N42237.AR.001187
NSB KINGS BAY
5090.3a

SUPPLEMENTAL RESOURCE CONSERVATION AND RECOVERY ACT FACILITY INVESTIGATION SITE 11 VOLUME I WORKPLAN NSB KINGS BAY GA
8/1/1994
ABB

SUPPLEMENTAL RESOURCE CONSERVATION AND RECOVERY ACT FACILITY INVESTIGATION FOR SITE 11

VOLUME I, WORKPLAN

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

UNIT IDENTIFICATION CODE: N42237
CLEAN, DISTRICT I
CONTRACT NO. N62467-89-D-0317

AUGUST 1994

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
NORTH CHARLESTON, SOUTH CAROLINA
29419-9010

ABB
ASEA BROWN BOVERI

The geologic work described and professional opinions rendered in the Supplemental Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Work Plan and Sampling and Analysis Plan for Site 11, Old Camden County Landfill, at Naval Submarine Base, Kings Bay, Georgia, were developed in accordance with commonly accepted procedures consistent with applicable standards of practice.

Laura B. Harris

Professional Geologist No. 1063
Expires December 31, 1995

ABB Environmental Services, Inc.

1400 Centerpoint Blvd.
Suite 158
Knoxville, Tennessee 37932-1968

Telephone
(615) 531-1922

Fax
(615) 531-8226

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION
unclassified

1b. RESTRICTIVE MARKINGS
N/A

2a. SECURITY CLASSIFICATION AUTHORITY
N/A

2b. DECLASSIFICATION/DOWNGRADING SCHEDULE

3. DISTRIBUTION/AVAILABILITY OF REPORT
N/A

4. PERFORMING ORGANIZATION REPORT NUMBER(S)

5. MONITORING ORGANIZATION REPORT NUMBER(S)

6a. NAME OF PERFORMING ORGANIZATION
ABB Environmental Services, Inc.

6b. OFFICE SYMBOL *(if applicable)*
ABB-ES

7a. NAME OF MONITORING ORGANIZATION
Naval Submarine Base, Georgia

6c. ADDRESS *(City, State, and ZIP Code)*
1400 Centerpoint Boulevard, Suite 158
Knoxville, TN 37932-1968

7b. ADDRESS *(City, State, and ZIP Code)*
Public Works Department
NSB, Code N561
Kings Bay, Georgia 31547

8a. NAME OF FUNDING/SPONSORING ORGANIZATION
SOUTHNAVFACENGCOM

8b. OFFICE SYMBOL *(if applicable)*
N/A

9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
N62467-89-D-0317

8c. ADDRESS *(City, State, and ZIP Code)*
2155 Eagle Drive
P.O. Box 10068
North Charleston, SC 29411-0068

10. SOURCE OF FUNDING NUMBERS

PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT ACCESSION NO.

11. TITLE *(Include Security Classification)*
(Unclassified) Supplemental Resource Conservation and Recovery Act Facility Investigation for Site 11, Volume I, Workplan, Naval Submarine Base, Kings Bay, Georgia

12. PERSONAL AUTHOR(S)
Laura Harris, Nora Weber, Kelly Mish

13a. TYPE OF REPORT
Final

13b. TIME COVERED
FROM 01/93 TO 09/93

14. DATE OF REPORT *(Year, Month, Day)*
August 1994

15. PAGE COUNT
143

16. SUPPLEMENTARY NOTATION

17. COSAT: CODES

FIELD	GROUP	SUB-GROUP

18. SUBJECT TERMS *(Continue on reverse if necessary and identify by block number)*
Background, Technical Approach, Sampling Locations, Air Sampling, Groundwater Monitoring, Soil Sampling, Monitoring Well Installation, Test Trenching

19. ABSTRACT *(Continue on reverse if necessary and identify by block number)*
See "Block No. 19, Abstract" on the back of this page.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT
☐ Unclassified/Unlimited ☒ Same as RPT ☐ DTIC Users

21. ABSTRACT SECURITY CLASSIFICATION
unclassified

22a. NAME OF RESPONSIBLE INDIVIDUAL
Mr. Anthony Robinson

22b. TELEPHONE *(Include Area Code)*
(803) 743-0339

22c. OFFICE SYMBOL
182

REPORT DOCUMENTATION PAGE--continued

Form Approved
OMB No. 0704-0188

Block No. 18, Subject Terms

Block No. 19, Abstract

Three volumes comprise the planning documents for a Supplemental Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) at Site 11, Old Camden County Landfill, at Naval Submarine Base, Kings Bay, Georgia. The Supplemental RFI was developed to investigate releases from the landfill that were identified during previous RFI investigative tasks. The Supplemental RFI was designed to support a Corrective Measures Study, Interim Corrective Measures, a Health and Environmental Assessment, and identification and characterization of contaminated media. Previous investigations had identified volatile organic compounds in groundwater that were attributed to releases from wastes disposed at the site.

Volume I, the Workplan, provides a record of site history, describes regional environmental factors, details previous investigative results, describes the Supplemental RFI tasks, describes site investigative methodology, and describes project organization and schedule. Appendix A of the workplan includes a preinvestigation evaluation of corrective measures technologies.

Volume II, the Sampling and Analysis Plan (SAP), focuses on the field investigation, analytical methods, and quality assurance and quality control (QA/QC) procedures. The SAP describes the project, site management, and field methods; details the technical approach and sampling plans; and describes QA/QC requirements for sample collection, sample analysis, data assessment, and reporting.

Volume III, the Health and Safety Plan (HASP), outlines health and safety procedures for field tasks. The HASP includes Material Safety Data Sheets for chemicals that may be encountered at the site and provides emergency information and telephone numbers.

DISTRIBUTION

	Final
Southern Division, Naval Facilities Engineering Command	3
Naval Submarine Base, Kings Bay, Georgia	15

SUPPLEMENTAL RESOURCE CONSERVATION AND RECOVERY ACT FACILITY INVESTIGATION WORKPLAN FOR SITE 11

VOLUME I, WORKPLAN

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

Unit Identification Code No. N42237

Contract Task Order No. 094

Contract No. N62467-89-D-0317

Prepared by:

ABB Environmental Services, Inc.
2590 Executive Center Circle, East
Tallahassee, Florida 32301

Prepared for:

Department of the Navy, Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive
North Charleston, South Carolina 29418

Anthony Robinson, Code 18511, Engineer-in-Charge

August 1994

FOREWORD

In accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the 1986 Superfund Amendments and Reauthorization Act (SARA), the 1976 Resource Conservation and Recovery Act (RCRA) as augmented by the 1984 Hazardous and Solid Waste Amendments (HSWA), and as directed in Executive Order 12580 of January 1987, the Department of Defense (DOD) conducts an Installation Restoration (IR) program for evaluating and remediating problems related to releases and disposal of toxic and hazardous materials at DOD facilities.

The Naval Assessment and Control of Installation Pollutants (NACIP) program was developed by the Navy to implement the IR program for all naval and Marine Corps facilities. The NACIP program was originally conducted in three phases: (1) Phase I, Initial Assessment Study, (2) Phase II, Confirmation Study (including a Verification Step and a Characterization Step), and (3) Phase III, Planning and Implementation of Remedial Measures. The three-phase IR program was modified and updated to be congruent with the CERCLA, SARA, RCRA, and HSWA driven DOD IR program.

The updated nomenclature for the RCRA and SARA process is as follows:

- Preliminary Assessment and Site Inspection
- Remedial Investigation
- Feasibility Study
- planning and implementation of remedial design

This Workplan discusses general background information and summarizes the scope of the Supplemental RCRA Facility Investigation (RFI) to be conducted at Site 11, Naval Submarine Base, Kings Bay, Georgia. This investigation includes characterization of the nature and extent of groundwater contamination, source characterization, surface soil and subsurface soil sampling, sediment sampling, and surface water sampling. The analytical program is designed to support a Health and Environmental Assessment, Interim Corrective Measure, and Corrective Measures Study.

Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM) has the responsibility for implementation of the naval and Marine Corps IR program in the southeastern and midwestern United States. Questions regarding this report should be addressed to the Public Affairs Office, Naval Submarine Base, Kings Bay, Georgia, at (912) 673-4714.

EXECUTIVE SUMMARY

This Workplan is Volume I of a three volume set of planning documents for the Supplemental Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) to be conducted at Site 11, Naval Submarine Base, Kings Bay, Georgia. Volumes II and III of the planning documents are the Sampling and Analysis Plan (SAP) and Health and Safety Plan (HASP), respectively.

The Workplan provides a description of the site history, environmental and geologic setting, previous investigative results, project management and reporting, and the methodology for performing the Health and Environmental Assessment (HEA). The site investigative tasks are briefly described in the Workplan. The SAP, Volume II, focuses on the field investigation methodology, analytical program, and quality assurance and quality control requirements for the project.

Work at Site 11 began in 1991 when an initial RFI Workplan was developed (ABB Environmental Services, Inc. [ABB-ES], 1991). The initial field investigation was completed in early 1992. In mid-1992 groundwater volatile organic compound (VOC) contamination was indicated at the site. Additional investigations were planned and implemented during 1992 and early 1993 to delineate the VOC contamination and to evaluate for imminent health threats resulting from the contamination. These investigations were conducted using screening methods. The Draft Final RFI Interim Report (ABB-ES, 1993a) was prepared using the existing information to address information requirements outlined in the USEPA RCRA Corrective Action Plan (U.S. Environmental Protection Agency [USEPA], 1988a) to the extent the information was available. The extent that these information requirements were not met formed the basis for planning the Supplemental RFI. These information requirements include contaminant characterization and collecting data to support an HEA and Corrective Measures Study. An Interim Measure (IM) is being planned concurrently with the Supplemental RFI and data will also be collected to support and complement the IM effort.

The Supplemental RFI includes the use confirmatory sampling and analytical methods. The Supplemental RFI includes collection of surface water and sediments samples, subsurface soil samples, surface soil samples, installation of groundwater monitoring wells and groundwater sampling, air sampling, and performing public health and ecological surveys. The laboratory program is based on using Contract Laboratory Program (CLP) protocol because the highest level of data quality can be achieved with data generated using CLP methods. Because the NSB has an RCRA permit and is obligated to follow RCRA requirements, a subset of samples will be analyzed for Appendix IX constituents using USEPA SW-846 methods.

TABLE OF CONTENTS

Supplemental Resource Conservation and Recovery
Act Facility Investigation for Site 11
Volume I, Workplan
Naval Submarine Base
Kings Bay, Georgia

TABLE OF CONTENTS (Continued)

Supplemental Resource Conservation and Recovery
Act Facility Investigation for Site 11
Volume I, Workplan
Naval Submarine Base
Kings Bay, Georgia

TABLE OF CONTENTS

Supplemental Resource Conservation and Recovery
Act Facility Investigation for Site 11
Volume I, Workplan
Naval Submarine Base
Kings Bay, Georgia

LIST OF FIGURES

Supplemental Resource Conservation and Recovery
Act Facility Investigation for Site 11
Volume I, Workplan
Naval Submarine Base
Kings Bay, Georgia

LIST OF TABLES

Supplemental Resource Conservation and Recovery
Act Facility Investigation for Site 11
Volume I, Workplan
Naval Submarine Base
Kings Bay, Georgia

GLOSSARY

ABB-ES	ABB Environmental Services, Inc.
ADD	Average Daily Dose
AQUIRE	aquatic information retrieval
ASTM	American Society for Testing and Materials
ATSDR	Agency for Toxic Substances and Disease Registry
bls	below land surface
BOD	biochemical oxygen demand
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulation
CLEAN	Comprehensive Long-Term Environmental Action, Navy
CLP	Contract Laboratory Program
CLP-RAS	Contract Laboratory Program-Routine Analytical Services
CMS	Corrective Measures Study
COD	chemical oxygen demand
CPC	contaminants of potential concern
°C	degrees Celsius
°F	degrees Fahrenheit
DOD	Department of Defense (U.S.)
DQO	data quality objective
EQP	Equilibrium Partitioning Theory
EP	Extraction Procedure
ERL	Effects Range Low
FOL	Field Operations Leader
ft/yr	feet per year
GA DNR	Georgia Department of Natural Resources
GPR	ground-penetrating radar
HASP	Health and Safety Plan
HEA	Health and Environmental Assessment
HEAST	Health Effects Assessment Summary Tables
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient
HSWA	Hazardous and Solid Waste Amendments
ICMS	Interim Corrective Measures Study
IDW	investigation-derived wastes
IM	Interim Measure
in/yr	inches per year
IR	Installation Restoration
IRIS	Integrated Risk Information System
LADD	Lifetime Average Daily Dose
LC_{50}	dose lethal to 50 percent of the test population

μg/ℓ	microgram per liter
μmhos/cm	micromhos per centimeter
MCLG	Maximum Contaminant Level Goal
MCL	Maximum Contaminant Level
mlw	mean low water
mg/ℓ	micrograms per liter
MOTKI	Military Ocean Terminal, Kings Bay
msl	mean sea level
NACIP	Naval Assessment and Control of Installation Pollutants
Navy	Department of the Navy
NCP	National Contingency Plan
NEESA	Naval Energy and Environmental Support Activity
NOAA	National Oceanic and Atmospheric Administration
NSB	Naval Submarine Base
PCB	polychlorinated biphenyl
PIW	private irrigation well
PMP	Project Management Plan
QA	quality assurance
QA/QC	quality assurance and quality control
QC	quality control
QAPP	Quality Assurance Project Plan
QRB	Quality Review Board
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RfD	Reference Dose
RFI	RCRA Facility Investigation
RPM	Remedial Project Manager
s.u.	standard units
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SC	screening concentration
SDWA	Safe Drinking Water Act
SOUTHNAVFACENGCOM	Southern Division, Naval Facilities Engineering Command
SOW	Statement of Work
SVOC	semivolatile organic compound
SWMU	Solid Waste Management Unit
TAL	Target Analyte List
TBC	to be considered
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TDS	total dissolved solids
THI	Total Hazard Index
TIC	tentatively identified compound
TL	Technical Leader

TOC	total organic carbon
TOM	Task Order Manager
TRC	Technical Review Committee
TSS	total suspended solids
UCL	95th percentile Upper Confidence Limit percent
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
VOC	volatile organic compound

1.0 INTRODUCTION

Under contract to the U.S. Department of the Navy (Navy), Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM), this Supplemental Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Workplan was prepared for Site 11, the Old Camden County Landfill, located on the Naval Submarine Base (NSB) in Kings Bay, Georgia. This Workplan is Volume I of a three volume set of planning documents for the Supplemental RFI. Volume II is the Sampling and Analysis Plan (SAP), and Volume III is the Health and Safety Plan (HASP). These documents were prepared under the Comprehensive Long-Term Environmental Action, Navy (CLEAN) Contract No. N62467-89-D-0317, Contract Task Order No. 041. The following subsections describe the regulatory setting, purpose of the work, and a brief description of the planning documents.

1.1 PURPOSE AND REGULATORY SETTING. The Department of Defense (DOD) conducts an Installation Restoration (IR) program for evaluating and remediating problems related to releases and disposal of toxic and hazardous materials at DOD facilities. SOUTHNAVFACENGCOM has the responsibility for executing the IR program in the southeastern United States. The IR program provides the mechanism for funding and management of investigations conducted at Site 11 at NSB Kings Bay.

Because NSB Kings Bay is operating under a current RCRA permit, the facility is obligated to follow RCRA regulations. The RCRA Corrective Action Program uses a four-phase approach to evaluate the condition of Solid Waste Management Units (SWMUs) and direct corrective action, if necessary, at these sites. The first step, an RCRA Facility Assessment (RFA), was not formally conducted at NSB Kings Bay by representatives of State and Federal regulatory agencies. However, the Georgia Department of Natural Resources (GA DNR) issued an Hazardous and Solid Waste Amendments (HSWA) Permit to the NSB on September 29, 1989. The HSWA permit identified four SWMUs suspected to be sources of current or past releases of hazardous substances to the environment:

- Site 5, Army Reserve Disposal Area, Towhee Trail;
- Site 11, Old Camden County Landfill;
- Site 12, Army Reserve Disposal Area, Future Dry Dock; and
- Site 16, Army Reserve Disposal Area, Motor Missile Magazines.

Sites 5, 12, and 16 were included in the initial RFI, but no sampling or analyses were conducted at Site 12 because it was reportedly remediated during construction of a dry dock. These sites are being handled separately from work at Site 11 because past investigations identified a release from Site 11 and contamination has moved off NSB property toward a residential area. This has necessitated an accelerated approach to identification and correction of contamination associated with Site 11.

The second step of corrective action includes developing an RFI Workplan and conducting an RFI to establish the presence or absence of toxic or hazardous substances and obtain information on the nature and extent of the contamination. Information collected during the RFI stage will be used to establish whether there is a need to implement additional phases of the Corrective Action Program. The third step, Interim Measure (IM), would involve controlling the further migration of contaminants and/or controlling potential sources of release. The fourth step, Corrective Measures Study (CMS), would evaluate and recommend specific technical methodologies for achieving long-term remedial action goals.

Several steps of the RCRA Corrective Action Program are currently being conducted at Site 11. Planning for the IM and CMS programs has begun and a Supplemental RFI program has also been developed to support both the IM and CMS, as well as to address the information requirements outlined in the *RCRA Corrective Action Plan* (Interim Final, U.S. Environmental Protection Agency [USEPA], 1988a).

1.2 OVERVIEW OF PLANNING DOCUMENTS. This Workplan (Volume I) provides a record of site history, describes regional environmental factors, details previous investigative results, describes the Supplemental RFI tasks, describes site investigative methodology, and describes project organization and schedule. Appendix A of the Workplan includes a preinvestigation evaluation of corrective measures technologies, which is specified as an RFI task in the *RCRA Corrective Action Plan* (Interim Final, USEPA, 1988a).

The SAP (Volume II) focuses on the field investigation, analytical methods, and quality assurance (QA) and quality control (QC) procedures. The SAP describes the project, site management and field methods, details the technical approach and sampling plans, and describes quality assurance and quality control (QA/QC) requirements for sample collection, sample analysis, data assessment, and reporting.

The HASP (Volume III) outlines health and safety procedures for field tasks. The HASP includes Material Safety Data Sheets for chemicals that may be encountered at the site and provides emergency information and telephone numbers.

2.0 FACILITY BACKGROUND

2.1 SITE LOCATION AND LAND USE. NSB Kings Bay is located in the southeast corner of Georgia approximately 8 miles north of the Georgia-Florida border. It covers a total area of approximately 16,168 acres. The closest community to the facility is the City of St. Marys, which borders the southern boundary of the base (Figure 2-1). NSB Kings Bay is located in Camden County, which has a population of 12,800 residing mainly in St. Marys, Kingsland, and Woodbine. The population in Camden County has increased steadily since 1940 with the introduction of paper manufacturing at St. Marys. Kings Bay, which borders the base on the eastern side, empties into Cumberland Sound and eventually the Atlantic Ocean.

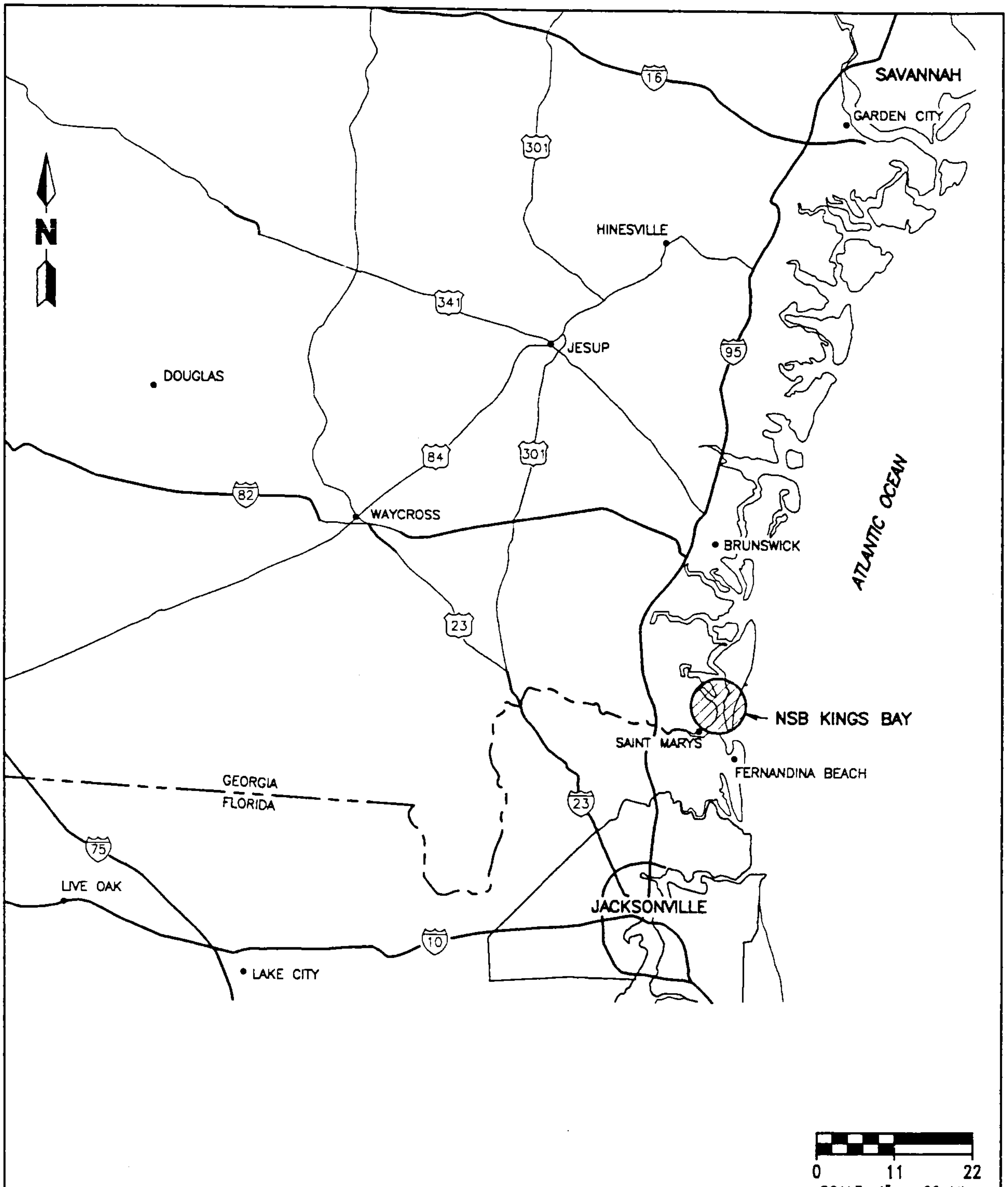
The Old Camden County Landfill is located adjacent to the northwest boundary of the NSB Kings Bay (Figure 2-2). The area of the base near the site is used for recreational purposes and hunting. Housing for base employees, a day-care center, and Navy lodge are also present in the area. Access to the site is limited to the extent that entry to the base is restricted. There are currently no controls to restrict access to the site within the base. Human activities near the site observed by field crews include jogging, bicycle riding, walking, and hunting.

2.1.1 General Facility Operations and History The history of the facility, as described in the RFI Interim Report for Site 11 (ABB Environmental Services, Inc. [ABB-ES], 1993a), is summarized in the following paragraphs of this subsection.

The U.S. Army began operations at NSB Kings Bay in the early 1950's. The property originally was developed as a military ocean terminal. From its inception until June 30, 1965, the terminal was known as the Kings Bay Army Terminal. The Kings Bay Army Terminal was constructed to meet the Department of the Army's requirements for east coast port facilities capable of transporting ammunition and other explosives in the event of a national emergency. During this time, the Kings Bay Army Terminal was used for training purposes by the U.S. Army Reserves.

On April 1, 1965, as a result of a major reorganization, the terminal was placed under the jurisdiction of the newly organized Military Traffic Management and Terminal Service. On July 1, 1965, the terminal became known as the U.S. Army Military Ocean Terminal, Kings Bay (MOTKI). MOTKI was designed to store ammunition or explosives for about 3 months and was directly subordinate to the Military Ocean Terminal, Southport, North Carolina. Facilities constructed at MOTKI included a 2,000-foot wharf, administration buildings, workshops, utility buildings, and 47 miles of railroad track for transporting explosives. MOTKI had no assigned military personnel and was maintained and operated by 19 U.S. Government Civil Service employees for reserve training operations and contingency purposes from 1965 to 1978. The mission of MOTKI was to plan programs, make military repairs, and provide fire prevention and protection functions for the terminal. Because there was no immediate operational need for this installation, it was placed on inactive status from 1965 until July 1, 1978.

In 1978, the Department of the Navy selected MOTKI as the east coast location for its Fleet Ballistic Missile submarine support facility. On July 1, 1978, the



SOURCE: MODIFIED FROM GEORGIA ROADMAP, H.M. GOUSHA, 1991.

FIGURE 2-1

REGIONAL LOCATION MAP

SUPPLEMENTAL RFI WORKPLAN

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

D:\DWG\ABB\8503-07\SRFI_WP\FIG_2-1\DMF\940622

KB_STE11.WP
MVL08.94

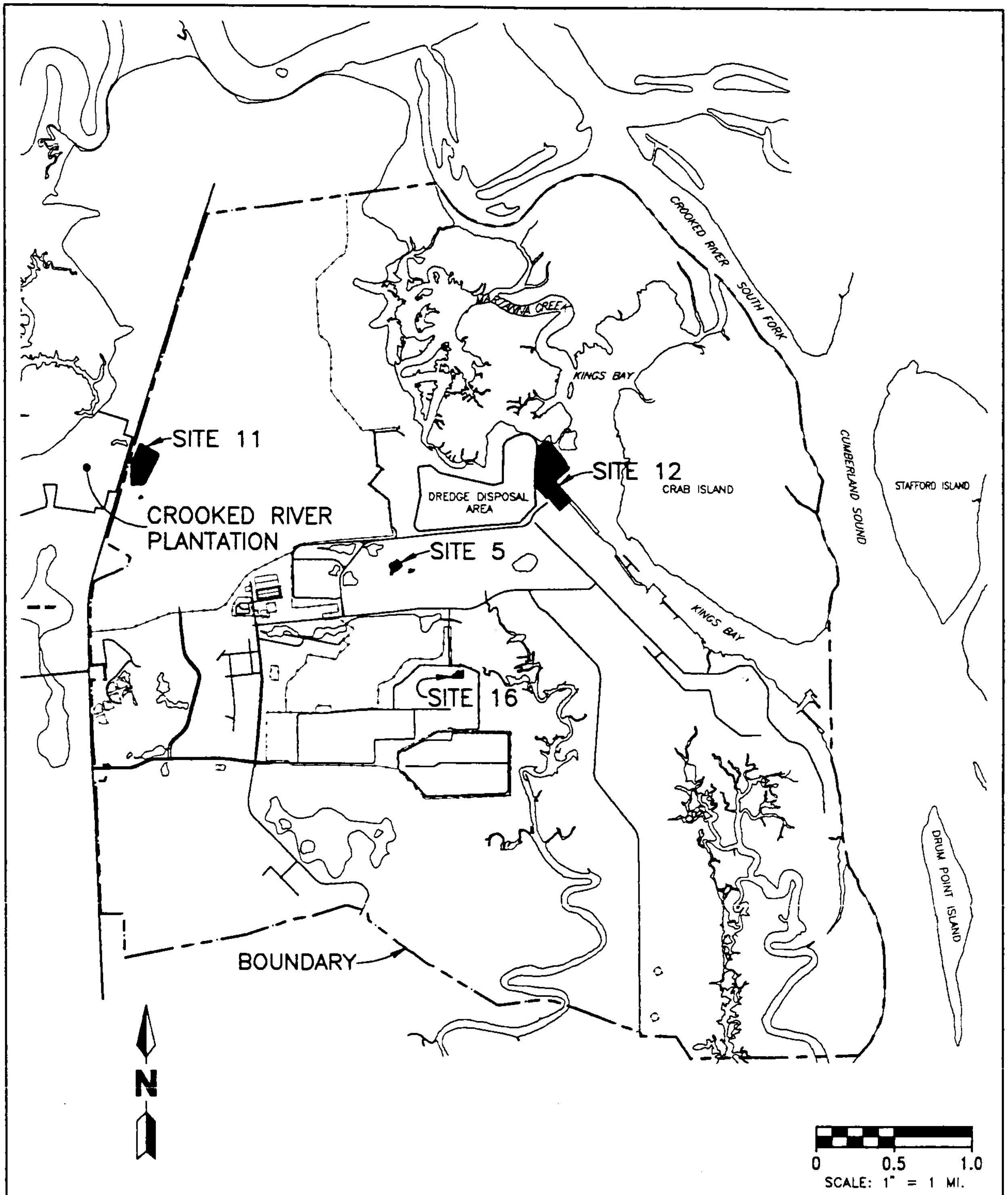


FIGURE 2-2

SITE LOCATION MAP

SUPPLEMENTAL RFI WORKPLAN

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

D:\DWG\ABB\8503-07\SRFI_WP\FIG_2-2\DMF\940622

site was established under a developmental status and was named the Naval Submarine Support Base. Construction of a refit facility for one submarine squadron (T-1) began in 1978 in anticipation of 10 Poseidon submarines. In 1979, the Navy moved Squadron 16 from Spain to Kings Bay, and the site's official name became the Naval Submarine Base, Kings Bay.

Currently, NSB Kings Bay supports TRIDENT submarines. New facilities completed in the early 1990's are for crew training, weapons handling and storage, submarine maintenance and repair, personnel support, and housing.

2.1.2 Adjacent Land Use Camden County lies midway between Jacksonville to the south, and the smaller urban area of Brunswick to the north. The existing land use in the region ranges from highly urbanized to rural development. The north, south, and west areas in the vicinity of the base are mostly light residential with some commercial development on the west side. On the east side of the base is Kings Bay. The region is predominantly rural with only about 8 percent of the land area developed. The majority of the undeveloped land is either marsh or swamp and does not lend itself to development or agricultural uses.

2.2 SITE HISTORY. The landfill was operated by Camden County from 1974 to October 1981. Reportedly, hazardous wastes were not accepted at the landfill. Discussions with landfill personnel indicated that domestic wastes were accepted from the following sources:

Source	Percentage of Total Waste
Camden County	60 percent
Naval Submarine Base, Kings Bay	20 to 30 percent
Blue Star Shipping Company	5 to 10 percent
Gilman Paper Company	5 to 10 percent

Wastes, including general household and office wastes, scrap paper, wood, and sludge and grit from the base sewage treatment plants, were brought to the site by truck. On the average, about 12 truckloads per day of wastes were disposed at the site. It was reported that for a 3-month period in 1974 or 1975, the Gilman Paper Company sent about seven truckloads of scrap paper (seven or eight bales per truck) to the landfill. A September 1981 letter from Captain R.A. Currier, Navy Commanding Officer, requested permission to dispose of approximately 100 cubic yards of fire-fighting pit sludges from a proposed dredge spoils disposal area. This waste did not exceed Extraction Procedure (EP) toxicity as described in 40 Code of Federal Regulations (CFR), Part 251.24, under Section 3001 of the RCRA. EP toxicity tests were applicable for waste characterization in 1981. Approval from the Camden County Health Department for the disposal of burnt oils and gasoline from fire-fighting residues was granted in December 1981.

The landfill was a trench and fill operation with trenches oriented in a southeast to northwest direction across the landfill. The trenches ranged from 575 to 775 feet in length and 35 to 50 feet in width. Excavation was into the water table, which may have been as deep as 12 feet below land surface (bls) during the time the landfill was operational. Burning of wastes took place once per week during 1974, but did not occur after 1974. Each day the wastes, including ash in 1974, were compacted and covered with at least 6 inches of soil. Upon closure, a final soil cover 2 feet thick was placed on the landfill. The estimated quantity of disposed waste is 500,000 cubic yards.

2.3 ENVIRONMENTAL DESCRIPTION.

2.3.1 Climatology NSB Kings Bay is located in an area characterized by a humid subtropical climate, with hot, wet summers and cool, dry winters. A summary of climatological data for the Kings Bay area is provided in Table 2-1. The normal annual temperature is approximately 70 degrees Fahrenheit (°F). Because of the moderating effect of the ocean, temperatures rarely rise above 100 °F. Normal annual precipitation is estimated to be 53 inches (Thibodeaux, 1979). Precipitation occurs mainly in the form of rain during summer months. Evapotranspiration rates range from 35 to 36 inches per year (in/yr). The average annual runoff for the southeastern Georgia area is estimated at less than 10 in/yr (U.S. Geological Survey [USGS], 1989). Based on the above estimates for annual precipitation, evapotranspiration, and surface water runoff, the annual infiltration to the surficial aquifer is estimated to be 7 inches. Relative humidity varies widely throughout the year, with an annual average of 87 percent in the morning and 55 percent in the afternoon. The highest relative humidity is generally encountered during June through October. The relative humidity is generally lowest during March through May (Thibodeaux, 1979).

Prevailing winds are westerly, with strong northerly components in winter and southerly components in summer. Figure 2-3 is a wind rose diagram for data obtained from the National Climatic Data Center for the period of record 1973 through 1982 for the Jacksonville, Florida, area. Prevailing wind speeds are highest (9 to 10 miles per hour) in late winter and early spring, and lowest during the summer. The seasonal and annual wind pattern is influenced by the land and water temperatures along the coast. Thunderstorms occur most frequently in summer months, and tornadoes commonly occur during March through May. Generally, tropical cyclones and hurricanes have occurred during the months of August and September.

2.3.2 Topography and Surface Drainage The NSB is included in the Harriett's Bluff Quadrangle (Figure 2-4). Elevations at NSB Kings Bay are measured relative to mean low water (mlw), rather than mean sea level (msl). The elevations at NSB Kings Bay range from zero feet mlw at the shoreline to 35 feet mlw in the western part of the base. The area around the base is generally flat and marshy, and traversed by slow meandering streams.

Elevations at the Old Camden County Landfill are higher than most surrounding areas, being approximately 35 feet mlw. The landfill surface is characterized by relatively flat to gently sloping surface topography. Drainage features provide topographic relief and, in the vicinity of the landfill, variations in elevations are approximately 10 feet.

NSB Kings Bay is drained by three major drainage networks, Marianna Creek, North River, and Cumberland Sound Basins, as shown in Figure 2-5 (Onyx/Landers-Atkins Planning Group, 1985). Because the NSB is relatively flat, roads and disturbed areas form artificial drainage patterns and dividing lines between drainage basins (ABB-ES, 1993a). Surface runoff at NSB Kings Bay is to rivers and

KB_STE11.WP
MVL.08.94

Table 2-1
Summary of Climatological Data[1]

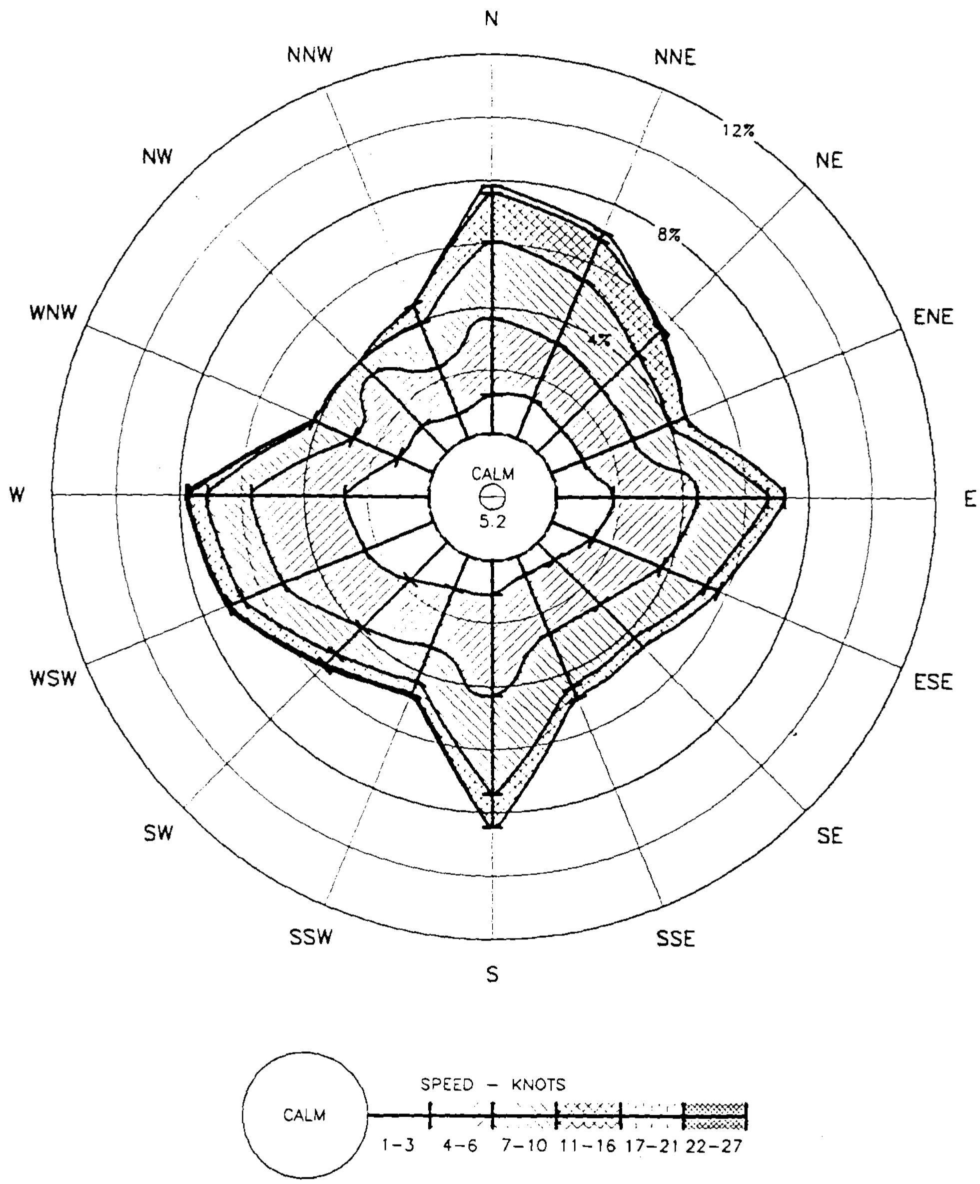
Supplemental Resource Conservation and Recovery
Act Facility Investigation for Site 11
Volume I, Workplan
Naval Submarine Base
Kings Bay, Georgia

	Length of Record (year)	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Average Relative Humidity (%)	35	87/57[2]	85/52	85/49	85/47	83/48	86/55	87/58	90/59	91/62	90/58	88/55	87/57	87/55
Normal Monthly and Annual Precipitation (inches)	NR	2.45	2.91	3.49	3.55	3.47	6.33	7.68	6.85	7.56	5.16	1.69	2.22	53.36
Normal Monthly and Annual Average Temperature (°F)	NR	55.9	57.5	62.2	68.7	75.8	80.8	82.6	82.3	79.4	71.0	61.7	56.1	69.5
Average Wind Speed (mph)	22	8.7	9.8	9.8	9.5	9.1	8.7	7.9	7.7	8.8	9.0	8.6	8.4	8.8

[1] Information reported for Jacksonville, Florida, station.
[2] 87/57 = Average relative humidity for 7:00 a.m./1:00 p.m.

Source: Thibodeaux, 1979.

Notes: % = percent.
NR = not recorded.
°F = degrees Fahrenheit.
mph = miles per hour.



SOURCE: NATIONAL CLIMATIC DATA CENTER.

FIGURE 2-3

WIND ROSE
JACKSONVILLE, FLORIDA
1973-1982, ALL MONTHS

SUPPLEMENTAL RFI
WORKPLAN

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

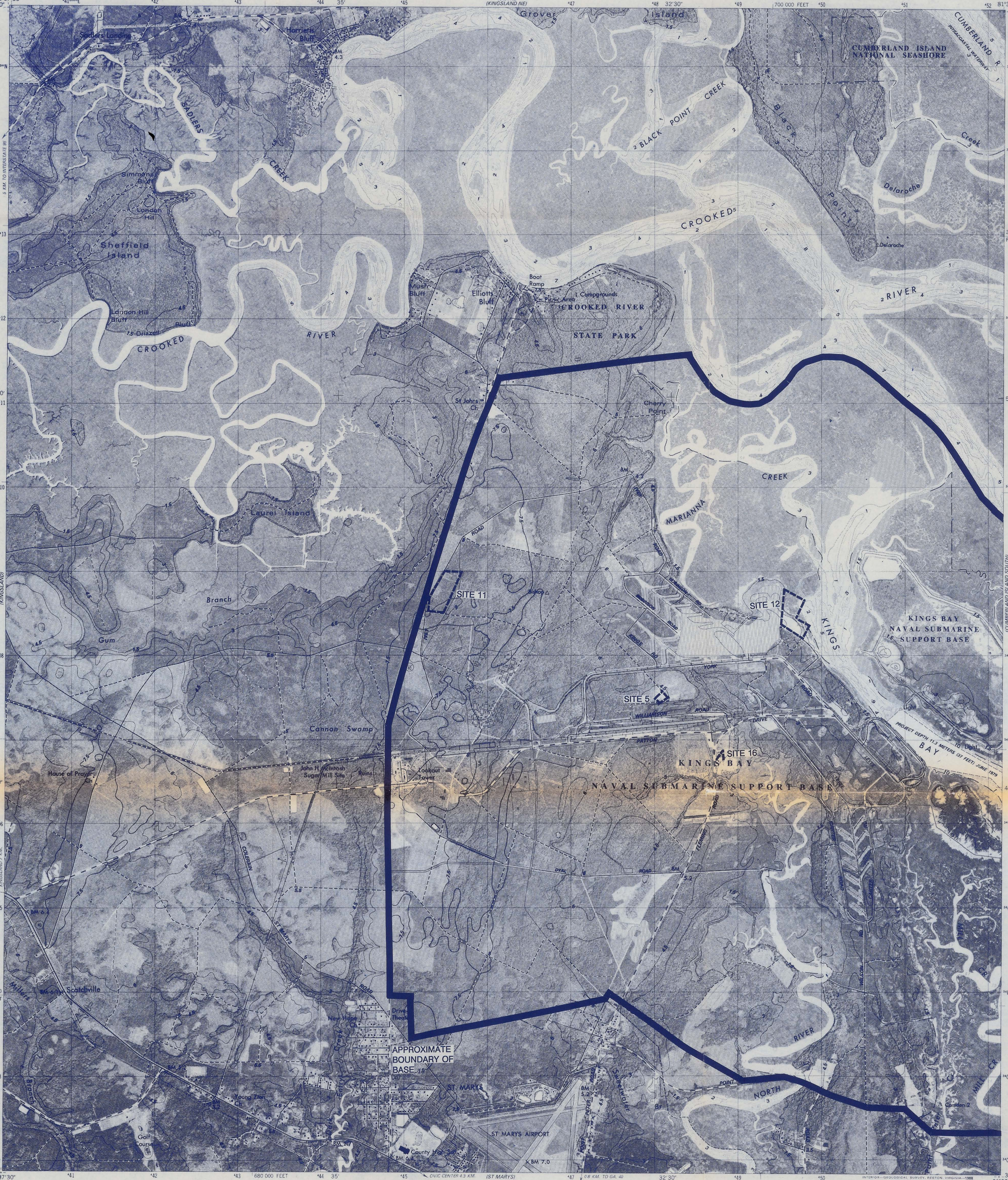
D:\DWG\ABB\8503-07\SRFI_WP\FIG_2-3\DMF\940622

THIS PAGE INTENTIONALLY LEFT BLANK.

