in Drinking Water by Microextraction and Gas Chromatograpy. EPA, EMSL, Cincinnati, OH.

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APPENDIX A--SAMPLE FIELD NOTE FORMS

Doc No: CLEJ-00351-3.03-09/01/9

WELL SAMPLING DATA FORM

Well Number: Date: Time:

Boring Diameter: Well Casing Diameter:

Annular Space Length: Stickup:

WATER LEVEL

Held:

Cut:

DTW: Top of Casing

COLUMN OF WATER IN WELL

Casing Length:

DTW Top of Casing:

Column of Water in Well:

VOLUME TO BE REMOVED

Gallons per foot of A.S. (from chart) =

Column of Water or Length of A.S. (whichever is less) X

Volume of Annular Space =

Gallons per foot of Casing =

Column of Water X

Volume of Casing =

Total Volume (Volume of A.S. + Volume of Casing) =

Number of Volumes to be Evacuated X

Total Volume to be Evacuated =

Method of Purging (pump, bailer, etc.):

FIELD ANALYSES	Start	Mid	End
Time			
pH			
Conductivity			
Temperature			

Total Volume Purged: gallons

Sample Date/Time: Sample Number:

FRACTIONS

VP	V	N	NF	C	O	S	UP	Z	B
CF	F	H	CL	M	P	R	RP	T	RS

Signed/Sampler: Date:

Signed Reviewer: Date:

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GALLONS PER FOOT OF SATURATED ANNULAR SPACE (A.S.) USING 30-PERCENT POROSITY

Well Casing Diameter (inches)	Bore-hole Diameter (inches)				
	4	6	8	10	12
2	0.15	0.39	0.73	1.17	1.71
4	0	0.24	0.59	1.03	1.57
6	0	0	0.34	0.78	1.32

GALLONS PER LINEAR FOOT OF CASING

Casing Diameter (inches)	Gallons per Foot of Casing
2	0.1632
3	0.3672
4	0.6528
5	1.0200
6	1.4688

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SOIL SAMPLING REPORT FORM	ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

BORING NO.: ______ PAGE ___ OF ___

BORING LOCATION: ______ DATE: ______

CONTRACTOR: ______

SAMPLER(S): ______ DRILLER: ______

SAMPLING METHOD: ______ DRILL TYPE: ______

SAMPLE NO.	DEPTH (FEET)	LITHOLOGIC DESCRIPTION	O.V.A. (ppm)	STANDARD PENETRATION BLOW COUNT	NOTES

86536.3

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HEAD SPACE ANALYSIS

Project Name ______________

Project Number ______________ Signature ______________

Instrument ______________ Date ______________

Borehole Number ______________

Sample #	Depth	Description	Reading

Borehole Number ______________

Sample #	Depth	Description	Reading

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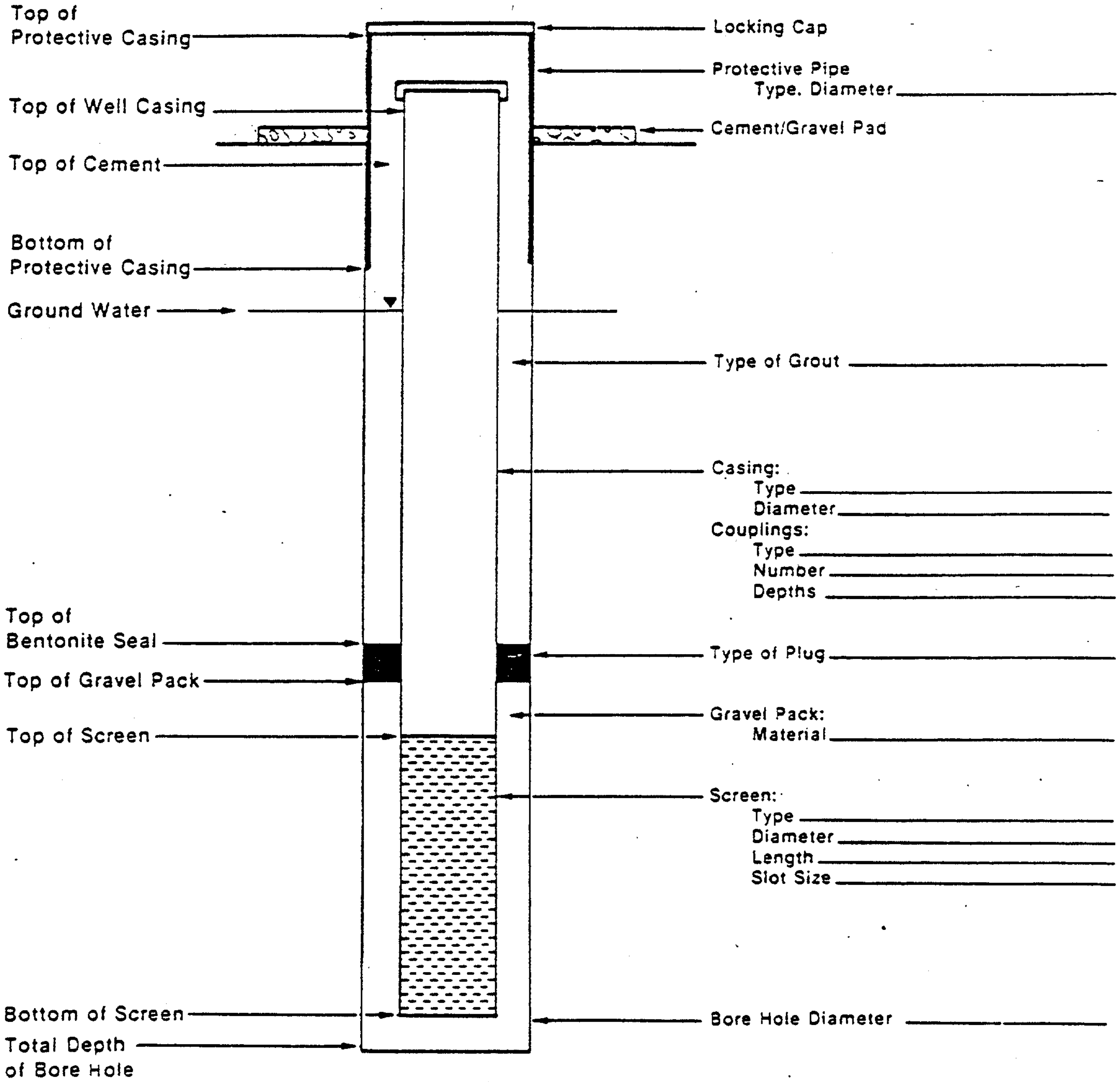
ENVIRONMENTAL SCIENCE
AND ENGINEERING, INC.

