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SUPPLEMENTAL RESOURCE CONSERVATION AND RECOVERY ACT FACILITY
INVESTIGATION SAMPLING AND ANALYSIS PLAN FOR SITE 11 VOLUME II NSB KINGS
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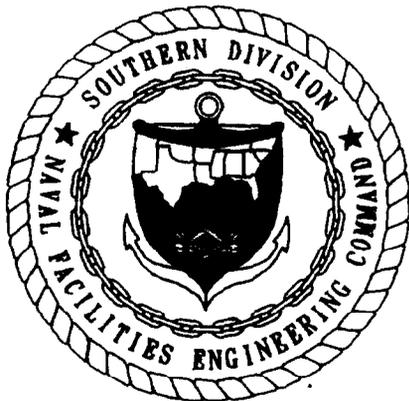
**SUPPLEMENTAL RESOURCE CONSERVATION AND
RECOVERY ACT FACILITY INVESTIGATION
SAMPLING AND ANALYSIS PLAN FOR SITE 11**

VOLUME II, SAMPLING AND ANALYSIS PLAN

**NAVAL SUBMARINE BASE KINGS BAY
KINGS BAY, GEORGIA**

**NAVY CLEAN, DISTRICT I
CONTRACT NO. N62467-89-D-0317**

AUGUST 1994



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



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.



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**SUPPLEMENTAL RESOURCE CONSERVATION AND RECOVERY ACT
FACILITY INVESTIGATION SAMPLING AND
ANALYSIS PLAN FOR SITE 11**

VOLUME II, SAMPLING AND ANALYSIS PLAN

**NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA**

Unit Identification Code No. N42237

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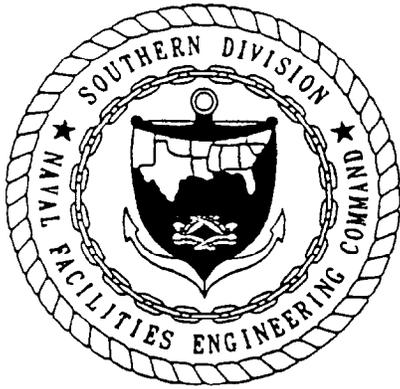
Block No. 19, Abstract

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.



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 and RCRA/HSWA-driven DOD IR program.

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

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

This sampling and analysis plan discusses the scope of the Supplemental RCRA Facility Investigation (RFI) to be conducted at Site 11, Naval Submarine Base (NSB), 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 Evaluation Assessment, Interim Corrective Measure, and Corrective Measures Study.

Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM) has the responsibility for implementation of the Navy 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 Sampling and Analysis Plan (SAP) is Volume II 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 (NSB), Kings Bay, Georgia. Volumes I and III of the planning documents are the Workplan and Health and Safety Plan, respectively.

The SAP includes the Field Sampling Plan (FSP) and the Quality Assurance Project Plan (QAPP). Together, the FSP and QAPP provide the technical approach and procedures for the field work to be conducted as part of the Supplemental RFI. The work to be conducted includes surface water and sediment sampling in Porcupine Lake, surface soil sampling at the landfill, subsurface soil sampling at locations in and around the landfill and in Crooked River Plantation Subdivision, installation of groundwater monitoring wells, groundwater sampling, sampling from test trenches excavated in the landfill, and air sampling. An ecological survey and public health survey will also be conducted.

The sampling and analytical program for samples collected during the Supplemental RFI was developed to provide information relating to contaminant characterization and to support a Health and Environmental Assessment, the Interim Measure, and Corrective Measures Study. The analytical program for the Supplemental RFI includes chemical and physical analyses. Chemical analyses for contaminant characterization will primarily be done using Contract Laboratory Program (CLP) protocol. However, because the NSB has an RCRA permit and is obligated to follow RCRA requirements, a subset of samples will be analyzed for USEPA (1992) Appendix IX constituents using SW-846 (USEPA, 1986) analytical protocol. CLP protocol was selected because the highest level of data quality can be achieved.

The SAP is intended as a working document for field personnel tasked with implementing the Supplemental RFI field work. The project purpose and description, environmental and geologic setting, site history, previous investigations, and project management are addressed in Volume I, Workplan, of the Supplemental RFI planning documents. A effort has been made to avoid duplication and/or triplication of information in the three volumes.

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GLOSSARY

ABB-ES	ABB Environmental Services, Inc.
APHA	American Public Health Association
AR	analytical reagent
ASTM	American Society for Testing and Material
bls	below land surface
BOD	biological oxygen demand
bss	below soil surface
$C_6H_8O_6$	ascorbic acid
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action, Navy
CLP	Contract Laboratory Program
CLP-RAS	Contract Laboratory Program-Routine Analytical Services
CMS	Corrective Measures Study
COC	chain-of-custody
COD	chemical oxygen demand
CMS	Corrective Measures Study
$^{\circ}C$	degrees Celsius
$^{\circ}F$	degrees Fahrenheit
DI	deionized
DOD	Department of Defense
DOT	U.S. Department of Transportation
DQO	Data Quality Objective
DRMO	Defense Reutilization and Marketing Office
E/T	engineering and treatability
EPA	Environmental Protection Agency
F/T	fate and transport
ft	feet
FOL	Field Operations Leader
FSP	Field Sampling Plan
g	gram
GC/MS	gas chromatography and mass spectroscopy
H_2S	hydrogen sulfide
H_2SO_4	sulfuric acid
HASP	Health and Safety Plan
HCl	hydrochloric acid
HCN	hydrogen cyanide
HEA	Health and Environmental Assessment
Herb/OP	herbicide and organophosphorus
HNO_3	nitric acid
HSWA	Hazardous and Solid Waste Amendments

GLOSSARY (Continued)

I.D.	identification
ID	inside diameter
IDW	investigation-derived waste
IM	Interim Measure
IR	Installation Restoration
KI	potassium iodine
L	liter
$\mu\text{g}/\ell$	micrograms per liter
$\mu\text{g}/\text{m}^3$	micrograms per cubic meter
mg/m^3	milligrams per cubic meter
m ℓ	milliliter
mm	millimeter
MS/MSD	matrix spike/matrix spike duplicate
N	normal
$\text{Na}_2\text{S}_2\text{O}_3$	sodium thiosulfate
NACIP	Naval Assessment and Control of Installation Pollutants
NaOH	sodium hydroxide
NEESA	Naval Energy and Environmental Support Activity
NSB	Naval Submarine Base
OVA	organic vapor analyzer
%	percent
PARCC	precision, accuracy, representativeness, completeness, and comparability
PCB	polychlorinated biphenyl
Pest/PCB	pesticide and polychlorinated biphenyl
PID	photoionization detector
PIW	private irrigation well
ppm	parts per million
psi	pounds per square inch
PVC	polyvinyl chloride
QA	quality assurance
QA/QC	quality control and quality assurance
QAM	Quality Assurance Manager
QAP	Quality Assurance Plan
QAPP	Quality Assurance Project Plan
QC	quality control
QRB	Quality Review Board
RCRA	Resource Conservation and Recovery Act
RE	Resident Engineer
RFI	RCRA Facility Investigation
RPD	relative percent difference
RPM	Remedial Project Manager

GLOSSARY (Continued)

SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SOP	Standard Operation Procedure
SOUTHNAVFACENGCOM	Southern Division, Naval Facilities Engineering Command
SOW	Statement of Work
SVOC	semivolatile organic compound
TAL	Target Analyte List
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TDS	total dissolved solid
TOC	total organic carbon
TOM	Task Order Manager
TSS	total suspended solid
USCS	Unified Soil Classification System
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
VOC	volatile organic compound

1.0 PROJECT DESCRIPTION

1.1 INTRODUCTION. The Sampling and Analysis Plan (SAP) is part of a three-volume set of the Supplemental Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) planning documents:

Volume I, Workplan,
Volume II, Sampling and Analysis Plan, and
Volume III, Health and Safety Plan (HASP).

Together the three volumes present the scope of the Supplemental RFI program. The Workplan (Volume I) discusses the purpose and regulatory setting and site history, details previous investigative results, and describes the environmental and geologic setting, the site investigative methodology, the project organization, and the schedule.

This SAP consists of two primary parts:

- Field Sampling Plan (FSP) (Section 2.0), and
- Quality Assurance Project Plan (QAPP) (Section 3.0).

The FSP and the QAPP have been incorporated into one document to provide one comprehensive reference that can be used by onsite field teams. This avoids triplication of many sections that are common to the Workplan, the FSP, and the QAPP (i.e., project purpose and description, environmental and geologic setting, site history, previous investigations, project organization, and schedule). These common sections are summarized in the Workplan.

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

The HASP (Volume III) outlines health and safety procedures for fieldwork being conducted as part of the Supplemental RFI for Site 11 at Naval Submarine Base (NSB), Kings Bay, Georgia. The HASP includes Material Safety Data Sheets for chemicals that may be encountered. The HASP also addresses health and safety procedures for work associated with an interim corrective measure at Site 11. The Interim Measure (IM) involves installation and operation of a pilot-scale groundwater extraction and treatment system. The scope of work for the IM is addressed in the IM Workplan (ABB-ES, 1993a).

1.2 PURPOSE AND REGULATORY SETTING. Previous investigations conducted at Site 11 indicated that a release to the environment has occurred from the waste disposed at the site. The previous investigations concentrated on defining the nature and extent of volatile organic compound (VOC) contaminants in groundwater in the surficial aquifer. The majority of data has been collected using screening technologies and confirmatory samples need to be collected to confirm the screening data.

The NSB has an RCRA permit and is required to follow RCRA regulations. The RCRA Corrective Action Program includes requirements to characterize the source of the release, to characterize impact to environmental media, and to implement corrective action. The RCRA Corrective Action Program uses a four-phase approach to identify, assess, and correct environmental problems associated with solid waste management units. Several steps of the RCRA Corrective Action Program are currently being conducted at Site 11. Planning for an IM and Corrective Measures Study (CMS) programs has begun and this Supplemental RFI program has been developed to support both the IM and CMS and to collect data in support of a Health and Environmental Assessment, as well as to address the information requirements outlined in the *RCRA Corrective Action Plan* (Interim Final, USEPA, 1988a).

2.0 FIELD SAMPLING PLAN

The FSP consists of two elements: site management and Supplemental RFI data collection. Site management (Subsection 2.1) comprises support activities for the data collection activities. Site management activities include mobilization, site access and security clearance, documentation, and field monitoring instrumentation. In addition, methods to be used for decontamination and control and disposal of investigation-derived wastes (IDWs) are included in this section.

Subsection 2.2, Supplemental RFI Data Collection, includes descriptions of the methods employed to gather information required to meet the Supplemental RFI objectives. Among these methods are subsurface soil sampling and analyses, monitoring well installation, groundwater sampling and analyses, test pit sampling at the landfill, ecological and public health surveys, and topographic and elevational surveys.

2.1 SITE MANAGEMENT. The following subsections describe mobilization activities, site access and security clearances, and documentation requirements for the fieldwork.

2.1.1 Mobilization The following activities will be performed at NSB Kings Bay as part of mobilization:

- staking and utility clearance (i.e., excavation permits) for all exploration and test pit locations;
- field team orientation, including acquisition of personnel badges and security clearances for work in secure areas; and
- field team and subcontractor health and safety meetings.

2.1.2 Site Access and Control NSB Kings Bay is an active base with various levels of security clearance for different areas of the base. Site 11 is located in the upper part of the base where routine security clearance is all that is necessary. No work is planned in controlled access areas. Where necessary, security police will be notified of the locations of on-base field activities. Badges will be obtained through base security. All sites are accessible from paved or dirt roads maintained by the base.

2.1.3 Documentation Records of all procedures performed during the RFI field investigation will be maintained as described below.

2.1.3.1 Field Logbooks Daily reports of investigative activities, including field data, will be kept in bound, weatherproof field logbooks. These logbooks will be maintained by the field team. Field personnel will be responsible for daily data entry in the field logbooks. The Field Operations Leader (FOL) will be responsible for reviewing the quality of the data entered in the logbooks and will maintain custody of the logbooks. Data entry into the logbooks, and any other onsite document (e.g., forms and notebooks), will be written in black ink and initialed by the author. Entry errors will be crossed out with a single line and initialed and dated by the author.

Field personnel will record in the field logbooks detailed documentation of daily events. Logbook entries can include such data as the names of onsite personnel, weather conditions, field sketches and maps, and unusual conditions (e.g., well tampering). Investigative and sampling activity entries can include sample designations and locations, sampling equipment used, field measurements, sample collection, sample handling, and shipping and decontamination events.

2.1.3.2 Field Change Logbook Field Change Logs will be maintained during the field investigation program to document deviations from the project Workplan and SAP. The FOL will be responsible for completing the log. At the end of the project, the Field Change Logs will be bound into a notebook labeled Field Change Logbook.

2.1.3.3 Field Data Sheets and Logs Field data sheets and logs are used to record specific data collected during the investigation or specific events of the investigation (e.g., lithologic description, equipment calibration, and chain-of-custody record). Field data sheets and logs will be maintained by field team personnel, who will document sample location and information, field measurements, soil identification, boring information, and equipment calibration. Sample field data sheets are part of Appendix A and include the chain-of-custody record, the boring log, the field instrument and quality assurance record, the well development log, the monitoring well construction log, the field change request form, the test pit log form, the groundwater sampling form, and other miscellaneous field data record forms. All field data sheets and logs will be maintained in the project files.

2.1.3.4 Plans A copy of the Supplemental RFI Workplan, SAP, and HASP will be kept onsite. As appropriate, copies of these plans will be provided to field team members.

2.1.4 Field Monitoring Instrumentation The following monitoring instruments may be used during field activities:

- photoionization detector (PID),
- organic vapor analyzer (OVA),
- explosimeter,
- radiation meter,
- pH-temperature-specific conductance meter,
- electronic water level meter,
- metal detector,
- two-way radios or cellular telephones,
- oil-water interface probe, and
- turbidity meter.

Instruments will be calibrated and inspected daily before field activities begin, as suggested by the manufacturers. Calibration information will be recorded in the field logbooks and on the field instrumentation quality assurance form. Monitoring equipment will be protected, as much as possible without hindering operation of the unit, from contamination during field exploration activities. Equipment maintenance will be performed according to manufacturer specifications before field use, or by rotating instruments into and out of the field on an instrument performance and maintenance schedule. As appropriate, routine periodic maintenance may be performed as a function of field calibration. Malfunctioning instruments will be repaired or replaced.

2.1.5 Equipment Decontamination Procedures To assure that analytical results reflect only those target parameter concentrations present at a particular sampling location, chemical sampling and field analytical equipment must be properly decontaminated prior to the field effort, during the sampling program (i.e., between sample points), and at the conclusion of the sampling program. This will minimize the potential for cross contamination between sample points and the transfer of contamination off site. Field decontamination procedures conducted during a field event will be documented in the field logbooks.

This section addresses the decontamination procedures for chemical sampling and field analytical equipment, as well as for drilling equipment. To clarify the decontamination procedures, the following definitions have been used:

Detergent. Detergent will be a standard brand of phosphate-free laboratory detergent such as Alconox™ or Liquinox™.

Acid solution. Acid solution will be made from reagent-grade nitric acid and deionized water.

Solvent. Solvent shall be pesticide-grade isopropanol.

Tap or potable water. Tap or potable water will be treated water from any municipal water treatment system.

Deionized water. Deionized water will be tap water that has been treated by passing through a standard deionizing resin column.

Organic-free water. Organic-free water will be tap water that has been treated with activated carbon and deionizing units. The water should contain no pesticides, herbicides, extractable organic compounds, and less than 50 micrograms per liter ($\mu\text{g}/\ell$) of purgeable organic compounds as measured by a low level gas chromatography and mass spectroscopy (GC/MS) scan. This organic-free water will be used for blank preparation and for final rinse in decontamination (where applicable). Laboratory analyses of equipment blanks will provide documentation as to the purity of the water source. Analyses will be by Contract Laboratory Program (CLP) procedures.

2.1.5.1 Field Decontamination Procedures The following U.S. Environmental Protection Agency (USEPA) Region IV field decontamination procedures will be followed.

Sampling Equipment for Chemical Analysis. Teflon™, stainless-steel, glass or metal sampling equipment used to collect samples for chemical analysis will be cleaned between sample locations as listed below.

1. Wash and scrub equipment thoroughly with detergent and tap water.
2. Rinse thoroughly with tap water.
3. Rinse thoroughly with deionized water.
4. Rinse with solvent (pesticide-grade isopropanol).
5. Rinse with organic-free water and allow to air dry as long as possible.

6. If organic-free water is not available, allow equipment to air dry as long as possible. Do not rinse again with deionized or distilled water.

2.1.5.2 Large Equipment Decontamination Large equipment (e.g., drill rigs, augers, drill pipe, backhoes, and casing) will be cleaned prior to use and between sample locations as outlined below.

Cleaning Procedures Prior to Initiation of Fieldwork. Any part of a drill rig or backhoe that will be over the borehole or sampling location (e.g., kelly bar and mast, drilling platform, hoist or chain pulldowns, spindles, cathead, and backhoe buckets) will be decontaminated prior to arriving at the site as described below.

1. Steam clean and wire brush to remove soil and rust.
2. Inspect to confirm that seals and gaskets are intact and that there are no residual oils, grease, or hydraulic fluids that could drip into the sample location.
3. Steam clean the drill rig prior to drilling each borehole.

Cleaning Procedures for Downhole Equipment. Drilling, sampling, and associated equipment that will come in contact with the downhole sampling medium will be cleaned as outlined below.

1. If caked mud, rust, and/or paint is present that cannot be removed by steam or high pressure wash, the downhole equipment will be sandblasted prior to arrival onsite.
2. Once onsite, the downhole equipment will be washed and scrubbed with tap water and detergent.
3. If necessary, steam clean and/or high pressure wash to remove soils. The steam cleaner or high pressure washer should be capable of generating a pressure of at least 2,500 pounds per square inch (psi) and producing hot water and/or steam (200 degrees Fahrenheit (°F) and above); allow equipment to air dry.
4. Printing and/or writing on well casing, screens, tremie tubing, and so forth, will be removed with emery cloth or sand paper prior to arrival onsite. Where possible, materials without printing or writing will be ordered.

2.1.5.3 Decontamination Staging Area and Fluid Disposal Cleaning and decontamination of equipment will occur at the decontamination pad constructed as part of the IM start-up activities. The pad will be concrete and will be sloped to drain to a collection sump. Large portable equipment (e.g., drill rods, auger flights, well casing, and screen) will be cleaned on saw horses or other supports.

Wash water collected in the sump will be pumped into a storage tank and will be bled into the influent of the IM treatment system. Sediment collected in the

sump will be removed periodically and will be stored in a rolloff storage bin with other soil IDW.

In the event clean sampling utensils (e.g., split-spoons, bowls, or spatulas) are needed at a boring location, these items may be decontaminated on location. The resulting decontamination fluids will be contained and later placed in the sump at the onsite decontamination pad. The resulting decontamination sediments, if any, will be contained in the sump and later placed in the rolloff bin.

2.1.6 Control and Disposal of Investigation-Derived Waste IDW associated with the Supplemental RFI field program can include soil cuttings, drilling mud, groundwater, decontamination water and solutions, and expendable materials such as sample gloves, paper towels, and tin foil. Handling and disposal of IDW are addressed in the IDW Management Plan for the Supplemental RFI and IM at Site 11 (ABB-ES, 1993b) and are discussed below.

Roll-off storage containers will be used to store drill cuttings and solids collected in the sump at the decontamination pad. Each container will have a 20 cubic yard capacity and a removable top. The gate-end of the roll-off containers will be lined with Visqueen™ to prevent potential leakage of any free liquid contained in the drill cuttings.

Liquid waste will be stored in 55-gallon drums and in 20,000-gallon capacity Baker water storage tanks.

The IDW will be segregated by medium, liquids (groundwater, development water, etc.) and solids (soils, expendables, etc.). Liquid IDW will be derived from two sources: (1) groundwater, generated during sampling and purging of monitoring wells and (2) wastewater, generated from decontamination procedures.

Liquid IDW will be collected from each point source (e.g., monitoring well, recovery well, etc.) and temporarily stored in 55-gallon drums or in mobile (truck- or trailer-mounted) 1,000-gallon capacity polyethylene tanks. Closed drums or tanks of liquid IDW will be transported to the secure, onsite storage area. Liquid from the drums or tanks will be pumped into the Baker water storage tanks. The liquid IDW will be stored in the Baker water storage tanks until it can be bled into to the influent of the IM treatment system.

Solid IDW will be derived from three sources: (1) the advancement of soil borings, (2) the installation of monitoring and recovery wells, and (3) disposable protective clothing, gloves, Visqueen™, and other expendable materials.

Solid wastes such as soils and drilling muds will be stored in the roll-off containers. Solid waste at each point source will be containerized, secured, transported to the storage area, and transferred to a roll-off container. A logbook will be kept, in which the sources of the contents in each container will be noted. The amount of solid waste from each point source will also be recorded as accurately as possible.

Roll-off containers for soil and drill cuttings will be positioned such that the rear of the container (the end with the gate) is slightly elevated, creating a positive slope away from the gate. This slope will allow any free liquids to collect at the front end. Acrylonitrile butadiene styrene drain tiles and a

stand pipe will be placed in the bottom front of the roll-off container to allow the field crew to monitor and remove free liquids that may accumulate. The liquids collected will be filtered, then managed as other liquid IDW discussed herein. The filter cake will be returned to a roll-off container.

Expendables will be segregated from other solids. Under no circumstance will expendables be combined with soils, drilling muds, etc. Expendables will be double-bagged in plastic bags and disposed in an NSB solid waste dumpster. Excessively soiled material will be washed at the decontamination pad to remove loose particles before disposal.

Liquid IDW will be processed through the IM pilot-scale treatment system. Effluent from the system is scheduled for both onsite screening and offsite laboratory analyses, which will be conducted as outlined in the IM Workplan (ABB-ES, 1993a). Details of the sampling schedule and required analyses of the effluent samples are given in the IM Workplan (ABB-ES, 1993a). Onsite analyses will include a select list of VOCs. Onsite analyses will be conducted in accordance with USEPA Region IV Level II Data Quality Objectives (DQOs), using an onsite gas chromatograph. Samples will be analyzed using a modification of USEPA Methods 8010 and 8020. The offsite laboratory program is summarized in Table 2-1.

Table 2-1
Summary of Offsite Laboratory Program for Effluent

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

Parameter	Analytical Method	Constituent
Volatle organic compounds	USEPA SW-846 Method 5030/8010 and 5030/8020 (modified) ¹	Benzene 1,2-Dichloroethane cis-1,2-Dichloroethene trans-1,2-Dichloroethene Ethylbenzene Tetrachloroethene Toluene Trichloroethene Xylenes (total) Vinyl chloride
Metals	USEPA SW-846 Method 6010 ¹	Cadmium Chromium Iron Manganese Lead
Total suspended solids	EPA Method 1602 ²	

¹ Test Methods for Evaluating Solid Waste, Physical Chemical Methods, SW-846, 3rd Edition, USEPA, 1986.

² Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, USEPA revised March 1983.

Notes: VOC = volatile organic compound.
USEPA = U.S. Environmental Protection Agency.
TSS = total suspended solids.

Composite soil samples for laboratory analyses will be collected from each roll-off container. Samples will be collected and analyzed in accordance with USEPA Region IV Level III DQOs. Each roll-off will be sampled by quadrants. Three discrete soil samples (aliquots) will be collected from each quadrant. Discrete samples will be collected from the near surface (approximately 1 foot below soil surface [bss]), the middle of the waste pile, and at the bottom of the container. A total of 12 aliquots will be retrieved from each roll-off container. The aliquots will be placed in a stainless-steel bowl and thoroughly mixed with a stainless-steel spoon or spatula. The mixed soil will then be placed into the appropriate sample containers, labeled, placed on ice in a cooler, and shipped to a laboratory for analyses. One soil sample per roll-off container will be analyzed by Toxicity Characteristic Leaching Procedure (TCLP) for all TCLP parameters.

Disposal of the soil sediments will be determined after the TCLP soil analytical data have been received and evaluated. If the analytical results for the IDW do not indicate quantifiable values, the sediments will be disposed of within the limits of Site 11. If the analytical results for the IDW are less than the TCLP threshold values but have quantifiable concentrations, the IDW will be disposed of in an RCRA Subtitle D landfill. If the analytical results for the IDW are greater than the TCLP threshold values, the IDW will be considered a hazardous waste.

All wastes scheduled for offsite disposal will be disposed through the Defense Reutilization and Marketing Office (DRMO). Hazardous waste containers will be labeled as hazardous and the IDW disposed through the DRMO with a hazardous waste manifest. Upon confirmation of hazardous characteristics, hazardous waste will be removed from the site in no less than 3 and no more than 90 days. Labeling, documentation, and transfer of the hazardous waste to the Base Operating Services Contractor will be accomplished in accordance with SUBASE INST 509.1A of July 11, 1989, Hazardous Waste Management Plan.

2.2 SUPPLEMENTAL RESOURCE CONSERVATION AND RECOVERY ACT FACILITY INVESTIGATION DATA COLLECTION. This subsection provides a description of each investigative technique to be used during the Supplemental RFI field program. Additional information is presented in the QAPP, Section 3.0, regarding sampling techniques and collection of samples for QA/QC purposes.

2.2.1 Surface Water and Sediment Sampling Surface water and sediment samples will be collected from five locations in Porcupine Lake (Figure 2-1). A boat will be used to access sample locations.

Four of the sediment samples and four of the surface water samples will be analyzed for all Target Compound List (TCL) and Target Analyte List (TAL) constituents, including cyanide and sulfide. One sediment sample and one surface water sample will be analyzed for USEPA (1992) Appendix IX constituents. Sediment samples will also be analyzed for total organic carbon (TOC). The analytical data for the surface water and sediment samples will be used to evaluate for migration of contaminated groundwater from Site 11 to the lake. Surface water samples will be collected within 1 foot of the bottom of the lake using a Beta sampling bottle. The bottom of the lake is the point of closest discharge of groundwater to surface water.

Sediment samples will be collected using a stainless-steel gravity corer. Samples for VOC analysis will be collected in a Teflon™ or stainless-steel sleeve contained inside the corer. The sleeve will be sealed air-tight at both ends before delivery to the laboratory. The sediment sample material for other analyses will be collected by compositing multiple sediment cores into a stainless-steel bowl or bucket until the volume required for the analyses is obtained. The sediments will be mixed thoroughly with a stainless-steel spoon or spatula and divided into the appropriate sample containers for shipment.

Surface water samples will be collected with a Beta sampling bottle. A Wildco Horizontal Beta Plus Bottle will be used. This device is constructed of a polyvinyl chloride (PVC) container, latex closing tubes, silicone gaskets, and stainless-steel trip mechanism. The samples will be collected according to American Society for Testing and Materials (ASTM) D 4136-82, Standard Practice for Sampling Phytoplankton with Water-Sampling Bottles, as described in Subsection 3.5.5.2 of this document.

2.2.2 Air Sampling The air quality evaluation for the RFI includes characterization of baseline air quality at the site and characterization of air quality during excavation of test trenches at the landfill. The air quality sampling program to be conducted during excavation of test trenches includes monitoring at the site perimeter and in nearby residential areas.

2.2.2.1 Baseline Air Quality Characterization Prior to conducting intrusive activities at the site (soil borings, test trenches, and surface soil sampling), an air monitoring program will be conducted to evaluate baseline air quality. A portable meteorological station capable of monitoring wind speed, wind direction, and temperature will be set up at the site. The meteorological station will be used to assist in the selection of upwind and downwind site perimeter monitoring stations. One upwind station and two downwind stations will be established. Sample stations will be located on platforms at approximate breathing height level (4 to 6 feet aboveground). To accommodate shifts in wind direction, the sampling locations will be selected on the morning of each day of testing. During the testing, if a sustained (greater than 1 to 2 hours) wind shift is observed, sampling will be temporarily suspended, and the sampling station locations will be moved to maintain the upwind and downwind monitoring network design.

Baseline air monitoring will be conducted during favorable meteorological conditions (i.e., no precipitation, low winds, and ambient temperature greater than 45 degrees Fahrenheit [°F]).

A total of three, 1-day sampling events will be conducted. Samples will be collected over an 8- to 9-hour period. Each sampling event will consist of the collection of one sample at each of the sampling locations. Additionally, one of the downwind stations will be sampled in duplicate for quality control (QC). Therefore, 4 samples will be collected for each of 3 sampling events, yielding a total of 12 samples. Sampling and analysis will be conducted in accordance with USEPA Method TO-1. Parameters for analyses include TCL VOCs. Sampling and analytical methodology are described the QAPP, Subsection 3.5.7.

2.2.2.2 Air Monitoring During Excavation Air monitoring during excavation of test trenches includes real-time measurements and collection of laboratory samples at the site perimeter. Additionally, air samples will be collected in

nearby residential areas to evaluate the potential for exposure of offsite receptors to VOCs in air.

Perimeter Monitoring and Real-time Measurements. During excavation, air monitoring will be conducted at the site perimeter to evaluate concentrations of vinyl chloride, which may result from disturbance of the site soils. To protect the health of onsite personnel and nearby, offsite receptors, an action limit of one half of the Occupational Safety and Health Administration permissible exposure limit is proposed, equivalent to 0.5 parts per million (ppm) or 1.28 milligrams per cubic meter (mg/m^3).

The nearest receptor, a residential home, is located approximately 200 to 300 feet from the site. It is assumed that with dilution from the air dispersion, a concentration of $1.28 \text{ mg}/\text{m}^3$ or less at the site fence line will result in receptor exposures less than the negligible risk level of 0.027 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$). As described below, the validity of this assumption and the adequacy of the proposed perimeter action limit will be evaluated via residential exposure monitoring during site excavation.

Perimeter monitoring during site excavation will be conducted using stain detector tubes. This methodology has been selected because it will provide inexpensive, real-time data specific to vinyl chloride and at a sufficiently low detection limit equivalent to the 0.5 ppm action limit. Stain detector tubes that will detect vinyl chloride at levels below 0.5 ppm are available from several manufacturers. Action limit monitoring will be conducted at one upwind and two downwind locations at a frequency of three times per day during excavation. If vinyl chloride is detected at a level lower than the action limit, monitoring will be increased to a rate of once per hour, until non-detectable levels are reached. In the event that action limits are detected, the FOL will be immediately notified, and the excavation in progress will be backfilled in an attempt to eliminate the emission.

Perimeter Monitoring and Collection of Laboratory Samples. As a supplement to the action limit monitoring for vinyl chloride, additional VOC sampling and analysis will be conducted at the site perimeter. The objective of this air monitoring will be to validate the vinyl chloride measurements obtained via the stain detector tubes and to evaluate the impact of site excavation on the site air quality, relative to the baseline levels.