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

STATE OF GEORGIA
DEPARTMENT OF NATURAL RESOURCES
EARTH AND WATER DIVISION

HARRIETTS BLUFF QUADRANGLE
GEORGIA—CAMDEN CO.
7.5 MINUTE SERIES ORTHOPHOTOMAP
(TOPOGRAPHIC—BATHYMETRIC)



Produced by the United States Geological Survey and the National Ocean Service

Control by USGS, NOS/NOAA, and USCE

Orthophotomap prepared by the Geological Survey from aerial photograph taken April 19, 1974. Topography by planetable surveys 1958; revised from aerial photographs taken 1974. Field checked 1975. Map edited 1980

Bathymetry compiled by the National Ocean Service from tide-coordinated hydrographic surveys
Soundings compiled from NOS 11503 and 11504
This information is not intended for navigational purposes
Mean lower low water (dotted) line and mean high water (solid) line compiled by NOS from tide-coordinated aerial photographs
Apparent shoreline (outer edge of vegetation) shown by photoimagery

Projection and 10,000-foot grid ticks: Georgia coordinate system, east zone (transverse Mercator)
1000-meter Universal Transverse Mercator grid, zone 17
1927 North American Datum
To place on the predicted North American Datum 1983, move the projection lines 21 meters south and 17 meters west as shown by dashed corner ticks

There may be private inholdings within the boundaries of the National or State reservations shown on this map

UTM GRID AND 1988 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

CONTOURS AND ELEVATIONS IN METERS

HYDROGRAPHIC SURVEY INFORMATION

Survey Number	Survey Date	Survey Scale	Survey Line Spacing (Naut. Miles)
H-5753	1935	1:10,000	.02-.12
H-5754	1934-35	1:10,000	.02-.08
H-5756	1935	1:10,000	.02-.10
H-9805	1979	1:2,500	.01-.02

Revisions shown in purple compiled in cooperation with State of Georgia agencies from aerial photographs taken 1983 and other sources. This information not checked. Map edited 1988

SCALE 1:24 000

CONTOUR INTERVAL 1.5 METERS
NATIONAL GEODETIC VERTICAL DATUM OF 1929
BATHYMETRIC CONTOUR INTERVAL 1 METER WITH SUPPLEMENTARY 0.5 METER CONTOURS — SOUNDINGS IN METERS
DATUM IS MEAN LOWER LOW WATER
THE RELATIONSHIP BETWEEN THE TWO DATUMS IS VARIABLE

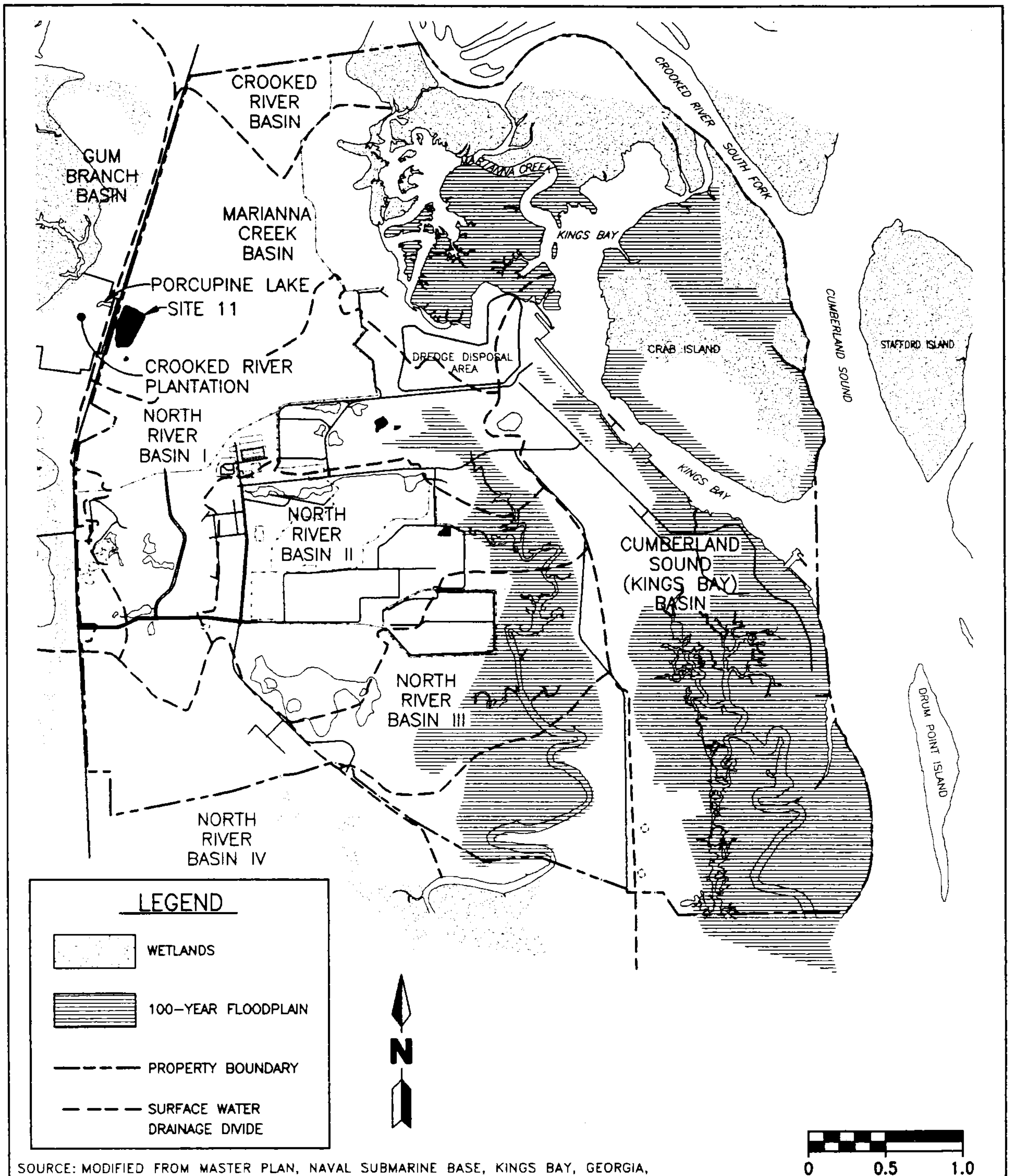
BASE MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
BATHYMETRIC SURVEY DATA COMPLIES WITH INTERNATIONAL HYDROGRAPHIC ORGANIZATION (IHO) SPECIAL PUBLICATION 44 ACCURACY STANDARDS AND/OR STANDARDS USED AT THE DATE OF THE SURVEY
FOR SALE BY U. S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225, OR RESTON, VIRGINIA 22092
AND NATIONAL OCEAN SERVICE, ROCKVILLE, MARYLAND 20852
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

NATIONAL OCEAN SERVICE HYDROGRAPHIC SURVEY INDEX

ROAD CLASSIFICATION
Primary highway, hard surface
Light-duty road, hard or improved surface
Secondary highway, hard surface
Unimproved road
Trails
Interstate Route
U. S. Route
State Route

HARRIETTS BLUFF, GA.
30081-G5-OM-024
1980
PHOTOREVISED 1988
DMA 4645 I SE—SERIES V8450

THIS PAGE INTENTIONALLY LEFT BLANK.



SOURCE: MODIFIED FROM MASTER PLAN, NAVAL SUBMARINE BASE, KINGS BAY, GEORGIA, ONYX/LANDERS-ATKINS PLANNING GROUP, 1985.

FIGURE 2-5

SURFACE WATER DRAINAGE BASINS, WETLANDS, AND 100-YEAR FLOODPLAIN MAP

SUPPLEMENTAL RFI WORKPLAN

NAVAL SUBMARINE BASE KINGS BAY, GEORGIA

D:\DWG\ABB\8503-07\SRFI_WP\FIG_2-5\DMF\940818

KB_STE11.WP
MVL.08.94

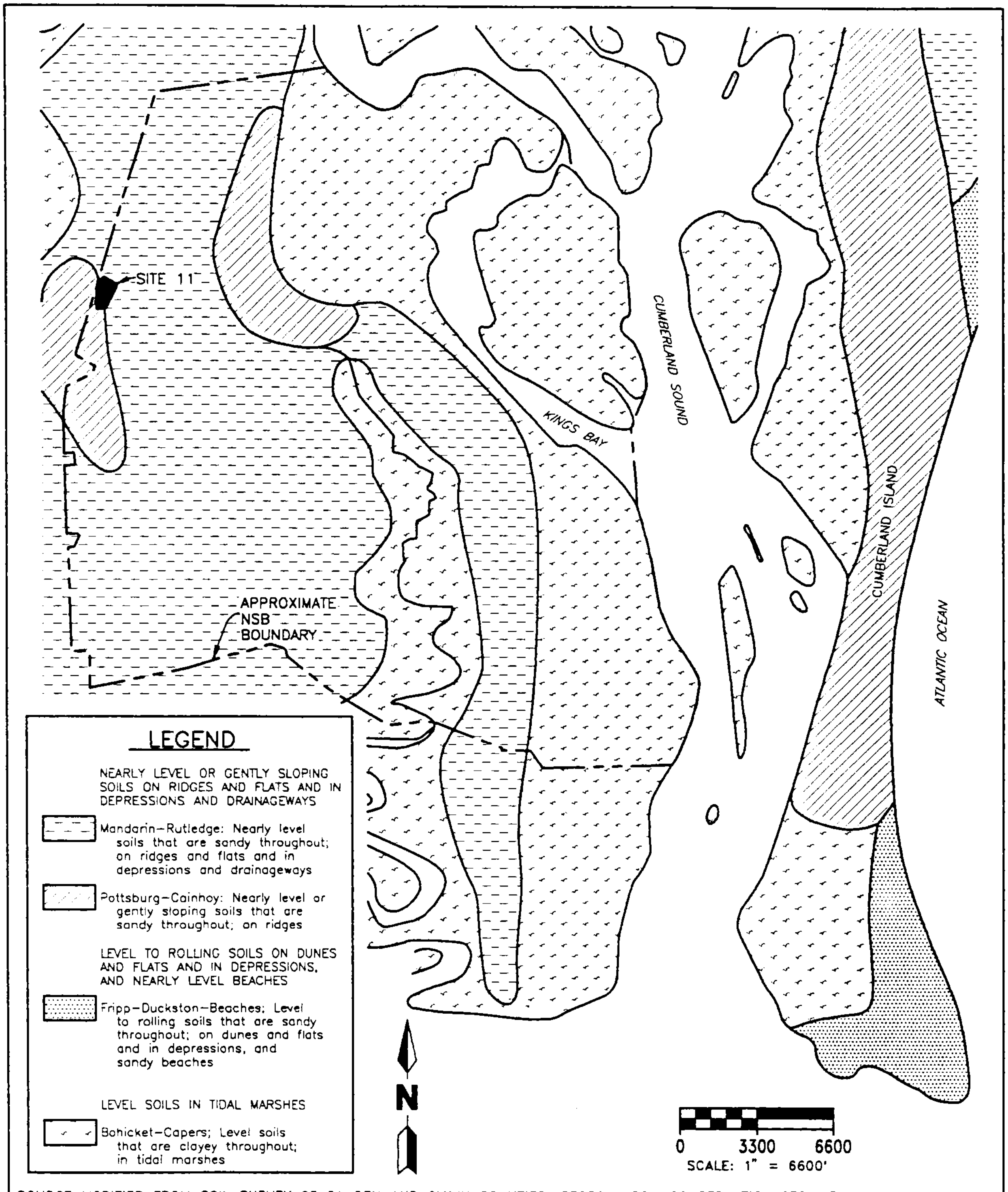
intermittent creeks via storm drainage ditches. Infiltration of precipitation to groundwater is promoted by the flat topography and permeable sands. Most surface water runoff is stored in the upland swamps and marshes and is diverted off base through long shallow ditches, rivers, and intermittent creeks. Water may eventually migrate through the surficial aquifer and discharge into streams, rivers, and springs, including the North River, Crooked River, and Marianna Creek. These streams and rivers eventually flow into Kings Bay and the Cumberland Sound.

The NSB Kings Bay drainage network covers an area of approximately 11,000 acres within the boundaries of the activity. Approximately 30 percent of this area is salt marsh, and the remainder consists of upland swamps and marshes. The major drainage outlet is the North River, draining approximately 49 percent of the area to the south. To the north, the Crooked River drains approximately 5 percent of the NSB, Marianna Creek drains 17 percent, and the remaining 29 percent of the NSB drains eastward into the Cumberland Sound (ABB-ES, 1993a). Porcupine Lake, a man-made lake supported by groundwater discharge, is located approximately 400 feet northwest of the Old Camden County Landfill, Site 11. This lake is the nearest surface water body to the landfill, and because it is hydraulically downgradient of the landfill, it could potentially be affected by releases from the landfill. The depth of the lake ranges from approximately 6 feet in the west end to 5 feet in the east end. The water in the lake is clear and supports abundant flora and fauna. Measurements of pH indicate the water is neutral, ranging from 6.61 to 7.10 standard units (s.u.). Specific conductance measurements ranged from 254 to 272 micromhos per centimeter (μmhos/cm). Temperature of the lake water ranged from 22.8 degrees Celsius (°C) to 24.1 °C. These measurements were taken in late October during the Interim Corrective Measure Screening Investigation (ABB-ES, 1993b).

Water quality in freshwater bodies in and near the NSB is affected by concentrations of mercury, possibly from mercury-based fungicides, and low levels of dissolved oxygen (ABB-ES, 1993a). Water quality within Kings Bay and Cumberland Sound are affected by dredging activities, spoils disposal, effluent discharge, sewage effluent discharge, construction, runoff from pine plantations and small agricultural areas, and waterfront industrial operations. The freshwater bodies described above are used principally for non-contact recreation including boating, fishing, and navigation.

The elevations of the 10-, 100-, and 500-year floodplains in the region are 6.8, 12.4, and 16.5 feet above msl, respectively. Approximately one-half of the facility lies within the 100-year floodplain. In general, land surrounding the low marshy areas near Marianna Creek and the North River lies within the 100-year floodplain (ABB-ES, 1993a).

<u>2.3.3 Soil</u> Four soil map units are associated with the NSB Kings Bay area (Figure 2-6), the Mandarin-Rutledge, Pottsburg-Cainhoy, Fripp-Duckston-Beaches, and the Bohicket-Capers soil (Soil Conservation Service, 1980). The Mandarin-Rutledge and Pottsburg-Cainhoy soil is associated with nearly level or gently sloping soil on ridges and flats and in depressions and drainageways. The Fripp-Duckston-Beaches soil is associated with level to rolling soil on dunes and flats and in depressions, and nearly level beaches. The Bohicket-Capers soil is associated with level soil in tidal marshes. The soil is described in this subsection based on information presented in the soil survey report for Camden County, Georgia (Soil Conservation Service, 1980).



SOURCE: MODIFIED FROM SOIL SURVEY OF CAMDEN AND GLYNN COUNTIES, GEORGIA, SOIL CONSERVATION SERVICE, 1980.

FIGURE 2-6

REGIONAL SOIL MAP

SUPPLEMENTAL RFI WORKPLAN

NAVAL SUBMARINE BASE KINGS BAY, GEORGIA

D:\DWG\ABB\8503-07\SRFI_WP\FIG_2-6\DMF\940622

Mandarin-Rutledge. Mandarin soil is typically fine-grained sand, somewhat poorly drained, and found on ridges and flats. A very dark gray surface layer approximately 3 inches thick is underlain by a predominantly light gray layer extending to a depth of 19 inches. A weakly cemented organic hardpan extends below this to approximately 34 inches. The hardpan color is dark brown in the lower section, very dark brown in the middle section, and black in the upper section. Light gray, white, and grayish brown layers lie beneath the hardpan to a depth of 62 inches. A second weakly cemented black organic hardpan underlies these layers to a depth of 80 inches or more.

Rutledge soil is typically fine-grained sand, very poorly drained, and found in depressions and drainageways. A black surface layer approximately 15 inches thick is underlain by a layer that is light gray mottled with brownish gray in the upper section, light brownish gray in the middle section, and grayish brown mottled with very dark grayish brown in the lower section. This layer extends to a depth of 70 inches or more.

This unit has a slope of mainly less than 1 percent and lies in the east-central and extreme western part of Camden County and on the coastal islands. Because of the wetness of the soil, it has poor potential for most uses except woodlands.

Pottsburg-Cainhoy. Pottsburg soil is typically sand, somewhat poorly drained, and nearly level. A gray surface layer approximately 4 inches thick is underlain by a layer that is light gray with brownish yellow and brown mottles in the upper section and white with brownish yellow and dark grayish-brown mottles in the lower section. This layer extends to a depth of 63 inches and is underlain by a weakly cemented dark brown organic hardpan extending to a depth of 80 inches or more.

Cainhoy soil is typically fine-grained sand, somewhat excessively drained, and nearly level and gently sloping. A dark gray surface layer approximately 5 inches thick is underlain by a layer that is brownish yellow and extends to a depth of 23 inches. A very pale brown layer extends to a depth of 50 inches. Below this layer are light gray and white layers to a depth of 101 inches. Next, a black and dark reddish brown layer extends to a depth of 120 inches.

This unit has a slope of 5 percent or less and lies on Cumberland Island and in the extreme western part of Camden County. Community development and recreation are the main uses for this unit. Due to the wetness of the soil on the lower landscapes, it has poor potential for urban uses. However, soil on the higher landscapes has good potential for most urban uses. The wetness of the lower landscape soil and the low available water capacity of the higher landscape soil are the main concerns for use and management of this map unit.

Fripp-Duckston-Beaches. Fripp soil is typically fine-grained sand, excessively drained, and found on undulating and rolling dunes. A grayish-brown surface layer approximately 6 inches thick is underlain by a layer that is pale brown in the upper section and white in the lower section. This layer extends to a depth of 80 inches.

Duckston soil is typically sand, poorly drained, and found in shallow depressions and on flats. A surface layer approximately 17 inches thick is grayish brown in the upper section and light brownish gray in the lower section. Below this surface layer is a predominantly light gray layer, greenish gray in the lower section, extending to a depth of 80 inches.

Beaches soil is found adjacent to the ocean and is typically fine-grained sand, sand, coarse-grained sand, and varying amounts of small shell fragments. This soil is covered twice daily by the tide.

This unit has a slope ranging from zero to 20 percent and lies on Cumberland Island. Soil in some areas has been developed for dwellings and recreation. Soil is too sandy for many wildlife and recreational uses. Because of flooding and wetness, potential is poor for most other uses.

Bohicket-Capers. Bohicket soil is typically very poorly drained soil that borders the ocean and is flooded twice daily by the tides. A dark silty clay loam approximately 8 inches thick is underlain by a dark greenish gray, silty clay and clay to a depth of 65 inches or more. Grass fibrous roots are found throughout the soil.

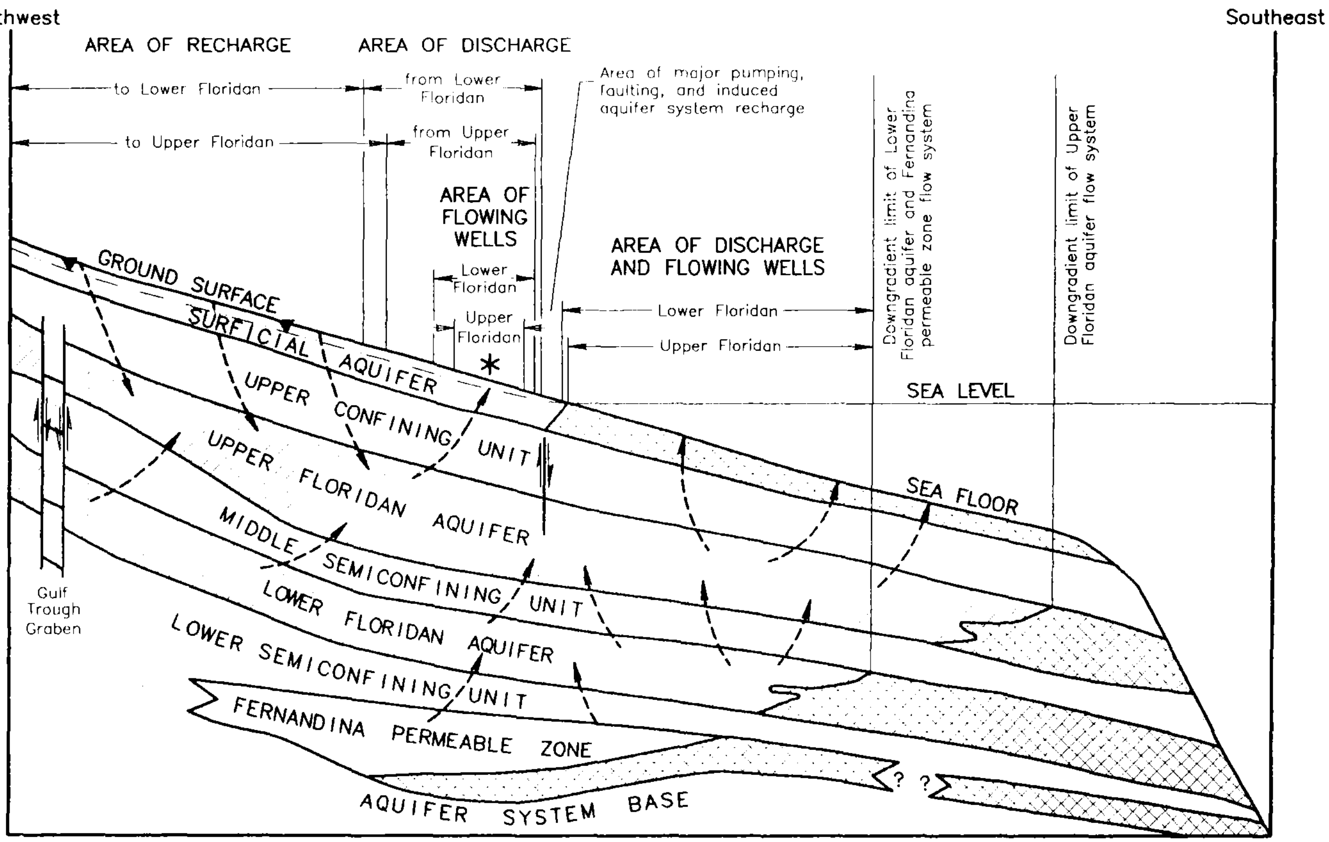
Capers soil is typically very poorly drained, extends inland along creeks and rivers, and is flooded frequently by the tide. A surface layer of very dark gray, silty clay approximately 8 inches thick is underlain by a very dark gray and dark gray clay to a depth of approximately 42 inches. Next is a greenish gray clay to a depth of 60 inches or more. Fine-grass roots are found throughout the soil.

This unit has a slope of less than 1 percent and is found mainly along the Cumberland Sound and the Satilla River. Soil in some areas has been developed for farming. However, because of flooding, wetness, and natural sulfur content, it is primarily used by wetland wildlife.

2.4 GEOLOGIC SETTING.

2.4.1 Regional Geology The Kings Bay region is located within the Coastal Plain physiographic province along the Georgia coastline. Seven different depositional shorelines have been discovered around Kings Bay that are a result of sea level fluctuations during the Quaternary period. The shoreline complexes have not been accurately dated, but are of approximate Pleistocene and Holocene age (C.C. Johnson, 1985).

A principal source for the hydrogeologic information discussed below is the *Hydrogeology of the Floridan Aquifer System in Southeast Georgia and Adjacent Parts of Florida and South Carolina* (Krause and Randolph, 1989). The uppermost aquifer in the Kings Bay area is the unconfined water table (surficial) aquifer. Below the surficial aquifer lies the upper confining unit. The primary artesian aquifer, or the Floridan aquifer system, lies below the upper confining unit. Figure 2-7 shows the conceptual model of the Floridan aquifer system in the Brunswick, Georgia, area from the Gulf Trough in the northwest to the offshore area in the southeast. Figure 2-8 provides a generalized correlation of these units with respect to stratigraphy, lithology, and hydrologic properties. Analyses of geophysical logs obtained from the U.S. Geological Survey (USGS) of area wells confirm a structural dip to the southwest of approximately 2 feet per mile in the above units. The surficial aquifer ranges in thickness from approximately 6 to 90 feet bls and consists of post-Miocene age, unconsolidated,



LEGEND

- WATER TABLE
- GROUNDWATER CIRCULATION
- FRESHWATER
- SALTWATER
- * APPROXIMATE LOCATION OF KINGS BAY

SOURCE: KRAUSE AND RANDOLPH, 1989.

FIGURE 2-7

CONCEPTUAL MODEL OF THE FLORIDAN AQUIFER SYSTEM

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

SUPPLEMENTAL RFI WORKPLAN

NAVAL SUBMARINE BASE KINGS BAY, GEORGIA

D:\DWG\ABB\8503-07\SRFI_WP\FIG_2-7\DMF\940818

THIS PAGE INTENTIONALLY LEFT BLANK.

System	Series	'nit es
Quaternary	Holocene and Pleistocene	
Tertiary	Pliocene	
	Miocene	rtesian and nonartesian water. for the underlying artesian water, ınected to the Upper Floridan
	Oligocene	vater, but generally less than Floridan aquifer system.
	Upper Eocene	500 gallons per minute from two f the formation.
	Middle Eocene	ınt contributor to the Floridan aquifer ge amounts of water in northeast eability solution cavities.
	Lower Eocene	ɔed to basal part, which yields large
	Paleocene	as the lower confining unit of the he Brunswick, Georgia, area, where ıeralized water there.
Cretaceous	Upper	permeability locally in the ıer Floridan aquifer. Contains highly an aquifer system in the Brunswick,

(Source: Modified from Krause and Ra

SUPPLEMENTAL RFI WORKPLAN

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

D:\DWG\ABB\8503-07\SRFI_WP\FIG_2-8\DMF\940622
KB_STE11.WP
MVL.08.94

fine-grained to very coarse-grained, well-sorted sand. Layers of poorly sorted sand, clayey silty sand, and, at depth, argillaceous limestone are interbedded with these well-sorted sand beds.

The primary source of recharge to the surficial aquifer is infiltration from precipitation. Water movement is laterally downgradient with discharge to streams, ponds, and other surface water bodies. Evaporation and transpiration, as well as downward migration to lower aquifers, account for some water loss. Water levels in the surficial aquifer respond rapidly to rainfall. Seasonal variations correspond to variations in rainfall and evapotranspiration. Water levels may fluctuate seasonally by 15 to 20 feet in areas of high topographic relief and high permeability aquifer material. In flat-lying areas where low-permeability material is present, seasonal fluctuations are commonly less than 10 feet. The surficial aquifer functions as a source of recharge for the Floridan aquifer system by downward leakage through the secondary aquifer in areas where the water table in the surficial aquifer is above the potentiometric surface in the Floridan. Where the head gradient between the surficial aquifer and the Floridan is in the opposite direction, the surficial aquifer receives recharge from the Floridan aquifer system.

The upper confining unit ranges from 380 to 530 feet thick. This confining unit separates the water table aquifer from the Floridan aquifer system and includes not only extremely low-permeability clay, but also moderately permeable sand beds. The confining unit is a regional formation, the Hawthorn Formation of late and middle Miocene age, present from north Florida to South Carolina. Over most of the region, the unit consists of middle Miocene age, interbedded sand, silt, clay, and low-permeability sandy clay beds. Groundwater yields in the confining unit are highly variable, and it is not considered a principal source of water (Krause and Randolph, 1989).

The Floridan aquifer system is composed of upper and lower permeable zones, termed the Upper Floridan and the Lower Floridan aquifers, respectively. This unit is used for drinking water, as it is of good quality and provides sufficient yield. In southeast Georgia and northeast Florida, the aquifer system contains cavities, cavernous zones, and solution channels tens of feet in the vertical and horizontal dimensions. Primarily, these zones are found in the Upper Floridan, but the Lower Floridan contains some of the largest. Most of these zones are oriented horizontally, enhancing lateral permeabilities. However, some solution channels have formed along probable zones of weakness caused by high-angle, nearly vertical fractures and faults. In extreme southeast Georgia and northeast Florida, permeable zones within the entire Floridan aquifer system are locally connected by these nearly vertical conduits.

Faults are believed to be present in the Floridan aquifer system along the coast in extreme southeast Georgia and northeast Florida; however, none were indicated on regional structure maps (Krause and Randolph, 1989).

The Upper Floridan aquifer consists primarily of late Eocene Ocala limestone and equivalents. The Ocala is a very fossiliferous limestone having high effective porosity and permeability, especially the upper part. Migration of groundwater along bedding planes, joints, fractures, and other zones of weakness have developed secondary permeability that makes the Ocala extremely permeable. The Upper Floridan is composed of two permeable zones in the area of southeast Georgia. These units are designated the upper and lower water-bearing zones.

The upper water-bearing zone ranges in thickness from 75 to 150 feet and consists of late Eocene age limestone that is very fossiliferous and permeable. The lower water-bearing zone ranges in thickness from 15 to 110 feet and consists of middle to late Eocene age dolomitic limestone that is recrystallized and less permeable than the upper water-bearing zone. Hydraulic characteristics of the Floridan aquifer system are primarily known for the Upper Floridan aquifer. Regional groundwater flow in the upper Floridan is primarily easterly with southeasterly and northeasterly components (Figure 2-9). Because of the aquifer's heterogeneity, transmissivity ranges from nearly zero near the aquifer's updip extent (east-central Georgia and southern South Carolina) to approximately 1 million square feet per day in the thick carbonate sequence in southern Georgia. Because the Upper Floridan is so prolific, water supply wells in southeast Georgia generally do not tap other water-bearing units beneath the Upper Floridan (Krause and Randolph, 1989).

The Lower Floridan aquifer consists primarily of middle to lower Eocene carbonate rocks that are less fossiliferous and more dolomitic than the Upper Floridan aquifer. The permeability of the unit is primarily secondary, developed along bedding planes and other zones of weakness. In the southeastern Georgia area, the Lower Floridan aquifer includes a water-bearing zone designated the Fernandina permeable zone. The Fernandina zone consists of Paleocene and late Cretaceous age recrystallized limestone and dolomite that is extremely permeable. The middle semi-confining unit, which lies between the Upper and Lower Floridan aquifers, consists of middle Eocene dense limestone and dolomite that is recrystallized and of low permeability.

<u>2.4.2 Surface Hydrology</u> NSB Kings Bay is dominated by the presence of large and small rivers draining into the Atlantic Ocean. The surface waters include the St. Marys River, the Satilla River, and the Crooked River. Most of the surface runoff at NSB Kings Bay is stored in the upland swamps and marshes and is diverted off base through long shallow ditches and meandering, low velocity, natural intermittent streams. Surface runoff at the site is slow because of flat slopes associated with high water table and dense ground cover vegetation (C.C. Johnson, 1985). The NSB Kings Bay drainage network covers approximately 11,000 acres within the boundaries of the activity located west of Kings Bay. Approximately 30 percent of this area is salt marsh, and the remainder is upland. The major drainage outlet on the activity is the North River draining 49 percent of the area to the south. To the north, the Crooked River drains 5 percent, and Marianna Creek drains 17 percent of the activity. The remaining 29 percent of the activity generally drains eastward into Cumberland Sound and Kings Bay.

The elevation of the 100-year floodplain in the region is slightly more than 10 feet above msl. Mainly because of the flatness of the region, about half of the facility would be inundated by a 100-year flood (C.C. Johnson, 1985). As shown on Figure 2-5, Site 11 is not within the 100-year floodplain.

The surface water in streams and creeks in the vicinity of the base are used mainly for noncontact recreation including boating, fishing, and navigation. Sources of surface water contamination may include runoff from pine plantations, small agricultural areas, poorly operating septic tanks, leachate from sanitary landfills, and runoff from impervious areas such as highways and parking lots.

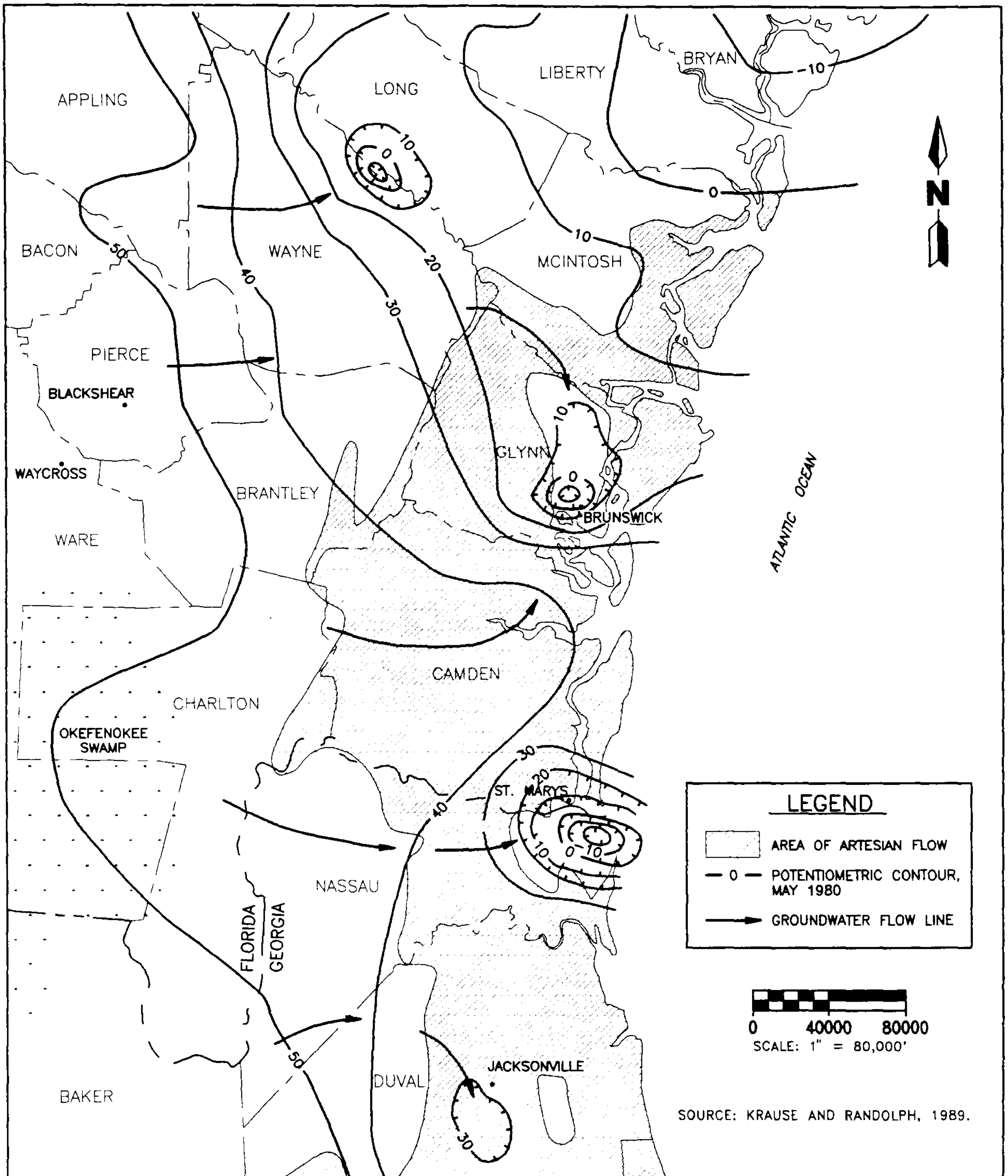


FIGURE 2-9

REGIONAL POTENTIOMETRIC SURFACE MAP FOR THE UPPER FLORIDAN AQUIFER

SUPPLEMENTAL RFI WORKPLAN

NAVAL SUBMARINE BASE KINGS BAY, GEORGIA

D:\DWG\ABB\8503-07\SRFI_WP\FIG_2-9\DMF\940818

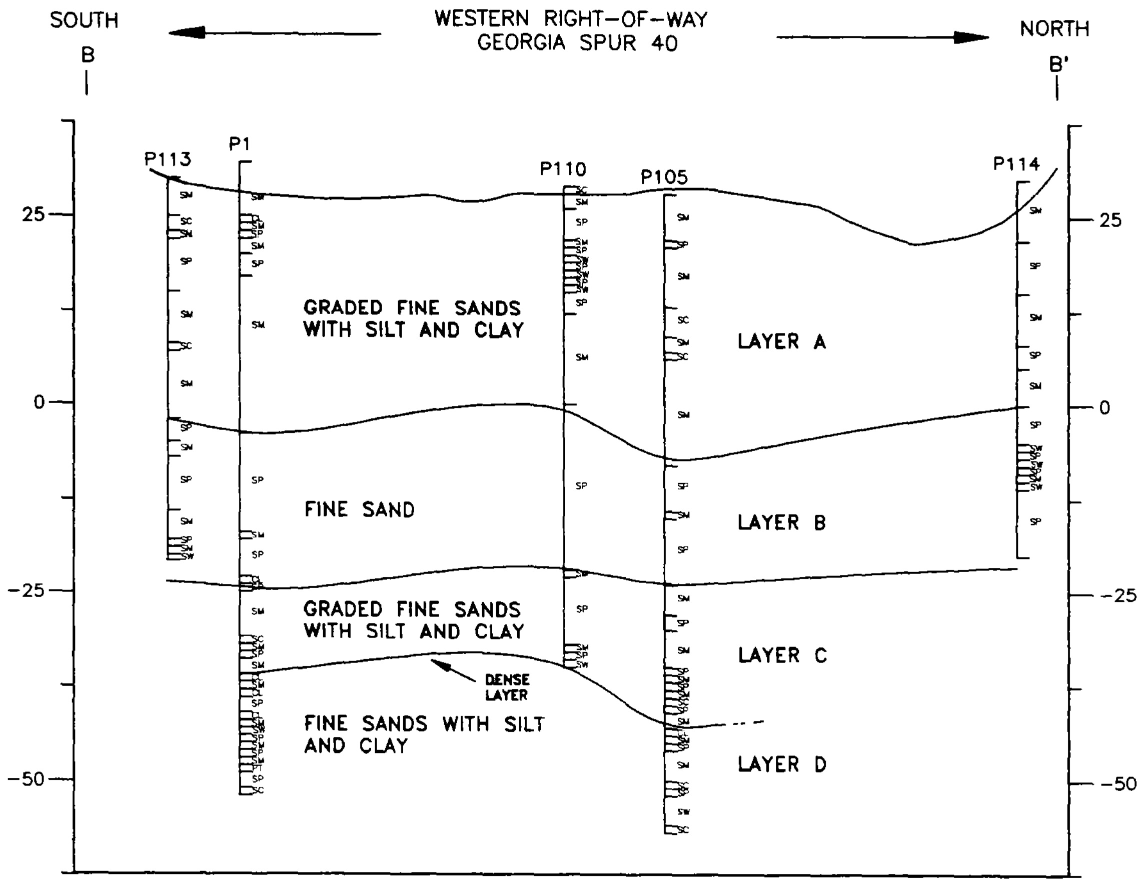
Water quality in the North River, Marianna Creek, and Mill Creek watersheds were characterized as generally highly colored, clear, with dissolved oxygen concentrations ranging from 9.2 to 13.2 milligrams per liter (mg/ℓ).

Conductivities were higher than in fresh waters in the vicinity, probably due to salt spray and tidal influence. Some of the Marianna Creek water quality monitoring stations were located within the estuarine complex as shown by the conductances ranging from 247 to 22,200 μmhos/cm. Heavy metal concentrations were low except for mercury. Mercury-based fungicide use was cited as a possible cause for the elevated mercury levels of 3.0 to 9.4 micrograms per liter (μg/ℓ) (C.C. Johnson, 1985).

<u>2.4.3 Hydrogeology</u> A conceptual model of the hydrogeologic setting at the landfill is discussed below. This model describes the generalized physical conditions of the site that affect contaminant migration. The conceptual model was developed based on hydrogeologic information obtained from previous investigations conducted at NSB Kings Bay. The conceptual model of the hydrogeology will be revised and/or refined as more information is made available by work included in this Supplemental RFI and the Interim Measures Study.

Figure 2-10 is a stratigraphic cross section developed from data collected during piezocone penetrations. Soil borings will be conducted during the Supplemental RFI to support and/or confirm information collected during piezocone penetrations. Piezocone data are correlated to soil types by relating point stress, sleeve friction, and the ratio of sleeve friction to point stress to equivalent soil parameters. The locations of piezocone penetrations and the location of the cross section are shown in Figure 2-11. The water table aquifer consists mainly of layers of fine-grained sands interbedded with silty and/or clayey fine-grained sands and some medium-grained sands (Figure 2-10). The aquifer thickness is approximately 90 feet in the vicinity of the landfill. The density of the layers is generally medium dense and dense. No stratum has been identified that would act as a confining layer or barrier to contaminant migration. The data collected to date indicates that the lithologic units are continuous in the area and have been undisturbed by faulting. Four stratigraphic units are identified in Figure 2-10 as Layers A, B, C, and D. These units were differentiated based on grain size variations of the sands. Layers A and C are deposits of fine-grained sands with silt and clay grading to medium-grained sands with less silty and clayey fines interpreted as representing cyclic fluctuations in sea level. These graded fine-grained sands are separated by a homogenous layer of sorted fine-grained sand. This fine-grained sand unit (Layer B) represents a period of stability in the sedimentary environment. Layer D was identified as a separate stratigraphic unit because it is neither homogenous (Layer B) or cyclic (Layers C and A). The top of Layer D is marked by a dense fine-grained sand layer recorded as a cemented unit during piezocone penetrations.

A groundwater potentiometric surface map was prepared from groundwater elevations measured on January 12, 1993 (Figure 2-12). The overall hydraulic gradient in the vicinity of the landfill is toward the west-northwest. Groundwater flows laterally in this direction and is interpreted to ultimately discharge to surface water. Groundwater level data collected over a 24-hour period indicates that there is no significant tidal influence on the aquifer at the landfill. Based on the regional hydrogeologic information, the upper confining unit lies below



LEGEND

STRATIGRAPHIC CONTACT

P114 — PIEZOCONE SAMPLE LOCATIONS AND ASSOCIATED UNIFIED SOIL CLASSIFICATION SYSTEM SOIL TYPES

NOTES:
ELEVATION IN FEET MEAN LOW WATER
VERTICAL EXAGGERATION: 10x
REFER TO FIGURE 2-11 OF THE WORKPLAN FOR LOCATION OF CROSS SECTION

0 125 250
SCALE: 1" = 250' (HORIZ.)

