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SAMPLING AND ANALYSIS PLAN NAS CECIL FIELD FL
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ABB ENVIRONMENTAL SERVICES, INC

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SAMPLING AND ANALYSIS PLAN

**NAVAL AIR STATION, CECIL FIELD
JACKSONVILLE, FLORIDA**

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Contract No. N62467-89-D-0317

Prepared by:

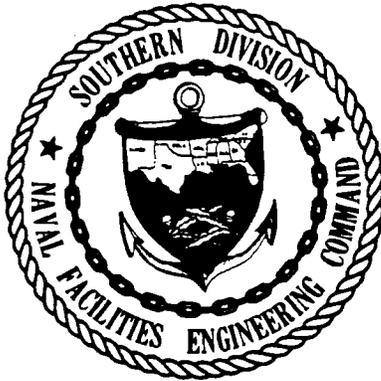
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SEPTEMBER 1991



FOREWORD

The Department of the Navy developed the Installation Restoration (IR) program to locate, identify, and remediate environmental contamination from the past disposal of hazardous materials at Navy and Marine Corps installations. The Navy IR program follows the Department of Defense Environmental Restoration Program as created by the Superfund Amendments and Reauthorization Act of 1986.

The IR program consists of Preliminary Assessment and Site Inspection, Remedial Investigation and Feasibility Study, and Remedial Design and Remedial Action. The Preliminary Assessment and Site Inspection identifies the presence of pollutants. The Remedial Investigation and Feasibility Study analyze the nature and extent of contamination and determine the optimum remediation solution. The Remedial Design and Remedial Action complete the implementation of the solution.

Preliminary Assessment has determined that Naval Air Station (NAS) Cecil Field has 12 waste sites that may pose a threat to the environment. Therefore, a Remedial Investigation will be performed to address the extent, magnitude, and impact of possible contamination at these waste sites. Six of the sites have been grouped together for this remedial investigation document. An additional six sites have been identified as possible contaminant source areas. These sites will be evaluated through the Potential Source of Contamination (PSC) Screening process.

The purpose of this Sampling and Analysis Plan is to summarize existing data, define RI/FS objectives, and propose methods and procedures to achieve those objectives. The Sampling and Analysis Plan contains the necessary Quality Assurance/Quality Control (QA/QC) information required for a site-specific Quality Assurance Project Plan (QAPP).

Questions regarding this report should be addressed to the Commanding Officer, Code OOB, P.O. Box 111, NAS Cecil Field, Jacksonville, Florida 32215-0111.

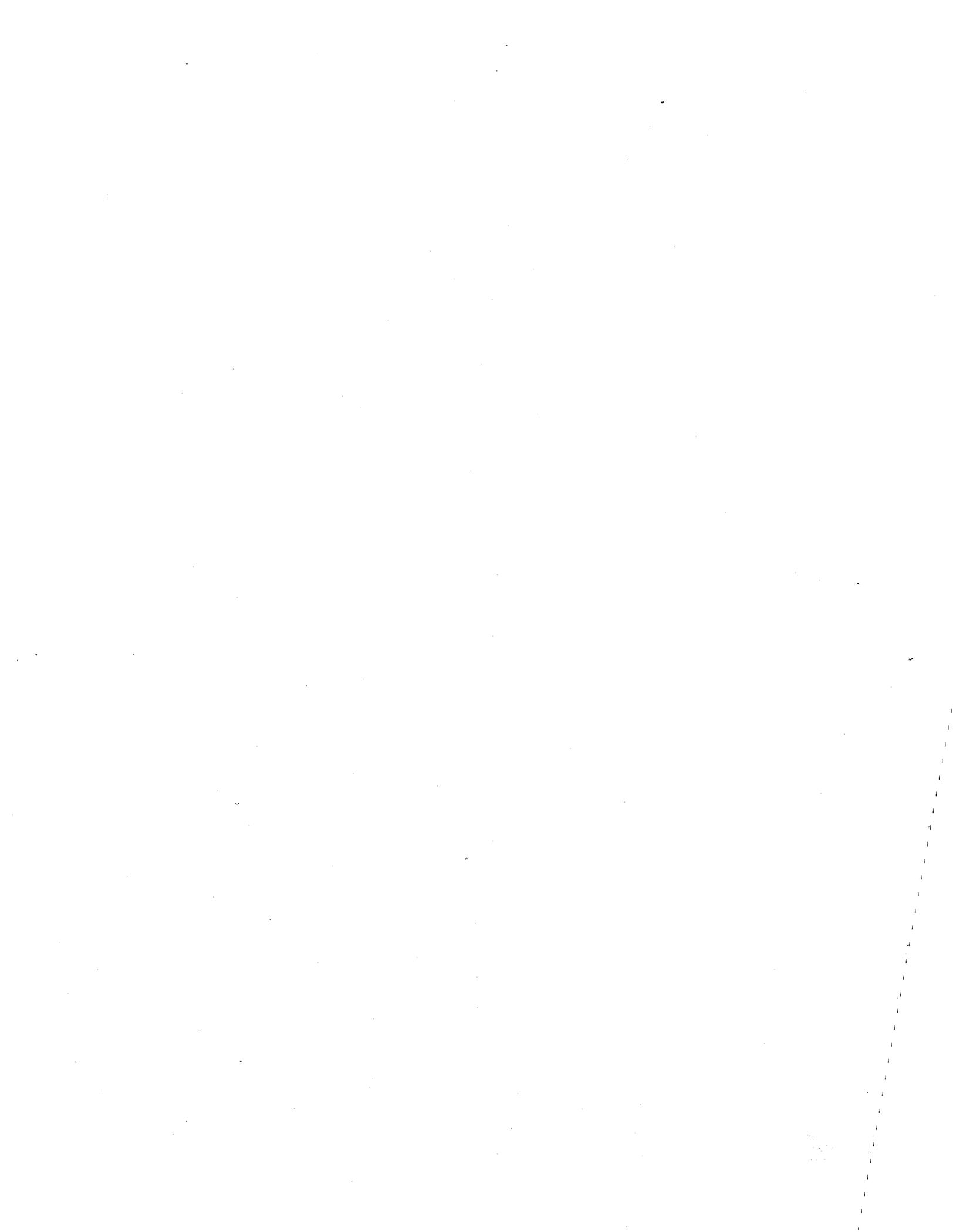


TABLE OF CONTENTS

Sampling and Analysis Plan

Section	Title	Page No.
1.0	INTRODUCTION	1-1
1.1	GENERAL	1-1
1.2	RI/FS GOALS	1-1
1.3	REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS) SITES	1-1
1.4	CONTAMINATION STATUS AT EACH SITE	1-4
1.5	SCOPE OF THE SAMPLING AND ANALYSIS PLAN	1-4
2.0	SITE BACKGROUND AND SAMPLING OBJECTIVES	2-1
2.1	GENERAL	2-1
2.2	DATA QUALITY OBJECTIVES	2-1
2.3	APPROACH TO ACHIEVING DATA QUALITY OBJECTIVES	2-1
2.4	SAP-SPECIFIC DATA QUALITY OBJECTIVES	2-4
2.4.1	Source Area and Volume Characterization	2-4
2.4.2	Source Contaminant Characterization	2-4
2.4.3	Contaminant Migration Potential	2-5
2.4.4	Surface Water Characterization	2-5
2.4.5	Groundwater Plume Characterization	2-5
2.4.6	Operable Units	2-5
2.4.6.1	Landfills	2-5
2.4.6.2	Oil and Sludge Disposal Areas	2-6
2.4.6.3	AIMD Seepage Pit	2-6
4.0	ANALYTICAL PROGRAM	4-1
4.1	ANALYTICAL PARAMETERS	4-1
4.2	ANALYTICAL METHODS AND SUMMARIES	4-1
5.0	SAMPLING EQUIPMENT AND PROCEDURES	5-1
5.1	GENERAL	5-1
5.2	MONITORING WELL INSTALLATION AND DEVELOPMENT	5-1
5.2.1	Hollow-Stem Auger Drilling Procedures	5-1
5.2.2	Permanent Monitoring Well Installation	5-1
5.2.2.1	Monitoring Well Materials and Construction	5-2
5.2.2.2	End Plugs and Well Caps	5-2
5.2.2.3	Filter Pack	5-2
5.2.2.4	Surface Casing	5-2
5.2.3	Well Development	5-2
5.2.4	Lithologic Logs and Well Completion Diagrams	5-3
5.3	AQUIFER TESTING	5-3
5.4	GROUNDWATER SAMPLING	5-3
5.4.1	Water Level Measurement	5-3
5.4.2	Purging	5-3
5.4.3	Sample Collection Procedures	5-8
5.4.4	Quality Assurance/Quality Control (QA/QC)	5-8

TABLE OF CONTENTS (Continued)

Sampling and Analysis Plan

Section	Title	Page No.
5.5	SURFACE WATER AND SEDIMENT SAMPLING	5-12
5.5.1	Flow Measurements	5-12
5.5.1.1	Current Meter	5-12
5.5.1.2	Water Stage Gauge	5-12
5.5.2	Sample Collection Procedures	5-14
5.5.2.1	Surface Water	5-14
5.5.2.2	Sediment	5-14
5.5.3	Sample Mixing	5-14
5.5.4	Quality Assurance/Quality Control (QA/QC)	5-14
5.6	SHALLOW SOIL SAMPLING	5-17
5.6.1	Stainless-Steel Hand Auger	5-17
5.6.2	Sample Compositing	5-17
5.6.3	Auxiliary Data	5-17
5.7	SUBSURFACE GAS TESTING	5-17
5.8	AIR QUALITY	5-17
5.8.1	Sample Screening	5-17
5.9	GEOPHYSICS	5-19
5.10	SURVEYING	5-19
5.11	EQUIPMENT, SAMPLING SUPPLIES, AND DECONTAMINATION LISTS	5-19
5.12	DECONTAMINATION PROCEDURES	5-19
5.12.1	Drilling and Monitoring Well Installation Equipment	5-21
5.12.1.1	Equipment Decontamination	5-21
5.12.2	Well Development and Aquifer Testing Equipment	5-23
5.12.3	Water Level Measurement Equipment	5-23
5.12.4	Water Sampling Equipment	5-23
5.12.5	Sampling Jars and Containers	5-24
5.12.6	Personnel Decontamination	5-24
6.0	SAMPLE HANDLING	6-1
6.1	SAMPLE PAPERWORK	6-1
6.1.1	Chain-of-Custody (COC)	6-1
6.1.2	Sample Labels	6-1
6.2	SHIPPING REQUIREMENTS	6-4
6.2.1	Shipping Containers	6-4
7.0	INVESTIGATION DERIVED WASTE HANDLING AND DISPOSAL	7-1

REFERENCES
BIBLIOGRAPHY

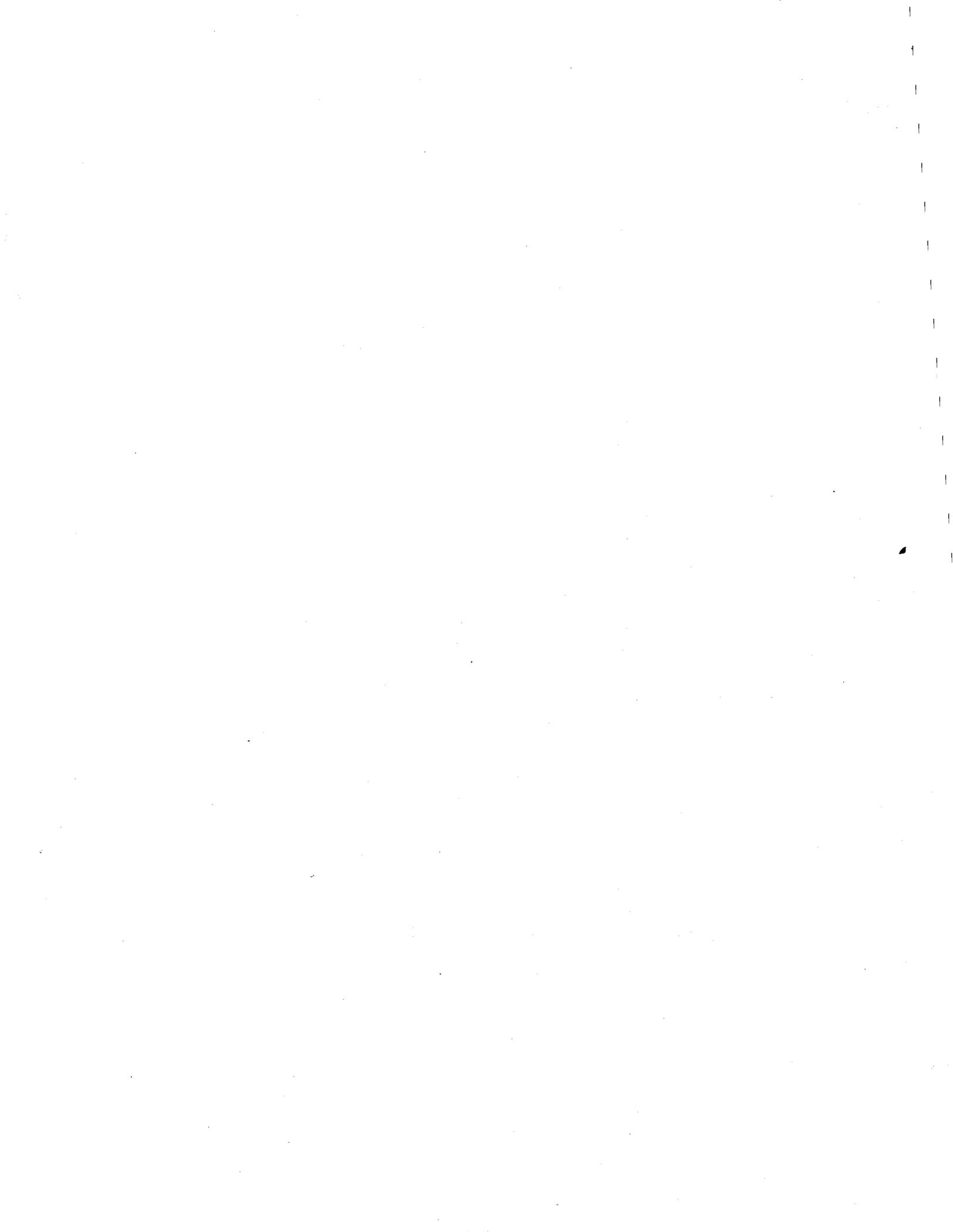
APPENDICES

- Appendix A: EPA-Approved Analytical Methods
- Appendix B: Field Instrumentation SOPs
- Appendix C: Technical Memoranda
- Appendix D: Alternate Well Casing Material Justification
- Appendix D: Alternate Well Casing Material Justification

LIST OF FIGURES

Sampling and Analysis Plan

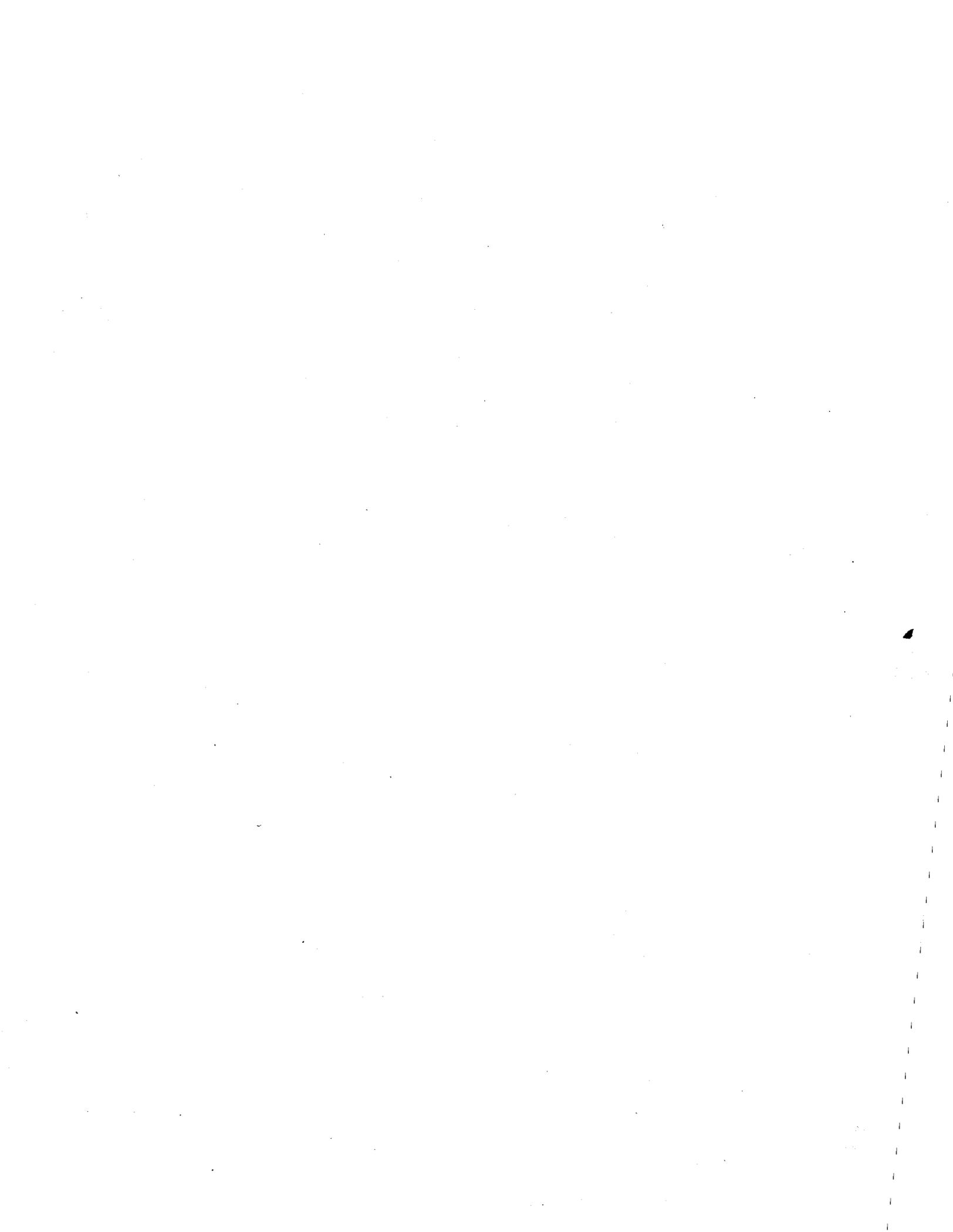
<u>Figure</u>	<u>Title</u>	<u>Page No.</u>
1-1	General Location Map	1-2
1-2	Site Location Map	1-3
3-1	Proposed Sampling Locations, Site 1 and 2	3-3
3-2	Proposed Sample Locations, Site 3	3-4
3-3	Proposed Sampling Locations, Site 5	3-5
3-4	Proposed Sampling Locations, Site 17	3-6
3-5	Proposed Sample Locations, Site 16	3-7
5-1	Groundwater Monitoring Well Installation Report	5-4
5-2	Well Construction Details	5-5
5-3	Groundwater Monitoring Well Installation Report (Example)	5-6
5-4	Typical Groundwater Monitoring Well	5-7
5-5	Quality Assurance/Quality Control Organization Chart	5-11
6-1	Chain-of-Custody Record	6-2
6-2	Sample Label	6-3