Three perimeter monitoring events are proposed during site excavation activities. The perimeter monitoring events will be scheduled to occur during periods of "worst case" excavation, for the evaluation of the maximum air quality impact of site activities.

Perimeter monitoring for VOCs will be conducted using the identical procedures identified above for the baseline air monitoring, including the daily designation of one upwind and two downwind sampling locations. One of the downwind stations will be sampled in duplicate for QC. Sampling and analysis will be conducted in accordance with USEPA Method TO-1 (using an alternative sorbent material) for the evaluation of TCL VOCs (including vinyl chloride)(USEPA, 1988c). As with the baseline event, 4 samples will be collected for each of the 3 sampling events, yielding 12 samples.

Residential Area Air Monitoring. In addition to the site perimeter air monitoring, air quality in the nearby residential areas will be evaluated to confirm that site excavation activities do not result in adverse exposures to offsite receptors.

Air monitoring will evaluate vinyl chloride concentrations near three residences located downwind of the site during a period of "worst case" excavation activity. As with the other air monitoring tasks, the sample locations will be selected on the day of testing, with the assistance of the onsite meteorological station.

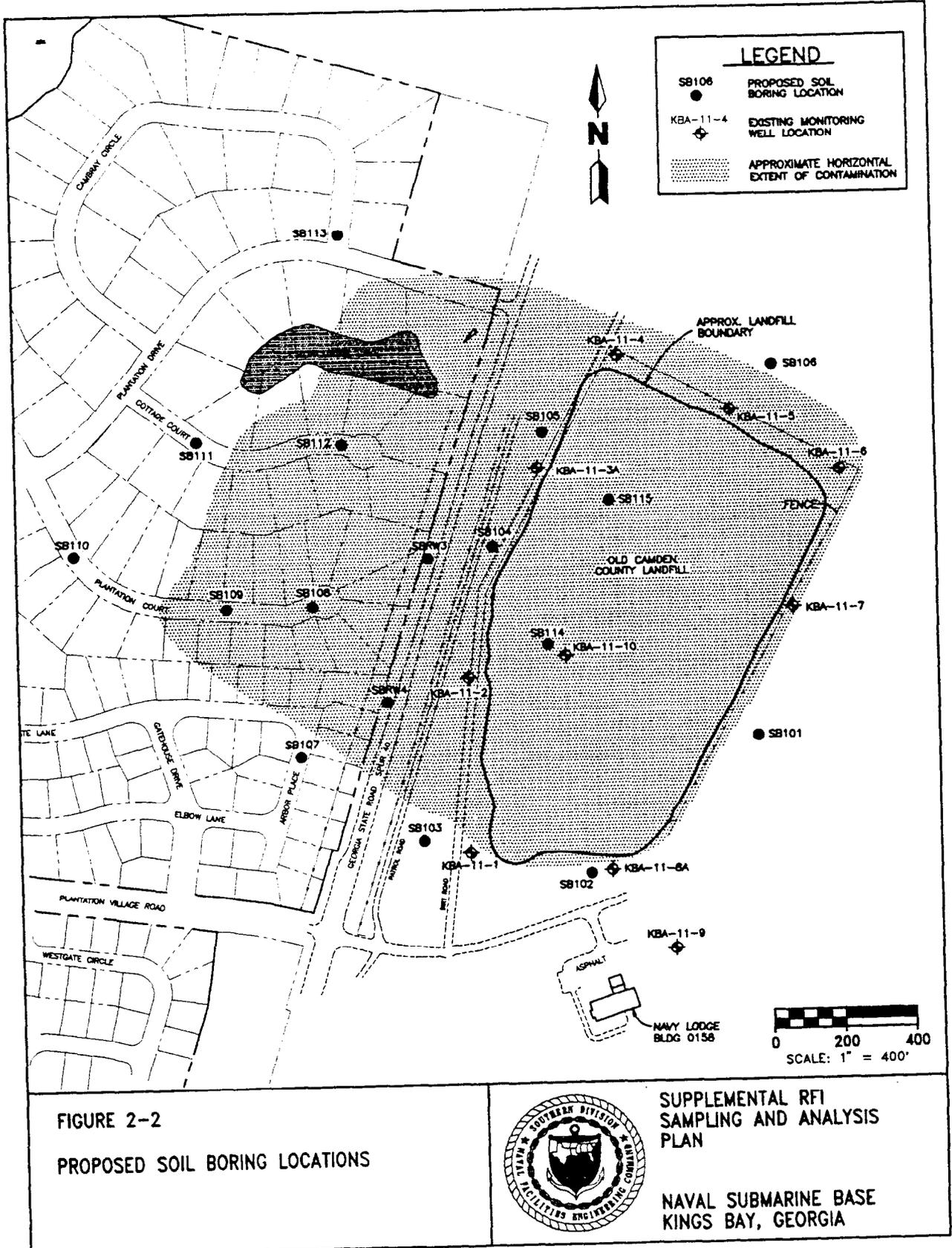
In addition to the three residential area samples, one additional station will be established upwind of the site. This sampling location will be used to evaluate a "background" concentration for vinyl chloride and other VOCs. Efforts will be made to locate this sampling station in an area that will not be impacted by the site or other localized potential sources of vinyl chloride or other VOCs. Obtaining a credible background concentration is essential to the success of the residential measurement program; the risk-based vinyl chloride concentration target is extremely low and it is important to evaluate background levels of this air contaminant as well as levels that may be attributed to site activities.

Three sampling events in the residential area are planned, using the same methodology as described in the baseline program. Including the background samples, a total of 12 samples will be generated for the residential air monitoring program.

Results of the residential air monitoring program will be used to confirm that offsite receptors have not been exposed to excessive concentrations (greater than the negligible risk concentration of $0.027 \mu\text{g}/\text{m}^3$) of vinyl chloride or other VOCs as a result of site activities. The perimeter action limit will be re-evaluated after receiving the results of the residential air monitoring and adjusted, if necessary.

2.2.3 Subsurface Soil Sampling Fifteen soil borings will be advanced during the Supplemental RFI field program for the purpose of collecting subsurface soil samples. Figure 2-2 shows the proposed soil boring locations. Results of previous investigations were used to develop the locations shown on Figure 2-2. Figure 2-2 also shows the approximate horizontal extent of VOC contamination in the groundwater beneath the study area, which helped determine, in part, the locations of the proposed soil borings. Using sound drilling practices, the borings will begin in the area of least contamination and proceed to the area of greatest contamination. Field personnel should complete soil borings outside the shaded area shown on Figure 2-2 before drilling at locations within the shaded area. Once all the borings outside the plume (shaded area) are complete, drilling should be performed at the farthest locations from the landfill and proceed toward the landfill, completing borings SB114 and SB115 last.

The depth of each boring will vary according to sample target depths and the total sample number and will vary from 60 to 92 feet below land surface (bls). Based upon subsurface conditions, OVA readings, or evidence of contamination, the total depth of each boring may be varied as needed. Soil samples will be collected from each boring for the purposes of lithologic characterization and physical and chemical analyses. During advancement of the borings and the collection of samples, air quality in the breathing zone will be monitored using an OVA.



Because of the fine-grained sediments beneath the site and borehole instability, the mud-rotary drilling method will be used to advance each boring. If conditions are encountered where mud-rotary drilling cannot be used, alternative drilling methods will be evaluated and the best method selected.

Upon completion of the sampling program, each boring will be abandoned. Each boring will be grouted using a mixture of neat cement and 2 to 4 percent of bentonite. The abandonment program will use the tremie pipe method and grout from bottom to top.

Subsurface soil samples are being collected for four purposes: (1) lithologic characterization, (2) analyses of fate and transport parameters, (3) contamination characterization chemical analyses, and (4) analyses of parameters for evaluation of *in situ* bioremediation. Split-spoon samplers, Shelby tubes, and ring samplers (brass sleeves that fit inside a split spoon) will be used to collect subsurface soil samples. Split-spoon soil samples will be collected at 5-foot intervals in all soil borings. Ring samplers and/or Shelby tube samplers will be used to obtain relatively undisturbed samples for fate and transport analyses (particularly bulk density and permeability). Stainless-steel split-spoon samplers 3 inches in diameter will be needed to obtain sufficient volume of sample material for analyses.

Split-spoon samples will be collected and lithologically characterized by field personnel using the Unified Soil Classification System (USCS). Depth intervals for sample collection have been predetermined based on previous investigative results. Table 2-2 summarizes the subsurface soil sampling program for the Supplemental RFI. As shown on Table 2-2, not all soil borings are targeted for collection of samples for chemical and/or physical analysis. Elevated OVA readings at the source (i.e., screening of soil collected during routine split-spoon sampling) or evidence of contamination based on visual examination may be cause for changing the predetermined sample depth at a location or collection of additional samples for analysis.

Fate and Transport Parameters. Seven soil samples, including one duplicate sample, will be collected from borings assumed to be in areas outside the contaminant plume (see Figure 2-2) for analyses of selected engineering parameters and/or fate and transport evaluations. These samples will be collected from borings SB101 and SB111 (see Figure 2-2). Four geologic layers were identified during piezocone penetrations conducted in previous investigations at the site (Figure 2-3). Two samples will be collected from each of the uppermost three layers to aid in the evaluation of potential contaminant migration through the respective soil media. These analyses include bulk density, soil sorptive capacity, cation exchange capacity, organic carbon content, sieve and hydrometer analysis, Atterberg limits, and permeability. The uppermost three layers (Layers A, B, and C in Figure 2-3) were selected for these analyses because groundwater contaminants are migrating within these layers.

Subsurface soil samples will also be collected from areas outside the contaminant plume and archived for possible sorption capacity testing for contaminants other than VOCs. Archived soil samples will be collected from borings SB103 and SB110 (see Figure 2-2). These locations were selected because they are in areas outside the plume and spatially distributed over the study area. The sample material for these archived samples will be obtained during routine split-spoon

**Table 2-2
Subsurface Soil Sampling Program**

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Boring I.D.	Total Depth (ft bls)	Sample Depth (ft bls)	Sample I.D.	Analyses
SB101	92	15, 40, 60, 75 ¹	SB101C	Sorptive capacity
		20 to 22	SB10120	F/T parameters ²
		25 to 27	SB10125	TCL VOCs TCL SVOCs TCL Pest/PCB TAL inorganics Cyanide Sulfide
		45 to 47	SB10145	TCL VOCs TCL SVOCs TCL Pest/PCBs TAL inorganics Cyanide Sulfide
		50 to 52	SB10150	F/T parameters ²
		65 to 67	SB10165	F/T parameters ²
		70 to 72	SB10170	TCL VOCs TCL SVOCs TCL Pest/PCBs TAL inorganics Cyanide Sulfide
SB102	70			Lithologic sampling only
SB103	60	15, 30, 45, 60 ¹	SB103C	Archive for sorptive capacity
SB104	92	25 to 27	SB10425	TCL VOCs TCL SVOCs TCL Pest/PCBs TAL inorganics Cyanide Sulfide
		40 to 42	SB10440	TCL VOCs TCL SVOCs TCL Pest/PCBs TAL inorganics Cyanide Sulfide
SB105	80			Lithologic sampling only
SB106	60			Lithologic sampling only
SB107	60			Lithologic sampling only

See notes at end of table.

**Table 2-2 (Continued)
Subsurface Soil Sampling Program**

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Boring I.D.	Total Depth (ft bls)	Sample Depth (ft bls)	Sample I.D.	Analyses
SB108	60	40 to 42	SB10840	TCL VOCs TCL SVOCs TCL Pest/PCB TAL inorganics Cyanide Sulfide
		45 to 47	SB10845	Phosphate binding Nitrate + nitrite Heterotrophic bacteria
SB109	92			Lithologic sampling only
SB110	60	30 to 32	SB11030	Phosphate binding Nitrite + nitrate Heterotrophic bacteria
		15, 35, 45, 60'		Archive for sorptive capacity
SB111	60	15 to 17	SB11115	F/T parameters ²
		30 to 32	SB11130	F/T parameters ²
		35 to 37	SB11135	Phosphate binding Nitrate + nitrite Heterotrophic bacteria
SB112	75	50 to 52	SB11150	F/T parameters ²
		30 to 32	SB11230	TCL VOCs TCL SVOCs TCL Pest/PCBs TAL inorganics Cyanide Sulfide
		35 to 37	SB11235	Phosphate binding Nitrite + nitrate Heterotrophic bacteria
SB113	60			Lithologic sampling only
SB114	90	12 to 14	SB11412	TCL VOCs TCL SVOCs TCL Pest/PCBs TAL inorganics Cyanide Sulfide
SB115	90	12 to 14	SB11512	TCL VOCs TCL SVOCs TCL Pest/PCB TAL inorganics Cyanide Sulfide

See notes at end of table.

**Table 2-2 (Continued)
Subsurface Soil Sampling Program**

Supplemental Resource Conservation and Recovery
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Naval Submarine Base
Kings Bay, Georgia

Boring I.D.	Total Depth (ft bls)	Sample Depth (ft bls)	Sample I.D.	Analyses
SBRW4	75	15 to 17	SBRW415	TCL VOCs TCL SVOCs TCL Pest/PCBs TAL inorganics Cyanide Sulfide
SBRW4	75	25 to 27	SBRW425	TCL VOCs TCL SVOCs TCL Pest/PCBs TAL inorganics Cyanide Sulfide
SBRW3	75	15 to 17	SBRW315	TCL VOCs TCL SVOCs TAL inorganics Cyanide Sulfide
		25 to 27	SBRW325	TCL VOCs TCL SVOCs TAL inorganics Cyanide Sulfide
<p>¹ Sample is to be a composite prepared from the split spoon samples collected from the depths listed.</p> <p>² Fate and transport parameters include bulk density, cation exchange capacity, organic carbon content, sieve analysis, hydrometer analysis, Atterberg limits, and permeability. Bulk density, Atterberg limits, and permeability tests require undisturbed sample to be collected in split spoons with brass liners. After collection seal liners with plastic caps and affix label to exterior of brass liner.</p> <p>Notes: I.D. = identification. ft = feet. bls = below land surface. F/T = fate and transport. TCL = Target Compound List. VOCs = volatile organic compounds. SVOCs = semivolatile organic compounds. Pest/PCBs = pesticides/polychlorinated biphenyls. TAL = Target Analyte List.</p>				

sampling. The archived soil will be stored at the onsite trailer under the custody of the Resident Engineer (RE).

Chemical Parameters. Three background samples (one each from geologic layer A, B, and C) and six samples from within the contaminant plume will be collected for analysis of TCL VOCs, TCL semivolatile organic compounds (SVOCs), TCL pesticides and polychlorinated biphenyls (PCBs), TAL inorganics, cyanide, and sulfide. Background samples will be collected from boring SB101. Contaminant plume samples will be collected from borings SB104, SB108, SB112, SB114, and SB115. Depths for these samples are listed in Table 2-2. These analytical data will be used to characterize potential soil contaminants and to support the CMS.

Bioremediation Parameters. Four soil samples will be collected to aid in the evaluation of bioremediation as a potential corrective measure method. These samples will be analyzed for phosphate binding, nitrate+nitrite, and heterotrophic bacteria. Two samples will be collected from within the contaminant plume (SB108 and SB112) and the other two will be collected from areas assumed to be outside the plume (see Table 2-2 and Figure 2-2). Sample depths are indicated in Table 2-2.

Subsurface Soil Samples from IM Recovery Wells. In an effort to support and enhance the contaminant characterization program of the Supplemental RFI, four subsurface soil samples will be collected from borings advanced during the IM recovery well installation program. The soil samples will be collected from borings for recovery wells RW-3 and RW-4, which are located on the western right-of-way of Spur 40 (see Figure 2-2). Sample depths and associated analyses are listed on Table 2-2. Two of these samples will be analyzed for all TCL and TAL analytes plus cyanide and sulfide. The other two will be analyzed for TCL VOCs and SVOCs, TAL inorganics, cyanide, and sulfide.

2.2.4 Surface Soil Sampling Hand augers will be used to collect surface soil samples (0 to 1 foot bls) for laboratory analyses. Hand augers will be decontaminated prior to use and between each sampling location. The soil sample characteristics will be logged by field personnel using the USCS. Detailed sampling procedures are included in Subsection 3.5.3.2 of the QAPP.

Five composite surface soil samples will be collected from locations within the landfill and two additional composite surface soil samples will be collected from locations east of the landfill (background samples). The 26 grids in the landfill shown on Figure 2-4 are based on the magnetic survey grid. Each grid is 200 feet square. The magnetic survey base lines are surveyed and will be used for reference by field personnel. Each composite sample will be composed of soil collected from the center and each corner of the grid. Therefore, each composite soil sample will be prepared by mixing aliquots of soil from five discrete locations.

Four of the composite surface soil samples collected from the landfill and one of the background composite soil samples will be analyzed for all TCL and TAL analytes, plus cyanide and sulfide. The remaining background sample and the remaining sample collected from the landfill will be analyzed for USEPA (1992) Appendix IX constituents, excluding dioxins and furans. The data collected from this task will be used to support the risk assessment evaluation.

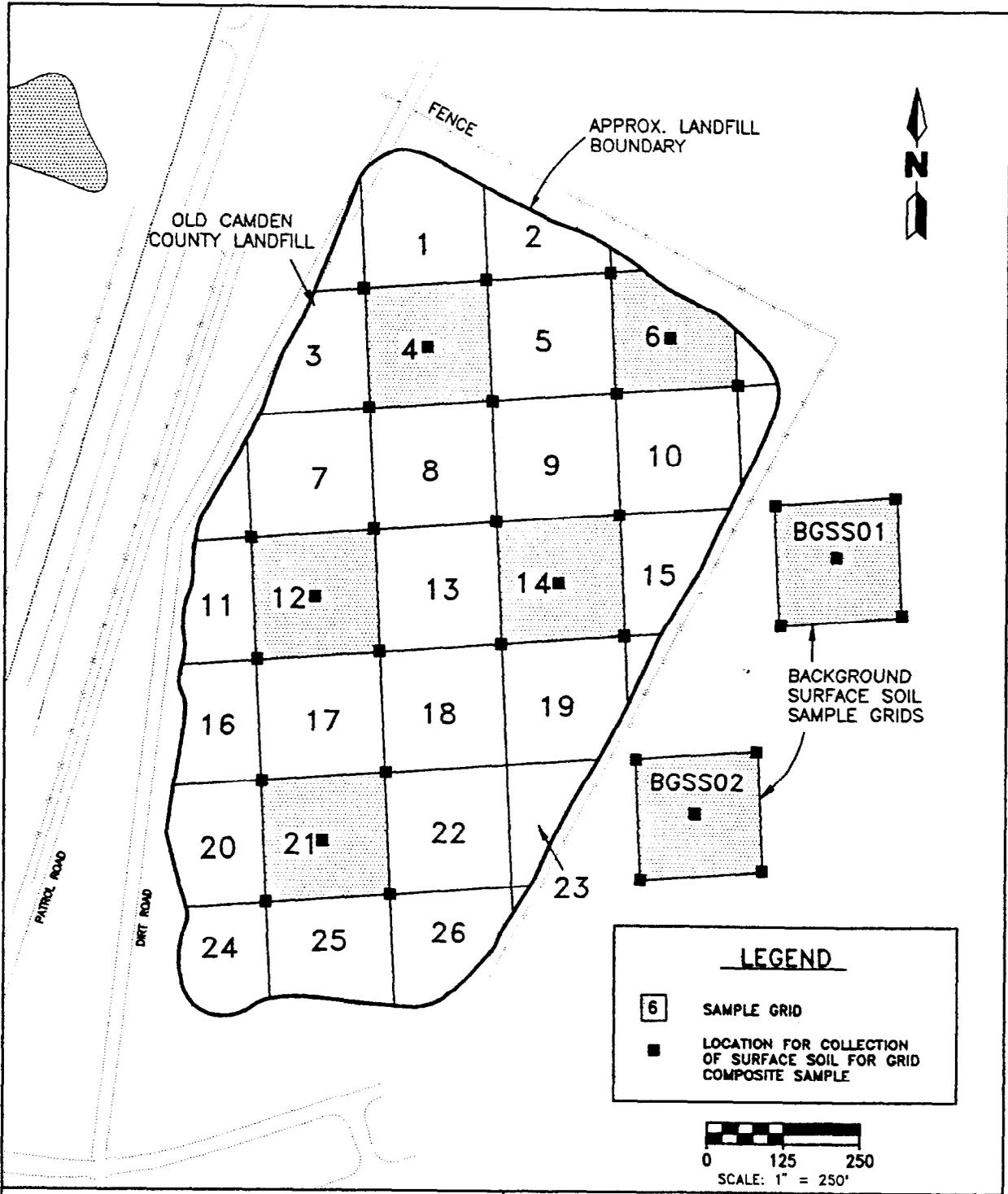


FIGURE 2-4

PROPOSED LOCATIONS FOR
COMPOSITE SURFACE SOIL SAMPLES



SUPPLEMENTAL RFI
SAMPLING AND ANALYSIS
PLAN

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

Additional surface soil samples may need to be collected from the subdivision to complete the risk assessment for the site. The need to collect these additional samples will be evaluated after the groundwater beneath the site and the subdivision has been further characterized. These additional surface soil samples will most likely need to be collected if contaminants other than VOCs, which have already been evaluated in the groundwater beneath the subdivision, are detected in the groundwater and the potential exists for contaminants to be conveyed to the surface by private irrigation wells (PIWs). The VOC data associated with sampling of PIWs in the subdivision do not indicate the potential for surface soil contamination.

2.2.5 Monitoring Well Installation Ten monitoring wells were installed to monitor the upper part of the surficial aquifer in previous investigations.

Twenty-five additional wells will be installed during the Supplemental RFI 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. Well screens will be placed at various depths within the surficial aquifer. Four wells will be screened below the contaminant plume to monitor clean groundwater beneath the plume and to possibly detect any encroachment the plume may have upon this deeper clean zone. The remaining 21 monitoring wells will be screened in the contaminant plume zone. The location and approximate screen depth of each monitoring well was selected based on the current knowledge of the contaminant plume and the local hydrogeology. In general, wells will be installed for confirmation sampling. The proposed monitoring well designations and their corresponding construction data (e.g., screened interval, top of filter pack, and top of bentonite seal) are summarized in Table 2-3. Locations for the monitoring wells are shown on Figure 2-5.

All wells will be drilled using dual-wall, reverse circulation, air drilling techniques or rotasonic drilling techniques. Either of these techniques would be considered appropriate for managing problems with flowing sands and to avoid the use of mud-rotary for monitoring well boreholes. Dual-wall, reverse circulation, air drilling and rotasonic drilling allow installation of a temporary outer casing that allows well construction to be performed similar to hollow-stem auger drilling. The technique is also fairly rapid compared to mud-rotary or hollow-stem auger and causes minimal disturbance to the aquifer.

For the four wells screened below the contaminant plume to be effective, each well must be double cased. For each of these wells, mud-rotary drilling techniques will be used to drill a borehole and set a permanent, steel outer casing to a depth below the base of the contaminant plume. This outer casing and its borehole will be grouted into place and the grout allowed to harden overnight. Using dual-wall, reverse circulation, air drilling or rotasonic drilling techniques, a second boring will be advanced through the grout inside the steel outer casing and into the soils below the base of the plume. A monitoring well will be installed into this second borehole and grouted into place. This well construction design will effectively separate the monitoring well screened interval from the overlying contaminant plume. Figure 2-6 shows a typical single-cased monitoring well installation in detail. This construction design will be used for all wells screened above the deeper, clean groundwater zone.

**Table 2-3
Monitoring Well Designations and Construction Details**

Supplemental Resource Conservation and Recovery
Act Facility Investigation for Site 11
Volume II, Sampling and Analysis Plan
Naval Submarine Base
Kings Bay, Georgia

Monitoring Well I.D.	Total Depth of Boring (ft bls)	Screened Interval (ft bls)	Top of Sand Pack (ft bls)	Top of Bentonite Seal (ft bls)
KBA-11-11A	37	25 to 35	23	21
KBA-11-11B	69	57 to 67	55	53
KBA-11-11C	92	80 to 90	78	76
KBA-11-8A	Existing	Existing	Existing	Existing
KBA-11-8B	42	30 to 40	28	26
KBA-11-8C	67	55 to 65	53	51
KBA-11-10A	Existing	Existing	Existing	Existing
KBA-11-10B	52	40 to 50	38	36
KBA-11-10C	82	70 to 80	68	66
KBA-11-12	40	28 to 38	26	24
KBA-11-13A	42	30 to 40	28	26
KBA-11-13B ¹	92*	80 to 90	78	76
KBA-11-3A	Existing	Existing	Existing	Existing
KBA-11-3B	47	35 to 45	33	31
KBA-11-3C ¹	77*	65 to 75	63	61
KBA-11-14	37	25 to 35	23	21
KBA-11-15	42	30 to 40	28	26
KBA-11-16	47	35 to 45	33	31
KBA-11-17A	32	20 to 30	18	16
KBA-11-17B	47	35 to 45	33	31
KBA-11-17C ¹	92*	80 to 90	78	76
KBA-11-18	47	35 to 45	33	31
KBA-11-19A	22	10 to 20	8	6
KBA-11-19B	72*	60 to 70	58	56
KBA-11-20	42	30 to 40	28	26
KBA-11-21A	42	30 to 40	28	26
KBA-11-22A	22	10 to 20	8	6
KBA-11-22B	52	40 to 50	38	36

¹ Double-cased monitoring well. Depth of outer casing at each location is as follows:

Location 4; KBA-11-13B; 75 feet bls Location 9; KBA-11-17C; 65 feet bls
Location 5; KBA-11-3C; 60 feet bls Location 12; KBA-11-19B; 55 feet bls

Notes: I.D. = identification.
ft = feet.
bls = below land surface.

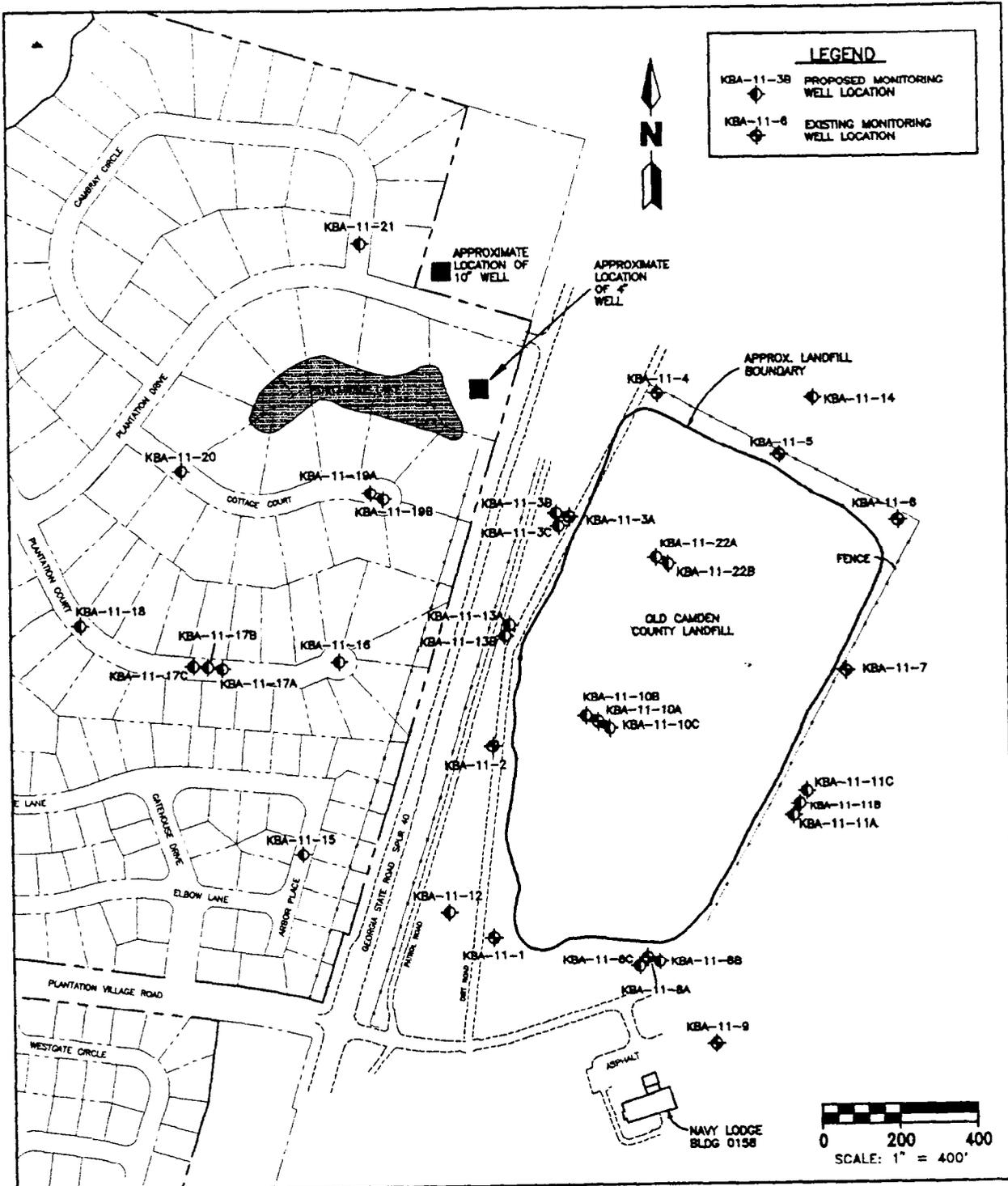
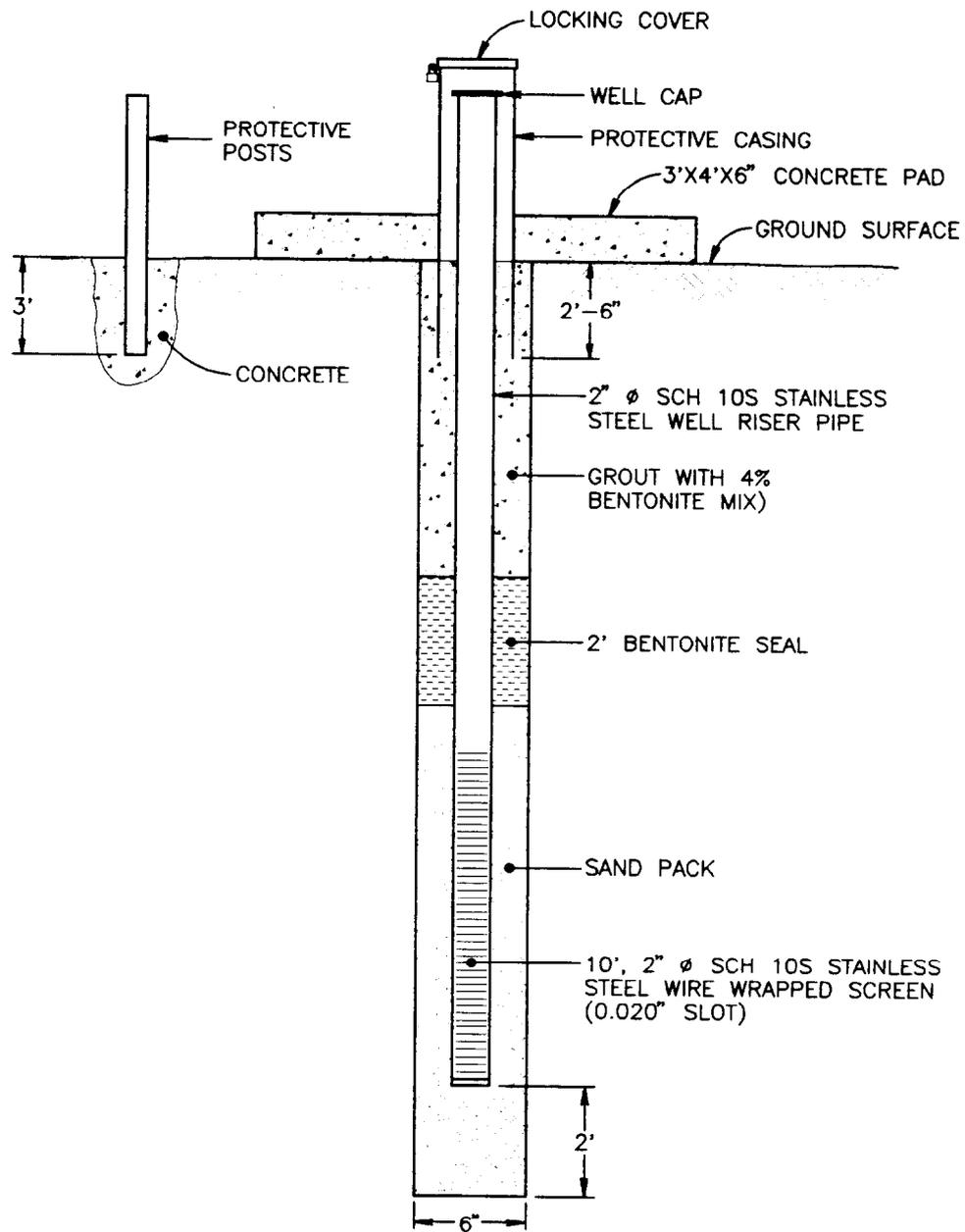


FIGURE 2-5
EXISTING AND PROPOSED
MONITORING WELL LOCATIONS



SUPPLEMENTAL RFI
SAMPLING AND ANALYSIS
PLAN

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA



NOT TO SCALE

FIGURE 2-6

MONITORING WELL DIAGRAM,
SINGLE CASED, ABOVEGROUND
COMPLETION



SUPPLEMENTAL RFI
SAMPLING AND ANALYSIS
PLAN

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

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Figure 2-7 shows a typical double-cased monitoring well installation in detail. Each monitoring well will be constructed using 2-inch inside-diameter (ID), flush-threaded, stainless-steel, riser pipe and a 10-foot, stainless-steel, continuous wire-wrapped screen with an 0.020-inch slot size. The bottom of each well will be set 2 feet above the total depth of the borehole. A filter pack will be placed between the well screen and the borehole wall from total depth of the borehole to 2 feet above the top of the screen using the tremie method. The filter pack material shall be clean quartz sand having a uniformity coefficient of 1 to 2 and a specific gravity of 2.6 to 2.7. Table 2-4 presents specifications for the filter pack material to be used for constructing the monitoring wells. The sand pack and well screen slot size were designed to allow maximum yield in the well based on methods presented in Driscoll (1986).