FIGURE 2-10

STRATIGRAPHIC CROSS SECTION

SUPPLEMENTAL RFI WORKPLAN

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

D:\DWG\ABB\8503-07\SRFI_WP\FIG_2-10\DMF\940818

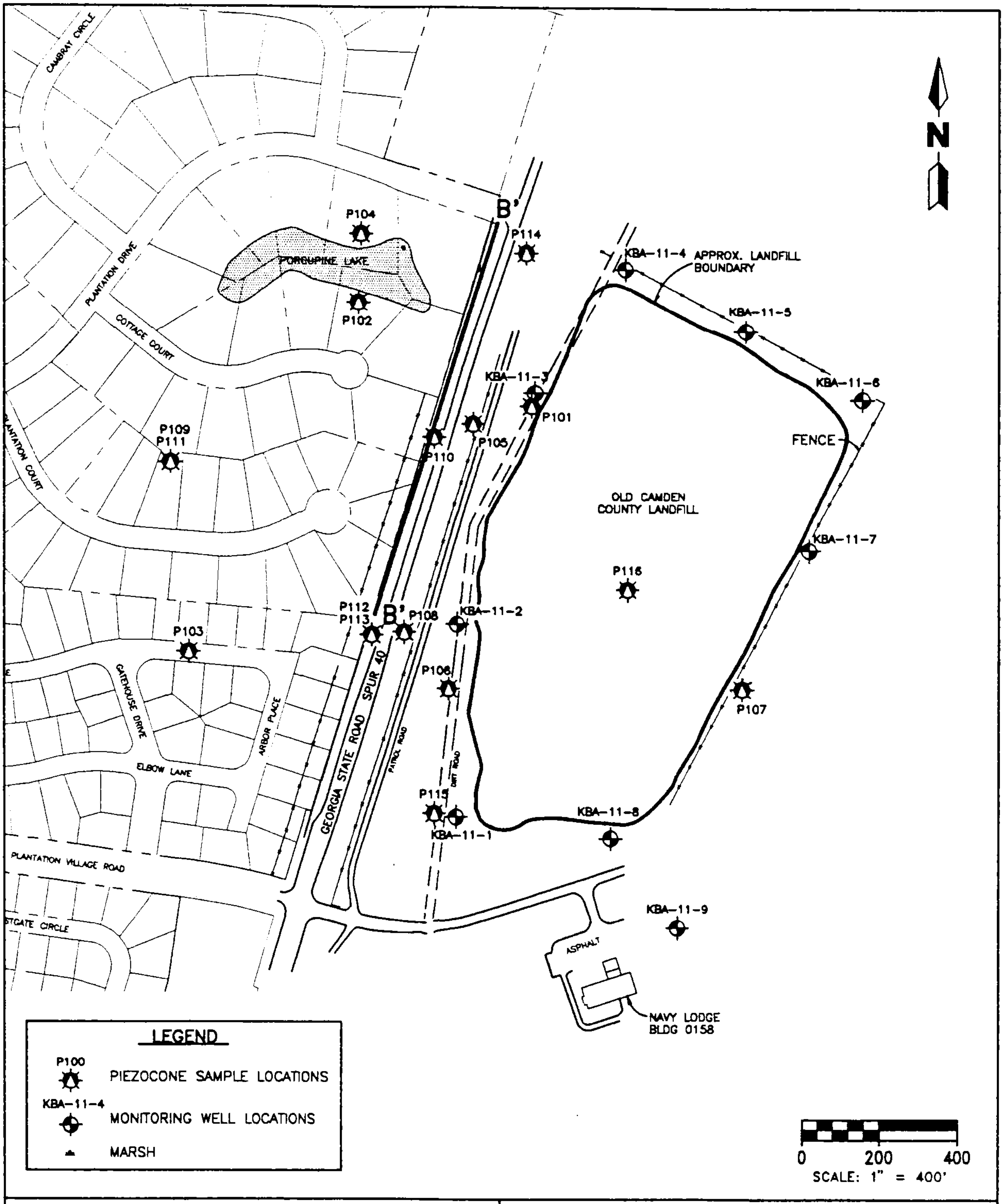


FIGURE 2-11

PIEZOCONE SAMPLE LOCATIONS

SUPPLEMENTAL RFI WORKPLAN

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

D:\DWG\ABB\8503-07\SRFI_WP\FIG_2-11\DMD\940627
KB_STE11.WP
MVL.08.94

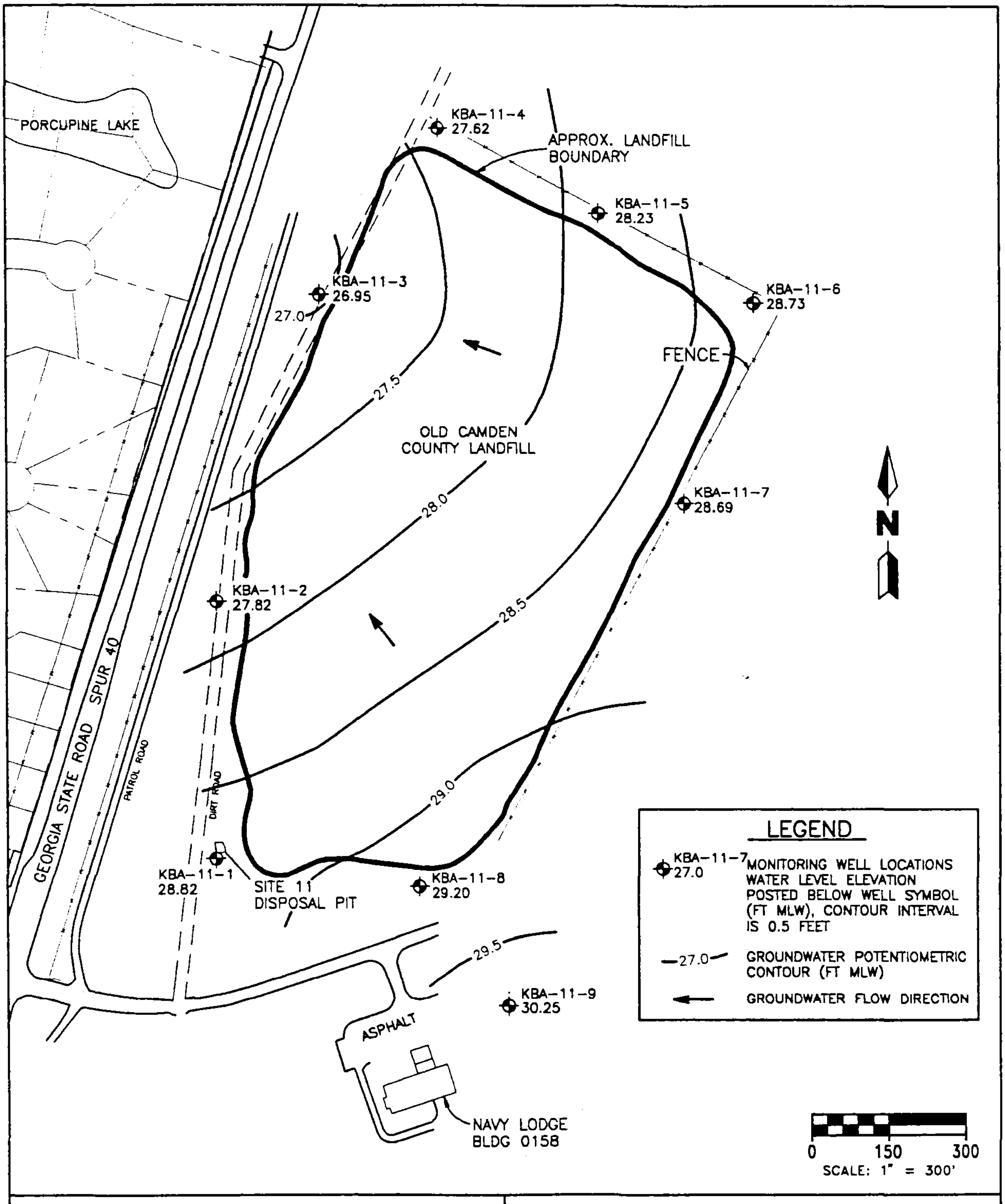


FIGURE 2-12

GROUNDWATER POTENTIOMETRIC
SURFACE MAP, JANUARY 14, 1993

SUPPLEMENTAL RFI
WORKPLAN

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

D:\DWG\ABB\8503-07\SRFI_WP\FIG_2-12\DMF\940627

the surficial aquifer, separating this unit from the primary potable source aquifer in the vicinity of the landfill, the Upper Floridan.

Figures 2-13 and 2-14 are head potential graphs developed from pore pressure data collected during piezocone penetrations. Locations of piezocone penetrations are shown in Figure 2-11. The overall head potential for the study area is downward.

Zones of upward head potential are present in the uppermost stratigraphic unit (Layer A), but shifts to downward head potential in Layer B, a fine-grained sand layer. The top of the fine-grained sand layer is approximately 30 feet bls and its base is approximately 50 feet bls. The majority of volatile organic compound (VOC) contaminants are present within this stratigraphic layer (30 to 50 feet bls).

Contaminant migration is affected by dispersive movement, advective transport due to actual hydraulic gradient—which may vary horizontally and vertically within the aquifer—and the influence of private irrigation well (PIW) use. PIWs are discussed in Section 2.6 of this workplan. Average seepage velocities were calculated based on the distance contaminants have migrated and the potential duration of travel. Velocity estimates are relative to the western side of the landfill, approximately 70 feet inside the NSB property line at its nearest point to the property line. Previous data regarding VOCs in groundwater indicate the plume is as far as 740 feet from the NSB property line (ABB-ES, 1993a), or as far as 810 feet from the western margin of the landfill. If the release occurred during the first year of landfill operation, 1994, and was observed in groundwater 810 feet downgradient in 1992, a minimum velocity estimate would be 45 feet per year (ft/yr). If the release occurred during the last year of landfill operation, 1981, a higher velocity estimate would be 74 ft/yr. The velocity estimated by time and travel would be greater than 74 ft/yr if the distance traveled is increased to include potential travel within the landfill prior to reaching the western margin of the landfill.

<u>2.5 SITE DESCRIPTION</u>. The Old Camden County Landfill is situated along the northwest boundary of the NSB Kings Bay. The width of the landfill ranges from approximately 140 feet at the southern end to approximately 775 feet at the northern end. The landfill is approximately 1,400 feet at its maximum length. The landfill operated as a trench and fill operation with trenches oriented in a southeast to northwest direction. Based on magnetic and ground-penetrating radar (GPR) surveys performed during previous investigations (Figures 2-15 and 2-16), the trenches range from 575 to 775 feet in length and 35 to 50 feet in width. GPR data also suggested that the spacing between trenches ranges from 3 to 5 feet and depth of refuse ranges from 2 to 3 feet bls to 10 to 12 feet bls. The GPR signature of the trenches is characterized by chaotic reflections and diffractions (Figure 2-16). The areas between the trenches are interpreted to represent areas of the landfill that do not have substantial amounts of refuse beneath them. The landfill was covered with 2 feet of fill in 1981. The landfill surface is currently vegetated with grasses, weeds, and pine saplings (ABB-ES, 1993a).

<u>2.6 GROUNDWATER USE</u>. The Crooked River Plantation Subdivision is a residential development of 630 homes located west of the landfill. The subdivision was built on 260 acres west of Spur 40 during the 1980's. A marsh fronts the north and

KB_STE11.WP
MVL.08.94

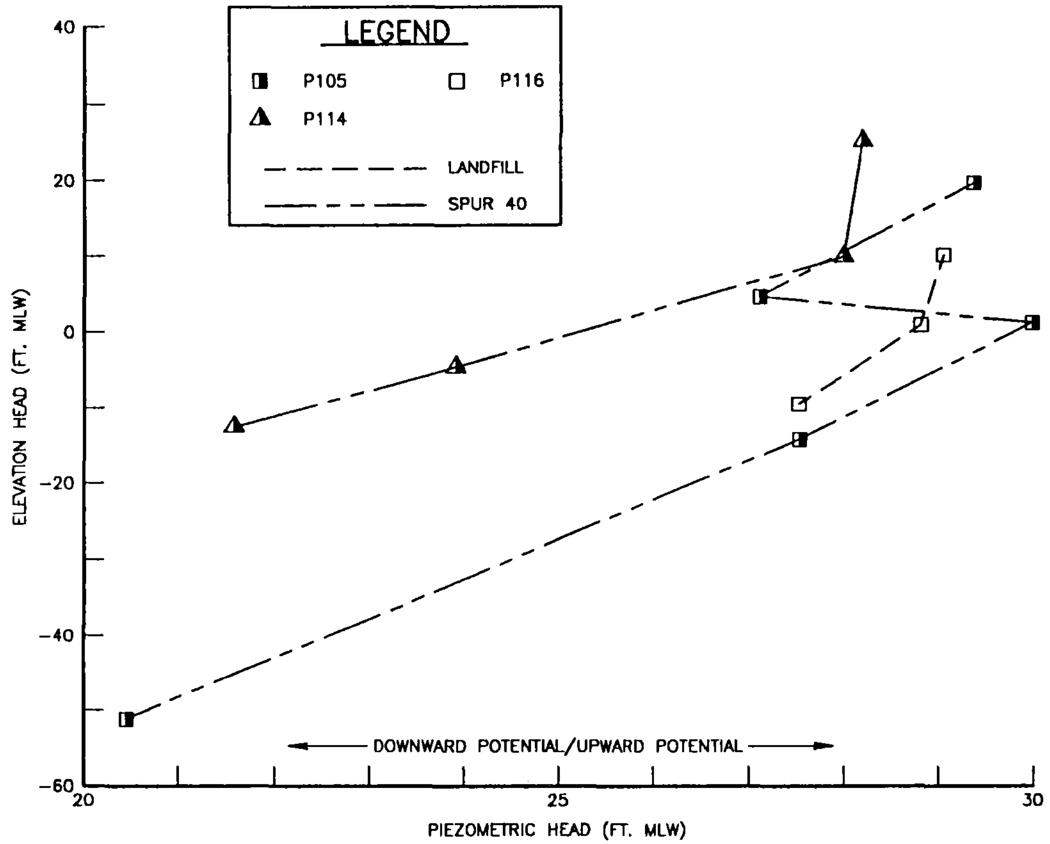


FIGURE 2-13

HYDRAULIC HEAD POTENTIAL GRAPH
LANDFILL AND SPUR 40 AREA

SUPPLEMENTAL RFI
WORKPLAN

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

D:\DWG\ABB\8503-07\SRFI_WP\FIG_2-13\DMF\940628

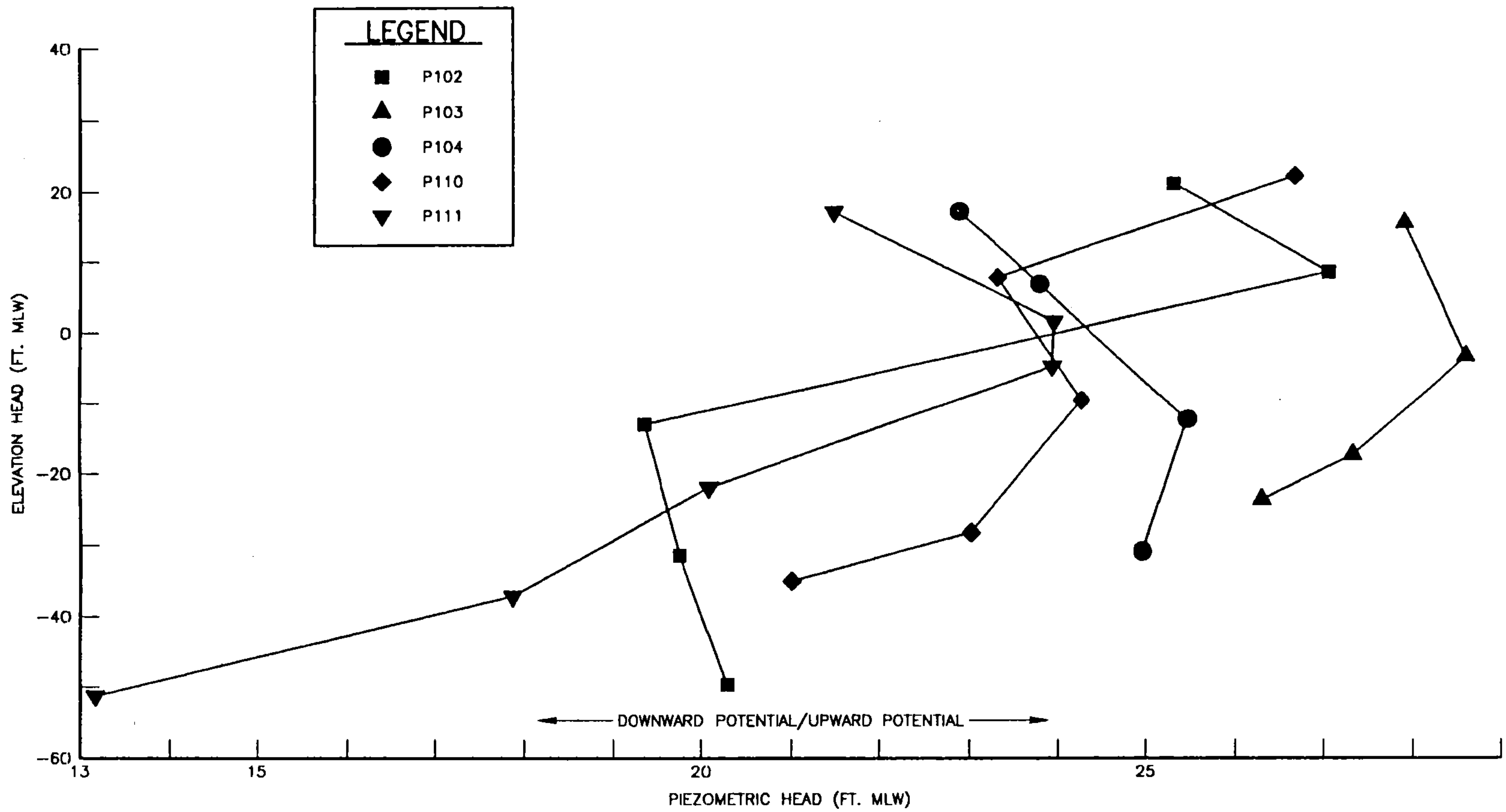


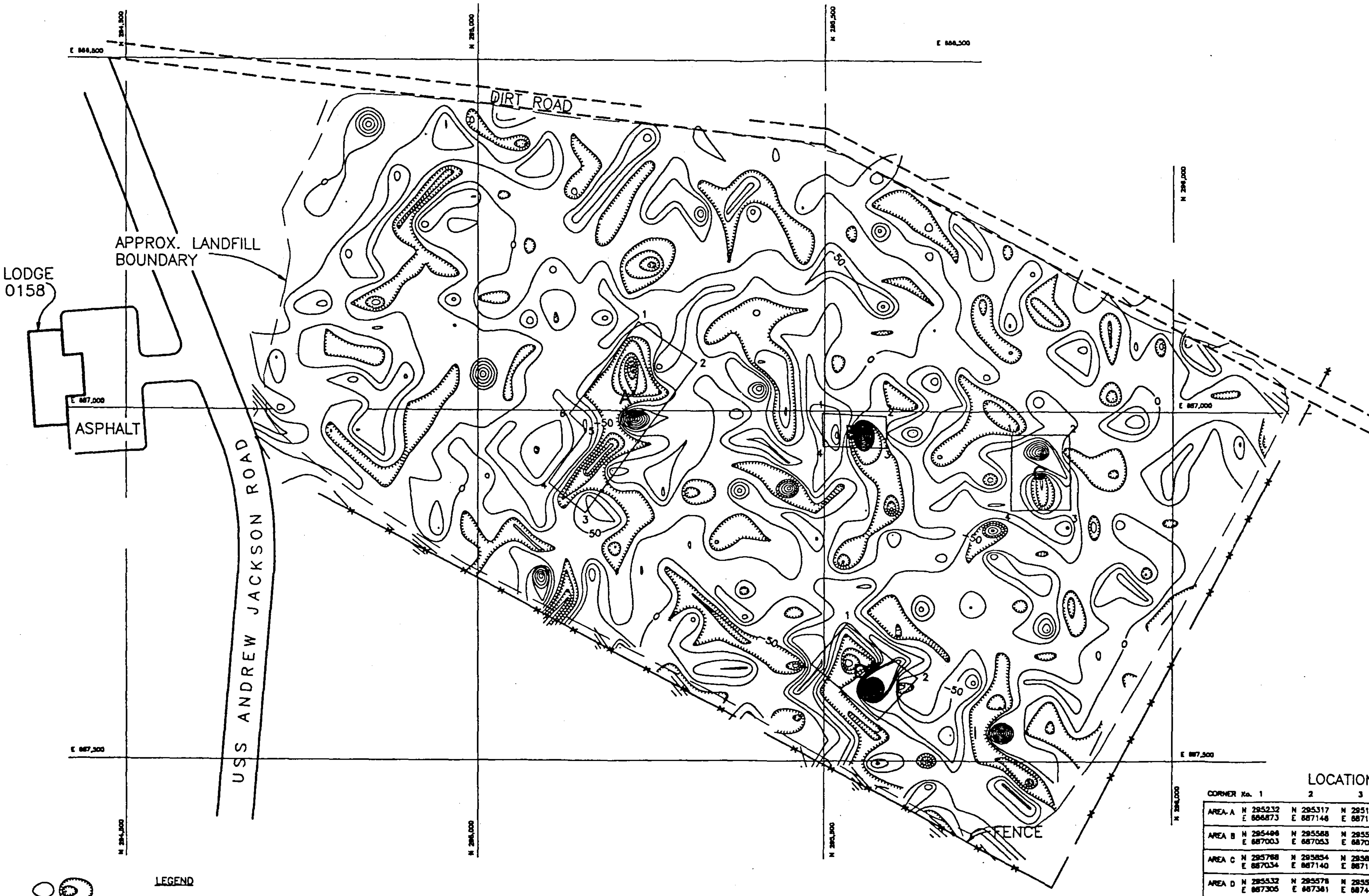
FIGURE 2-14

HYDRAULIC HEAD POTENTIAL GRAPH
SUBDIVISION AREA

SUPPLEMENTAL RFI
WORKPLAN

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

D:\DWG\ABB\8503-07\SRFI_WP\FIG_2-14\DMF\940628



LOCATION TABLE

CORNER No.	1	2	3	4	5	6
AREA A	N 295232 E 686873	N 295317 E 687146	N 295155 E 687146	N 295103 E 687103	N 295157 E 687028	N 295133 E 687004
AREA B	N 295496 E 687003	N 295588 E 687053	N 295588 E 687053	N 295497 E 687050		
AREA C	N 295768 E 687034	N 295854 E 687140	N 295854 E 687140	N 295497 E 687141		
AREA D	N 295532 E 687305	N 295578 E 687381	N 295578 E 687442	N 295482 E 687381		

LEGEND

VERTICAL GRADIENT CONTOURS
CONTOUR INTERVAL - 50 GAMMAS

INTERPRETED EXTENT OF LANDFILL

A — AREA DISPLAYING ELEVATED VERTICAL GRADIENT VALUES SEE LOCATION TABLE

GRAPHIC SCALE (FT.)
150 0 150 300

FIGURE 2-15

MAGNETOMETER SURVEY
VERTICAL GRADIENT CONTOURS

SUPPLEMENTAL RFI
WORKPLAN

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

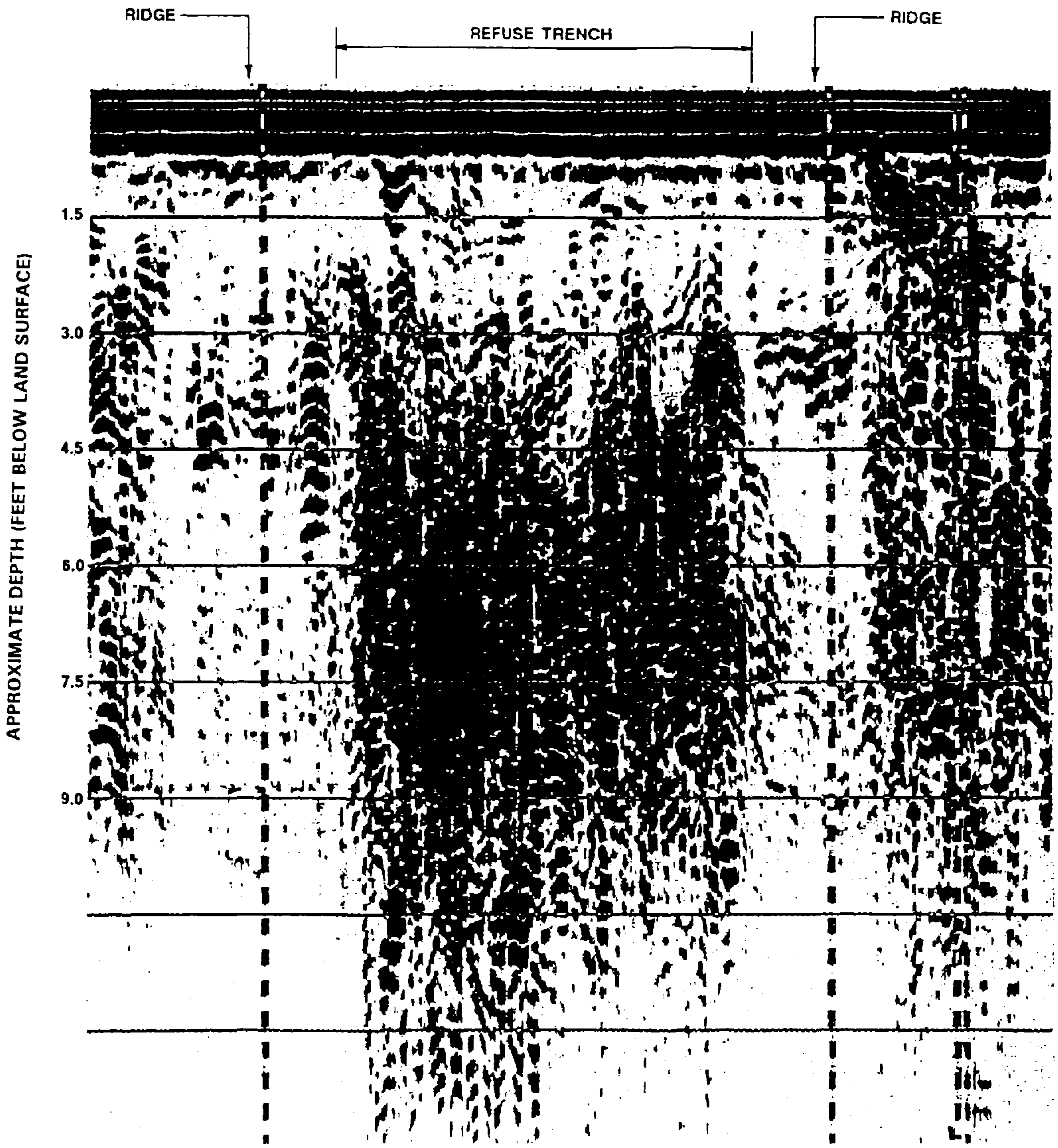


FIGURE 2-16

GROUND-PENETRATING RADAR PROFILE

SUPPLEMENTAL RFI WORKPLAN

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

D:\DWG\ABB\8503-07\SRFI_WP\FIG_2-16\DMF\940627

west perimeter of the subdivision. More than 90 homes in the subdivision have PIWs that draw groundwater from the surficial aquifer. Based on the residential survey of the Crooked River Plantation Subdivision residents and the fact that the subdivision is supplied by the city water system, the PIWs are not used as drinking water.

The USGS, Georgia Department of Natural Resources (GA DNR), and the Camden County Health Department were contacted for information relating to location of public and/or private water supply wells. Table 2-2 summarizes information obtained. Approximate locations of the wells are shown in Figure 2-17.

Groundwater in the surficial aquifer is used primarily for irrigation. The public water supply for the NSB Kings Bay and surrounding towns and urban areas comes from the Floridan aquifer system. In Camden County, water treatment facilities for St. Marys and Kingsland are adequate for present demands. Currently, the city of St. Marys is served by two water supply wells. One well is located on Jefferson Road near the NSB Kings Bay boundary (No. 48 on Figure 2-17), approximately 3 miles south of Site 11. The other well is located adjacent to the southern boundary of the St. Marys Airport (No. 49 of Figure 2-17), approximately 4 miles south-southeast of Site 11. Two other wells are available on a standby basis. One is located near Mission Trace Drive in Mission Trace (No. 50 on Figure 2-17), approximately 2.2 miles southwest of Site 11. The other is located on Ready Street near City Hall (No. 51 on Figure 2-17), approximately 5 miles south-southeast of Site 11. The city of Kingsland is served by two water supply wells located off South Grove Boulevard near Colony Pines (not within the Harriett's Bluff Quadrangle). These wells are approximately 6 miles west-southwest of Site 11.

Private wells supply water for most of the individual homes within the unincorporated areas of Camden County. NSB Kings Bay obtains its potable water from three groundwater wells within its property boundaries. Relative to Site 11, these three wells are approximately 1 mile to the south, 2 miles to the east, and 3.2 miles to the east-southeast. These wells are approximately 900 feet deep and 18 inches in diameter.

During a residential survey, 94 PIWs were identified in the Crooked River Plantation Subdivision (ABB-ES, 1993b). Survey forms indicated that the groundwater from the private irrigation wells is used for a variety of non-potable purposes including irrigation, washing cars and yard items, and for filling swimming pools, children's wading pools, and for other water-using play devices. Two residents indicated groundwater was used as drinking water for pets. Groundwater samples were collected from 62 PIWs in the Crooked River Plantation Subdivision during previous investigations (Section 2.7). The locations of the PIWs are shown on Figure 2-18.

Measurements of pH, specific conductance, temperature, and flow rates were collected during PIW sampling. Field analytical data indicate that five of the PIW samples contained VOCs potentially related to the plume, including vinyl chloride, cis-1,2-dichloroethene, and ethylbenzene. Three PIW samples contained VOCs potentially related to the plume based on offsite analytical results. For a detailed discussion of the PIW sample results, see the Interim Corrective Measures Study (ICMS) Investigation Report (ABB-ES, 1993b). Residents have been asked to curtail contact with groundwater and not to provide groundwater for pet drinking water.

Table 2-2
Summary of Water Supply Well Data

Supplemental Resource Conservation and Recovery
Act Facility Investigation for Site 11
Volume I, Workplan
Naval Submarine Base
Kings Bay, Georgia

USGS Grid No.[1]	Map No.[2]	Latitude	Longitude	Bottom of Casing (ft bls)	Well Depth (ft bls)	Station Name[3]	Well Use
33E002	1	30° 46' 27"	81° 37' 12"	80	474	Rayonier, Inc.	Unused
33E003	2	30° 47' 51"	81° 32' 01"	302	--	NSB Refill Station	Unused
33E004	3	30° 49' 10"	81° 32' 38"	186	516	NSB Etowah	Recreational
33E005	4	30° 52' 08"	81° 35' 03"	--	650	W. Bailey	--
33E006	5	30° 46' 08"	81° 34' 52"	--	750	Finn & Neighbor	--
33E007	6	30° 45' 10"	81° 34' 38"	525	770	G. H. Davis	Domestic
33E008	7	30° 50' 37"	81° 33' 23"	261	470	Crooked River State Park	Unused
33E009	8	30° 50' 45"	81° 33' 46"	250	565	American Legion	--
33E018	9	30° 48' 00"	81° 31' 05"	145	486	NSB Club	Unused
33E023	10	30° 50' 31"	81° 34' 27"	450	650	R. Norieka	Domestic
33E027	11	30° 47' 56"	81° 31' 11"	555	990	NSB TW1	Observational
33E032	12	30° 47' 39"	81° 34' 31"	585	894	NSB 1	Commercial
33E033	13	30° 47' 43"	81° 33' 42"	585	813	NSB 2	Fire Fighting
33E034	14	30° 47' 52"	81° 31' 12"	500	810	NSB 4	Commercial
33E035	15	30° 47' 59"	81° 31' 19"	500	800	NSB 3	Commercial
33E037	16	30° 49' 13"	81° 35' 31"	--	575	C. Drury, Laurel Island	Unused
33E038	17	30° 51' 57"	81° 31' 56"	66	340	Brunswick Pulp and Paper	Unused
33E039	18	30° 47' 49"	81° 33' 53"	100/560/950	1,150	NSB Observ. No. 1	Observational
33E040	19	30° 47' 49"	81° 33' 53"	100	750	NSB Observ. No. 2	Observational
EE3046	20	30° 49' 16"	81° 36' 07"	245	650	Joiner/Greene/Crocker/Oneil	Domestic
33E047	21	30° 45' 15"	81° 36' 57"	87	111	Osprey Cove Golf Course	Institutional
33E048	22	30° 45' 15"	81° 36' 57"	334	502	Osprey Cove Golf Course	Institutional

See notes at end of table.

Table 2-2 (Continued)
Summary of Water Supply Well Data

Supplemental Resource Conservation and Recovery
Act Facility Investigation for Site 11
Volume I, Workplan
Naval Submarine Base
Kings Bay, Georgia

USGS Grid No.[1]	Map No.[2]	Latitude	Longitude	Bottom of Casing (ft bls)	Well Depth (ft bls)	Station Name[3]	Well Use
NA	23	30° 49' 42"	81° 34' 12"	--	45	Private Residence	Domestic
NA	24	30° 49' 45"	81° 34' 06"	--	45	Private Residence	Domestic
NA	25	30° 52' 13"	81° 36' 57"	--	200 (Avg)	Sadler Cove (39)	--
NA	26	30° 52' 06"	81° 37' 04"	--	200 (Avg)	Mallard Pointe (112)	--
NA	27	30° 52' 27"	81° 36' 49"	--	200 (Avg)	Sadler Creek (112)	--
NA	28	30° 50' 29"	81° 36' 29"	--	200 (Avg)	London Hill (16)	--
NA	29	30° 52' 16"	81° 35' 04"	--	200 (Avg)	Harriett's Bluff (6)	--
NA	30	30° 50' 35"	81° 34' 17"	--	125 (Avg)	Timber Ridge (5)	--
NA	31	30° 50' 22"	81° 34' 31"	--	125 (Avg)	Elliott's Plantation	--
NA	32	30° 50' 30"	81° 34' 22"	--	125 (Avg)	Riverbend (3)	--
NA	33	30° 50' 39"	81° 34' 19"	--	125 (Avg)	Marsh Point	--
NA	34	30° 50' 23"	81° 34' 09"	--	125 (Avg)	Foxwood (40)	--
NA	35	30° 45' 36"	81° 34' 43"	--	60 (Avg)	Gaines Davis (7)	--
NA	36	30° 45' 57"	81° 34' 48"	--	60 (Avg)	New Hope Baptist Church	--
NA	37	30° 45' 39"	81° 36' 06"	--	60 (Avg)	Woodsville	--
NA	38	30° 45' 02"	81° 34' 25"	--	60 (Avg)	Bank South	--
NA	39	30° 45' 10"	81° 35' 10"	--	60 (Avg)	Shadowlawn (4)	--
NA	40	30° 45' 29"	81° 31' 26"	--	85 (Avg)	N. River Oaks (9)	--
NA	41	30° 45' 25"	81° 31' 21"	--	85 (Avg)	Highland Oaks (23)	--
NA	42	30° 45' 22"	81° 31' 31"	--	--	River Oaks (24)	--

See notes at end of table.

Table 2-2 (Continued)
Summary of Water Supply Well Data

Supplemental Resource Conservation and Recovery
Act Facility Investigation for Site 11
Volume I, Workplan
Naval Submarine Base
Kings Bay, Georgia

USGS Grid No.[1]	Map No.[2]	Latitude	Longitude	Bottom of Casing (ft bls)	Well Depth (ft bls)	Station Name[3]	Well Use
NA	43	30° 45' 13"	81° 31' 35"	--	85 (Avg)	Chaneys MHP (2)	--
NA	44	30° 45' 10"	81° 31' 22"	--	85 (Avg)	Pagan Street	--
NA	45	30° 44' 50"	81° 31' 25"	--	85 (Avg)	Marchi Drive	--
NA	46	30° 44' 39"	81° 31' 28"	--	85 (Avg)	Lonesome Pine Road	--
NA	47	30° 45' 21"	81° 31' 20"	--	85 (Avg)	Palmetto Street	--
NA	48	30° 47' 14"	81° 35' 17"	--	--	City of St. Marys	Public Supply
NA	49	30° 45' 01"	81° 33' 45"	--	--	City of St. Marys	Public Supply
NA	50	30° 45' 52"	81° 34' 25"	--	--	City of St. Marys	Public Supply (Standby)
NA	51	30° 44' 24"	81° 33' 02"	--	--	City of St. Marys	Public Supply (Standby)
NA	52	30° 45' 00"	81° 31' 24"	--	--	Point Peter	--
NA	53	30° 50' 07"	81° 34' 18"	--	--	Unnamed	--
NA	54	30° 47' 58"	81° 32' 45"	--	--	NSB 6	Raw Water Supply

[1] Grid Number is based on U.S. Geological Survey (USGS) designation for a well location.
[2] Map Number corresponds to location identification on Figure 2-17 of this report.
[3] Number in parentheses indicates total number of supply wells in the area of the station.

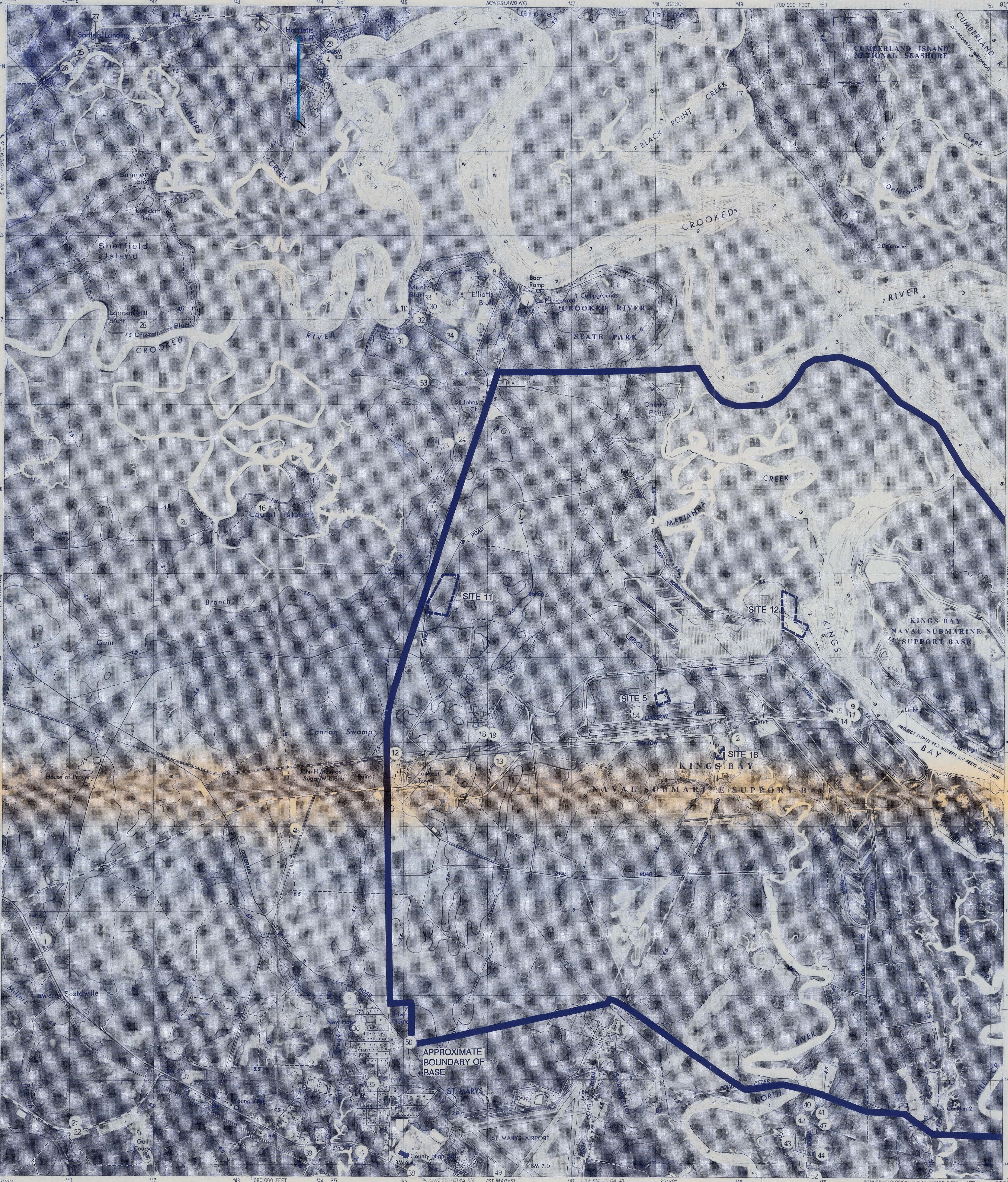
Notes: USGS = U.S. Geological Survey.
ft = feet.
bls = below land surface.
NA = not applicable.
Avg = average.
-- = no data.

THIS PAGE INTENTIONALLY LEFT BLANK.

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

STATE OF GEORGIA
DEPARTMENT OF NATURAL RESOURCES
EARTH AND WATER DIVISION

HARRIETTS BLUFF QUADRANGLE
GEORGIA—CAMDEN CO.
7.5 MINUTE SERIES ORTHOPHOTOMAP
(TOPOGRAPHIC—BATHYMETRIC)



Produced by the United States Geological Survey and the National Ocean Service

Control by USGS, NOS/NOAA, and USCE

Orthophotomap prepared by the Geological Survey from aerial photograph taken April 19, 1974. Topography by planetable surveys 1958; revised from aerial photographs taken 1974. Field checked 1975. Map edited 1980

Bathymetry compiled by the National Ocean Service from tide-coordinated hydrographic surveys
Soundings compiled from NOS 11503 and 11504
This information is not intended for navigational purposes
Mean lower low water (dotted) line and mean high water (solid) line compiled by NOS from tide-coordinated aerial photographs
Apparent shoreline (outer edge of vegetation) shown by photoimagery

Projection and 10,000-foot grid ticks: Georgia coordinate system, east zone (transverse Mercator)
1000-meter Universal Transverse Mercator grid, zone 17
1927 North American Datum
To place on the predicted North American Datum 1983, move the projection lines 21 meters south and 17 meters west as shown by dashed corner ticks

There may be private inholdings within the boundaries of the National or State reservations shown on this map

UTM GRID AND 1988 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

CONTOURS AND ELEVATIONS IN METERS

HYDROGRAPHIC SURVEY INFORMATION

Survey Number	Survey Date	Survey Scale	Survey Line Spacing (Naut. Miles)
H-5753	1935	1:10,000	.02-.12
H-5754	1934-35	1:10,000	.02-.08
H-5756	1935	1:10,000	.02-.10
H-9805	1979	1:2,500	.01-.02

Revisions shown in purple compiled in cooperation with State of Georgia agencies from aerial photographs taken 1983 and other sources. This information not checked. Map edited 1988

SCALE 1:24 000

CONTOUR INTERVAL 1.5 METERS
NATIONAL GEODETIC VERTICAL DATUM OF 1929
BATHYMETRIC CONTOUR INTERVAL 1 METER WITH SUPPLEMENTARY 0.5 METER CONTOURS — SOUNDINGS IN METERS
DATUM IS MEAN LOWER LOW WATER
THE RELATIONSHIP BETWEEN THE TWO DATUMS IS VARIABLE

BASE MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
BATHYMETRIC SURVEY DATA COMPLIES WITH INTERNATIONAL HYDROGRAPHIC ORGANIZATION (IHO) SPECIAL PUBLICATION 44 ACCURACY STANDARDS AND/OR STANDARDS USED AT THE DATE OF THE SURVEY
FOR SALE BY U. S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225, OR RESTON, VIRGINIA 22092 AND NATIONAL OCEAN SERVICE, ROCKVILLE, MARYLAND 20852
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

NATIONAL OCEAN SERVICE HYDROGRAPHIC SURVEY INDEX

ROAD CLASSIFICATION
Primary highway, hard surface
Light-duty road, hard or improved surface
Secondary highway, hard surface
Unimproved road
Trails
Interstate Route
U. S. Route
State Route

HARRIETTS BLUFF, GA.