MONITOR WELL CONSTRUCTION

Logged By: ____________________
Drilling Contractor: ____________________
Driller's Name: ____________________
Well Number: ____________________
Client: ____________________
Location: ____________________
Job Number: ____________________
Date/Time: Start __________ Finish __________
Comments (Lost circulation interval. Water level changes. Hole collapse interval. etc.):

Depths in Reference
to Ground Level



NOT TO SCALE

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ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No.___ ____________________

Client____
Project____

Location of Boring:	
Water Level	
Time	
Date	

Boring No._____ Date________________ Sheet____ of____
Type of Boring______________ Rig____________________
Casing used______ Size______ Drilling mud used______
Boring begun___________ Boring completed___________
Ground Elevation____________ referred to ____________
____ Datum
Field Party:____

Depth of Casing, ft.	Sample No.	Sample depth from-to (in feet)	Blows/foot on Sampler	ID of Sampler (inches)	Tot. length of recov. sample	Length of Lab. sample	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.

Geologist

MONITOR WELL WATER LEVEL MEASUREMENTS

Sheet ___ of ___

Site ____________________
Client ____________________
Project Number ____________________

Measured By ____________________
Reference Mark:
Top of well casing _____
Ground surface _____

			Tape Reading			
Well	Date	Time	Held Length	Wet Length	Depth To Water	Comments

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APPENDIX B--CLEANING PROCEDURES FOR AUTOMATIC SAMPLING EQUIPMENT

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B.5 CLEANING PROCEDURES FOR AUTOMATIC WASTEWATER SAMPLING EQUIPMENT

B.5.1 General

All ISCO and other automatic samplers will be cleaned as follows:

- The exterior and accessible interior (excluding the waterproof timing mechanism) portions of automatic samplers will be washed with laboratory detergent and rinsed with tap water.
- The face of the timing case mechanism will be cleaned with a clean damp cloth.
- All tubing (sample intake and pump tubing) will be discarded after use.
- New precleaned, silastic pump tubing (see Section B.6.1) will be installed.
- When utilizing the samplers for collecting samples for metals and/or organic compounds analyses, the metal distributor tubes should not be used; only glass or silastic pump tubing should be used for this purpose.
- The ISCO 1680 automatic samplers should not be used for collecting samples for organic compounds analyses in the individual bottle mode because there is no way to properly clean the distributor plate to remove any residual organic compounds. The sample tubing headers may not be used to collect samples for organic compounds analyses for the same reason. The ISCO 2100 automatic samplers may be used to collect samples for organic compounds analyses in the individual bottle mode, if the specific cleaning procedures for the ISCO 2100 glass sequential bottles are followed as outlined in Section B.5.8.

Specific cleaning procedures for components of the ISCO automatic samplers follow.