LIST OF TABLES

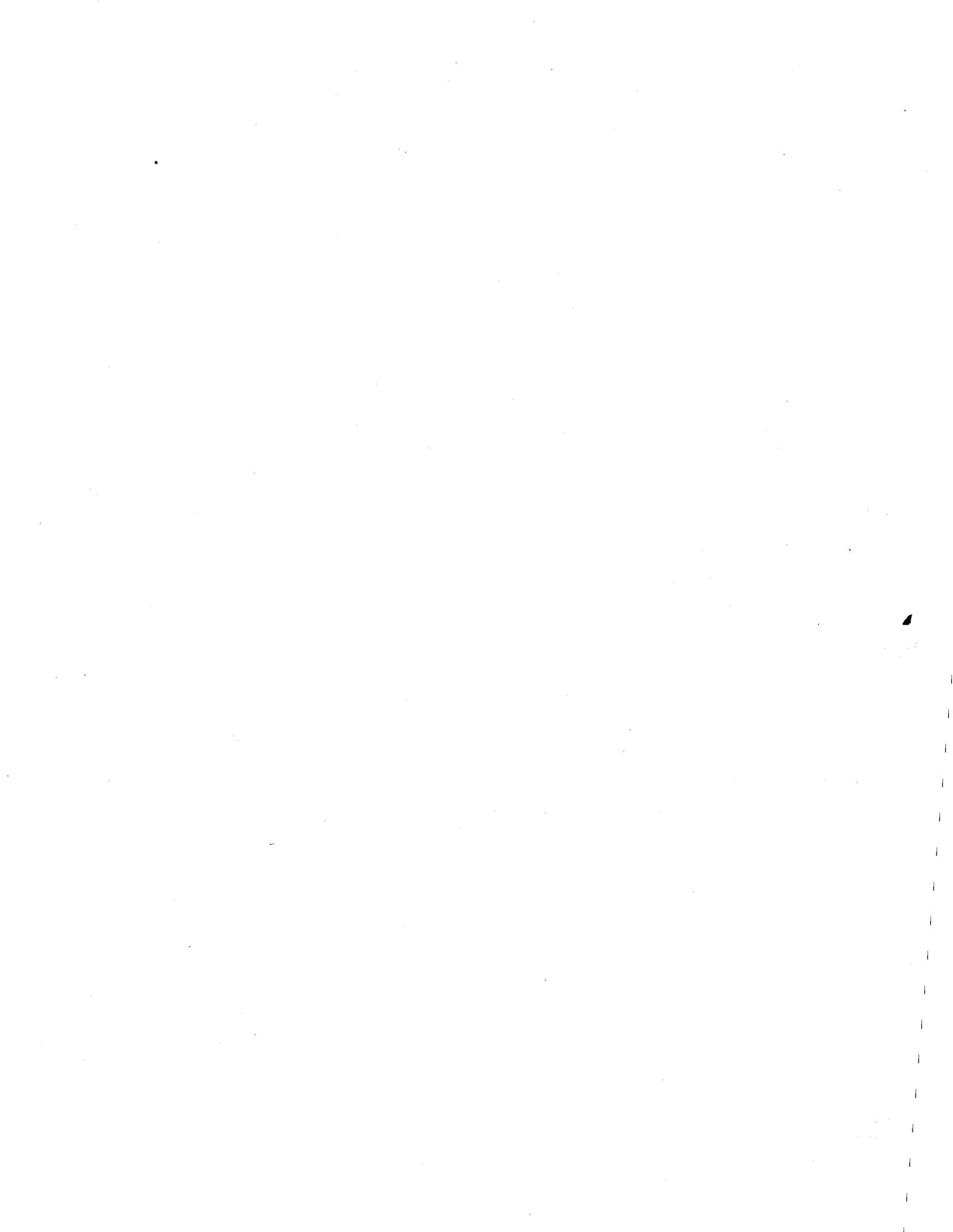
Sampling and Analysis Plan

Tables	Title	Page No.
1-1	Summary of Maximum Concentrations of Previously Identified Contaminants, Groundwater	1-5
2-1	Sampling Objectives	2-2
2-2	Summary of Data Collection Activities	2-3
2-3	Navy Field Quality Assurance/Quality Control (QA/QC) Requirements	2-7
2-4	Estimated Number of Quality Assurance/Quality Control (QA/QC) Samples by Matrix	2-7
3-1	Summary of the Number of Sampling Locations by Site	3-2
4-1	Suspected Contaminants	4-2
4-2	Florida Drinking Water Standards and USEPA MCL Comparison	4-3
4-3	Analytical Methods Selected	4-5
4-4	Summary of Proposed Site Investigations and Sample Analytical Requirements For Operable Unit 1	4-10
4-5	Summary of Proposed Site Investigations and Sample Analytical Requirements For Operable Unit 2	4-12
4-6	Summary of Proposed Site Investigations and Sample Analytical Requirements For Operable Unit 7	4-15
5-1	Sample Containers, Preservatives, and Holding Times	5-9
5-2	Estimated Summary of Groundwater and QA/QC Analyses	5-13
5-3	Estimated Summary of Surface Water and Quality Assurance/Quality Control (QA/QC) Analyses	5-15
5-4	Estimated Summary of Sediment and QA/QC Analyses	5-16
5-5	Estimated Summary of Soil Boring and Quality Assurance/Quality Control (QA/QC) Analyses	5-18
5-7	Sampling Equipment and Decontamination Supplies	5-20



LIST OF ACRONYMS

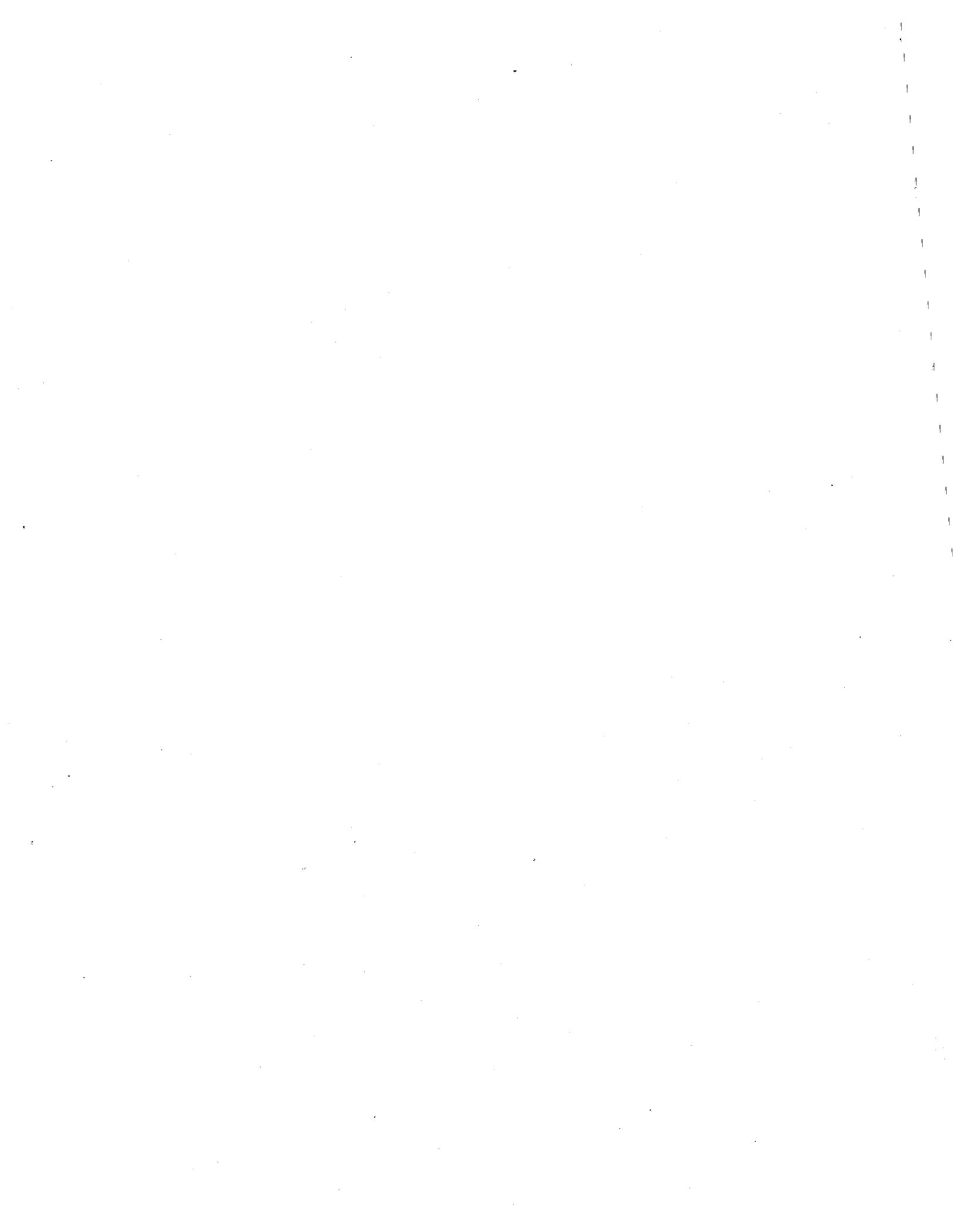
AA	atomic absorption
AIMD	Aircraft Intermediate Maintenance Division
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
COC	Chain-of-Custody
CLP	Contract Laboratory Program
DOT	Department of Transportation
DQOs	data quality objectives
EIC	Engineer-In-Charge
EM	electromagnetic induction
USEPA	U.S. Environmental Protection Agency
FFTAs	fire fighter training areas
FID	flame ionization detector
FS	Feasibility Study
GC/MS	gas chromatography/mass spectroscopy
GPR	ground penetrating radar
ICP	Inductively coupled plasma
IR	Installation Restoration Program
LQAC	laboratory QA contact
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MDL	method detection limit
MEK	2-butanone (methyl ethyl ketone)
MIBK	4-methyl-2-pentanone (methyl isobutyl ketone)
NGVD	National Geodetic Vertical Datum
NPL	National Priorities List
OUs	operable units
OVA	organic vapor analyzer
OSHA	Occupational Safety and Health Administration
PAH	polynuclear aromatic hydrocarbon
PID	photoionization detector (i.e., HNU)
PCBs	polychlorinated biphenyls
PQL	practical quantification levels
PSC	Potential Sources of Contamination
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
RF	response factor
RI	Remedial Investigation
RSD	relative standard deviation
SAP	Sampling and Analysis Plan
SARA	Superfund Amendment and Reauthorization Act
SOUTHNAVFACENGCOM	Department of the Navy, Southern Division, Naval Facilities Engineering Command
SOPs	standard operation procedures
SWMU	Solid Waste Management Unit
TAL	Target Analyte List
TCE	Trichloroethylene
TCL	Target Compound List
TOC	top of casing
TRPH	total recoverable petroleum hydrocarbon
VOAs	volatile organic analytes



EXECUTIVE SUMMARY

This Sampling and Analysis Plan (SAP) describes the data collection and sample analysis procedures to be conducted at the Cecil Field Naval Air Station (NAS Cecil Field) near Jacksonville, Florida. Data collection and laboratory analyses are being performed as part of the Remedial Investigation (RI) and Feasibility Study (FS) program for the Southern Division of the Naval Facilities Engineering Command. The RI/FS program is being conducted as part of the Naval Installation Restoration (IR) program whose objective is to identify and evaluate past hazardous waste sites and control the migration of hazardous contaminants from those sites. The Navy is proceeding with the IR program at NAS Cecil Field using the guidance of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Superfund Amendment and Reauthorization Act (SARA) RI/FS process.

This document covers six of the twelve sites under remedial investigation at NAS Cecil Field. The approach to conducting the comprehensive RI/FS program at these sites is set forth in four planning documents, including the Sampling and Analysis Plan. A comprehensive understanding of the entire program requires knowledge of all plans. This SAP details procedures for field sampling and data quality assurance/quality control. This plan discusses objectives of the sampling program and ultimate use of the data. It specifies sampling protocol and procedures, as well as types, locations, frequency of samples to be collected, and general quality assurance.



1.0 INTRODUCTION

1.1 GENERAL. This Sampling and Analysis Plan (SAP) describes the data collection and sample analysis procedures to be conducted at the Cecil Field Naval Air Station (NAS Cecil Field) near Jacksonville, Florida (Figure 1-1). Data collection and laboratory analyses are being performed as part of the Remedial Investigation (RI) and Feasibility Study (FS) program for the Southern Division of the Naval Facilities Engineering Command. The RI/FS program is being conducted as part of the Naval Installation Restoration (IR) program whose objective is to identify and evaluate past hazardous waste sites and control the migration of hazardous contaminants from such sites. The Navy is proceeding with the IR program at NAS Cecil Field using the guidance of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the Superfund Amendment and Reauthorization Act (SARA) RI/FS process. Based on the U.S. Environmental Protection Agency's (USEPA) evaluation of data collected during previous investigations, the station has been listed on the National Priorities List (NPL).

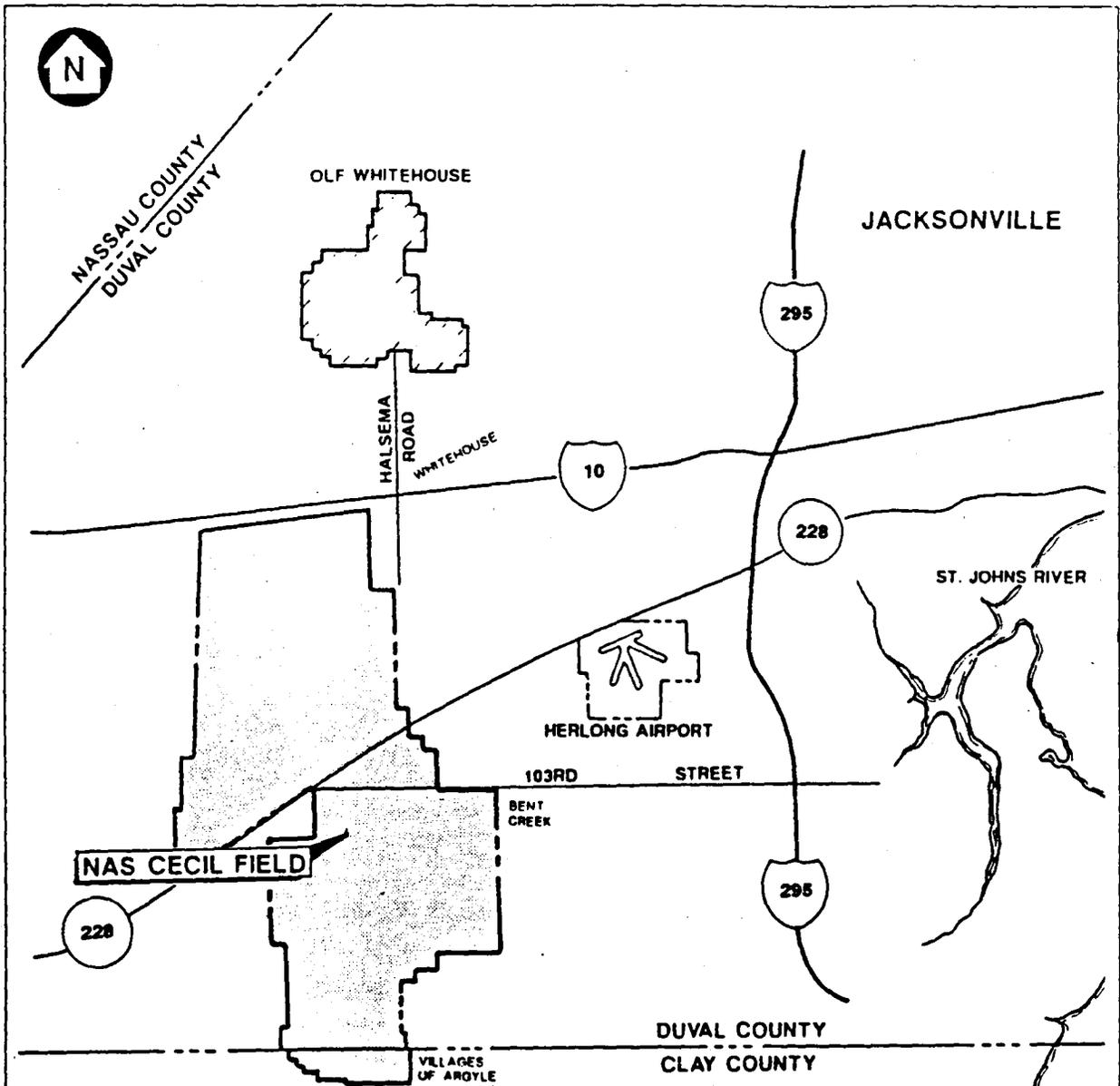
This document covers the sampling and analysis activities at three operable units containing a total of six sites. The approach to conducting the comprehensive RI/FS program at these sites is set forth in four planning documents. In addition to this SAP, these documents include the Community Relations Plan (CRP), the Workplan, and the Health and Safety Plan (HASP). A comprehensive understanding of the entire program requires knowledge of all plans. This SAP details procedures for field sampling and data quality assurance/quality control. Implementation of the field procedures also requires knowledge of the Site Health and Safety Plan and the Site Management Plan.

1.2 RI/FS GOALS. The goals of the RI/FS program are to assess the extent, magnitude, and impact of possible contamination at waste disposal sites and to develop appropriate remedial actions for sites that are determined to pose a threat to human health and/or the environment. The RI/FS emphasizes the collection of sufficient information to support risk management decisions concerning the appropriate remediation at a given site.

The RI process serves as the mechanism for data collection to identify source and migration pathway characteristics, and for conducting the risk assessment and testing necessary to aid in the FS process. The FS process uses the information collected in the RI to develop, screen, and evaluate potential remedial alternatives. The processes are conducted concurrently with data collection to provide information relevant to the selection of a remedial action.

1.3 REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS) SITES. Locations of the six sites at NAS Cecil Field addressed in this program are shown on Figure 1-2. These sites have been grouped into three operable units (OUs). The OUs are based on suspected waste types and disposal practices. They consist of:

- Landfills (Sites 1 and 2),
- Oil and Sludge Disposal Areas (Sites 3, 5, and 17), and
- The Aircraft Intermediate Maintenance Department (AIMD) Seepage Pit (Site 16).