Table 2-4
Performance Specifications for Filter Pack for Monitoring Wells

Supplemental Resource Conservation and Recovery
Act Facility Investigation for Site 11
Volume II, Sampling and Analysis Plan
Naval Submarine Base
Kings Bay, Georgia

Sieve No.	Opening (mm)	% Passing	Design Range % Passing	Design Range % Retained
10	2.000	95	87 to 100	0 to 13
16	1.180	88	80 to 96	4 to 20
20	0.850	60	52 to 68	32 to 48
30	0.600	16	8 to 24	76 to 92
50	0.300	3	0 to 11	89 to 100

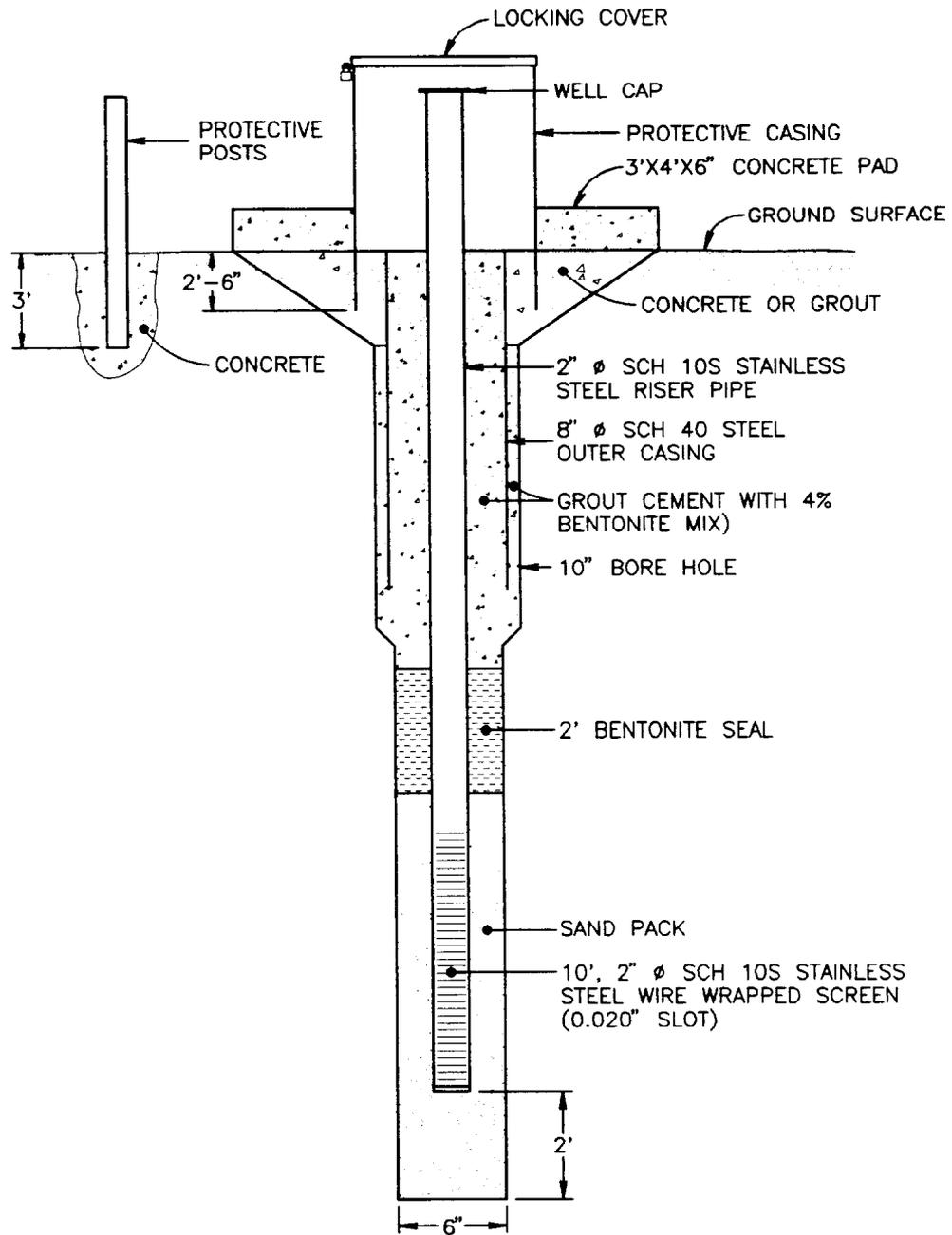
Uniformity Coefficient = 1.50 ± 20 percent
Screen Slot Size = .020 inch

Notes: mm = millimeter.
% = percent.
No. = number.

A 2-foot-thick bentonite pellet seal will be installed above the sandpack. Neat cement grout containing 2 to 4 percent bentonite will be placed by tremie method from the top of the bentonite seal to within 2 feet of the ground surface.

Tops of the monitoring wells installed in the Crooked River Plantation Subdivision will be completed flush to the ground. Tops of the monitoring wells installed around the landfill will be have aboveground completions. Components of the aboveground completions are shown in Figures 2-6 and 2-7. Components of wells completed flush to the ground are shown in Figures 2-8 and 2-9. Wells will be permanently identified by securing an embossed metal identification plate in the concrete at the ground surface.

Each well will be developed after a minimum of 24 hours grout set time to remove fines, improve the hydraulic connection with the natural soil, and to obtain a



NOT TO SCALE

FIGURE 2-7

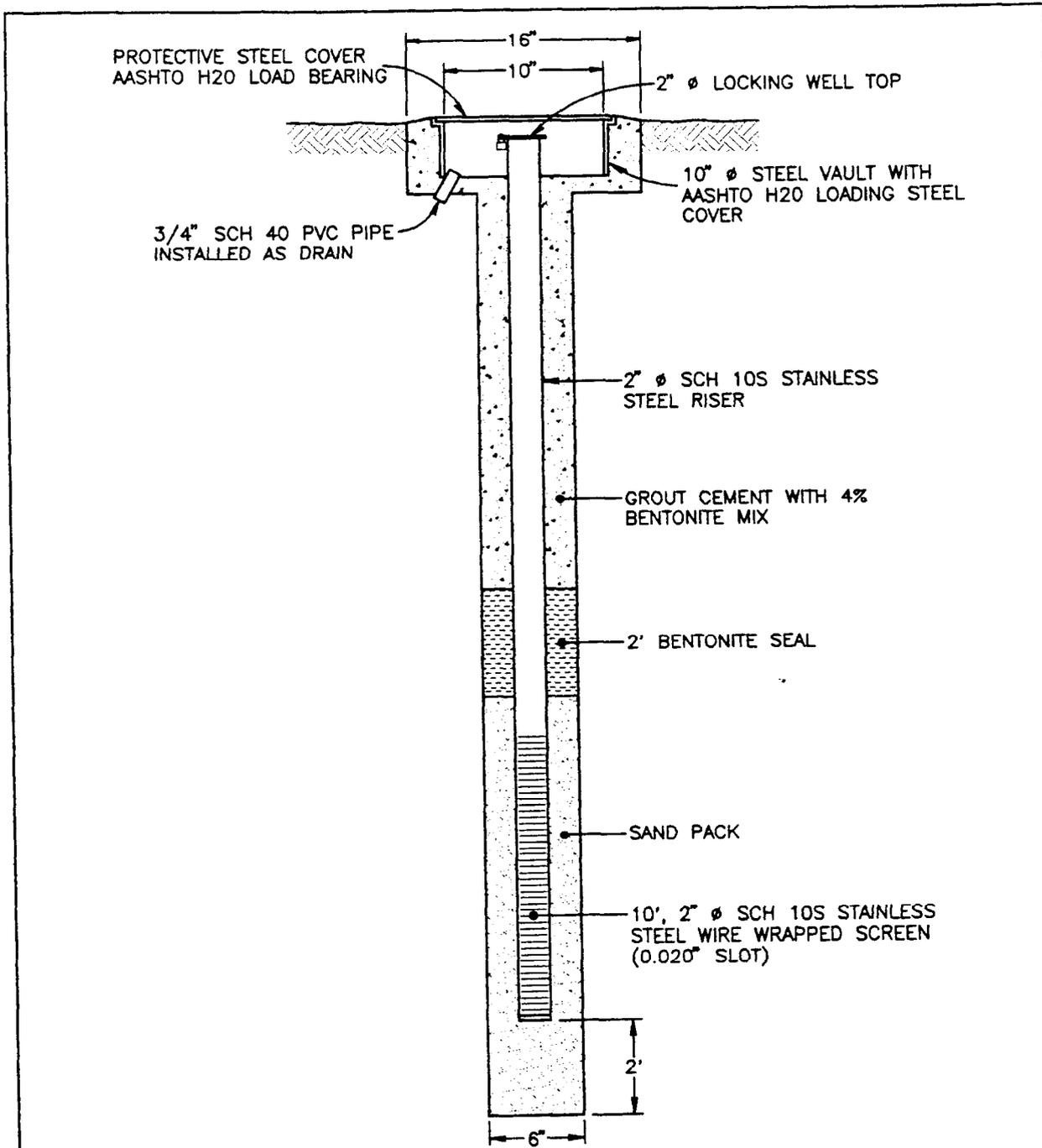
MONITORING WELL DIAGRAM,
DOUBLE CASED, ABOVEGROUND
COMPLETION



SUPPLEMENTAL RFI
SAMPLING AND ANALYSIS
PLAN

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

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NOT TO SCALE

FIGURE 2-8

MONITORING WELL DIAGRAM,
SINGLE CASED, COMPLETED
FLUSH WITH GROUND



SUPPLEMENTAL RFI
SAMPLING AND ANALYSIS
PLAN

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

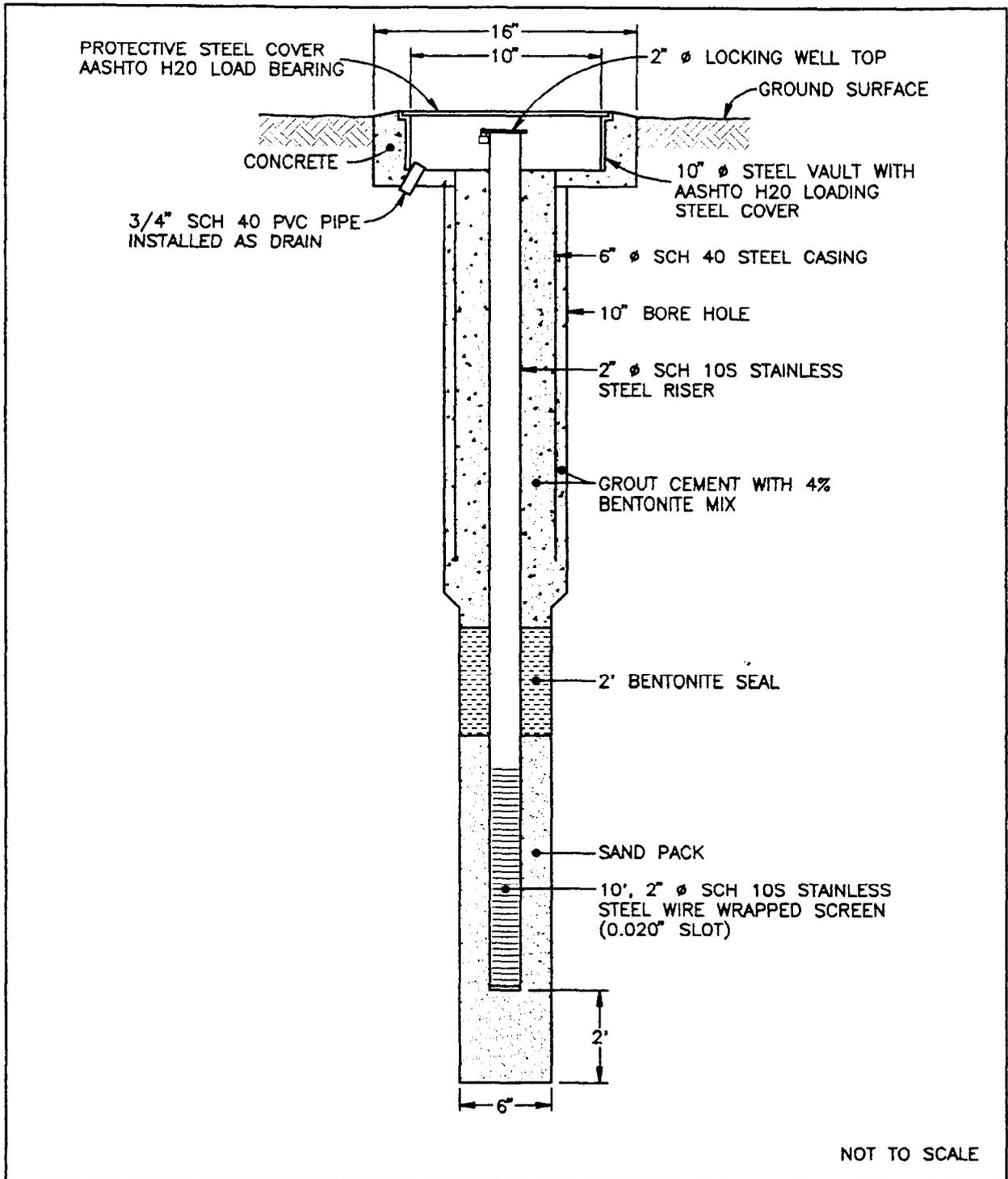


FIGURE 2-9

MONITORING WELL DIAGRAM,
DOUBLE CASED, COMPLETED
FLUSH WITH GROUND



SUPPLEMENTAL RFI
SAMPLING AND ANALYSIS
PLAN

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

representative groundwater sample. Monitoring wells will be developed by alternately pumping and surging the wells. Monitoring wells greater than 50 feet deep must be developed using a submersible pump suitable for use in a 2-inch ID casing. Monitoring wells less than 50 feet deep may be developed using black polyethylene pipe equipped with a foot valve, in combination with a pneumatic surge pump, gasoline-powered diaphragm pump, or equivalent. A surge block will be employed during development of each well. Development will continue until clear, sand-free formation water is produced and pH, conductivity, and temperature parameters of the groundwater have stabilized to within 10 percent for duplicate measurements for each parameter.

2.2.6 Groundwater Sampling This subsection describes the groundwater sampling program for all existing and new monitoring wells, recovery wells and treatment system associated with the IM, and potential sampling of PIWs.

2.2.6.1 Monitoring Wells Groundwater samples will be collected from all new and existing monitoring wells. Figure 2-5 shows the locations of the existing monitoring wells and the proposed locations for the new wells. Sampling will proceed from the least contaminated wells (wells outside and upgradient of the contaminant plume) to the most contaminated (wells located inside the plume).

Results of previous investigations were used to locate the wells shown on Figure 2-5. Figure 2-5 also shows the approximate horizontal extent of VOC contamination (shaded area). All monitoring wells outside the shaded area shown on Figure 2-5 will be sampled before any monitoring wells inside the shaded area are sampled. When all the monitoring wells outside the shaded area have been sampled, sampling of monitoring wells inside the shaded area (inside the limits of the plume) will begin at locations farthest from the landfill and proceed toward the landfill, sampling monitoring wells at locations KBA-11-10 and KBA-11-22 last.

Wells containing free product (none are expected) will not be sampled for trace chemical analyses unless necessitated by special circumstances or Navy request. The sampling locations will be recorded in the field logbook and indicated on a site map. Two monitoring events have been scheduled. The first sampling event will occur 30 days following completion of all well installation and development activities. The second sampling event will occur 30 days after the first.

Table 2-5 summarizes the analytical program for the first groundwater sampling event. Except as noted for the first sampling event, groundwater samples will be collected and submitted for laboratory analysis of all TCL and TAL analytes, cyanide, and sulfide. During the first monitoring event, groundwater samples collected from monitoring wells KBA-11-11B, KBA-11-13A, and KBA-11-19A will be analyzed for USEPA (1992) Appendix IX constituents, excluding dioxins and furans. These wells were selected because two (KBA-11-13A and KBA-11-19A) are in the plume, one being on NSB property and one in the subdivision, and one (KBA-11-11B) is a background monitoring well. All the monitoring wells will have unfiltered and filtered groundwater samples collected for all inorganic analyses.

Three groundwater samples will be collected for engineering and treatability parameters, which include:

- alkalinity, carbonate, and bicarbonate (as calcium carbonate);
- hardness (as calcium carbonate);

**Table 2-5
Groundwater Sampling Program for the First Sampling Event¹**

Supplemental Resource Conservation and Recovery
Act Facility Investigation for Site 11
Volume II, Sampling and Analysis Plan
Naval Submarine Base
Kings Bay, Georgia

Monitoring Well I.D.	Depth to Bottom of Screen ² (ft bls)	Sample I.D.	Analyses
KBA-11-1	12	01GW01	TCL, TAL, cyanide, sulfide
KBA-11-2	12	02GW01	TCL, TAL, cyanide, sulfide
KBA-11-3A	12	03AGW01	TCL, TAL, cyanide, sulfide
KBA-11-3B	45	03BGW01	TCL, TAL, cyanide, sulfide
KBA-11-3C	75	03CGW01	TCL, TAL, cyanide, sulfide
KBA-11-4	12	04GW01	TCL, TAL, cyanide, sulfide
KBA-11-5	12	05GW01	TCL, TAL, cyanide, sulfide
KBA-11-6	13	06GW01	TCL, TAL, cyanide, sulfide
KBA-11-7	12	07GW01	TCL, TAL, cyanide, sulfide
KBA-11-8A	13	08AGW01	TCL, TAL, cyanide, sulfide
KBA-11-8B	40	08BGW01	TCL, TAL, cyanide, sulfide
KBA-11-8C	65	08CGW01	TCL, TAL, cyanide, sulfide
KBA-11-9	11	09GW01	TCL, TAL, cyanide, sulfide
KBA-11-10A	18	10AGW01	TCL, TAL, cyanide, sulfide
KBA-11-10B	50	10BGW01	TCL, TAL, cyanide, sulfide
KBA-11-10C	80	10CGW01	TCL, TAL, cyanide, sulfide
KBA-11-11A	35	11AGW01	TCL, TAL, cyanide, sulfide
KBA-11-11B	67	11BGW01	Appendix IX E/T parameters ³
KBA-11-11C	90	11CGW01	TCL, TAL, cyanide, sulfide
KBA-11-12	38	12GW01	TCL, TAL, cyanide, sulfide
KBA-11-13A	40	13AGW01	Appendix IX
KBA-11-13B	90	13BGW01	TCL, TAL, cyanide, sulfide
KBA-11-14	35	14GW01	TCL, TAL, cyanide, sulfide
KBA-11-15	40	15GW01	TCL, TAL, cyanide, sulfide
KBA-11-16	45	16GW01	TCL, TAL, cyanide, sulfide
KBA-11-17A	30	17AGW01	TCL, TAL, cyanide, sulfide
KBA-11-17B	45	17BGW01	TCL, TAL, cyanide, sulfide
KBA-11-17C	90	17CGW01	TCL, TAL, cyanide, sulfide

See notes at end of table.

**Table 2-5 (Continued)
Groundwater Sampling Program for the First Sampling Event¹**

Supplemental Resource Conservation and Recovery
Act Facility Investigation for Site 11
Volume II, Sampling and Analysis Plan
Naval Submarine Base
Kings Bay, Georgia

Monitoring Well I.D.	Depth to Bottom of Screen ² (ft bls)	Sample I.D.	Analyses
KBA-11-18	45	18GW01	E/T parameters ³ TCL, TAL, cyanide, sulfide
KBA-11-19A	20	19AGW01	Appendix IX
KBA-11-19B	70	19BGW01	TCL, TAL, cyanide, sulfide
KBA-11-20	40	20GW01	E/T parameters ³ TCL, TAL, cyanide, sulfide
KBA-11-21	40	21GW01	TCL, TAL, cyanide, sulfide
KBA-11-22A	20	22AGW01	TCL, TAL, cyanide, sulfide
KBA-11-22B	50	22BGW01	TCL, TAL, cyanide, sulfide

¹ The sampling program for the second sampling event includes all Target Compound List and Target Analyte List analytes, cyanide, and sulfide. No samples will be collected for Appendix IX or engineering and treatability (E/T) analyses during the second event.

² Depths for monitoring wells to be installed during the Supplemental Resource Conservation and Recovery Act Facility Investigation are based on the proposed target depths.

³ Refer to Subsection 2.2.6.1 of this Sampling and Analysis Plan for the list of engineering/treatability (E/T) parameters.

Notes: I.D. = identification.

ft = feet.

bls = below land surface.

TCL = Target Compound List (volatile organic compounds, semivolatile organic compound, pesticides, and polychlorinated biphenyls).

TAL = Target Analyte List.

E/T = engineering and treatability.

SVOC = semivolatile organic compound.

Appendix IX = parameters listed in Appendix IX of USEPA, 1992.

- total solids;
- total suspended solids;
- pH;
- specific conductivity;
- biological oxygen demand (BOD), 5-day and 20-day;
- chemical oxygen demand (COD);
- TOC;
- TAL metals (included as part of the contamination characterization analyses);
- chlorides;
- sulfates;
- nitrogen series;
- phosphorus; and
- dissolved oxygen.

One of the samples will be collected from an upgradient location (KBA-11-11B) and the other two samples (KBA-11-18 and KBA-11-20) will be collected from monitoring wells located in Crooked River Plantation Subdivision and assumed to be outside the contaminant plume.

Groundwater levels will be measured in the monitoring wells prior to groundwater sampling. Water levels will be measured from the north side of the top of each well casing to the nearest 0.01 foot using an electronic water-level indicator. Field personnel will also measure the total depth of each monitoring well. From these data, the volume of standing water inside the well casing will be calculated, and three to five times that volume, or until the well goes dry, will be evacuated with a submersible pump or bailer. Field measurements of pH, specific conductance, and temperature will be taken several times during well evacuation to aid in the collection of representative samples. Consistent pH, specific conductance, and temperature measurements indicate that stagnant water from inside the well casing has been removed, and representative groundwater from the aquifer has entered the well screen. Field measurements are considered consistent when three consecutive readings for each parameter, collected at 5-minute intervals, vary less than 10 percent.

At monitoring wells completed aboveground, an engineer's rule will be used to measure the distance from the top of the concrete pad to the top of the well casing and to the top of the protective casing. These data should be recorded in the field logbook. The purpose of these measurements is to provide data for comparison to survey measurements. The surveyed top of casing and ground elevation data will be used to calculate the distance between the concrete pad and the top of casing and these numbers compared to field measurements as a check.

After purging, groundwater samples will be collected for laboratory analysis using either a stainless-steel or Teflon™ bailer and clean nylon or monofilament line. Samples from deep monitoring wells may require the use of a submersible sampling pump. Detailed sampling procedures are included in Subsection 3.5.5.1 of the QAPP.

2.2.6.2 Groundwater Sampling Associated with the Interim Measure Groundwater samples will be collected from the recovery wells and from the treatment system installed during the IM. Groundwater samples will be analyzed and the data assessed to evaluate treatability of the groundwater and the operational

effectiveness of the treatment unit(s). Groundwater samples collected as part of this task are discussed in the IM Workplan (ABB-ES, 1993a).

2.2.6.3 Private Irrigation Wells During the Interim Corrective Measures Study, investigation groundwater samples from PIWs were collected to evaluate the potential for plume-related VOCs in irrigation water. If contaminants are identified during the Supplemental RFI groundwater sampling program that were not previously evaluated in PIW samples, then additional samples will be collected from PIWs for analyses of the new constituents of potential concern.

Groundwater samples will be collected from PIWs directly from spigots or sprinkler heads, by disassembling the sprinkler head to allow free flow of water with minimal aeration. When possible, groundwater samples will be collected from the spigot nearest to the well head. Before sample collection, each PIW will be purged for 15 minutes, during which time flow rates will be recorded by measuring the time required to fill a 6-gallon bucket. Flow rates will not be measured from the PIWs that will be purged and sampled through sprinkler heads. The pH, specific conductance, and temperature will be measured and recorded each 5 minutes while purging the wells.

2.2.7 Borehole Geophysics Two deep wells are located in the Crooked River Plantation Subdivision near the intersection of Plantation Drive and Spur 40 (see Figure 2-5). These two wells are reportedly not used for any purpose. Borehole geophysics, conducted by the U.S. Geological Survey (USGS), will be used to collect stratigraphic information from these two wells. It is anticipated that natural gamma geophysical logging techniques will be used. The wells are located on private property and permission from the property owners must be obtained before this work can be done.

One well is 10 inches in diameter and extends to approximately 320 to 380 feet bls, as reported by Mr. Danny Meridith the contractor who drilled the well. Steel casing was set in the borehole to a depth of 280 feet bls and the borehole extended 40 to 50 feet beyond the casing.

The second well is 4 inches in diameter and is located in the yard of Lot No. 1 on Plantation Drive at the intersection of Plantation Drive and Spur 40. The depth of this well is unknown but is estimated to range from 600 to 700 feet bls. The well is constructed of 4-inch steel casing. The steel casing extends aboveground to a 4-inch gate valve.

2.2.8 Test Trench Sampling Test trenches are an excellent method of obtaining waste samples from landfills. 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).

A magnetometer survey was conducted at Site 11 during the initial RFI. The results of the geophysical survey and groundwater chemical data were used to determine the proposed test trench locations shown in Figure 2-10. The test trenches will be excavated in areas where magnetic anomalies occur and in areas suspected to be "hot spots" of the contaminant plume. The locations of the proposed test trenches are summarized relative to magnetic survey coordinates in Table 2-6. The magnetic survey baselines are surveyed locations that can be used by field personnel to position the test trenches in the field.