30081-G5-OM-024

1980
PHOTOREVISED 1988
DMA 4645 I SE–SERIES V8450

7 Approximate Location of Water Supply Well

THIS PAGE INTENTIONALLY LEFT BLANK.

THIS PAGE INTENTIONALLY LEFT BLANK.

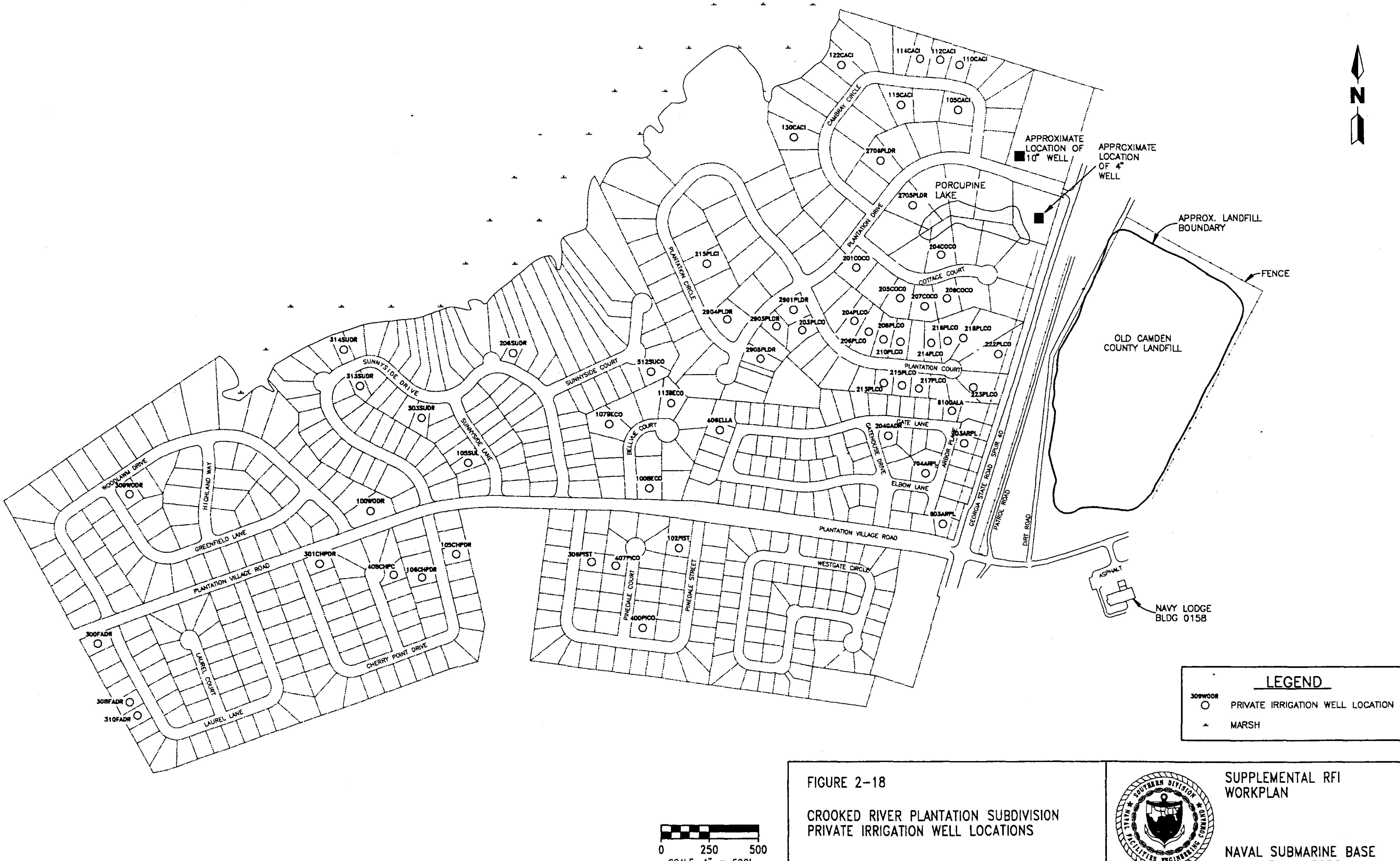


FIGURE 2-18

CRODKED RIVER PLANTATION SUBDIVISION
PRIVATE IRRIGATION WELL LOCATIONS

SUPPLEMENTAL RFI WORKPLAN

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

D:\DWG\ABB\8503-07\SRFI_WP\FIG_2-18\DMF\940628
KB_STE11.WP
MVL.08.94

Two deep wells are present in the vicinity of the lake (Figure 2-18). No boring logs were available for either well. A 10-inch well, located north of Porcupine Lake near the intersection of Plantation Drive and Spur 40, is reported to extend to a depth of approximately 320 to 380 feet bls. This well was originally planned for potable water supply but was never completed as such. The well was abandoned by capping the steel casing. Sometime later, a paving contractor tapped the steel casing with a 2-inch hand valve and installed a 2-inch polyvinyl chloride pipe connecting the well to the lake. It was reported that this well was artesian and would be used to sustain the lake during droughts. During the ICMS Investigation, the valve was opened but no water flow from the well was observed. A 4-inch well is located in the yard of Lot No. 1 on Plantation Drive at the intersection of Plantation Drive and Spur 40. The well is reported to be artesian. It was also intended to sustain Porcupine Lake during droughts. The depth of this well is estimated to range from 600 to 700 feet bls. There is no indication that either of these wells has been used.

The potential for future groundwater development of the Floridan aquifer system in the southeastern Georgia area ranges from 0 to 10 million gallons per day (USGS, 1989). Local variables include problems with water quality and excessive declines in groundwater levels.

2.7 PREVIOUS INVESTIGATIONS. Site 11, the Old Camden County Landfill, was first investigated in 1985 when an Initial Assessment Study was performed at NSB Kings Bay under the IR program (C.C. Johnson, 1985). The Initial Assessment Study consisted of records searches and interviews. Sixteen sites were evaluated and none were recommended for further investigation. However, four sites, including the Old Camden County Landfill, required further action under the facility HSWA permit issued to NSB Kings Bay by the GA DNR. An RFI Workplan was prepared in response to the HSWA permit requirements (ABB-ES, 1991).

An RFI Workplan was implemented in January 1992. At Site 11, the RFI included geophysical surveys, subsurface soil sampling, and the installation of nine groundwater monitoring wells along the landfill perimeter. Part of the RFI included six bimonthly groundwater monitoring events. The sixth monitoring event was completed in January 1993. During the first three groundwater monitoring events at Site 11, concentrations of vinyl chloride ranging from 18 to 150 $\mu g/\ell$ were detected in samples from monitoring well KBA-11-2, located on the western edge of the landfill. In August 1992, a Phase I Interim Investigation was conducted to begin characterization of VOCs in groundwater. Results of this investigation are presented in the Phase I Interim Investigation Memorandum (ABB-ES, 1992a) and are summarized in the following paragraphs.

The Phase I Interim Investigation was implemented in August 1992 and included collection of 36 groundwater samples. These groundwater samples were collected from 25 locations downgradient of the landfill. The groundwater samples were analyzed in an onsite laboratory for VOCs, including vinyl chloride, chloroethane, trans-1,2-dichloroethene, trichloroethene, and tetrachloroethene. Duplicate groundwater samples were also sent to an offsite analytical laboratory for confirmation.

The results of this investigation confirmed that at least 17 VOCs had migrated, via the groundwater, beyond the boundary of the landfill and as far as the western right-of-way of Spur 40. These chemicals included solvent-related VOCs such as the dichloroethene and vinyl chloride as well as fuel-related VOCs such as benzene, ethylbenzene, toluene, and xylenes. This information led to the development of an Interim Corrective Measures Screening Investigation Workplan (ABB-ES, 1992b).

The ICMS investigation was implemented in October and November of 1992 and included an ambient air screening survey, collection of groundwater samples within the surficial aquifer, and collection of soil vapor, sediment, surface water, and PIW samples. An air screening survey conducted for vinyl chloride did not indicate the presence of "hot spots" within the Crooked River Plantation Subdivision, a residential development west of the landfill. Results of the groundwater investigation indicated the contaminant plume extends approximately 600 feet west of the NSB Kings Bay property line. VOCs were detected in groundwater at depths ranging from 11 to 57 feet bls to the west of the landfill, and included chlorinated solvents such as vinyl chloride, dichloroethene, trichloroethene, and tetrachloroethene, and fuel-related VOCs, such as benzene, toluene, ethylbenzene, and xylenes. No VOC or semivolatile organic compound (SVOC) contaminants were identified in the sediment or surface water samples collected from Porcupine Lake. SVOCs detected in groundwater samples collected from locations near the landfill included naphthalene and phenolic compounds. Five of 51 PIW samples contained VOCs that are common to the plume, including vinyl chloride, cis-1,2-dichloroethene, and ethylbenzene. Of the 27 samples submitted for offsite analysis, acetone and carbon disulfide were found in four and nine samples, respectively. These compounds are not considered related to the plume.

During January and March of 1993, follow-on activities to the initial ICMS investigation were conducted. These activities included collection of groundwater samples from 11 PIWs (January) and from within the surficial aquifer to the north of and within the landfill (March). Results of this follow-on work are reported in an addendum to the ICMS report, included as Section 8.0 of the ICMS report. None of the PIW samples contained VOCs related to the plume. Analysis of the groundwater samples from the landfill indicated that the concentrations of VOCs beneath the landfill are generally less than those detected from locations along the western margin of the landfill and extending to the western right of Spur 40. This may indicate the source of the VOCs is near the western margin of the landfill or that the source is depleted and the majority of VOCs has migrated away from the source.

3.0 DATA QUALITY OBJECTIVES

The intended use of data and the required data quality objectives (DQOs) are best defined during the planning stages to confirm that collection, decontamination, containerization, shipping, and analytical methods are consistent with the degree of confidence required of the resultant data. The following section provides a brief description of DQO levels and identifies the levels associated with each Supplemental RFI field task.

3.1 GENERAL DESCRIPTION. DQOs refer to standards for analytical precision, accuracy, reproducibility, completeness, and comparability. Five DQO levels have been defined by the USEPA: Level I, Field Screening; Level II, Field Analysis; Level III, Laboratory Analysis and Data Validation (including Contract Laboratory Program (CLP) Routine Analytical Services (RAS); Level IV, CLP-RAS and Data Validation; and Level V, Non-Conventional Parameter Analysis.

Task-specific DQOs for this study range from Level I, primarily for initial screening activities, Level II for field measurements; and Levels III, IV, and V for characterization and confirmation sampling. Level IV DQOs provide the highest standards for data quality. Because Level IV data can only be obtained using CLP protocol, the analytical program for the Supplemental RFI includes CLP analytical methods.

3.2 TASK SPECIFIC. The purposes of the Supplemental RFI field program are to obtain data to: (1) fill data gaps identified in the RFI Interim Report (ABB-ES, 1993a), (2) support a Health and Environmental Assessment (HEA), (3) provide contamination and fate and transport data needed to meet regulatory requirements, and (4) develop engineering and contamination characterization data needed to fulfill the requirements for the CMS. The sampling and analytical program is, by necessity, rather complex as a result of differences in the intended use of the data. Some data will be used for multiple purposes, such as groundwater contamination characterization data that will be used to satisfy regulatory requirements, and used by engineers to perform the CMS, and by risk assessment specialists evaluating human health and ecological risks. Other data are very specific as to their uses, including data collected to evaluate the potential for *in situ* bioremediation (bacteria count, nitrate and nitrite, and phosphate binding). The remaining subsections of Section 3.2 discuss this topic further.

The investigative methods that will be used to collect data are briefly discussed in this section. A more detailed discussion of each method, including decontamination and waste disposal procedures, is presented in Section 2.0 of the Field SAP. QA/QC procedures are detailed in Section 3.0 of the SAP, the Quality Assurance Project Plan (QAPP).

3.2.1 Health and Environmental Assessment Level III data are needed at a minimum to support the HEA require Level III data at a minimum. During the Supplemental RFI Level III and Level IV, DQOs will be used. Samples for Appendix IX analyses will be collected, analyzed, and validated according to Level III DQOs. Samples for CLP-RAS will be collected, analyzed, and validated according to Level IV DQOs. Activities planned specifically to support the human health and ecological risk evaluation include sampling and analysis of surface soil at the landfill, and sediment and surface water from Porcupine Lake. Groundwater contamination characterization data will be used to support the HEA.

3.2.2 Interim Measure (IM) and Corrective Measures Study Data needed to support the IM and CMS include conventional chemical data such as that associated with contamination characterization analyses (CLP-RAS, Appendix IX), but also includes nonconventional parameters referred to herein as fate and transport analyses and engineering and treatability parameters. Fate and transport analyses associated with this Supplemental RFI address soil properties that affect the way contaminants behave in the environment and include sorptive capacity, bulk density, permeability, sieve and hydrometer grain size analyses, Atterberg limits, cation exchange capacity, and organic carbon content. Engineering and treatability analyses address characteristics of groundwater that influence the feasibility and/or design of a corrective measure. Groundwater engineering and treatability parameters for this investigation include alkalinity, carbonate, bicarbonate, hardness, total solids, total suspended solids, total volatile suspended solids, pH, specific conductivity, biochemical oxygen demand (BOD), chemical oxygen demand (COD) total organic carbon, Target Analyte List (TAL) metals, chlorides, sulfates, nitrogen series, phosphorus, and dissolved oxygen. Most of the fate and transport and engineering and treatability parameters are nonconventional (Level V), exceptions being metals analyses that will achieve Level III DQOs.

3.2.3 Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Activities to fill data gaps identified in the RFI Interim Report (ABB-ES, 1993a) include characterization of the status of contamination of air, groundwater, soil, surface water, sediment, soil fate and transport analyses, source characterization, and collection of stratigraphic information. Contamination characterization analyses will include parameters listed in Appendix IX of Title 40, CFR, Part 264 (USEPA, 1992) and CLP-RAS parameters and Level III and IV DQOs, respectively. The RFI activities include confirmation of stratigraphic, groundwater, and air data obtained using screening techniques during previous investigations. Test trenching is proposed as a means of source characterization, which has only been done using remote geophysical techniques. The RFI also has an obligation to collect data sufficient to support other tasks, such as the IM, CMS, and HEA, as mentioned earlier in Section 3.2.

4.0 TECHNICAL APPROACH

The Supplemental RFI technical approach for NSB Kings Bay will include field investigations, data analysis and evaluation, and report preparation. The field investigation serves as the mechanism for data collection. The proposed field activities for the Supplemental RFI are based on several considerations including: (1) previous investigations, (2) data gaps identified in the RFI Interim Report, (3) data needed to support an HEA, and (4) engineering and chemical data needed to support the CMS. A separate workplan for the IM has been developed for the site that addresses installation of a pilot-scale groundwater extraction treatment system to remove VOC contaminants from groundwater in the surficial aquifer.

4.1 FIELD INVESTIGATION ACTIVITIES.

This section identifies the field tasks to be performed at the Old Camden County Landfill (Site 11) during the Supplemental RFI.

4.1.1 Surface Water and Sediment Sampling Five locations in Porcupine Lake will be sampled (Figure 4-1). The sampling will be concurrent with the Ecological Survey discussed in Subsection 4.3.10. The results will be used to evaluate migration of groundwater contamination from Site 11. If contamination is identified, the results will be used to assess contaminant exposures for aquatic receptors (see Section 5.3).

4.1.2 Air Sampling The air monitoring program for the Supplemental RFI is briefly described in this subsection. Details of the air monitoring program are presented in Subsection 2.2.2 of the SAP. Air quality at and around the site will be evaluated to characterize levels of VOCs. Air monitoring will be conducted to evaluate the baseline air quality at the site, prior to excavation activities. During excavation, air monitoring will be conducted to evaluate the impact of excavation activities on air quality, in comparison to the baseline levels. Action levels will be established for the site perimeter for target VOCs; monitoring will then be conducted throughout the excavation period to evaluate site emissions relative to the action limits. Action limit exceedances will result in the implementation of corrective action procedures to suppress vapors.

Additionally, air monitoring will be conducted at sampling locations in the nearby residential area to evaluate the exposure of individuals to VOCs during excavation activities. A background sample will be collected upwind of the residential area for comparison.

4.1.3 Subsurface Soil Sampling The subsurface soil sampling program for the Supplemental RFI is briefly described in this subsection and discussed in more detail in Subsection 3.2.3 of the SAP. Fifteen soil borings will be advanced using mud rotary techniques for purposes of collecting subsurface soil samples for lithologic characterization and physical and chemical analyses. Split-spoon soil samples will be collected at 5-foot intervals. Ring samplers (brass sleeves inside split-spoons) and/or Shelby tube soil samples will be collected to obtain relatively undisturbed samples for fate and transport analysis (particularly bulk density and permeability). The soil borings will be abandoned upon completion of soil sampling using a grout placed by tremie method. The proposed soil boring

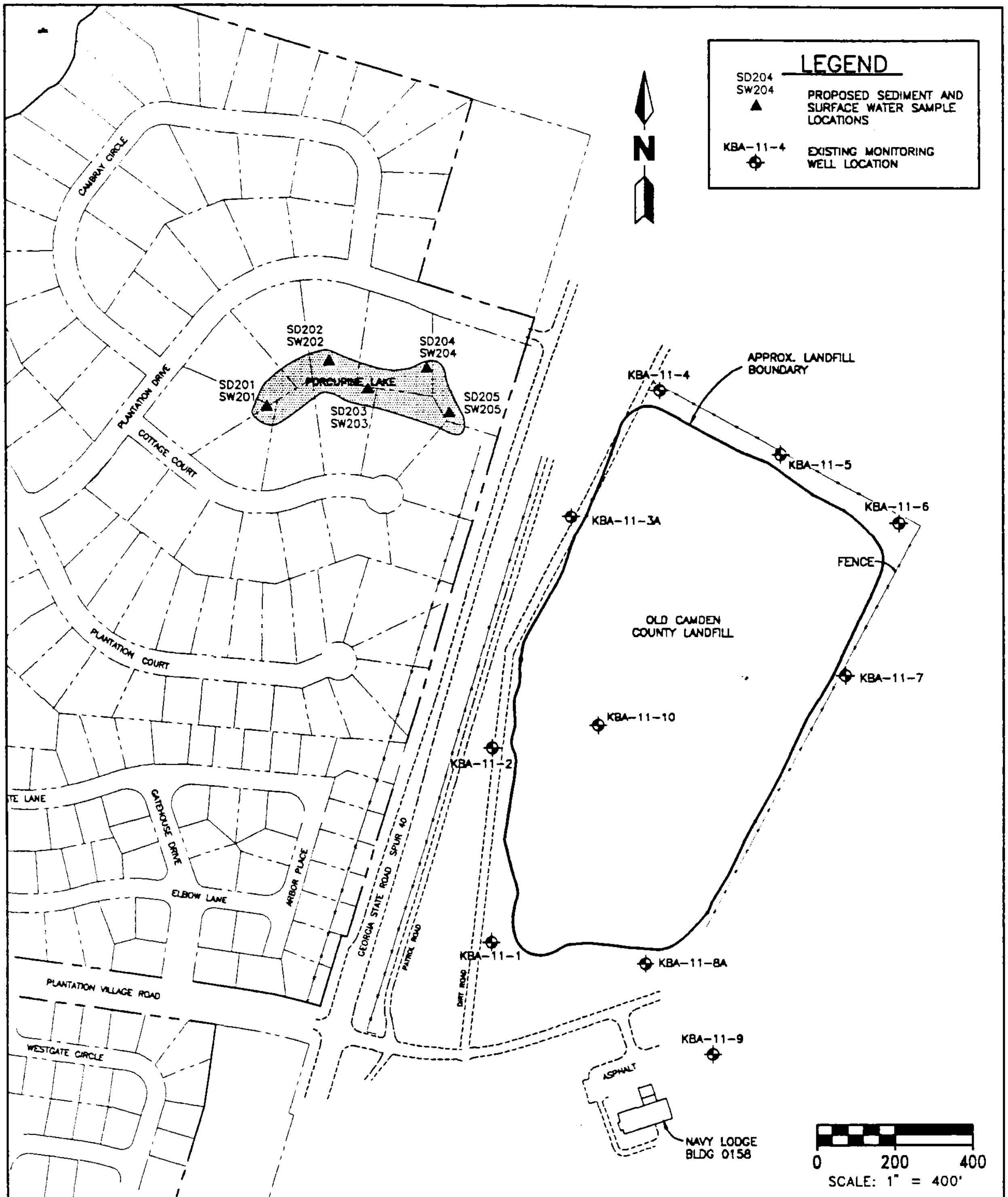


FIGURE 4-1

PROPOSED SEDIMENT AND SURFACE WATER SAMPLE LOCATIONS

SUPPLEMENTAL RFI WORKPLAN

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

D:\DWG\ABB\8503-07\SRFI_WP\FIG_4-1\DMF\940627

locations are shown in Figure 4-2. The analytical program for the subsurface soil samples includes Appendix IX analyses (USEPA, 1992), CLP-RAS, fate and transport parameters, and parameters for evaluation of *in situ* bioremediation as a possible corrective measure. The analytical program for the supplemental RFI is discussed in detail in Section 4.4.

Recovery wells will be drilled by mud rotary techniques as part of the IM (ABB-ES, 1993c). Subsurface soil samples will be collected at 5-foot intervals for physical descriptions and chemical analysis while drilling these boreholes. The chemical analyses for soil samples from the boreholes drilled for the IM recovery wells will include CLP-RAS.

4.1.4 Surface Soil Sampling Five composite surface soil samples will be collected from locations within the landfill and two additional surface soil samples will be collected from locations east of the landfill (background samples). The samples will be collected for lithologic characterization, chemical analyses, and used to support the HEA. Composite surface sampling is described in detail in Subsection 2.2.4 of the SAP. Each will be composed of five aliquots of soil collected from the center and each corner of grid nodes as shown on Figure 4-3.

Additional surface soil samples may need to be collected from the subdivision to complete the HEA. The need to collect these additional samples will be evaluated after the groundwater contamination has been further characterized. These additional surface soil samples will most likely need to be collected if contaminants other than VOCs are detected in the groundwater and the potential exists for contaminants to be conveyed to the surface by PIWs. VOCs have already been evaluated in irrigation water from PIWs and the need for surface soil sampling in the subdivision was not indicated.

4.1.5 Monitoring Well Installation Monitoring well installation for the Supplemental RFI is briefly described in this subsection and discussed in detail in Subsection 2.2.5 of the SAP. Ten monitoring wells were installed to monitor the upper part of the surficial aquifer in previous investigations. Additional monitoring wells will be installed to monitor various intervals within the surficial aquifer. The monitoring wells will be installed to provide groundwater samples for laboratory analyses (chemical and engineering parameters) and to monitor groundwater elevations.

Twenty-five new monitoring wells will be installed in and around the landfill and in Crooked River Plantation Subdivision. The existing and proposed monitoring well locations are shown on Figure 4-4. The monitoring wells will be screened at various depths within the surficial aquifer as described in Subsection 2.2.6 of the SAP. Four wells will be constructed to monitor groundwater at intervals assumed to be below the contaminant plume. The location and screened interval depth of each monitoring well was selected based on the current knowledge of the contaminant plume and the local hydrogeology.

Dual-wall, reverse circulation, air or rotasonic drilling techniques will be used to advance the boreholes for the monitoring wells. These drilling techniques were selected because they are rapid and allow flowing sands and borehole instability to be managed without the use of drilling mud. The four monitoring wells installed to monitor groundwater below the contaminant plume will be constructed using permanent steel outer casings. The outer casings will be

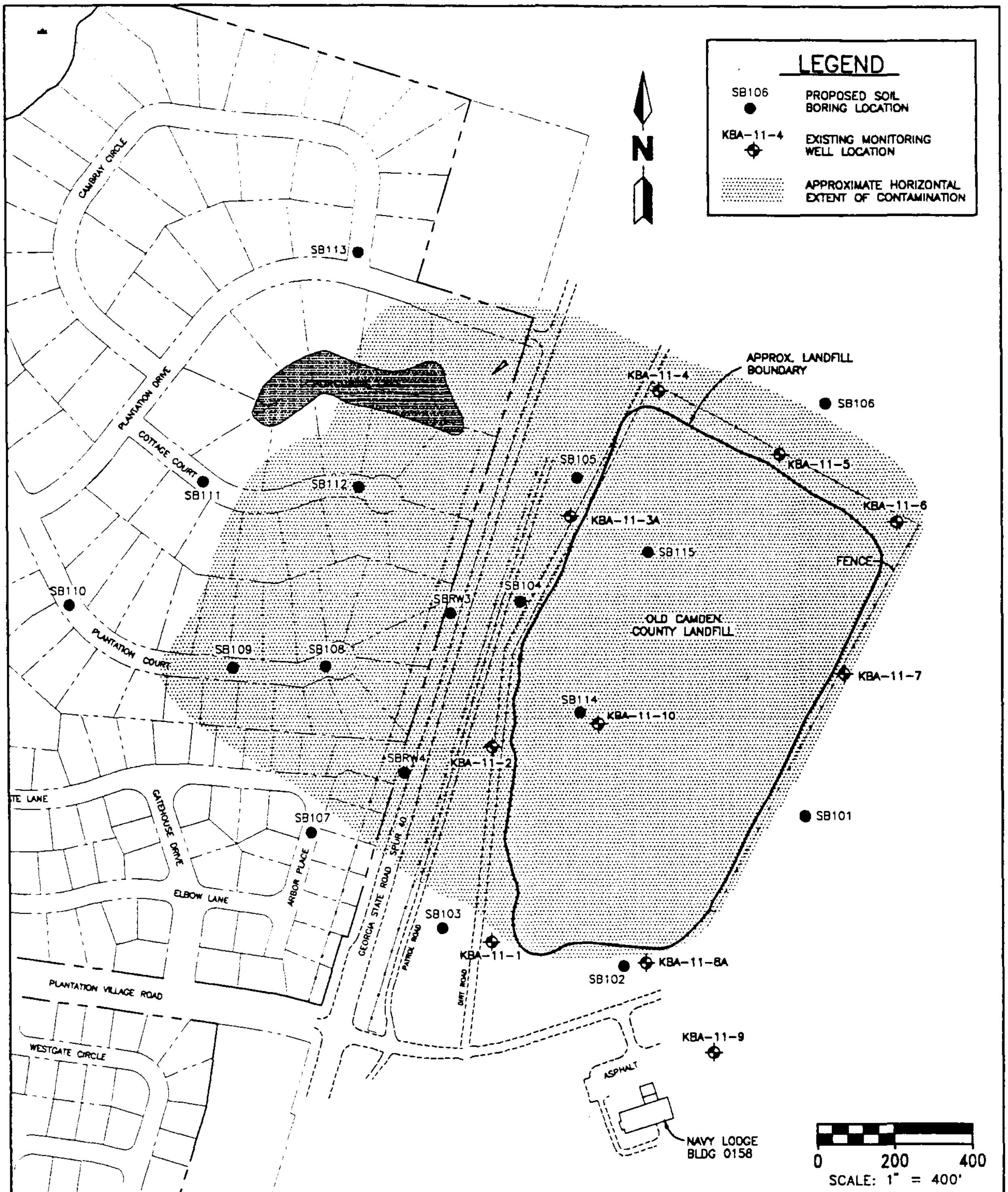


FIGURE 4-2

PROPOSED SOIL BORING LOCATIONS

SUPPLEMENTAL RFI WORKPLAN

NAVAL SUBMARINE BASE KINGS BAY, GEORGIA

D:\DWG\ABB\8503-07\SRFI_WP\FIG_4-2\DMF\940623

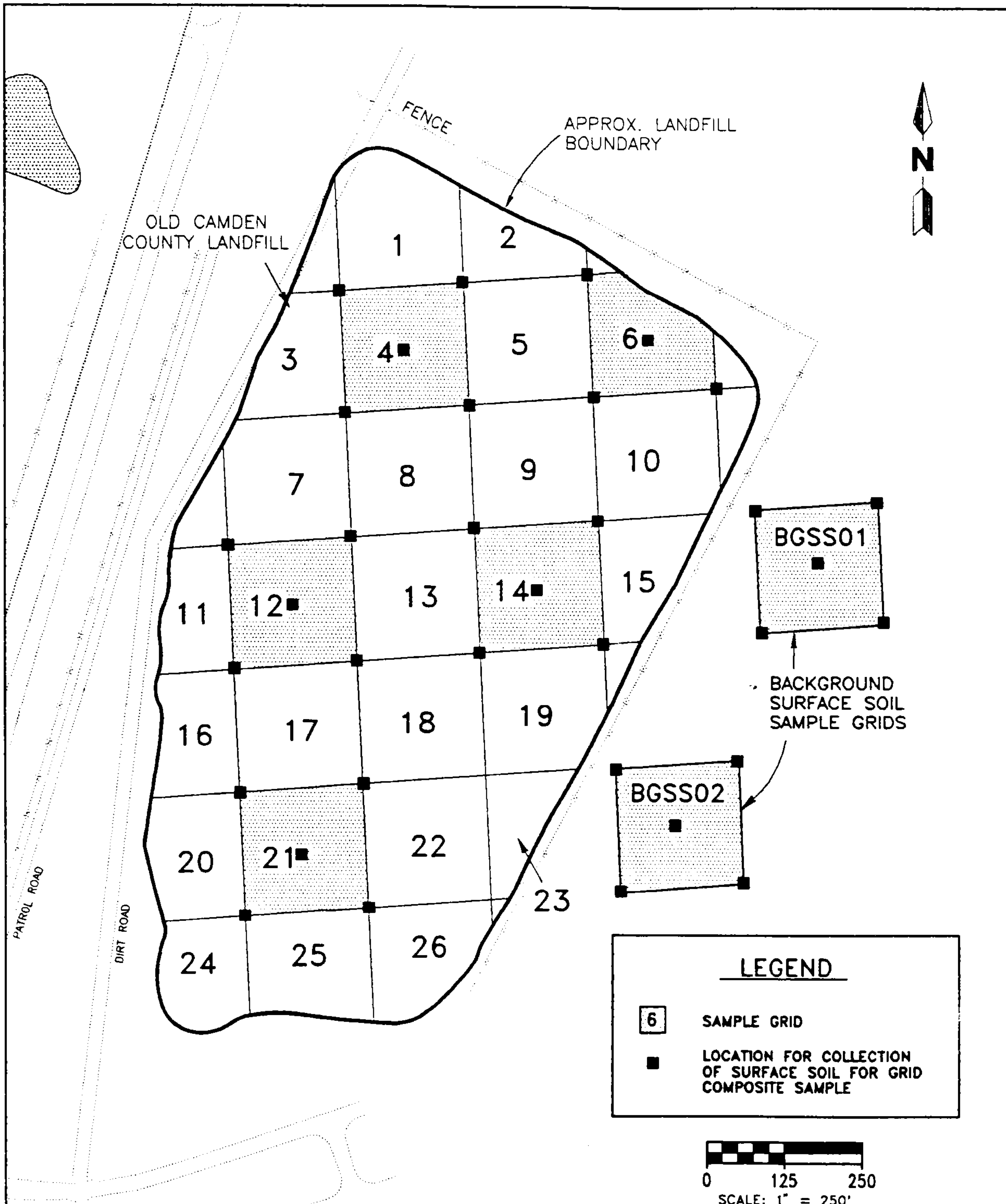


FIGURE 4-3

PROPOSED LOCATIONS FOR COMPOSITE SURFACE SOIL SAMPLES

SUPPLEMENTAL RFI WORKPLAN

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

D:\DWG\ABB\8503-07\SRFI_WP\FIG_4-3\DMF\940622
KB_STE11.WP
MVL.08.94

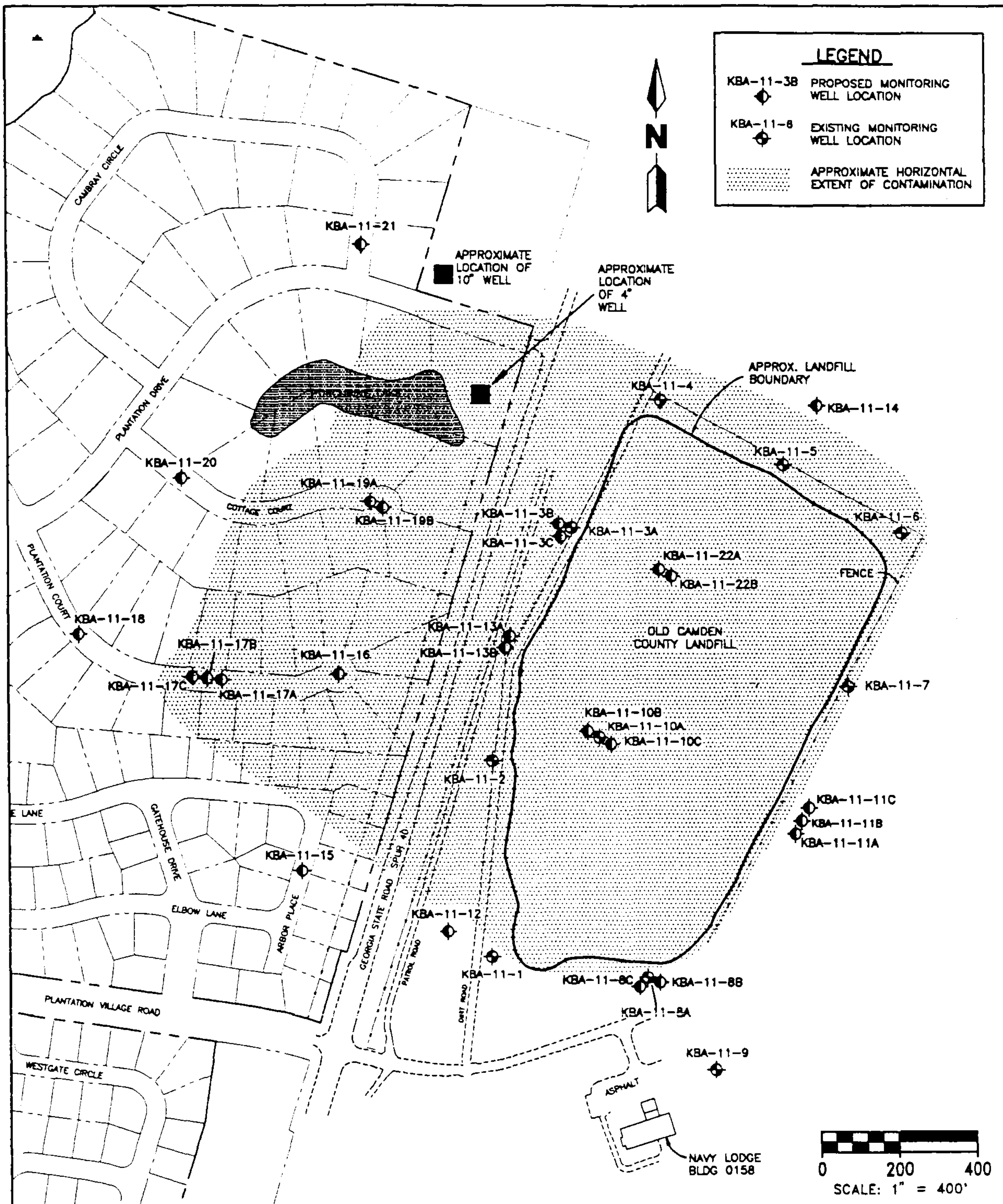


FIGURE 4-4

EXISTING AND PROPOSED MONITORING WELL LOCATIONS

SUPPLEMENTAL RFI WORKPLAN

NAVAL SUBMARINE BASE KINGS BAY, GEORGIA

D:\DWG\ABB\8503-07\SRFI_WP\FIG_4-4\DMF\940623

installed in the part of the surficial aquifer containing contaminated groundwater. These casings will be installed using the mud rotary drilling technique. The casings will be grouted in place. After the grout has set a minimum of 24 hours, the boreholes will be drilled using dual-wall, reverse circulation, air or rotasonic drilling techniques.

4.1.6 Groundwater Sampling The groundwater sampling program for the Supplemental RFI is briefly described in this subsection and discussed in detail in Subsection 2.2.6 of the SAP.

Monitoring Wells. Groundwater samples will be collected from all new and existing monitoring wells to evaluate the groundwater contamination characteristics and for engineering and treatability parameters. Figure 4-4 shows the location of the existing monitoring wells and the proposed locations for the new wells. Figure 4-4 was developed, in part, based on data collected during previous investigations and shows the approximate horizontal extent of groundwater VOC contamination. Sampling will proceed from the least contaminated areas (wells outside and upgradient of the contaminant plume) to the most contaminated (wells located inside the plume). Monitoring wells located outside the shaded area shown on Figure 2-3 will be sampled first. When all the monitoring wells located outside the plume (shaded area) have been sampled, sampling will begin inside the plume at the farthest location from the landfill and proceed toward the landfill.

Wells with free product (none are expected) will not be sampled for trace chemical analyses unless necessitated by special circumstances or Navy request. Two sampling events have been scheduled. The first event will occur 30 days after all monitoring well installation and development activities have been completed. The second sampling event will occur 30 days after the first event.

The analytical program for the groundwater samples includes CLP-RAS, with a subset of samples collected during the first event analyzed for USEPA (1992) Appendix IX constituents.

Private Irrigation Wells Located in the Subdivision. In the event that contaminants that were not previously sampled are identified during this Supplemental RFI groundwater sampling program, then a plan to sample the private irrigation wells for the constituents of concern will be developed.

4.1.7 Borehole Geophysics Two deep existing wells are located in the Crooked River Plantation Subdivision near the intersection of Plantation Drive and Spur 40 (Figure 4-4). No boring logs are available for either well. Borehole geophysics will be used to provide subsurface information on the stratigraphy of these two wells. The borehole geophysics will include natural gamma logging techniques performed by the USGS.

4.1.8 Test Trenches This subsection briefly describes test trenching activities planned for the Supplemental RFI. This task is discussed in detail in Subsection 2.2.8 of the SAP. Test trenching will be used for source characterization and to allow collection of soil and leachate or liquid samples from disposal cells in the Old Camden County Landfill. Test trenching allows for a larger, more representative area to be observed than do drilling methods. Test trenches also allow selection of specific samples from the pile of spoiled, stockpiled material, or trench (biased grab sampling).

Magnetometer and GPR geophysical techniques were conducted at the Old Camden County Landfill during the initial RFI for purposes of delineating the lateral extent of buried wastes and providing information regarding the configuration of the disposal cells. Ten test trenches will be excavated in the landfill to depths of approximately 10 to 12 feet bls, or until groundwater is encountered, to allow visual examination of waste and sampling of the soil and liquid from the disposal cells. The test trenches will be excavated in areas where magnetic anomalies were observed and in areas suspected to be "hot spots" of the contaminant plume. The approximate trench locations are shown on Figure 4-5.

Five soil samples will be collected from areas in contact with the wastes. In addition, five samples of leachate or liquid material will be collected if encountered in the test trenches. Soil and liquid samples will be from the same trench to allow qualitative correlation of data associated with contaminants sorbed to soil and those associated with an aqueous phase. Soil samples may be composites of as many as five aliquots of material from a single trench.

Because of health and safety reasons, the samples will be collected from the backhoe bucket. The air sampling program will be coordinated with the test pit operations.

<u>4.1.9 Aquifer Characterization</u> Aquifer characterization tests are being conducted as part of the IM. These tests include a 25-hour pumping test on one of the recovery wells, step-drawdown tests at each recovery well installed, a 24- to 36-hour pumping test at each of six recovery wells, and long-term (7 to 10 days) pumping test at a selected recovery well. Other long-term tests will be performed by pumping simultaneously from two recovery wells and then from all six recovery wells to delineate the groundwater extraction system's capture zone. These activities are addressed in the IM Workplan (ABB-ES, 1993c).

<u>4.1.10 Ecological Survey</u> The ecological survey is discussed in Section 5.0 of this Workplan. The ecological survey is limited in scope to qualitative identification of potential receptors and potential exposure pathways. An aquatic field survey will be completed at the same time as the sampling of surface waters and sediments. The field survey will include sampling of benthic macroinvertebrates and qualitative sampling of fish, as described in the following paragraph.

Macroinvertebrate samples will be collected in a quantitative manner consistent with State of Georgia guidelines. The samples will be collected concurrently with the surface water and sediment samples for chemical analyses. The samples will, however, not be processed (numbers of organisms counted or species identified) unless contamination in the concurrent surface water and sediment samples is identified. The qualitative fish sampling includes identification of species and recording numbers of individuals observed.

A terrestrial field survey will be completed during the same field event as the aquatic survey. The terrestrial survey will be limited to identification of the plant communities on and near Site 11, identification of any wildlife or signs of wildlife usage, and completion of a records search. The goal is to characterize the terrestrial wildlife habitat offered by Site 11 and surrounding

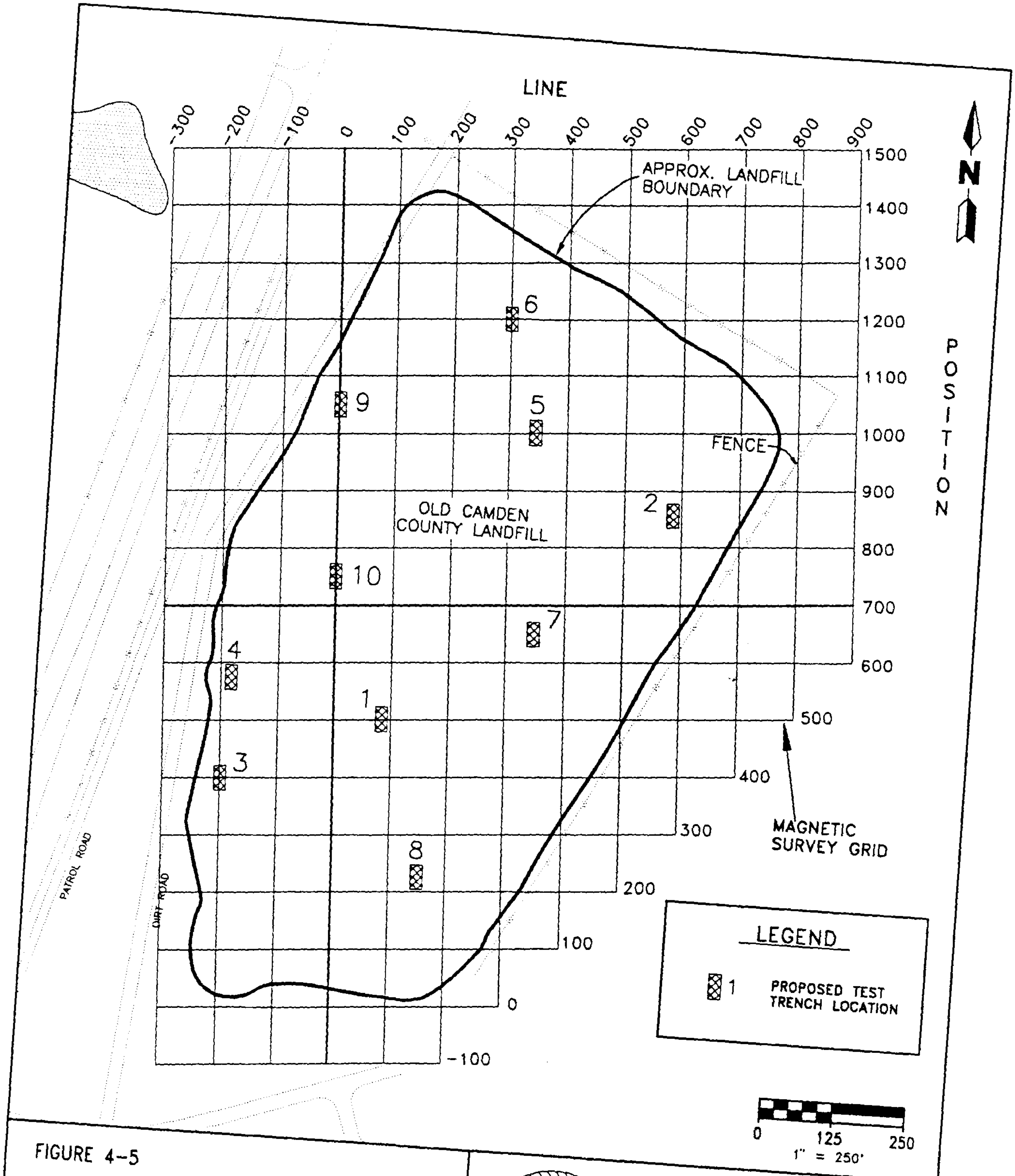


FIGURE 4-5

PROPOSED TEST TRENCH LOCATIONS

SUPPLEMENTAL RFI WORKPLAN

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

D:\DWG\ABB\8503-07\SRFI_WP\FIG_4-5\DMF\940622
KB_STE11.WP
MVL.08.94

areas and to identify terrestrial wildlife species that may be exposed to soil contamination. The terrestrial field survey will include a search for information on State and Federal rare, endangered, and threatened species that may inhabit or migrate to Site 11.