ADAPTED FROM ENVIRODYNE ENGINEERS 1985



FIGURE 1-1
GENERAL LOCATION MAP



SAMPLING AND ANALYSIS PLAN
NAS CECIL FIELD
JACKSONVILLE, FLORIDA

Site summaries for each site detail suspected waste types, summarize historical land use and previous data collection results, are included in the Workplan.

1.4 CONTAMINATION STATUS AT EACH SITE. A brief summary of the analytical data from previous investigations is included in Table 1-1. Primary contaminants of concern include:

- metals (cadmium, chromium, and lead),
- extractable organics (polynuclear aromatic hydrocarbons), and
- volatile organics (1,1,1-trichloroethane, toluene, benzene, ethyl benzene, etc.).

Samples from some monitoring wells revealed concentrations of chromium, lead, cadmium, benzene, and trichloroethylene (TCE) that were above Florida drinking water standards (Table 1-1). More detailed discussions of the previously identified contaminants and their migration potentials are provided in the Workplan. The HASP addresses field safety procedures and discusses health hazards associated with suspected contaminants.

1.5 SCOPE OF THE SAMPLING AND ANALYSIS PLAN. The purpose of the SAP is to document the procedures for field activities and sample analyses. This plan was prepared in accordance with the 1988 "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (USEPA/540/G-89/004 draft). This plan discusses objectives of the sampling program and ultimate use of the data. It specifies sampling protocol and procedures; as well as types, locations, frequency of samples to be collected; and general laboratory quality assurance.

Chapters 2 and 3 of the SAP provide background and data quality objectives information, which are detailed in the Workplan. Field activities, including detailed sampling specifications and sampling locations, are provided in Chapters 4 through 7. The field sampling sections describe the specific data collection activities that will be conducted during the field investigation phase of the remedial investigation. These data will be used to characterize the site, to conduct the baseline risk assessment, and to develop and evaluate remedial alternatives.

**Table 1-1
Summary of Maximum Concentrations of Previously
Identified Contaminants, Groundwater (except where noted)**

Sampling and Analysis Plan
NAS Cecil Field
Jacksonville, Florida

Site	Contaminant	Concentration
Site 1, Old Landfill (SWMU A)	Bis (2-ethylhexyl) phthalate	130 µg/l
	Lead ¹	294 µg/l
	Chromium ¹	176 µg/l
	Methylene chloride (sediment)	53 µg/kg
	Cadmium (sediment)	20 mg/kg
	Lead (sediment)	14 mg/kg
Site 2, Recent Landfill (SWMU B)	Naphthalene	10 µg/l
	Chromium ¹	425 µg/l
	Lead ¹	385 µg/l
	Cadmium ¹	12 µg/l
Site 3, Oil and Sludge Disposal Area (SWMU C)	1,1-Dichloroethane ¹	210 µg/l
	1,1-Dichloroethylene	110 µg/l
	Benzene ¹	4 µg/l
	Ethyl benzene	10 µg/l
	Toluene	8 µg/l
	1,1,1-Trichloroethane	88 µg/l
	4-Methylphenol	29 µg/l
	bis (2-Ethylhexyl) phthalate	19 µg/l
	Naphthalene	280 µg/l
	2-Methylnaphthalene	190 µg/l
	Chromium ¹	90 µg/l
Lead ¹	164 µg/l	
Site 5, Oil Disposal Area Northwest (SWMU E)	bis (2-Ethylhexyl) phthalate	13 µg/l
	Cadmium	5 µg/l
	Chromium	39 µg/l
	Naphthalene	10 µg/l
	2-Methylnaphthalene	10 µg/l
	Lead	49 µg/l
	Chromium (sediment)	9 mg/kg
	Lead (sediment)	7 mg/kg
	Methylene chloride (sediment)	43 µg/kg
	Methylene chloride (soil)	23 µg/kg
	Ethyl benzene (soil)	12 µg/kg
	Arochlor 1260 (PCBs) (soil)	580 µg/kg
	Lead (soil)	14 mg/kg
	Chromium (soil)	6.5 mg/kg
Site 16, AIMD Seepage Pit (SWMU L)	1,2-trans-Dichloroethylene	380 µg/l
	Trichloroethylene ¹	400 µg/l
	Chromium ¹	74 µg/l
	Lead ¹	175 µg/l
	Mercury	0.3 µg/l
	1,1,1-Trichloroethane (soil)	19 µg/kg
	Chromium (soil)	6.7 mg/kg
	Lead (soil)	11 mg/kg

Table 1-1 (Continued)
Summary of Maximum Concentrations of Previously
Identified Contaminants, Groundwater (except where noted)

Sampling and Analysis Plan
 NAS Cecil Field
 Jacksonville, Florida

Site	Contaminant	Concentration
Site 17, Oil and Sludge Disposal Pit Southwest (SWMU M)	Lead	7 $\mu\text{g/l}$

¹Above groundwater standards for Florida Administrative Code 17-550 maximum contaminant levels and USEPA Safe Drinking Water Act maximum contaminant levels (52 FR 25690, July 8, 1987).

Notes: SWMU = Solid Waste Management Unit.

$\mu\text{g/l}$ = microgram per liter.

mg/kg = milligram per kilogram.

$\mu\text{g/kg}$ = microgram per kilogram.

AIMD = Aircraft Intermediate Maintenance Department.

Source: See Appendix D of the Workplan.

2.0 SITE BACKGROUND AND SAMPLING OBJECTIVES

2.1 GENERAL. Site background and setting information is detailed in the RI/FS Workplan for NAS Cecil Field. It provides historical review of site use and summarizes both our current understanding of the environmental setting and existing data from previous studies. The RI/FS Workplan also documents the initial evaluation and scoping process, which identifies the suspected contaminants, the potential migration and exposure pathways, and the potential health and environmental impacts. From this evaluation, specific data quality objectives were developed to support risk assessment and remedial alternatives evaluations.

The data quality objectives (DQOs) for the RI are presented in the Workplan. The purpose of the RI is to provide the data necessary for source, migration pathway, and potential receptor characterization in sufficient detail to support the evaluation of potential remedial alternatives through the FS process. The Workplan approach to data collection is to ensure that site characterization efforts are directed towards providing information relevant to selection of remedial actions. The objectives and the approach to achieving those objectives are reiterated below with the description of RI tasks directly related to achieving DQOs.

2.2 DATA QUALITY OBJECTIVES. The objectives of the RI, risk assessment (RA), and FS activities are summarized in Table 2-1. Data generated during each investigation should be of sufficient type, quantity and quality to meet the investigation's objectives.

RI characterization activities will encompass characterization of the source volumes and associated contaminant concentrations, and identify migration pathways. The RI activities will include physical and geophysical screening methods to define source area boundaries, source sampling and sample analysis, and migration pathway sampling and sample analysis. A summary of the RI DQOs and associated data collection activities, by operable unit, is included as Table 2-2. After reviewing the RI results, additional RI activities may be necessary to further characterize downgradient migration pathways, quantify land and water use, and model contaminant transport.

FS activities will be designed to provide detailed data regarding the technical feasibility of selected remedial alternatives through the use of treatability or bench scale studies. To expedite the RI/FS process, potential remedial alternatives will be tested concurrently with the RI sampling. The FS activities may include collection of media-specific baseline data (i.e., soils organic content and natural water quality constituents), solidification and leaching potential evaluation, RCRA waste characterization, thermal treatment and destruction trial testing, etc.

2.3 APPROACH TO ACHIEVING DATA QUALITY OBJECTIVES. The RI data collection efforts are summarized by operable unit and site below, following discussion of the data quality objectives. The specific sampling and analytical methods to be employed, as well as detailed field activity protocols, are described in Chapters 4 and 5. Additional information regarding site work activities is provided in the Health and Safety Plan.

**Table 2-1
Sampling Objectives**

Sampling Analysis Plan
NAS Cecil Field
Jacksonville, Florida

Investigations	Remedial Investigation	Risk Assessment	Feasibility Study
<u>PSC Screening</u> Potential source of contamination screening.	Limited sampling and analysis to establish the presence or absence of contaminants at source or in indicator pathways.	Develop preliminary baseline risk assessment to define risk under the no-action alternative.	Evaluate applicability of no-action alternative.
<u>RI</u> characterize contaminant distribution and migration potential.	Detailed sampling and analysis to establish general vertical and areal extent of contamination and contaminant concentrations.	Identify potential receptors; and evaluate environmental and public health threat. Establish appropriate levels of risk reduction.	Identify applicable remedial technologies, ARARs, and effective pathway controls. Evaluate treatment scenarios. Evaluate costs to achieve ARARs.
<u>FS</u> Remedial alternatives evaluation.	Further characterization of pathways and sources for control evaluation.	Refine uncertainties in measurement of public health threat.	Evaluate applicable standards or risks. Identify applicable remedial technologies.

Notes: PSC = potential source of contamination.
 RI = Remedial Investigation.
 ARARs = Applicable or Relevant and Appropriate Requirements.
 FS = Feasibility Study.

**Table 2-2
Summary of Data Collection Activities**

Sampling and Analysis Plan
NAS Cecil Field
Jacksonville, Florida

Operable Unit	Data Collection Activities
<p>LANDFILLS (Sites 1 and 2)</p> <ul style="list-style-type: none"> - Source volume characterization - Groundwater plume characterization - Contaminant transport potential 	<ul style="list-style-type: none"> - Electromagnetic induction (EM) survey, Piezocone penetration test (PCPT) - Monitor well construction, sampling, and analysis - Permeability (slug) testing of monitor wells, water table elevation measurement, surface water elevation and flow measure, surface water/sediment sampling and analysis, ambient air monitoring
<p>OIL/SLUDGE DISPOSAL AREAS (Sites 3, 5, and 17)</p> <ul style="list-style-type: none"> - Source volume characterization - Source contaminant characterization - Groundwater plume characterization - Contaminant transport potential 	<ul style="list-style-type: none"> - Soil gas survey - GPR Survey - Soil sampling and analysis - Monitor well construction, sampling, and analysis - Permeability (slug) testing of monitor wells, water table elevation measurement, surface water elevation and flow measure, surface water/sediment sampling and analysis, ambient air monitoring
<p>AIMD SEEPAGE PIT (Site 16)</p> <ul style="list-style-type: none"> - Source identification - Source area characterization - Groundwater plume characterization - Surface water discharge point characterization - Contaminant migration potential 	<ul style="list-style-type: none"> - Soil gas survey - GPR survey - Soil sampling and analysis - Monitor well construction, sampling, and analysis - Surface water/sediment sampling and analysis - Permeability (slug) testing of monitor wells, water table elevation measurement, surface flow measurement

2.4 SAP-SPECIFIC DATA QUALITY OBJECTIVES. The DQOs are to characterize the site, delineate the source of contamination, and determine if contamination has migrated away from the source and, if so, by which pathways. Source characterization and delineation include the following field investigation tasks: geophysical surveys; soil gas surveys; and the collection and analyses of soil, surface water and sediment, ambient air, and groundwater monitoring. Other data will be used to evaluate contaminant migration potential [permeability (slug) tests, surface water and groundwater level data, surface water and sediment sampling and analysis, and ambient air monitoring]. The data to be collected at each site is generally described in the following chapters, which focus on specific DQOs.

2.4.1 Source Area and Volume Characterization Electromagnetic induction (EM) surveys will be conducted at the Operable Unit 1 (Sites 1 and 2). The survey is intended for use as a reconnaissance tool to locate the areal extent of the source at the surface. EM can be used to map local and general changes in the natural hydrogeologic setting by measuring differences in near surface conductivities and can be used to detect and measure boundaries of a conductivity plume.

Ground Penetrating Radar (GPR) surveys are proposed for Sites 3, 5, 17, and 16. GPR is a non-intrusive survey capable of discriminating changes within the soil's micro-horizons. An abrupt profile change represents disturbed soil, which may indicate the edge of a trench or pit. Because GPR has the ability to discriminate small objects, it is often used to find buried objects such as drums.

Soil gas surveys will be used to measure and identify organic vapors in soil pores, indicating contaminant areas. Delineation of the waste or contaminated area by soil gas survey will be used in source volume characterization at Operable Units 2 and 7.

The geophysical and soil gas survey information allows for improved targeting of sample borehole and monitoring well locations.

Samples collected from shallow soil borings and during monitoring well installation at all sites will be field screened using an organic vapor analyzer (OVA) to determine depth of contamination.

The piezocone penetration test (PCPT) is proposed for use at Operable Unit 1 to establish the subsurface soil profile. The PCPT can quickly and efficiently provide subsurface stratigraphic data and also provide quantity and quality data necessary to make important field decisions via instantaneous on-board computer interpretation programs.

2.4.2 Source Contaminant Characterization Soil sample collection and analysis will be conducted to characterize source contaminants. Geologic borehole logs will be used to document physical characteristics (through visual inspection) of collected samples, whereas analytical results will be used to chemically characterize the waste. This sampling and analysis will be conducted at oil and sludge disposal areas and the AIMD seepage pit.

2.4.3 Contaminant Migration Potential The primary objective of the field investigation of the RI/FS is to characterize the nature and extent of contamination such that informed decisions can be made as to the level of risk associated with each site, and the appropriate types of remedial responses. This process involves collecting various onsite data to give a preliminary estimate of the locations of contaminants that may have migrated, and to estimate migration rates and directions.

PCPT and borehole logging will be used to identify subsurface characteristics that may influence contaminant migration. Permeability testing and water table elevation measurements will be conducted for all sites. Surface water elevation and flow measurements will be collected at Sites 1 and 2. Surface water and sediment sampling and sample analysis will be completed at Sites 1, 2, 5 and 16. The potentiometric surface of the secondary artesian aquifer will be measured in the three proposed 120-foot deep wells.

Occupational Health and Safety Administration (OSHA) required ambient air monitoring will be conducted during activities at all sites, as described in the Health and Safety Plan.

2.4.4 Surface Water Characterization Surface water and sediment samples will be analyzed to determine if sites adjacent to streams have had a detrimental effect on surface water quality. Samples will be collected above, adjacent, and downgradient of Sites 1 and 2, along Rowell Creek, also, from the unnamed creek between the sites. Upgradient and downgradient samples will be collected from the unnamed creek adjacent to Site 5. At Site 16, a sample will be collected from the stormwater discharge point located across the runway.

2.4.5 Groundwater Plume Characterization Monitoring well installation and groundwater sampling and analyses will be conducted to characterize any groundwater contaminant plumes. Monitoring wells may be clustered so that water quality in both the upper 10 feet of the surficial aquifer and the lower 10 feet of the surficial aquifer can be characterized. The 16 existing and 34 proposed monitoring wells will be used to measure physical characteristics of groundwater flow, such as direction, velocity, and transmissivity. The information will be examined as part of the investigation of contaminant transport potential.

2.4.6 Operable Units Operable units and the purpose for sample collection will be discussed below.

2.4.6.1 Landfills Source volume characterization for Sites 1 and 2 will be accomplished using EM and PCPT to define the landfill boundaries. The open boreholes, during monitoring well construction, will be monitored using an OVA with PID to detect organic vapors that may be emanating from the buried waste material. Additional monitoring wells will be constructed either to complement existing monitor wells, or in two-well (shallow and deep) clusters. Surface water and sediment samples will be collected from Rowell Creek, upgradient and downgradient of the sites and from the small creek between the sites. Proposed sampling locations (for all media) are shown in Chapter 3. Summaries of the proposed sampling and laboratory analysis are provided in Chapter 4.

2.4.6.2 Oil and Sludge Disposal Areas RI characterization activities will be conducted for Sites 3, 5, and 17. A soil gas survey will be conducted on each site prior to initiation of field sampling to identify the extent of contamination. Soil borings will be constructed within the identified contamination area using a stainless steel bucket auger. Eight borings at Site 3 will be sampled at two intervals; 2.5 to 4.0 bls feet and at the water table. Seven borings at Site 5 will be sampled at three intervals; 0 to 1.5 feet, 2.5 to 4.0 feet and at the water table. If groundwater/leachate is encountered during monitoring well construction, field parameters of pH, specific conductance, and temperature will be measured and recorded. Shallow monitoring wells will also be constructed and sampled around and downgradient of each site. Surface water and sediment samples will be collected adjacent to Site 5. The proposed sampling and laboratory analyses are summarized in Chapters 3 and 4.

2.4.6.3 AIMD Seepage Pit The RI characterization activities for Site 16 will be initiated with a soil gas survey to confirm the location of the contamination and to characterize the source area volume. Ground penetrating radar will be used to locate underground utilities and other subsurface features. Soil borings will be collected in the source area(s) to a depth of 8.0 feet bls using split-spoon sampling techniques, with soil samples collected at two intervals. Shallow monitoring wells will be constructed around the pit for sample collection and to confirm the direction of groundwater flow. A downgradient well will be installed into the lower parts of the surficial aquifer (about 50 feet below land surface [bls]) and another well will be installed into the secondary artesian aquifer (about 120 feet bls). Surface water and sediment samples will be collected at the point of discharge from the drainage ditch. The proposed sampling, field and laboratory activities are summarized in Chapters 3 and 4.

2.4.7 Field and Laboratory Quality Assurance/Quality Control (QA/QC) Objectives Samples will be collected and analyzed to provide both field and laboratory QA/QC. Table 2-3 lists the Navy requirements for QA/QC samples (NEESA, 1988). The types of samples, their purpose, and the number to be collected in the field are discussed below.

QA/QC samples are collected in the field to verify the precision and accuracy of the data. A summary of the estimated number of QA/QC samples by matrix is included as Table 2-4.

The following types of QA/QC samples will be collected in the field.

- Trip blanks are used to identify contaminants introduced to the sample between the time the samples are collected and the time the laboratory analysis is completed. They originate from analyte-free water taken to the sampling site and are returned unopened to the laboratory with the samples undergoing volatile organic analyses (VOAs). One trip blank will accompany each cooler containing VOAs, and should be stored at the laboratory with the samples. Trip blanks are analyzed for VOAs only. For planning purposes, trip blanks were assigned at a frequency of 1 trip blank for every 10 samples for chemical analyses. This is at a rate of 10 wells to be sampled per day. It is estimated a total of 36 trip blanks will be required (see Table 2-4).

Table 2-3
Navy Field Quality Assurance/Quality Control (QA/QC) Requirements

Sampling and Analysis Plan
 NAS Cecil Field
 Jacksonville, Florida

Type of Sample	Level D Data	
	Metal	Organic
Trip blank (for volatiles only)	Not applicable	1 per cooler
Equipment rinsate ¹	1 per day	1 per day
Field blank	1 per source per event for all levels and all an- alytes	1 per source per event for all levels and all analytes
Field duplicates ²	1 in 10	1 in 10

¹ Samples are collected daily; however, only samples from every other day are analyzed. Other samples are held and analyzed only if evidence of contamination exists.