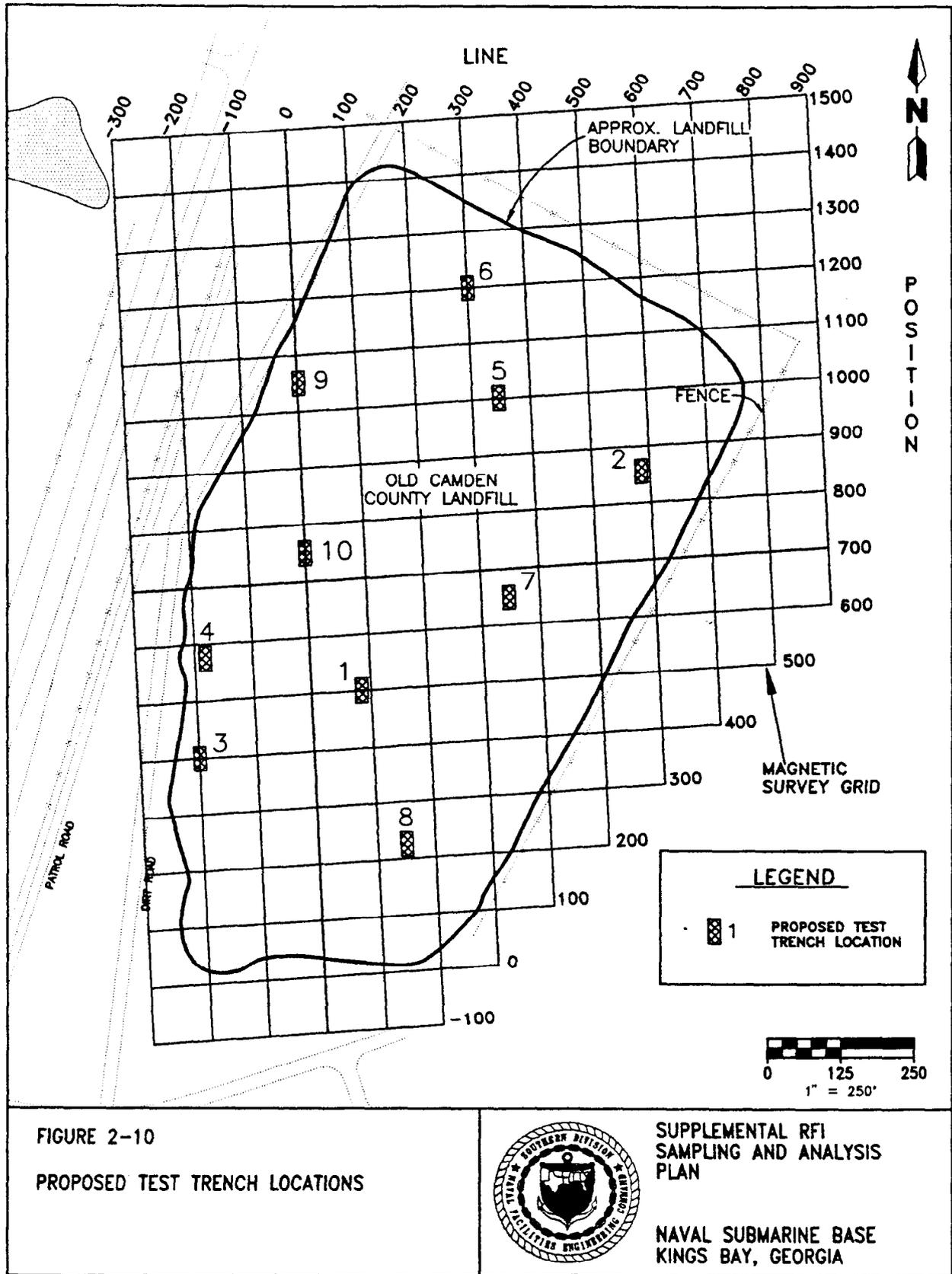


FIGURE 2-10
 PROPOSED TEST TRENCH LOCATIONS



SUPPLEMENTAL RFI
 SAMPLING AND ANALYSIS
 PLAN

NAVAL SUBMARINE BASE
 KINGS BAY, GEORGIA

Table 2-6
Test Trench Locations Relative to the Magnetic
Survey Grid

Supplemental Resource Conservation and Recovery
 Act Facility Investigation for Site 11
 Volume II, Sampling and Analysis Plan
 Naval Submarine Base
 Kings Bay, Georgia

Trench Number	Line	Position
1	80	500
2	580	850
3	-200	400
4	-180	570
5	350	1,000
6	300	1,200
7	350	650
8	150	230
9	0	1,050
10	0	750

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.

Selection of aliquots for composite soil samples will include material from the side wall between trenches, visibly stained soil, soil having high OVA readings when screened, and soil placed as daily cover during landfill operations. Because 10 test trenches are to be excavated, but samples collected from only 5 trenches, field crews will select trenches most likely to contain contaminated media based on visual observation of the wastes, screening excavated material with the OVA, evidence of free product, or stained soils. Four of the soil samples and four of the leachate and liquid samples will be analyzed for all TCL and TAL analytes, plus cyanide and sulfide. One of the soil and one of the leachate and liquid samples will be analyzed for USEPA (1992) Appendix IX constituents.

Because of health and safety reasons, the soil samples will be collected from the stockpiled material and/or from the backhoe bucket and not the trench proper. Liquid material, if present, will be sampled with a bailer or other remote sampling tools (i.e., telescoping poles and dipper may be used). Remote sampling will allow liquid sample collection while personnel remain outside the trench area. The air sampling program will be coordinated with the test trench operations.

The actual layout of each test trench and spoils pile holding area will be predicated by onsite conditions and wind direction at the time the test trench is made. During excavation, sampling, and logging of each test trench, the backhoe operator and all site personnel will remain upwind or crosswind of the

test trench and spoils pile. Wind direction will be monitored by means of a wind sock or other banner located in a prominent position visible to all personnel. Material excavated from the test trenches will be temporarily stockpiled on plastic adjacent to the excavation. Trenches excavated within a single day may be left open during the workday, but all trenches will be backfilled before the field crew leaves the site for the day. The site will not be left unattended while open trenches are present. Each trench will be surrounded by caution tape and the stockpile area included within the taped area. The taped area is the exclusion zone, in which level B personal protective equipment is required. The exclusion zone will be large enough to accommodate the excavation equipment.

Ten test trenches will be excavated in the landfill, each to a depth of approximately 10 to 12 feet bls, or to groundwater, whichever is encountered first. The purpose of trenching is to allow visual examination and possible sampling of the waste materials, both solid and liquid. Test trenches will be oriented perpendicular to the long dimension of a disposal cell and will extend from one side wall of a cell to at least half the width of the cell. Test trenching procedures are described in detail in Subsection 3.5.6 of the QAPP.

Test trench logs will be completed by the onsite geologist and will contain a sketch of trench conditions, trench location (two or more permanent landmarks will be referenced on a site map if possible), date of excavation, total depth of excavation, dimensions of trench, method of sample acquisition, type and size of samples, description of soil and waste material encountered, groundwater levels, and organic vapor levels. Photographs will be taken at each test trench location to provide additional documentation of test trenching operations and the wastes encountered. A card showing the test trench number, site name, and a scale will be included in each photograph, if possible. The test trench locations will be marked in the field with flagging and/or stakes and the locations will be surveyed by a subcontractor (see Subsection 2.2.11).

2.2.9 Ecological Survey The ecological survey will include an aquatic survey and a terrestrial survey.

Aquatic Survey. The aquatic survey will be completed to identify potential receptors of surface water and sediment contamination in Porcupine Lake. The survey will be completed concurrently with the surface water and sediment sampling. Two biologists will be responsible for the aquatic survey and the surface water and sediment sampling. The biologists will take samples of benthic macroinvertebrates with the use of petite ponar dredge. Three replicate dredge samples will be collected from each surface water and sediment sampling location. Dredge samples will be washed through a sieve bucket to remove fine materials. The reduced samples will be preserved in formalin or isopropyl alcohol for identification of species in the laboratory. The benthic samples will be processed in the laboratory only if sediment or surface water contamination is identified in the concurrent samples from the same location (see Surface Water and Sediment Sampling, Subsection 2.2.1). Fish species will be identified based on qualitative sampling and literature information. The qualitative sampling will be limited to the use of net seines and dip nets.

Terrestrial Survey. The terrestrial survey will be completed to identify potential receptors of contamination in surface soil at Site 11. Terrestrial receptors include mammals, birds, reptiles, amphibians, and plants. The survey will require 1 day for two biologists to complete and will consist of a records

search and a site walkover. The terrestrial survey will identify plant communities at Site 11. The plant identifications will be recorded in the field logbook. The plant species information will be used in the ecological assessment to characterize the habitat(s) at the site. The records search will include interviews and correspondence with state and local wildlife officials, local natural heritage program staff, and base personnel.

2.2.10 Public Health Survey A public health survey consisting of an area reconnaissance, interviews, and records search will be conducted by Public Health Risk Assessment specialists. 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 Health and Environmental Assessment (HEA).

2.2.11 Topographic and Water Elevation Survey An elevation and location survey will be performed by a Georgia-licensed surveyor to locate all sampling locations, including monitoring wells, soil borings, test trenches, surface soil samples, and any other necessary control points. The north side of the inner casing (riser) for all monitoring wells will be surveyed for both horizontal and vertical control to a minimum degree of accuracy of 0.1 and 0.01 foot, respectively. Other exploration locations, such as surface soil sample locations, test trench locations, and soil borings, will be marked in the field and will be surveyed for horizontal and vertical control to a minimum degree of accuracy of 0.1 foot.

Sampling locations and other control points will be plotted on site-specific base maps and will be available in both digitized and hard-copy formats. Identification of sampling locations will be in terms of latitude and longitude coordinates and State Plane Coordinates in accordance with the Federal Interagency Coordinating Committee for Digital Cartography recommendations.

3.0 QUALITY ASSURANCE PROJECT PLAN

3.1 PROJECT DESCRIPTION. The QAPP is one of two primary parts of the SAP; the FSP (Section 2.0) being the other part. In turn, the SAP is part of a three-volume set of the Supplemental RFI planning documents:

Volume I, Workplan;
Volume II, SAP; and
Volume III, HASP.

The QAPP and the FSP have been incorporated into one document to provide one comprehensive document that can be used by onsite field teams. This avoids triplication of many sections that are common to the Workplan, the FSP, and the QAPP (i.e., project purpose and description, environmental and geologic setting, site history, previous investigations, project organization, and schedule). These common sections are summarized in the Workplan.

3.1.1 Purpose The QAPP provides procedures to be followed so that data acquired during the Supplemental RFI will be of known quality and reliability. This QAPP contains policies, organization, objectives, functional activities, and specific QA/QC procedures that will be used to conduct the investigation.

3.2 PROJECT ORGANIZATION AND RESPONSIBILITIES. The Supplemental RFI planning documents have been prepared under the Comprehensive Long-Term Environmental Action, Navy (CLEAN) contract with Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOC). Key individuals in the project structure are highlighted below and the project organization is depicted in Figure 3-1.

SOUTHNAVFACENGCOC. SOUTHNAVFACENGCOC is responsible for establishing policy and guidance for the CLEAN program. SOUTHNAVFACENGCOC awards contracts, approves funding, and has primary control of report release and interagency communication.

NSB Kings Bay Environmental Coordinator. The Environmental Coordinator will coordinate and monitor Supplemental RFI activities at NSB Kings Bay. The Environmental Coordinator maintains a working relationship with local, State, and Federal regulatory agencies.

SOUTHNAVFACENGCOC Remedial Project Manager. The SOUTHNAVFACENGCOC Remedial Project Manager (RPM) is responsible for the technical and financial management of the Supplemental RFI and design activities at NSB Kings Bay. The RPM prepares the project statement of work; develops the project Site Management Plan; manages project scope, schedule, and budget; and provides technical review and approval of all deliverables. The RPM will be responsible for changes in the scope of work determined during Project Managers' Meetings.

Task Order Manager. The Consultant Task Order Manager (TOM) for the Supplemental is responsible for evaluating the appropriateness and adequacy of the technical and engineering services provided. The TOM is also responsible for resource management, for confirming that the project fulfills the requirements of the Contract Task Order, and for the daily conduct of work, including integration of input from supporting disciplines and subcontractors.

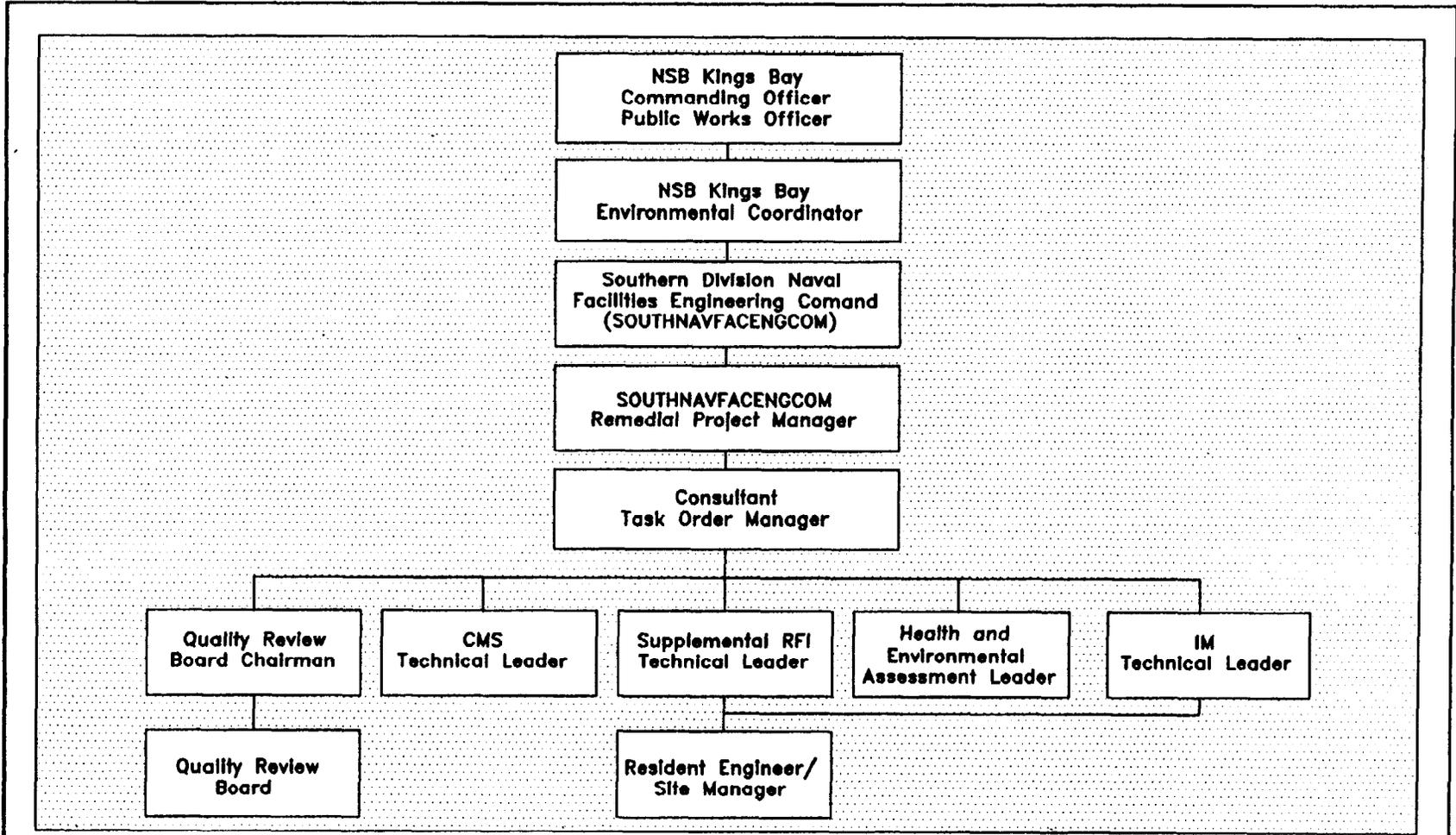


FIGURE 3-1
PROJECT ORGANIZATION



SUPPLEMENTAL RFI
SAMPLING AND ANALYSIS
PLAN

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

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

Resident Engineer/Site Manager. The RE will be responsible for the day-to-day execution of the Supplemental RFI and IM field programs. These responsibilities include coordination of activities; record keeping; communication with the Activity, technical leaders, and TOM; adherence to QA/QC requirements; subcontractor oversight; mobilization of equipment; local agency interaction; and preparation of sampling event reports. The RE will also ensure that all field activities are performed consistent with the project Workplan and supporting documents. These responsibilities include appropriate logging and documentation of standard and approved drilling and monitoring well installation methods to confirm that pertinent drilling and testing information is obtained during the exploration program. Other responsibilities include oversight of sampling activities and site characterization studies.

Risk Assessment Team. The Risk Assessment Team will be responsible for the ecological assessment and public health assessment and will plan and perform the risk assessment supported by Supplemental RFI data.

Quality Review Board Chairman. The Quality Review Board (QRB) Chairman will be responsible for the coordination of QRB activities, which include technical review of Workplans and planning documents, interaction with the technical leads, and guidance with regulatory and technical requirements. QRB members include: an RCRA regulatory expert, a Supplemental RFI expert and Georgia registered professional geologist, an IM expert, a risk expert, and a Health and Safety Manager.

Corrective Measures Study Technical Leader. The CMS Technical Leader will be responsible for coordinating CMS activities and for ensuring that the CMS progresses in accordance with project plans and supporting documents. The CMS Technical Leader will also oversee development of remedial alternatives and records of decision.

IM Technical Leader. The IM Technical Leader will be responsible for coordinating IM activities and for ensuring that the IM progresses in accordance with project plans and supporting documents.

3.3 DATA QUALITY OBJECTIVES (DQOs). DQOs have been developed for the Supplemental RFI at Site 11 to ensure that data collected will be of sufficient quality to support decision-making for future response activities at the site. The principal objectives of the Supplemental RFI, and consequently the data generated from field activities, are to satisfy regulatory requirements for performing an RFI, to support IM and CMS activities, and to support an ecological and human health risk assessment. Site-specific questions such as how the data will be used and how much data are required were addressed during the development of the DQOs. In addition, the required data quality was addressed to indicate the magnitude of error that could be tolerated by the data user. The following subsections provide a brief description of DQO levels and identify the levels associated with each Supplemental RFI field task.

3.3.1 DQO Levels, General Description DQOs refer to standards for analytical precision, accuracy, representativeness, completeness, and comparability (PARCC). Five DQO levels have been defined by the USEPA: Level I, Field Screening; Level II, Field Analysis; Level III, Laboratory Analysis; Level IV, Contract Laboratory Program Routine Analytical Services (CLP-RAS); and Level V, Non-Conventional Parameter Analysis (USEPA, 1991a).

The Naval Energy and Environmental Support Activity (NEESA) has adopted three of these levels as quality assurance (QA) requirements, Levels C, D, and E, which correspond with USEPA Levels III, IV, and V, respectively (NEESA, 1988). For the purposes of this document, the USEPA nomenclature (Levels I through V) will be used.

The DQO level needed for a specific task is generally based on the intended use of the data and on the limitations of the analytical instrumentation. Many field screening and field analytical techniques are intended to provide a rapid turn-around time and qualitative data for decision-making in the field. Field techniques necessarily involve rugged instrumentation with less sample preparation and rapid analysis. More precise and accurate analytical methods are used when both qualitative and quantitative data are needed, such as to support site characterization, confirmation, enforcement, treatability, and/or remedial action. The DQO level also specifies laboratory QC requirements and the deliverable package associated with the analysis. The five broad categories of data quality used in the Supplemental RFI process are described below.

Level I, Field Screening. Field screening provides rapid real-time results that can be used to determine optimal placement of sampling locations and for health and safety support. Data generated provide information concerning the presence or absence of certain constituents or groups of constituents. The data are generally qualitative rather than quantitative.

Level I sampling requirements include the use of equipment and sampling containers that are clean (soap and tap water), visibly free of contamination, and free of analytes detectable by the screening method employed (USEPA, 1991a).

Level II, Field Analysis. Field analysis includes the use of more sophisticated analytical instruments in the field, including onsite gas chromatographs and mobile laboratories. The data generated may be both qualitative and quantitative, but the degree of QA/QC achievable may be more variable than with laboratory analysis.

Level II sampling and equipment requirements include the use of sampling equipment constructed of material that is compatible with the parameters being analyzed (e.g., PVC for inorganic parameter analyses, or chrome-plated material for organic parameter analyses) and field-cleaning procedures that include a potable water and soap scrub followed by a potable water rinse (or steam cleaning or high pressure washing).

The use of potable water is limited only by the parameters being analyzed and the minimum quantitation limits of the analytical method; water containing up to one-half the minimum quantitation limit of the parameters of concern may be used. A minimum of 10 percent of samples collected for DQO Level II analysis should be split for DQO Level III analysis. These samples must be representative of all samples analyzed in the field (USEPA, 1991a).

Level III, Laboratory Analysis. Laboratory analytical data are generated using USEPA-approved methods to achieve a level of confidence set by specified QA/QC protocols. Level III DQOs are appropriate for data collected for most activities including site characterization (i.e., qualitative and quantitative identification of contaminants and contaminant source[s] and extent of migration) and treatability studies.

Level III field methods, decontamination procedures, and sampling equipment construction materials are as specified in the USEPA *Standard Operating Procedures and Quality Assurance Manual* (USEPA, 1991a). Cleaning of downhole drilling or excavation equipment must be performed, as with Level IV requirements, with the exclusion of the deionized (DI) water rinse, the double rinse with pesticide-grade isopropanol, and the rinse with organic-free water. All other cleaning and decontamination guidance must be followed.

When wells are constructed using materials that are not inert with respect to the contaminants being analyzed, data collected from those wells are DQO Level III or lower for those incompatible analytes, even if DQO Level IV analytical procedures are used.

Level III field QC sampling requirements include the following.

- A minimum of one equipment rinsate blank per day will be collected for each day sampling equipment is field cleaned (every other rinsate is analyzed unless analytes pertinent to the project are found).
- If samples are preserved, a preservative blank will be collected and analyzed at the beginning of the study.
- One blank of each type of source water will be collected and analyzed during each sampling event. A sampling event is considered to be from the time sampling personnel arrive at the site until these people leave for more than 1 day (NEESA, 1988).
- One trip blank will be collected and will accompany each cooler that is used for transporting samples to be analyzed for VOCs.
- Field duplicates will be collected at a frequency of 10 percent per sample matrix.

A minimum of 5 percent of samples collected for DQO Level III analysis should be split for DQO Level IV analysis. These samples must be representative of all samples submitted for Level III analysis (USEPA, 1991a).

Level IV, Contract Laboratory Program. Level IV DQOs are the most stringent and are defined as data collected in accordance with USEPA Standard Operating Procedures (SOPs) (USEPA, 1991a) and analyzed in accordance with the USEPA CLP (USEPA, 1990a and 1990b). Data collected for characterization and confirmation during an RFI, during remedial action, for compliance monitoring, or for enforcement often require Level IV for DQOs. Level IV field QC sampling requirements are equivalent to Level III requirements.

Level V, Nonconventional Parameter Analysis. Specific site investigations or remedial design characteristics may require the analysis of contaminants or

conditions that are nonconventional. The Level V DQOs associated with these types of analysis must, by definition, be defined on an individual basis. The DQOs identified will depend on the specific collection method, decontamination procedures, and analysis to be used. These analyses are non-CLP, USEPA accepted methods, or equivalent.

3.3.2 Task-Specific DQOs Tasks for the Supplemental RFI at Site 11 will involve data collection with DQOs ranging from Level I through Level V. The following discusses the primary tasks for the Supplemental RFI and the associated DQO level.

- **Soil Sample Screening, Level I:** Split-spoon samples from discrete depths in soil borings will be screened in the field with an OVA, providing Level I data concerning the presence or absence of volatile compounds.
- **Air Quality Monitoring, Level I:** For health and safety purposes, air quality will be monitored in the breathing zone during soil intrusive studies (e.g., test trenching) by OVA or by PID, providing Level I data concerning the presence or absence of volatile compounds.
- **Field Parameter Analysis, Level II:** Field measurements of surface water and groundwater temperature, pH, and specific conductance will be performed to screen samples for laboratory analysis and to determine aquifer stabilization during well purging. These measurements are both quantitative and qualitative and the data generated can conform with both Level I and II DQOs. (Analyses of pH and specific conductivity will also be analyzed offsite by a laboratory which will conform with Level V DQOs.)
- **Site Investigation Air Monitoring, Level III:** Air samples will be collected during the Supplemental RFI field program for risk assessment purposes and to support the CMS. These samples will be analyzed for TCL VOCs in accordance with Level III DQOs.
- **Characterization and Confirmation Sampling, Level III and Level IV:** Groundwater samples, surface water samples, sediment samples, and soil samples collected during the Supplemental RFI will be collected and analyzed in accordance with Level III DQOs or Level IV DQOs. These samples will be used for site chemical characterization and confirmation.
- **Engineering and Treatability Studies, Level V:** Samples collected to evaluate the effectiveness and feasibility of selected remedial alternatives will be analyzed in conformance with Level V DQOs.
- **Fate and Transport Analyses, Level V:** Subsurface soil samples collected to evaluate the fate and transport of site-related contaminants in the aquifer will be analyzed in conformance with Level V DQOs.

These RFI data will be used, as applicable, for health and safety monitoring, site characterization, public health and ecological risk assessment, and evaluating remedial alternatives.

3.4 QUALITY ASSURANCE AND QUALITY CONTROL APPROACH. The approach to providing reliable data that meet the DQOs will include QA/QC requirements for each of the chemical data types generated during the field investigation. The details of field measurement QA/QC are included in Subsection 3.4.1.2 where precision, accuracy, representativeness, comparability, and completeness (PARCC) parameters for Level I and II DQOs are presented. The QA/QC efforts for laboratory analyses will include collection and submittal of several sets of QC samples and data validation. Level III and Level IV laboratory data must be validated and assessed to determine the validity of the data and to ensure that DQOs are met. Sample results are validated through comparison to QA/QC data to assure that analytical results fall within acceptable accuracy and precision confidence limits, and to eliminate, correct, or flag matrix and other interference effects. Details of the laboratory data validation procedures are outlined in Subsection 3.4.2. Validated data are summarized and organized into formats that facilitate data evaluation. Data evaluation includes site characterization and analysis of contaminants, contaminant distribution, and transport mechanisms, fate, and risk assessment.

3.4.1 Data Assessment DQOs are based on the premise that different data uses require different levels of data quality. Data quality refers to a degree of uncertainty with respect to PARCC. These DQOs are established on site conditions, objectives of the project tasks, and knowledge of available measurement systems. The acceptance criteria for PARCC parameters for the Supplemental RFI have been defined for the different levels of DQOs required for each task and are outlined below.

3.4.1.1 Precision, Accuracy, Representativeness, Comparability, and Completeness (PARCC) Parameters for Level III and IV DQOs The acceptance criteria for PARCC parameters for the Supplemental RFI for Level III and IV DQOs outlined in this subsection are consistent with the QC requirements of the USEPA SW-846 analytical methods chosen and the USEPA CLP guidelines.

Precision. Precision is defined as the agreement among individual measurements of the same chemical constituent in a sample, obtained under similar conditions. Precision objectives for analysis of site samples will be measured using duplicates (including matrix spike duplicates). Acceptance criteria for field duplicate precision for Level III and Level IV DQOs have been set at 30 and 50 for aqueous and solid analyses, respectively. Acceptance criteria for laboratory duplicate precision for Level III and Level IV DQOs have been set at 20 and 35 for aqueous and solid analyses, respectively.

The precision criteria to be used for matrix spike duplicates are compound-specific, and will be as required in the USEPA CLP guidelines for data meeting Level IV data quality. The precision criteria for matrix spike duplicates for analytical data meeting Level III data quality will be designated by the laboratory based on their historical performance.

Precision will be shown as a relative percent difference (RPD) where

$$RPD = (X1 - X2) / \frac{X1 + X2}{2} * 100 \quad (1)$$

where

RPD = relative percent difference between results,
X1 and X2 = results of duplicate analysis, and
 $|X1-X2|$ = absolute difference between duplicates X1 and X2.

Precision objectives apply to both field and laboratory duplicates. However, field duplicates based on the analytical results take into account the level of error introduced by field sampling techniques, field conditions, and analytical variability. The RPD of all laboratory duplicates will be reported by the laboratory, and the RPD of field duplicates will be calculated to evaluate the sample precision.

In accordance with NEESA guidelines, the collection frequency for field duplicates will be 10 percent for data meeting Level III and Level IV DQOs and 5 percent of data meeting Level V DQOS.

Accuracy. Accuracy is defined as the degree to which the analytical measurement reflects the true concentration level present. Accuracy will be measured as percentage recovery for matrix spikes as the primary criterion and percentage recovery of surrogate spikes as a secondary QC criterion for GC/MS analyses. The acceptance criteria for accuracy for laboratory samples have been defined on a matrix and analytical parameter basis for the DQO Level IV CLP analyses. For non-CLP analyses, accuracy ranges are not specified by the analytical methods and are laboratory dependent. These criteria are outlined in Tables 3-1 through 3-4. The acceptance criteria for data meeting Level III data quality will be designated by the laboratory based on their historical performance for each analytical method used.

A matrix spike is a sample (of a particular matrix) to which predetermined quantities of standard solutions of certain target analytes are added prior to sample extraction and digestion and analysis. Samples are split into replicates, one replicate is spiked and both aliquots are analyzed.

Accuracy can also be evaluated using the recovery of surrogate spikes in the organic analyses. These spikes consist of organic compounds which are similar to analytes of interest in chemical composition, extraction, and chromatography, but which are not normally found in environmental samples. These compounds are spiked into all blanks, standards, and samples prior to analysis.

Percentage recoveries of the surrogate and matrix spikes will be reported by the laboratory for all analyses with the samples. Variations from the 100 percent recovery may be due to matrix interferences, laboratory spike handling procedures, or sample heterogeneities between replicates. The percentage recovery of the spikes can be calculated from the following equation:

$$\text{percentage recovery} = (X-B)/T * 100 \quad (2)$$

where

X = measured amount in sample after spiking,
B = background amount in sample, and
T = amount of spike added.

**Table 3-1
Accuracy Ranges for Contract Laboratory Program
Volatile Organic Compound Analysis**

Supplemental Resource Conservation and
Recovery Act Facility Investigation for Site 11
Volume II, Sampling and Analysis Plan
Naval Submarine Base
Kings Bay, Georgia

Spiking/Surrogate Compound	Accuracy Ranges	
	Water (Low Level) ¹	Soil and Sediment
	Percent Recovery Range for Matrix Spike Samples	
1,1-Dichloroethene	61 to 145	59 to 172
Trichloroethane	71 to 120	62 to 137
Chlorobenzene	75 to 130	60 to 133
Toluene	76 to 125	59 to 139
Benzene	76 to 127	66 to 142
	Percent Recovery for surrogate spikes	
4-Bromofluorobenzene	86 to 115	59 to 113
1,2-Dichloroethane - d4	76 to 114	70 to 121
Toluene - d8	88 to 110	84 to 138
<p>¹ Low quantitation limit method will be used for aqueous volatile organic compounds (VOCs).</p> <p>Sources: Contract Laboratory Program (CLP) Statement of Work for Organics Analysis. U.S. Environmental Protection Agency (USEPA) Document No. OLM01.9.</p> <p>Contract Laboratory Program (CLP) Statement of Work for Low Concentration Water Organics Analysis. USEPA Document No. OLC01.0.</p>		

**Table 3-2
Accuracy Ranges for Contract Laboratory Program
Semivolatile Organic Compound Analysis**

Supplemental Resource Conservation and
Recovery Act Facility Investigation for Site 11
Volume II, Sampling and Analysis Plan
Naval Submarine Base
Kings Bay, Georgia

Spiking/Surrogate Compound	Accuracy Ranges	
	Water	Soil and Sediment
	Percent Recovery Range for Matrix Spike Samples	
1,2,4-Trichlorobenzene	39 to 98	38 to 107
Acenaphthene	46 to 118	31 to 137
2,4-Dinitrotoluene	24 to 96	28 to 89
Pyrene	26 to 127	35 to 142
N-Nitroso-di-n-propylamine	41 to 116	41 to 126
1,4-Dichlorobenzene	36 to 97	28 to 104
Phenol	12 to 89	26 to 90
2-Chlorophenol	27 to 123	25 to 102
4-Chloro-3-methylphenol	23 to 97	26 to 103
4-Nitrophenol	10 to 80	11 to 114
Pentachlorophenol	9 to 103	17 to 109
	Percent Recovery for surrogate spikes	
Nitrobenzene - ds	35 to 114	23 to 20
2-Fluorobiphenyl	43 to 16	30 to 115
p-Terphenyl - d14	33 to 41	18 to 137
Phenol - db	10 to 94	24 to 113
2-Fluorophenol	21 to 100	25 to 121
2,4,6-Tribromophenol	10 to 123	19 to 122
Source: Contract Laboratory Program (CLP) Statement of Work for Organics Analysis. U.S. Environmental Protection Agency Document No. OLM01.9.		