4.1.11 Public Health Survey A public health survey consisting of area reconnaissance, interviews, and records search will be conducted by a Public Health Risk Assessment Specialist. The survey will be conducted to examine on-base and off-base communities, activities, and drinking water sources. Information gathered will be used to develop potential exposure pathways to be evaluated in the HEA.

4.1.12 Decontamination Procedures Decontamination procedures will be practiced to provide personal safety and to ensure sample quality. Equipment and materials decontamination procedures will be performed regardless of the detection of contaminants. Decontamination procedures are described in detail in Subsection 2.1.5 of the SAP.

4.1.13 Investigation-Derived Wastes Investigation-derived wastes (IDW) associated with the field program include soil cuttings, drilling mud, groundwater from well development and purging, and decontamination water. Pertinent elements of IDW management are described in this subsection. Details of IDW management are included in Subsection 2.1.6 of the SAP and in the IDW Management Plan for Site 11 (ABB-ES, 1993d).

Soil cuttings and drilling mud generated during drilling activities will be placed in covered rolloff bins for temporary storage. One composite sample will be collected from each rolloff bin and analyzed by the toxicity characteristic leaching procedure (TCLP) for all TCLP parameters. An appropriate disposal facility will be selected based upon the results of the analyses.

IDW liquid wastes generated from monitoring well development and purging and from decontamination activities will be stored in a Baker water storage tank at the site and bled into the influent of the IM treatment system.

4.1.14 Survey of Sampling Locations An elevation and location survey will be performed by a surveyor licensed by the State of Georgia. The surveyor will measure monitoring wells, soil boring locations, surface soil sample locations, test trench locations, and any other necessary control points, using both State Plane Coordinates and latitude and longitude.

The inner casing (riser) for the monitoring wells, recovery wells, and ground surface for the soil borings will be surveyed for both horizontal and vertical control to a degree of accuracy of 0.1 and 0.01 foot, respectively. The elevation of the surface of the concrete pad will be surveyed at monitoring wells completed above ground, and the elevation of the top of the well vault will be surveyed at locations completed flush to the ground.

Sampling locations and other control points will be plotted on site-specific maps. In addition, the survey data will be organized and reported using State Plane Coordinates and latitude and longitude coordinates according to the Federal Interagency Coordinating Committee for Digital Cartography recommendations.

4.2 ANALYTICAL PROGRAM. This section discusses the laboratory analytical methods and associated DQO levels for the matrices to be sampled during the Supplemental RFI program.

4.2.1 Engineering and Treatability Analyses Engineering and treatability analyses include soil analyses used to evaluate *in situ* bioremediation as a possible corrective measure and groundwater analyses used to evaluate the suitability of the IM treatment system (and possibly other types of treatment systems) for groundwater remediation.

4.2.1.1 **Soil** Four subsurface soil samples will be collected for analyses of phosphate binding, nitrate, nitrite, and heterotrophic bacteria. Samples will be analyzed by the treatability laboratory in conformance with USEPA Level V DQOs. Table 4-1 includes the corresponding analytical method numbers for these analyses.

4.2.1.2 **Groundwater** Three groundwater samples will be collected for analyses of alkalinity, hardness, total dissolved solids (TDS), total suspended solids (TSS), total volatile suspended solids, pH, specific conductance, BOD (5-day and 20-day), COD, total organic carbon, chlorides, sulfates, nitrogen series, and phosphorus. Samples will be analyzed by a contract laboratory in conformance with USEPA Level V DQOs. Table 4-1 includes a list of corresponding analytical method numbers for these analyses.

4.2.2 Analyses for Contamination Characterization This subsection describes the analytical program samples to be submitted for analyses of USEPA (1992) Appendix IX constituents and CLP-RAS. These include subsurface soil samples, surface soil samples, sediment and surface water samples, and samples of soil and liquid from test trenches. The data resulting from these analyses will be used to evaluate the contaminant status of the media sampled. The data associated with subsurface soil and groundwater samples will also be used to support the CMS, and the surface soil, sediment, and surface water data will be used to support the HEA. The sample quantities discussed in the following paragraphs do not include QA/QC samples, such as duplicates and matrix spike samples.

4.2.2.1 **Appendix IX Analyses** One surface soil sample, three groundwater samples, one sediment sample, one surface water sample, and one leachate sample and soil sample from within the test pits will be collected for analysis of Appendix IX VOCs, SVOCs, organochlorine pesticides, polychlorinated biphenyls (PCBs), herbicides, organophosphorus pesticides, and inorganics (including sulfide and cyanide). Three filtered groundwater samples will also be collected and analyzed for USEPA (1992) Appendix IX inorganics (including sulfide and cyanide). Samples will be analyzed by a Naval Energy and Environmental Support Activity (NEESA)-approved contract laboratory in conformance with USEPA Level III DQOs and USEPA (1986) SW-846 analytical methods. Table 4-1 provides a list of analyses and corresponding analytical method numbers.

4.2.2.2 **Contract Laboratory Program Analyses** The Supplemental RFI includes CLP analyses because CLP protocol is required to achieve Level IV DQOs. The following samples will be collected and analyzed for Target Compound List (TCL) VOCs, TCL SVOCs, TCL pesticides and PCBs, and TAL inorganics (including cyanide) in conformance with CLP protocols and USEPA Level IV DQOs: 9 subsurface soil

Table 4-1
List of Chemical and Physical Analyses and Corresponding Analytical Method Numbers

Supplemental Resource Conservation and Recovery
Act Facility Investigation for Site 11
Volume I, Workplan
Naval Submarine Base
Kings Bay, Georgia

Parameter	Analytical Method	Reference	DQO Level
Contamination Characterization			
TCL VOCs	1990 CLP SOW	(1)	III,IV
TCL SVOCs	1990 CLP SOW	(1)	III,IV
TCL Pesticides/PCBs	1990 CLP SOW	(1)	III,IV
TAL Inorganics	1990 CLP SOW	(1)	III,IV
Sulfide	SW-846 Method 9030	(2)	III
Appendix IX VOCs	SW-846 Method 8240	(2)	III
Appendix IX SVOCs	SW-846 Method 8270	(2)	III
Appendix IX Organochlorine Pesticides and PCBs	SW-846 Method 8080	(2)	III
Appendix IX Herbicides	SW-846 Method 8150	(2)	III
Appendix IX Organophosphorus Pesticides	SW-846 Method 8140	(2)	III
Appendix IX Inorganics	Various SW-846 Methods	(2)	III
Total Dissolved Solids	EPA Method 160.1	(3)	V
Total Suspended Solids	EPA Method 160.2	(3)	V
Fate and Transport			
Bulk Density	ASTM E12-70	(4)	V
Cation Exchange Capacity	SW-846 Method 9081	(2)	V
Total Organic Carbon	SW-846 Method 9060	(2)	V
Sieve Analysis	ASTM D-421	(4)	V
Hydrometer Analysis	ASTM D-422	(4)	V
Atterberg Limits	ASTM D-4318	(4)	V
Permeability	ASTM D-2434	(4)	V
Soil Sorptive Capacity	SW-846 Methods 8010/8020 (modified)	(2)	V
Engineering and Treatability			
Alkalinity	EPA Method 310.1	(3)	V
Hardness	EPA Method 130.1	(3)	V

See notes at end of table.

Table 4-1 (Continued)
List of Chemical and Physical Analyses and Corresponding Analytical Method Numbers

Supplemental Resource Conservation and Recovery
Act Facility Investigation for Site 11
Volume I, Workplan
Naval Submarine Base
Kings Bay, Georgia

Parameter	Analytical Method	Reference	DQO Level
Total and Volatile Suspended Solids	EPA Method 160.2M	(3)	V
pH	EPA Method 150.1	(3)	V
Specific Conductivity	EPA Method 120.1	(3)	V
Biochemical Oxygen Demand (5-day and 20-day)	EPA Method 405.1/404.1M	(3)	V
Chemical Oxygen Demand	EPA Method 410.4	(3)	V
Total Organic Carbon	EPA Method 415.1	(3)	V
Chlorides	EPA Method 325.1/325.3	(3)	V
Sulfates	EPA Method 375.4/375.2	(3)	V
Nitrogen Series	EPA Method 351.3/350.1/353.2	(3)	V
Phosphorus	EPA Method 365.1	(3)	V
Bioremediation			
Phosphate Binding	Standard Method 4500-P/E (modified)	(5)	V
Nitrite/Nitrate	Standard Methods 4500B/4500E (modified)	(5)	V
Heterotrophic Bacteria Count	Standard Method 9215C (modified)	(5)	V

References:

(1) Contract Laboratory Program Statement of Work for Organic Analysis (USEPA Document No. OLM01.9, revised June 1991) and Contract Laboratory Program Statement of Work for Inorganic Analysis (USEPA Document No. ILM02.0, revised June 1991).

(2) Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846), 3rd Edition, USEPA, 1986.

(3) Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, revised March 1983.

(4) American Society for Testing and Materials. 1984 Annual Book of ASTM Standards.

Notes: DQO = data quality objective.
TCL = target compound list.
VOC = volatile organic compound.
CLP = Contract Laboratory Program.
SOW = statement of work.
SVOC = semivolatile organic compound.
PCB = polychlorinated biphenyl.
EPA = Environmental Protection Agency.
ASTM = American Society for Testing and Materials.
TAL = target analyte list.

samples from soil borings installed as part of the supplemental RFI and 2 subsurface soil samples collected from the IM recovery well borings; 6 surface soil samples, 32 groundwater samples (during the first round of groundwater sampling); 4 leachate samples and four soil samples from within the test pits; 4 sediment samples; and 4 surface water samples. All samples will also be analyzed for sulfide in conformance with USEPA Level III DQOs. Groundwater samples will be analyzed for TSS and TDS in conformance with Level V DQOs. Thirty-two filtered groundwater samples will also be collected and analyzed for TAL inorganics (including cyanide and sulfide). Table 4-1 lists the analyses and corresponding analytical method numbers.

Two subsurface soil samples and 35 groundwater samples (groundwater sampling event No. 2) will be collected and analyzed for TCL VOCs, TCL SVOCs, and TAL inorganics (including cyanide) in conformance with CLP protocols. USEPA Level IV DQOs will be used for the subsurface soil samples. Level III DQOs will be used for the groundwater samples collected during the second sampling event. These samples will also be analyzed for sulfide conformance with USEPA Level III DQOs. Groundwater samples will be analyzed for TSS and TDS in conformance with Level V DQOs. Thirty-five filtered samples will also be collected and analyzed for TAL inorganics (including cyanide and sulfide). Table 4-1 lists the analyses and corresponding analytical method numbers.

4.2.3 Fate and Transport Analyses Seven subsurface soil samples, including one duplicate sample, will be collected for analyses of bulk density, cation exchange capacity, organic carbon content, sieve analysis, hydrometer analysis, Atterberg limits, and permeability. These analyses will be performed by a contract laboratory in conformance with USEPA Level V DQOs. One composite soil sample will be collected for soil sorptive analyses to be performed by the treatability laboratory. The composite sample will be analyzed in conformance with USEPA Level V DQOs. Table 4-1 lists the analyses and corresponding analytical method numbers.

4.3 DATA VALIDATION. Data validation will be performed on all data collected in conformance with Level III and Level IV DQOs. Data collected in conformance with Level V DQOs do not require validation; however, evaluation of Level V data will include a review of data relative to laboratory QA/QC requirements and duplicate analyses.

4.3.1 Appendix IX Analyses Samples requiring USEPA (1992) Appendix IX analyses will be analyzed and validated according to Level III DQOs. Data validation will be performed according to USEPA Level III QC criteria and QC criteria specified by each analytical method to establish data quality and useability. The USEPA functional guidelines for evaluating organic and inorganic data (USEPA, 1988b; 1990c) will be used, where applicable, to validate the laboratory data.

4.3.2 Contract Laboratory Program Analyses Samples analyzed in conformance with CLP protocols and Level III DQOs will be validated according to Level III DQOs. Data validation will be performed according to USEPA Level III and QC criteria specified by each analytical method to establish data quality and useability. The USEPA functional guidelines for evaluating organic and inorganic data (USEPA, 1988b; 1990c) will be used to validate the laboratory data.

Samples analyzed in conformance with CLP protocols and Level IV DQOs will be validated according to Level IV DQOs. Data validation will be performed according to USEPA Level IV and QC criteria specified by each analytical method to establish data quality and useability. In accordance with Level IV criteria, the USEPA functional guidelines for evaluating organic and inorganic data (USEPA, 1988b; 1990c) will be used to validate the laboratory data.

4.4 DATA EVALUATION AND INTERPRETATION. Data evaluation is the process of organizing validated data into a working format and then reviewing the validated data to confirm that project DQOs have been met. Data quality indicators of representativeness and completeness are measured to evaluate conformance to the DQOs.

Data interpretation is the process of reviewing the validated data and identifying the presence or absence of site-related chemical compounds in environmental samples collected during the investigation.

4.5 GROUNDWATER FATE AND TRANSPORT MODELING. Computer groundwater modeling programs will be used to simulate the movement of contaminants within the soil and groundwater system. Software to be used includes MODFLOW, MODPATH, and MT3D. The modeling is intended to simulate head distribution and groundwater flow path within the surficial aquifer and to also simulate the fate of chemicals released to groundwater. The output from the modeling will be used as a baseline for the CMS. Various scenarios relating to potential corrective measures can be simulated once a baseline simulation has been developed. The process of calibrating the baseline model can also provide insight into the nature of the release at the source and dominant factors in the local environment that affect the migration and concentrations of contaminants detected at the site.

5.0 HEALTH AND ENVIRONMENTAL ASSESSMENT

The purpose of the HEA is to evaluate whether contamination is present in environmental media or whether potential releases at Site 11 present a current or potential future threat to human health or the environment. The results of the assessment will be used to make decisions concerning possible interim corrective measures or a CMS. The results may also be used to substantiate a No Further Action decision.

The HEA is completed in three parts. The quality of the available analytical data for Site 11 is evaluated as described in Section 5.1. The Human Health Risk Assessment (HHRA) is described in Section 5.2 and the Ecological Assessment is described in Section 5.3.

5.1 DATA QUALITY EVALUATION. All the validated data from the RFI will be gathered in a database and reviewed for completeness of the DQOs for an HEA. The analytical methods used and quantitation limits of all samples will be reviewed for appropriateness for quantitative HEAs. Environmental samples with elevated quantitation limits or rejected results will be identified and their significance to the risk assessment will be evaluated. Chemicals that are not detected at least once in a medium will be eliminated from the HEA. Unless tentatively identified compounds (TICs) are judged, either by estimated concentration or number, to possibly influence the HEA, they will only be evaluated qualitatively in the HEA.

5.2 HUMAN HEALTH RISK ASSESSMENT. The HHRA will be conducted according to the appropriate Federal and State guidelines including:

- Supplemental Region IV Risk Assessment Guidance (USEPA, 1991), and
- RCRA Facility Investigation Guidance (USEPA, 1989a).

The HHRA will be conducted in five parts:

- data evaluation and summarization,
- identification of Contaminants of Potential Concern (CPCs),
- exposure assessment covering both present and future uses of the site,
- toxicity assessment of the CPCs, and
- risk characterization.

5.2.1 Identification of Contaminants of Potential Concern If the number of contaminants in the data set is relatively large, a screening process may be implemented to identify the contaminants potentially posing the greatest health risk. A set of screening concentrations (SCs) based on either a cancer risk of $1x10^{-6}$ or a non-cancer Hazard Quotient (HQ) of 0.1 will be developed for contaminants detected in each medium. The SCs will be based on a potential residential exposure and the derivation method will be documented in the HHRA.

Regulatory requirements for contaminants present at the site will also be identified.

Maximum concentrations of contaminants detected in each medium will be compared with the SCs and/or regulatory requirements. Those contaminants detected in each medium above SCs or regulatory requirements will be considered CPCs and studied through the remainder of the HHRA. Contaminants detected at levels below SCs or regulatory requirements will generally be dropped from the HHRA unless they could present a human health risk disproportionate to the concentration of the contaminant detected. Factors that could result in retention of a contaminant as a CPC include weight of evidence classifications of toxicity values, mobility, persistence, or bioaccumulation.

5.2.2 **Exposure Assessment** In the exposure assessment, the types and magnitudes of potential human exposures to CPCs will be estimated in a four-step process that includes:

- characterization of the exposure setting,
- identification of exposure pathways,
- quantification of exposures, and
- construction of exposure scenarios.

The physical characteristics of the site and the nature of surrounding populations will be evaluated to provide a basis for assessing potential exposures. Important site characteristics that may influence human contact with site contaminants include surface conditions, soil type, degree of vegetative cover, and conditions that may affect the migration of contaminants, such as speed and direction of groundwater flow.

Population characteristics to be evaluated include the location of current populations relative to the site and usual activities of these populations. The presence of potentially sensitive subpopulations, such as children and elderly or infirmed persons, will also be evaluated.

The information gained in the exposure setting will be used to identify potential exposure pathways. A completed exposure pathway describes the specific way that a human receptor comes into contact with site contaminants. A completed pathway links the source of contamination, a potential exposure point and/or migratory pathway, and the location and activities of human receptors.

To quantify contaminant exposures in the identified human receptors, exposure point concentrations for each contaminant are calculated as contaminant intakes for each completed exposure pathway. In accordance with USEPA Region IV guidance, the exposure point concentration for a contaminant in a medium will be the lower of either the maximum detected concentration at the site or the 95th percentile Upper Confidence Limit (UCL) of the estimated mean, as calculated by the equation:

$$95\%\ UCL = e^{\left(x + 0.5s^2 + \frac{sH}{\sqrt{n-1}}\right)} \qquad (1)$$

where

95 % UCL	=	95th percentile UCL of the estimated mean,
e	=	2.71828,
x	=	arithmetic mean of log-transformed data,
s	=	standard deviation of log-transformed data,
H	=	statistic from Gilbert (1987), and
n	=	number of samples.

One-half the sample quantitation limit will be used as a surrogate value in the determination of the UCL at sample points at which a chemical was not detected. USEPA Region IV policy is to determine groundwater UCLs based only on results taken within the contaminant plume. Data collected from points outside the plume will not be used to calculate the UCL.

Exposure point concentrations for some exposure pathways may use the results from modeling rather than from field samples. Exposures to contaminants volatilizing from water used for lawn irrigation and indoor showers will be modeled as will potential soil exposures at the surface of the landfill. Other modeling efforts anticipated for the HHRA include groundwater modeling of contaminant migration from the landfill to the adjacent neighborhood and air modeling of particulate dust generation at the landfill.

Once the exposure point concentration for each contaminant has been selected, intakes via each exposure pathway for all identified human receptors will be calculated using standard USEPA methodology (USEPA, 1989b). Intakes for receptors will be based on the age and weight of the receptor, intake or contact rate, exposure frequency, exposure duration, and averaging time. The Average Daily Dose (ADD) will be used in the characterization of non-cancer risks. The Lifetime Average Daily Dose (LADD) will be used in the cancer risk characterization.

The final step in the exposure assessment will be the construction of exposure scenarios. Each exposure scenario will be based on an identified or projected population of human receptors. For identified human receptors, contaminant intakes for selected exposure pathways over relevant exposure periods may be grouped for analyses. For example, one scenario will address potential exposures of a child trespasser playing on the landfill. In addition to currently existing scenarios, scenarios for potential future land uses at the site will also be developed. One of these scenarios will be residential use of the land, assuming the presence of children and long-term residents on the site.

5.2.3 Toxicity Assessment The toxicity assessment summarizes available information on the potential toxic effects of the CPCs and provides an estimate of the relationship of dose to the likelihood or severity of adverse human health effects. The USEPA has gathered and analyzed toxicity information for the majority of chemicals expected at Kings Bay. Weight of evidence classifications and numerical toxicity factors have been developed and subjected to extensive peer review. This toxicity information is made available in several sources including:

- Integrated Risk Information System (IRIS),
- Health Effects Assessment Summary Tables (HEAST), and

- Agency for Toxic Substances and Disease Registry (ATSDR) Toxicology Profiles.

If no information is available about a specific chemical in these sources, the risk assessor will consult with GA DNR staff to determine appropriate toxicity values.

The results of the exposure assessment will identify the exposure periods for which non-cancer toxicity information is required. Current Reference Doses (RfDs) for all CPCs will be obtained from IRIS, the HEAST, or GA DNR. Chronic RfDs will be collected for use in long-term and child exposures. For shorter exposures, such as workers or adult trespassers, subchronic RfDs and One- and Ten-Day Health Advisories may be used as toxicity values if the risk assessor determines their use is appropriate. If necessary, the risk assessor may develop RfDs for some chemicals, especially TICs. Any toxicity values developed by the risk assessor will be made available to GA DNR staff for review and will be used in the HHRA only with prior approval of GA DNR.

In addition to the current RfD values, the HHRA will include other information relevant to interpreting the significance of potential health risks. The critical study on which the RfD is based will be described as will the critical effect in the study, any uncertainty and modifying factors applied to the development of the RfD, and the degree of confidence assigned to the RfD.

Toxicity factors for carcinogenic chemicals will include current slope factors and weight of evidence classifications for all carcinogens. For confirmed human carcinogens (USEPA Class A), the cancer type observed in exposed humans will also be identified.

Route-to-route extrapolations, especially for dermal exposures, and absorption adjustments to toxicity values will be made by the risk assessor, as necessary, consistent with good professional judgment.

5.2.4 Risk Characterization The risk characterization combines the results of the exposure and toxicity assessments in quantitative expressions of potential health risks associated with chemical exposure. The first step in the risk characterization will be to collect the results of these assessments and conduct a final "reality check" to make sure that the results will be reasonable and representative of potential risk levels. Exposure point concentrations, absorption adjustments, exposure factors, and durations will be checked for correctness.

In the second step of the risk characterization, cancer risks and non-cancer HQs will be calculated for each CPC in each identified exposure pathway. For each exposure pathway, cancer risks from each chemical will be summed to estimate pathway-specific cancer risk, and non-cancer HQs will be summed to estimate a pathway-specific Hazard Index (HI).

The third step of risk characterization will consist of combining pathway-specific cancer risks and HIs for each scenario. Each scenario will be described with a specific statement indicating whether the scenario represents:

- an exposure known to be occurring under current conditions,

- an exposure possibly occurring under current conditions, or

- an exposure not believed to be occurring under present conditions but possible in the future if site conditions change.

For each scenario, the selected pathway-specific risks will be summed to estimate total cancer risk. Similarly, pathway-specific HIs will be summed to estimate the Total Hazard Index (THI). If the calculated THI for a scenario is equal to or higher than 1.0, the risk assessor will review the critical studies for each CPC to determine whether combination of the HQs is appropriate. If the THI for a scenario is less than 1.0, the segregation of the HQs will not be undertaken.

The risk characterization will also contain an analysis of the uncertainties associated with the risk assessment process. Uncertainties, which will be addressed, arise from several sources:

- uncertainties in the representativeness of analytical data for actual chemicals and concentrations at the site,

- uncertainties in modeling results used to determine exposure point concentrations,

- uncertainties in exposure factors used to calculate intakes,

- uncertainties in the appropriateness of toxicity values, and

- potential for synergistic or antagonistic interaction of CPCs.

The final step in the HHRA is to calculate concentrations of the contaminants detected in each media that are protective of human health and the environment. These contaminant concentrations may be used as alternate cleanup levels if it is demonstrated that the best available remedial technologies will be unable to achieve cleanup to either background levels or Maximum Contaminant Levels (MCLs). The major results of the HHRA; the most significant contaminants, exposure pathways, and risks; and the proposed alternate site-specific remedial levels will be summarized at the end of the HHRA.

<u>5.3 ENVIRONMENTAL ASSESSMENT</u>. The environmental assessment for Site 11 at NSB Kings Bay will be completed according to guidance for the Health and Environmental Assessment in the *RCRA Facility Investigation Guidance* (USEPA, 1989a).

The environmental assessment will include five components: Field Survey (Subsection 5.3.1), Identification of Potential Ecological Receptors and Exposure Routes (Subsection 5.3.2), Identification of Constituents of Concern (Subsection 5.3.3), Exposure Assessment (Subsection 5.3.3), Exposure Limit Criteria (Subsection 5.3.4), and Risk Characterization (Subsection 5.3.5).

<u>5.3.1 Ecological Field Survey</u> An ecological field survey will be completed by two biologists with the purpose of collecting information on the ecological setting of Site 11 and surrounding areas. The survey will focus on the area covered by the landfill and Porcupine Lake. The vegetative cover of the landfill and immediate surrounding areas will be described qualitatively and the habitat

it provides for terrestrial wildlife will be discussed. Based on the type of habitats identified, a list of terrestrial wildlife species that may inhabit the area on the landfill, areas surrounding the landfill, and Porcupine Lake will be developed. The survey results will include a description of any endangered or threatened species near the facility.

Aquatic receptors in Porcupine Lake will be identified based on qualitative sampling of benthic invertebrates and fish during the ecological field survey. The ecological field survey will be completed at the same time as the surface and sediment sampling. Three replicate benthic macroinvertebrate samples will be collected from the same locations as the sediment samples by use of a petite ponar dredge. The benthic samples will be processed quantitatively to identify if the community is impacted and to develop exposure limit criteria for sediments (Subsection 5.3.4). If the concurrent surface water or sediment sample is not contaminated, the benthic samples will not be processed.

After review of the chemical analyses of sediment samples (past or future), further biological sampling will be considered that is necessary to develop exposure limit criteria. These may include sampling and analyses of fish tissue (or other aquatic organisms) and sediment bioassay. For example, if the sediment contamination is represented by persistent chemicals that may accumulate in fish tissue and may result in contaminant exposures for receptors consuming fish, then the fish will be sampled to determine if this exposure is possible and, if so, the extent of the exposures. If the sediment contamination could be directly toxic to aquatic organisms, then sediment bioassays may be considered.

<u>5.3.2 Identification of Ecological Receptors and Exposure Routes</u> Contaminant releases from the site, constituents, and constituent concentrations in affected media will be identified based on the results of the field investigations. Potential routes of exposure for ecological receptors (identified during the field survey in Subsection 5.3.1) will be identified based on the overlap of the receptors habitat with the contaminated media and the life histories of the receptors. Surface water and sediment aquatic receptors (plants and animals) may be exposed to contamination as a result of direct contact or ingestion. They may also be exposed to contamination as a result of ingesting prey that has accumulated contamination from the sediment or surface water. Terrestrial wildlife may be exposed to contamination in surface water or sediment via direct contact, direct ingestion, or ingestion of contaminated aquatic life. Terrestrial wildlife may also be exposed to contamination in surface soil as a result of direct contact, direct ingestion, indirect ingestion, or ingestion of contaminated soil organisms or plants. The most plausible exposure pathways will be evaluated in the environmental assessment.

<u>5.3.3 Identification of Contaminants of Potential Concern</u> This part of the Supplemental RFI will establish the contaminated media to which ecological receptors may come into contact. CPCs will be selected separately for surface water, sediments, and groundwater.

Contaminant concentrations will be summarized as to frequency of detection, range of detected concentrations, and average concentrations detected. Contaminants will be selected as being of concern if the maximum detected concentrations exceeds two times the average background concentration.

5.3.4 Exposure Assessment The Exposure Assessment will predict concentrations of CPCs for each of the pathways identified in Subsection 5.3.2. Contaminant exposure concentrations will be identified for each of the environmental media at the site identified as contaminated. For sediment and surface water, the exposure concentrations for aquatic species will be equal to the concentrations measured in the samples. For groundwater, exposure concentrations will be based on the concentrations of contaminants in groundwater and the predicted rate of groundwater discharge to Porcupine Lake. For exposures related to soil contamination, the measured concentrations will be used to approximated exposures for soil invertebrates and plants. Contaminant exposures for terrestrial species related to potential dietary exposures will be based on a simple food chain model. The food chain model will predict contaminant concentrations in prey items based on the concentrations measured in soil, surface water, and sediment.

5.3.5 Exposure Limit Criteria Exposure limit criteria will be identified or derived for each of the contaminated environmental media and receptor exposure routes. Aquatic exposure limit criteria for groundwater or surface water contamination will be determined based on the following hierarchy:

1. State of Georgia Surface Water Quality Standards;

2. Federal Ambient Water Quality Standards;

3. lowest reported concentration of the constituent in the USEPA aquatic information retrieval (AQUIRE) database associated with an adverse effect to growth, reproduction, or survival of a freshwater species; and

4. one tenth of the lowest reported LC_{50} (dose lethal to 50 percent of the test population) concentration for a constituent in the USEPA AQUIRE database.

Exposure limit criteria for surface soil for plants and soil invertebrates will be identified based on literature information associating contaminant concentrations in soil with adverse effects.

Preliminary exposure limit criteria for surface soil for terrestrial wildlife will be derived to reflect a soil contaminant concentration that is not predicted to result in a dietary exposure for wildlife species associated with adverse effects to growth, reproduction, or survival. Dietary exposures will be predicted based on a simple food chain model.

If the preliminary exposure limit criteria are exceeded for either plants, invertebrates, or terrestrial wildlife, then further sampling will be considered to derive final exposure limit criteria. These studies may include measurement of contaminant concentrations in food items (plants, worms, birds, or mammals) or measurement of toxicity (soil bioassays). The final exposure limit criteria will be used to determined corrective measures action levels.

Preliminary exposure limit criteria for sediment will be the National Oceanic and Atmospheric Administration (NOAA) Effects Range Low (ERL) values (NOAA, 1990). Where ERL values are not available for Non-polar Hydrophobic Organic constituents Equilibrium Partitioning Theory (EQP) values may be calculated to derive sediment exposure limit criteria.

Final exposure limit criteria for sediment will be derived based on the results of the macroinvertebrate community analyses, the results of the sediment sampling, and the preliminary exposure limit criteria.

5.3.6 Risk Characterization The risk characterization will consist of comparisons of the contaminant exposure concentrations identified in Subsection 5.3.2 with the exposure limit criteria identified in Subsection 5.3.5. If exposure limits are exceeded, then a recommendation for interim corrective measures or a corrective measures study will be made.

6.0 PROJECT MANAGEMENT PLAN

This Project Management Plan (PMP) is submitted as part of the workplan for the Supplemental RFI for Site 11, the Old Camden County Landfill, at NSB Kings Bay, Georgia. In general, the PMP applies to all aspects of work associated with environmental issues at Site 11. The PMP is developed to provide a discussion of the technical approach, schedules, budgets, and personnel qualifications. This section is divided into four parts: project management, technical management, quality management, and program objectives. The technical approach for the Supplemental RFI is contained in Section 4.0 of this document. Budgets are submitted to the Navy in response to Statements of Work pertaining to the execution of the overall Site 11 program objectives. The schedule for the RFI and other parts of the program for Site 11, will be presented in Corrective Action memoranda that will be prepared at a later date and submitted to the GA DNR. This section includes a description of the program objective and process flow charts that will be used to develop the schedules.

6.1 PROJECT MANAGEMENT APPROACH. The NSB Kings Bay RCRA program for Site 11 is managed at three levels; Navy management by NSB Kings Bay personnel, Navy management by SOUTHNAVFACENGCOM, and consultant management. These management levels provide the guidance for the execution of the RCRA program at Site 11. Figure 6-1 provides the program organizational structure.

6.1.1 Naval Submarine Base, Kings Bay, Management The Commanding Officer has ultimate responsibility for all activities associated with the NSB. The NSB Public Works Officer has been delegated authority for the environmental activities associated with NSB Kings Bay. The Public Works Officer is responsible for ensuring work is performed in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information that is submitted. The civilian Environmental Coordinator is responsible for the day-to-day interaction with the SOUTHNAVFACENGCOM Remedial Project Manager (RPM) and the Consultant's Task Order Manager (TOM).

Communication with the appropriate regulatory agencies is handled through NSB management. Communication with the public is handled through the Public Affairs Office at the Sub-base. Support for this communication is provided by SOUTHNAVFACENGCOM and the Consultant.

6.1.2 Southern Division, Naval Facilities Engineering Command, Management SOUTHNAVFACENGCOM is responsible for establishing policies and guidance for the Navy's IR program. SOUTHNAVFACENGCOM awards contract task orders, approves funding, and has primary control of report release. The RPM at SOUTHNAVFACENGCOM is responsible for the administration of the Contract Task Order with the Consultant. The RPM provides support to the Activity and is the primary point of contact for the Consultant. The RPM is responsible for the technical and financial management of the RCRA program at NSB Kings Bay. The RPM prepares Statements of Work, monitors project progress, provides input to the development of the project schedules, monitors project scope, authorizes any required change orders, and provides technical review and approval of all deliverables. The RPM also provides the NSB with technical, contractual, and regulatory support for issues dealing with the RCRA program at the NSB.

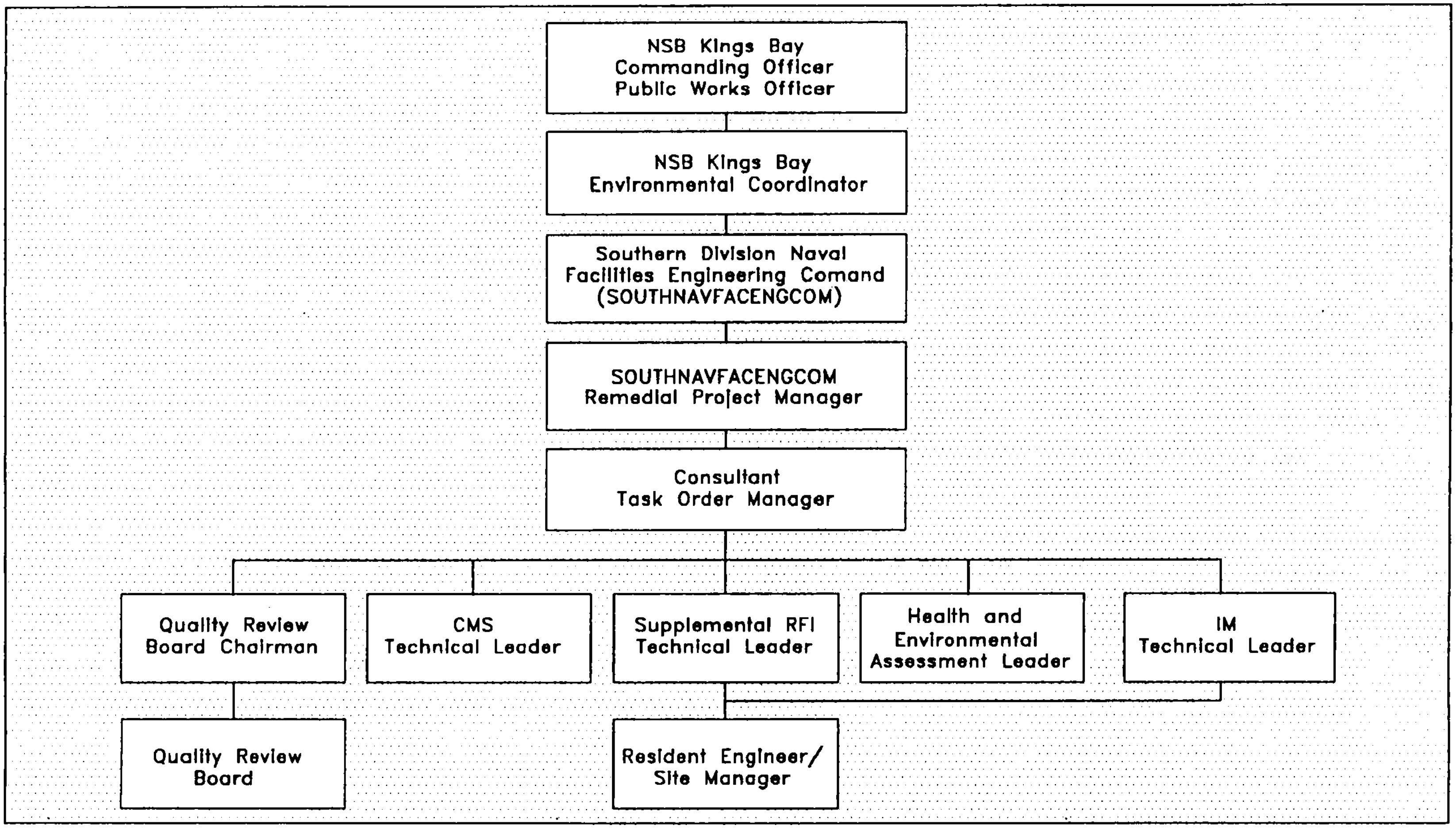


FIGURE 6-1

PROJECT ORGANIZATION

SUPPLEMENTAL RFI
WORKPLAN

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

D:\DWG\ABB\8503-07\SRFI_WP\FIG_6-1\DMF\940622

6.1.3 Consultant Management The Consultant's management approach is divided into levels of responsibility as indicated in Figure 6-1. The Consultant is responsible for providing an evaluation and recommendation of the appropriateness and adequacy of the technical and engineering services necessary for the execution of the program at NSB Kings Bay. The Consultant provides necessary support activities for this execution, such as subcontract administration, subcontractor oversight, community relations support, and coordination of field activities. The Consultant also provides support relating to regulatory issues.

The TOM is the primary point of contact for the RPM and the NSB Kings Bay management staff. The TOM is responsible for the financial and schedule management. He will report monthly to the RPM on project management activities related to financial and schedule items. The TOM also has responsibility for the daily conduct of work, including the integration of input from the technical support staff and the Quality Review Board (QRB) members. The TOM is responsible for the quality management and release of documents to the Navy. The TOM for this project is a Professional Engineer with more than 8 years experience in engineering consultation and project management.

The Resident Engineer and Site Manager will provide onsite management during field operations. He will be the daily point of contact to the NSB Kings Bay management staff. He will provide close interaction with the TOM and the Technical Leads involved with the project. His responsibilities include coordination of activities, record keeping, and overall adherence to project QA/QC requirements. He will also provide input to bimonthly reporting associated with the Supplemental RFI and the IM. The Resident Engineer will be a Civil Engineering graduate with 3 to 5 years experience.

6.2 TECHNICAL MANAGEMENT APPROACH. The corrective action program that is being developed for Site 11 involves a multi-phased approach based on technical innovation. The implementation of this plan is through concurrent, multiple tasks, or phases. The RFI is being completed with the initiation of this Supplemental RFI Workplan. The IM is being initiated through a Phase I Workplan that will be submitted under separate cover. The Phase II IM will be implemented after the Phase I is nearly completed. The CMS was initiated with the Pre-investigation Evaluation of Corrective Measures Technologies report included as an appendix to this document. A Health and Environmental Assessment will be included as part of the RFI report. Due to the complexity of each of these tasks, a team or technical leader has been assigned for each phase of the project. The different leaders and their interaction with the project management are indicated in Figure 6-1. The Supplemental RFI Technical Lead is also acting in the capacity as the overall Technical Lead Coordinator, or chairman of the Technical Lead Committee.

6.2.1 Supplemental RFI Technical Lead The Supplemental RFI Technical Lead will be responsible for identification and oversight of the program objectives for the RFI. The RFI Technical Lead will focus on project team capabilities for execution of subtasks, coordinate with the TOM for the mobilization and execution of the field program, and provide guidance and oversight for the data interpretation for the Supplemental RFI. The RFI project staff team will supply documents to the Technical Lead for review prior to release to the TOM. The RFI Technical Lead will also interact with the Resident Engineer during field activities to provide guidance and technical expertise to the RFI field program. Technical reporting for the RFI will be provided by the RFI Technical Lead.

The Supplemental RFI Technical Lead will also act in the capacity of the overall Technical Lead Coordinator. This will involve periodic review of overall NSB Kings Bay program objectives, consistency in tasks, interaction of tasks with each other for shared technical knowledge, and chairing Technical Leads meetings. The RFI Technical Lead is a Senior Hydrogeologist with over 7 years experience. The RFI Technical Lead is a registered professional geologist in Tennessee and in Georgia. The Technical Lead is anticipated to take the Georgia Professional Geologist examination in 1993. Georgia Professional Geologist oversight and project supervision is provided by a Technical Expert on the QRB (Subsection 6.3.2).

<u>6.2.2 Health and Environmental Assessment Lead(s)</u> Leadership for the HEA is divided between two personnel, the Human Health Technical Lead and the Environmental and Ecological Technical Lead. The HEA Leads are responsible for evaluating the data as it relates to potential exposure to contaminants released from the site. They will plan and provide guidance for data collection to support the RCRA HEA required by the RCRA Corrective Action Plan Guidance Document (USEPA, 1988a). The Human Health Technical Lead is Senior Toxicologist and a Board Certified Human Health Toxicologist with over 5 years experience. The Environmental Technical Lead is a Senior Ecologist with over 6 years of applied ecology and aquatic toxicology.

<u>6.2.3 Interim Measure Technical Lead</u> The IM Technical Lead will be responsible for identification and oversight of the IM program objectives. The IM Technical Lead will focus on project team capabilities for execution of subtasks, coordinate with the TOM for the mobilization and execution of the field program, and provide guidance and oversight for the data interpretation associated with the IM. The IM project team staff will supply documents to the IM Technical Lead for review prior to release to the TOM. The Technical Lead will also interact with the Resident Engineer during field activities to provide guidance and technical expertise to the field program. Technical reporting for the IM will be provided by the IM Technical Lead. The IM Technical Lead is a Principle Hydrogeologist with over 12 years experience in environmental engineering studies, design, and construction activities. Georgia Professional Geologist oversight and project supervision is provided by a Technical Expert on the QRB (Subsection 6.3.4).

<u>6.2.4 Corrective Measure Study Technical Lead</u> The CMS Technical Lead will be responsible for identification and oversight of the CMS program objectives. The CMS Technical Lead will focus on project team capabilities for execution of subtasks and provide guidance and oversight for the data interpretation as it will relate to the CMS. The CMS project team will supply documents to the CMS Technical Lead for review prior to release to the TOM. The CMS Technical Lead is a Consulting Engineer with over 11 years experience.