² The duplicate must be taken from the same sample that will become the laboratory matrix/spike duplicate for organics or for the sample used as a duplicate in inorganic analysis.

Table 2-4
Estimated Number of Quality Assurance/Quality Control (QA/QC) Samples by Matrix

Sampling and Analysis Plan
 NAS Cecil Field
 Jacksonville, Florida

	Groundwater	Surface Water	Sediment	Soil Borings	Total
Trip blanks	10	4	4	18	36
Equipment rinsates	21	7	7	36	71
Field blanks	16	7	7	16	46
Field duplicates	16	7	7	37	67
Additional laboratory volumes	20	6	2	0	28
Totals	83	31	27	107	248

- Equipment rinsate blanks are the final analyte-free (ASTM Type II water) water rinse from equipment cleaning collected daily during a sampling event. They are used to detect contaminants that may have been introduced by sampling equipment. Initially, samples from every other day should be analyzed. If analytes pertinent to the project are found in the rinsate, the subsequent equipment rinsate samples must be analyzed on a daily basis. The results from the blanks will be used to flag or assess the levels of analytes in the samples. This comparison is made during data evaluation. The rinsates are analyzed for the same parameter as the related samples. Examples of equipment from which rinsates are required are: augers, bailers, split spoons, pumps, filters, etc. Equipment rinsates were also estimated at a frequency of 1 sample for every 10 samples collected. This is the same frequency as trip blanks. An estimated total of 71 equipment rinsates will be collected and approximately half will be analyzed (see Table 2-4).
- Field blanks consist of the source water used in decontamination and steam cleaning. They are used to detect contaminants that may have been introduced during equipment cleaning. At a minimum, one field blank from each sample matrix per sampling event (Note: a sampling event is from the time sample personnel arrive at the site until personnel leave for more than 24 hours), including each source of water will be collected and analyzed for the same parameters as the samples. A total of 46 field blanks are proposed (see Table 2-4).
- Field duplicates and split-duplicates for groundwater, surface water and sediment, and soil samples will be collected. Soil sample duplicates and splits will be collected and homogenized prior to being split. Samples for VOC analysis will not be homogenized. Select segments of soil are taken from the length of the core and placed in glass vials. Water field duplicates will be collected simultaneously with the original samples. Field duplicates will be collected at a frequency of 1 QA/QC sample for every 10 original samples per sample matrix; 67 samples are estimated (see Table 2-4). These samples will be submitted blindly (i.e., with an alias station number) to the lab for additional QA/QC data evaluation.

The following samples are collected in the field to perform laboratory QA/QC procedures.

- Additional laboratory QA/QC volume samples will be submitted to the laboratory at a frequency of 1 QA/QC sample for every 20 original samples per sample matrix. This allows the lab to perform matrix spike and spike duplicate analyses as part of the laboratory QA/QC procedures. These samples are identified by the same station number as the original sample sent to the lab. An estimated 28 samples will be submitted (see Table 2-4).

"Background" samples are collected and analyzed to document and indicate a historical baseline. In order to have a basis of comparison of site water quality and soil and sediment to background levels, the collection of samples from control stations will be completed. Control samples upgradient from the source of waste are as important as the samples collected downgradient, and were chosen to ensure representative results.

3.0 SAMPLING LOCATIONS AND DESIGNATIONS

The distribution and number of groundwater, surface water and sediment, and soil samples to be collected are listed by site in Table 3-1. The proposed locations for these samples and the designations are identified on Figures 3-1 through 3-5. In addition to this sampling, physical data will be collected for each site to characterize migration pathways and to quantify the contaminant migration potential. These data will include water table elevations (all groundwater monitoring wells), aquifer permeabilities (hydraulic conductivity), and a surface water stage and flow rate (location to be determined). The analytical requirements for each sample submitted to the laboratory are detailed in Chapter 4.

Based on the site contaminant migration pathway modeling and scoping efforts described in the Workplan, the RI groundwater assessments will focus on the surficial aquifer. One well tapping the secondary artesian aquifer will be installed at each operable unit, to ensure that contamination has not migrated into this system. References to "shallow" monitoring wells include monitoring wells designed to intercept the water table surface (i.e., for suspected petroleum product contamination), and monitoring wells screened within the first 5 to 10 feet of the saturated zone (estimated to begin at a depth of 5 to 15 feet below ground surface). References to "deep" monitor wells include wells tapping the bottom 5 to 10 feet of the surficial aquifer (located at estimated depths of 20 to 50+ feet below ground surface). Well location designations include a "D" or an "S" to identify the deep and shallow wells. Wells into the secondary artesian aquifer will be approximately 120 feet bls and will be designated as "DD."

The locations of the groundwater monitoring wells are proposed based on the location of existing wells, the need for a background sampling well, and the need to characterize groundwater flow direction. Data from previous geophysical surveys were also considered and are included and summarized in the Workplan. Where data points are located near surface water, groundwater data will provide an indication of the surface water and shallow groundwater-water recharge and discharge relationships. Final field locations will also be based upon the results of the reconnaissance surveys (geophysical and soil gas) and field conditions.

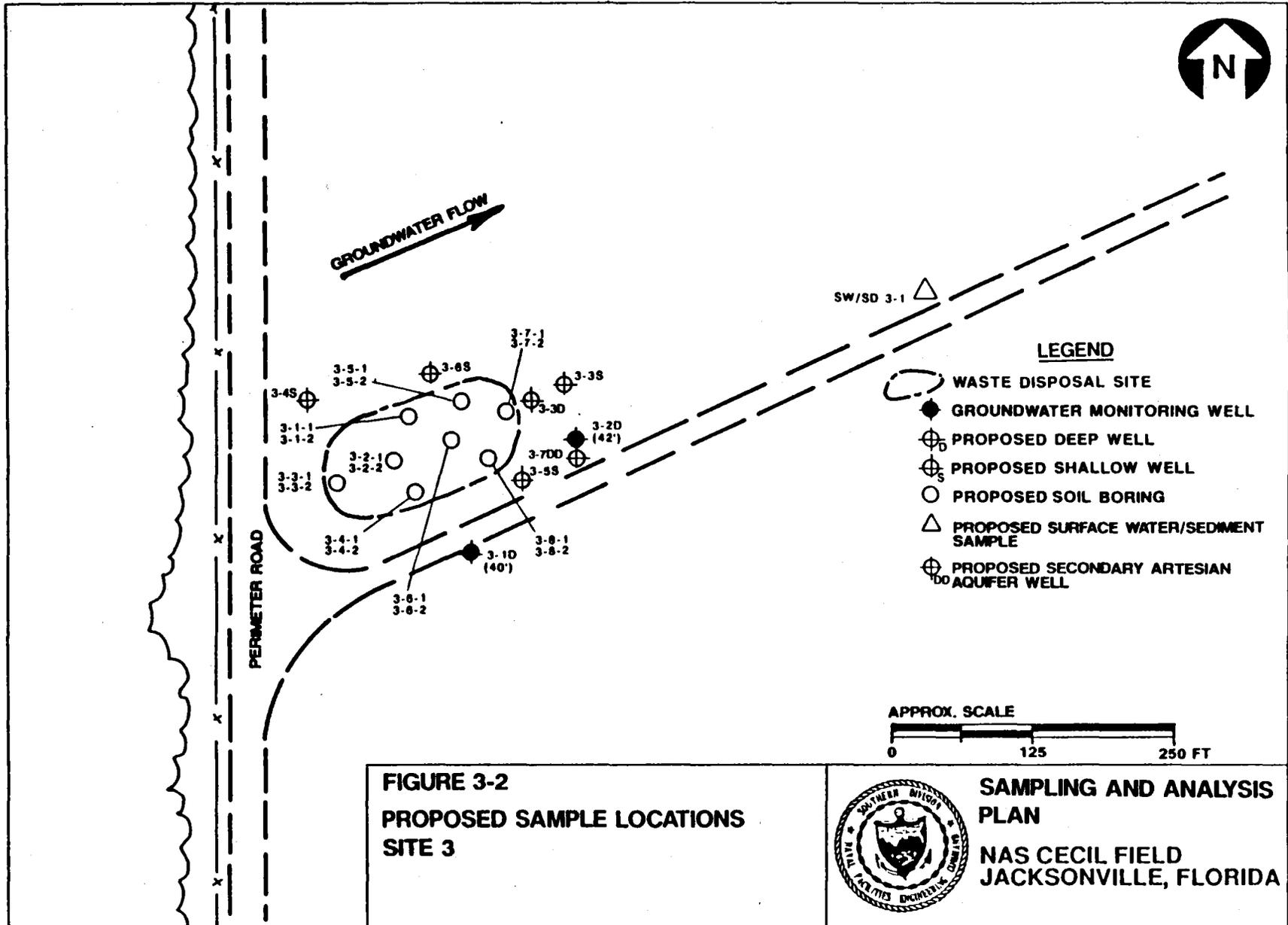
Therefore, the proposed locations on the figures in this document may change in the final report. All borings and well locations will be restored to conditions acceptable to the Navy. However, when trees are cleared it will be difficult to restore the site to original conditions. Stormwater controls and aesthetics design will be included into the remedial plan.

The shallow soil boring sampling for RI assessments is designed to focus on the probable contaminant distribution within the unsaturated zone, based on past disposal practices and site conditions. Specific soil sample locations and sample intervals may be modified based on the results of geophysical surveys to better suit field conditions (i.e., water table elevations).

**Table 3-1
Summary of the Number of Sampling Locations by Site**

Sampling and Analysis Plan
NAS Cecil Field
Jacksonville, Florida

Sampling Location	Existing Wells	Proposed Wells	Total No. of Wells Per Site	Surface Water	Sediment	Borings	Intervals	Soil Gas	Surface Soil
Operable Unit 1									
Site No. 1	4	8	12	4	4	0	0	0	0
Site No. 2	2	6	8	1	1	0	0	0	0
Operable Unit 2									
Site No. 3	2	6	8	0	0	8	18	25	0
Site No. 5	2	4	6	2	2	7	21	25	0
Site No. 17	3	3	6	0	0	3	8	25	0
Operable Unit 7									
Site No. 18	3	7	10	1	1	6	12	25	2
Totals	18	34	60	8	8	24	65	100	2





LEGEND

-  WASTE DISPOSAL SITE
-  GROUNDWATER MONITORING WELL
-  PROPOSED SOIL BORING
-  PROPOSED DEEP WELL
-  PROPOSED SHALLOW WELL
-  PROPOSED SURFACE WATER/
SEDIMENT SAMPLE

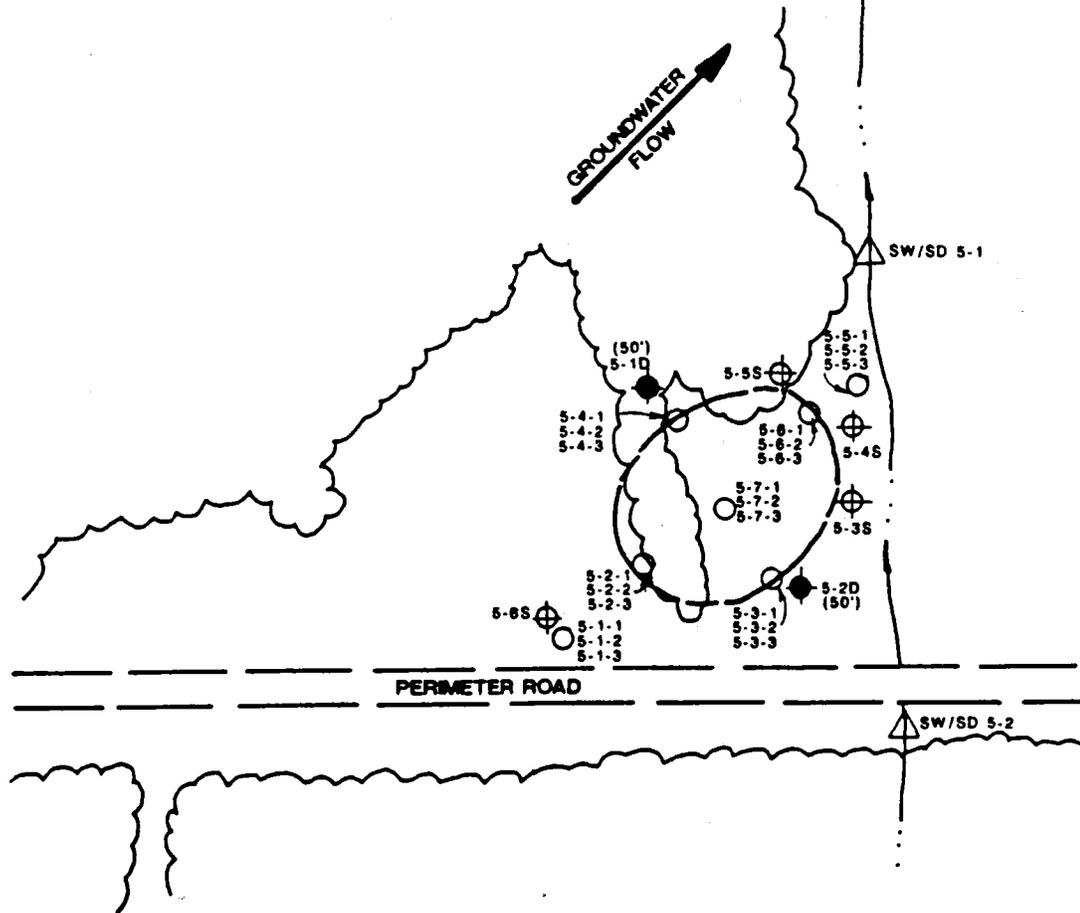


FIGURE 3-3
PROPOSED SAMPLING LOCATIONS
SITE 5



SAMPLING AND ANALYSIS
PLAN
NAS CECIL FIELD
JACKSONVILLE, FLORIDA

- LEGEND**
-  WASTE DISPOSAL SITE
 -  GROUNDWATER MONITORING WELL
 -  PROPOSED SHALLOW WELL
 -  PROPOSED SOIL BORING

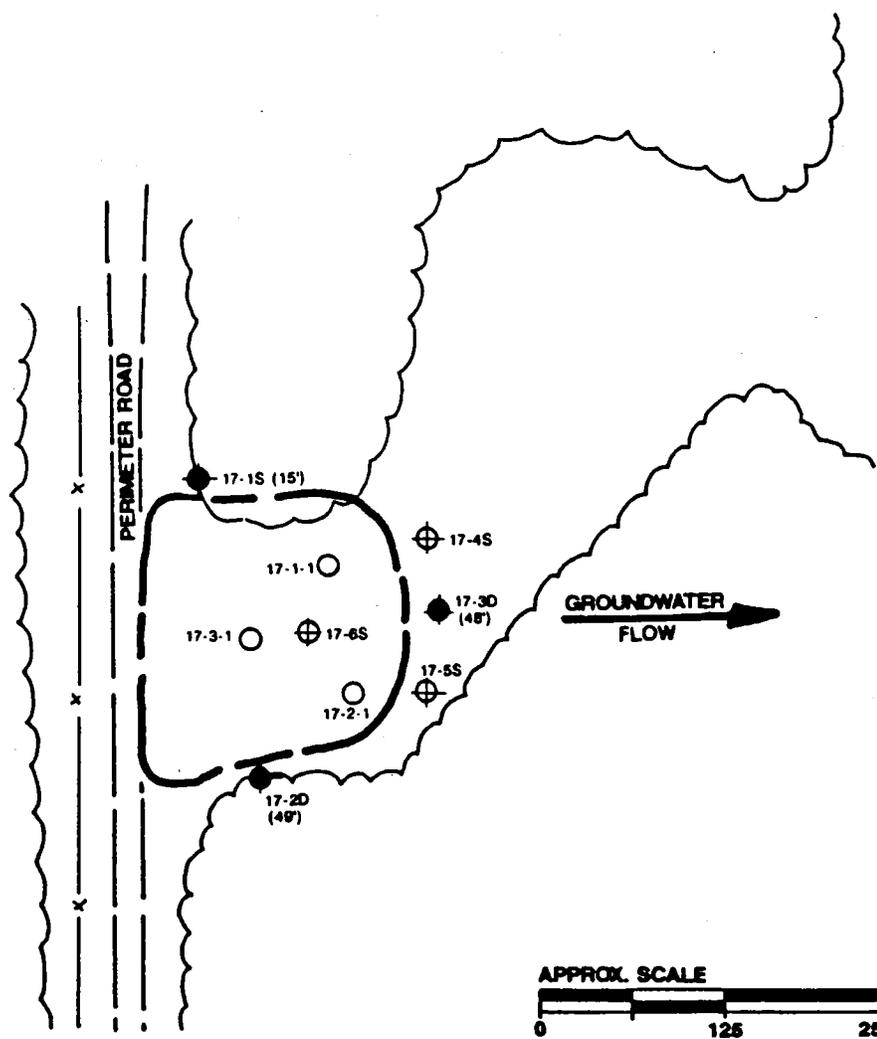
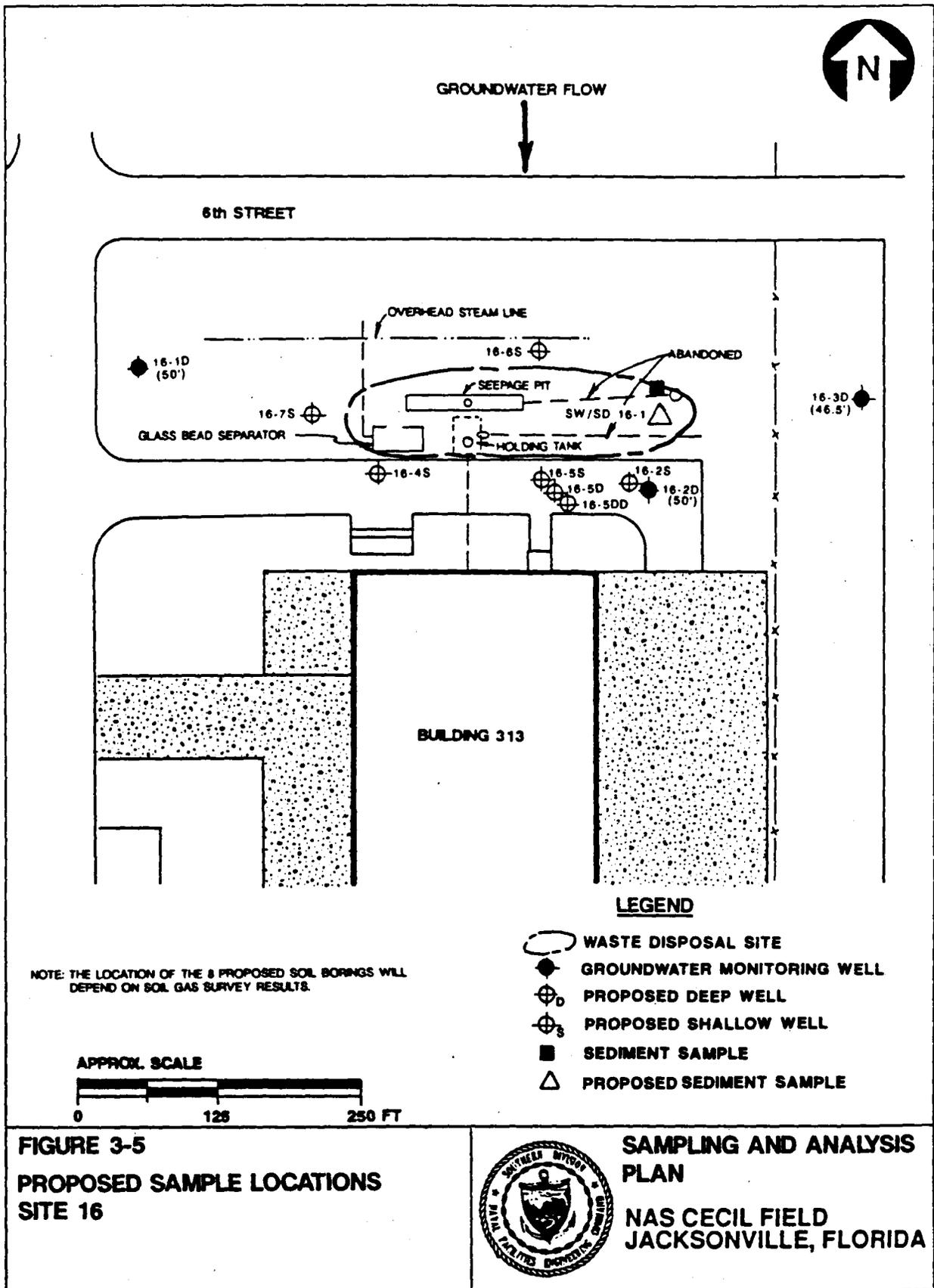


FIGURE 3-4
PROPOSED SAMPLING LOCATIONS
SITE 17



SAMPLING AND ANALYSIS
PLAN
NAS CECIL FIELD
JACKSONVILLE, FLORIDA



The location and number of surface water and sediment samples are identified on Figures 3-1 through 3-5, and totaled in Table 3-1. The locations of sampling points provide information from both background and downgradient of the sites, and points between.