**Table 3-3
Accuracy Ranges for Contract Laboratory Program Pesticide
and Polychlorinated Biphenyl Analysis**

Supplemental Resource Conservation and
Recovery Act Facility Investigation for Site 11
Volume II, Sampling and Analysis Plan
Naval Submarine Base
Kings Bay, Georgia

Spiking/Surrogate Compound	Accuracy Ranges	
	Water	Soil and Sediment
Percent Recovery Range for Matrix Spike Samples		
Lindane	56 to 123	46 to 127
Heptachlor	40 to 131	35 to 130
Aldrin	40 to 120	34 to 132
Dieldrin	52 to 126	31 to 134
Endrin	56 to 121	42 to 139
4,4'-Dichlorodiphenyltrichloroethane	38 to 127	23 to 34
Percent Recovery for surrogate spikes		
Dibutylchloroendate	24 to 126	20 to 150
Source: Contract Laboratory Program (CLP) Statement of Work for Organics Analysis. U.S. Environmental Protection Agency Document No. OLM01.9.		

**Table 3-4
Accuracy Ranges for Contract Laboratory Program Inorganic Analysis**

Supplemental Resource Conservation and
Recovery Act Facility Investigation for Site 11
Volume II, Sampling and Analysis Plan
Naval Submarine Base
Kings Bay, Georgia

Spiking Compound	Accuracy Ranges	
	Water	Soil and Sediment
Percent Recovery Range for Matrix Spike Samples		
All inorganic analytes	75 to 125	75 to 125
Source: Contract Laboratory Program (CLP) Statement of Work for Inorganics Analysis. U.S. Environmental Protection Agency Document No. ILM02.1.		

Representativeness. Representativeness expresses the degree to which sample data depict an existing environmental condition. Representativeness is accomplished through proper selection of sampling locations and sampling techniques and collection of a sufficient number of samples. The sampling locations in this RFI will be chosen in a biased approach based on previous analytical data, screening data collected in the field, and apparent and measured flow directions.

Sampling and analytical protocols were chosen so that measurements of samples will be as representative of the media and conditions being measured as possible.

Sample collection, handling, and documentation will be performed in accordance with USEPA Region IV SOPs (USEPA, 1991a) to ensure that collection and handling techniques do not alter the sample and to provide an adequate tracking mechanism from the time of collection through laboratory analysis.

The collection and analysis of field blanks, trip blanks, and equipment rinsate blanks; conformance with requirements for analytical methods such as extraction and analysis holding times; and analysis of method blanks will also be used to ensure representativeness of sample data. Sample representativeness will be achieved to the greatest degree possible by adhering to the site sampling plan and sampling procedures described in Subsection 3.5.

Completeness. The characteristic of completeness is a measure of the amount of valid data obtained compared to the amount of data originally intended to be obtained. The completeness goal for DQO Levels III, IV, and V has been chosen as 85 percent, which is consistent with the CLP requirements of 80 to 85 percent.

The sampling objectives described in these planning documents allow for a sufficient number of samples to accomplish the project objectives. However, the number of samples presented are estimates that may be revised based on screening data collected in the field. Examples of circumstances that may cause variations might include increasing or decreasing the number of samples needed for adequate delineation or characterization, increasing or decreasing the number of samples required for characterization of IDWs, and/or decreasing the number of screening samples if site conditions constrain the use of a particular method.

Comparability. The characteristic of comparability reflects the confidence with which one data set can be compared with other measurements and the expression of results consistent with other organizations reporting similar data. In general, comparability can be determined by comparing data from replicate split samples that are analyzed by two separate contract laboratories. However, for the Supplemental RFI, analyses of split samples is not required. Comparability for the Supplemental RFI will be accomplished through the use of standard techniques for sample collection and analysis and the reporting of results in appropriate units. Comparability of analytical procedures also implies using analytical methodologies that produce results comparable in terms of precision, accuracy, and effective range of calibration.

3.4.1.2 PARCC Parameters for Level I and II DQOs For Levels I and II field measurement data, the objective for precision is to achieve and maintain factory equipment specifications. For the pH meter, precision will be tested by multiple readings in the medium of concern. Consecutive readings should agree within ± 0.1 standard pH units after the instrument has been field calibrated with standard buffers before each use. The thermometer will be visually inspected prior to

each use. The OVA will be calibrated prior to field use. Water level indicator readings will be precise within ± 0.01 foot for duplicate measurements.

As with precision, accuracy of field measurements is achieved through maintenance of equipment in accordance with factory specifications and calibration instructions. For many instruments, accuracy can be assessed through comparison of instrument response to an independent, known standard. The pH meter and conductivity meters are calibrated with solutions traceable to the American National Standards Institute. A calibration check will be made on all water level indicators before the initiation of fieldwork. The calibration check will be made using a surveyor's tape or other standard measuring device. The OVA will be calibrated prior to shipment to the field.

Field activities performed at DQO Levels I and II are onsite measurement techniques that provide information in real-time or after minimal delay. The completeness achieved for these methods may be more variable than those for standard analytical methods. A higher degree of completeness may be achieved because measurements can be readily repeated. However, site conditions may constrain the use of some techniques, resulting in fewer valid analyses than anticipated.

Representativeness for Level I and II DQO measurements will be achieved through proper selection of sampling locations and sampling techniques. Comparability of Level I and II data will be maintained through consistent sample collection, handling, analysis, data evaluation, record keeping, and reporting.

3.4.1.3 PARCC Parameters for Level V DQOs Analytical precision will be determined by field duplicates for data meeting Level V DQOs. Acceptance criteria for field duplicate precision for Level V DQOs have been set at 30 and 50 for aqueous and solid analyses, respectively. The control criteria for accuracy will be established by the contract laboratory and is based on the historical performance of each analytical method.

3.4.2 Data Validation Validation of data is a systematic process of reviewing a body of data to provide assurance that the data are adequate for their intended use. The usability of measurements made during the Supplemental RFI will be determined by evaluating the data against the established DQOs for PARCC. Data validation will be performed for all data meeting Level III and Level IV requirements. 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.

In general validation will be performed using guidelines established by the USEPA and NEESA. These guidelines provide a systematic procedure for evaluating laboratory QA/QC measures such as holding times, blank analyses, surrogate recoveries, matrix spike results, GC/MS tuning, instrument calibration, compound identification, and method performance. Upon receipt, analytical data will be validated according to the protocol outlined below.

Appendix IX Analyses. Samples requiring Appendix IX analysis will be analyzed and validated according to Level III DQOs. Data validation will be performed according to USEPA Level III (NEESA Level C QC criteria) and QC criteria specified by each analytical method. These criteria are described in Subsection 7.3.2 of NEESA Document 20.2-047B (NEESA, 1988). The USEPA *National Functional*

Guidelines for Organic Data Review (USEPA, 1990c) and *Laboratory Data Validation: Functional Guidelines for Evaluating Inorganics Analyses* (USEPA, 1988b) will also be used, where applicable, to validate the laboratory data.

CLP 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 DQOs (NEESA Level C QC criteria) and QC criteria specified by each analytical method. NEESA Level C criteria are described in Subsection 7.3.2 of NEESA Document 20.2-047B (NEESA, 1988). The USEPA *National Functional Guidelines for Organic Data Review* (USEPA, 1990c) and *Laboratory Data Validation: Functional Guidelines for Evaluating Inorganics Analyses* (USEPA, 1988b) will also be used, where applicable, 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 DQOs (NEESA Level D QC criteria). NEESA Level D criteria are described in Subsection 7.3.1 of NEESA Document 20.2-047B (NEESA, 1988). In accordance with Level D criteria, the USEPA *National Functional Guidelines for Organic Data Review* (USEPA, 1990c) and *Laboratory Data Validation: Functional Guidelines for Evaluating Inorganics Analyses* (USEPA, 1988b) will be used to validate the laboratory data.

Pesticide and PCB data will be validated according to the guidelines presented in the USEPA Draft *Pesticide/Aroclor Data Review Guidelines* (USEPA, 1991b), that were developed as an extension of the USEPA *National Functional Guidelines for Organic Data Review*, (USEPA, 1990c). The guidelines for evaluating pesticide and PCB data were revised in response to significant changes in the pesticide and PCB analytical procedure associated with the CLP 1990 Statement of Work (SOW) (as compared to the 1988 SOW).

Validated data will be prepared in three initial formats: raw laboratory data, data marked with validation qualifiers or annotations, and corrected or validated data. The validated data can then be used for site contaminant characterization and assessment.

3.5 SAMPLING PROCEDURES. The following subsections describe the sampling procedures that may be used during Supplemental RFI field activities.

3.5.1 Sampling Site Location The rationale for each sampling site location is identified in the site Workplan. To permit proper evaluation of the sample analytical results, it is important that the actual location of the samples be properly documented. If possible, sampling sites will be marked in the field with stakes or flagging. All sampling site locations will be accurately referenced on a base map. All sampling site locations will be described in the field logbook. Photographs of sampling sites will be taken as necessary to document site conditions.

3.5.2 Air Quality Screening Air quality screening is most often used when real-time monitoring is required for health and safety purposes. Equipment for real-time monitoring will be calibrated according to manufacturers' instructions prior to use. Equipment that may be used during this investigation includes:

- oxygen deficiency meter,
- combustible gas monitor (explosimeter),
- chemically reactive indicating tubes (e.g., Draeger) for specific compounds (vinyl chloride, hydrogen cyanide [HCN], hydrogen sulfide [H₂S], etc.),
- PID survey meter (total volatile organics), and
- OVA (total or specific volatile organics).

All real-time monitoring results will be recorded in the field logbook and on the appropriate field data sheets.

3.5.3 Surface Soil and Sediment Sampling Several sampling techniques will be employed during soil and sediment sampling activities conducted as part of this investigation. The sampling techniques were selected to provide practical, efficient means of obtaining samples in a manner consistent with safety protocol and QA/QC requirements. Additionally, these techniques employ equipment that is normally available for use. The selection of sampling techniques to be employed at this site are based upon the depth from which samples must be obtained, the nature of the soil to be sampled, and on the analytical requirements.

3.5.3.1 Sediment Samples Sediment samples will be collected from the sediment found in Porcupine Lake. Generally, the sediment samples will be collected in conjunction with surface water samples at the lake (Subsection 3.5.5.2) to help define the partitioning of the contaminants between the soil and water. If both water and sediment samples are to be collected at a given sampling site, the water samples will be collected prior to the sediment sample.

A gravity corer will be used to collect the sediment samples from the lake bottom. A gravity corer is a metal tube with a replaceable tapered nosepiece on the leading end, which is advanced into the sediments, and a ball or other type check valve on the trailing end of the tube. The check valve allows water to pass through the corer on descent, but prevents washout during recovery. The tapered nosepiece facilitates cutting and reduces core disturbance during penetration. Most corers are constructed of brass or steel, and many accept inner liners (for VOC sample analysis) and additional weights (for greater sediment penetration). The gravity corer sampler relies on the weight of the sampler and gravity to penetrate the sediments. Sample collection and documentation procedures include the following steps.

1. Attach a precleaned corer to the required length of sample line. Solid braided 5 millimeter (mm) (3/16 inch) nylon line is sufficient; 20 mm (3/4 inch) nylon, however, is easier to grasp during hand hoisting.
2. Secure the free end of the line to a fixed support to prevent accidental loss of the corer.
3. Measure and mark the distance to the top of the sediment on the sampler line to later determine depth of sediment coring.
4. Allow corer to free fall through liquid to bottom.

5. Determine depth of sediment penetration.
6. Retrieve corer with a smooth, continuous lifting motion. Do not bump corer because this may result in some sample loss.
7. Remove nosepiece from corer and slide inner liner with sediment sample out of corer into a stainless-steel pan. If the sample is designated for VOC analysis, do not remove or otherwise disturb the sample. Cap and seal both ends of the inner liner so that the liner is airtight. Proceed to step 10. If the sample is designated for analysis other than VOCs, caution must be exercised at this point not to lose the sample, particularly if it is coarse grained. Only those corers that have some water in the core tubes above the sediment will be retained. This ensures that the sediment surface is intact and provides a reference point for determining the sample depth below the sediment-water interface. Scan the sediment sample with an OVA or PID and record the results in the field logbook.
8. Visually examine the sample and record its characteristics (e.g., texture, color, consistency, moisture content, layering, and other pertinent data) using the USCS.
9. Transfer sample into the appropriate sample bottle with a clean stainless-steel spoon, scoop, or spatula.
10. Properly label all containers and prepare chain-of-custody documents. Record sample location, description, sample numbers, and other pertinent information in the field book and sample record form.
11. Place the properly labeled sample bottles in a cooler with ice.
12. Decontaminate the sampling device in accordance with specified procedures.

Equipment needed to collect the gravity corer samples includes the gravity corer and liners, nylon sample line, OVA or PID meter, glass or stainless-steel mixing bowls, stainless-steel spoons or spatulas, appropriate numbers and types of sample containers, sample tags and/or labels, and appropriate forms and documentation, field logbook, decontamination equipment and supplies, and personnel protective equipment, as necessary.

3.5.3.2 Surface Soil Samples Surface soil samples will be obtained by using a hand auger (for sample depths 0 to 5 feet bls) and/or stainless-steel tulip bulb planters (for sample depths from 0 to 6 inches bls) for laboratory analysis. Equipment and materials involved in the collection of surface soil samples includes hand augers, tulip bulb planters, stainless-steel trays or bowls, stainless-steel scoops, shovels, trowels, spoons or spatulas, appropriate sample containers, sample tags and/or labels, and the appropriate forms and documentation, field logbook, plastic zip-top bags and sealing tape, decontamination equipment and supplies, protective clothing and gear, and an OVA or PID. Sample collection and documentation procedures include the following steps.

1. Put on the personnel protective clothing and equipment, as necessary.

2. Place plastic sheeting on a flat, level surface near the sampling area, if possible. Place decontamination equipment and supplies, sampling equipment, sampling containers, and insulated cooler on separate plastic sheeting. Cover all equipment and supplies with plastic sheeting when not in use.
3. Use a hand auger to remove the surface soils until the designed sample depth has been reached. A sample is then collected inside the hand auger. The sample is transferred into a stainless-steel or Teflon™-lined container. Scan the sample with an OVA or PID meter and record the results in the field logbook.
4. Use a clean stainless-steel or Teflon™-lined scoop, trowel, shovel, spoon, or spatula to obtain a minimum of three sample volumes or the volume needed to fill the specified sample container.
5. Fill and cap VOC vials as quickly as possible. Immediately label the VOC container with the appropriate information and place in a cooler with ice. Mix remainder of sample directly in a clean stainless-steel or Teflon™-lined tray or bowl. Fill and cap each sample container. Place VOC containers on ice immediately.
6. Label each sample container with the appropriate information and place in a cooler with ice. Fill out chain-of-custody documents and package samples.
7. Visually examine the remaining sample and record its characteristics (e.g., texture, color, consistency, moisture content, layering, and other pertinent data) using the USCS.
8. Record sample location, description, sample numbers, and other pertinent information in the field logbook and sample record form.
9. Decontaminate the sampling device in accordance with specified procedures.

3.5.4 Subsurface Soil Samples Mud rotary drilling techniques will be used to advance the boreholes from which the subsurface soil samples will be collected. The drill cuttings from the borehole are removed by pumping the drilling mud from a sump down through the drill rods and bit and up the annulus between the borehole and the drill rods. The drill rod and bit can be removed from the uncased borehole and a sampler (split spoon or Shelby tube) attached to the drill rods and lowered down the borehole to collect a soil sample from the bottom of the boring. A sample of the water and the drilling mud will be collected for laboratory analysis. Stainless-steel, split-spoon soil samplers will be used to collect subsurface soil samples for engineering and treatability analyses, CLP analyses, and for some of the fate and transport analyses. A Shelby tube, and/or ring samplers, will be used to collect subsurface soil samples for some of the fate and transport analyses, which require relatively undisturbed samples of soils from borings. Equipment required to collect the subsurface soil samples includes split-spoon samplers, ring samplers (brass liners that fit inside the split-spoons), Shelby tubes, glass or stainless-steel mixing bowls, stainless-steel spoons and spatulas, appropriate sampling containers, sample tags and/or labels and appropriate forms and documentation, field logbook, decontamination

equipment and supplies, appropriate equipment (OVA or PID) for breathing zone and sample screening, and personnel protective equipment, as necessary.

Split-Spoon Sample Collection Procedure. A split-spoon sampler consists of a split, stainless-steel tube or sample barrel threaded at both ends. A sharpened drive shoe secures the leading, penetrating the end of the barrel and an adaptor secures the trailing end. The adaptor contains a check valve and is threaded to connect directly to the drill rods. The split spoon is driven into relatively undisturbed soil below the base of the borehole. After the sampler has been driven, it is withdrawn from the borehole and the sampler is opened after removing both drive shoe and adaptor. Sample collection and documentation procedures include the following steps.

1. Scan the soil with an OVA or PID and record the results in the field logbook.
2. Visually examine the sample and record its characteristics (e.g., texture, color, consistency, moisture content, layering, and other pertinent data) using the USCS.
3. Remove the portion(s) of the sample selected for chemical analysis and place it into appropriate containers. Soil intended for VOC analysis should be collected from the inner portion of the sample, placed in the appropriate sample containers, labeled with the appropriate information, and placed in a cooler with ice, immediately. Soil intended for other types of analyses should be placed in a glass or stainless-steel mixing bowl and thoroughly mixed using a stainless-steel spoon or spatula. Once the sample has been thoroughly mixed, sample material should be placed in the appropriate sample containers.
4. Discard any excessively disturbed or loose material found in the top portion of the sampler, which may not be representative of the interval sampled. This material will be discarded with other boring spoils at each boring location.
5. Properly label all containers and prepare chain-of-custody documents. Record sample location, description, sample numbers, and other pertinent information in the field logbook.
6. Decontaminate the sampling device in accordance with specified procedures.

The sampler must exercise considerable care while collecting samples for analysis. Methods to assure that high quality samples are collected are described below.

1. Make sure that the sample is obtained from undisturbed soil below the bottom of the borehole. This is accomplished by monitoring or checking the drill crew's measurements, observing the sampling process and examining the sample once it is retrieved.

2. Carefully remove and discard any portions of the sample that may have become contaminated by contacting the drilling fluids (e.g., bentonite or drilling mud).
3. Conserve sample volume, because under certain soil conditions it may be difficult or impossible to achieve good sample recovery with split-spoons.

Procedures employed to prevent cross contamination during test boring sampling operations include the following.

- Samples are collected immediately after the boring is advanced to the desired sampling elevation.
- The down-hole sampling tools are decontaminated prior to the collection of each sample.
- The drilling technique and procedures to be used, particularly the use of drilling fluids, are carefully evaluated for each site.

Ring Sampler Collection Procedure. Ring samplers are not to be used for collection of samples for chemical analysis. Bulk density and permeability tests require undisturbed samples and ring samplers are for this purpose only. Ring samplers are brass sleeves inserted into split-spoon samplers. Sample collection and documentation procedures include the following steps.

1. The brass sleeves are inserted into the split-spoon sampler.
2. If possible, the sample will be obtained by using the drill rig to hydraulically push the split-spoon and ring sampler in one continuous movement. The maximum hydraulic pressure will be recorded in the field logbook.
3. Upon retrieval of the sampler, the brass liners will be removed from the split spoon. The actual length of the sample will be measured and recorded (excluding slough or cuttings). Airtight fitting plastic caps will be placed at the ends of the ring samplers. The seam between the cap and tube will be wrapped with tape.
4. The ring samplers and the top cap will be labeled by writing on them with an indelible marker or by affixing a label. The label will be secured to the ring sampler by wrapping clear tape over the label and completely around the tube. The top and bottom will be marked on the sampler, so that the orientation of the soil sample is known.
5. As much as possible, the ring samplers will be carried or transported in an upright vertical position to maintain the *in situ* orientation and to minimize sample dis-aggregation.

Shelby Tube Sample Collection Procedure. Shelby tube samplers will be used in fine-grained or cohesive soil to obtain relatively undisturbed soil samples for geotechnical laboratory testing. The samplers are constructed of steel tubing about 1 mm thick (for tubes 2 inches in diameter). The lower, penetrating end is bent to form a tapered cutting edge. The upper, trailing end is fastened to

a check valve to help hold the sample in the tube when the tube is being withdrawn from the sample interval. Sample collection and documentation procedures include the following steps.

1. The Shelby tube will be attached to the drill rods. The tube will be advanced by hydraulically pushing it in one continuous movement with the drill rig. The maximum hydraulic pressure will be recorded in the field logbook. At the end of the designated push interval and before lifting the sample, the tube will be twisted to break the bottom of the sample.
2. Upon recovery of the tube, the actual length of sample will be measured and recorded (excluding slough or cuttings). At least 1/2 inch of soil will be cleaned from each end of the tube, and the ends of the soil sample squared off. The cuttings and slough, if present, will be removed before sealing the tube. The resulting space at each end of the tube will be filled with melted sealing material, such as approved wax, or with expandable packers. Previously decontaminated Teflon™ or stainless-steel plugs may also be used. After this initial sealing, a dry filler such as cuttings, sand, or paper can be placed in the remaining void areas and sealing is repeated. The filler prevents the sample from breaking the initial end seals during handling and shipment. The ends of the tube will then be closed with tight-fitting metal or plastic caps, and the seam between the cap and tube will be wrapped with tape. Finally, the ends will be dipped in hot wax, completely covering the tape to ensure airtight sealing.
3. The sample container and the top cap will be labeled by writing on them with an indelible marker or by affixing a label. If possible, all labeling will be located in the top foot of the tube. The information on the tube will include the project number, project name, date of sampling, boring number, zone of sampling, and any other information the geologist or field engineer thinks is pertinent. In addition, the tube will be marked "TOP" and "BOTTOM" so that the orientation of the sample is known.
4. Visually examine the sample that has been cleaned from the tube and record its characteristics (e.g., texture, color, consistency, moisture content, layering, and other pertinent data) using the USCS.

As much as possible, the tubes should be carried by hand to the soil laboratory in an upright vertical position to maintain the *in situ* orientation and to minimize sample dis-aggregation. If the tubes are transported by truck or automobile, they will be carefully padded and wedged in place to prevent movement and minimize vibration. If the tubes are shipped as freight, they will be packed in secure boxes with dividers built in to prevent movement of the tubes, or the boxes will be tightly filled with packing material such as wood chips to prevent movement. The boxes will be marked "FRAGILE" and "KEEP FROM HEAT AND FREEZING" and labeled according to the type of hazard presented by the assumed contamination.

3.5.5 Water Sampling The following subsections describe the water sampling procedures that will be used during this investigation to collect groundwater

samples, surface water, and wastewater samples. Many of the sampling procedures are consistent for all types of water sampling and are discussed here.

Sample Collection. Water sample containers are generally filled directly from the source, sampler, or pump discharge without special considerations. A major exception is the collection of VOC samples. VOC samples must be collected as specified below. Each sample is collected in duplicate.

1. Uncap the sample bottle, taking care not to touch the Teflon™-faced septa. If the septa is contaminated in any way, it will be replaced with a clean, untouched septa.
2. If a chlorine residual is potentially present in the sample, check for chlorine content with potassium iodine (KI) paper or a chloride residual comparator. If a residual chlorine content is detected, add 3 drops of 10 percent sodium thiosulfate ($\text{Na}_2\text{S}_2\text{O}_3$) to the sample container prior to filling the bottle.
3. Fill the sample vial slowly from the bailer or pump discharge, minimizing air entrainment or contaminant volatilization, until the vial overflows.
4. Place the Teflon™-faced silicon rubber septa on the convex meniscus, Teflon™ side (shiny side) down and screw cap on.
5. Invert the bottle, tap side of bottle lightly, and check for air bubbles.
6. If air bubbles are present, open the bottle, add sample to eliminate air bubbles, and reseal. Repeat this procedure until the bottle is filled and no air bubbles are detected. If after three attempts bubbles are still present, discharge bottle and start over.

Sample Preservation. The following preservation procedures are examples of typical preservation protocols specific to the indicated analyses.

Volatile Organic Analytes. Fill the sample bottle as previously described. If chlorine is detected, 10 percent sodium thiosulfate ($\text{Na}_2\text{S}_2\text{O}_3$) should be added (3 drops) to the sample container prior to filling the container. Place samples on ice until shipment. Also note that if hold times are anticipated to exceed 7 days, the sample should be preserved with hydrochloric acid (HCl) to a pH less than 2.

Extractable Organic Analytes. Fill the sample bottle, seal with a Teflon™-lined cap, and place on ice for shipment.

Elements. Following any required filtration, fill the sample bottle, preserve the sample to a pH less than 2 with nitric acid (HNO_3), seal container, and place sample on ice for shipment.

Chemical Oxygen Demand and Total Organic Carbon and Ammonia. Fill sample bottle as described above, add sulfuric acid (H_2SO_4) to a pH less than 2, cap bottle, and place sample on ice for shipment.

Cyanide. Fill the sample bottle, and if chlorine is present, add 1 milliliter of 10 percent ascorbic acid ($C_6H_8O_6$). Add 10 normal (N) sodium hydroxide (NaOH) to a pH of greater than 12, cap bottle, and place sample on ice for shipment.

Sulfide. Fill the sample bottle, add 10 N NaOH and zinc acetate to a pH of greater than 9, cap bottle, and place sample on ice for shipment.

Measurements for pH and temperature should never be taken from the sample containers. When preserving samples, pH paper should be used to verify the pH of the preserved sample. The sample should be poured across the pH paper. Never place pH paper directly into sample.

3.5.5.1 Groundwater Sampling Groundwater samples will be collected from the estimated 35 new and existing monitoring wells. In addition, groundwater samples may also be collected from the PIWs located in the subdivision.

Groundwater samples will be put into various containers depending on the sample and analytical requirements for each location and will be analyzed for the parameters selected for the project as discussed in Section 2.0. Preprinted labels will be prepared for all groundwater samples. The pH, specific conductance, and temperature of each sample will be measured in the field.

Where possible, sampling will proceed from least contaminated wells (wells outside and upgradient of the contaminant plume) to most contaminated (wells located inside the plume). Groundwater sample collection procedures including purging techniques and sampling procedures are discussed in this subsection. A submersible pump and/or bailer will be used to purge the wells and to collect groundwater samples. The purging and sampling techniques outlined below help ensure the collection of representative samples.

Purging Technique. Wells will be purged before groundwater sampling to remove stagnant water so that a representative sample may be obtained. Wells will be sampled within 24 hours after purging.

Purging equipment includes:

- pump (centrifugal or submersible), pump tubing, Teflon™ or stainless-steel bailer, and line;
- power source (e.g., generator), if required;
- water-level meter or weighted surveyor tape;
- temperature, conductivity, and pH meters;
- personnel protective equipment as specified in the site-specific HASP;
- decontamination supplies; and
- drums for storage and disposal of hazardous waste, if required.

Purging of standing well water is considered complete when either five well volumes have been purged, or the well has been pumped dry.

Method of Well Purging:

1. Put on personnel protective clothing and equipment as specified in the site-specific HASP.
2. Open well cover and check condition of the wellhead.
3. Calculate volume of water in well by measuring distance from the bottom of the well to the static water level (height of standing water), then measure the inside diameter of well or casing. Water level measurements should be measured from the same point each time it is measured with minimum measurements made in 1/10th of a foot. Note: more stringent measurements may be required for specific project programs (i.e., 1/100th of a foot). Traditionally, water level measurements are measured from a marked reference point located on the north side of the top of casing of the well.
4. Calculate well volume by using the follow formula (or its equivalent):

$$v = 5.88d^2h \quad \text{where,} \quad \begin{array}{l} h = \text{height of standing water column} \\ d = \text{inside diameter of well in feet} \\ v = \text{volume of water in gallons} \end{array}$$

5. Prepare pump and tubing or bailer and lower it into casing.
6. Remove three to five well volumes, recording measurements of pH, specific conductance, and temperature for each volume purged.
7. Purging is complete when three to five well volumes have been removed and parameters of pH, specific conductance, and temperature vary less than 10 percent between consecutive measurements.
8. If well goes dry during pumping or bailing, purging is considered to be complete.
9. Record pertinent data in field logbook.
10. Remove pump assembly or bailer from the well and decontaminate as required.
11. Dispose of produced water as required by project Workplan.

Whenever possible, monitoring well purging will be accomplished with a pump. Wells will be purged with bailers only when circumstances make the use of a pump difficult or impossible or excessively time consuming.

To prevent backflow of purged water into wells, submersible pumps must be equipped with a check valve, and centrifugal pumps must have a foot valve. When sampling for organics or metals, certain precautions must be taken to minimize the risk of contaminating the groundwater sample with the pump. In general, any parts of the pump and tubing that contact the groundwater must be constructed of Teflon™ and stainless steel.

Sampling Procedures for Monitoring Wells. Wells with free product will not be sampled for trace chemical analyses unless necessitated by special circumstances or client request. The sampling locations will be recorded in the field logbook and indicated on a site map. Groundwater sampling equipment includes:

- bailers constructed of appropriate material (i.e., Teflon™, stainless steel, polypropylene);
- clean and unused (nylon or monofilament) line of sufficient length to lower bailer (new lanyard must be used for each well);
- a pump (type dictated by physical conditions);
- appropriate sample containers with labels and preservatives, as required;
- coolers with wet ice;
- water-level meter and/or other water-level measuring device;
- temperature, conductivity, and pH instruments;
- plastic sheeting;
- decontamination supplies, as required; and
- personnel protective clothing and equipment, if required by the site-specific HASP.

Groundwater sampling procedures include the following steps.