B.5.2 ISCO 1680 Automatic Sampler Rotary Funnel and Distributor

1. Use only for non-organic compounds sample collection using individual sequential bottles.
2. Clean with hot water, laboratory detergent and a brush.
3. Rinse thoroughly with deionized water.
4. Replace in sampler.

B.5.3 ISCO 1680 Automatic Sampler Metal Tube

1. Clean as outlined in C.5.2.

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B.5.4 <u>All Automatic Sampler Headers</u>

1. Disassemble header and using a bottle brush, wash with hot water and phosphate free laboratory detergent.
2. Rinse thoroughly with deionized water.
3. Reassemble header, let dry thoroughly and wrap with aluminum foil.

B.5.5 <u>Reusable Glass Composite Sample Containers</u>*

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

---

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

B.5.6 Plastic Reusable Composite Sample Containers*

1. Proceed with the cleaning procedures as outlined in B.5.5 but omit the solvent rinse.

B.5.7 ISCO 1680 and 2100 Glass Sequential Sample Bottles Automatic Sampler Base for Sequential Mode**

1. Rinse with 10 percent nitric acid.

2. Rinse thoroughly with tap water.

3. Dishwasher, wash cycle, using laboratory detergent cycle, followed by tap and deionized water rinse cycles.

4. Replace bottles in covered, automatic sampler base; cover with aluminum foil for storage.

5. Rinse bottles in the field as soon as possible after using tap water.

B.5.8 ISCO 2100 Glass Sequential Sample Bottles (Automatic Sampler Base For Sequential Mode) To Be Used For Collecting Samples for Organic Compounds Analyses

1. Proceed as outlined in Steps 1-4 in Section B.5.7.

2. Rinse twice with solvent and allow to air dry for at least 24 hours.

3. Replace in covered, automatic sampler base; cover with aluminum foil for storage and mark the base as follows: "Cleaned for organic analyses."

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

** - These ISCO 1680 glass sequential sample bottles are not to be used for collecting samples for organic compounds analyses. The ISCO 2100 bottles also are not to be used for collecting samples for organic compounds analyses unless the cleaning procedures outlined in B.5.8 are used.

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B.5.9 Bottle Siphons Used To Transfer Sample From Composite Container

1. Use a new siphon for each sampling location.

2. Use 3/8-inch Teflon® tubing for samples collected for organic compounds analyses. The tubing should be rinsed with solvent and dried in the ASB drying oven overnight before use. The ends of the siphon should be capped with aluminum foil and/or Teflon® film for storage. The siphon should be flushed with sample thoroughly before use.

3. The 3/8-inch PVC tubing utilized for samples, other than those collected for organic compounds analyses, should be thoroughly flushed with sample before use.

B.5.10 Reusable Teflon® Composite Mixer Rods

1. Follow procedure outlined in Section B.3.

2. Wrap rod in aluminum foil for storage.

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B.6 CLEANING PROCEDURES FOR SAMPLE TUBING

B.6.1 Silastic Rubber Pump Tubing Used In Automatic Samplers and Other Peristaltic Pumps

New precleaned tubing must be used for each automatic sampler set-up. The silastic rubber pump tubing need not be replaced in peristaltic pumps where the sample does not contact the tubing or where the pump is being used for purging purposes (i.e., not being used to collect samples).

The silastic tubing shall be precleaned as follows:

1. Flush tubing with hot tap water and phosphate-free laboratory detergent.
2. Rinse tubing thoroughly with hot tap water.
3. Rinse tubing with deionized water.
4. Install tubing in automatic sampler or peristaltic pump.
5. Cap both ends of tubing with aluminum foil.

B.6.2 Teflon® Sample Tubing

Use only new Teflon® tubing precleaned as follows for collection of samples for organic compounds analyses:

1. Teflon® tubing shall be precut in convenient lengths before cleaning.
2. Rinse outside of tubing with solvent.
3. Flush interior of tubing with solvent.
4. Dry overnight in the ASB drying oven.
5. Wrap tubing and cap ends with aluminum foil to prevent contamination during storage.

B.6.3 Polyvinyl Chloride (PVC) Sample Tubing (1/8, 1/4, or 3/8 Inch)

1. Use only new tubing.
2. The tubing will be flushed with sample immediately before use to remove any residues from the manufacturing or extruding process.
3. Polyvinyl chloride tubing will be used selectively where organic compounds are not of concern.
4. Tubing should be stored in original container and not removed from this container until needed.

B.6.4 Stainless Steel Tubing

1. Wash with laboratory detergent and hot water using a long, narrow, bottle brush.

2. Proceed with Steps 2-6 as outlined in Section B.4 (footnote applies).

B.6.5 Glass Tubing

Use new glass tubing, precleaned as follows:

1. Rinse thoroughly with solvent.

2. Air dry for at least 24 hours.

3. Wrap tubing completely with aluminum foil to prevent contamination during storage.

4. Discard tubing after use.

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