The order of sample collection within each media will begin with suspected "clean" locations (background) and progress to collection of the suspected most contaminated samples. The order of site sampling also progresses from areas suspected to be free of wastes to the suspected most affected areas. Types of wastes disposed and operable units were also considered.

4.0 ANALYTICAL PROGRAM

4.1 ANALYTICAL PARAMETERS. The analytical parameters are proposed based on suspected and identified waste types as discussed in the Workplan. Table 4-1 shows the types of parameters suspected at each operable unit based on previous sampling, known disposal, and the type of site. The suspected parameter groups include:

- metals,
- purgeable halocarbons,
- purgeable aromatics,
- pesticide and polychlorinated biphenyls (PCBs),
- nitroaromatics,
- phenols, and
- extractable organics.

4.2 ANALYTICAL METHODS AND SUMMARIES. Additional analytical methods are proposed based on the above list and knowledge of what was disposed of at the sites. Analytical methods selected are based on the detection levels required for data comparison with the Florida Drinking Water Standards (Part III, Chapter 17-550) and USEPA's maximum contaminant levels (MCL) (EPA, 1988b). Table 4-2 lists the Florida standards in comparison with USEPA's MCL, maximum contaminant level goal (MCLG), proposed MCLG, and practical quantification levels (PQL). The Navy requires that analytical methods either be approved by the USEPA or developed by the Navy (NEESA, 1988). These USEPA methods are provided in Appendix A.

USEPA Contract Laboratory Program (CLP) analytical methods for determining the Target Compound List (TCL) (USEPA, 1988) and Target Analyte List (TAL) parameters (USEPA, 1988) shall be used. Table 4-3 lists the TCL and TAL parameters and the soil and water contract required quantification limits (CRQL).

There are six compounds with CRQL higher than Florida's Primary Drinking Water Standards: benzene, trichloroethene, tetrachlorethene, vinyl chloride, 1,2-dichloroethane, and carbon tetrachloroethane. If any of these compounds are detected in groundwater, but at a concentration that can not be quantified, then the sample will be reanalyzed using USEPA Method 601 or 602. Tables 4-4 through 4-6 list each operable unit, sample location, and the associated analytical requirements.

**Table 4-1
Suspected Contaminants**

Sampling and Analysis Plan
NAS Cecil Field
Jacksonville, Florida

Operable Units	Site	Suspected Contaminant					
		Metals	Purgeable Halocarbons	Purgeable Aromatics	Pesticide and PCBs	Nitro-Aromatics	Phenols
Landfills	1	c	c	c	x	-	-
	2	c	x	c	x	-	-
Oil and Grease Pits	3	c	c	c	s	-	-
	5	c	c	c	c	-	-
	17	c	x	x	s	-	-
AIMD Drainfield	16	c	c	x	-	-	x

¹Sodium cyanide disposed into this pit.

NOTES: c = Identified during previous sampling.
 x = suspected.
 - = not suspected.
 s = suspected due only to its identification at a similar site during a previous sampling event.

**Table 4-2
Florida Drinking Water Standards and USEPA MCL Comparison**

Sampling and Analysis Plan
NAS Cecil Field
Jacksonville, Florida

Contaminants	Florida Drinking Water Standards		U.S. Environmental Protection Agency			
	Primary	Secondary	PQL(a)	MCL(b)	MCLG(c)	Proposed MCLG(d)
Arsenic, total	50	-	10	50	--	50
Barium, total	1,000	--	20	1,000	--	1,500
Cadmium, total	10	--	1	10	--	5
Chromium, total	50	--	10	50	--	120
Fluoride (mg/l)	4	2	--	4/2+	--	--
Lead, total	50	--	10	50	--	20
Mercury, inorganic	2	--	--	2	--	3
Nitrate-N (mg/l)	10	--	--	10	--	10
Selenium, total	10	--	20	10	--	45
Silver, total	50	--	70	50/90+	--	--
Sodium, (mg/l)	160	--	--	--	--	--
Chloride, (mg/l)	--	250	--	250+	--	--
Color (color units)	--	15	--	15+	--	--
Copper, total	--	1,000	60	1,000+	--	1,300
Corrosivity	--	Non-corrosive	--	Non-corrosive	--	--
Foaming agents	--	500	--	500+	--	--
Iron, total	--	300	--	300+	--	--
Manganese, total	--	50	--	50+	--	--
Odor (threshold odor number)	--	3	--	3+	--	--
pH (standard units)	--	6.5-8.5	--	6.5-8.5	--	--
Sulfate, mg/l)	--	250	--	250+	--	--
TDS, (mg/l)	--	500	--	500+	--	--
Zinc, total	--	5,000	20	5,000	--	--
Chlorinated hydrocarbons						
Endrin	.2	--	.1	.2	--	--
Lindane	4	--	5	4	--	--
Methoxychlor	100	--	2	100	--	340
Toxaphene	5	--	2	5	--	0
Chlorophenoxy						
2,4-D	100	--	10	100	--	70
2,4,5 -TP	10	--	2	10	--	52
Total trihalomethanes (sum of bromodichloromethane, dibromochloromethane, tribromomethane (bromoform), and trichloromethane (chloroform))	100	--	1	100(ii)	--	--

Table 4-2 (Continued)
Florida Drinking Water Standards and USEPA MCL Comparison

Sampling and Analysis Plan
 NAS Cecil Field
 Jacksonville, Florida

Contaminants	Florida Drinking Water Standards		U.S. Environmental Protection Agency			
	Primary	Secondary	PQL(a)	MCL(b)	MCLG(c)	Proposed MCLG(d)
Volatile Organics						
Trichloroethene	3	--	1	5	0	--
Tetrachloroethene	3	--	.5	5*	--	0
Carbon tetrachloride	3	--	1	5*	0	--
Vinyl chloride	1	--	2	2*	0	--
1,1,1-trichloroethane	200	--	5	200*	200	--
1,2-dichloroethane	3	--	.5	5*	0	--
Benzene	1	--	2	5*	0	--
Ethylene dibromide	0.2	--	5	--	--	0
p - dichlorobenzene	75	--	2	75*/5 + +	0	--
1,1-dichloroethene	7	--	1	7*	7	--
Microbiological	one per 10 mℓ (avg)	--	--	one per 100 mℓ (avg)	--	--
	four per 1 mℓ (max)	--	--	four per 100 mℓ (max)	--	--
Radionuclides						
Ra-226 and Ra-228 (pCi/ℓ)	5	--	--	5	--	--
Gross alpha (pCi/ℓ)	15	--	--	15	--	--

NOTES: (a) Source 52 FR 25947. Practical quantification limits (PQL) are presented for standard analytical methods. It may be appropriate to use different analytical methods to achieve lower quantification limits in some cases.

(b) 40 CFR 141 and 143.

(c) 40 CFR 141.50.

(d) 50 FR 46938, November 13, 1985.

* MCL (maximum contaminant level) as established in the Federal Register (FR 52 25690), July 8, 1987.

+ Secondary MCL.

+ + Proposed MCL.

MCLG Maximum contaminant level goal.

(i) Based on the standard for total trihalomethanes at 100 µg/ℓ.

µg/ℓ - micrograms per liter avg - average TDS - total dissolved solids pCi/ℓ - picocuries per liter
 mg/ℓ - milligrams per liter max - maximum mℓ - milliliter

Sources: Florida Administrative Codes Part III, Chapter 17-550, Maximum Contaminant Levels for Drinking Water Standards, January 1989, pp. 8-16.

USEPA Guidance on Remedial Actions for Contaminated Groundwater at Superfund Sites, December 1988.

Notes: All units in µg/ℓ except where noted.
 PQL = practical quantitation limits.

**Table 4-3
Target Compound List and Contract Required Quantitation Limits***

Sampling and Analysis Plan
NAS Cecil Field
Jacksonville, Florida

Parameters	Quantitation Limits**	
	Water ($\mu\text{g}/\ell$)	Low Soil/Sediment ($\mu\text{g}/\text{kg}$)
Volatile Organic Chemicals¹		
1. Chloromethane	10	10
2. Bromomethane	10	10
3. Vinyl chloride	10	10
4. Chloroethane	10	10
5. Methylene chloride	5	5
6. Acetone	10	10
7. Carbon disulfide	5	5
8. 1,1-Dichloroethene	5	5
9. 1,1-Dichloroethane	5	5
10. 1,2-Dichloroethene (total)	5	5
11. Chloroform	5	5
12. 1,2-Dichloroethane	5	5
13. 2-Butanone	10	10
14. 1,1,1-Trichloroethane	5	5
15. Carbon tetrachloride	5	5
16. Vinyl acetate	10	10
17. Bromodichloromethane	5	5
18. 1,2-Dichloropropane	5	5
19. cis-1,3-Dichloropropene	5	5
20. Trichloroethene	5	5
21. Dibromochloromethane	5	5
22. 1,1,2-Trichloroethane	5	5
23. Benzene	5	5
24. trans-1,3-Dichloropropene	5	5
25. Bromoform	5	5
26. 4-Methyl-2-pentanone	10	10
27. 2-Hexanone	10	10
28. Tetrachloroethene	5	5
29. Toluene	5	5
30. 1,1,2,2-Tetrachloroethane	5	5
31. Chlorobenzene	5	5
32. Ethyl benzene	5	5
33. Styrene	5	5
34. Xylenes (total)	5	5

Table 4-3 (Continued)
Target Compound List and Contract Required Quantitation Limits*

Sampling and Analysis Plan
 NAS Cecil Field
 Jacksonville, Florida

Parameters	Quantitation Limits**	
	Water ($\mu\text{g}/\ell$)	Low Soil/Sediment ($\mu\text{g}/\text{kg}$)
Semivolatile Organic Chemicals²		
36. bis (2-Chloroethyl) ether	10	330
37. 2-Chlorophenol	10	330
38. 1,3-Dichlorobenzene	10	330
39. 1,4-Dichlorobenzene	10	330
40. Benzyl alcohol	10	330
41. 1,2-Dichlorobenzene	10	330
42. 2-Methylphenol	10	330
43. bis (2-Chloroisopropyl) ether	10	330
44. 4-Methylphenol	10	330
45. N-Nitroso-di-n-dipropylamine	10	330
46. Hexachloroethane	10	330
47. Nitrobenzene	10	330
48. Isophorone	10	330
49. 2-Nitrophenol	10	330
50. 2,4-Dimethylphenol	10	330
51. Benzoic acid	50	1,600
52. bis (2-Chloroethoxy) methane	10	330
53. 2,4-Dichlorophenol	10	330
54. 1,2,4-Trichlorobenzene	10	330
55. Naphthalene	10	330
56. 4-Chloraniline	10	330
57. Hexachlorobutadiene	10	330
58. 4-Chloro-3-methylphenol (para-chloro-meta-cresol)	10	330
59. 2-Methylnaphthalene	10	330
60. Hexachlorocyclopentadiene	10	330
61. 2,4,6-Trichlorophenol	10	330
62. 2,4,5-Trichlorophenol	50	1,600
63. 2-Chloronaphthalene	10	330
64. 2-Nitroaniline	50	1,600
65. Dimethylphthalate	10	330
66. Acenaphthylene	10	330
67. 2,6-Dinitrotoluene	10	330
68. 3-Nitroaniline	50	1,600
69. Acenaphthene	10	330
70. 2,4-Dinitrophenol	50	1,600
71. 4-Nitrophenol	50	1,600
72. Dibenzofuran	10	330
73. 2,4-Dinitrotoluene	10	330
74. Diethylphthalate	10	330
75. 4-Chlorophenyl-phenyl ether	10	330

Table 4-3 (Continued)
Target Compound List and Contract Required Quantitation Limits*

Sampling and Analysis Plan
 NAS Cecil Field
 Jacksonville, Florida

Parameters	Quantitation Limits**	
	Water ($\mu\text{g}/\ell$)	Low Soil/Sediment ($\mu\text{g}/\text{kg}$)
Semivolatile Organic Chemicals (Cont.)		
78. 4,6-Dinitro-2-methylphenol	50	1,600
79. N-nitrosodiphenylamine	10	330
80. 4-Bromophenyl-phenylether	10	330
81. Hexachlorobenzene	10	330
82. Pentachlorophenol	50	1,600
83. Phenanthrene	10	330
84. Anthracene	10	330
85. Di-n-butylphthalate	10	330
86. Fluoranthene	10	330
87. Pyrene	10	330
88. Butylbenzylphthalate	10	330
89. 3,3'-Dichlorobenzidine	20	660
90. Benzo(a)anthracene	10	330
91. Chrysene	10	330
92. bis (2-Ethylhexyl)phthalate	10	330
93. Di-n-octylphthalate	10	330
94. Benzo(b)fluoranthene	10	330
95. Benzo(k)fluoranthene	10	330
96. Benzo(a)pyrene	10	330
97. Indeno (1,2,3-cd)pyrene	10	330
98. Dibenz(a,h)anthracene	10	330
99. Benzo(g,h,i)perylene	10	330

**Table 4-3 (Continued)
Target Compound List and Contract Required Quantitation Limits***

Sampling and Analysis Plan
NAS Cecil Field
Jacksonville, Florida

Parameters	Quantitation Limits**	
	Water ($\mu\text{g}/\ell$)	Low Soil/Sediment ($\mu\text{g}/\text{kg}$)
Pesticides and Polychlorinated Biphenyls³		
100. alpha-BHC	0.05	8.0
101. beta-BHC	0.05	8.0
102. delta-BHC	0.05	8.0
103. gamma-BHC (Lindane)	0.05	8.0
104. Heptachlor	0.05	8.0
105. Aldrin	0.05	8.0
106. Heptachlor epoxide	0.05	8.0
107. Endosulfan I	0.05	8.0
108. Dieldrin	0.10	16.0
109. 4,4'-DDE	0.10	16.0
110. Endrin	0.10	16.0
111. Endosulfan II	0.10	16.0
112. 4,4'-DDD	0.10	16.0
113. Endosulfan sulfate	0.10	16.0
114. 4,4'-DDT	0.10	16.0
115. Methoxychlor	0.5	80.0
116. Endrin ketone	0.10	16.0
117. alpha-Chlordane	0.5	80.0
118. gamma-Chlordane	0.5	80.0
119. Toxaphene	1.0	160.0
120. Aroclor-1016	0.5	80.0
121. Aroclor-1221	0.5	80.0
122. Aroclor-1232	0.5	80.0
123. Aroclor-1242	0.5	80.0
124. Aroclor-1248	0.5	80.0
125. Aroclor-1254	1.0	160.0
126. Aroclor-1260	1.0	160.0

Table 4-3 (Continued)
Target Analyte List (TCL) and Contract Required Quantitation Limits*

Sampling and Analysis Plan
 NAS Cecil Field
 Jacksonville, Florida

Component	Quantitation Limits**	
	Water ($\mu\text{g}/\ell$)	Soil (mg/kg)
Arsenic	10	20
Lead	3	0.6
Selenium	5	1.0
Thallium	10	2.0
Aluminum	200	40
Antimony	60	12
Barium	200	40
Beryllium	5	1.0
Calcium	5,000	1,000
Cadmium	5	1.0
Chromium	10	2.0
Cobalt	50	10
Copper	25	5.0
Iron	100	20
Lead	100	2.0
Magnesium	5,000	1,000
Managanese	15	3.0
Nickel	40	8.0
Potassium	5,000	1,000
Silver	10	2.0
Sodium	5,000	1,000
Vanadium	50	10
Zinc	20	4.0
Mercury	0.2	0.02
Cyanide	10	1.0

¹Medium soil/sediment contract required quantitation limits (CRQL) for volatile TCL compounds are 125 times the individual low soil/sediment CRQL.

²Medium soil/sediment contract required quantitation limits (CRQL) for semivolatile TCL compounds are 60 times the individual low soil/sediment CRQL.

³Medium soil/sediment contract required quantitation limits for pesticide/PCB TCL compounds are 15 times the individual low soil/sediment CRQL.