1. Put on protective clothing and equipment as necessary.
2. Prepare the site for sample collection by covering the ground surface around the well head with plastic sheeting.
3. Open well and note condition of casing and cap. Check for vapors using vapor analyzing equipment.
4. Determine static water level and depth to well bottom using water-level meter or tape. Record this information in field logbook.
5. Determine purge volume and purge the well.
6. Arrange sample containers in order of use. VOC samples, if required will be sampled first, followed in order by SVOC and other samples.
7. Lower bailer or pump intake (as appropriate for parameters of concern) into well. Bailer should enter the water slowly to prevent aeration, particularly when VOC and SVOC samples are being collected. Retrieve the filled bailer to the surface. Try not to allow line or bailer to directly contact the sampler, ground, or other surroundings.

8. Collect the samples in the following manner.
 - Collect VOC samples first. Fill sample vials directly from bailer with as little agitation as possible. Fill until the sample forms a convex meniscus above the top edge of the vial, and then carefully cap the vial. Invert VOC sample bottles and tap to check for air bubbles.
 - Other samples will be placed directly in the appropriate container from the discharge tubing of the pump or bailer in the following order, as applicable: TOC; SVOCs; pesticides, PCBs, and herbicides; metals; cyanide and sulfide; BOD; and ammonia.
9. Add preservative (if needed), cap, seal, and properly label all containers. Place filled containers into the cooler(s) immediately.
10. Record sample types and amounts collected and time and date of collection in the field logbook. Prepare chain-of-custody. Prepare samples for shipment to the laboratory.
11. Decontaminate sampling equipment (as required).

Groundwater sampling (or purging) with a bailer for metals and organic compounds should only be done with a stainless-steel or Teflon™ bailer.

Private Irrigation Wells. Groundwater samples will be collected from PIWs located in the subdivision only if contaminants are identified during this groundwater sampling program (monitoring and recovery wells) that were not sampled for in previous groundwater sampling events and the potential exists for these contaminants to be conveyed to the surface by the PIWs.

Groundwater samples will be collected directly from spigots or sprinkler heads. Whenever possible, spigots closest to the wellhead and pump will be used to collect samples. Before sample collection, each PIW will be purged for 15 minutes, during which time flow rates will be measured by measuring the time required to fill a 6-gallon bucket. Flow rates will not be measured from the PIWs that will be purged through sprinkler heads. The pH, specific conductance, and temperature will be periodically measured and recorded while purging the wells.

3.5.5.2 Surface Water Samples will be collected from the surface water found in Porcupine Lake. Water samples will be collected from within 1 foot of the bottom of the lake using a Beta sampling bottle from a boat at the lake. A Beta sampling bottle consists of a cylindrical tube with stoppers at each end and a closing device activated by a messenger.

Surface water sampling equipment includes:

- Beta sampling bottles constructed of Teflon™-lined PVC,
- clean and unused (nylon or monofilament) line of sufficient length to lower sampling bottle,

- appropriate sample containers with labels and preservatives, as required,
- water level meter and/or other water-level measuring device, and
- temperature, conductivity, pH, instruments.

Surface water sampling procedures include the following steps.

1. Put on protective clothing and equipment as necessary.
2. Determine depth to lake bottom using water-level meter or tape. Record this information in field logbook.
3. Arrange sample containers in order of use. VOC samples, if required will be sampled first, followed in order by SVOC and other samples.
4. Lower the sampler in the open position to the desired depth (1 foot above bottom of lake). The sample bottle should be lowered slowly to prevent aeration, particularly when VOC and SVOC samples are being collected. Retrieve the filled sampler to the surface.
5. Collect the samples in the following manner.
 - Collect VOC samples first. Fill sample vials directly from bailer with as little agitation as possible. Fill until the sample forms a convex meniscus above the top edge of the vial, and then carefully cap the vial. Invert VOC sample bottles and tap to check for air bubbles.
 - Other samples will be placed directly in the appropriate container from the sampler in the following order, as applicable: TOC; SVOCs; pesticides, PCBs, and herbicides; metals; cyanide and sulfide; BOD; and ammonia.
6. Add preservative (if needed), cap, seal, and properly label all containers. Place filled containers into the cooler(s) immediately.
7. Record sample types and amounts collected, and time and date of collection in the field logbook. Prepare chain-of-custody. Prepare samples for shipment to the laboratory.
8. Decontaminate sampling equipment (as required).

3.5.6 Test Trench Sampling Ten test trenches will be excavated to a depth of 10 to 12 feet bls or to groundwater, whichever is encountered first, in selected landfill cells to allow visual examination and possible sampling of the waste material (solid and liquid). The long axis of each test trench will be perpendicular to the long axis of the landfill cell being investigated, creating a cross section of that cell. The length of each test trench will be at least one-half the width of the cell being investigated. Trenches will probably vary from 20 to 25 feet in length.

The proposed test trench locations are discussed in Section 2.0. The material excavated from the test trenches will be temporarily stockpiled on plastic placed adjacent to the trench. The material will be placed back into the test trench following completion of test trench sampling. Test trench operations, sampling procedures, equipment, potential health and safety problems, and documentation are discussed below.

Equipment: The following is a list of equipment that may be needed for taking samples from the test trenches:

- backhoe or other excavating machinery;
- stainless-steel shovels, picks, or scoops;
- personnel protective equipment;
- air monitoring equipment (OVA or PID);
- peristaltic pump and tubing;
- bailer and nylon sample line;
- sample containers;
- sample tags and/or labels and appropriate forms and documentation; and
- field logbook.

Sampling Procedures: To expedite the sampling and recording efforts and to minimize periods of potential exposure during the excavation of test trenches, the sampling crew will have sufficient tools and equipment to sample each trench prior to requiring decontamination. The backhoe and tools will be decontaminated between each test trench. The backhoe bucket and boom will be decontaminated as required during excavation of each test trench.

The actual layout of each test trench, temporary staging area, and spoils pile will be predicated by onsite conditions and wind direction at the time the test trench is made. During excavation, sampling, and logging of each test trench, the backhoe operator and all site personnel will remain upwind or crosswind of the test trench and spoils pile. Wind direction will be monitored by means of a wind sock or other banner located in a prominent position visible to all personnel.

Preselection and the use of hand and horn signals is important during completion of test trenches due to noise levels around the machine. The sampling crew and backhoe operator will rehearse appropriate signals ahead of time and be thoroughly familiar with their meaning. All personnel will be equipped with air blast horn devices, especially when wearing respiratory safety gear that hinders communication.

Sampling of unopened buried drums is excluded from this test trenching protocol. Such work will be conducted on a site-specific basis and appropriate safety and sampling protocols will be used for each instance.

Test trenches will be logged as they are excavated. Records for each test trench will be made on prepared forms or in the field logbook. If the log is made in the field logbook, it will be transcribed to prepared forms. These records include plan and profile sketches and photographs of the test trench showing all materials encountered, their depths, and distribution in the test trenches and sample locations. These records will also include safety and sample screening information. An example test trench record form is shown in Appendix A.

The actual depth and type of samples obtained from each test trench will be selected at the time the test trench is excavated. Sufficient samples are usually obtained and analyzed to quantify contaminant distribution as a function of depth for each test trench. Additional samples of each waste phase and any fluids encountered in each test trench may be collected.

Test trenches will be excavated and sampled in the following manner.

1. The sampler and backhoe operator will plan the excavation.
2. The backhoe operator will excavate the test trench in several depth increments.
3. After each increment, the operator will wait while the sampler inspects the test trench to decide if conditions are appropriate for sampling. Practical depth increments range from 2 to 4 feet.
4. The backhoe operator, who will have the best view of the test trench, will immediately cease digging if:
 - any fluid phase or groundwater seepage is encountered in the test trench,
 - any drums or other potential waste containers are encountered, or
 - distinct changes of material are encountered.

This action is necessary to permit proper sampling of the test trench and to prevent a breach of safety protocol.

For instance, should any fluids or seepage be encountered, they could, after suitable screening and monitoring, be sampled. Waste and sludge deposits could likewise be sampled before proceeding. Should uncollapsed drums be encountered, the test trench would be terminated, backfilled, and redug at an adjacent location.

5. The test trench will be sampled as described in the following subsections.

Sampling from Ground Surface. Solid samples can be collected from the backhoe bucket, the soils pile, or directly from the test trench. Liquid samples will be collected directly from the test trench from the ground surface. The method will be selected in the field at the time the test trench is sampled.

a. Backhoe Bucket Sampling. The sampler or crew chief will direct the backhoe operator to remove material from the selected depth or location within the test trench. The bucket will be brought to the surface and moved away from the trench. The sampler will approach the bucket and monitor its contents with the PID and/or OVA meter. If granular or loose soils and/or uniform materials are encountered, the sample will be obtained directly from the bucket. The sample will be collected from the center of the bucket and placed in sample jars using a clean stainless-steel trowel or spatula.

If a composite sample is desired, several depths or locations within the trench will be selected and a bucket filled from each area. A sample container will be filled from each bucket and then emptied into a mixing surface (e.g., stainless-steel or Pyrex™ pan) and thoroughly stirred prior to being placed into the sample jars. The disposable mixing surfaces will be discarded into the test trench when it is backfilled. If cohesive soils or multiphase conditions are encountered (e.g., the bucket contains a mixture of soil and sludge) the sampler will proceed as above if practical; if not, she/he will direct the backhoe operator to empty the bucket onto plastic sheeting on the ground. The sampler will then obtain the sample from the interior of soil clods or lumps or sludge using a clean stainless-steel trowel or spatula.

b. Sample Collection Directly from the Test Trench. Solid samples will be collected directly from the test trench when soil conditions preclude obtaining suitable samples from the backhoe bucket (e.g., caving or excessive mixing of soils or wastes within the test trench) or when samples from relatively small discrete zones within the test trench are required. This approach is also required to sample seepage occurring at discrete levels or zones in the test trench. In these circumstances, samples will be obtained by means of extendable handled tools: scrapers, trowels, spoons, or cups. The face of the test trench will be scraped to remove the smeared zone that has contacted the backhoe bucket. Solid material to be sampled will then be removed from the test trench wall by means of long-handled scoops or trowels. The sample will then be thoroughly stirred on a clean disposable mixing surface and placed in the sample containers.

Liquid material will be sampled from the ground surface if encountered in the test trench. A bailer or peristaltic pump with a sufficient length of tubing to reach the desired sample depth will be used to collect fluid samples. If fluid and solid material are removed from the trench, then the retrieved fluid material may be sampled by collecting in a bailer or cup and decanting it into sample jars.

In-Trench Sampling Safety. Personnel will sample and log trenches from the ground surface except as provided for by the following criteria.

1. If the project will benefit significantly from the improved quality of the test trench logging and sampling data that would be obtained if personnel enter a test trench rather than conduct such operations from the ground surface.
2. If there is no practical alternative means of obtaining such data.
3. If the Site Safety Officer determines that such action can be accomplished without breaching site safety protocol. This decision will be based on actual monitoring of the test trench after it is dug (including, at a minimum, measurements of volatile organics, explosive gases, and available oxygen).
4. If an experienced geotechnical professional determines that the test trench is stable or is made stable prior to entrance of any personnel in accordance with 29 Code of Federal Regulations (CFR) 1926.652 (Special Training Requirements).

If all of these conditions are satisfied, one person will enter the test trench. This individual will be dressed in safety gear as required by the conditions in the trench. This person will be affixed to a safety rope and continuously monitored while in the trench. A second individual will be fully dressed in appropriate gear and on standby during all trench entry operations. The individual entering the trench will remain therein for as brief a period as practical, commensurate with performance of her/his work. After removing the smeared zone, samples will be obtained with a stainless-steel trowel or spoon.

Sampling in the Vicinity of Drums. Should collapsed or highly corroded drums be encountered that are obviously empty and pose no unusual threat, the test trench could be continued after appropriate monitoring. If possible, the test trench would be sampled from the ground surface by means of long-handled scoops or trowels. As described above, the face of the test trench must be first scraped to remove the smeared zone that has contacted the backhoe bucket. Attempts to sample drums or containers also could be made from the ground surface, with appropriate safety procedures.

Backfilling of Test Trenches. Before backfilling, the onsite crew will photograph all significant features exposed by the test trench. If possible, each photograph will include a scale to show dimensions, site number, test trench number, depth, description of feature, and date of photograph. In addition, a geologic description of each photograph will be included in the field logbook. All photographs will be indexed and maintained in the project files for future reference. After inspection, backfill material will be returned to the trench under the direction of the field supervisor.

3.5.7 Air Quality Monitoring Air quality samples for the evaluation of TCL VOCs will be collected and analyzed in accordance with USEPA Method TO-1, as found in the *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air* (USEPA, 1988c). The method will be modified to use an alternative sorbent material. The method recommends the use of Tenax sorbent; however, Tenax does not effectively adsorb vinyl chloride, which is the primary VOC of concern at Site 11. Use of an alternative sorbent, such as Supelco Carbotrap, will enable the efficient collection and desorption of TCL VOCs, including vinyl chloride.

Samples will be collected over an 8- to 9-hour period at each location, at a flow rate of approximately 0.15 liters per minute. A large sample volume is necessary to achieve low detection limits. A field logbook will be maintained that will note sample times, locations, and general ambient conditions during each event.

3.5.8 Decontamination Procedures Equipment to be decontaminated during this project may include: (1) drill rig, (2) backhoe, (3) tools, (4) monitoring equipment, (5) respirators, (6) sample containers, (7) truck or trailer, and (8) laboratory equipment.

All decontamination will be done by personnel in protective gear appropriate for the level of decontamination, established by the Site Safety Officer. The decontamination work tasks will be split or rotated among support and work crews.

3.5.8.1 Drilling Rig, Backhoe, and Tools All drilling rigs, drilling and sampling equipment, backhoe, and all other associated equipment involved in the drilling, test trenching, and sampling activities will be cleaned and

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

Any part of the drill rig, backhoe, etc., that is over the borehole or test trench (kelly bar or mast, drilling platform, hoist or chain pulldowns, spindles, cathead, backhoe buckets, etc.) will be steam cleaned and wire brushed before being brought on the site to remove all rust, soil, and other material that may have come from other hazardous waste sites. The drill rig, backhoe, and other equipment associated with the drilling and sampling activities will be inspected to ensure that all oil, grease, hydraulic fluid, etc., have been removed, and all seals and gaskets are intact and there are no fluid leaks. No oils (except for vegetable oil) or grease will be used to lubricate drill stem threads or any other drilling equipment being used over the borehole or in the borehole. If drill stems have a tendency to tighten during drilling, Teflon™ string and/or vegetable oil can be used on the drill stem threads. The drill rig(s) and backhoe will be steam cleaned and wire brushed prior to drilling and test pitting at each location, respectfully. In addition, all downhole drilling, sampling, and associated equipment that will come into contact with the downhole equipment and sample medium will be cleaned and decontaminated by the following procedures.

1. Clean with tap water and laboratory grade, phosphate-free detergent, using a brush, if necessary, to remove particulate matter and surface films. Steam cleaning and/or high pressure hot water washing may be necessary to remove matter that is difficult to remove with the brush. Drill rods, Shelby tubes, split-spoons, etc., that are hollow or have holes that transmit water or drilling fluids, will be cleaned on the inside and on the outside. The steam cleaner and/or high pressure hot water washer will be capable of generating a pressure of at least 2,500 psi and producing hot water and/or steam (200 °F or greater).
2. Rinse thoroughly with tap water (potable).

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

3. Rinse thoroughly with DI water.
4. Rinse with solvent (pesticide-grade isopropanol).
5. Rinse thoroughly with organic-free water and allow to air dry. Do not rinse with DI or distilled water.

Note: Organic-free water can be processed onsite by purchasing or leasing a mobile deionization-organic filtration system.

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

6. Wrap with aluminum foil, if appropriate, to prevent contamination if equipment is going to be stored or transported. Clean plastic can be used to wrap drill stems, casings, etc., if they have been air dried.
7. Well casing, tremie tubing, etc., that are made of plastic (PVC) will not be solvent-rinsed during the cleaning and decontamination process. Used plastic materials that cannot be cleaned are not acceptable and will be discarded.

Cleaning and decontamination of all equipment will occur at a designated area on the site, downgradient, and downwind from the clean equipment drying and storing area. The cleaning and decontamination area will contain a wash water and/or waste trench excavated either with a backhoe or other heavy equipment. The trench and surrounding area will be lined with a plastic sheeting and designed to promote runoff of the wash and rinse water into the trench. If the trench cannot be excavated, a catch basin can be constructed out of wood and lined with plastic to contain the waste and rinse water until it can be containerized. All cleaning of drill rods, well screen and casing, etc., will be conducted above the plastic sheeting using saw horses or other appropriate means. At the completion of the drilling activities, the trench will be backfilled with the appropriate material designated by the site project leader, but only after the trench has been sampled, and the waste and rinse water has been pumped into 55-gallon drums for disposal. No solvent rinsates will be placed in the trench. All solvent rinsates shall be collected in separate containers for proper disposal.

Tap water (potable) brought on the site for drilling and cleaning purposes will be contained in a pre-cleaned tank of sufficient size so that drilling activities can proceed without having to stop and haul water. A stainless-steel water tank with a minimum capacity of 1,000 gallons is preferred.

3.5.8.2 Sample Containers Exterior surfaces of sample bottles will be decontaminated prior to packing for transportation to the analytical laboratory. Sample containers will be wiped clean at the sample site, but it will be difficult to keep the containers completely clean. The samples will be taken to the decontamination area. Here they will be further cleaned as necessary and transferred to a clean carrier and the sample identities noted and checked off against the chain-of-custody record. The samples, now in a clean carrier, will be stored in a secure area prior to shipment.

3.5.8.3 Monitoring Equipment Monitoring equipment will be protected as much as possible from contamination by draping, masking, or otherwise covering with plastic as much of the instruments as possible without hindering the operation of the unit. The OVA meter, for example, can be placed in a clear plastic bag that allows reading of the scale and operation of the knobs. The OVA sensor can be partially wrapped, keeping the sensor tip and discharge port clear.

The contaminated equipment will be taken from the drop area and the protective coverings removed and disposed of in the appropriate containers. Any direct or obvious contamination will be brushed or wiped with a disposable paper wipe. The units can then be taken inside, wiped off with damp disposable wipes, and dried. The units will be checked, standardized, and recharged as necessary for the next day's operation. They will then be prepared with new protective coverings.

3.6 ANALYTICAL PROCEDURES. Procedures for chemical analyses of environmental samples are selected to support the achievement of DQOs. The analytical parameters, method references, and corresponding DQOs for each of the Supplemental RFI tasks are outlined in Tables 3-5 through 3-8. Subsection 2.2 of this document discusses the number of samples to be collected per media during each task of the Supplemental RFI. Subsection 3.7 discusses the total number of laboratory analytical measurements to be taken for the required field and laboratory QC samples to be collected during the Supplemental RFI.

Laboratory analytical samples will be collected and analyzed in conformance with Level III, IV and Level V DQOs and USEPA Region IV Standard Operating Procedures (SOPs) (USEPA, 1991a) with the exception of the Level V DQO analyses to be performed by a treatability laboratory. The analytical procedures for these parameters are based on methodologies adapted from *Standard Methods for the Examination of Water and Wastewater* (American Public Health Association [APHA] and others, 1992) and are included in the SOPs in Appendix B of this document.

Air quality samples for the evaluation of VOCs will be collected and analyzed in conformance with Level III DQOs and in accordance with USEPA Method TO-1 (USEPA, 1988c). Method TO-1 is recommended for this program because of the low detection limits that must be achieved. This method provides for the detection of all target VOCs, including vinyl chloride, at concentrations less than their corresponding negligible risk concentrations. Alternative sampling procedures, such as USEPA Method TO-14 (SUMMA canister method) will not achieve sufficiently low detection limits to enable the confirmation of negligible risk concentrations. The specific sorbent to be used, the proposed sample volume, and the required analytical detection limits will be coordinated with the laboratory at the onset of the program.

3.6.1 Laboratory Selection The subcontract laboratory will be qualified to perform CLP analyses, will have an active QA/QC program, and will be NEESA-approved. This laboratory will conduct all analyses requiring Level III, IV, and V DQOs, except for the Level V fate and transport measurements to be conducted at a treatability laboratory.

3.6.2 Calibration Procedures and Frequency Procedures and documentation required for calibration of laboratory instruments and equipment are addressed in the analytical procedures and are contained in USEPA Region IV SOPs (USEPA, 1991a) and USEPA CLP procedure manuals for organic and inorganic analyses (USEPA, 1990a; 1990b). The calibration procedures and documentation for analyses to be conducted at a treatability laboratory including calibration frequencies and control limits are outlined in the SOPs in Appendix B.

**Table 3-5
Analytical Protocol for Characterization and Confirmation Sampling**

Supplemental Resource Conservation and
Recovery Act Facility Investigation for Site 11
Volume II, Sampling and Analysis Plan
Naval Submarine Base
Kings Bay, Georgia

Parameter	Analytical Method	Reference	DQO Level
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

References:

- (1) Contract Laboratory Program Statement of Work for Organic Analysis (U.S. Environmental Protection Agency [USEPA] Document OLMO1.9, revised June 1991a),

Contract Laboratory Program Statement of Work for Low Concentration Water for Organic Analysis (USEPA Document OLCO1.O), and

Contract Laboratory Program Statement of Work for Inorganic Analysis (USEPA Document No. ILMO2.1, revised June 1991a).
- (2) Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846), 3rd Edition, USEPA 1986.

Notes: DQO = Data Quality Objective.
TCL = Target Compound List.
VOC = volatile organic compound.
CLP = Contract Laboratory Program.
SOW = Statement of Work.
SVOC = semivolatitle organic compound.
PCB = polychlorinated biphenyl.
TAL = Target Analyte List.

**Table 3-6
Analytical Protocol for Engineering and Treatability Studies**

Supplemental Resource Conservation and
Recovery Act Facility Investigation for Site 11
Volume II, Sampling and Analysis Plan
Naval Submarine Base
Kings Bay, Georgia

Parameter	Analytical Method	Reference	DQO Level
Total dissolved solids	EPA Method 160.1	(1)	V
Total suspended solids	EPA Method 160.2	(1)	V
Alkalinity	EPA Method 310.1	(1)	V
Hardness	EPA Method 130.1	(1)	V
Total and volatile suspended solids	EPA Method 160.2M	(1)	V
pH	EPA Method 150.1	(1)	V
Specific conductivity	EPA Method 120.1	(1)	V
Biochemical oxygen demand (5-day and 20-day)	EPA Method 405.1/404.1M	(1)	V
Chemical oxygen demand	EPA Method 410.4	(1)	V
Total organic carbon	SW-846 Method 9060	(2)	V
Chlorides	EPA Method 325.1/325.3	(1)	V
Sulfates	EPA Method 375.4/375.2	(1)	V
Nitrogen series	EPA Method 351.3/350.1/353.2	(1)	V
Phosphorus	EPA Method 365.1	(1)	V
Phosphate (total)	Standard Method 4500-P/E (modified)	(3)	V
Nitrate and nitrite + nitrogen	Standard Method 4500B/4500E (modified)	(3)	V
Heterotrophic bacteria count	Standard Method 9215C (modified)	(3)	V

References:

- (1) Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, revised March 1983.
- (2) Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846), 3rd Edition, U.S. Environmental Protection Agency (USEPA) 1986.
- (3) Standard Methods for the Examination of Water and Wastes, APHA and others. 1992, 18th Edition, and The Treatability Laboratory Standard Operating Procedures located in Appendix B.

Notes: DQO = Data Quality Objective.
EPA = Environmental Protection Agency.

Table 3-7
Analytical Protocol for Fate and Transport Studies

Supplemental Resource Conservation and
Recovery Act Facility Investigation for Site 11
Volume II, Sampling and Analysis Plan
Naval Submarine Base
Kings Bay, Georgia

Parameter	Analytical Method	Reference	DQO Level
Bulk density	ASTM E12-70	(1)	V
Cation exchange capacity	SW-846 Method 9081	(2)	V
Total organic carbon	SW-846 Method 9060	(2)	V
Sieve analysis	ASTM D-421	(1)	V
Hydrometer analysis	ASTM D-422	(1)	V
Atterberg limits	ASTM D-4318	(1)	V
Permeability	ASTM D-2434	(1)	V
VOCs for soil sorptive capacity	SW Methods 8010/8020 (modified)	(2,3)	V

References:

- (1) American Society for Testing and Materials. 1984 Annual Book of ASTM Standards.
- (2) Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846), 3rd Edition, U.S. Environmental Protection Agency 1986.
- (3) The Treatability Laboratory Standard Operating Procedures located in Appendix B.

Notes: DQO = Data Quality Objective.
ASTM = American Society for Testing and Materials.
VOC = volatile organic compound.

Table 3-8
Analytical Protocol for Site Investigation Air Monitoring

Supplemental Resource Conservation and
Recovery Act Facility Investigation for Site 11
Volume II, Sampling and Analysis Plan
Naval Submarine Base
Kings Bay, Georgia

Parameter	Analytical Method	Reference	DQO Level
Air sampling for TCL VOCs	EPA Method TO-1	(1)	III

Reference:

- (1) Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air. U.S. Environmental Protection Agency Document No. 600-A-89-017. June 1988.

Notes: DQO = Data Quality Objective.
TCL = Target Compound List.
VOC = volatile organic compound.
EPA = Environmental Protection Agency.

Field instruments and equipment will be calibrated and inspected daily before field activities begin, as suggested by the manufacturers. Calibration information will be recorded in a calibration log, which will be kept on file at the field office trailer. Malfunctioning instruments will be repaired or replaced. Monitoring equipment will be protected from contamination during field exploration activities (as much as possible without hindering operation of the unit). Equipment maintenance will be performed according to manufacturer specifications before field use, or by rotating instruments into and out of the field on an instrument performance and maintenance schedule. As appropriate, routine periodic maintenance may be performed as a function of field calibration.

3.6.3 Sample Containers, Preservation, and Holding Times For most sampling episodes, sample containers will be obtained from a NEESA-approved subcontract laboratory. NEESA requires all subcontract laboratories to have a current and comprehensive Quality Assurance Plan (QAP) and sample container requirements that meet USEPA CLP QA requirements.

Preservatives, controlled holding times, and selected container materials may be required to avoid sample degradation or alteration prior to laboratory analysis. Common preservation techniques include pH control, chemical complexation, and refrigeration or freezing. Holding times are controlled to minimize the time between sample collection and analysis, which in turn minimizes the reaction time for potential mechanisms of analyte loss or alteration. Selected container materials may be required to minimize sorption, leaching, or other interactions between the sample and the container. Amber containers may be required to block the sunlight and reduce photolytic degradation in selected analytes. In general, preservatives, holding times, and container materials are selected to inhibit biological activity, retard degradation or other alteration processes, reduce volatility, and/or reduce sorption, leaching, and complexation. Sufficient sample volumes must be collected to accommodate specified analytical methods and to allow for the analysis of laboratory QA/QC samples, where required.

3.6.3.1 Sample Containers In general, samples for organic analysis will be stored in glass containers, and samples for inorganic analysis will be stored in plastic containers. As container specifications depend on the analyte and sample matrix types (as indicated in Table 3-9), separate samples will be collected when both organic and inorganic analyses are required. Containers will be kept in the dark (to minimize biological or photooxidation/photolysis breakdown of constituents) until they reach the analytical laboratory. The sample container will generally allow approximately 5 to 10 percent air space ("ullage") to allow for expansion or vaporization if the sample is heated during transport (1 liter of water at 4 degrees Celsius (°C) expands by 15 milliliter (ml) if heated to 130 °F/55 °C). Important exceptions include VOCs, COD, and BOD, all of which do not allow headspace in the container. When sample containers are stored onsite, the containers will be kept sealed and away from solvents that are also being stored. Ideally, solvents should be kept in separate facilities from clean containers and organic-free water.

3.6.3.2 Preservation Techniques Preservation techniques for selected analytes are presented in Table 3-9. Reagents required for sample preservation will generally be added to the sample containers by the subcontract laboratory prior to shipment. In some instances, preservatives may be added in the field. Samples will be preserved immediately upon collection in the field. In general,

aqueous samples of low concentration organics (or soil samples of low or medium concentration organics) are cooled to 4 °C with ice.

Low concentration aqueous samples for metals are preserved with HNO₃, whereas low or medium concentration soil samples for metals are cooled to 4 °C. Samples that should not be immediately preserved in the field include the following.

- Samples collected within a hazardous waste site that are known or thought to be highly contaminated with toxic materials should not be preserved. Barrel, drum, closed container, spillage, or other source samples from hazardous waste sites are not to be preserved with any chemical. These samples may be preserved with ice, if necessary.
- Samples that have extremely low or high pH or samples that may generate potentially dangerous gases should not be preserved.
- Water samples with a considerable solids content may require filtering prior to preservation with HNO₃. These samples can be preserved with ice and returned to the laboratory for filtering and preservation.

All samples preserved with chemicals will be clearly labeled. If containers are preserved by a subcontract laboratory, additional preservatives will be from the same source. The following subsections describe the procedures for preparing and adding chemical preservatives. Table 3-9 indicates specific analytes for which these preservatives are recommended.

Addition of Acid or Base. Addition of the following acids or bases may be specified for sample preservation:

Acid or Base	Concentration	Amount Required for Preservation ^{1,2}
HCl	1:1 dilution of concentrated HCl (6 N)	5 to 10 mL
H ₂ SO ₄	1:1 dilution of concentrated H ₂ SO ₄ (18 N)	2 to 5 mL
HNO ₃	Undiluted concentrated HNO ₃ (16 N)	2 to 5 mL
NaOH	400 grams solid NaOH in 870 mL water (10 N)	2 mL

¹ Amount of HCl, H₂SO₄, or HNO₃ to add (at the specified strength) per liter of water to reduce the sample pH to less than 2, assuming that the water is initially at pH 7, is poorly buffered, and does not contain particulate matter.

² Amount of NaOH to raise pH of 1 liter of water to 12.

Notes: HCl = hydrochloric acid. HNO₃ = nitric acid. NaOH = sodium hydroxide.
H₂SO₄ = sulfuric acid. mL = milliliter. N = normal.

HCl, H₂SO₄, and NaOH will be analytical reagent (AR) grade and will be diluted to the required concentration with double-distilled, deionized water in the laboratory performing the analyses or by field personnel. This procedure will be followed prior to conducting field sampling. HNO₃ for metals preservation must be ultra-purified metals grade HNO₃.