<u>6.3 QUALITY MANAGEMENT APPROACH</u>. The Navy and the Consultant are committed to total quality management for this project. As a part of the quality process, a QRB has been established for guidance and senior technical oversight to the program at NSB Kings Bay. The QRB is comprised of senior technical staff members with specialization to provide guidance to each of the tasks within the program.

They will facilitate information sharing, provide review, and assist in project planning. Description of the members of this board and the chairman are provided in Subsections 6.3.1 through 6.3.5.

Another function of the QRB will be to conduct unannounced audits of the field programs at NSB Kings Bay. These audits will be directed towards assuring execution of the field program(s) is in accordance with procedures established in the planning documents. The QRB will also recommend and implement corrective actions if needed.

Another part of the total quality management approach is to involve the regulatory agencies, local officials, and the public in the process. To accomplish this a Technical Review Committee (TRC) was established. The TRC is comprised of NSB Kings Bay representatives, city of St. Marys' officials, Camden County officials, Georgia Department of Transportation officials, residents from the Crooked River Plantation Subdivision, GA DNR representatives, and a USEPA representative. A TRC meeting is convened at appropriate times to discuss progress of the program, review documents that are in the submittal process, and brief TRC members on new information. In conjunction with the TRC process, communication with GA DNR officials has been established and teaming efforts are established.

6.3.1 Quality Review Board Chairman The QRB Chairman will be responsible for overall direction of the Technical Experts that sit on the QRB. This QRB Chairman has final authority for the release of documents to the Navy. He is a member of the Consultant's Board of Technical Directors. He provides guidance and oversight of the quality objectives for the entire CLEAN program. He is also available as a sounding board and moderator for Technical Expert and Technical Lead interaction. The QRB Chairman is a Professional Engineer with over 20 years experience. He has expertise in groundwater hydrology, hydraulics of sediment transport, and hydraulic engineering.

6.3.2 Supplemental RFI Technical Expert The Supplemental RFI Technical Expert will be responsible for providing expertise to the RFI program at NSB Kings Bay. He will provide guidance and input to the direction of activities associated with the program. He will also provide review of documents created by the RFI project team. He has close interaction with the RFI Technical Lead. As a dual function, he will provide review and guidance for geologic aspects of the IM. The Supplemental RFI Technical Expert is a Professional Geologist in the State of Georgia, with over 20 years experience.

6.3.3 Health and Environmental Assessment Technical Expert The HEA Technical Expert will be responsible for providing guidance and expertise for the HEA part of the RFI at NSB Kings Bay. He will provide senior review in the planning and performance of the HEA. The HEA Technical Expert has over 11 years of risk assessment and risk analysis experience.

6.3.4 Interim Measure Technical Expert The IM Technical Expert will be responsible for providing engineering guidance and expertise for the IM. He interacts closely with the IM Technical Lead. In addition to the IM Technical Expert, a Professional Engineer registered in the State of Georgia will provide supervision and responsible charge to the engineering design of the IM. These two personnel will sit on the QRB for the IM tasks. The IM Professional Engineer has over 11 years experience in remedial investigations, environmental compliance, and pilot-scale treatability studies. The IM Technical Expert has over 20 years experience in remedial projects including bioremediation and groundwater extraction.

<u>6.3.5 RCRA Process Technical Expert</u> The RCRA Process Technical Expert will provide guidance and review of the RCRA regulatory aspects and processes for the NSB Kings Bay program. The RCRA Process Technical Expert will interact closely with the RFI, the IM, and CMS Technical Leads. In addition, she will communicate closely with the other members of the QRB. The RCRA Process Expert has over 11 years experience. This includes over 5 years experience in regulatory compliance, permitting, and corrective action in the RCRA regulatory arena.

<u>6.3.6 Corrective Measure Study Technical Expert</u> The CMS Technical Expert will be responsible for providing guidance and expertise for the CMS tasks. The CMS Technical Expert will coordinate with the CMS, RFI, and the IM Technical Leads for interaction in meeting the overall objectives and goals of the CMS. The CMS Technical Lead is a Consulting Engineer with over 11 years experience.

<u>6.4 PROGRAM OBJECTIVES</u>. The NSB Kings Bay RCRA program started in October 1991 with the submission of a RFI Workplan for investigation of three sites at NSB Kings Bay. In late August 1992, a release was confirmed at one site, Site 11, the Old Camden County Landfill. Since that time, Site 11 has been on an RCRA Corrective Action track independent of the other sites. The program objectives discussed here are for the actions at Site 11, only. Figure 6-2 provides a process flow diagram for the activities at NSB Kings Bay since the 1991 RFI Workplan, with emphasis on Site 11.

At present, the Supplemental RFI and Phase I of the IM are concurrent. These tasks are designed to complement each other and to provide information necessary for the CMS. The schedule for execution of these tasks is being phased into place as more knowledge of the site is obtained. A Corrective Action Plan for the Phase I IM has been submitted to GA DNR, with a projected schedule for this phase of the IM. Additional Corrective Action Plans will be submitted with schedules at a later date.

This document, the Supplemental RFI Workplan, is the planning document for the execution of the completion of the RFI at Site 11. If, during the course of this phase, it becomes necessary to modify the approach, an addendum to this document will be issued. In the Fall of 1993, the Supplemental RFI field program began. The initial field program included soil borings, subsurface soil sampling, installation of monitoring wells, and groundwater sampling. The remainder of the field program is anticipated to be conducted during 1994.

Reporting for the RFI includes bimonthly reports to the Navy addressing project management and technical activities. Additionally, two technical memoranda will be prepared addressing the initial field program and two groundwater sampling events. After completion of the entire Supplemental RFI field program and after all data have been evaluated and interpreted, an RFI Report for Site 11 will be prepared.

The CMS may start as early as Summer of 1994, but it is more likely that it will commence in Spring of 1995.

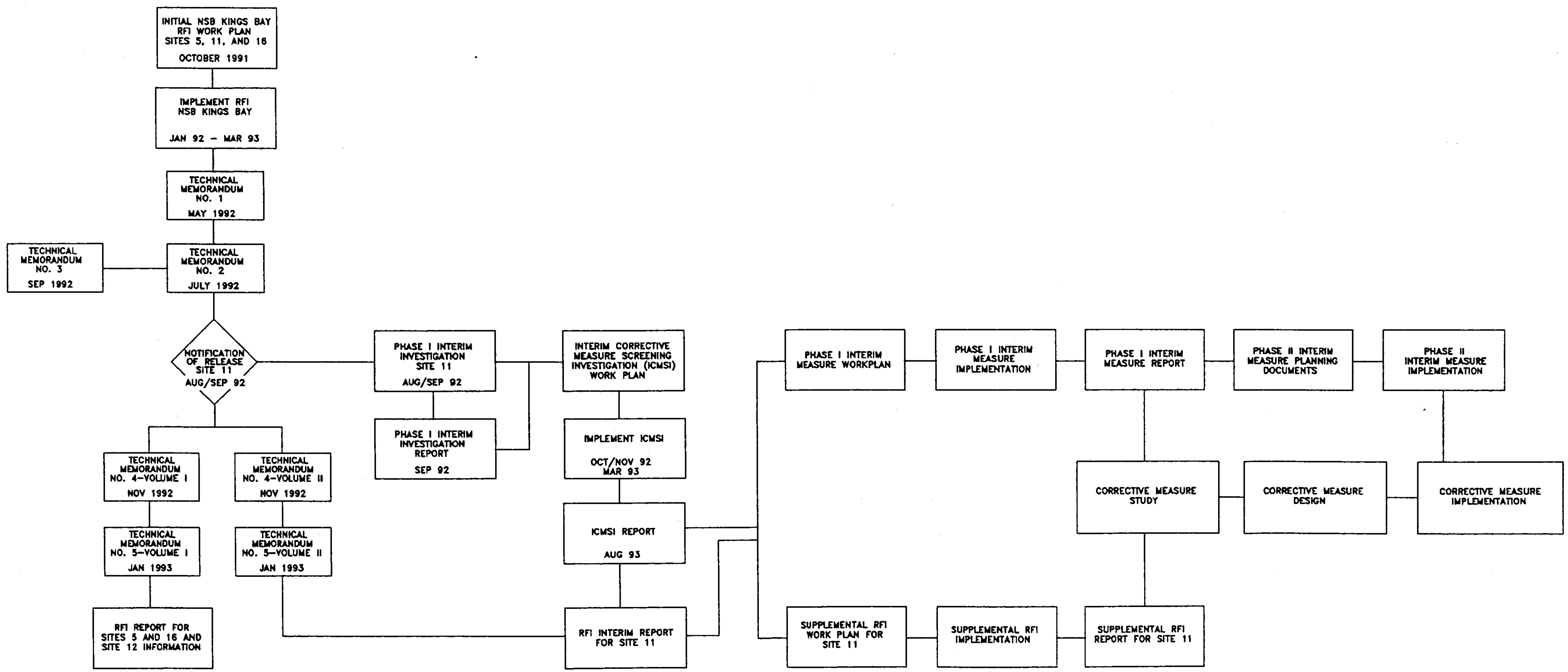


FIGURE 6–2

PROGRAM STRUCTURE

SUPPLEMENTAL RFI WORKPLAN

NAVAL SUBMARINE BASE KINGS BAY, GEORGIA

D:\DWG\ABB\8503–07\SRFI_WP\FIG_6–2\DMF\940627
KB_STE11.WP
MVL.08.94

7.0 PROJECT MANAGEMENT

This section identifies key roles in the project meetings, project organization, project deliverables, and the proposed project schedule.

7.1 PROJECT MEETINGS. Kickoff meetings will be conducted prior to each field task (e.g., soil borings, monitoring well installation, and groundwater sampling) to brief field staff on project goals and requirements.

Routine telephone meetings will be conducted as needed between the Resident Engineer and the Technical Lead. The Resident Engineer will provide progress reports to the TOM and advise of any problems.

Regulatory Workshop Meetings and TRC Meetings will be scheduled throughout the duration of the project. The purpose of these meetings will be to provide information briefings and to resolve any project issues. The TOM and appropriate Technical Leads will attend the meetings.

7.2 ORGANIZATION.

Southern Division, Naval Facilities Engineering Command. SOUTHNAVFACENGCOM is responsible for establishing policies and guidance for the CLEAN program. SOUTHNAVFACENGCOM awards contracts, approves funding, and has primary control of report releases and interagency communications.

NSB Kings Bay Environmental Coordinator. The base environmental coordinator will coordinate and monitor the Supplemental RFI activities at NSB Kings Bay. The environmental coordinator will provide local support and be the primary point of contact with the local, State, and Federal regulatory agencies.

Southern Division Remedial Project Manager. The SOUTHNAVFACENGCOM RPM is responsible for the technical and financial management of the RFI activities at NSB Kings Bay. The RPM will prepare the project statement of work; monitor project scope, schedule, and budget; and provide technical review and approval of all deliverables. Also, the RPM will authorize changes in the scope of work determined during Project Managers' Meetings.

Task Order Manager. The Consultant's TOM for the NSB Kings Bay Supplemental RFI for Site 11 is responsible for evaluating the appropriateness and adequacy of the technical and engineering services provided. The TOM is also responsible for financial and schedule management and for confirming that the project fulfills the contracted scope of work. The TOM will be responsible for implementing changes in the scope of work determined during Project Managers' meetings. The TOM is also responsible for the daily conduct of work, including integration of input from supporting disciplines and subcontractors, and is the primary project contact with the RPM.

Technical Leader. The Technical Lead will be responsible for field studies and the development of the final report. The Technical Lead will also be responsible for the quality and completeness of data gathered during the field program, including overall management and coordination of fieldwork, supervision, and scheduling of work.

Field Operations Leader. The Field Operations Leader (FOL) will be responsible for ensuring that field activities are performed consistent with the project workplan and supporting documents. This will include appropriate logging and documentation of standard and approved drilling and monitoring well installation during the exploration program. Other responsibilities include oversight of sampling activities and site characterization studies, and communication with the Technical Lead.

Quality Review Board. The QRB provides many years of experience that will facilitate the Supplemental RFI and will be integrated into the review process and provide for senior review of documents and deliverables while working closely with the Technical Director and other team members as required.

RCRA Process Expert. The RCRA Process Expert will attend regulatory meetings and provide input throughout the project to confirm that RCRA regulatory issues are addressed.

Corrective Measures Study Leader. The CMS Leader will be responsible for identification and oversight of the program objectives and will work closely with other project team members during execution of the CMS portion of the project.

Interim Measure Leader. The IM Leader will be responsible for identification and oversight of the program objectives and will work closely with other project team members during the execution of the IM part of the project.

RFI Leader. The RFI Leader will be responsible for the Supplemental RFI activities to ensure the field program and associated reports meet the objectives of the program. Additionally, the RFI Leader will be responsible for review of analytical data and data evaluation.

Risk Assessment. A risk assessment team will be responsible for evaluating the Human Health Risk and for evaluating the Ecological Risk associated with the Old Camden County Landfill (Site 11).

7.3 PROJECT DELIVERABLES. Project deliverables will include the following:

Field Event Reports. The field event reports will be used by the TOM and the Navy to aid in tracking and managing the project schedule and budget. The fieldwork will be conducted in shifts, and the field event reports for each field effort will be prepared each time there is a break in field activities. This will allow for better recall of information critical to future evaluation and assessment of site conditions, which may be overlooked if the field reports are delayed until the end of the entire project.

Technical Memorandum Reports. Two technical memoranda reports will be prepared for the Supplemental RFI. The first technical memorandum will address soil borings and soil sampling results, monitoring well installation, and the results of groundwater sampling. The results of this groundwater sampling event will be compared to previous data collected from the site. The second technical memorandum will address the second groundwater sampling event, comparison to previous results, and recommendations for future groundwater monitoring.

Bimonthly Progress and Budget Summary Reports. A report describing the status of the Supplemental RFI will be prepared every 2 months. The reports will describe previous activities, schedule variances, problems, planned activities, and other relevant factors appropriate for the Navy to submit to regulatory agencies.

Supplemental RFI Reports. A draft Supplemental RFI report will be submitted to the Navy for its review. Navy recommendations and modifications from their review of the draft Supplemental RFI Report will be incorporated into the Final Supplemental RFI Report.

7.4 PROJECT SCHEDULE. Accurate schedule planning, tracking, and reporting are important for expeditious completion of the Supplemental RFI for Site 11 at NSB Kings Bay. For purposes of this Workplan, the schedule is presented in Figure 5-1. The schedule reports will be updated to reflect actual progress during the project and will be forwarded to the SOUTHNAVFACENGCOM RPM, NSB Kings Bay, and USEPA (if required). Upon notice to proceed, the duration and schedule will be revised to reflect current dates. The schedule assumes ready access to the site.

REFERENCES

ABB Environmental Services, Inc. (ABB-ES), 1991, Potential Source of Contamination (PSC) Site Investigation/Solid Waste Management Unit (SI/SWMU) RCRA Facility Investigation (RFI) Work Plan Naval Submarine Base, Kings Bay, Georgia: prepared for Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM), Contract Task Order No. 030, CLEAN District 1, Contract No. N62467-89-D-0317, October.

ABB-ES, 1992a, Phase I Interim Investigation, Memorandum, Site 11, Naval Installation Restoration Program, Naval Submarine Base, Kings Bay, Georgia: prepared for SOUTHNAVFACENGCOM, September.

ABB-ES, 1992b, Technical Work Plan Interim Corrective Measure Screening Investigation, Site 11 RCRA Facility Investigation NSB, Kings Bay, Georgia: prepared for SOUTHNAVFACENGCOM, Contract Task Order No. 041, CLEAN District 1, Contract No. N62467-89-D-0317, October.

ABB-ES, 1993a, RFI Interim Report for Site 11, Naval Installation Restoration Program, Naval Submarine Base, Kings Bay, Georgia: prepared for SOUTHNAVFACENGCOM, Contract No. N62467-89-D0317, August.

ABB-ES, 1993b, Interim Corrective Measure Screening Investigation Report - Site 11 RCRA Facility Investigation, Naval Submarine Base, Kings Bay, Georgia: prepared for SOUTHNAVFACENGCOM, Contract Task Order No. 041, CLEAN District 1, Contract No. N62467-89-D-0317, February.

ABB-ES, 1993c, Interim Measure Work Plan for Site 11, Old Camden County Landfill, Phase I Activities, Naval Submarine Base, Kings Bay, Georgia: prepared for SOUTHNAVFACENGCOM, Contract No. N62467-89-D0317, September.

ABB-ES, 1993d, Investigation-Derived Waste (IDW) Management Plan for Site 11, Naval Submarine Base, Kings Bay, Georgia: prepared for SOUTHNAVFACENGCOM, Contract No. N62467-89-D0317, September.

C.C. Johnson & Associates, Inc., 1985, Initial Assessment Study, Naval Energy and Environmental Support Activity, Naval Submarine Base, Kings Bay, Georgia: Contract No. N62474-84-C-3384, September.

Gilbert, R.O., 1987, Statistical Methods for Environmental Monitoring: Van Nostrand Reinhold, New York.

Krause, R.E., and Randolph, R.B., 1989, Hydrogeology of the Floridan Aquifer System in Southeast Georgia and adjacent parts of Florida and South Carolina: U.S. Geological Survey (USGS) Professional Paper 1403-D, 65 p.

National Oceanic and Atmospheric Administration (NOAA), 1990, The Potential for Biological Effects of Sediment Sorbed Contaminants Tested in the National Status and Trends Program: NOAA Technical Memorandum NOS OMA 52, Seattle, Washington, March 1990.

Onyx/Landers-Atkins Planning Group, 1985, Master Plan, NSB Kings Bay.

Soil Conservation Service, 1980, Soil Conservation Survey of Camden and Glynn Counties, Georgia: U.S. Department of Agriculture, November.

Thibodeaux, L.J., 1979, Chemodynamics: Environmental Movement of Chemicals in Air, Water, and Soil: John Wiley and Sons, New York.

U.S. Environmental Protection Agency (USEPA), 1986, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods: SW-846, 3rd Edition.

USEPA, 1988a, RCRA Corrective Action Plan (Interim Final): Office of Solid Waste, Office of Waste Programs Enforcement, EPA/530-SW-88-028, June.

USEPA, 1988b, Laboratory Data Validation: Functional Guidelines for Evaluating Inorganics Analyses: July.

USEPA, 1989a, RCRA Facility Investigation (RFI) Guidance: Waste Management Division, Office of Soil Waste, USEPA 530/SW-89-031, Washington, D.C., May.

USEPA, 1989b, Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A) Interim Final: Office of Emergency And Remedial Response, EPA/540/1-89/002.

USEPA, 1990a, Contract Laboratory Program, Statement of Work for Organics Analysis: USEPA Document No. ILM01.9, revised June 1991.

USEPA, 1990b, Contract Laboratory Program, Statement of Work for Inorganics Analysis: USEPA Document No. ILM02.1, revised June 1991.

USEPA, 1990c, National Functional Guidelines for Organic Data Review: December 1990, revised June 1991.

USEPA, 1991, Supplemental Region IV Risk Assessment Guidance: Washington D.C. March 26.

USEPA, 1992, Title 40 Code of Federal Regulations, Part 264, Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, Office of Federal Register, National Archives and Records Administration, July.

APPENDIX A

PREINVESTIGATION EVALUATION OF CORRECTIVE MEASURES TECHNOLOGIES

PREINVESTIGATION EVALUATION OF

CORRECTIVE MEASURES TECHNOLOGIES FOR SITE 11

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

CONTRACT TASK ORDER NO. 094

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION, NAVY (CLEAN)
DISTRICT 1

CONTRACT NO. N62467-89-D-0317

Prepared by:

ABB Environmental Services, Inc.
2590 Executive Center Circle, East
Tallahassee, Florida 32301

Prepared for:

Department of the Navy, Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive
North Charleston, South Carolina 29418

AUGUST 1994

TABLE OF CONTENTS

Preinvestigation Evaluation of
Corrective Measures Technologies for Site 11
Naval Submarine Base
Kings Bay, Georgia

LIST OF FIGURES

Preinvestigation Evaluation of
Corrective Measures Technologies for Site 11
Naval Submarine Base
Kings Bay, Georgia

LIST OF TABLES

Preinvestigation Evaluation of
Corrective Measures Technologies for Site 11
Naval Submarine Base
Kings Bay, Georgia

GLOSSARY OF ACRONYMS

ACL	Alternative Concentration Limit
APC	air pollution control
AWQC	Ambient Water Quality Criteria
BOD	biological oxygen demand
Ca	calcium
CFR	Code of Federal Regulations
CMS	Corrective Measures Study
COD	chemical oxygen demand
°C	degrees celsius
°F	degrees fahrenheit
DO	dissolved oxygen
Fe	iron
HEA	Health and Environmental Assessment
IM	Interim Measure
K	potassium
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
Mg	magnesium
mg/ℓ	milligram per liter
NSB	Naval Submarine Base
PCB	polychlorinated biphenyl
PIW	private irrigation wells
PO_4	phosphates
POTW	Publicly Owned Treatment Works
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SDWA	Safe Drinking Water Act
SVOC	semi-volatile organic compounds
TDS	total dissolved solids
TOC	total organic carbon
TSS	total suspended solids
TWA	Time Weighted Average
μg/ℓ	microgram per liter
$\mu g/m^3$	microgram per cubic meter
USEPA	U.S. Environmental Protection Agency
UV	ultraviolet
VOC	volatile organic compounds

1.0 INTRODUCTION

The purpose of the Preinvestigation Evaluation of Corrective Measure Technologies is to identify potential corrective measures technologies that may be used onsite or offsite for the containment, treatment, remediation, and/or disposal of contaminated media. As a result of this screening process, the data needed to evaluate the potential corrective measures technologies for remediating the contaminated groundwater at the Old Camden County Landfill will be identified. This process enables the RCRA (Resource Conservation Recovery Act) Facility Investigation (RFI) field sampling crew to collect the data necessary to evaluate potential technologies. This approach makes the field sampling program more cost-effective and efficient.

Several steps are necessary to develop an initial list of technologies to be considered. Existing data must be evaluated and a conceptual understanding of the site developed. All known or suspected sources of contamination, types of contaminants and affected media, routes of migration, and human and environmental receptors should be identified (Section 2.0 of this Appendix). An initial identification of regulatory requirements is necessary to establish analytical procedures and detection limits required for data collection and ascertain special site characteristics which need to be identified. (Section 3.0 of this Appendix). A preliminary list of corrective action objectives, site-specific quantitative goals that define the extent of clean-up required, is then developed (Section 4.0 of this Appendix). Following these initial steps, selected technologies are evaluated for potential application at the Old Camden County Landfill (Section 5.0 of this Appendix). An evaluation of data gaps that need to be addressed in the Supplemental RFI will also be provided (Section 6.0 of this Appendix).

2.0 DESCRIPTION OF THE CURRENT SITUATION

A detailed discussion of the site, including the regional location, pertinent boundary features, general physiography, hydrogeology, historical uses of the landfill, and nature and extent of contamination is presented in Section 2.0 of the Supplemental RFI Work Plan. Only pertinent information to the development of the corrective measures objectives is repeated in this section.

The Old Camden County Landfill is situated along the northwest boundary of the Naval Submarine Base (NSB) (Figure 2-2 of the Supplemental RFI Work Plan) and was operated by Camden County from 1974 to 1981. On the average, approximately 12 truckloads per day of general solid wastes were disposed of at the landfill (ABB-ES, 1993a). Burning of wastes was allowed during the first year of operation and was prohibited in 1975. The landfill was a trench-and-fill operation with trenches oriented in a southeast to northwest direction. The wastes (and ash) were compacted and covered daily with at least 6 inches of clean fill. The landfill ceased operations in October 1981 and was covered with 2 feet of fill.

Approximately 500,000 cubic yards of waste were disposed of at the landfill between 1974 and 1981. The wastes reportedly consisted of general household waste, office waste, scrap paper and wood, and waste sludge and grit from the NSB sewage treatment plant. Approval from the Camden County Health Department for the disposal of fire-fighting residues from burnt oils and gasoline was granted in December 1981 (ABB-ES, 1993a).

Currently, the landfill ranges from approximately 140 feet wide at the southern end to approximately 780 feet wide at the northern end and is approximately 1,400 feet at its maximum length. Based on magnetic and Ground Penetrating Radar surveys performed during previous investigations, the trenches range in length from 575 to 775 feet and 35 to 50 feet in width. The waste is approximately 12 feet deep and the water table is approximately 6 feet below ground surface. The surface of the landfill is flat and slightly undulating and is vegetated with grasses, weeds, and pine saplings (ABB-ES, 1993a).

2.1 WASTE CHARACTERISTICS. Knowledge of the chemical characteristics of the waste are based on the results of the investigations completed to date. A summary of the investigations carried out to date is presented in Table 2-1. Chlorinated and non-chlorinated solvents and fuel-related volatile organic compounds (VOCs) have been identified as constituents of the waste at the landfill. Little semi-volatile organic compound (SVOC), pesticide, or polychlorinated biphenyl (PCB) data is available. Chemical data and field observations indicate that contaminants are present as solute (dissolved) in groundwater. Concentrations of contaminants in the groundwater plume are generally less than 1 milligram per liter (mg/ℓ), except for vinyl chloride and cis-1,2-dichloroethene, which have been detected at concentrations that exceed 1 mg/ℓ. Contaminants detected in the plume are listed in Table 2-2 along with their physical and chemical properties.

Results of the investigations indicate VOC contaminants have migrated off NSB property and are present in groundwater beneath a residential area, extending approximately 740 feet from the NSB property line (Figure 2-1). VOC contaminants are present in groundwater at depths approximately 60 feet below ground surface.

Table 2-1
Investigation Chronology and Source Documents

Preinvestigation Evaluation of
Corrective Measures Technologies for Site 11
Naval Submarine Base, Kings Bay, Georgia

Investigation	Dates Conducted	Activities	Source Document
RFI Field Program	Jan/Feb 1992	Soil Borings Geophysical Surveys Subsurface Soil Sampling Monitoring Well Installation Slug Tests Groundwater Sampling Event No. 1	Technical Memorandum No. 1[1] Potential Source of Contamination Investigation/Site Investigation Solid Waste Management Unit RCRA Facility Investigation Work Plan[2]
RFI Field Program	May 1992	Groundwater Sampling Event No. 2	Technical Memorandum No. 2[3]
RFI Field Program	July 1992	Groundwater Sampling No. 3	Technical Memorandum No. 3[4]
Phase I Interim Investigation	August 1992	Piezocone Penetrations Groundwater Sampling	Phase I Interim Investigation Memorandum[5]
RFI Field Program	Sept 1992	Groundwater Sampling Event No. 4	Technical Memorandum No. 4[6]
Interim Corrective Measure Screening Investigation	Oct/Nov 1992	Records Search Piezocone Penetrations Air Screening Survey Groundwater Sampling Soil Vapor Sampling Sediment Sampling Surface Water Sampling Private Irrigation Well Sampling Screening Risk Evaluation	Interim Corrective Measure Screening Investigation Report[7] Technical Work Plan Interim Corrective Measure Screening Investigation[8]
RFI Field Program	Nov 1992	Groundwater Sampling Event No. 5	Technical Memorandum No. 5[9]
RFI Field Program	Jan 1993	Groundwater Sampling Event No. 6	RFI Interim Report for Site 11[10]

[1] ABB-ES 1992a.
[2] ABB-ES 1991.
[3] ABB-ES 1992b.
[4] ABB-ES 1992c.
[5] ABB-ES 1992d.
[6] ABB-ES 1992e.
[7] ABB-ES 1993b.
[8] ABB-ES 1992f.
[9] ABB-ES 1993c.
[10] ABB-ES 1993a.

Note: RFI = RCRA Facility Investigation.

Table 2-2
Physical and Chemical Characteristics of VOCs and SVOCs Detected in Groundwater

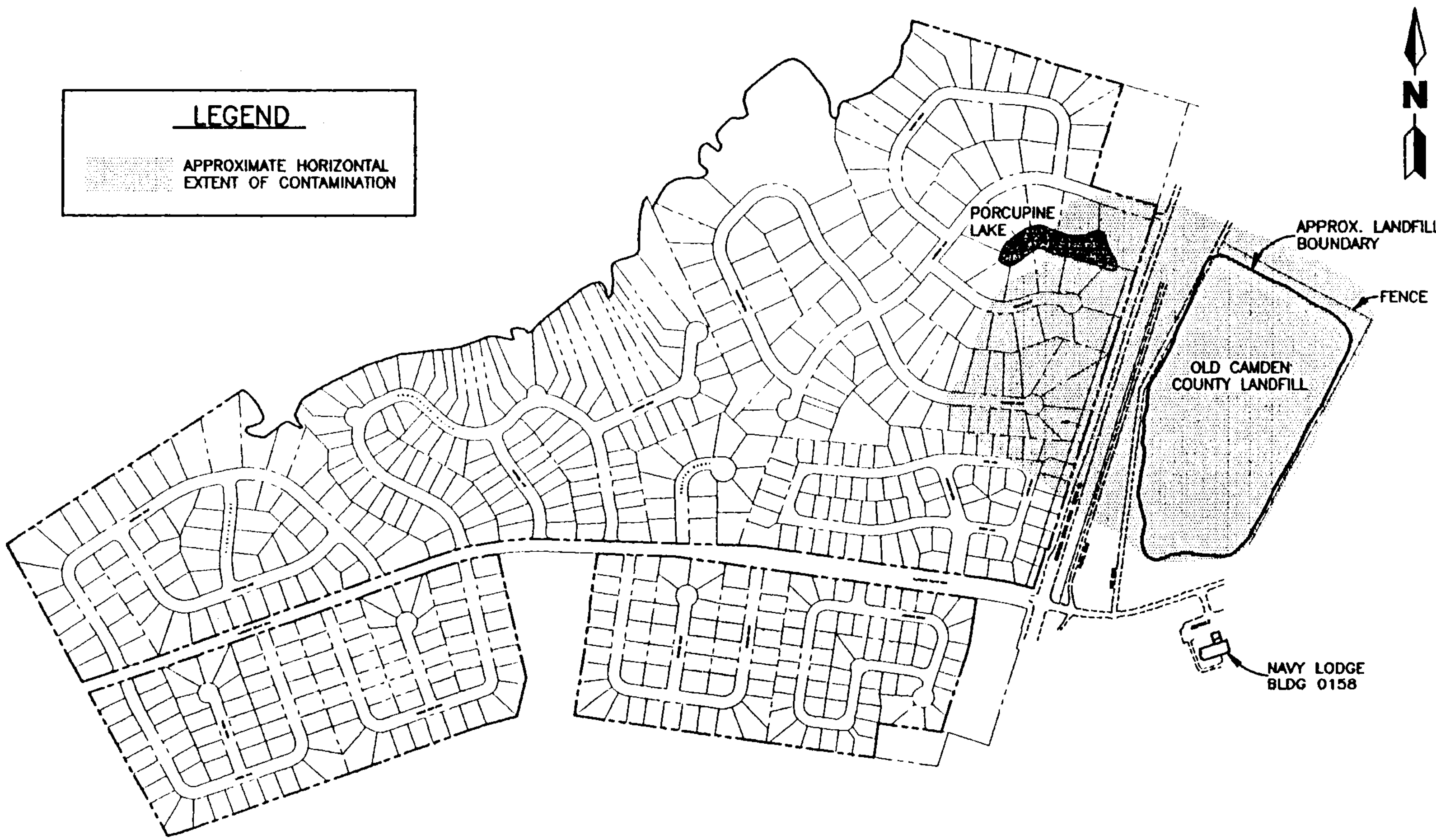
Preinvestigation Evaluation of
Corrective Measures Technologies for Site 11
Naval Submarine Base, Kings Bay, Georgia

Chemical	Physical Form	Chemical Class	Molecular Weight	Specific Density	Boiling Point (°F)	Solubility in[1] Water	Vapor Pressure	Flash Point (°F)
Acetone	Liquid	Solvent	58.1	0.7899 @ 20/4°C	133	Miscible	180 mm	0
Benzene	Liquid	Solvent	78.11	0.8765 @ 20/4°C	176	1,000 mg/ℓ	76 mm	12
2-Butanone (methol ethyl ketone)	Liquid	Solvent	72.1	0.8054 @ 20/4°C	175	25.5 % wt.	71 mm	16
Chlorobenzene	Liquid	Solvent	112.6	1.1058 @ 20/4°C	270	503 mg/ℓ	12 mm	85
Carbon disulfide	Liquid	Solvent	76.1	1.2632 @ 20/4°C	116	0.1185 % wt.	297 mm	-22
1,4-Dichlorobenzene	Liquid	Solvent	147.0	1.3048 @ 20/4°C	357	137 mg/ℓ	1 mm	151
1,1-Dichloroethane	Liquid	Solvent	99.0	1.1757 @ 20/4°C	135	5,060 mg/ℓ	230 mm	22
1,2-Dichloroethane	Liquid	Solvent	99.0	1.2351 @ 20/4°C	182	8,300 mg/ℓ	64 mm	63
cis-1,2-Dichloroethene	Liquid	Solvent	96.9	1.257 @ 20/4°C	140	NA	NA	36
Trans-1,2-dichloroethene	Liquid	Solvent	96.9	1.257 @ 20/4°C	118	6,300 mg/ℓ	265	36
1,2-Dichloropropane	Liquid	Solvent	113.0	1.560 @ 20/4°C	206	2,800 mg/ℓ	42 mm	60
Ethylbenzene	Liquid	Solvent	106.2	0.8670 @ 20/4°C	277	206 mg/ℓ	10 mm	55
2-Hexanone (methyl butyl ketone)	Liquid	Solvent	100.2	0.8113 @ 20/4°C	262	35,000 mg/ℓ	4 mm	77
4-Methyl-2-pentanone (methyl isobutyl ketone)	Liquid	Solvent	100.2	0.7978 @ 20/4°C	242	17,000 mg/ℓ	15 mm	64
Naphthalene	Solid	Base	128.2	1.162 @ 20/4°C	424	30 mg/ℓ	0.054	174
2,4-Dimethylphenol	Solid	Acid	122.2	0.965 @ 20/4°C	410	7,868 mg/ℓ	0.062 mm	7,230
2-Methylphenol	Solid/ Liquid	Acid	108.1	1.047 @ 20/4°C	376	25,000 mg/ℓ	0.24 mm	178
4-Methylphenol	Solid	Acid	108.1	1.018 @ 20/4°C	395	23,000 mg/ℓ	0.04 mm	187
Tetrachloroethylene	Liquid	Solvent	165.8	1.6227 @ 20/4°C	250	150 mg/ℓ	14 mm	NA
Toluene	Liquid	Solvent	92.1	0.8669 @ 20/4°C	232	524 mg/ℓ	22 mm	40
Trichloroethene	Liquid	Solvent	131.4	1.4642 @ 20/4°C	189	1,100 mg/ℓ	58 mm	90
Xylenes (total)	Liquid	Solvent	106.2	0.8802 @ 20/4°C	269-292	152 mg/ℓ	9 mm	64
Vinyl chloride	Gas	Solvent	62.5	0.9106 @ 20/4°C	7	1,100 mg/ℓ	>1 atm	N/A

[1] Solubility in fresh water at 25°C
[2] Vapor pressure at 20°C to 25°C

Notes: atm = atmosphere.
°C = degrees celsius.
°F = degrees fahrenheit.
mg/ℓ = milligrams per liter.
mm = millimeter.
NA = not available.
VOC = volatile organic compound
SVOC = semivolatile organic compound.
wt. = weight.

Sources: Montgomery, 1991; Montgomery and Welkon, 1989; and NIOSH, 1990.



0 400 800
SCALE: 1" = 800'

FIGURE 2-1

APPROXIMATE HORIZONTAL EXTENT OF VOC CONTAMINATION

PREINVESTIGATION EVALUATION OF CORRECTIVE MEASURES TECHNOLOGIES

NAVAL SUBMARINE BASE KINGS BAY, GEORGIA

D:\DWG\ABB\8503-07\PREINV\FIG_2-1\DWF\940623

Detailed information concerning the aquifer configuration/stratigraphy is presented in Section 2.4 of the Supplemental RFI Work Plan.

<u>2.2 POTENTIAL RECEPTORS</u>. The area of the base near the site is used for recreational purposes (e.g., jogging, bicycle riding, and walking) and hunting. Housing for base employees, a day care center, and Navy Lodge are also present in this area. Access to the site is limited to the extent that entry to the base is restricted. There are no controls to restrict access to the site within the base.

The Crooked River Plantation Subdivision is a residential development of 630 homes located off base and west of the landfill (Figure 2-1). The subdivision was built on 260 acres west of the landfill. A marsh fronts the north and west perimeter of the subdivision. More than 90 homes in the subdivision have private irrigation wells (PIWs) that draw groundwater from the surficial aquifer, but not for use as drinking water. The groundwater from the PIWs is used for a variety of non-potable purposes including: irrigation, washing cars and yard items, filling swimming pools and children's wading pools, and as drinking water for pets (ABB-ES, 1993b). A conceptual model (Figure 2-2) has been developed indicating suspected types of contaminants and affected media, routes of migration, and human and environmental receptors. Only current routes of exposure have been identified in this model. Potential future uses of the groundwater (i.e., as drinking water) have not been included in the conceptual model.

The public water supply for NSB Kings Bay and surrounding towns and urban areas comes from the Floridan aquifer system. The approximate location of public water supply wells within the Harriett's Bluff topographic quadrangle are shown in Figure 2-3. NSB Kings Bay obtains its potable water from three groundwater wells within its property boundaries. Relative to the landfill, these three wells are approximately 1 mile to the south, 2 miles to the east, and 3.2 miles to the east-southeast. These wells are approximately 900 feet deep and 18 inches in diameter. The Floridan aquifer is interpreted to be separated from the surficial aquifer containing the contamination by an aquitard beginning approximately 90 feet below ground surface and ranging from 380 to 530 feet thick.

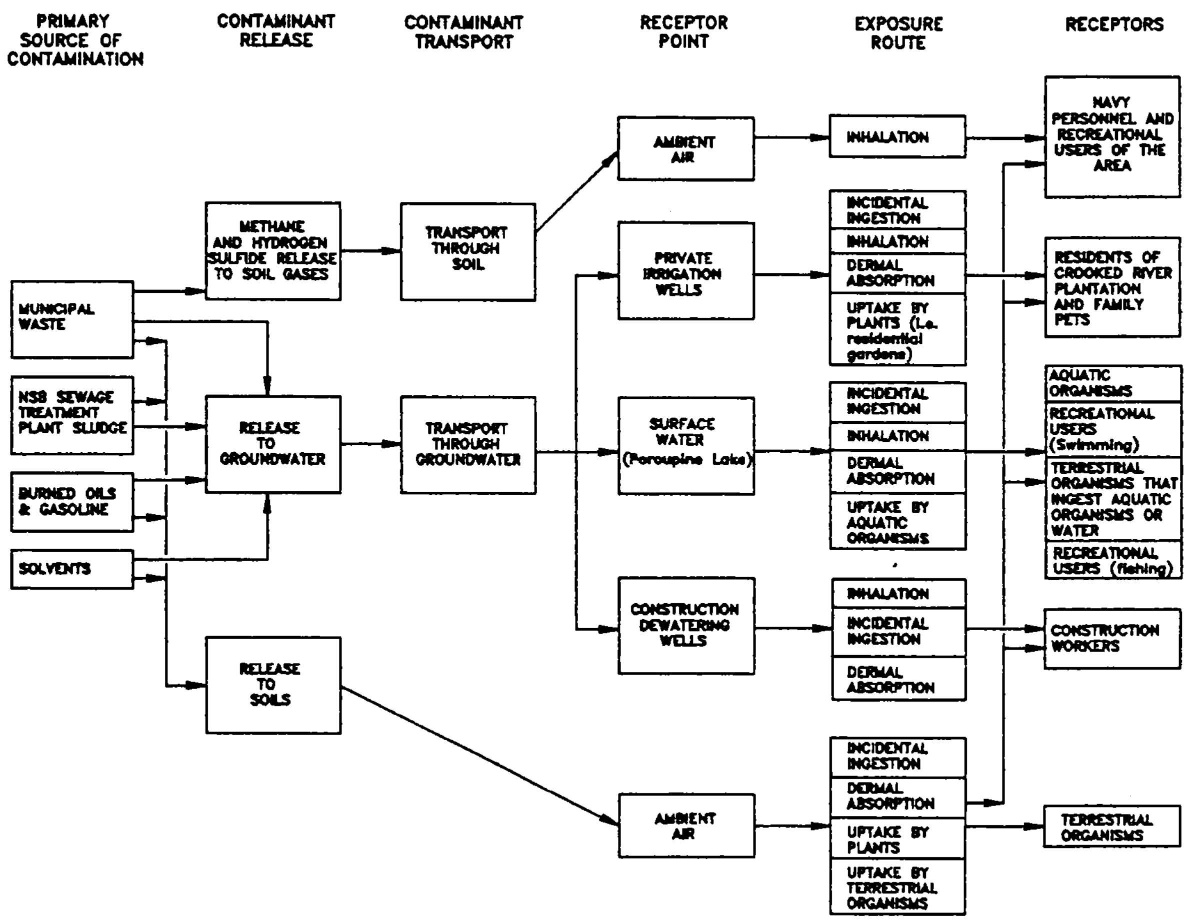


FIGURE 2-2

CONCEPTUAL SITE MODEL
CURRENT EXPOSURE

PREINVESTIGATION EVALUATION OF CORRECTIVE MEASURES TECHNOLOGIES

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

D:\DWG\ABB\8503-07\PREINV\FIG_2-2\DMF\940621

KB_STE11.WP
MVL.08.94

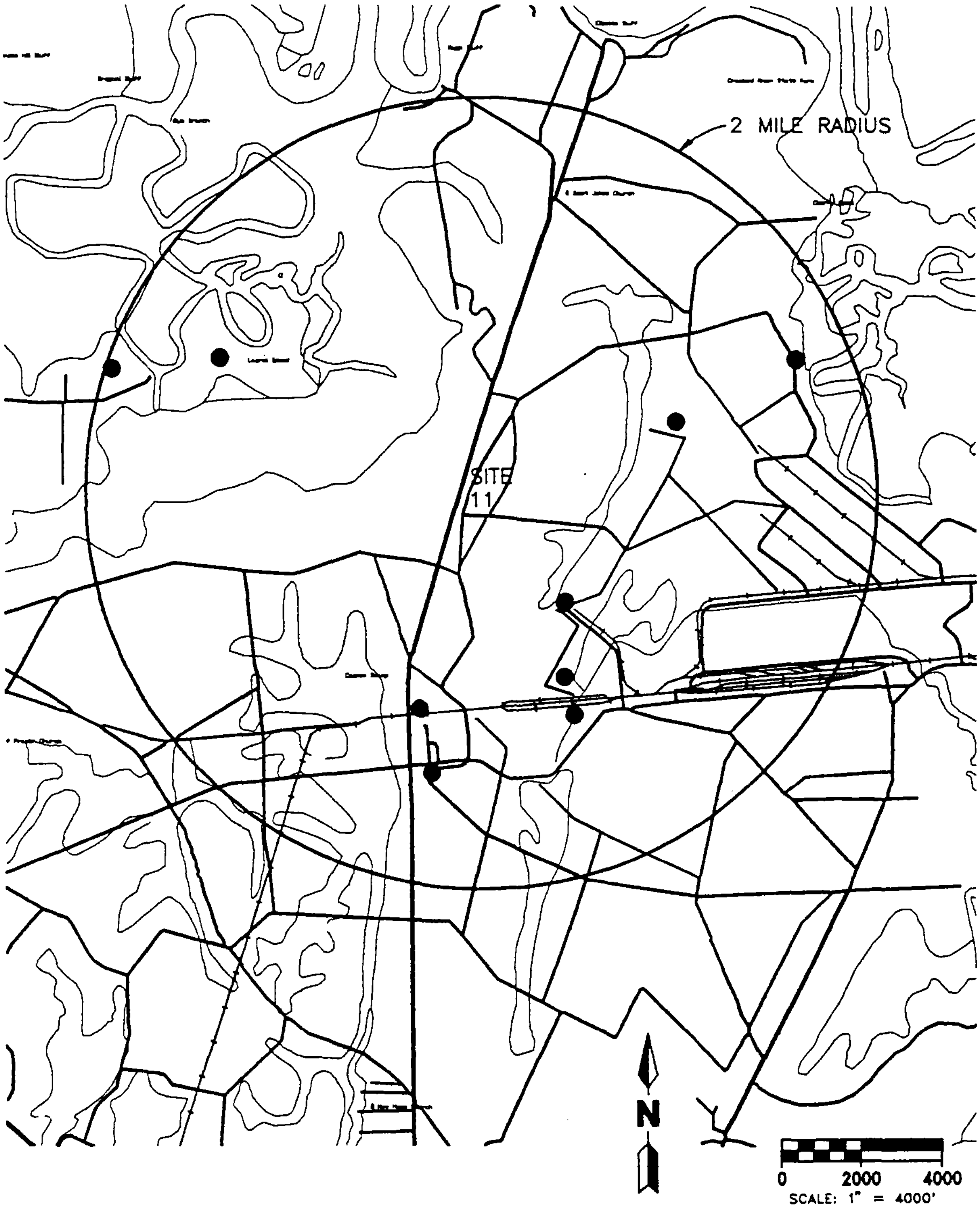


FIGURE 2-3

APPROXIMATE LOCATIONS OF
PUBLIC SUPPLY WELLS

PRIENVESTIGATION EVALUATION
OF CORRECTIVE MEASURES
TECHNOLOGIES

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

D:\DWG\ABB\8503-07\PREINV\FIG_2-3\DMF\940622

3.0 REGULATORY REQUIREMENTS

The regulatory setting under which NSB Kings Bay is operating is discussed in Section 1.1 of the Supplemental RFI Work Plan. The facility is currently under an RCRA permit and is required to follow RCRA regulations. Under RCRA, cleanup levels are established by the regulators based on their assessment of actions necessary to protect human health and the environment.