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

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

Table 4-4
Summary of Proposed Site Investigations and Sample Analytical Requirements
For Operable Unit 1

Sampling and Analysis
 NAS Cecil Field
 Jacksonville, Florida

Well ID	Environmental Matrix	Sample Interval (BLS)	A	B	C	D	E	F
CEF 1-1S	Groundwater	10-15	A	B	C	D	E	
CEF 1-2D	Groundwater	5-40	A					F
CEF 1-3D	Groundwater	6.5-46	A					F
CEF 1-4S	Groundwater	5-18	A	B	C	D	E	
CEF 1-1D	Groundwater	~40	A	B	C	D	E	
CEF 1-2S	Groundwater	~15	A	B	C	D	E	
CEF 1-3S	Groundwater	~15	A	B	C	D	E	
CEF 1-4D	Groundwater	~40	A	B	C	D	E	
CEF 1-5S	Groundwater	~15	A	B	C	D	E	
CEF 1-5D	Groundwater	~40	A	B	C	D	E	
CEF 1-6S	Groundwater	~15	A	B	C	D	E	
CEF 1-7DD	Groundwater	~120	A	B	C	D	E	
SW 1-4	Surface water		A	B	C	D	E	
SW 1-5	Surface water		A	B	C	D	E	
SW 1-6	Surface water		A	B	C	D	E	
SW 1-7	Surface water		A	B	C	D	E	
SD 1-4	Sediment			B	C	D	E	
SD 1-5	Sediment			B	C	D	E	
SD 1-6	Sediment			B	C	D	E	
SD 1-7	Sediment			B	C	D	E	
CEF 2-1S	Groundwater	4.5-22	A	B	C	D	E	
CEF 2-2D	Groundwater	7.5-34	A					F
CEF 2-1D	Groundwater	~40	A	B	C	D	E	
CEF 2-2S	Groundwater	~15	A	B	C	D	E	
CEF 2-3S	Groundwater	~15	A	B	C	D	E	
CEF 2-3D	Groundwater	~40	A	B	C	D	E	
CEF 2-4S	Groundwater	~15	A	B	C	D	E	

Table 4-4 (Continued)
Summary of Proposed Site Investigations and Sample Analytical Requirements
For Operable Unit 1

Sampling and Analysis
 NAS Cecil Field
 Jacksonville, Florida

Well ID	Environmental Matrix	Sample Interval (BLS)	A	B	C	D	E	F
CEF 2-5S	Groundwater	~15	A	B	C	D	E	
SW 2-7	Surface water		A	B	C	D	E	
SD 2-7	Sediment		A	B	C	D	E	

Notes: A = Field pH, temperature, and specific conductance.
 B = Target compound list for volatiles.
 C = Target compound list for semivolatiles.
 D = Target analyte list for metals.
 E = Cyanide.
 F = Water levels only.

**Table 4-5
Summary of Proposed Site Investigations and Sample Analytical Requirements
For Operable Unit 2**

Sampling and Analysis Plan
NAS Cecil Field
Jacksonville, Florida

Well ID	Environmental Matrix	Sample Interval (BLS)	A	B	C	D	E	F
CEF 3-1D	Groundwater	10-40	A					F
CEF 3-2D	Groundwater	7-42	A					F
CEF 3-3S	Groundwater	~15	A	B	C	D	E	
CEF 3-3D	Groundwater	~40	A	B	C	D	E	
CEF 3-4S	Groundwater	~15	A	B	C	D	E	
CEF 3-5S	Groundwater	~15	A	B	C	D	E	
CEF 3-6S	Groundwater	~15	A	B	C	D	E	
CEF 3-7DD	Groundwater	~120	A	B	C	D	E	
BOR 3-1-1	Soil	1.5-4.0		B	C	D	E	
BOR 3-1-2	Soil	4.0-GW		B	C	D	E	
BOR 3-2-1	Soil	1.5-4.0		B	C	D	E	
BOR 3-2-2	Soil	4.0-GW		B	C	D	E	
BOR 3-3-1	Soil	1.5-4.0		B	C	D	E	
BOR 3-3-2	Soil	4.0-GW		B	C	D	E	
BOR 3-4-1	Soil	1.5-4.0		B	C	D	E	
BOR 3-4-2	Soil	4.0-GW		B	C	D	E	
BOR 3-5-1	Soil	1.5-4.0		B	C	D	E	
BOR 3-5-2	Soil	4.0-GW		B	C	D	E	
BOR 3-6-1	Soil	1.5-4.0		B	C	D	E	
BOR 3-6-2	Soil	4.0-GW		B	C	D	E	
BOR 3-7-1	Soil	1.5-4.0		B	C	D	E	
BOR 3-7-2	Soil	4.0-GW		B	C	D	E	
BOR 3-8-1	Soil	1.5-4.0		B	C	D	E	
BOR 3-8-2	Soil	4.0-GW		B	C	D	E	

Table 4-5 (Continued)
Summary of Proposed Site Investigations and Sample Analytical Requirements
For Operable Unit 2

Sampling and Analysis Plan
 NAS Cecil Field
 Jacksonville, Florida

Well ID	Environmental Matrix	Sample Interval (BLS)	A	B	C	D	E	F
CEF 5-1D	Groundwater	7-50	A					F
CEF 5-2D	Groundwater	7-50	A					F
CEF 5-3S	Groundwater	~15	A	B	C	D	E	
CEF 5-4S	Groundwater	~15	A	B	C	D	E	
CEF 5-5S	Groundwater	~15	A	B	C	D	E	
CEF 5-6S	Groundwater	~15	A	B	C	D	E	
SW 5-1	Surface Water		A	B	C	D	E	
SW 5-2	Surface water		A	B	C	D	E	
SD 5-1	Sediment			B	C	D	E	
SD 5-2	Sediment			B	C	D	E	
BOR 5-1-1	Soil	0-1.5		B	C	D	E	
BOR 5-1-2	Soil	2.5-4.0		B	C	D	E	
BOR 5-1-3	Soil	GW		B	C	D	E	
BOR 5-2-1	Soil	0-1.5		B	C	D	E	
BOR 5-2-2	Soil	2.5-4.0		B	C	D	E	
BOR 5-2-3	Soil	GW		B	C	D	E	
BOR 5-3-1	Soil	0-1.5		B	C	D	E	
BOR 5-3-2	Soil	2.5-4.0		B	C	D	E	
BOR 5-3-3	Soil	GW		B	C	D	E	
BOR 5-4-1	Soil	0-1.5		B	C	D	E	
BOR 5-4-2	Soil	2.5-4.0		B	C	D	E	
BOR 5-4-3	Soil	GW		B	C	D	E	
BOR 5-5-1	Soil	0-1.5		B	C	D	E	
BOR 5-5-2	Soil	2.5-4.0		B	C	D	E	
BOR 5-5-3	Soil	GW		B	C	D	E	
BOR 5-6-1	Soil	0-1.5		B	C	D	E	
BOR 5-6-2	Soil	2.5-4.0		B	C	D	E	

Table 4-5 (Continued)
Summary of Proposed Site Investigations and Sample Analytical Requirements
For Operable Unit 2

Sampling and Analysis Plan
 NAS Cecil Field
 Jacksonville, Florida

Well ID	Environmental Matrix	Sample Interval (BLS)	A	B	C	D	E	F
BOR 5-6-3	Soil	GW		B	C	D	E	
BOR 5-7-1	Soil	0-1.5		B	C	D	E	
BOR 5-7-2	Soil	2.5-4.0		B	C	D	E	
BOR 5-7-3	Soil	GW		B	C	D	E	
CEF 17-1S	Groundwater	10-15	A	B	C	D	E	
CEF 17-2D	Groundwater	6-49	A					F
CEF 17-3D	Groundwater	3.5-48	A					F
CEF 17-4S	Groundwater	~15	A	B	C	D	E	
CEF 17-5S	Groundwater	~15	A	B	C	D	E	
CEF 17-6S	Groundwater	~15	A	B	C	D	E	
BOR 17-1-1	Soil	0-1.5		B	C	D	E	
BOR 17-1-2	Soil	2.5-4.0		B	C	D	E	
BOR 17-2-1	Soil	0-1.5		B	C	D	E	
BOR 17-2-2	Soil	2.5-4.0		B	C	D	E	
BOR 17-3-1	Soil	0-1.5		B	C	D	E	
BOR 17-3-2	Soil	2.5-4.0		B	C	D	E	

Notes: A = Field pH, temperature, and specific conductance.
 B = Target compound list for volatiles.
 C = Target compound list for semivolatiles.
 D = Target analyte list for metals.
 E = Cyanide.
 F = Water levels only.

**Table 4-6
Summary of Proposed Site Investigations and Sample Analytical Requirements
For Operable Unit 7**

RI/FS Workplan
NAS Cecil Field
Jacksonville, Florida

Well ID	Environmental Matrix	Screened Interval (BLS)	A	B	C	D	E	F
CEF 16-1D	Groundwater	6-50						F
CEF 16-2D	Groundwater	6.5-50						F
CEF 16-3D	Groundwater	7-46.5						F
CEF 16-2S	Groundwater	~ 15	A	B	C	D	E	
CEF 16-4S	Groundwater	~ 15	A	B	C	D	E	
CEF 16-5S	Groundwater	~ 15	A	B	C	D	E	
CEF 16-5D	Groundwater	~ 40	A	B	C	D	E	
CEF 16-5DD	Groundwater	~ 120	A	B	C	D	E	
CEF 16-6S	Groundwater	~ 15	A	B	C	D	E	
CEF 16-7S	Groundwater	~ 15	A	B	C	D	E	
				B	C	D	E	
SW 16-1	Surface water		A	B	C	D	E	
SD 16-1	Sediment			B	C	D	E	
BOR 16-1-1	Soil	4.5-6.0		B	C	D	E	
BOR 16-1-2	Soil	GW		B	C	D	E	
BOR 16-2-1	Soil	4.5-6.0		B	C	D	E	
BOR 16-2-2	Soil	GW		B	C	D	E	
BOR 16-3-1	Soil	4.5-6.0		B	C	D	E	
BOR 16-3-2	Soil	GW		B	C	D	E	
BOR 16-4-1	Soil	4.5-6.0		B	C	D	E	
BOR 16-4-2	Soil	GW		B	C	D	E	
BOR 16-5-1	Soil	4.5-6.0		B	C	D	E	
BOR 16-5-2	Soil	GW		B	C	D	E	
BOR 16-6-1	Soil	4.5-6.0		B	C	D	E	
BOR 16-6-2	Soil	GW		B	C	D	E	

Table 4-6 (Continued)
Summary of Proposed Site Investigations and Sample Analytical Requirements
For Operable Unit 7

RI/FS Workplan
 NAS Cecil Field
 Jacksonville, Florida

Well ID	Environmental Matrix	Screened Interval (BLS)	A	B	C	D	E	F
BOR 16-7-1	Soil	1.0-2.0		B	C	D	E	
BOR 16-8-1	Soil	1.0-2.0		B	C	D	E	

- Notes:
- A = Field pH, temperature, and specific conductance.
 - B = Target compound list for volatiles.
 - C = Target compound list for semivolatiles.
 - D = Target analyte list for metals.
 - E = Cyanide.
 - F = Water levels only.

5.0 SAMPLING EQUIPMENT AND PROCEDURES

5.1 GENERAL. Sampling procedures for each sample matrix are outlined in this chapter. The purpose of this chapter is to provide the field personnel Standard Operating Procedures (SOPs) to perform the work. Appendix B includes SOPs of the field instruments (i.e., calibration procedures, trouble shooting, etc.). The following documents were used to compile the information in this chapter.

- USEPA, February 1, 1991, "Standard Operating Procedures and Quality Assurance Manual":, USEPA Region IV.
- USEPA, December 1987, "A Compendium of Superfund Field Operations Methods": USEPA/540/P-87/001.
- NEESA, June 1988, "Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program.

5.2 MONITORING WELL INSTALLATION AND DEVELOPMENT.

5.2.1 Hollow-Stem Auger Drilling Procedures Drilling locations will be marked by the field hydrogeologist. The proposed drilling sites are identified at the locations shown on Figures 3-1 through 3-5. Physical site access, field conditions, or the results of geophysical surveys, may alter their location. Utilities, both underground and above ground, will be located prior to drilling. The Navy will assist in facilitating utility clearance and drill site location selection.

Drilling will be conducted with a truck-mounted or track-mounted hollow-stem auger rig equipped with split-spoon samplers if the site hydrogeologist needs to collect a sample for physical examination and OVA or PID readings. All information will be documented in a field logbook. The logbook will contain the following information:

- borehole number and location;
- description of soils and subsurface conditions;
- type of drilling equipment, driller, and drilling company;
- type and size of well screen;
- depth to well screen;
- drilling and sampling times;
- depth to water table, date and time measured, and measuring point;
- type of samples taken and time and depths taken;
- volume of water purged and calculations;
- type of sampling equipment and/or cleaning procedures; and
- daily signatures by field personnel.

5.2.2 Permanent Monitoring Well Installation Permanent monitoring wells will be drilled using hollow stem auger techniques. Monitoring wells drilled into the secondary artesian aquifer will be double cased to the confining layer. Double casing will help prevent cross-contamination between contaminated and noncontaminated zones. Mud rotary drilling may be necessary during the drilling of wells into the secondary artesian aquifer. Navy guidelines will be adhered to with additional information from the USEPA Region IV guidelines for monitoring

well installation (NEESA, 1988; USEPA, 1986). Chapter 5.11 includes the decontamination procedures for drilling equipment.

5.2.2.1 Monitoring Well Materials and Construction Casings with well screens appropriate for the formation encountered will be installed in unconsolidated soils to prevent soil and other foreign material from entering the well during pumping and sampling. The space surrounding the screen will be filter packed (Sub-paragraph 5.2.2.4) by means of a tremie pipe to ensure accurate placement. The remainder of the space surrounding the casing above the filter pack will be sealed with bentonite and then a cement/bentonite (2-5 percent) grout to the ground surface. The bentonite seal will be allowed to hydrate the time period specified by the manufacturer. Two inch inner diameter (ID) casing will be used for the monitoring wells. The field hydrogeologist, in coordination with the Navy, will determine which deep wells will require 4-inch I.D. casing. Schedule 40 PVC casing and screens with flush-threaded joints will be installed. Appendix D contains justification for use of PVC well construction materials. The screen will be No. 10 slot and will be in 5 foot section lengths. Screen length is based on previous well installations and may vary based on site-specific geology. Both casing and screen will be properly decontaminated prior to installation (Paragraph 5.11).

5.2.2.2 End Plugs and Well Caps The end plug and well cap will be flush threaded, Schedule 40 polyvinyl chloride (PVC). Markings, writing, or paint strips are not allowed on any of the materials.

5.2.2.3 Filter Pack Filter pack will be No. 1 standard, 98-percent pure silica, cleaned with potable water, and will have a uniformity coefficient of 1 to 3 and a specific gravity of 2.6 to 2.7. The size of the filter pack will be No. 6 to 20 grade unless otherwise noted in the field. Bentonite pellets will be 90-percent montmorillonite clay, 1/4-inch in diameter, with a bulk dry density of 80 pounds per cubic foot, and will have a specific gravity of 1.2 and a pH of 8.5 to 10.5. Portland cement Type I containing 2 to 5 percent bentonite will be used for the grout.

5.2.2.4 Surface Casing. A locking, 16-gauge steel protective well cover, approximately 5 feet in total length, will be installed. The padlocks will be brass, corrosion resistant, and keyed alike. The concrete surface pad will be 3 feet by 4 feet by 6 inches according to ASTM C 150. Two 3/16-inch weep holes will be drilled into the protective well cover above the concrete surface pad. A protective steel post (2-inch diameter, 6-foot length, 1/4-inch thickness, and concrete filled) will be installed near the well. The casing will be painted with high visibility yellow epoxy paint AASHTO M220. A well designation sign of sheet aluminum, 1/8 inch by 18 inches by 6 inches, will be stamped with the well designation in 4-inch letters and numbers.

5.2.3 Well Development Well development will begin no sooner than 24 hours, but no later than 48 hours after placement of the grout. Wells are developed by excessive pumping. The development process will result in wells that are relatively clean and as sediment free as possible. Periodic readings (every 5 minutes) of groundwater pH, temperature, and specific conductance will be obtained during development. Stabilization of these parameters and sediment-free water indicate proper development.

5.2.4 Lithologic Logs and Well Completion Diagrams Figures 5-1, 5-2, and 5-3 show the Navy's requirements for lithologic logs and well completion diagrams. These will be completed by the field hydrogeologist. Figure 5-4 shows the planned well construction diagram to be used for this site.

Lithologic samples will be collected every 5 feet (a minimum of three samples per site) and archived for future reference.

5.3 AQUIFER TESTING. Slug tests will be conducted at three monitoring wells per operable unit. The procedure for conducting a rising head slug test is detailed in Attachment 2 in Appendix C.

5.4 GROUNDWATER SAMPLING.

5.4.1 Water Level Measurement Prior to purging a well for sampling, water level and total well depth readings will be taken from the top of casing (TOC). This measuring point will be located consistently on each well from permanently established reference marks. The reference point will be the north side of the well casing if possible and documented in field records. The measurement from the TOC to ground level will also be recorded. All water levels will be made and recorded to the nearest 0.01 foot.

Water level measurements will be made using either a stainless steel tape or electrical water level indicator. The electrical water level indicator consists of a spool of dual conductor wire, a probe attached to the end, and an indicator. When the probe comes in contact with the water, the circuit is closed and a meter light and/or buzzer attached to the spool will signal the contact. Either piece of equipment used will be decontaminated between wells.

At wells where an oily layer is present, an oil-water interface probe will be used. The top of the oil level can be determined and also the thickness of the oil by then determining the top of water. These wells should be sampled last to avoid possible cross-contamination of the equipment. Section 5.9 details the specifics of survey information related to water level measurements.

All devices used to measure groundwater levels will be calibrated against the Invar™ steel surveyor's chain. These devices will be calibrated to 0.01 foot per 10-foot length. Before each use, these devices will be prepared according to the manufacturer's instructions (if applicable) and checked for obvious damage.

All equipment entering the monitoring wells will be decontaminated onsite.

5.4.2 Purging Wells will be purged before taking samples in order to clear the well of stagnant water that has been standing in the well casing and may not be representative of aquifer conditions. Wells will be purged until three to five times the volume of standing water in the well have been removed and until the pH, temperature, and specific conductance measurements of the groundwater being developed stabilize. If a well is pumped dry, this constitutes an adequate purge and the well can be sampled following the recovery.

TITLE:		LOG of WELL:		BORING NO.					
CLIENT:				PROJECT NO:					
CONTRACTOR:			DATE STARTED:		COMPLTD:				
METHOD:		CASE SIZE:	BORE DIA:	PROTECTION LEVEL:					
TOC ELEV.: FT.		MONITOR INST.:	TOT DPTH:FT.	DPTH TO $\frac{3}{8}$ FT.					
LOGGED BY:		WELL DEVELOPMENT DATE:			SITE:				
DEPTH FT.	LABORATORY SAMPLE ID.	SAMPLE	RECOVERY	HEADSPACE (open)	SOIL/ROCK DESCRIPTION	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
5									
10									
15									
20									
25									
30									

PAGE 1 of SAMPLE ABB ENVIRONMENTAL SERVICES, INC.