**Table 3-9
Sample Container and Preservation Requirements**

Supplemental Resource Conservation and
Recovery Act Facility Investigation for Site 11
Volume II, Sampling and Analysis Plan
Naval Submarine Base
Kings Bay, Georgia

Parameter	Matrix	Holding Time (from time of collection)	Container	Preservative	Minimum Sample Size ¹
Volatile organic aromatics	Water	14 days	2 40 mL vials with Teflon™-lined caps	4 drops concentrated HCl, 4 °C	40 mL
	Soil	14 days	Glass with Teflon™-lined septum	4 °C	10 g
Volatile organic halogenated compounds	Water	14 days	2 40 mL vials with Teflon™-lined caps	4 drops concentrated HCl, 4 °C	40 mL
	Soil	14 days	Glass with Teflon™-lined septum	4 °C	10 g
Extractable organics	Water	7 days extraction 40 days analysis	1 L amber glass with Teflon™ liner	4 °C	1,000 mL
	Soil	14 days extraction 40 days analysis	Amber glass jar with Teflon™ liner or core tube	4 °C	50 g
Organophosphorus pesticides	Water	7 days extraction 40 days analysis	1 L borosilicate glass	Adjust pH to 6.0 to 8.0 with H ₂ SO ₄ or 10 N NaOH, 4 °C	1,000 mL
	Soil	14 days extraction 30 days analysis	1 L borosilicate glass	4 °C	100 g
Chlorinated herbicides	Water	7 days extraction 30 days analysis	1 L borosilicate glass	4 °C	1,000 mL
	Soil	7 days extraction 30 days analysis	1 L borosilicate glass	4 °C	100 g
Organochlorine pesticides and PCB	Water	7 days extraction 30 days analysis	1 L borosilicate glass	4 °C	1,000 mL
	Soil	14 days extraction 30 days analysis	1 L borosilicate glass	Adjust pH to 6.0-8.0 with 1:1 H ₂ SO ₄ or NaOH, 4 °C	100 g
Metals (other than mercury)	Water	180 days	Polyethylene or glass	HNO ₃ to pH <2 ²	100 mL
	Soil	180 days	Polyethylene or glass	4 °C	10 g
Mercury (CVAA)	Water	28 days	Polyethylene	HNO ₃ to pH <2	100 mL
	Soil/waste	28 days	Core tube or glass jar	4 °C	10 g
Selenium (GFAA)	Water	6 months	Polyethylene	HNO ₃ to pH <2	100 mL
	Soil/waste	6 months	Core tube or glass jar	4 °C	10 g
Thallium (GFAA)	Water	6 months	Polyethylene	HNO ₃ to pH <2	100 l
	Soil/waste	6 months	Core tube or glass jar	4 °C	10 g
Lead (GFAA)	Water	6 months	Polyethylene	HNO ₃ to pH <2	100 mL
	Soil/waste	6 months	Core tube or glass jar	4 °C	10 g

See notes at end of table.

Table 3-9 (Continued)
Sample Container and Preservation Requirements

Supplemental Resource Conservation and
Recovery Act Facility Investigation for Site 11
Volume II, Sampling and Analysis Plan
Naval Submarine Base
Kings Bay, Georgia

Parameter	Matrix	Holding Time (from time of collection)	Container	Preservative	Minimum Sample Size ¹
Chloride	Water	20 days	Polyethylene or glass bottle	4 °C	125 mL
Nitrogen, organic and Kjeldahl	Water	28 days	Polyethylene or glass bottle	Adjust pH to <2.0 with H ₂ SO ₄ , 4 °C	500 mL
Nitrate	Water	48 hours	Polyethylene or glass bottle	4 °C	125 mL
Nitrate + nitrite	Water	28 days	Polyethylene or glass bottle	Adjust pH to <2.0 with H ₂ SO ₄	125 mL
Phosphorus, total	Water	28 days	Polyethylene or glass bottle	Adjust pH to <2.0 with H ₂ SO ₄	125 mL
Hardness	Water	28 days	Polyethylene or glass bottle	4 °C	125 mL
Alkalinity	Water	28 days	Polyethylene or glass bottle	4 °C	125 mL
Sulfate	Water	28 days	Polyethylene or glass bottle	4 °C	125 mL
Residue	Water	7 days	Polyethylene or glass bottle	4 °C	500 mL
Chemical oxygen demand	Water	28 days	Polyethylene or glass bottle	Adjust pH to <2.0 with H ₂ SO ₄ , 4 °C	1000 mL
Biochemical oxygen demand	Water	48 hours	Polyethylene or glass bottle	4 °C	1000 mL
Total organic carbon	Soil	28 days	Polyethylene or glass bottle	Adjust pH to <2.0, 4 °C	10 g

¹ Additional sample must be collected for matrix spike or matrix spike duplicate samples.

Notes: mL = milliliter.
HCl = hydrochloric acid.
°C = degrees Celsius.
g = gram.
L = liter.
H₂SO₄ = sulfuric acid.
N = normal.
NaOH = sodium hydroxide.
PCB = polychlorinated biphenyls.
HNO₃ = nitric acid.

The approximate volumes needed to acidify 1 liter of neutral water to a pH of less than 2 (or raise the pH to 12) are shown in the last column of the above table. However, if the water is more alkaline or acidic, contains inorganic or organic buffers, or contains suspended particles, more acid or base may be required. The final pH must be checked using narrow-range pH paper. Never dip pH paper into the sample; apply a drop of sample to the pH paper using the stirring rod.

Sample acidification or base addition will proceed as follows: (1) check initial pH of sample with wide range (0 to 14) pH paper; (2) fill sample bottle to within 5 to 10 ml of final desired volume and add about half of estimated acid or base required, stir gently and check pH with medium range pH paper (pH 0 to 6 or pH 7.5 to 14); and (3) add acid or base a few drops at a time while stirring gently. Check for final pH using narrow range (0 to 2.5 or 11 to 13) pH paper; when desired pH is reached, cap sample bottle and seal.

Cyanide Preservation. Pre-sample preservation is required to prevent oxidizing agents such as chlorine from decomposing cyanide compounds. To test for oxidizing agents, place a drop of the sample on KI-starch test paper; a blue color indicates the need for treatment. Add ascorbic acid ($C_6H_8O_6$) to the sample a few crystals at a time, until a drop of sample produces no color on the KI-starch paper. Then add an additional 0.6 gram of $C_6H_8O_6$ for each liter of sample volume. Add NaOH solution to raise pH to greater than 12 as described above.

Sulfide can also adversely affect cyanide analyses. To test for sulfide, place a drop of the sample on lead acetate test paper previously moistened with acetic acid buffer solution (pH 4). Darkening of the paper indicates the presence of sulfide. If sulfide is present, add cadmium nitrate powder (to form a yellow cadmium sulfide precipitate) until the lead acetate test yields negative results. Filter the sample to remove precipitate and add NaOH solution to the filtrate (to raise pH above 12). Avoid a large excess of cadmium and a long contact time to minimize a loss by complexation or occlusion of cyanide on the precipitated material.

Sulfide Preservation. Samples for sulfide analysis must be preserved by the addition of 4 drops (0.2 ml) of 2 N zinc acetate solution per 100 ml sample. The sample pH is then raised to 9 using NaOH solution (1 to 2 drops). The 2 N zinc acetate solution is made by dissolving 220 grams of zinc acetate in 870 ml of distilled water to make 1 liter of solution.

Preservation of Organic Samples Containing Residual Chlorine. Some organic samples containing residual chlorine must be treated to remove this chlorine upon collection. Test the samples for residual chlorine using USEPA Method 330.4 or 330.5 (field test kits are available for this purpose). If residual chlorine is present, add 0.008 percent sodium thiosulfate (80 milligrams per liter of sample) to the sample vial first, then fill the vial to at least half volume with sample. Add the acid and then fill the remainder of the vial as per the stated procedure.

3.6.4 Sample Identification Samples collected for laboratory analysis during the field investigation will be labeled in accordance with the standard sample identification (I.D.) protocols described below. Sample I.D.s will be media-specific and will be up to nine characters in length. The general sample I.D. will have the form T###[I] [D] where T represents any valid type I.D., # represents any decimal digit, I represents any valid depth interval character,

and D represents any valid sample descriptor character. Brackets placed around a character indicate that the character is optional (e.g. [I] means the depth interval I.D. may be 1, 2, or 0 characters wide).

The first and second character of the general sample I.D. is mandatory. It is a character that denotes the sample type. Valid characters are the following:

SB = Subsurface Soil (Soil Boring)
SD = SeDiment
FB = Field Blank
ER = Equipment Rinsate
GW = GroundWater
SS = Surface Soil
BT = Trip Blank
SW = Surface Water
TL = Trench Liquid
TS = Trench Soil

The third, fourth, and fifth characters of the general sample I.D. are composed of a integer between 001 and 999 (e.g., 001, 002...). This number identifies the location at which the sample was collected. Groundwater sample I.D.s may contain a letter as the fifth character that describes the monitoring well I.D. (e.g., 13A).

The sixth and seventh characters of the general sample I.D. are present only under certain conditions. These characters are depth interval identifiers and serve to describe the depth bls at which the sample was obtained (e.g., a sample collected at 4 feet bls would be denoted 04). For test trench sample I.D.s, the sixth and seventh characters will be used to document the position in the test trench where the sample was collected (e.g., north, northwest, southeast, etc.).

The eighth character of the general sample I.D. differentiate samples of the same type that are obtained from the same location. This condition will occur when duplicates are collected. The valid character for field duplicates is "D."

3.6.5 Sample Handling, Packaging, and Shipping Sample packaging and shipping procedures will protect the integrity of the samples and prevent detrimental effects from leakage or breakage. Regulations for packaging, marking, labeling, and shipping hazardous materials and wastes are promulgated by the U.S. Department of Transportation (DOT) and described in the Code of Federal Regulations (49 CFR 171 through 177; in particular 172.402h, Packages Containing Samples). In general, these regulations were not intended to hamper shipment of samples collected at controlled or uncontrolled hazardous waste sites or samples collected during emergency responses. However, the USEPA has agreed through a memorandum of agreement to package, mark, label, and ship samples observing DOT procedures. The information presented here is for general guidance.

Correct packaging, storing, and shipping of environmental samples is necessary to:

- ensure samples remain sealed in original containers,
- prevent breakage,
- prevent cross contamination of individual samples,
- ensure sample characteristics are preserved,

- prevent contamination to receiving personnel, and
- ensure samples are protected against tampering when not in sampler's possession.

Prior to packaging, each sample container will be inspected to verify correct labeling. Labels will be secured to containers with clear tape. Each container will have a signed and dated custody seal over the cap, secured with clear tape. Samples will be shipped to the laboratory via commercial ground or air carrier within 24 hours of sample collection.

All breakable sample containers (glass) will be protected with packing. Bubble-pack bags or strips are acceptable. (Strips will extend 1/2 inch below the base of the container.) Sample containers may be placed in sealable plastic bags such as a zip-lock type. Bottles up to 1 liter can be placed in 1-gallon bags. Larger bottles will be placed in heavy duty garbage bags and sealed.

Samples will be shipped in durable coolers packed with bubble-pack or vermiculite. Samples will be kept cool with double-bagged clean ice. Bottles with Teflon™ septums will be placed inverted with top of bottle facing downward. Completed Chain-of-Custody (COC) forms will be placed in a plastic bag and taped to the inside lid of the shipping container. If COC forms refer to multiple containers, they will be placed in the lead container.

A signed and dated COC seal will be secured with clear tape over the front of the container lid. The container will be sealed by wrapping it in filament tape. The air bill or manifest number and container sequence (if multiple containers are being shipped with a single COC) will be written on the tape on the container lid. "This Side Up" with a vertical arrow will be written on both sides of the container.

Until relinquished to the carrier, the shipping containers are to remain with field personnel or remain in a locked vehicle so as not to be accessible to others. Upon shipping, the laboratory will be contacted and advised of the contents, arrival date and time, carrier, and number of containers.

3.7 QUALITY CONTROL SAMPLES. An estimate of the number and types of QC samples to be collected for laboratory analyses during each Supplemental RFI task is outlined in Table 3-10. A brief description of QC samples and frequency of collection is presented below. Selected definitions were obtained from USEPA Region IV SOPs (USEPA, 1991a).

The estimated number of various QC samples presented in Table 3-10 is based on the following.

- There are multiple field efforts associated with the various media being sampled.
- Two separate groundwater sampling events are represented.
- Rinsate samples will be collected every other day that media sampling is conducted.

Table 3-10
Quality Control Samples for the Supplemental Resource Conservation and Recovery Act Facility Investigation Field Program

Supplemental Resource Conservation and
 Recovery Act Facility Investigation for Site 11
 Volume II, Sampling and Analysis Plan
 Naval Submarine Base
 Kings Bay, Georgia

Sample Type ¹	TCL VOCs	TCL SVOCs	TCL Pest/PCB	TAL Inorganics	Herb/OP pesticides	Soil E/T Parameters ²	Groundwater E/T Parameters ³	Sorptive Capacity	F/T Parameters ⁴
Trip Blanks	34	0	0	0	0	0	0	0	0
Rinsate Blanks	20	20	20	20	4	0	0	0	0
Source Water Blanks	12	12	12	12	2	0	0	0	0
Field Duplicates									
Surface soil	1	1	1	1	1	0	0	0	0
Subsurface soil	2	2	1	2	0	1	0	0	1
Groundwater	8	8	4	14	1	0	1	0	0
Test trench leachate	1	1	1	1	1	0	0	0	0
Test trench soil	1	1	1	1	1	0	0	0	0
Sediment	1	1	1	1	1	0	0	0	0
Surface water	1	1	1	1	1	0	0	0	0
Air	9	0	0	0	0	0	0	0	0
MS/MSD									
Surface soil	1	1	1	1	1	0	0	0	0
Subsurface soil	1	1	1	1	0	1	0	0	0
Groundwater	4	4	2	7	1	0	1	0	0
Test trench leachate	1	1	1	1	1	0	0	0	0
Test trench soil	1	1	1	1	1	0	0	0	0
Sediment	1	1	1	1	1	0	0	0	0
Surface water	1	1	1	1	1	0	0	0	0
Air	2	0	0	0	0	0	0	0	0

See notes at end of table.

Table 3-10 (Continued)
Quality Control Samples for the Supplemental Resource Conservation and Recovery Act Facility Investigation Field Program

Supplemental Resource Conservation and
Recovery Act Facility Investigation for Site 11
Volume II, Sampling and Analysis Plan
Naval Submarine Base
Kings Bay, Georgia

¹ Refer to Subsection 3.7 for collection frequency of quality control samples.

² Soil engineering and treatability (E/T) parameters include phosphate, nitrate, nitrite, and heterotrophic bacteria.

³ Groundwater E/T parameters include alkalinity, hardness, total volatile suspended solids, pH, specific conductivity, biological oxygen demand (BOD) (5-day and 20-day), chemical oxygen demand, total organic compound (TOC), chlorides, sulfates, nitrogen series, phosphorus, oil and grease, and color.

⁴ F/T Parameters include bulk density, cation exchange capacity, TOC, sieve analysis, hydrometer analysis, Atterberg limits, and permeability.

Notes: TCL = Target Compound List.

VOCs = volatile organic compounds.

SVOC = semivolatile organic compound.

Pest/PCB = organochlorine pesticides and polychlorinated biphenyl.

TAL = Target Analyte List.

TDS/TSS = total dissolved solid and total suspended solid.

Herb/OP pesticides = Appendix IX chlorinated herbicides and organophosphorus pesticides.

E/T = engineering and treatability.

F/T = fate and transport.

MS/MSD = matrix spike and matrix spike duplicate.

TOC = total organic compound.

- The proposed number samples of each media and the corresponding number of days anticipated to complete the sampling is as follows:

	Samples	Days
Surface soil	7	2
Subsurface soil	11	6
Sediment	5	1
Surface water	5	1
Trench soil	5	5
Trench liquid	5	5
Groundwater	62	20
Air	30	9

Duplicate Samples. Duplicate samples are two or more samples collected simultaneously into separate containers from the same source under identical conditions. One duplicate will be collected for every 10 samples of a single matrix except for Level V samples in which the frequency will be 1 every 20 samples. Duplicate samples are intended to assess the homogeneity of the sampled media and the precision of the sampling protocol.

Trip Blanks. Trip blanks are prepared by the laboratory using ASTM Type II water prior to the sampling event and are kept with the investigative samples throughout the sampling event and are packaged and shipped with the investigative samples. These containers should never be opened prior to laboratory analysis. One trip blank will be included with each shipment of samples scheduled for volatile organic analysis. Trip blanks are required for assessing the potential for contaminating samples with VOCs during sampling or in transit.

Equipment Rinsate Blanks. Equipment rinsate blanks are collected by running organic-free deionized water over and/or through sample collection equipment after it has been decontaminated. Equipment rinsate blanks will be collected at a frequency of one per day per type of sampling tool used. These blanks are used to assess the adequacy of decontamination procedures and to trace potential cross contamination. Initially, every other rinsate is analyzed. If analytes pertinent to the project are found, the preceding rinsate blank is analyzed, and all following rinsate blanks are analyzed for the analyte. Other analytes not found are analyzed in every other rinsate sample.

Matrix Spike and Matrix Spike Duplicates. Matrix spike and matrix spike duplicate (MS/MSD) samples are additional samples collected in the field from a single sampling location. These samples are spiked in the laboratory with a known compound (or set of compounds) of known concentrations. The concentration detected after analysis provides an estimate of the amount of compound "lost" (e.g., sorbed to glassware, volatilized, degraded) during the analytical procedure. A comparison of the original concentration to the final concentration provides data concerning analytical precision and accuracy. One set of MS/MSD samples will be collected per 20 or fewer samples per matrix or every 14 days.

Field Water Blanks. Field water blanks include a complete set of samples collected from each water source used in the investigation. One set of samples will be collected from each water source (potable, DI, and organic free) used at

the beginning of the project. Intermediate samples may be collected if deemed necessary. These samples should account for potential artifacts that could be introduced through decontamination procedures.

Preservative Blanks. Preservative blanks are prepared by filling sample containers with organic-free water and adding the appropriate preservative. One set of preservative blank samples will be collected at the initiation of the field sampling program. These blanks will identify potential artifacts that may be introduced through the use of preservatives in sample containers.

Background Samples. Background samples are collected from areas upgradient and away from known or suspected contaminated areas. Several background (also called upgradient) samples will be collected for groundwater, surface soil, and subsurface soil. Background samples allow identification of possible upgradient sources and/or confirm upgradient delineation. In addition, background inorganic analyses allow the estimation of concentrations for naturally occurring compounds.

3.8 SAMPLING RECORDS. Maintaining proper records is a significant aspect of sample collection. At the time samples are obtained, the following will be recorded by the sampler in the field logbook:

- sample site location,
- sample type and depth,
- date and time of sampling,
- project and sample designations,
- sampler identification,
- analyses requested, and
- sample preservation.

Additionally, the sampler must initiate COC procedures and describe the sample site in adequate detail to allow collection of additional samples from the same sample site, if necessary.

3.9 SAMPLE CUSTODY. The control of a sample is accomplished through a COC record. COC is initiated during bottle preparation by the laboratory and will be maintained through sample collection, shipment, storage, and analysis as a legal record of possession of the sample.

Possession will be traceable by means of a COC form (Figure 3-2), which will remain with the samples at all times and bears the name of the person responsible for the samples. Procedures for maintaining the appropriate sample custody information will be in accordance with USEPA Region IV SOPs (USEPA, 1991a).

Samples other than those collected for *in situ* analysis are identified by using a sample label that is attached to the sample container. The following information is included on the sample container label:

- project number,
- field identification or sample station number (a unique number identifying the sample),

- date and time of sample collection,
- type of sample (e.g., water, soil, sediment) and a brief description of the sampling location,
- the signature(s) of the sampler(s),
- whether the sample is preserved or unpreserved,
- the general types of analyses to be conducted, and
- any relevant comments regarding the sample.

A COC form is used to record the custody of all samples or other physical evidence collected and maintained by field personnel. The following information must be supplied in the indicated spaces in detail to complete the COC record:

- site name and address;
- project number;
- project name;
- signature of sampler in the designated signature blank;
- sampling station number, date, time of sample collection, and a brief description of the type of sample and the sampling location;
- sample bottle type (i.e., 40 ml glass) plus the intended analysis (i.e., TCL-VOC);
- for each sample the number of containers for each bottle type; and
- field investigator and subsequent transferee(s) signatures. (Both the person relinquishing the samples and the person receiving them must sign the form along with the date and time this occurred.)

When samples are relinquished to a shipping company for transport, the tracking number from the shipping bill or receipt will be recorded on the sample COC form. As necessary, carriers (e.g., United Parcel Service, Federal Express, or Greyhound) will be used to ship samples. In these cases the air bill becomes part of the COC.

All samples will be accompanied by the COC record. The original and one copy of the record will be shipped inside the shipping container if samples are shipped. One copy of the record will be retained by the field investigator. The original record will be transmitted to the field investigator after samples are accepted by the laboratory. This copy will become part of the project records. The COC record will be signed and dated upon receipt by the laboratory. Custody tracking will be maintained by the laboratory from sample receipt through storage, analysis, and disposal in accordance with the individual laboratory's QAP.

In the event that a legal COC is required for a project, custody will begin at the time of receipt of the clean sample containers from the contract laboratory.

The COC form has appropriate spaces to allow signatures and dates to document the transfer of the cleaned sample containers from the laboratory to the sample team. In addition, use of custody seals will be implemented during shipment of bottles and samples to document the integrity of the samples and bottles. The custody seal will be placed on the shipping container so that it cannot be opened without breaking the seal. The seal will be signed, dated, and the time recorded by the field investigator. By using a unique sample identification number for each sample, all ancillary records can be traced to specific sampling events.

3.10 DATA MANAGEMENT PLAN. Three broad categories make up data management: laboratory data management, sample data management, and field data management. Laboratory data management consists of storing, retrieving, editing, validating, and reporting the results of the laboratory chemical analyses. Sample data management consists of tracking the origin, location, and status of a set of chemical data obtained from the analysis of an environmental sample. Field data management consists of storing, retrieving, and reporting the results of measurements taken in the field.

Laboratory data management begins with receipt of unvalidated data (one hard copy and one electronic copy) from the laboratory. The laboratory data manager later receives validated data from the data validator. One hard copy of all chemical data is kept in-house in a locked file cabinet to allow access to the raw data. A second hard copy of the unvalidated data is stored offsite. Upon receipt of the validated data, the laboratory data manager uploads the electronic copy into a secure database. Data in the database are backed-up daily and the back-ups are stored for 2 weeks in a fire-safe vault. At the conclusion of the project, the laboratory data manager archives the electronic data and moves the in-house copy of the unvalidated data to a storage site separate from the first storage site. This minimizes the risk of catastrophic data loss.

Sample management begins upon creation of the sample. The sample data manager tracks the life cycle of each sample and uses milestones in the life cycle as reference points to judge the status of individual samples. Milestones include sample collection, sample receipt by the laboratory, unvalidated sample data receipt, and validated sample receipt, as well as various steps in the process needed to confirm the quality of the electronic data. As each milestone is achieved, the sample data manager records the achievement in a sample data management database. This database is a secure database backed-up daily on a 14-day cycle. The back-up is stored in a fire-safe vault for 2 weeks. At the conclusion of the project, the sample data manager archives the database and makes two copies to store in separate storage facilities.

Field data management procedures vary depending on the type of data collected. In all cases, two hard copies of the data exist. One copy resides in the field office, and one copy resides in the home office. Where appropriate, electronic field data also exist. The main objectives of the field data manager are to store the field data and to ensure the integrity of any reproductions of the field data. When the project is completed, the field data manager ensures that two correct copies of all field data exist. The field data manager stores each copy in a separate storage facility.

3.10.1 Data Evaluation Chemical and physical data collected during the Supplemental RFI will be used to further characterize the source and extent of

contamination, to evaluate the potential levels of risk posed to human health and the environment, and to support the IM study. Physical data (e.g., groundwater and surface water elevations and flow, soil composition, and hydraulic conductivity) and chemical data (laboratory analyses and field screening data) will be integrated to form a conceptual overview of the site.

Data will be summarized and plotted on scaled maps to facilitate the analysis of contaminant distribution and potential mechanisms of transport. Chemical data will be compared to applicable or relevant and appropriate requirements and contaminants of concern will be identified. Physical and chemical data will be evaluated to assess the distribution of contaminants, contaminant interactions, transport mechanisms, and potential fate. This includes an evaluation of factors such as: groundwater transport, groundwater-surface water interactions, surface water transport, vadose zone transport, volatilization and advection, soil erosion, retardation, degradation, and transformation. The evaluation of the factors listed above will be subject to the availability of sufficient experimental and empirical reference data.

Groundwater, solute transport, geochemical, and/or ecosystem fate and transport modeling may be performed after initial data evaluation. There are currently insufficient data to determine which model(s) may be useful for this site.

Plausible exposure pathways and exposure scenarios will be evaluated to assess potential levels of risk posed by the contaminants of concern. The risk assessment is based on an evaluation of exposure patterns, available toxicity data, and dose-response relationships. Ultimately, the data collected will be evaluated to support no further action or remedial action decisions, treatability studies, and remedial design.

3.10.2 Evaluation of Data Gaps All data will be continually assessed and evaluated to determine: (1) the type of contamination present, (2) if it presents a threat, (3) if it has been delineated, and finally (4) what further action is needed (i.e., evaluation of remedial alternatives). The goal is to eliminate lengthy interim report development and review times by allowing continual data assessment and rapid decision making.

3.11 INTERNAL QUALITY CONTROL. Field and laboratory QC samples are discussed in Subsection 3.7, Quality Control Samples, and an estimate of the number and types of QC samples to be collected for screening and laboratory analyses during the supplemental RFI is included in Table 3-10.

Other internal QC activities are undertaken during the conduct of work to ensure that the service, designs, and documents produced meet currently accepted professional standards. Small assignments or tasks entail periodic discussions among the technical staff, the Task Leader, and Project Manager. QC on larger assignments may require professional review teams and/or internal audits.

3.12 PERFORMANCE AND SYSTEMS AUDITS. Audits are performed to verify that work being completed within the Supplemental RFI program complies with QA program goals. Internal audits of laboratory subcontractors are routinely conducted and subcontracted laboratories must be CLP qualified and NEESA approved.

Systems audits may be conducted on system components to evaluate appropriate selection and use. The project systems audit includes evaluation of field, office, and laboratory procedures. System audits may address the following components:

- organization and personnel,
- facilities and equipment,
- analytical methodology,
- sampling and sample handling procedures, and
- data handling.

All primary documents will receive internal technical reviews and a minimum of one internal audit will be scheduled for the field program. A minimum of one internal audit will be scheduled by the Quality Assurance Manager (QAM) in coordination with the Task Order Manager (TOM) during the Supplemental RFI activities. All audit records, including audit plans, reports, written responses, and corrective action forms, will be maintained with the project files.

3.13 PREVENTIVE MAINTENANCE. Preventive maintenance for laboratory equipment and instruments will be performed in accordance with CLP requirements and the individual laboratory QA/QC program. Field equipment will be maintained according to the manufacturers' suggested preventive maintenance plans.

Problem prevention can be applied to all phases of project implementation. The key to preventing and resolving problems is careful advanced planning and close communications between management and technical personnel in both client and contractor organizations. Problems will be anticipated and prevented by undertaking the following measures:

- identifying possible problems that have a high probability of occurrence or a potentially significant negative impact on performance (e.g., quality of services performed, schedules, and costs);
- identifying events, observations, or other signals possibly indicative of a developing problem;
- identifying the organizational level most likely to recognize a developing problem and the level with authority to react to the problem;
- developing preventive measures for avoiding or reducing the impact of a problem that preferably can be implemented at the same organizational level at which the problem is recognized; and
- communicating the information generated in the preceding steps to appropriate staff.

3.14 CORRECTIVE ACTION. Corrective or preventive actions to improve project quality will be implemented if potential or existing conditions are identified that may have an adverse impact on data quantity or quality. Corrective actions may be immediate or long term. Any member of the NSB Kings Bay program who identifies a condition adversely affecting quality can initiate corrective action

by completing a nonconformance report or by issuing a memorandum to the QAM. The written communication must identify the condition and explain how it may affect data quantity or quality.

Immediate corrective action is applied to spontaneous, nonrecurring problems, such as instrument malfunctions. Staff who detect or suspect nonconformance to previously established criteria or protocol in equipment, instruments, data, or methods should immediately notify his or her Task Leader. If the problem is limited in scope, the Task Leader decides on the corrective action measure, documents the solution, and notifies the Project Manager and the QAM in a memorandum. If the problem has impaired the quality of the project or could re-occur in the future, the TOM will follow procedures outlined in the ABB-ES CLEAN QAPP and a Corrective Action form will be placed with the project files.

Corrective actions may also be initiated as a result of performance evaluations, systems audits, laboratory and field comparison studies, QA project audits conducted by the QAM or Navy CLEAN QA specialists, or other activities. The QAM is responsible for documenting notifications, recommendations, and final decisions. The Project Manager is jointly responsible for notifying program staff and implementing the agreed-upon course of action. The QAM is responsible for verifying the efficacy of the implemented actions. To the extent possible, the development and implementation of preventive and corrective actions should be timed to not adversely impact project schedules or subsequent data generation and processing activities. The QAM will also be responsible for developing and implementing routine program controls to minimize the need for corrective actions.

3.15 QUALITY ASSURANCE REPORTS. Management personnel at all levels will receive QA reports appropriate to their level of responsibility. The QAM will receive copies of all QA documentation. QC documentation will be maintained in the project files. For the Kings Bay Supplemental RFI program, verbal reports will be presented in each Project Managers' meeting.

Other types of QA reports may include periodic assessment of measurement data accuracy, precision, and completeness; results of performance audits and/or systems audits; significant QA problems and recommended solutions for future projects; and the status of solutions to any problems previously identified. Additionally, incidents requiring corrective action will be fully documented. Procedurally, the QAM will submit the reports to management. These reports will be addressed to the TOM. The summary of findings will be factual, concise, and complete. Required supporting information will be appended to the report.