Regulator-determined cleanup levels must be attained for hazardous substances remaining on site at the completion of the corrective action. Corrective action implementation should also comply with regulatory requirements to protect public health and the environment. Generally, regulatory requirements pertain to either contaminant levels or to performance or design standards to ensure protection at all points of potential exposure. Regulatory requirements are divided into three general categories: chemical-specific, location-specific, and action-specific. These are presented in Table 3-1.

3.1 CHEMICAL-SPECIFIC REGULATORY REQUIREMENTS. Chemical-specific requirements establish the corrective action objectives because they set health- or risk-based concentration limits or discharge limitations in various environmental media for specific hazardous substances, pollutants, and contaminants. They govern the extent of site remediation by providing either actual clean-up levels or a basis for calculating such levels. If a chemical has more than one regulatory requirement, the most stringent generally should be attained. If no regulatory requirement exists, or if the regulation for a substance is considered not to be sufficiently protective, the Federal or State non-regulatory requirements such as criteria, advisories, and guidance could be used in conjunction with a risk assessment to develop the appropriate clean-up level.

Chemical-specific regulatory requirements for NSB Kings Bay, identified in Table 3-1, are described below. The State of Georgia does not classify groundwater aquifers. Therefore, assuming all groundwater may be a potential drinking water supply, the Safe Drinking Water Act (SDWA) Maximum Contaminant Levels (MCLs), and Maximum Contaminant Level Goals (MCLGs), which are applicable to public water systems, are appropriate clean-up levels for potential drinking water supplies. MCLs are legally enforceable Federal drinking water standards, based on advisories and health effects of a contaminant, and reflect the technical and economic feasibility of removing the contaminants from water supplies. SDWA MCLGs are non-enforceable health goals established by the U.S. Environmental Protection Agency (USEPA) and set at levels that would result in no known or anticipated adverse health effects with an adequate margin of safety.
RCRA concentration limits (40 Code of Federal Regulations (CFR) 264.94) are applicable to active RCRA facilities and establish three categories of groundwater protection standards: background concentrations, MCLs, and Alternative Concentration Limits (ACLs). RCRA MCLs are numerically the same as SDWA MCLs; therefore, by complying with SDWA MCLs, cleanup will be consistent with RCRA MCLs. If no MCL exists, a background level or health-based (assuming human and ecological exposure) ACL may be developed on a case-by-case basis as a groundwater protection standard. ACLs are developed in accordance with 40 CFR 264.94 and are based on the concentration at which the contaminant will adversely

Table 3-1
Preliminary Site-Specific Regulatory Requirements

Preinvestigation Evaluation of
Corrective Measures Technologies for Site 11
Naval Submarine Base, Kings Bay, Georgia

Requirement	Requirement Synopsis	Consideration in the CMS
CHEMICAL-SPECIFIC REQUIREMENTS		
GROUNDWATER AND SURFACE WATER		
Federal Safe Drinking Water Act (SDWA) - Maximum Contaminant Levels (MCLs) (40 Code of Federal Regulations (CFR) 141.11 - 141.16)	MCLs have been promulgated for a number of common organic and inorganic contaminants. These are legally enforceable levels that regulate the concentration of contaminants in public drinking water supplies, but may also be considered relevant and appropriate for groundwater aquifers used for drinking water or potential sources of drinking water.	To assess the potential risks to human health due to consumption of groundwater, contaminant concentrations will be compared to their MCLs.
SDWA - Maximum Contaminant Level Goals (MCLGs) (40 CFR 141.50 - 141.51)	MCLGs are health-based criteria for a number of organic and inorganic contaminants in drinking water sources. MCLGs are used in cases in which multiple contaminants or pathways of exposure present extraordinary risks to human health.	The 1990 National Contingency Plan states that non-zero MCLGs are to be used as goals. Contaminant concentrations in groundwater will be compared to their MCLGs.
Federal Ambient Water Quality Criteria (AWQC)	Federal AWQC include (1) health-based criteria for 95 carcinogenic and noncarcinogenic compounds and (2) water quality parameters. AWQC established for the protection of human health are set at levels considered safe for consumption of drinking water as well as consumption of fish. Remedial actions involving contaminated surface water or groundwater must consider the uses of the water and the circumstances of the release or threatened release. These factors determine whether AWQC are relevant and appropriate.	This requirement is generally used for evaluating impacts to surface water bodies.
Resource Conservation and Recovery Act (RCRA) Subpart F - Groundwater Protection Standards (40 CFR 254.94)	Subpart F outlines three possible standards for setting cleanup levels for remediation of groundwater contamination attributable to an RCRA facility. These standards include: (1) MCLs, (2) background concentrations, and (3) Alternative Concentration Limits.	Contaminants will be compared to MCLs and background concentrations of inorganics and pesticides will be established for comparison. Alternative concentration limits may be considered.
Federal Guidance and Criteria To Be Considered SDWA - Secondary Maximum Contaminant Levels (SMCLs) (40 CFR 143)	Unenforceable standards that apply to public water systems and specify the maximum contaminant levels of contaminants that may adversely affect the odor or appearance of drinking water.	SMCLs are generally considered relative to discharge of treated water to surface water sources that are potential drinking water sources.
USEPA Risk Reference Doses (RfDs)	RfDs are dose levels developed by the USEPA for noncarcinogenic effects for lifetime exposure. Humans may be exposed to these levels without an appreciable risk of deleterious effects during a lifetime.	USEPA RfDs are used to characterize risks due to noncarcinogens in various media.

See notes at end of table.

Table 3-1 (Continued)
Preliminary Site-Specific Regulatory Requirements

Preinvestigation Evaluation of
Corrective Measures Technologies for Site 11
Naval Submarine Base, Kings Bay, Georgia

Requirement	Requirement Synopsis	Consideration in the CMS
CHEMICAL-SPECIFIC REQUIREMENTS		
GROUNDWATER AND SURFACE WATER		
Federal Safe Drinking Water Act (SDWA) - Maximum Contaminant Levels (MCLs) (40 Code of Federal Regulations (CFR) 141.11 - 141.16)	MCLs have been promulgated for a number of common organic and inorganic contaminants. These are legally enforceable levels that regulate the concentration of contaminants in public drinking water supplies, but may also be considered relevant and appropriate for groundwater aquifers used for drinking water or potential sources of drinking water.	To assess the potential risks to human health due to consumption of groundwater, contaminant concentrations will be compared to their MCLs.
SDWA - Maximum Contaminant Level Goals (MCLGs) (40 CFR 141.50 - 141.51)	MCLGs are health-based criteria for a number of organic and inorganic contaminants in drinking water sources. MCLGs are used in cases in which multiple contaminants or pathways of exposure present extraordinary risks to human health.	The 1990 National Contingency Plan states that non-zero MCLGs are to be used as goals. Contaminant concentrations in groundwater will be compared to their MCLGs.
Federal Ambient Water Quality Criteria (AWQC)	Federal AWQC include (1) health-based criteria for 95 carcinogenic and noncarcinogenic compounds and (2) water quality parameters. AWQC established for the protection of human health are set at levels considered safe for consumption of drinking water as well as consumption of fish. Remedial actions involving contaminated surface water or groundwater must consider the uses of the water and the circumstances of the release or threatened release. These factors determine whether AWQC are relevant and appropriate.	This requirement is generally used for evaluating impacts to surface water bodies.
Resource Conservation and Recovery Act (RCRA) Subpart F - Groundwater Protection Standards (40 CFR 254.94)	Subpart F outlines three possible standards for setting cleanup levels for remediation of groundwater contamination attributable to an RCRA facility. These standards include: (1) MCLs, (2) background concentrations, and (3) Alternative Concentration Limits.	Contaminants will be compared to MCLs and background concentrations of inorganics and pesticides will be established for comparison. Alternative concentration limits may be considered.
Federal Guidance and Criteria To Be Considered SDWA - Secondary Maximum Contaminant Levels (SMCLs) (40 CFR 143)	Unenforceable standards that apply to public water systems and specify the maximum contaminant levels of contaminants that may adversely affect the odor or appearance of drinking water.	SMCLs are generally considered relative to discharge of treated water to surface water sources that are potential drinking water sources.
USEPA Risk Reference Doses (RfDs)	RfDs are dose levels developed by the USEPA for noncarcinogenic effects for lifetime exposure. Humans may be exposed to these levels without an appreciable risk of deleterious effects during a lifetime.	USEPA RfDs are used to characterize risks due to noncarcinogens in various media.

See notes at end of table.

Table 3-1 (Continued)
Preliminary Site-Specific Regulatory Requirements

Preinvestigation Evaluation of
Corrective Measures Technologies for Site 11
Naval Submarine Base, Kings Bay, Georgia

Requirement	Requirement Synopsis	Consideration in the CMS
USEPA Regulation National Emission Standards for Hazardous Air Pollutants (NESHAP) (40 CFR 61)	These regulations establish emission standards for various types of sources of emissions of air pollutants designated as hazardous or having serious health effects from ambient exposure to the substance.	Benzene and vinyl chloride have been designated hazardous air pollutants. Substances causing serious health effects include chlorinated benzenes, tetrachloroethene, and toluene.
Federal Guidance and Criteria To Be Considered American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs), Time Weighted Averages (TWAs), and Short Term Exposure Limits (STELs)	TLV-TWAs and TLV-STELs are issued as consensus standards for controlling air quality in workplace environments.	These values would be used to establish limits of exposure for workers, to be used during remediation activities.
State Guidance and Criteria To Be Considered Guidelines for Ambient Impact Assessment of Toxic Air Pollutant Emissions (Georgia DNR, July 1984)	These guidelines are used in the review of all air quality applications for construction and operating permits for sources of toxic air pollutants. Acceptable ambient pollutant concentrations are discussed.	Emissions during remedial actions should not exceed these concentrations.
WASTE MATERIAL		
Federal RCRA - Identification and Listing of Hazardous Wastes (40 CFR 261)	Defines those wastes that are subject to regulations as hazardous wastes under 40 CFR Parts 264-265 and Parts 124, 270, and 271.	Analytical results will be evaluated against the criteria and definitions of hazardous waste. The criteria and definition of hazardous waste may be referred to and utilized in development of remedial alternatives and during any remedial actions.
State Georgia Hazardous Waste Management Rules - Identification and Listing of Hazardous Wastes (Georgia DNR)	These rules set forth Georgia's definitions and criteria for establishing whether waste materials are hazardous and subject to associated hazardous waste regulations.	These regulations supplement RCRA requirements. Those criteria and definitions more stringent than RCRA take precedence over Federal requirements.
LOCATION-SPECIFIC REQUIREMENTS		
Federal Endangered Species Act (16 U.S.C. 1531, 50 CFR parts 81, 225, 402)	Directs the states to establish programs for the protection of endangered or protected species in the states jurisdiction	In complying with Section 404, a natural resources inventory should be performed and the Georgia Department of Fish and Wildlife should be contacted if endangered species are encountered onsite.
Fish and Wildlife Coordination Act (16 U.S.C. 661) and FWS/NWF Advisories	Assist in the protection and development of all species of wildlife and their habitat.	Conduct surveys and investigations of the wildlife, including lands controlled by any U.S. agency.

See notes at end of table.

Table 3-1 (Continued)
Preliminary Site-Specific Regulatory Requirements

Preinvestigation Evaluation of
Corrective Measures Technologies for Site 11
Naval Submarine Base, Kings Bay, Georgia

Requirement	Requirement Synopsis	Consideration in the CMS
Federal		
USEPA Regulations on Criteria for Classification of Solid Waste Disposal Facilities and Practices (40 CFR 257)	These criteria are for use under RCRA in determining which solid waste disposal facilities pose a reasonable probability of adverse effects on health or the environment.	These criteria are relevant and appropriate to those alternatives proposing land-based management of wastes. Criteria set forth in these regulations will be met through attainment of ARARs identified under the CWA, SDWA, CAA, and RCRA.
Addendum for the Final Criteria for Municipal Solid Waste Landfills (40 CFR Part 258: August 1991)	These requirements include revisions to the Criteria for Classification of Solid Waste Disposal Facilities and Practices set forth in 40 CFR Part 257. These revisions were developed in response to the 1984 Hazardous and Solid Waste Amendments to RCRA.	The revised minimum Federal criteria for municipal solid waste landfills, including groundwater monitoring requirements, corrective action requirements, and closure and post-closure requirements should be met in closing out Site 11.
RCRA - Subpart B - General Facility Standards (40 CFR 264.10 - 264.18)	These requirements outline general waste analysis, security measures, inspections, training requirements, and location standards for operators of hazardous waste treatment facilities.	Subpart B requirements will apply to the design and operation of any onsite treatment facilities.
RCRA - Subpart C - Preparedness and Prevention (40 CFR 264.30-264.37)	This regulation outlines requirements for safety equipment and spill-control requirements for hazardous waste facilities. Part of the regulation includes a requirement that facilities be designed, maintained, constructed, and operated to minimize the possibility of an unplanned release that could threaten human health or the environment.	Safety and communication equipment will be available at the site during implementation of the final remedy. Local authorities will be familiarized with site operations.
RCRA - Subpart D - Contingency Plan and Emergency Procedures (40 CFR 264.50-264.56)	This regulation outlines the requirements for a contingency plan and emergency procedures to be used following explosions, fires, etc.	A contingency plan for all remedial site work must be developed that describes: (1) actions to be taken during an emergency, (2) compliance with SPCC plans, and (3) agreements with and names, addresses, and telephone numbers of local emergency services. Copies of the plans will be kept onsite and filed with local emergency facilities.
RCRA - Subpart E - Manifest System, Record Keeping, and Reporting (40 CFR 264.70 - 264.77)	This regulation details the manifesting requirements of treatment facilities and outlines the requirements of the manifest system in 40 CFR Section 264.71.	All waste transported offsite must be accompanied by a manifest. Operating records, including a description and quantification of the treatment process, storage location, and monitoring and testing data should be kept onsite.

See notes at end of table.

Table 3-1 (Continued)
Preliminary Site-Specific Regulatory Requirements

Preinvestigation Evaluation of
Corrective Measures Technologies for Site 11
Naval Submarine Base, Kings Bay, Georgia

Requirement	Requirement Synopsis	Consideration in the CMS
RCRA - Releases from Solid Waste Management Units (40 CFR 264.90-264.109)	This regulation details groundwater monitoring requirements for hazardous waste treatment facilities. The regulation outlines general groundwater monitoring standards, as well as standards for detection monitoring, compliance monitoring, and corrective action monitoring.	Long-term groundwater monitoring is included in proposed corrective measures. The specific monitoring program needs to comply with requirements for when source materials are left in place.
RCRA - Closure and Post-closure (40 CFR 264.110-264.120)	This regulation details general requirements for closure and post-closure of hazardous waste facilities, including installation of a groundwater monitoring program.	Those parts of the regulation concerned with long-term monitoring and maintenance of the site will be considered during remedial design.
RCRA - Landfills (40 CFR 264.300-264.339)	This regulation details the design, operation, monitoring, inspection, recordkeeping, closure, and permit requirements for an RCRA landfill. Two liners must be installed to prevent groundwater contamination. A leachate collection system must be placed above and between the liner systems.	Minimum design and performance requirements for landfill capping will be incorporated into the capping alternative.
CWA - Pretreatment Standards for POTW Discharge (40 CFR Part 403)	This regulation specifies pretreatment standards for discharges to a POTW. If treated groundwater is discharged to a POTW, the POTW must have mechanisms available to meet the requirements of the National Pretreatment Program - Introduction of Pollutants which cause pass through or interference are prohibited. Discharges must also comply with any local POTW regulations. If hazardous waste is discharged to the POTW, the POTW may be subject to RCRA permit-by-rule.	If treated groundwater is discharged to a POTW, the discharge must meet all discharge limitations imposed by the POTW.
Occupational Safety and Health Administration (OSHA) - General Industry Standards (29 CFR Part 1910)	These regulations specify the 8-hour time-weighted average concentration for various organic compounds. Training requirements for workers at hazardous wastes operations are specified in 29 CFR 1910.120.	Proper respiratory equipment will be worn if it is impossible to maintain the work atmosphere below the concentration. Workers performing activities would be required to have completed specific training requirements.
OSHA - Safety and Health Standards (29 CFR Part 1926)	This regulation specifies the type of safety equipment and procedures to be followed during site remediation.	All appropriate safety equipment will be onsite. In addition, safety procedures will be followed during onsite activities.
OSHA - Recordkeeping, Reporting, and Related Regulations (29 CFR 1904)	This regulation outlines the recordkeeping and reporting requirements for an employer under OSHA.	These requirements apply to all site contractors and subcontractors, and must be followed during all site work.

See notes at end of table.

Table 3-1 (Continued)
Preliminary Site-Specific Regulatory Requirements

Preinvestigation Evaluation of
Corrective Measures Technologies for Site 11
Naval Submarine Base, Kings Bay, Georgia

Requirement	Requirement Synopsis	Consideration in the CMS
State		
Georgia Hazardous Waste Management Act (Code of Georgia, Title 12, Chapter 8, Article 3)	Under this act, the State of Georgia instituted a comprehensive statewide program for regulating the generation, storage, treatment, and disposal of hazardous wastes as identified in Appendix VIII of 40 CFR 261.3. It further delegates the authority to administer this Act, and the rules associated with it, to the Director, Environmental Protection Division, Georgia DNR.	Specific requirements of this act are promulgated under Georgia Chapter 391-3-11. The act will be complied with through attainment of specific Georgia hazardous waste regulations.
Georgia Hazardous Waste Management Rules (Rules and Regulations of State of Georgia, Title 391, Article 3, Chapter 11)	These rules establish the policies, procedures, requirements, and standards necessary to implement the Georgia Hazardous Waste Management Act. Federal regulations 40 CFR 260-268, 124, and 270 are incorporated by reference.	The State of Georgia Division of Hazardous Waste must be notified of any activities associated with the transportation, storage, treatment, and disposal of hazardous wastes. Compliance with Federal ARARs will meet all other State requirements of this regulation.
Georgia Comprehensive Solid Waste Management Act (Code of Georgia, Title 12, Chapter 8, Article 2)	Through this act, the State of Georgia instituted a comprehensive statewide solid waste management program to regulate the location, design, and method of operation of solid waste handling and disposal facilities. This act also provides for the handling and disposal of special solid wastes although it requires that additional criteria be met at those facilities.	Specific requirements of this act are promulgated under Georgia Chapter 391-3-4. The Act will be complied with through attainment of specific Georgia solid waste regulations, if applicable.
Georgia Solid Waste Management Rules (Rules and Regulations of State of Georgia, Title 391, Article 3, Chapter 4)	These rules establish the requirements for handling and disposing of solid wastes and special wastes in the State of Georgia.	Closure and post-closure monitoring requirements are specified under this regulation.

Notes: ACGIH = American Conference of Governmental Industrial Hygienists.
AIC = acceptable intake - chronic.
AIS = acceptable intake - subchronic.
ARARs = applicable or relevant and appropriate requirements.
AWQC = ambient water quality criteria.
CAA = Clean Air Act.
CFR = Code of Federal Regulations.
CMS = Corrective Measures Study.
CSF = cancer slope factor.
CWA = Clean Water Act.
DNR = Department of Natural Resources.
FWS = Fish and Wildlife Service.
HEA = health effects assessments.
MCL = Maximum Contaminant Level.
MCLG = Maximum Contaminant Level Goal.
NESHAP = National Emissions Standards.
NWF = National Wildlife Federation.
OSHA = Occupational Safety and Health Administration.
POTW = Publicly Owned Treatment Works.
ppm = parts per million.
RCRA = Resource Conservation and Recovery Act.
RfDs = reference doses.
SDWA = Safe Drinking Water Act.
SMCL = Secondary Maximum Contaminant Level.
SPCC = spill prevention control and containment.
STEL = short-term exposure limit.
TBC = to be considered.
TLV = threshold limit value.
TWA = time weighted average.
$\mu g/m^3$ = micrograms per cubic meter.
USEPA = U.S. Environmental Protection Agency.
VOC = volatile organic compound.

affect groundwater quality and hydraulically connected surface water. The ACL takes into consideration factors such as physical and chemical characteristics of the waste, hydrogeological characteristics of the site, the quantity and direction of groundwater flow, current and future uses of groundwater, existing quality of the area groundwater, and the persistence and permanence of adverse effects. Additional factors are listed in 40 CFR 264.94.

The Georgia Hazardous Waste Management Rules are applicable when developing appropriate cleanup standards at an RCRA site. Georgia Hazardous Waste Management Rules are consistent with the regulatory requirements of 40 CFR Parts 260 through 270; therefore, RCRA groundwater protection standards are also applicable to Site 11 under Georgia regulations. In addition, Georgia Drinking Water Standards or MCLs (Georgia Department of Natural Resources, July 1992) are applicable when developing appropriate cleanup levels. Georgia groundwater quality standards, MCLs, MCLGs, Ambient Water Quality Criteria (AWQC), and background levels will all be assessed and used during the evaluation of the corrective measures at Site 11 to develop appropriate cleanup levels. If considered appropriate, ACLs will be developed in the absence of other criteria. A preliminary list of chemicals of potential concern and the associated chemical specific regulation is presented in Table 3-2.

Federal nonregulatory criteria to be considered when regulatory requirements are not available for specific contaminants, or that may be used in conjunction with the health evaluation, include USEPA Risk Reference Doses and USEPA Carcinogenic Assessment Group Cancer Slope Factors (USEPA, 1989).

3.2 LOCATION-SPECIFIC REGULATORY REQUIREMENTS. Location-specific regulations are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because of a site's particular characteristic or location. Site features governed by location-specific regulatory requirements may include natural features such as wetlands, floodplains, and sensitive ecosystems. These regulatory requirements provide a basis for assessing existing site conditions, which subsequently aid in assessing potential remedies. These features have currently not been identified at the landfill. Federal regulations that may be applied are summarized in Table 3-1.

3.3 ACTION-SPECIFIC REGULATORY REQUIREMENTS. Action-specific regulations are usually technology- or activity-based limitations controlling actions conducted at hazardous waste sites. These requirements are triggered by the activities associated with the components selected to develop proposed corrective measures. Action-specific requirements do not in themselves determine the corrective measure; rather, they indicate how a selected corrective measure must be achieved. As remedial alternatives are developed, action-specific regulatory requirements also provide a basis for assessing feasibility and effectiveness. During the Corrective Measures Study (CMS) detailed analysis of remedial alternatives, each alternative will be evaluated for compliance with these regulations. The following paragraphs summarize the important regulations governing actions at the site.

RCRA requirements in 40 CFR 261 through 268 will be considered for actions conducted at the landfill. These regulations apply to generating, handling, treating, storing, and disposing of hazardous materials. Wastes regulated under

Table 3-2
Chemical-Specific Regulatory Requirements

Preinvestigation Evaluation of
Corrective Measures Technologies for Site 11
Naval Submarine Base, Kings Bay, Georgia

Chemical (µg/ℓ)	Federal MCL (µg/ℓ)	MCLG (µg/ℓ)	Federal AWQC (µg/ℓ)	Georgia Drinking[1] Water Standards (µg/ℓ)	Georgia Surface[2] Water Criteria (µg/ℓ)
Acetone	----	----	----	----	----
Ethylbenzene	700	700	1,400	700	28,718
Chlorobenzene	100	100	488	100	20
1,1-Dichloroethane	----	----	----	----	----
trans-1,2-Dichloroethene	100	100	----	100	136,319
Methylene Chloride	5	0	----	----	1,578
2-Butanone	----	----	----	----	----
Tetrachloroethene	5	0	0.8	5	8.85
Carbon Disulfide	----	----	----	----	----
Trichloroethene	5	0	2.7	5	81
Vinyl Chloride	2	0	2.0	2	525
Toluene	1,000	1,000	14,300	1,000	301,941
Bromomethane	----	----	----	----	470.8
1,1-Dichloroethene	7	7	0.033	7	3.2
cis-1,2-Dichloroethene	70	70	----	70	----
Benzene	5	0	0.66	5	71.28
1,2-Dichlorobenzene	600	600	----	600	2,600
1,4-Dichlorobenzene	75	75	----	75	2,600
Dichlorodifluoromethane	----	----	----	----	----
m/p-Xylene	*	*	----	----	----
o-Xylene	*	*	----	----	----
Xylenes (Total)	10,000	10,000	----	10,000	----
1,2-Dichloroethane	5	0	----	----	----
1,2-Dichloropropane	5	0	----	----	----
2-Hexanone	----	----	----	----	----
4-Methyl-2-pentanone	----	----	----	----	----

[1] Georgia Drinking Water Standards, Rules for Safe Drinking Water, Chapter 391-3-5, Revised July 1992, Rules of Georgia Department of Natural Resources Environmental Protection Division.
[2] Georgia Surface Water Criteria, Georgia Water Quality Control Specifications and Standards, The Bureau of National Affairs, Inc., August 1991.

Notes: * = see xylenes (total).
---- = none reported.
MCL = Maximum Contaminant Level, USEPA Office of Water, December 1992; The Bureau of National Affairs, Inc., July 1992.
MCLG = Maximum Contaminant Level Goal, USEPA Office of Water, April 1992; The Bureau of National Affairs, July 1992.
Federal AWQC = Federal Ambient Water Quality Criteria.
Federal AWQC = Water Quality Criteria Summary Concentrations, Published Criteria (Water and Organisms) USEPA Office of Science and Technology Health and Ecological Criteria Division, May 1991.
µg/ℓ = micrograms per liter.

RCRA are classified as either listed or characteristic wastes. Listed wastes are those wastes generated by a specific process. Characteristic wastes are those that exhibit the characteristics of toxicity, reactivity, corrosivity, or ignitability. Alternatives that involve onsite disposal of non-hazardous waste must comply with USEPA Criteria for Classification of Solid Waste Disposal Facilities and Practices (40 CFR Part 257) and the Addendum for the Final Criteria for Municipal Solid Waste Landfills (40 CFR Part 258). Occupational Safety and Health Administration regulations (29 CFR Parts 1926, 1910, and 1904) govern site worker health and safety. All phases of the corrective measures program at NSB Kings Bay must be executed in compliance with these regulations.

The Georgia Hazardous Waste Management Rules cover the requirements associated with: notification of hazardous waste activities; proof of adequate financial responsibility; identification and listing of hazardous wastes; standards applicable to generators of hazardous wastes, transporters of hazardous waste, and treatment, storage or disposal of hazardous wastes; and permitting hazardous waste facilities. The State of Georgia Division of Hazardous Waste is responsible for administering these rules. In addition, the Georgia Solid Waste Management Rules will also be considered during the site remediation. These rules include defining the closure and post-closure requirements associated with solid waste disposal sites and further require the implementation of a state-approved groundwater monitoring system at all sanitary landfills.

4.0 CORRECTIVE ACTION OBJECTIVES

This section presents the basis for selecting appropriate corrective action technologies and developing and analyzing potential corrective action alternatives. The corrective action objectives are based on the exceedance of MCLs by the contaminants detected in groundwater at and in the vicinity of the site. General response actions that form the basis for developing and analyzing potential corrective action technologies and alternatives are also presented in this subsection.

Generally, corrective action objectives are developed based on site-specific conditions identified during the investigation and human health and environmental assessment (HEA) activities. Regulations that establish clean-up standards are also used to determine corrective action objectives (Section 3.0). The investigation is incomplete (soil characterization, waste characterization, and the characterization of chemicals in groundwater other than VOCs is not complete) and no HEA has been performed at Site 11. Therefore, the data collected during previous investigations will be used to develop preliminary corrective action objectives for use in the preinvestigation screening of corrective measure technologies. The objectives are statements of goals for the remediation of chemicals of concern in each medium at the site.

The site media of potential concern identified for this screening evaluation are soil/waste in the landfill, landfill gases (e.g., methane) and groundwater. Table 4-1 presents the basis for corrective action, the corrective action objectives for the site media of concern, and the general response actions.

General response actions describe potential medium-specific measures that may be employed to address corrective action objectives. These corrective measures include treatment, containment, excavation, extraction, disposal, institutional actions, or a combination of these options. General response actions lay the groundwork for identifying specific technologies presented in Section 5.0.

Table 4-1
Basis for Site Corrective Action

Preinvestigation Evaluation of
Corrective Measures Technologies for Site 11
Naval Submarine Base, Kings Bay, Georgia

Basis for Corrective Action	Preliminary Corrective Action Objectives	General Response Actions
SOIL/WASTES IN UNSATURATED ZONE		
The Interim RFI states that VOCs have leached into the groundwater degrading groundwater quality. The contaminants have migrated offsite and the contaminated plume is beneath a residential area.	Prevent or mitigate the release of VOCs into the aquifer beneath the Landfill.	No Action/Institutional Actions: No Action Deed Restrictions Containment Actions: Capping *In Situ* Treatment Actions: Removal Actions: Excavate, treat on- or offsite, and/or Disposal
GROUNDWATER		
Contaminated groundwater has migrated offsite and is currently being used by the residents of Crooked River Plantation for watering their lawns, washing cars, and filling swimming pools, resulting in potential exposure to migrating contaminants.	Reduce the concentrations of principal chemicals such as vinyl chloride, and dichloroethene in the extracted groundwater and/or intercept contaminated groundwater in order to mitigate potential offsite impacts.	No Action/Institutional Actions: No Action Deed Restrictions Monitor Containment Actions: Hydraulic Barriers Surficial Cap Removal, Injection/ Extraction Wells Treatment and/or Disposal Actions: Interceptor Trenches/ Trench Drains Extraction Well *In Situ* Treatment Actions: Sparging Bioremediation Reactive Wall

Notes: RFI = RCRA Facility Investigation.
VOCs = volatile organic compounds.

5.0 SCREENING OF CORRECTIVE MEASURES TECHNOLOGIES

The development of corrective action alternatives consists of three primary activities: identifying potential treatment technologies; screening the technologies based on their effectiveness and implementability; and assembling the technologies into alternatives for the media of concern at the site. The first two components of these activities are a part of the Preinvestigation Screening of Corrective Measures Technologies. The alternatives will be developed in the CMS.

Section 4.0 identifies the corrective action objectives and general response actions for the old Camden County Landfill. Based on the corrective action objectives and the general response actions, together with site information provided in the RFI Interim Report (ABB-ES, 1993a), general corrective actions were identified for the landfill (source area, soil/wastes) and the contaminated groundwater plume. Air, surface water, and sediment are not being addressed. The preliminary risk evaluation did not identify air as a media of concern and contaminants were not identified during past sampling activities at Porcupine Lake. The identified corrective action technologies, however, include an evaluation of chemical transfer or discharge to these media. Federal and State regulations limit the discharge of chemicals in treated water to surface water and sediment. Additionally, Federal and State regulations have prescribed standards that must be met to limit emissions of treatment off-gases to the atmosphere. For this reason, corrective actions would be designed and operated in such a way that these media would not be affected by treatment of chemicals present in the soil/waste and groundwater.

5.1 TECHNOLOGY IDENTIFICATION. For both the source area and groundwater, lists of suitable individual technologies that can be assembled into remedial alternatives capable of mitigating the hazards due to the leaching of contaminants into the groundwater are provided in Tables 5-1 and 5-2. Technologies were identified and evaluated based on a review of literature sources and experience in developing similar corrective measures studies. The technologies for each media are separated by function into eight response categories: no action, limited action, containment, collection, *in situ* treatment, removal/treatment, ancillary treatment, and disposal.

The no action alternative will be included as part of the evaluation with other corrective action alternatives for the site. The limited action category includes technologies that restrict access to contaminated areas by physical means, establish institutional controls through legal channels (e.g., deed restrictions), or provide an alternate water supply to the residents (i.e., fill in wells and provide a separate water meter for recreational and lawn care use of municipal water). Technologies in this category reduce the possibility of exposure to contaminants but do not reduce the toxicity, mobility, or volume of the identified hazards. Monitoring is necessary to evaluate the extent to which exposure to contaminants is actually controlled.

Containment actions include technologies that involve little or no treatment, but provide protection to human health and the environment by preventing the migration of contaminants. Thus, containment technologies attempt to reduce potential routes of exposure through isolation. Containment actions usually

Table 5-1
Identification of Source Area Corrective Action Technologies

Preinvestigation Evaluation of
Corrective Measures Technologies for Site 11
Naval Submarine Base, Kings Bay, Georgia

General Response Action	Corrective Action Technology	Description of Technology
NO ACTION	None	No Action
MINIMAL ACTION		
	Deed Restriction	All deeds for property within area would include restrictions on use of property, and on development and domestic use of groundwater.
CONTAINMENT OF SOIL/ LANDFILL CONTENTS		
	Surface Controls	Reshaping of topography to manage infiltration and runoff to control erosion.
	Cap/Hydraulic Barrier	Compacted clay and/or covered with a synthetic membrane (20 MIL) followed by 1 foot of sand and 1.5 feet of fill and 6 inches of topsoil to provide erosion and moisture control and freeze-thaw protection.
REMOVAL OF SOIL AND WASTES		
	Excavation	Use of mechanical excavation equipment to remove and load landfill wastes for disposal.
	Disposal Offsite	Transport of excavated soil/waste to an RCRA-permitted landfill.
TREATMENT OF EXCAVATED SOIL/HOT SPOTS AND WASTES		
	Onsite Incineration	In onsite incineration, landfill wastes are thermally destroyed in a controlled oxygen sufficient environment.
	Low Temperature Thermal Volatilization	Low temperature thermal volatilization may be used to remove VOCs from excavated soil.
	Offsite Treatment	Incineration of contaminated soil/waste at an RCRA-permitted facility.
IN SITU TREATMENT OF SOIL AND/OR WASTES		
	Vapor Extraction	Volatile organics stripped from soil/water and recovered in vapor from extraction wells.
	Steam Stripping	Force steam through the soil/waste and extract by a vacuum collection system to remove VOCs and SVOCs.
	Biodegradation	Soil/wastes may be seeded with microorganisms and/or nutrients to allow biological degradation.
	Solidification/ Stabilization	Soil mixed with a pozzolanic/cement material which can solidify and reduce mobility of contaminants.

See notes at end of table.

Table 5-1 (Continued)
Identification of Source Area Corrective Action Technologies

Preinvestigation Evaluation of
Corrective Measures Technologies for Site 11
Naval Submarine Base, Kings Bay, Georgia

General Response Action	Corrective Action Technology	Description of Technology
COLLECTION OF LANDFILL GAS (LFG)		
	Pipe Vents	Atmospheric vents are used for venting LFG to prevent building up pressure and offsite subsurface mitigation. Vents may be used in conjunction with flares or other off-gas control techniques.
	Passive Trench Vents	Constructed by excavating a deep narrow trench surrounding the waste site or spanning a section of the area perimeter. The trench is backfilled with gravel, forming a path of least resistance through which gases migrate upward to the atmosphere. Trenches are most successfully used where the depth of LFG migration is limited by groundwater or an impervious formation.
	Extraction Wells	Applied vacuum withdraws LFG in both the horizontal and vertical directions. Wells are connected by a collection header which leads to an off-gas control (e.g., blower/burner facility).
	Air Injection System	Wells are constructed in the natural soil between the landfill and threatened structures. A blower pumps air into the wells, creating a pressurized zone which both diverts LFG flow and dilutes subsurface methane concentrations.
MONITORING		
	Monitoring Wells	A monitoring program must be established to evaluate performance and effectiveness of containment/treatment technologies.

Notes: RCRA = Resource Conservation and Recovery Act.
VOC = volatile organic compound.
LFG = landfill gas.
SVOC = semivolatile organic compound.

Table 5-2
Identification of Groundwater Corrective Action Technologies

Preinvestigation Evaluation of
Corrective Measures Technologies for Site 11
Naval Submarine Base, Kings Bay, Georgia

General Response Action	Corrective Action Technology	Description of Technology
NO ACTION	None	No Action
MINIMAL ACTION		
	Monitoring	Document concentration and spatial distribution of contaminants.
	Institutional Controls	Implement zoning or other restrictions to prohibit the future use of contaminant groundwater within and around the site area.
	Provide alternate water supply	This action may include providing separate meters for municipal water used for lawn and recreational activities, thus eliminating sewage costs for residents.
CONTAINMENT		
	Hydraulic Barriers	
	Sheet Pile	Divert groundwater flow around plume/source areas with sheet piling.
	Slurry Wall	Trench around areas of contamination is filled with a soil (or cement) bentonite slurry.
	Vibrating Beam	Vibrating force to advance beams into the ground with injection of slurry as beam is withdrawn, to create a low permeable barrier.
	Grout Curtain	Pressure injection of grout in a regular pattern of drilled holes.
	Block Displacement	A slurry is injected so that it forms a subsurface barrier around and below a specific mass or "block" of material. Continued pressure injection of the slurry produces an uplift force on the bottom of the block, resulting in vertical displacement.
	Diversion	Utilize groundwater extraction and/or recharge wells to divert groundwater flow around plume/source areas.
	Cap	Prevent precipitation infiltration to plume areas by installing a low-permeability clay or synthetic cover over contained area.
COLLECTION		
	Interceptor Trenches	Utilize trenches, drains, and piping to collect (by gravity flow) and/or pumping groundwater for treatment.
	Extraction Wells	Install strategically located pumping wells to collect groundwater for treatment.

See notes at end of table.

Table 5-2 (Continued)
Identification of Groundwater Corrective Action Technologies

Preinvestigation Evaluation of
Corrective Measures Technologies for Site 11
Naval Submarine Base, Kings Bay, Georgia

General Response Action	Corrective Action Technology	Description of Technology
EXTRACTED GROUNDWATER TREATMENT		
	Oxidation	Oxidize organics in extracted groundwater through application of one or more of the following oxidation processes: ozone, ultraviolet light, hydrogen peroxide.
	Air Stripping	Reduce concentrations of VOCs through intimate contact of extracted groundwater with air. Water descends down a packed column while air is forced up the column to promote mass transfer of organics from aqueous to gaseous phase. Gaseous phase may require further treatment to meet air regulations.
	Steam Stripping	Remove VOCs through intimate contact of extracted groundwater and steam. Similar to air stripping, but steam is utilized to elevate temperatures and enhance removal of VOCs.
	Carbon Adsorption	Reduce concentrations of aqueous or gaseous phase organics through adsorption onto available granular activated carbon sites. May be used as a polishing step for treatment such as air stripping or oxidation to further reduce organic contaminant concentrations.
	Wet Air Oxidation	Destroy organic compounds in an aqueous solution by inducing oxidation and hydrolysis reactions at high temperature and pressure. Oxygen, at elevated temperatures, enhances oxidation of organic compounds to carbon dioxide and water.
	Supercritical Water Oxidation	Destroy organic compounds in an aqueous solution at high temperature and pressure. Supercritical water oxidation uses higher temperatures and pressures than wet air oxidation.
	Thin Film Evaporation	Remove low volatile contaminants from extracted groundwater by vaporizing water from contaminants. Process produces a concentrated waste stream requiring further treatment.
	Reverse Osmosis	Remove organic compounds from extracted groundwater using membrane processes. Process will remove organics with >200 molecular weight.

See notes at end of table.

Table 5-2 (Continued)
Identification of Groundwater Corrective Action Technologies

Preinvestigation Evaluation of
Corrective Measures Technologies for Site 11
Naval Submarine Base, Kings Bay, Georgia

General Response Action	Corrective Action Technology	Description of Technology
	Biological Treatment	Destroy organic compounds through biodegradation, or chemical conversion of the organic wastes by introducing the extracted groundwater to either an aerobic or anaerobic biological treatment process. Microorganisms and nutrients (if needed) are added to induce one or more of the responses.
IN SITU TREATMENT		
	In Situ Biological	Introduce microorganisms, nutrients and oxygen into the groundwater using a matrix of extraction wells and recirculation techniques.
	In Situ Chemical	
	Reactive Wall	A permeable reactive wall consisting of a porous media combined with a metal catalyst is installed across flow path of contaminant plume. Halogenated organic compounds degradation reactions occur only in the presence of the metal catalyst.
	In Situ Physical	
	Air Sparging	Air forced into the contaminated aquifer through wells creates bubbles. Contamination partitions from the water to the air bubbles. The vapors that evolve as the bubbles burst at the water table must be removed (e.g., SVE).
ANCILLARY	Aeration	Aerate the groundwater prior to treatment to precipitate out inorganic iron, and manganese, calcium, and magnesium by changing the oxidation/reduction.
	Filtration	Remove suspended solids from the wastewater streams by forcing the water through a sand filter or cartridge-type filter.
	Oxidation-Reduction	Add chemical reagents to groundwater, changing the oxidation state of the inorganics to a more treatable form.
	Precipitation/Flocculation/ Sedimentation	Form a solid phase, usually particulate matter suspended in a liquid phase, containing the pollutant to be removed. Process requires close control of pH. Process generates a sludge which may require further treatment prior to disposal.

See notes at end of table.