**FIGURE 5-1
GROUNDWATER MONITORING WELL
INSTALLATION REPORT**



**SAMPLING AND ANALYSIS
PLAN**

**NAS CECIL FIELD
JACKSONVILLE, FLORIDA**

DEPARTMENT OF THE NAVY

SOUTHERN DIVISION

NAVAL FACILITIES ENGINEERING COMMAND

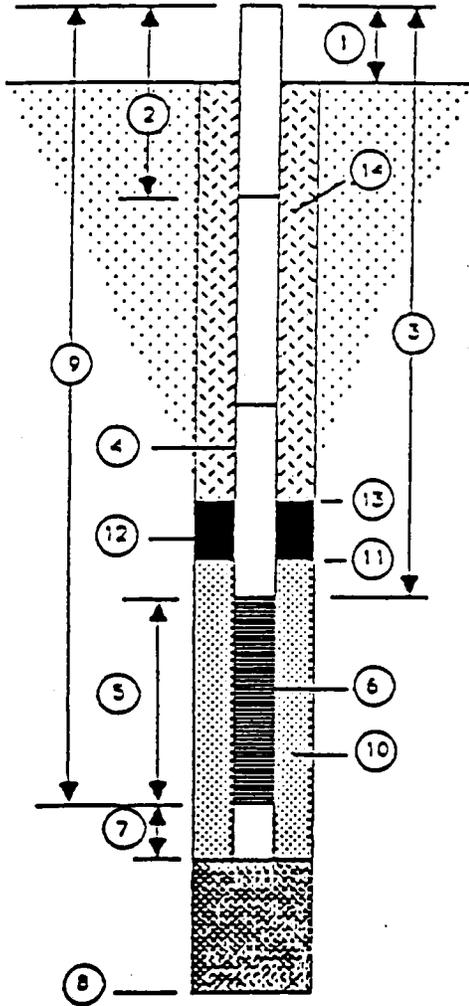
2155 EAGLE DR., P. O. BOX 10068

CHARLESTON, S. C. 29411 - 0068

WELL CONSTRUCTION DETAILS

WELL NUMBER _____

DATE OF INSTALLATION _____



1. Height of Casing above ground _____
2. Depth to first Coupling _____
Coupling interval Depths _____
3. Total Length of Blank Pipe _____
4. Type of Blank Pipe _____
5. Length of Screen _____
6. Type of Screen _____
7. Length of Sump _____
8. Total Depth of Boring _____ Hole Diameter _____
9. Depth to Bottom of Screen _____
10. Type of Screen Filter _____
Quantity Used _____ Size _____ U/C _____
11. Depth To Top of Filter _____
12. Type of Seal _____
Quantity Used _____
13. Depth To Top of Seal _____
14. Type of Grout _____
Grout Mixture _____
Method of Placement _____

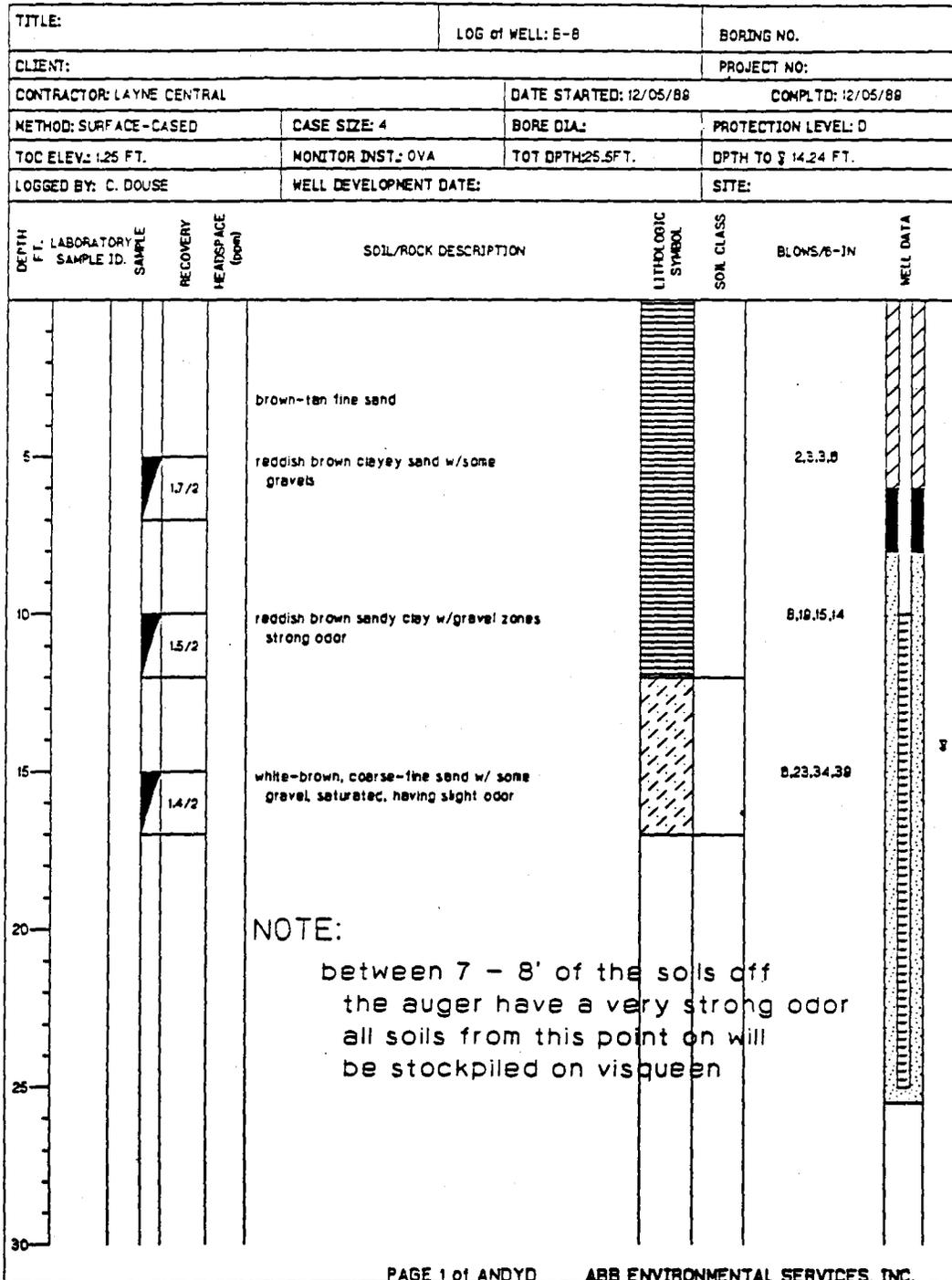
FIGURE 5-2

WELL CONSTRUCTION DETAILS



SAMPLING AND ANALYSIS PLAN

NAS CECIL FIELD
JACKSONVILLE, FLORIDA



**FIGURE 5-3
GROUNDWATER MONITORING WELL
INSTALLATION REPORT (EXAMPLE)**



**SAMPLING AND ANALYSIS
PLAN
NAS CECIL FIELD
JACKSONVILLE, FLORIDA**

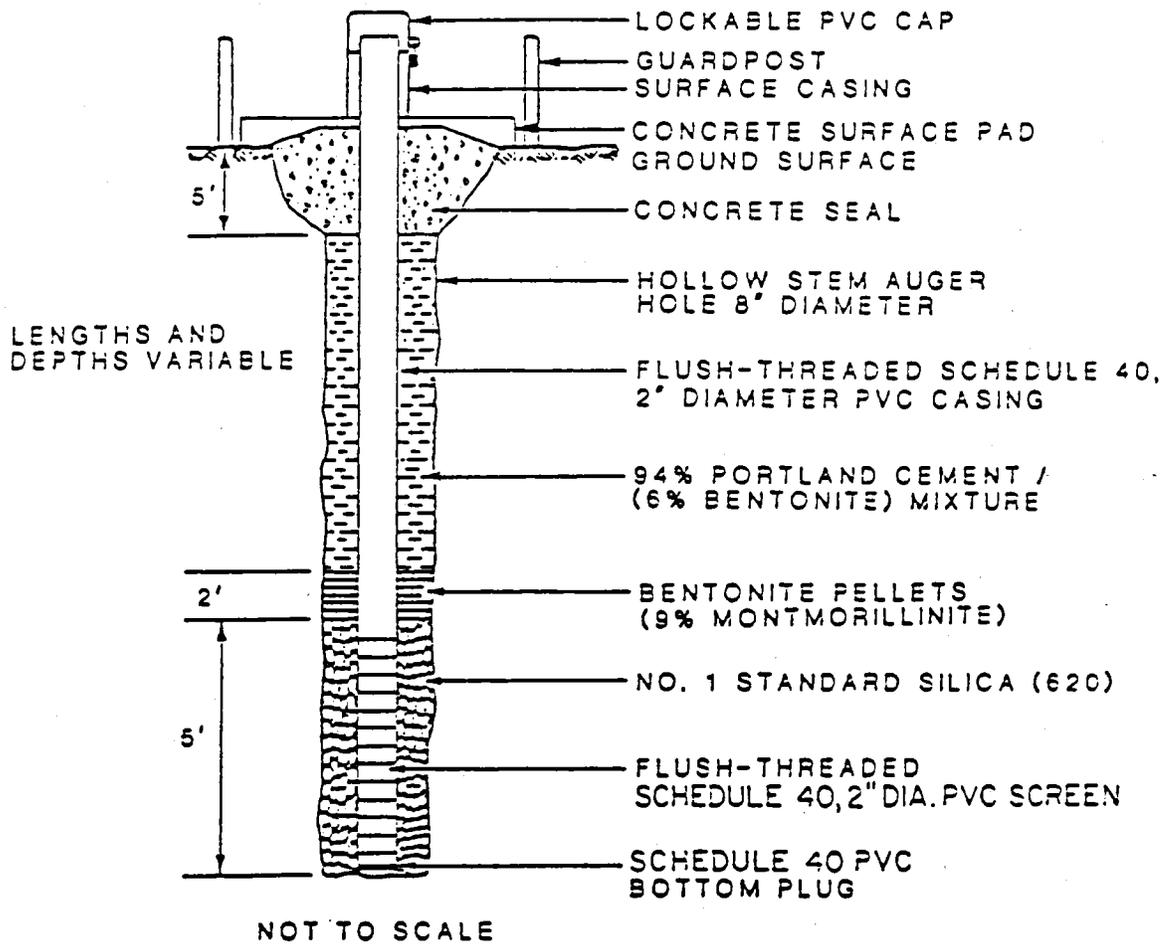


FIGURE 5-4

**TYPICAL GROUNDWATER
MONITORING WELL**



**SAMPLING AND ANALYSIS
PLAN**

**NAS CECIL FIELD
JACKSONVILLE, FLORIDA**

The wells will either be purged with a bailer or a pump. Standard, decontaminated, stainless steel or Teflon™ bailers with new nylon rope will be lowered into the top of the water column, allowed to fill, and then removed. The purged water will be discarded onsite. A centrifugal pump will be used to purge the higher producing wells. Only the intake line will be placed into the water column.

In order to purge wells, the volume of water in the well will be calculated. To determine the volume, the following method will be used: measure the distance from the bottom of the well to the static water level, then measure the inside diameter of the well or casing. Obtain the volume of the well by the formula:

$$v = 3.1416 r^2 h \quad (1)$$

where v = volume of water in cubic feet,
 r = radius of well in feet, and
 h = depth of water column in feet.

To convert to gallons, multiply v by 7.48 gallons per cubic foot.

The pumping rate of a pump during well development will be determined by collecting the flow of water from the pump in a bucket of known volume and measuring the time it takes to fill the bucket. The result will be flow rate in gallons per minute.

5.4.3 Sample Collection Procedures Tables 4-4 through and 4-6 list the existing and proposed monitoring wells to be sampled and the required analyses. Some of the existing wells will only have water levels measured. Following purging, samples will be collected using a closed-top Teflon™ bailer. Samples for volatile organic compounds will be collected using a closed-top bottom discharging Teflon™ bailer. VOA samples will be collected first, extractables next, then all pesticides and PCBs (including herbicides, fungicides, and fumigants), metals, cyanide, and total recoverable petroleum hydrocarbons (TRPH). All samples will be placed in coolers out of the sun and iced as soon as possible after collection. All equipment will be decontaminated prior to the sampling of each well (Section 5.11). When bailing, new foil or plastic sheeting will be placed on the ground around each well to prevent contamination of sampling equipment during bailing in the event any equipment is dropped or otherwise comes in contact with the ground. The closed top Teflon™ bailer will have a leader of Teflon™ coated wire on which braided nylon cord will be affixed and used to raise and lower the bailer into the well without contacting the groundwater with the nylon cord. The nylon cord will be discarded between wells.

Metals samples will be preserved with nitric acid (HNO_3) to a pH of less than 2. The cyanide samples will be preserved with sodium hydroxide (NaOH) to a pH of greater than 12. The phenols and cresols are preserved with sulfuric acid (H_2SO_4) to a pH of less than 2 (see Table 5-1). All samples requiring preservation will be preserved and the pH will be measured in the field.

5.4.4 Quality Assurance/Quality Control (QA/QC) The Quality Assurance/Quality Control (QA/QC) organization is depicted in Figure 5-5. The field operations header is responsible for ensuring that all field procedures comply with standard

Table 5-1
Sample Containers, Preservatives, and Holding Times

Sampling and Analysis Plan
 NAS Cecil Field
 Jacksonville, Florida

Parameter	Container	Preservative	Holding Time
Purgeable halocarbons, purgeable aromatics, EDB	Water; two 40-ml glass vials with Teflon™-lined septa	Cool, 4 °C HCL to pH <2	10 days
	Soil; one 16-oz. (full) wide-mouth glass jar, Teflon™-lined lid	Cool, 4 °C	10 days
PCB/pesticides, and chlorinated herbicides	Water; one gallon glass amber jar	Cool, 4 °C	Extract within 10 days, analyze 40 days
	Soil; one 16-oz. wide-mouth glass jar, Teflon™-lined lid	Cool, 4 °C	Extract within 10 days, analyze 40 days
Organophosphorus pesticides	Water; one 80-oz. amber jar Teflon™-lined lids	Cool, 4 °C	Extract within 10 days, analyze 40 days
	Soil; one 16-oz. wide-mouth glass jar, Teflon™-lined lid	Cool, 4 °C	Extract within 10 days, analyze 40 days
Nitroaromatics	Water; one 80-oz. glass amber jar	Cool, 4 °C	Extract within 10 days, analyze 40 days
	Soil; one 16-oz. wide-mouth glass jar, Teflon™ lined lid	Cool, 4 °C	Extract within 10 days, analyze 40 days
Metals	Water; one 1-liter polyethylene bottle	50% solution HNO ₃ to pH <2; cool, 4 °C	6 months
	Soil; one 16-oz. wide-mouth glass jar, Teflon™-lined lid	Cool, 4 °C	6 months
Cyanide	Wide; one 1-liter polyethylene bottle	NaOH to pH > 12 Cool, 4 °C, add 0.6 g ascorbic acid if residual chlorine present	14 days
	Soil; one 8-oz. wide-mouth glass jar, Teflon™-lined lid	Cool, 4 °C	14 days
Cresols; Phenols	Water; two 1-liter amber glass jars	H ₂ SO ₄ (Phenols - 50% solution) to pH <2; cool 4 °C	28 days
	Soil; one 16-oz. wide-mouth glass jar, Teflon™-lined lid	Cool, 4 °C	28 days
Total Recoverable Petroleum Hydrocarbons	Water; one 1-liter amber glass jar	Cool, 4 °C	28 days
		Cool, 4 °C	Extract within 7 days, analyze 40 days

**Table 5-1 (Continued)
Sample Containers, Preservatives, and Holding Times**

Sampling and Analysis Plan
NAS Cecil Field
Jacksonville, Florida

Parameter	Container	Preservative	Holding Time
Polynuclear Aromatic Hydrocarbons	Soil; one 16-oz. wide-mouth glass jar, Teflon™-lined lid	Cool, 4 °C	28 days

Notes: EDB = ethylene dibromide.
ml = milliliter.
HCL = hydrochloric acid.
oz. = ounce.
PCB = polychlorinated biphenyl.
HNO₃ = nitric acid.
NaOH = sodium hydroxide.
H₂SO₄ = sulfuric acid.

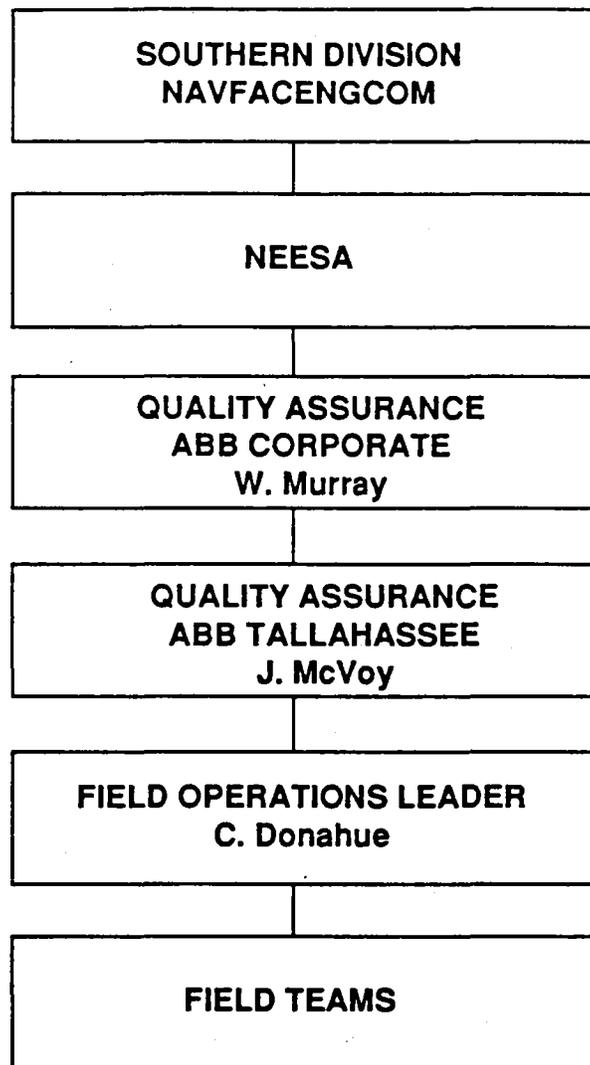


FIGURE 5-5
QUALITY ASSURANCE
QUALITY CONTROL
ORGANIZATION CHART



**SAMPLING AND ANALYSIS
PLAN**

**NAS CECIL FIELD
JAVKSONVILLE, FLORIDA**

operating procedures (SOP). Table 5-2 lists the estimated QA/QC sample requirements for the proposed and existing wells.