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APPENDIX A
FIELD FORMS

TITLE:		LOG of WELL:	BORING NO.
CLIENT: U.S. Navy, SOUTHNAVFACENGCOM			PROJECT NO:
CONTRACTOR:		DATE STARTED:	COMPLTD:
METHOD:	CASE SIZE:	BORING DIA:	PROTECTION LEVEL:
TOC ELEV.: FT.	MONITOR INST.:	TOT DPTH: FT.	DPTH TO ∇ FT.
LOGGED BY:	WELL DEVELOPMENT DATE:		SITE:

DEPTH FT.	LABORATORY SAMPLE ID	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/8-IN	WELL DATA
5									
10									
15									
20									
25									

FIELD CHANGE REQUEST FORM

PROJECT:		FIELD CHANGE NUMBER:
PROJECT NUMBER:		
APPLICABLE DOCUMENT:		
DESCRIPTION:		
REASON FOR CHANGE:		
RECOMMENDED DISPOSITION:		
IMPACT ON PRESENT & COMPLETED WORK:		
FINAL DISPOSITION:		
REQUESTED BY:		
FIELD/TASK ORDER MANAGER:		
APPROVALS:		
SOUTH DIV NAVFAENGC E.I.C.:		

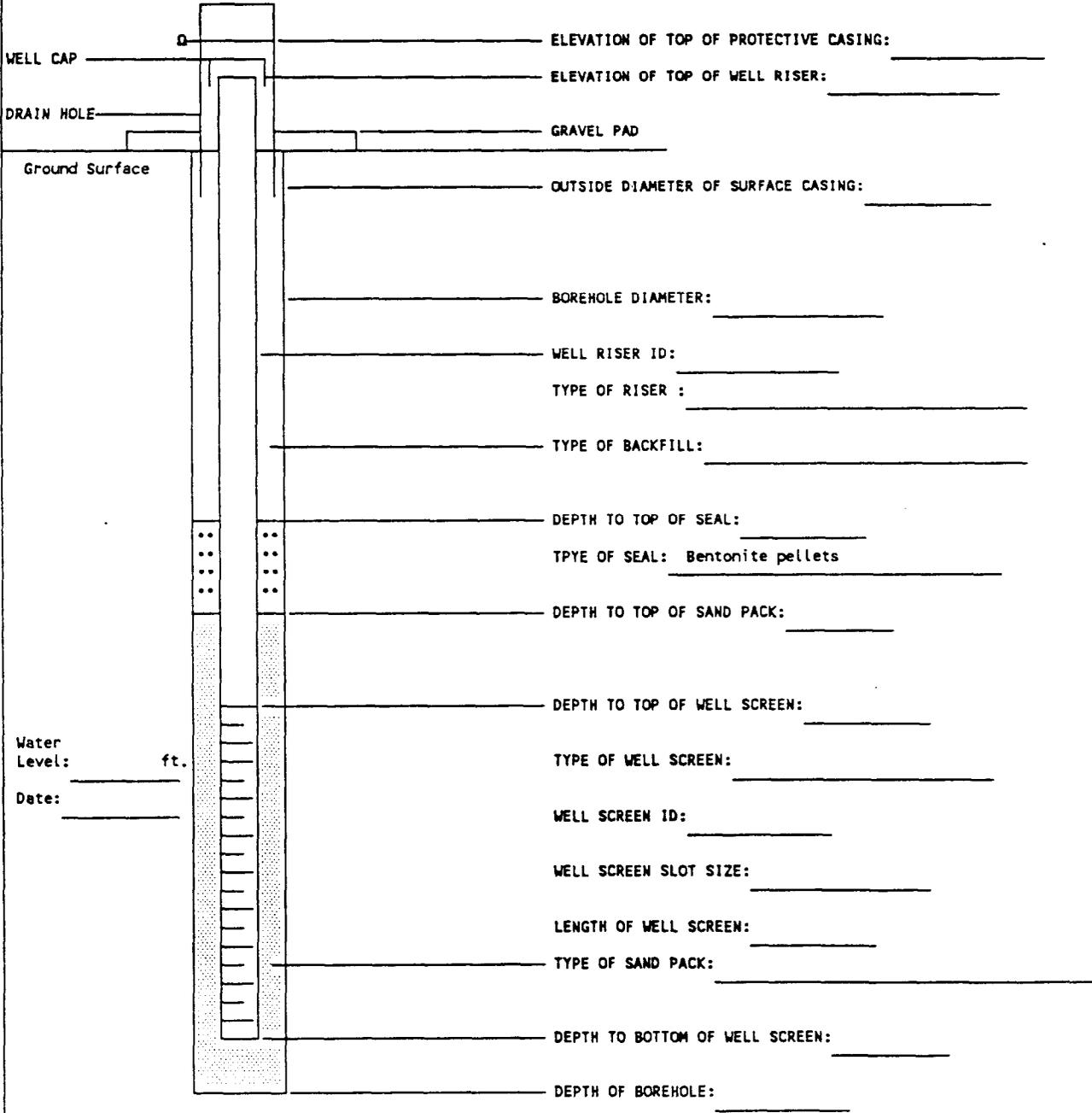
OH#3/006.PLR

WELL INSTALLATION DIAGRAM

PROJECT: _____
 PROJECT No.: _____
 ELEVATION: _____
 FIELD GEOLOGIST: _____

SITE NAME: _____
 DATE INSTALLED: _____
 DRILLING METHOD: _____
 AUGER SIZE: _____

Site: _____
 Well ID: _____



WELL DEVELOPMENT LOG		WELL NO.:	Page _____ of _____
Installation:		Site:	
Project No.:	Client/Project:		
HAZWRAP Contractor:		Dev. Contractor:	
Dev. Start:	(: — m)	Dev. End:	(: — m) Csg Dia.:
Developed by:			Dev. Rig (Y / N)

Dev. Method _____

Equipment _____

Pre-Dev. SWL _____ Maximum drawdown during pumping _____ ft at _____ gpm

Range and Average discharge rate _____ gpm

Total quantity of material bailed _____

Total quantity of water discharged by pumping _____

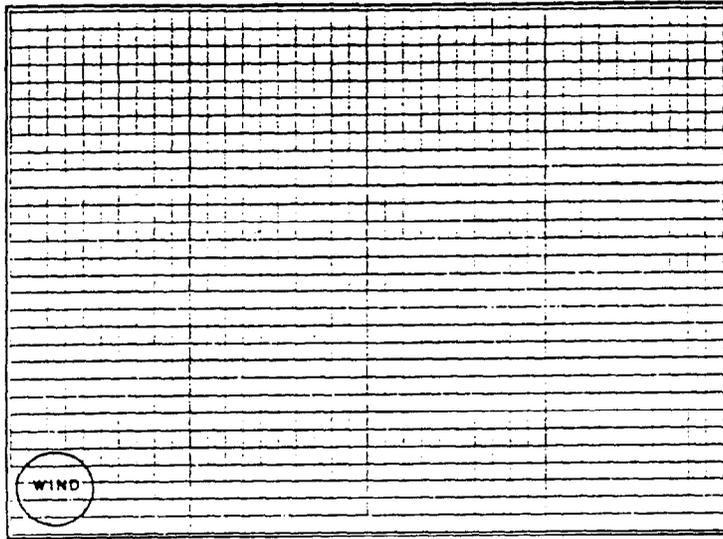
Disposition of discharge water _____

Time	Volume Removed (gal)	Water Level ft.BTOC	Turbidity	Clarity/Color	Temp. °C	pH	Conductivity	Remarks

TEST PIT RECORD

SITE _____
TEST PIT _____ DATE _____ TIME ST. _____ END _____
COORDINATES _____ GRID ELEMENT _____

SKETCH MAP OF TEST PIT SITE
(SHOW SURFACE MONITORING RESULTS)



CREW MEMBERS

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.

MONITOR EQUIPMENT

PI METER Y N
EXPLOSIVE GAS Y N
AVAIL. OXYGEN Y N
OVA Y N
OTHER _____

PHOTOGRAPHS, ROLL _____
EXPOSURE _____

NOTES _____

APPENDIX B

TREATABILITY LABORATORY STANDARD OPERATING PROCEDURES

ABB-ES Standard Operating Procedure 1/92

Method for Analysis of Nutrients in Aqueous Samples

General Discussion:

These methods call for the analysis of a blank (DI water), a site sample, and a site sample which has been spiked with a low concentration of nutrients. If the analysis is valid, the difference between the spiked and non-spiked site water should be the same as the difference between the spiked DI water and the blank. If method is not valid, then the site sample should be diluted and the procedure repeated.

example: a. DI water
 b. DI water + spike
 c. sample
 d. sample + spike

$$b - a = d - c \text{ (within 20\%)}$$

Pre-preparation:

If solids are present in sample or are formed during analysis, they should be removed by filtration or centrifugation.

AMMONIA NITROGEN: NH₃

Method: based on Nesslerization Method
(4500 - NH₃ B., Standard Methods, 1992)
LaMotte chemical test kits for ammonia(CODE 4795)

Principle:

Ammonia, under alkaline conditions, reacts with mercuric iodide to form a yellow to yellow-orange complex. Iron will also react with alkaline mercuric iodide to form a precipitate. Pretreatment of sample with sodium potassium tartrate (Rochelle' salt) will minimize interferences.

Range: 1-9 ppm ammonia nitrogen (N)

Spike: 0.1 ml 775 ppm NH₄Cl in 5.0 ml (=4 ppm ammonia nitrogen)

Note: the test sample must be neutralized before proceeding with the test.

Procedure:

1. Fill the test tube to the 5 ml line with water sample to be tested
2. Add 4 drops of Ammonia Nitrogen Reagent No.I (4797) and mix.
3. Add 8 drops of Ammonia Nitrogen Reagent No.2 (4798) and mix.
4. Allow 5 minutes for maximum color development. Inserting the test tube into Color Comparator (4796). Match the color with the standard to obtain the test result expressed in ppm ammonia Nitrogen (N).
5. If sample is too concentrated, dilute the sample with DI water and repeat step 1-4.

By Spectrophotometer: Read at 400 nm -425 nm

Preparation of standard curve: Prepare at least 4 standards. Make up standards adding the following volumes of spike solution and diluting to 5.0 ml DI water; 0, 25ul, 50ul, 75ul, 100ul (=0, 1, 2, 3, 4 ppm).

NITRATE NITROGEN: NO₃

Method: Based on Cadmium Reduction Method
(4500 - NO₃ E., Standard Methods 1992)
LaMotte chemical test kits for nitrate (CODE 3110)

Principle:

Nitrate is reduced quantitatively to nitrite in the presence of cadmium. The nitrite produced thus is determined by diazotizing with sulfanilamine and coupling with N-(1-naphthyl)-ethylenediamine dihydrochloride to form a highly colored dye that is measured colorimetrically.

Range: 0.25-10 ppm nitrate nitrogen (N)

Spike: 0.1 ml 600 ppm NaNO₃ in 2.5 ml (= 4 ppm nitrate nitrogen)

Procedure:

1. Fill the sample bottle (0688) to the first line (2.5 ml) with the sample.
2. Add the Acid Reagent (V-6278) to the second line (5.0 ml total). Cap and mix. Wait 2 minutes.
3. Use the 0.1 g spoon to add one level measure of Nitrate Reducing Reagent (V-6279) to the tube.
4. Cap and invert the tube 50-60 times in one minute.
5. Let stand 10 minutes. Mix before inserting the Color Comparator (3109). Match the color with the standards to obtain the test result expressed in ppm Nitrate nitrogen (N).
6. If the sample is too concentrated dilute the sample with the DI water and repeat the test.

ORTHOPHOSPHATE: PO₄

Method: Based on Stannous Chloride Method
(4500 - P D., Standard Methods, 1992)
LaMotte Chemical test kits for Phosphate (CODE 4408)

Principle:

Orthophosphate reacts in acid conditions with ammonium vanadomolybdate to form vanadomolybdophosphoric acid. Vanadomolybdophosphoric acid is reduced by stannous chloride to intensely colored molybdenum blue.

Range: 1.0 - 10.0 ppm orthophosphate (PO₄)

Spike: 0.1 ml 290 ppm KH₂PO₄ in 5 ml (4 ppm PO₄)

Procedure:

1. Fill the test tube to the 5 ml line with the water sample.
2. Add 1.0 ml of VM-Phosphate Reagent (4410) to the test sample and, mix by inverting the tube several times.
3. Let stand for 5 minutes. Then use the plain pipet to add 3 drops of Reduction Reagent (6405) and mix. A blue color will develop in 10 seconds.
4. Insert the test tube into Color Comparator (4414), read the test result within 30 seconds.
5. If the sample is too concentrated dilute the sample with DI water, and repeat the test.

BY Spectrophotometer: Read at 650 nm - 690 nm

Preparation of standard curve: Prepare at least 4 standards.
Make up standards adding the following volumes of spike solution and diluting to 5 ml DI water; 0, 25ul, 50ul, 75ul, 100ul (= 1, 2, 3, 4 ppm). Read in spectrophotometer and determine the phosphate concentration from the calibration curve.

Tripolyphosphate: Acid Hydrolysis Step
(4500 - P B., Standard Method, 1992)

General Discussion:

The Stannous Chloride Method for orthophosphate does not respond to the presence of condensed phosphates such as poly-, tripoly-, and higher molecular weight species such as hexametaphate. In addition, some natural waters contain organic phosphate compounds that are hydrolyzed to orthophosphate under test conditions. Although hydrolytically stable under normal conditions, they can be rapidly hydrolyzed at low PH and elevated temperatures. After hydrolysis the sample needs to be adjusted to near neutral PH in order to perform the orthophosphate test. By using the procedure for orthophosphate, both before and after hydrolysis, the amount of ortho- and polyphosphates can be determined.

Reagents:

1. Phenolphthalein indicator, aqueous solution
2. Strong acid solution:
Slowly add 300 ml concentrated sulfuric acid to 600 ml DI water. Let the mixture cool, add 4.0 ml of concentrated nitric acid and dilute to 1 liter with DI water.

Procedure:

1. To 100 ml sample (or portion diluted to 100 ml), add 1 drop of Phenolphthalein Reagent (2246). If a red color develops, add strong acid solution dropwise, to just discharge the color. Then add 1 ml more of strong acid solution. If no red color develops, simply add 1 ml of strong acid solution. If there is < 100 ml of sample, then proportionate amounts of reagent should be used.
2. Heat sample for 30 minutes in the autoclave.
3. Allow samples to cool to room temperature, then neutralize to a faint pink color with 6 N sodium hydroxide solution. Restore solution to its original 100 ml volume with DI water.
4. Run orthophosphate analysis.

Calculation of Phosphate Content:

1. ppm PO_4 before hydrolysis = orthophosphate
2. ppm PO_4 after hydrolysis = ortho + polyphosphate (total phosphate)
3. (2) - (1) = polyphosphate

TABLE 1
QUALITY CONTROL OBJECTIVES - INORGANIC MINERAL NUTRIENTS
BIOLOGICAL INVESTIGATION TESTS

ANALYTICAL METHODS LEVEL V QC	
QUALITY CONTROL MEASURE	FREQUENCY
Laboratory Method Blank	One per batch or 20 samples of similar matrix and per day after calibration
Matrix Spike	One per batch or 20 samples of similar matrix

ANALYTICAL METHODS LEVEL V QC	
QUALITY CONTROL MEASURE	CONTROL LIMIT
Laboratory Method Blank	≤ PQL
Sample Duplicate	< 50 RPD
Matrix Spike	± 25% Recovery

PQL = practical quantitation limit
 RPD = Relative percent difference

ABB-ES Standard Operating Procedure 3/93

Heterotrophic Plate Counting Modified Standard Method 9215C

Analyte: Heterotrophic Bacteria

Matrix: Aqueous (fresh and saline) or soil

Summary of Method:

Aqueous samples or soil extracts are serially diluted. Aliquots of the diluted sample are spread on agar plates and individual cells multiply and form colonies on the agar surface. The colonies are counted and an estimate for the number of live bacteria present in the soil, or aqueous sample, can be made.

Apparatus:

1. Incubator
2. Glass Rod
3. Turntable
4. Disposable glass pipettes

Reagents and Media:

1. Plate Count Agar (American Scientific #0479-01 or equivalent)

0.8 grams Nutrient Agar

1 Liter Distilled Water

Agar is autoclaved for 15 minutes and poured into sterile disposable petri plates.

2. Stock Phosphate Buffer solution:

5 grams NH_4Cl

5 grams NaHP_3O_5

500 ml distilled water

Check pH. Adjust to between 6.8 and 7.2, if necessary

Dilute to 1 Liter with distilled water

3. Dilute Solution:

10 ml Stock phosphate buffer

1 L Distilled water

Place 9 ml (\pm 0.2 ml) dilution solution into test tube or bottle (or 99 ml \pm 2 ml in a large bottle). Autoclave for 15 minutes.

Procedure:

1. Soil samples are extracted by adding 5 g soil to 45 ml dilute buffer. Samples are shaken for 20 minutes.
2. Water samples and soil extracts are serially diluted 1 to 10. Water samples are diluted to 1×10^{-6} and soil extracts are diluted to 10^{-7} .
3. Pipet 0.3 ml of diluted sample onto the surface of a nutrient agar plate. Distribute inoculum over surface on the plate using a sterile bent glass rod and rotating the dish on a turntable. Let the inoculum be adsorbed completely into the medium before placing in the incubator.
4. Incubate plates in an inverted position at $22 \text{ }^{\circ}\text{C} \pm 5 \text{ }^{\circ}\text{C}$ for one week.
5. Count all colonies on dilution plates that have between approximately 30 to 300 colonies each. Calculate the number of bacteria in the sample by multiplying the count per plate by the reciprocal of the dilution used. Report counts as colony forming units (CFU) per ml of water or per gram of soil.
6. If all plates have greater than 300 colonies, use the dilution plate having a count nearest to 300 colonies. Compute the count as above and report as Estimated CFU per ml or per gram.
7. If all plates have less than 30 colonies, report the count as Less than one (<1) times the reciprocal of the lowest dilution.

To Enumerate special classes of aerobic bacteria (eg. fuel degraders, toluene degraders), the following amendments to the procedure are made.

1. Nobel (organic free agar) is used instead of nutrient agar.
2. The carbon source is made available by either incorporating it into the agar or by incubating the agar plates in a desiccator that contains the target compound as a vapor phase.

To Enumerate special classes of anaerobic bacteria, (eg. denitrifiers) the following amendments to the procedure are made.

1. Nobel (organic free agar) is used instead of nutrient agar. The agar is prepared using anaerobic/denitrifier specific media.
2. Ammendment same as number 2 above.
3. Plates will be incubated under anaerobic conditions.

Quality Control

Quality control procedures for the heterotrophic plate count method include analysis of blank control samples and duplicates. The table below outlines the QA objectives for this analysis.

QUALITY CONTROL OBJECTIVES - HETEROTROPHIC PLATE COUNT BIOLOGICAL TREATMENT INVESTIGATION TESTS

HETEROTROPHIC PLATE COUNT FOR WATER MODIFIED STANDARD METHOD 9215C Level III QC	
QUALITY CONTROL MEASURE	FREQUENCY
Laboratory Method Blank	One per batch
Duplicate Analyses - Soil	10% of samples analyzed

HETEROTROPHIC PLATE COUNT FOR WATER MODIFIED METHOD 9215C Level III QC		
QUALITY CONTROL MEASURE	PARAMETER(S)	CONTROL LIMIT
Laboratory Method Blank	Colony Forming Unit (CFU)	< 50 CFU/ml
Duplicate Analyses	CFU	< 100% RPD
Method Detection Limits (MDL)	CFU	1000 CFU/g
Reporting Units CFU/g	CFU	CRU/g

RPD = Relative Percent Difference

Reference: Adapted from Standard Method 9215C, American Public Health Assoc. Standard Method for the Examination of Water and Wastewater, 17th Edition, 1989.

ABB-ES Standard Operating Procedure 3/93

Modified EPA Method 5030/8010 and 5030/8020 for Volatile Organics

Scope of Application

ABB-ES Bioremediation Systems' use of method 8010/8020 is based on the methods prescribed by EPA for volatile organics hydrocarbons, however, it has been modified such that only certain compounds will be quantitated. This method is used for both soil and aqueous samples. The target list of compounds for the modified method 8010/8020 routinely are:

Method 8010 Analytes

chloroform	1,1-Dichloroethylene
1,2-Dichloroethane	1,2-Dichloroethylene
1,1,1-Trichloroethane	methylene chloride
Trichloroethylene	vinyl chloride
Tetrachloroethylene	

Method 8020 Analytes

benzene
toluene
ethylbenzene
xylenes

Modified project-specific target lists are also routinely used.

Since the compounds of interest in this method are volatile in nature and they, as well as reagents necessary for the extraction can pose potential threats to health, standard good laboratory practice (GLP) will be required. This includes no eating, drinking, smoking in laboratories. Proper attire such as lab coat and gloves are necessary. All sample extractions and standard preparations will take place in either sealed containers or a laboratory hood.

Sample Requirements

The samples will be obtained using proper techniques with regard to sample handling and preservations. Maximum holding time for aqueous samples will be 7 days. Soil samples must be extracted within 14 days and analyzed within 40 days. The sample size required for analysis is 5 g for soils and 5 ml for water.

Analytical Procedure

The instrument to be used is a Hewlett-Packard model 5890 gas chromatograph fitted with a DB-624 megabore capillary column (J&W Scientific) and equipped with an electrolytic conductivity (halogen-specific) detector and a photoionization detector. Samples are introduced to the gc by purge and trap using a Tekmar automatic sampler (ALS) connected to a liquid sample concentrator (LSC) which uses a combined Tenax, silica, activated carbon trap. Separation of compounds is achieved by a temperature program beginning at 35° for 4 minutes then increasing by 8° per minute to 200° and holding for 1 minute.

Sample Preparation

Low level soil samples are prepared placing 5 gms of soil into the purge vessel. The vessel is then filled with 5ml of deionized water and spiked with an appropriate amount of internal and surrogate standard. Soil samples (medium level) are prepared by extracting volatile organic compounds from the soil using 4 g soil and 10 ml Methanol, shaken for 15 minutes in a small vial and then centrifuged. Surrogate standard, 0-chlorotoluene, is also prior to extraction. A representative volume of extract (100 ul or less) is then removed from the vial and injected into a purge vessel filled with 5 ml of deionized water and then spiked with an appropriate amount of an internal standard. The sample is then injected into the automatic sampler purge and trap.

Aqueous samples are transferred to a 5 ml glass syringe and then spiked with the appropriate internal and surrogate standard solutions. The sample will be diluted with deionized water when appropriate. The sample is then injected into the automatic sampler purge and trap.

All samples must fall within +/- 5% of the calibration range. If samples are not within this range an appropriate dilution shall be performed.

Calibration Standard Preparation

A minimum of three calibration standard solutions, each of which contain the target compounds, are prepared every two weeks. The calibration standards are made to final concentration of 5 ug/ml to 50 ug/ml and 250 ug/ml. The vinyl chloride standards are made up separately.

The standard compounds are obtained from a referenced source. To prepare, for example, the 50 ng/ul calibration standard, 50 ul of a 5000 ng/ul standard (prepared by Supelco) is added to a 1 ml mini-inert vial that contains 950ul methanol. The final volume of the standard is 1 ml. All standard compounds are added via syringe. The syringe is rinsed with 10 volumes of methanol between each subsequent standard component addition. The vinyl chloride standards are purchased at concentrations of 200 ug/ml and used directly. Vinyl Chloride standards are replaced weekly. Calibration standard preparation, repeated weekly is documented in the standard preparation log including source and traceability. All calibration standards are stored at 0°C.

Internal and Surrogate Standard Preparation

The internal standard routinely used for 8010/8020 analysis is bromofluorobenzene (BFB) and the surrogate standard is routinely chlorotoluene (CT). The internal standard is prepared by adding 50 ul of BFB (5000 ng/ul) to 950 ul of methanol that is in a mini-inert vial. The surrogate standard is prepared by adding 50 ul of CT (5000 ug/ml) to 950 ul of methanol that is in a mini-inert vial. The final concentration of the standard is 250 ng/ul. Internal and surrogate standard preparations are documented in the standard preparation log book. The standard is stored at 0°C.

Check Standard Preparation

A check standard is prepared from standards that have been obtained from a different referenced source than was used for calibration standards. The check standard contains all compounds in calibration standard and is made in the same manner. The concentration of check standard is the same concentration as the mid-level calibration standard.

Calibration Procedures

A three level standard curve is used to calibrate the GC for 8010/8020 analysis. Calibration standards are prepared by adding calibration solution and Internal/surrogate standard to a 5 ml syringe of deionized water. The sample is placed into the purge tube on the GC. This procedure is repeated for the other calibration levels.

The area values obtained for the calibration standard analysis are evaluated. The RSD of the response factors from the initial calibration is calculated and must be $\leq 20\%$.

The calibration procedure is performed weekly. Daily, a mid-level standard is analyzed prior to analyzing samples. The value must be within $\pm 15\%$ of the standard value. If the standard is outside the range, a another mid-level standard may be analyzed. If this fails to fall within the range, the instrument is recalibrated. A continuing calibration standard is run every 10 samples or per batch. Documentation of calibration including, dates and results of calibration, I.D. of standards and personnel performing calibration are recorded in the log book.

Pre-Analysis

Prior to sample analysis, the autosampler must be properly cleaned. First, remove old samples (if any) by unscrewing the glass purge chambers and discarding the water or soil. Then, put the ALS and LSC toggle switches in the "hold" position, and "step" the LSC to "purge" (leaving it in hold). This will cause helium gas to exit through the purge needle, expelling sample that may exist from prior analyses. To do the remaining positions, "step" the ALS toggle, leaving the LSC in "purge". When this is completed, wipe each purge needle with a Kim-wipe and firmly screw on clean purge chambers. The chambers must be rinsed with MeOH and dried at 103°C for 1/2 hour, prior to use.

Loading Autosampler; Standard and Blank

At the beginning of each day when samples are analyzed, a standard and blank must be run. Using clean 5 ml syringes, screw a needle onto the syringe and fill the syringe with deionized water until the syringe is overflowing. Discharge excess water through the needle, remove the needle and inject 5 ul of STD and 2 ul of IS/SS through the needle port and into the 5 mls of water. The blank is prepared by injecting 2 ul (or the appropriate volume) of the Internal and surrogate standards only. Leaving the needle off, inject the spiked water by screwing the syringe on to the injection port of the ALS position (usually ALS 1 for the standard), turning the ALS valve so the arrow is pointing outward, inject the sample, and finally, turn the ALS valve so the arrow points to the right again.

Routine Analysis

For routine analysis, samples are loaded in the same manner as described for standard and blank. A final volume of 5 ml is always injected into the purge chamber. Each sample must have Internal Standard and Surrogate Standard solution added to it just prior to putting on purge chamber. Data is quantified using the Internal Standard Method.

Internal Standard Calibration

Internal standard calibration relies on a known amount of a compound being added to the mixture before the injection is made. As with the external standard method, we can write the following set of equations:

$$\text{Conc. Int. Std.} = \text{D.F.} * (\text{A.IS} * \text{R.F. IS} + \text{R.O. IS}) / \text{Amt. Inj}$$

$$\text{Conc. Unknown} = \text{D.F.} * (\text{A} * \text{R.F} + \text{R.O.}) / \text{Amt. Inj}$$

where:

* = multiply

Conc. Int. Std. is the known concentration of the internal standard.

D.F. is the dilution factor as entered by the chemist.

A.IS is the area of the internal standard peak.

R.F. IS is the response factor of the internal standard.

R.O. IS is the response offset of the internal standard.

Amt. Inj is the amount injected as entered by the chemist.

Conc. Unknown is the concentration needed to be calculated.

A is the area of the unknown peak.

R.F. is the response factor of the unknown peak.

R.O. is the response offset of the unknown peak.

With internal standard calibration, you can eliminate the amount injected variable because the concentration of the internal standard is known. Solving the above two equations, we get:

$$\text{Conc. Unknown} = (A \cdot R.F. + R.O.) / (A \cdot IS \cdot R.F. \cdot IS + R.O. \cdot IS)$$

The internal standard method allows the chemist to eliminate the effects of varying injection volumes and dilution factors.

The response factors used in the above equation are the same as used in an external standard calculation. This allows the software to use a single method file for both external and internal standard calculations.

Quality Control

Quality control procedures for the modified 8010 method include calibration standards, calibration check standards, blanks, internal standard, surrogate standards, duplicates. The objectives are outlined in Table 1. The calibration procedures and frequencies are listed above. A method blank shall be analyzed daily after calibration or calibration check runs, when samples are to be analyzed, and after the analysis of any high concentration sample.

Interference

Contamination by carryover can occur whenever high-level and low-level samples are sequentially analyzed. To reduce carryover, the sample syringe or purging device must be rinsed out between samples with reagent water or solvent. Whenever an unusually concentrated sample is encountered, it should be followed by an analysis of a solvent blank or of reagent water to check for cross contamination. For volatile samples containing large amounts of water-soluble materials, suspended solids, high boiling compounds or high organohalide levels, it may be necessary to wash out the syringe or purging device with a detergent solution, rinse it with distilled water, and then dry it in a 105°C oven between analyses. All data will be recorded, results will not be blank corrected.

Preventative Maintenance and Repair

Preventative maintenance and repair is performed as recommended by equipment manufacturer's specifications. Equipment log books are used to document maintenance and repair performed.

Data Reporting

Analytical results (raw data) will be collected using an IBM compatible computer system using Perkin Elmer software to measure peak height/area and interpret results in concentrations (ppb). As always, documentation of analyses will appear in a laboratory log. Final results, after QC review, will be reported in two forms: one, a report form which will list results for a sample and second, a data print out from BRS's computerized system.

**TABLE 1
QUALITY CONTROL OBJECTIVES - VOLATILE ORGANICS**

VOLATILE ORGANICS IN WATER MODIFIED EPA METHOD 5030/8010 5030/8020 Level V QC	
QUALITY CONTROL MEASURE	FREQUENCY
Laboratory Method Blank	One per batch or 20 samples of similar matrix and per day after calibration
Continuing Calibration Standard	Daily at the beginning of the day before samples are analyzed, and after every 10 samples
Surrogate Standard	Added to each blank and standard
Sample Duplicate	10% of samples analyzed
Matrix Spike/Matrix Spike Duplicate	One per matrix analyzed

VOLATILE ORGANICS IN WATER MODIFIED EPA METHOD 5030/8010 & 5030/8020 Level V QC		
QUALITY CONTROL MEASURE	PARAMETER(S)	CONTROL LIMIT
Laboratory Method Blank	modified 8010/8020 list analytes*	≤ PQL
Method Detection Limit (MDL)	modified 8010/8020 list analytes*	1 ug/kg
Practical Quantitation Limit (PQL) Reporting units ug/kg	modified 8010/8020 list analytes*	5 ug/kg
Initial Calibration	modified 8010/8020 list analytes*	≤ 20% RSD of RF's
Continuing Calibration Standard	modified 8010/8020 list analytes*	+ 20 % of stnd value
Surrogate Standard	o-chlorotoluene	75 - 125% Recovery
Sample Duplicate	modified 8010/8020 list analytes*	≤ 40 RPD

* Modified list analytes listed in ABB-ES's 5030/8010 & 8020 SOP

RSD = Relative Standard Deviation

RF = Response Factor

RPD = Relative Percent Difference

REFERENCES

U.S. Environmental Protection Agency (USEPA), 1986, Test Method for Evaluating Solid Waste-
Physical/Chemical Methods, SW-846 Third Edition, Office of Solid Waste, U.S. EPA, Washington,
D.C.