Table 5-2 (Continued)
Identification of Groundwater Corrective Action Technologies

Preinvestigation Evaluation of
Corrective Measures Technologies for Site 11
Naval Submarine Base, Kings Bay, Georgia

General Response Action	Corrective Action Technology	Description of Technology
OFF-GAS TREATMENT	Carbon Adsorption	Remove gas-phase VOCs with activated carbon.
	Thermal Oxidation	Incinerate gas-phase VOCs.
	Catalytic Oxidation	Combust gas-phase VOCs at a lower temperature than thermal oxidation by using a catalyst.
DISPOSAL		
	Landfill	Dispose of treatment residue (e.g., biological treatment sludge, pretreatment sludge, spent carbon) in an appropriately permitted RCRA facility.
	Incineration (offsite)	Incinerate treatment residue (e.g., spent carbon) at an offsite facility.
	Surface Water Discharge	Discharge treated groundwater to permitted outfall for release to a surface water body.
	Groundwater Infiltration	Infiltrate treated groundwater back into aquifer to expedite clean up process.
	Discharge to POTW	Discharge treated or untreated groundwater to POTW.

Notes: VOC = volatile organic compound.
SVE = soil vapor extraction.
RCRA = Resource Conservation and Recovery Act.
POTW = publicly owned treatment works.

consist of covering contaminated areas or controlling groundwater movement through the use of low-permeability barriers or containment walls. Groundwater extraction and recharge wells can also be used to contain the plume by preventing further migration through a system of managed hydraulic gradients.

Collection actions may be used for alternatives involving contaminated groundwater. Collection actions include technologies that may be used in conjunction with treatment, disposal, and/or recycling techniques when developing corrective action alternatives. Typical collection technologies include subsurface trench drains and extraction wells. For soil, this would coincide with technologies for the removal of contaminated soil prior to treatment or disposal. A typical soil removal technique is excavation.

Treatment actions include technologies that specifically act to reduce the toxicity, mobility, and volume of contaminants by biological, physical, or chemical processes. In this evaluation, *in situ* treatment technologies (e.g., treatment not requiring prior removal of the medium of concern), such as vacuum extraction or bioremediation, and removal treatment methods, such as thermal soil aeration or incineration, are separated into their respective categories.

Ancillary actions describe support technologies for containment, treatment, or disposal actions. For example, groundwater may require metals removal prior to treatment for organic contaminants to prevent system failure.

Disposal actions are intended to prevent exposure and consolidate waste material. Disposal actions may be combined with treatment actions when developing corrective action alternatives. For example, groundwater may be treated by air stripping (treatment action) and the groundwater discharged to a publicly owned treatment works (POTW) (disposal action).

5.2 TECHNOLOGY SCREENING. The technology screening process reduces the universe of potentially applicable technology types by evaluating options with respect to their effectiveness in meeting corrective action objectives and technical implementability. Technologies were evaluated to assess whether they are applicable to the site-specific compounds and environmental media and suitable for the location and conditions of the site. The technology screening phase for Site 11 is consistent with the RCRA Corrective Action Plan (Interim Final) (USEPA, 1988a) and the Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (Interim Final) (USEPA, 1988b).

The characteristics of a given site, waste type, or technology may influence the effectiveness or implementability of the technology in question. Site 11 has not been completely characterized, thus the final technology screening in the CMS report may change. This is an initial screening effort to identify data needs that can be met during the Supplemental RFI.

Site characteristics that can influence the applicability of a technology are space requirements, soil types, and depth of waste. These characteristics can prevent or make implementing certain technologies difficult (e.g., interceptor trenches to 60 feet to capture groundwater contamination).

Waste characteristics that were considered included the following physical properties: volatility, solubility, and specific chemical constituents and properties that affect the performance of a technology. Those technologies whose use are clearly precluded by waste or site characteristics were eliminated from further consideration.

Long-term management requirements for residual contamination or untreated wastes reduce the effectiveness of a technology. Technologies vary in the degree of long-term management required. An effective technology must also provide environmental or human health benefits by reducing at least one of the following: toxicity, mobility, or volume of the waste or reduce the potential for exposure to contaminants.

In addition to site conditions or waste characteristics, the degree of development, performance history, or problems related to the technology type may also adversely affect the technology's effectiveness or ease of implementation. If the technology is not available at full scale, does not produce consistent or reliable results, or produces hazardous residuals, for example, the technology may not be considered further. Tables 5-3 (source area) and 5-4 (groundwater) present the screening of technologies for the landfill. Technologies that are not effective or cannot be implemented at Site 11 for the reasons described previously have been eliminated from further consideration, as indicated in the tables. The remaining technologies will be evaluated for the data requirements to implement in Section 6.0.

Several reference sources were used during the screening of technologies, including the following:

Vendor Information System for Innovative Treatment Technologies (VISITT) Version 2.0. USEPA Office of Solid Waste and Emergency Response. June 1993a.

RCRA Corrective Action Plan (Interim Final). USEPA. Office of Solid Waste. June 1988.

Remediation Technologies Screening Matrix USEPA Office of Solid Waste and Emergency Response and U.S. Air Force Environics Directorate. July 1993b.

Second Forum on Innovative Hazardous Waste Treatment Technologies: Domestic and International Philadelphia, Pennsylvania. USEPA. Office of Solid Waste and Emergency Response. May 1990.

The Superfund Innovative Technology Evaluation Program: Technology Profiles Fifth Edition. USEPA. Office of Solid Waste and Emergency Response. November 1992.

In addition to these references, information from individual vendors was obtained.

Table 5-3
Source Area Corrective Measures Technology Screening

Preinvestigation Evaluation of
Corrective Measures Technologies for Site 11
Naval Submarine Base, Kings Bay, Georgia

Process/Technology	Advantages	Disadvantages	Status	Comments
None (No Action)	No capital or operating costs.	Does not reduce mobility, toxicity, or volume of site materials in soil. Does not prevent future contact with soil, sediment, surface water, and landfill contents. Does not remove threat of groundwater contamination. Annual costs for monitoring.	Retained	Would not satisfy any corrective action objectives. If there is no exposure source and the current cap is acceptable to the regulator, the source area no-action alternative may be viable.
Access Restriction to Prevent Exposure (e.g., deed restrictions, prohibition of groundwater use)	No construction or site activity to potentially expose public and environmental receptors to site chemicals. Low initial cost. Low annual cost.	Does not remove or prevent continuing groundwater contamination. Would not reduce mobility, toxicity, or volume of materials in landfill. Difficult to enforce. Requires long-term enforcement (maintenance). Does not prevent future contact with soil, sediment, surface water, and landfill contents.	Retained	Would not satisfy most corrective action objectives. Could protect anything left in place from development.
Surface Controls	Slows down rate of surface erosion. Controls flow of surface water. Reduces water infiltration and associated leachate generation. Initial cost is generally low. Low annual cost.	Requires long-term operation and maintenance expenses. Does not prevent future contact with soil, sediment, surface water, and landfill contents. May temporarily increase contaminated dust fugitive emissions during regrading.	Retained	Would not satisfy most corrective action objectives.
Cap-Double Barrier	Prevents direct contact with soil, sediments, and landfill contents. Minimizes erosion. Reduces infiltration and associated leachate generation in compliance with RCRA Subtitle C guidance. Controls landfill gas emission. Prevents overland flow of leachate. Low annual cost. Controls contaminated dust migration of fugitive emissions after cap construction. Must be used if landfill contains RCRA listed or characteristic hazardous waste. No handling of waste materials.	Problems including increased infiltration through cap fractures as a result of ponding may arise if substantial differential settlement occurs after cap is constructed. Requires long-term maintenance. Initial cost is medium to high.	Retained	Combined with groundwater treatment, would satisfy most corrective action objectives.

See notes at end of table.

Table 5-3 (Continued)
Source Corrective Measures Technology Screening

Preinvestigation Evaluation of
Corrective Measures Technologies for Site 11
Naval Submarine Base, Kings Bay, Georgia

Process/Technology	Advantages	Disadvantages	Status	Comments
Mechanical Excavation of Soil/Hot Spots	Removes landfill contents thus prevents long-term direct contact with soil, sediment, and landfill contents. Prevents leachate generation and landfill gas generation at the site. No direct annual cost.	Impractical for large landfills (>100,000 cubic yards). May release VOCs and malodorous gases to the atmosphere posing a health and olfactory threat to nearby residents. Potential for fires and explosions from uncontrolled release of methane gas present. Requires handling of waste materials. Initial cost is high. Does not reduce volume, mass, or toxicity of contaminants.	Eliminated	Because landfill contains 500,000+ cubic yards, with no known hot spots, adverse effects could be significant and far outweigh the benefits of removing wastes, especially considering the high cost.
Consolidation of Soil/Hot Spots	Reduces area of waste to be capped or treated. Annual cost is for containment or treatment process. May be cost-effective alternative to capping for source areas at double liner large landfills where wastes can be consolidated in a limited area.	May release VOCs and malodorous gases to the atmosphere. Potential for fires and explosions from methane gases released. May pose health and safety risk to construction workers. Initial cost is medium to high.	Retained	Usually viable only for small volume hot spots, and relatively broad areas of thinly deposited waste.
Disposal Onsite In RCRA Subtitle C Landfill	Meets all corrective action objectives.	Usually not constructed onsite because of nonconforming site characteristics. Waste is still onsite. Requires significant material handling. Initial cost very high. Moderate annual cost. Potential for VOC and malodorous gas releases and methane gas problems.	Eliminated	Would require excavation of entire landfill with significant associated adverse effects and long-term commitment to monitoring and future corrective actions.
Disposal Offsite In RCRA Subtitle C Landfill	Wastes are removed from site. No annual cost if all waste and contaminated soil are removed.	May require pretreatment of waste prior to disposal to meet land disposal restrictions. Usually only viable for hot spots. Requires significant material handling. Initial cost very high. Potential for VOC and malodorous gas releases and methane gas problems. Retains long-term liability for corrective actions at landfill receiving wastes.	Eliminated	Limited Subtitle C Landfill capacity and USEPA policy to manage waste onsite.

See notes at end of table.

Table 5-3 (Continued)
Source Corrective Measures Technology Screening

Preinvestigation Evaluation of
Corrective Measures Technologies for Site 11
Naval Submarine Base, Kings Bay, Georgia

Process/Technology	Advantages	Disadvantages	Status	Comments
Onsite Incineration of Soil/Wastes	Reduces waste requiring management. Significantly reduces mobility, toxicity, and volume of waste. No additional annual cost under this technology after all waste is incinerated because ash would be deposited in landfill which will already be monitored.	Usually viable only for hot spots. May require pretreatment of wastes. High concentration of inorganics would inhibit efficiency. Residual ash may have to be disposed at a RCRA landfill. Requires significant material handling. Requires pilot testing. Initial cost high to very high. Potential for VOC and malodorous gas releases and methane gas problems.	Eliminated	No evidence of hot spots at landfill, incineration of entire landfilled waste volume would be cost-prohibitive and take several years.
Low Temperature Thermal Volatilization of Soil/Hot Spots	VOCs are removed. No annual cost for this technology after all waste and soil is treated, but there is an annual cost of the containment/treatment process selected to handle residual waste, soil, and liquid.	Usually viable only for VOC hot spot areas. Rarely effective because of mixed nature of waste materials thus may require pretreatment of debris. Requires significant material handling. Requires pilot testing. Initial cost moderate to high. Only can be used in combination with some other containment/treatment process. Potential for VOC releases and methane gas problems.	Eliminated	Would not satisfy most corrective action objectives.
Biodegradation of Soil/Hot Spots in Landfill	Remediates soil and groundwater without excavating overlying soils. Non-energy intensive treatment method.	Landfill contents must be characterized to determine site-limiting characteristics for biodegradation. Usually viable only for hot spots. Effectiveness is uncertain because results have not been demonstrated with diverse mixed wastes typical of municipal landfills. Requires pilot testing.	Eliminated	Innovative technology has not proven effective for vinyl chloride.
Vapor Extraction of Soil/Hot Spots in Landfill	Suitable for hot spots. Reduces significantly the mobility of other volatile contaminants. Particularly cost-effective for landfills that require landfill gas collection and treatment. Minimal handling of waste materials.	Applicable for VOC removal but inorganic and semivolatile contamination will remain. Initial and annual costs are moderate.	Retained	Combined with groundwater treatment, would satisfy most corrective action objectives.

See notes at end of table.

Table 5-3 (Continued)
Source Corrective Measures Technology Screening

Preinvestigation Evaluation of
Corrective Measures Technologies for Site 11
Naval Submarine Base, Kings Bay, Georgia

Process/Technology	Advantages	Disadvantages	Status	Comments
Solidification/ Stabilization of Soil/Hot Spots	Reduces mobility of contaminants. Effective for soils contaminated with inorganics and low concentrations of organics.	Usually viable only for hot spots. Leaching of organics is only reduced but not eliminated. Rarely used at municipal landfills. Pretreatment may be required. Effective depth generally limited to about 12 feet. Stabilization may be reversible over time. All waste remains on site therefore containment is still required. Potential for VOC releases and methane gas problems during implementation as voids are filled with grout. Initial cost moderate. Annual cost uncertain.	Eliminated	Technology is not effective for mixed waste soil.
Off-site Treatment in RCRA Incinerator	Wastes are removed from site. No annual cost.	Rarely viable due to limited capacity of incineration facility. Initial cost very high. May require pretreatment. Requires significant material handling. Potential for VOC and malodorous gas releases and methane gas problems during transportation and staging.	Eliminated	Anticipated large volume, long time to implement, and associated cost makes this impractical.
Passive Pipe Venting of Landfill Gas (LFG)	Simple, inexpensive, and effective at reducing LFG pressure.	May increase odor problems. May increase potential for methane fires or explosions at point of discharge. Initial cost low. Not a treatment technology or process. Potential for releasing VOCs. Does not prevent migration due to diffusive flow.	Retained	
Trench Venting of LFG	Relatively inexpensive and requires little maintenance. More effective than pipe venting to minimize lateral migration of LFG. Low annual cost. Protects cap from gas buildup.	May increase odor problems. Runoff may infiltrate and clog open vents. Initial cost low. Not a treatment technology or process. Potential for releasing VOCs and methane gas.	Retained	Applicability of this technology not known because extent of methane migration not known.

See notes at end of table.

Table 5-3 (Continued)
Source Corrective Measures Technology Screening

Preinvestigation Evaluation of
Corrective Measures Technologies for Site 11
Naval Submarine Base, Kings Bay, Georgia

Process/Technology	Advantages	Disadvantages	Status	Comments
Extraction Well Collection of LFG	Has larger area of influence than passive pipe venting. Controls odors better than passive venting. With proper off-gas control, removes most risks from LFG.	More expensive than passive systems to install. Initial cost low to moderate. Annual operating and maintenance cost very high compared to passive venting systems.	Retained	Applicability of this technology not known because extent of methane migration not known.
Air Injection System Control of LFG	Effective at minimizing LFG migration from landfill into adjacent structure.	Application of this technology is site-specific because injection wells must be located a sufficient distance from landfill to prevent forcing air into refuse.	Retained	Applicability of this technology not known because extent of methane migration not known.
Monitoring	Ensures compliance with established media protection standards.		Retained	Requirement of any treatment train.

Notes: LFG = landfill gas.
NCP = National Contingency Plan.
RCRA = Resource Conservation and Recovery Act.
USEPA = U.S. Environmental Protection Agency.
VOC = volatile organic compound.

KB_STE11.WP
MVL.08.94

Table 5-4
Groundwater Remediation Technology Screening

Preinvestigation Evaluation of
Corrective Measures Technologies for Site 11
Naval Submarine Base, Kings Bay, Georgia

Process/Technology	Advantages	Disadvantages	Status	Comments
None (No Action)	Does not cause exposure to workers during remediation. No capital or operating costs.	Does not reduce mobility, toxicity, or volume of contamination in the groundwater except through natural attenuation which may be a very long process.	Retained	Would not satisfy any corrective action objectives. Retained for comparison.
Minimal Action (e.g., zoning and deed restrictions, well use advisories, point of use treatment, remove/ disconnect private wells).	No construction or site activity to release site chemicals and potentially expose public and environmental receptors. Low initial cost.	Would not reduce mobility, toxicity, or volume of contaminants. Difficult to enforce. Requires long-term enforcement (maintenance). Monitoring costs could be substantial. Point of use treatment not effective for vinyl chloride.	Retained	Would not satisfy most corrective action objectives. Could restrict use of groundwater through deed restrictions and removal/disconnecting private wells.
Containment				
Cap	Reduces migration of contaminants. Easily implemented if a ready source of clay is available.	Does not prevent horizontal leaching and vertical migration of contaminants in groundwater or reduce toxicity and volume. There would be restrictions on future land use.	Retained	Potentially applicable.
Hydraulic Barriers	Prevents vertical migration of contaminants. Vertical barriers usually have short construction time, cause minimal environmental impact during construction and can be cost-effective.	Does not reduce toxicity and volume of waste. Long-term integrity of the barrier may be compromised by direct contact with contaminated plume. Requires extensive construction quality control/assurance to be effective.	Eliminated	The contaminated plume has migrated offsite into a residential area. Would not prevent exposure of residents who continue to extract groundwater from plume.
Collection				
Interceptor Trenches	Interceptor systems prevent contaminated groundwater from moving downgradient toward wells or surface water. These systems are relatively inexpensive to install and operate.	Underflow may occur. An interceptor system located onsite would not be capable of capturing the plume which has migrated offsite. The interceptor system would need to be combined with a treatment technology.	Retained	The contaminated plume has migrated offsite into a residential area but combined with a downgradient activity this technology may prove useful.
Extraction Wells	Widely use technique for capturing groundwater contamination. Proven technology for controlling groundwater flow and capturing dissolved contaminants.	May form stagnation zone downgradient of extraction wells. Tailing effect could affect removal of groundwater containing low solubility contaminants. Contaminants adsorbed to the aquifer material can be difficult to capture and will increase time required for restoration.	Retained	Used to capture groundwater VOC plume which has migrated offsite to residential area. Interim Corrective Measure pilot test will employ the use of recovery wells.

See notes at end of table.

Table 5-4 (Continued)
Groundwater Remediation Technology Screening

Preinvestigation Evaluation of
Corrective Measures Technologies for Site 11
Naval Submarine Base, Kings Bay, Georgia

Process/Technology	Advantages	Disadvantages	Status	Comments
<u>Treatment</u>				
Oxidation	Permanent destruction of organics into carbon dioxide and water, or nontoxic intermediates. Destruction efficiencies range from 70 to >99%. Produces no air emissions or sludge. Residence times are typically 5 minutes or less. Operation poses no increased risk to public health or environment. Effluent may be discharged to receiving waters, groundwater, or local POTW. Demonstrated technology. Systems can accommodate flow rates from 1 to 1,000 gpm. Pilot studies have shown processes to be applicable to all TCL organics. Experienced vendors available to perform bench and/or pilot-scale tests.	High suspended solids or oxidized metals (e.g., iron, manganese) may require pretreatment to maintain overall effectiveness. Lower removal rates for some organics (e.g., ketones).	Retained	Effective in removing currently identified contaminants. No residual contamination to deal with.
Air Stripping Packed Tower Plate Tower	Reduces toxicity of waste stream. Established technology. Widely available. Simple to operate, low cost, easy installation, can achieve very low levels of contaminants. Packed towers are less expensive and have smaller pressure drops than plate towers. Plate towers are preferable where the liquid contains suspended solids as they can be more easily cleaned.	Discharge permit required. An air pollution control device may be required. Extraction of VOCs limited by rate of VOC diffusion into the aqueous phase. Packed towers tend to plug more readily. Plate towers are more expensive and are less efficient in removing VOCs.	Retained	Known contaminants easily treated by this technology.
Steam Stripping	Effective for removal of aromatics and chlorinated aliphatics. Elevated temperatures enhance contaminant removal.	Produces concentrated waste stream requiring further treatment. Pretreatment for removal of naturally occurring inorganics or acidification of feed stream may be required to prevent fouling by production of compounds such as calcium carbonate on the packing material.	Eliminated	Produces a concentrated liquid waste that would require further treatment. Air stripping/sparging is believed to be effective in removing the volatile contaminants of concern. Therefore, steam would not be necessary.
Carbon Absorption	Reduces toxicity of waste stream. Immobilizes contaminants within the pores of the carbon. Single units can accommodate flow rates up to 700 gpm. Quick start-up times. Effectively treats most nonpolar organics and various metals and inorganics. Well documented for groundwater applications.	Does not destroy contaminants, only concentrates them and transfers them to another media. Waste carbon is more toxic than influent water; special disposal, regeneration, or destruction is required. Vinyl chloride is not removed effectively. Pretreatment may be required for suspended solids, oil, or greases. .	Eliminated	Does not effectively remove vinyl chloride, a major contaminant.

See notes at end of table.

Table 5-4 (Continued)
Groundwater Remediation Technology Screening

Preinvestigation Evaluation of
Corrective Measures Technologies for Site 11
Naval Submarine Base, Kings Bay, Georgia

Process/Technology	Advantages	Disadvantages	Status	Comments
Wet Air Oxidation	This system is thermally self-sustaining, accepts wastes with organic concentrations ranging between those considered ideal for biological treatment and those considered for incineration, detoxifies the TCL of pollutants, and the products of oxidation stay in the liquid phase.	This technology is not economical for dilute organic concentrations (<1%). Generally achieves 80 percent oxidation of organic constituents which may not meet treatment requirements. Off-gas treatment may be required. The high temperature and pressure system would require extensive monitoring.	Eliminated	Eliminated due to low efficiency and limitations of the technology.
Supercritical Water Oxidation	Can chemically oxidize waste in less than a minute at greater than 99.9% efficiency. Inorganics are removed as well. No off-gas processing is required.	This technology is not economical for dilute organic concentrations (<1%). This high temperature and pressure system would require extensive monitoring. Full-scale systems are not available.	Eliminated	Eliminated due to limitations of the technology.
Thin Film Evaporation		Process not proven for organics identified at the site. Process produces a concentrated waste stream requiring further treatment.	Eliminated	Process not applicable for contaminants of concern at the landfill.
Reverse Osmosis	Stated systems can accomplish any desired removal efficiency. These systems are readily available.	Not proven reliable for lower molecular weight organics present at the site. Process produces a concentrated waste stream requiring further treatment. High maintenance and energy requirements.	Eliminated	Process not applicable for contaminants of concern at the landfill.
Biological Treatment	Can achieve removal rates of greater than 99 percent. Most effective when dedicated to a waste stream of fairly constant composition. Microorganisms can be acclimated to a particular waste stream. Organic contaminants are destroyed rather than transferred to another medium. Usually very cost-effective.	Requires bench-scale or pilot test to design optimum system. Chlorinated organics are generally more difficult to treat biologically due to their toxicity to microorganisms. Metals are not removed by this process. Systems are fragile (e.g., organisms can be killed if changes in waste stream composition, concentration, or temperature occur). This process can produce sludge if the cells have accumulated heavy metals or hazardous organics.	Retained	May be applicable to organic contaminants.

See notes at end of table.

Table 5-4 (Continued)
Groundwater Remediation Technology Screening

Preinvestigation Evaluation of
Corrective Measures Technologies for Site 11
Naval Submarine Base, Kings Bay, Georgia

Process/Technology	Advantages	Disadvantages	Status	Comments
In Situ Biological	Contaminants in subsurface soil and groundwater can be treated without excavating soil or extracting groundwater. The end result is carbon dioxide, water, and a bacterial biomass. Can be used to treat contaminants sorbed to aquifer materials or trapped in pore space. The time required for treatment often can be faster than withdrawal and treating. Cost-effective remedy.	This is an innovative treatment technology which has not been proven for vinyl chloride. Heavy metals and toxic concentrations of organic compounds may inhibit activity of indigenous microorganisms. Will require a bench-scale and/or pilot test. Injection wells may become clogged with profuse microbial growth resulting from addition of nutrients and oxygen. Nutrients added to the aquifer must be contained in the treatment zone because transport to surface waters could result in eutrophication. Increased microbial biomass can exert an oxygen demand that can form anaerobic conditions in the aquifer, which may result in production of hydrogen sulfide or other objectional by-products.	Eliminated	Vinyl chloride is difficult to degrade. Requires two stage process.
In Situ Physical				
Air Sparging/Stripping	Low concentrations achievable. Simple technology in terms of equipment. No groundwater discharge. Numerous full- and pilot-scale applications performed. Unsaturated zone is remediated along with the saturated zone.	Cost is dependent on stratigraphy. Dependent on hydraulic conductivities. Coordination between soil vapor extraction and air sparging is required to prevent spread of vapor phase contamination.	Retained	Applicable to known contaminants. Would enhance source remediation.
In Situ Chemical Reactive Wall	Contaminants in subsurface soil and groundwater can be treated without excavating soil or extracting groundwater. The plume is shallow near the landfill, making installation of the wall relatively easy. Cost-effective remedy.	This is an innovative technology that has not been fully tested in situ and the actual mechanism for degradation is not completely understood. Previous in situ studies have obtained 91 to 95 percent reduction in concentrations of PCE and TCE, respectively. Vinyl chloride has not been tested. The breakdown products of this reaction have not been fully characterized. If the wall is placed onsite, contamination beyond the wall would not be treated.	Eliminated	Would not capture plume which has migrated into residential area. Has not been tested on vinyl chloride.

See notes at end of table.

Table 5-4 (Continued)
Groundwater Remediation Technology Screening

Preinvestigation Evaluation of
Corrective Measures Technologies for Site 11
Naval Submarine Base, Kings Bay, Georgia

Process/Technology	Advantages	Disadvantages	Status	Comments
Ancillary				
Aeration	Applicable for pretreatment to remove naturally occurring inorganics (e.g., iron, lead, manganese) to prevent fouling of main treatment system. Easily implemented as a support treatment.	May release VOCs into the air during the aeration process. Would require air emission controls.	Retained	May be effective after VOC removal.
Filtration	Would remove some solids from groundwater. Easily implemented as a support treatment. The operation can be set up to be automatic.	Would need to be enclosed system to retain VOCs. Transfer contaminants to another media which would have to be disposed.	Retained	May be effective for pretreatment for solids removal.
Oxidation/Reduction	Applicable for pretreatment to remove naturally occurring inorganics (e.g., iron, lead, manganese) to prevent fouling of the main treatment system. Easily implemented as a support system. The equipment required is relatively simple. The system is normally operated in a closed vessel, therefore, no significant air pollution impacts are expected.	Narrow pH ranges need to be maintained for optimum reaction rates. Strong oxidizers do not discriminate between natural organics and contaminants; thus, an excess amount of applied agents may be required if natural organics are present. Presence of wide range of contaminants may complicate the process and produce unwanted side effects (e.g., change Cr III to Cr VI). Produces sludge to be disposed.	Retained	May be applicable for pretreatment.
Precipitation/Flocculation/ Sedimentation	Effective pretreatment for groundwater to remove heavy metals. Mobile units are available. Onsite units can handle up to 560 gpm. Equipment is simple and easy to use and readily available. Systems can be designed to insert into complex treatment systems. Well demonstrated; used to treat industrial and municipal waste streams as well as contaminated groundwater.	Heavy metal sludge is produced. Metals in sludge may be remobilized by a change in chemical environment (e.g., pH). Metal sludge must be disposed of or receive further treatment. Hydrogen sulfide may be produced. Relatively long detention times are required to allow settling. Chemical environment must be strictly controlled and monitored to maintain correct operating conditions.	Retained	As possible pretreatment.
Carbon Adsorption of Gas Phase VOCs	Reduces toxicity of waste stream. Immobilizes contaminants within the pores of the carbon. Quick start-up times. Effectively treats most volatile organics. Well documented for volatile emissions.	Does not destroy contaminants, only concentrates them and transfers them to another media. Special disposal, regeneration, or destruction of carbon is required. Vinyl chloride is not removed effectively.	Eliminated	Not an effective treatment for vinyl chloride.

See notes at end of table.

Table 5-4 (Continued)
Groundwater Remediation Technology Screening

Preinvestigation Evaluation of
Corrective Measures Technologies for Site 11
Naval Submarine Base, Kings Bay, Georgia

Process/Technology	Advantages	Disadvantages	Status	Comments
Thermal Oxidation of Gas Phase VOCs	Easily implemented, highly adaptable, low start-up cost. For compounds which are not easily oxidized, high temperatures (>1200° F) may be required.	Not very effective in treating highly chlorinated or sulfur-containing compounds. The presence of a single compound that is difficult to destroy may lower overall mixture destruction. Bench-scale or pilot test required.	Retained	May be an effective off-gas treatment.
Catalytic Oxidation of Gas Phase VOCs	97 to 98 percent overall destruction efficiencies of chlorinated hydrocarbons is achievable. Easy to install. Operating temperatures are lower than thermal oxidizers.	Not very effective in treating highly chlorinated or sulfur-containing compounds. The presence of a single compound that is difficult to destroy may lower overall mixture destruction. Bench-scale or pilot test required.	Retained	May be an effective off-gas treatment.
Disposal Landfill Treatment Residue (offsite)	Wastes are removed from site.	Would not reduce mobility, toxicity, or volume of contaminants in pretreatment sludge. Land disposal restrictions may apply. May require pretreatment of waste prior to disposal to meet land disposal restrictions.	Retained	Retained for possible use pretreatment sludge disposal.
Incinerate Treatment Residue (offsite)	Reduces mobility, toxicity, and volume of waste.	May require pretreatment of waste (e.g., sludge dewatering). High concentrations of inorganics would inhibit efficiency. Initial cost high to very high.	Retained	May be used for disposal/ treatment of pretreatment sludge.
Surface Water Discharge of Treated Groundwater		Treated water discharged to surface water must meet NPDES permit limits. Significant distance (> miles) to nearest surface water body. Public may not endorse this option.	Eliminated	Base and community POTW are nearby to serve as alternate receptors.
Infiltrate Treated Groundwater	If discharged upgradient, may assist in flushing groundwater contaminants. Groundwater recharge may prevent stagnant areas and extraction wells from going dry.	Recharged groundwater must be treated to meet groundwater quality standards. Infiltration of groundwater could make chemicals migrate further into the residential area.	Retained	Retained for possible discharge option.
Discharge Treated Groundwater to NSB water treatment plant or county POTW	Easily implemented if use base wastewater treatment plant or county POTW. Treatment plants would further treat groundwater to meet their discharge standards.	Must meet POTW pretreatment standards and flow rate requirements. If hazardous waste is discharged to either the base or local POTW, the POTW may be subject to RCRA permit-by-rule.	Retained	Retained for possible discharge option.

Notes: POTW = Publicly owned treatment works.
gpm = gallons per minute.
TCL = Target Compound List.
VOC = volatile organic compound.
PCE = tetrachloroethene.
TCE = trichloroethene.
NSB = Naval Submarine Base.
NPDES = National Pollution Discharge Elimination System.
RCRA = Resource Conservation and Recovery Act.

6.0 EVALUATION OF DATA NEEDS FOR TECHNOLOGY/TREATMENT SELECTION

To focus the sampling efforts during the Supplemental RFI field program, this Preinvestigation Evaluation of Corrective Measures Technologies has been developed to identify data needs. During this evaluation, additional data requirements have been identified to assess site risks and evaluate potential corrective measures technologies. Additional data needed for the HEA includes identification of human and ecological populations in the area and land use(s). These data requirements are more fully described in Section 5.0 of the Supplemental RFI Work Plan.

Table 6-1 lists data collection requirements and the purposes for which the data will be used. The table is divided into containment technologies, collection technologies, and the general categories of physical, chemical, thermal, and biological treatment technologies. Each treatment technology within a general category (e.g., physical) require essentially the same types of data (specifics are noted).

Many of the data requirements specified in Table 6-1 have already been collected. The data that is not available and which is necessary to proceed with the CMS include:

- Source characterization (e.g., waste composition, volume, and areal extent)
- Presence and distribution of landfill gases (i.e., methane and hydrogen sulfide)
- Full contaminant analysis (i.e., VOCs, SVOCs, pesticides/PCBs, inorganics) of the media of potential concern (i.e., groundwater, surface water and sediment, soil, and waste within the landfill);
- Horizontal and vertical extent of contamination (including SVOCs, if any)
- Groundwater quality parameters (e.g., total dissolved solids (TDS), total suspended solids (TSS), biological oxygen demand (BOD), total organic carbon (TOC), dissolved oxygen (DO), chemical oxygen demand (COD), salinity, alkalinity, hardness, chlorides, nitrates, ammonia, phosphates, sulfides/sulfates)
- Aquifer ability to transmit water (e.g., pump tests)

Some of the data requirements mentioned above will be collected during the Interim Measure (IM) pilot test (i.e., alkalinity, hardness, total solids, TSS, total volatile suspended solids, BOD, COD, TOC, Target Analyte List metals, chlorides, sulfates, nitrogen series, phosphorous, and DO). A pump test will also be completed during the pilot test.

Additional data that are desirable to have to proceed through the conceptual and detailed design include: availability of soil with low permeability or hydraulic conductivity, groundwater turbidity, viscosity, heat and volatile matter content, and nutrient analysis (ammonia, nitrates, phosphates, calcium, magnesium, iron, sodium, potassium). Groundwater samples are being collected for nutrient analysis during the IM pilot test.

Table 6-1
Evaluation of Data Needs for Treatment Technologies

Preinvestigation Evaluation of
Corrective Measures Technologies for Site 11
Naval Submarine Base, Kings Bay, Georgia

Technology	Data Collection Requirements	Purpose of Data
Containment		
Cap with Surface Controls	Areal extent of landfill wastes, density of solid waste in landfill	Density influences the rate and total amount of settlement and the bearing capacity of the completed fill.
	Composition of Wastes (degree of compaction and ratio of daily cover to waste material)	Settlement depends on these factors.
	Presence and distribution of landfill gases (e.g., methane and hydrogen sulfide)	Needed to design landfill gas-venting system.
	Availability of soil with low permeability or hydraulic conductivity	Determines whether clay or other material is used for cap.
	Vadose zone characteristics (permeability, porosity, chemical characteristics, vertical and horizontal extent of contamination)	Estimate flux, velocity, and pollutant movement in vadose zone. Evaluate infiltration of leachate and migration of landfill gases.
In Situ Treatment		
Air Sparging/Stripping	Soil properties (air permeability, porosity, grain size, lithology)	Determines applicability and sizing of technology.
	Chemical constituents	Estimate effectiveness of technology to remove site contaminants.
	[Note: Data needs for evaluating the use of recovery/reinjection wells would also be applicable.]	
Collection		
Interceptor Trenches Extraction Wells	Aquifer hydrogeologic boundaries and locations (e.g., multilevel well installation) and analysis of groundwater quality (e.g., pH, TDS, TSS, BOD, TOC, DO, COD, salinity, alkalinity, temperature, nitrates, ammonia, phosphates, sulfides/ sulfates, heavy metals, specific contaminant concentrations)	Define flow limits and distribution of contaminants to be captured. Evaluate exposure via groundwater, define contaminant plume for evaluation of interception methods.
	Direction of flow (water level measurements in monitoring wells)	Identify most likely pathways of contaminant migration
	Aquifer ability to transmit water (i.e., pump test) and rate of flow (hydraulic gradient, permeability, effective porosity)	Determine potential quantities and rates for hydraulic capacity
	Location and rate of recharge/ discharge areas (field mapping of groundwater recharge areas and groundwater discharge areas)	Determine interception points for withdrawal/ recharge options or areas of capping.

See notes at end of table.

Table 6-1 (Continued)
Evaluation of Data Needs for Treatment Technologies

Preinvestigation Evaluation of
Corrective Measures Technologies for Site 11
Naval Submarine Base, Kings Bay, Georgia

Technology	Data Collection Requirements	Purpose of Data
<u>Physical</u>		
<u>Extracted Groundwater Treatment</u>	Constituent Analysis, including VOCs, SVOCs, and inorganics such as iron and manganese	VOC removal efficiency estimates and potential for clogging by precipitate and slime formation
Air Stripping		
		Density separation (e.g., aeration)
<u>Ancillary</u>	Specific Gravity	
		Affects pumping and handling (e.g., filtration); settling of agglomerated solids (e.g., precipitation)
Aeration		
	Viscosity	
Filtration		
		Separation
Precipitation/Flocculation/Sedimentation		Retention time in treatment system
	Dissolved/Total/Suspended Solids	
		Potential fouling of system
	Temperature of groundwater	
	Heavy metals content	
<u>Chemical</u>		
<u>Extracted Groundwater Treatment</u>	pH	pH adjustment needs, corrosivity
		Photolysis (i.e., UV oxidation)
	Turbidity	
Oxidation		Determines appropriate treatment technology and sizing
<u>Ancillary</u>	Chemical constituents	
		Dehalogenation may be required
Oxidation/Reduction		
	Halogen content	
	[Note: Generally, the data needs for evaluating and comparing chemical processes include the data needed for physical treatment technologies.]	

See notes at end of table.

Table 6-1 (Continued)
Evaluation of Data Needs for Treatment Technologies

Preinvestigation Evaluation of
Corrective Measures Technologies for Site 11
Naval Submarine Base, Kings Bay, Georgia

Technology	Data Collection Requirements	Purpose of Data
Thermal	Heat content, volatile matter content	Applicability of technology to contaminants and estimate need for supplemental fuel
Ancillary		
Thermal Oxidation of Gas Phase VOCs	Halogen content	Refractory design, flue gas ductwork specification, APC requirements
Catalytic Oxidation of Gas Phase VOCs	[Note: Generally, the data needs for evaluating thermal processes include the data needed for physical treatment.]	
Biological	Gross organic components (BOD, TOC)	Waste strength and type, need for supplemental organic substrate
Extracted Groundwater Treatment	Chemical Analyses (VOCs, SVOCs, pesticides/PCBs, inorganics)	Toxicity to process microbes
	Dissolved Oxygen (during operation of system)	Aerobic reaction rates/ interference with anaerobic system
	pH	pH adjustment
	Nutrient analysis (NH_3, NO_3, PO_4, Ca, Mg, Fe, Na, K)	Nutrient requirements
	Oxidation/reduction potential	Chemical competition /reactions
	Influent temperature	Reaction kinetics

Notes: APC = air pollution control.
BOD = biological oxygen demand.
Ca = calcium.
COD = chemical oxygen demand.
DO = dissolved oxygen.
Fe = iron.
PO_4 = phosphates
TDS = total dissolved solids.
TSS = total suspended solids.
K = potassium.
Mg = magnesium.
Na = sodium.
NH_3 = ammonia.
NO_3 = nitrate.
PCB = polychlorinated biphenyls.
SVOC = semivolatile organic compounds.
TOC = total organic carbon.
VOC = volatile organic compounds.
UV = ultraviolet.

REFERENCES

ABB Environmental Services, Inc. (ABB-ES), 1991. Potential Source of Contamination (PSC) Site Investigation/Solid Waste Management Unit (SI/SWMU) RCRA Facility Investigation (RFI) Work Plan Naval Submarine Base, Kings Bay, Georgia. Contract Task Order No. 030 Navy CLEAN - District 1, Contract No. N62467-89-D-0317. October.

ABB Environmental Services, Inc. (ABB-ES), 1992a. RCRA Facility Investigation/Site Inspection Technical Memorandum No. 1, Naval Installation Restoration Program, Navel Submarine Base, Kings Bay, Georgia. Contract No. N63467-89-D-0319. June.

ABB Environmental Services, Inc. (ABB-ES), 1992b. RCRA Facility Investigation/Site Inspection Technical Memorandum No. 2, Naval Installation Restoration Program, Naval Submarine Base, Kings Bay Georgia. Contract No. N63467-89-D-0317. July.

ABB Environmental Services, Inc. (ABB-ES), 1992c. RCRA Facility Investigation/Site Inspection Technical Memorandum No. 3, Naval Installation Restoration Program, Naval Submarine Base, Kings Bay Georgia. Contract No. N63467-89-D-0317. September.

ABB Environmental Services, Inc. (ABB-ES), 1992d. Phase I Interim Investigation, Memorandum, Site 11, Naval Installation Restoration Program, Naval Submarine Base, Kings Bay, Georgia. September.

ABB Environmental Services, Inc. (ABB-ES), 1992e. RCRA Facility Investigation/Site Inspection Technical Memorandum No. 4, Volume I, Site 11, Old Camden County Landfill, Naval Installation Restoration Program, Naval Submarine Base, Kings Bay Georgia. Contract No. N63467-89-D-0317. December.

ABB Environmental Services, Inc. (ABB-ES), 1992f. Technical Work Plan Interim Corrective Measure Screening Investigation - Site 11 RCRA Facility Investigation NSB, Kings Bay, Georgia. Contract Task Order No. 041 Navy CLEAN-District 1, Contract No. N62467-89-D-0317. October.

ABB Environmental Services, Inc. (ABB-ES), 1993a. RFI Interim Report for Site 11, Naval Installation Restoration Program, Naval Submarine Base, Kings Bay, Georgia. Contract No. N62467-89-D0317. August.

ABB Environmental Services, Inc. (ABB-ES), 1993b. Interim Corrective Measure Screening Investigation Report - Site 11 RCRA Facility Investigation, Naval Submarine Base, Kings Bay, Georgia. Contract Task Order No. 041 Navy CLEAN - District 1, Contract No. N62467-89-D-0317. February.

ABB Environmental Services, Inc. (ABB-ES), 1993c. RCRA Facility Investigation/Site Inspection Technical Memorandum No. 5, Volume I, Site 11, Old Camden County Landfill, Naval Installation Restoration Program, Naval Submarine Base, Kings Bay, Georgia. Contract No. N634467-89-D-0317. March.

Bureau of National Affairs, Inc. 1991. Georgia Surface Water Criteria, Georgia Water Quality Control Specifications and Standards. August.

Georgia Department of Natural Resources. 1992. Georgia Drinking Water Standards, Rules for Safe Drinking Water. Chapter 391-3-5, Revised July 1992.

Montgomery, John, H., and Linda M. Welkon, 1989. Groundwater Chemicals Desk Reference. Lewis Publishers, Inc. Chelsea, Michigan.

Montgomery, John, H., 1991. Groundwater Chemicals Desk Reference, Vol. 2. Lewis Publishers, Inc., Chelsea, Michigan.

NIOSH, 1990. NIOSH Pocket Guide to Chemical Hazards. U.S. Department of Health and Human Services. Washington, D.C., June.

U.S. Environmental Protection Agency (USEPA), 1988a. RCRA Corrective Action Plan (Interim Final). Office of Solid Waste, Office of Waste Programs Enforcement. EPA/530-SW-88-028. June.

U.S. Environmental Protection Agency (USEPA), 1988b. Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA. Office of Emergency and Remedial Response, Office of Solid Waste and Emergency Response. EPA/540/G-89/004. October.

U.S. Environmental Protection Agency (USEPA), 1989. Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual. (Part A) Interim Final. Office of Emergency And Remedial Response, EPA/540/1-89/002.

U.S. Environmental Protection Agency (USEPA), 1990. Second Forum on Innovative Hazardous Waste Treatment Technologies: Domestic and International. Philadelphia, Pennsylvania. Office of Solid Waste and Emergency Response, Office of Research and Development. EPA/540/2-90/009. September.

U.S. Environmental Protection Agency (USEPA), 1992. The Superfund Innovative Technology Evaluation Program: Technology Profiles. Office of Solid Waste and Emergency Response, Office of Research and Development. EPA/540/R-92/077. November.

U.S. Environmental Protection Agency (USEPA), 1993a. Vendor Information System for Innovative Treatment Technologies (VISITT). Office of Solid Waste and Emergency Response. June 1993.

U.S. Environmental Protection Agency (USEPA), 1993b. Remediation Technologies Screening Matrix. USEPA Office of Solid Waste and Emergency Response and U.S. Air Force Environics Directorate. July.