5.5 SURFACE WATER AND SEDIMENT SAMPLING. Surface water and sediment sampling will consist of sample collection (for laboratory analyses) as well as the collection of flow characteristics of the streams at Sites 1, 2, 5, and 16 (see Figure 3-19). The proposed sampling locations and analyses are described in Chapters 3 and 4. The actual location will be based upon field conditions and the need to collect representative samples as described in these sections.

5.5.1 Flow Measurements Flow measurements will be collected at each surface water sampling point. They are based on determining cross-sectional area and velocity across that area. For open channels, especially the smaller ones, the surface water flow is best measured directly using a current meter.

5.5.1.1 Current Meter Flow measurements will be obtained using a current meter at a location in the stream where the dimensions are not likely to change during the time period in which flow measurements will be taken. The locations will also be selected to ensure that representative chemical samples are collected. A site will be selected that exhibits the greatest degree of cross-sectional homogeneity. Mixing zones will be taken into account and this is principally governed by turbulence and water velocity. The selection of a site immediately downstream of a riffle area insures good vertical mixing. This is also the best sediment sampling location.

The cross-sectional area of the stream will be determined by measuring the depth of the water at several equidistant points across the stream. The number of readings to be taken to increase accuracy will depend on the width of the stream, from two or three for streams less than 5-feet across to 15 to 25 for streams wider than 50 feet across. Ideally, the stream should be partitioned into sections small enough that less than 10 percent of the total stream flow passes through each section. Width and depth are expressed in terms of meters or feet, and the cross-sectional area is expressed as square meters or square feet.

Velocity is measured by head differential or pressure differential relationships in the stream. The velocity is obtained by placing the probe of the meter into the stream at a calculated depth at each of the sampling locations determined above and taking a reading. The person measuring the velocity should be located downstream of the probe. The placement depth of the probe is at a point 0.6 of the total depth below the surface. The velocity reading will be in meters per second or feet per second. When the cross-sectional area for each subsection is multiplied by the flow velocity for each subsection, their product is the volumetric flow rate for each subsection. The total discharge flow is the sum of all individual subsection flows, whereas the average stream velocity is that sum (total discharge) divided by the total cross-sectional area, expressed as cubic meters per second or cubic feet per second.

5.5.1.2 Water Stage Gauge One stage gauge will be installed onto the bridge buttress downstream of Site 1. The gauge will be surveyed as described in Section 5.9. The gauge will be a rigid rod or board, precisely graduated, and firmly mounted as a permanent reference point.

**Table 5-2
Estimated Summary of Groundwater and QA/QC Analyses**

Sampling and Analysis Plan
NAS Cecil Field
Jacksonville, Florida

	Analysis			
	B	C	D	E
Total number of groundwater analyses	38	38	38	38
Number of QA/QC trip blank samples	4	4	4	0
Number of QA/QC rinsates	4	4	4	4
Number of QA/QC field blanks*	2	2	2	2
Number of QA/QC field duplicates (blind)	4	4	4	4
Number of QA/QC additional laboratory volume samples	1	1	1	1
Total QA/QC samples	14	14	14	11
Total GW samples	38	38	38	38
Total GW and QA/QC	52	52	52	49

Notes: Analyses types (A-Q) are listed in Chapter 4.

At a minimum of one sample for each source water for a given sampling event.

* = Normally there are two field blanks per event; a sample of potable water used in cleaning and a sample of ASTM Type II water for decontamination.

B = Target compound list for volatiles.

C = Target compound list for semivolatiles.

D = Target analyte list for metals.

E = Cyanide.

5.5.2 Sample Collection Procedures Sites 1, 2, 5, and 16 have surface water and sediment sampling locations. This section pertains to the sample collection procedures for surface water and sediments. Proposed locations at each site are identified in Chapter 3.

5.5.2.1 Surface Water Table 5-3 lists the laboratory analysis requirements for surface water samples collected at sites identified above. Samples are collected directly into the sample containers, which are pointed upstream. Preservatives will be added to the samples as required based on intended analysis, and pH will be checked after collecting the samples. In addition to flow measurements, pH, temperature, and specific conductance will be measured in the field.

5.5.2.2 Sediment Table 5-4 lists the chemical analyses required at each site for sediment sampling. Sites that are located immediately upstream or downstream from the confluence of two streams or rivers should generally be avoided because flows from two tributaries may not immediately mix, and the sediment may be moving almost as two streams in proportion to the inflow from the tributaries. Potential sites upstream from the confluence with another stream may also be unsuitable at times due to possible backflow, which can upset the normal movement of sediment. A sediment sample will be collected at the center of a small channel.

To collect a sediment sample from a stream bed, scooping will be used for shallow locations. If the water is wadeable, the sediment sample will be collected by scooping using a stainless-steel spoon or grain scoop. This will reduce the potential for cross-contamination. This method is accomplished by wading into the stream and, while facing upstream (into the current), scooping the sample along the stream bottom in the upstream direction. If the stream is too deep to wade but less than 8-feet deep, a stainless steel grain scoop attached to a piece of conduit will be used.

If the stream has a significant flow and is too deep to wade, a stainless steel Ponar™ dredge will be used to collect sediment samples. Care will be taken to minimize disturbance of sediments during sample collection.

5.5.3 Sample Mixing Sediments collected for chemical analysis (except those collected for VOAs) will be thoroughly mixed before being placed in the appropriate sample containers (Section 5.10). The sediment sample will be removed from the sampling device and placed in a glass or Teflon™-coated stainless-steel pan, then thoroughly mixed using a stainless-steel or Teflon™-coated, stainless-steel spoon. The sediment in the pan will be scraped from the sides, corners, and bottom of the pan, rolled to the middle of the pan, and initially mixed. The sample will be quartered and moved to the four corners of the pan. Each quarter of the sample will be mixed individually. Each quarter is then rolled to the center of the pan and the entire sample mixed again. This procedure is continued to ensure that all parts of the sample are mixed and that the sample is as homogeneous as possible before being placed in the sample containers. Sediment samples are then placed in the same type of sample containers listed for soil samples (see Table 5-1).

5.5.4 Quality Assurance/Quality Control (QA/QC). Tables 5-3 and 5-4 list the estimated QA/QC requirements for surface water and sediment sampling.

Table 5-3
Estimated Summary of Surface Water and Quality Assurance/Quality Control
(QA/QC) Analyses

Sampling and Analysis Plan
 NAS Cecil Field
 Jacksonville, Florida

	Analysis			
	B	C	D	E
Total number of surface water analyses	8	8	8	8
Number of QA/QC trip blank samples	1	1	1	0
Number of QA/QC equipment rinsates	1	1	1	1
Number of QA/QC field blanks	2	2	2	2
Number of QA/QC field duplicates (blind)	1	1	1	1
Number of QA/QC additional laboratory volume samples	1	1	1	1
Total QA/QC samples	6	6	6	5
Total SW samples	8	8	8	8
Total SW and QA/QC	14	14	14	13

Notes: B = Target compound list for volatiles.
 C = Target compound list for semivolatiles.
 D = Target analyte list for metals.
 E = Cyanide.

Table 5-4
Estimated Summary of Sediment and QA/QC Analyses

Sampling and Analysis Plan
 NAS Cecil Field
 Jacksonville, Florida

	Analysis			
	B	C	D	E
Total number of sediment analyses	8	8	8	8
Number of QA/QC trip blank samples	1	1	1	0
Number of QA/QC equipment rinsates	1	1	1	1
Number of QA/QC field blanks	2	2	2	2
Number of QA/QC field duplicates (blind)	1	1	1	1
Number of QA/QC additional laboratory volume samples	0	0	0	1
Total QA/QC samples	5	5	5	5
Total SD samples	8	8	8	8
Total SD and QA/QC	13	13	13	13

Notes: B = Target compound list for volatiles.
 C = Target compound list for semivolatiles.
 D = Target analyte list for metals.
 E = Cyanide.

5.6 SHALLOW SOIL SAMPLING. Shallow surface soil to shallow subsurface soil sampling will be conducted at Sites 3, 5, 16, and 17. Table 5-6 identifies the estimated QA/QC analysis required.

Prior to sampling, leaves, grass, and surface debris will be removed from the area to be sampled using a clean stainless-steel spoon or shovel. Surface soils will then be collected using a precleaned, stainless-steel scoop or spoon. Shallow subsurface soil samples will be collected at the desired depths by using a stainless-steel hand auger. All proper decontamination of sampling apparatus will be conducted between sample borings and sample depths (see Section 5.11).

5.6.1 Stainless-Steel Hand Auger The stainless-steel hand auger consists of three basic parts: (1) the bucket, (2) extension, and (3) handle. At the bottom end of the bucket are two cutting edges. Samples are obtained by turning the cross arm at the same time the operator presses the auger into the ground. When sampling deeper subsurface soils, a number of 3-foot extensions may be joined end-to-end to increase the depth from which soil may be sampled. The depths likely to be encountered for these sites are very shallow (i.e., approximately 5 feet).

5.6.2 Sample Compositing Volatile samples will be collected as grab samples, whereas all other chemical analyses will be composited by mixing the appropriate depths in a glass or Teflon™ coated stainless-steel pan, then mixed with a Teflon™ or stainless-steel spoon. This material can then be transferred to the appropriate sample container.

5.6.3 Auxiliary Data Lithologic logs will be recorded during sample collection. In addition, OVA/PID readings will be listed in the field notebook and on the logs. Figure 5-1 shows a typical soil boring log as required by the Navy.

5.7 SUBSURFACE GAS TESTING. Soil gas surveys are proposed for Sites 3, 5, 16, and 17. A soil gas survey consists of a probe driven into the ground above the water table. The probe is purged for several minutes by connecting the probe to a vacuum pump. After a suitable purge time, a soil gas sample is collected with a gas-tight syringe. The syringe sample is then injected into a portable gas chromatograph (GC). The results are plotted onto a map.

5.8 AIR QUALITY. This section describes field air quality monitoring and air sampling activities related to site characterization activities. The methods and equipment necessary for real-time air quality monitoring in the field are discussed in the HASP. With regard to site characterization activities, real-time monitoring will help in selection of sampling locations and screening of samples (i.e., screening of split-spoon samples to select samples for laboratory analysis) and health and safety issues.

5.8.1 Sample Screening Initial air monitoring activities will focus on screening soil samples at all sites, and providing reconnaissance information should off-gassing occur at select sites. This screening will help to refine or redefine the air monitoring requirements for the remedial response activities. The screening will be accomplished using a flame ionization detector (FID) (i.e., OVA), PID (i.e., HNU), and possibly an OVA using the gas chromatograph mode if

Table 5-5
Estimated Summary of Soil Boring and Quality Assurance/Quality Control
(QA/QC) Analyses

Sampling and Analysis Plan
 NAS Cecil Field
 Jacksonville, Florida

	Analysis			
	B	C	D	E
Total number of soil boring analyses	57	57	57	57
Number of QA/QC trip blank samples	6	6	6	0
Number of QA/QC rinsates	6	6	6	6
Number of QA/QC field blanks	2	2	2	2
Number of QA/QC field duplicates (blind)	6	6	6	6
Number of QA/QC additional laboratory volume samples	6	6	6	6
Total QA/QC samples	26	26	26	20
Total boring samples	57	57	57	57
Total boring and QA/QC	83	83	83	77

Note: B = Target compound list for volatiles.
 C = Target compound list for semivolatiles.
 D = Target analyte list for metals.
 E = Cyanide.

off-gassing is suspected. The results of the screening will provide input to the Health and Safety Plan.

5.9 GEOPHYSICS. EM, GPR, and PCPT are proposed for use at the sites identified below. The specific instruments to be used, the proposed grid and/or location of the surveys, and the methods to be employed will be described in a proposal from the geophysical consultant following site inspection. The project manager and the Navy Engineer-in-Charge (EIC) will approve the program. The use of the surveys is described below.

EM surveys will be conducted at the Landfills (Sites 1 and 2). The survey is intended for use as a reconnaissance tool to locate the areal extent of the source at the surface. EM surveys can be used to map local and general changes in the natural hydrogeologic setting by measuring differences in near surface conductivities and can be used to detect and measure boundaries of a conductivity plume. This information allows for improved target sample borehole and monitoring well location selection.

GPR surveys are proposed for Sites 3, 5, and 16. GPR is a non-intrusive survey capable of discriminating changes within the soil's micro-horizons. An abrupt profile change represents disturbed soil, which may indicate the edge of a trench or pit. GPR can often discriminate small objects, consequently, it is used to find buried objects such as drums.

PCPT is proposed for use at Sites 1 and 2. PCPT will be used to help evaluate natural soil and geologic conditions around these sites.

5.10 SURVEYING. All monitoring well locations and elevations, surface water sampling locations, and soil sampling locations will be surveyed by a State of Florida registered surveyor. Datum for elevation control is the National Geodetic Vertical Datum (NGVD) of 1929, formerly known as 1929 sea level datum, established by the U.S. Coastal and Geodetic Survey. Benchmarks of known elevation will be used. If no benchmark is located in the vicinity, an arbitrary temporary benchmark will be established on a permanent location (i.e., bridge wingwall, foundation, or corner post). The location of all benchmarks used will be shown on the site sketch map. When practical, elevation surveys will be conducted to form a circuit. That is, the survey line will close back to a benchmark. Horizontal locations will be accurate to 1 foot, and vertical elevations will be accurate to 0.01 foot.

Surveyors will follow all onsite OSHA health and safety regulations associated with a hazardous waste site.

5.11 EQUIPMENT, SAMPLING SUPPLIES, AND DECONTAMINATION LISTS. Table 5-1 lists the sample container requirements. Table 5-7 lists the types of equipment necessary for field work.

5.12 DECONTAMINATION PROCEDURES. All down-hole drilling equipment (the drill rig, tools, drill pipe, casing, development equipment, well sounder, etc.) will be decontaminated by a steam cleaner with the capability of adding a deionized water or isopropanol rinse. Decontamination of the drill rig will take place prior to beginning work, between each well location, and after the last well is completed. A semi-permanent "decon" pad will be constructed at a location

**Table 5-7
Sampling Equipment and Decontamination Supplies**

Sampling and Analysis Plan
NAS Cecil Field
Jacksonville, Florida

Equipment	Personal Protective Equipment	Sampling Supplies	Decontamination Supplies
OVA/PID	Booties	Aluminum foil	Buckets (stainless steel)
Bailers	Tyvek™	Sharpies	Liquinox™ or Alconox™
Well keys	Latex gloves	Pens	Isopropanol
Well sounders	Surgical gloves	Polyethylene bags	Organic-free water
Engineers tape	APR/Cartridges (GMC-H)	Trash bags	Deionized water
Conductivity meters	Hard hats	Sample paperwork	Spray bottles
Thermometers		Duct tape	Plastic sheeting
Geophysical equipment		Strapping tape	Brushes
Logbook and field forms		Wide clear tape	Plywood
Preservatives		Ice	
Camera and film		Paper towels	
Sample containers		Nylon rope	
Coolers		pH Paper (range 0-14)	
Bubble wrap			
Reference check samples			
Calculator			
Tools			
Drums			
pH meters			

Notes: OVA/PID = organic vapor analyzer/photoionization detector.
APR = Air purifying respirator

determined in coordination with the Navy. The drill rig will be driven to this location and decontaminated between wells. The location of this pad should minimize the distance the rig must travel on any road.

The decon pad will consist of 10-millimeter polyethylene sheeting on top of plywood sheets large enough to accommodate a drill rig. The ground will slope to one end creating a sump pump collection area. The decontamination water can be pumped into 55-gallon drums from the sump. Sheets of plywood can be set up against fences (if fences are present) to decrease the chances of wind blowing the steam mist into other areas. All decontamination waste will be contained and handled according to Chapter 7.

Decontamination procedures are used on all pieces of equipment that may come into contact with other materials and cause cross-contamination. This includes drill rig, drill pipe, augers, casing, bailers, and the outside of sample containers.

Materials used in the decontamination process include:

- phosphate-free detergent (i.e., Alconox™ or Liquinox™),
- standard cleaning solvent (pesticide-grade isopropanol),
- tap water from any municipal water treatment system,
- brushes that are not wire wrapped,
- stainless steel wash tubs, and
- organic free water.

5.12.1 Drilling and Monitoring Well Installation Equipment

5.12.1.1 Equipment Decontamination All drilling equipment and materials will be decontaminated before any drilling operations and between borings. All tools used for soil sampling and packaging, including split-spoon samplers, sample-cutting knives, etc., will be decontaminated before collecting each sample. Well casing, screens, and fittings are to be delivered to the site free from inks and printing and in a clean condition. They will be decontaminated onsite in the presence of an ABB-ES representative. Equipment cleaning and decontamination will be conducted in a designated area, downgradient and downwind from the clean equipment drying and storage area.

The drilling auger, bits, drill pipe, and other drilling equipment that will go into the borehole will be cleaned before mobilization onsite. Between borings and at the completion of work, the equipment will again be cleaned. The drilling subcontractor will scrape and remove all earthen materials from the equipment, and hose down equipment with a portable, high-pressure, hot water washer (steam cleaner) prior to decontaminating the equipment as described in the following paragraphs.

The cleaning of the drilling equipment will take place at the central decontamination area. Equipment that is reused (i.e. split-spoon sampler used for lithologic sampling) at each drilling location will be cleaned at each individual drill site.

Soil sampling equipment will be decontaminated at the individual drilling sites. The sampling equipment decontamination line will be set up as follows for cleaning equipment.

1. A source of potable water will be supplied by the drilling subcontractor for washdown of sampling equipment.
2. A wash tub will be filled to a depth of about 6 inches with potable water and a Liquinox™ or Alconox™ detergent solution.
3. Supplies of pesticide-grade isopropanol will be placed in separate Teflon™ spray bottles.
4. Separate tubs will be provided to contain water and solvent rinsates.
5. Organic-free water will be stored onsite in glass or stainless steel containers.

All equipment associated with drilling activities should be inspected prior to coming onsite to ensure that all oil, grease, hydraulic fluid, etc. has been removed, all gaskets and seals are intact, and no fluids are leaking. If the surfaces of downhole augering, drilling, and sampling equipment are painted, badly rusted, or coated with materials that cannot be removed by the steam cleaning and wire-brush method, they must be sandblasted. The drill rig must be steam cleaned prior to drilling each borehole. All soil, sediment, surface water, and groundwater sampling equipment that is painted, badly rusted, or coated with materials that cannot be removed by the steam cleaning and wire-brush method must be sandblasted. The following decontamination procedures apply to all soil, sediment, surface water, and groundwater sampling equipment and all downhole drilling, sampling, and well construction equipment that may come in contact with the downhole equipment or sample medium. Equipment should be decontaminated prior to collecting each sample or prior to drilling each borehole.

1. Clean the equipment with tap water and laboratory grade, phosphate free detergent, using a brush, if necessary, to remove particulate matter and surface films. Steam cleaning may be necessary to remove matter that is difficult to remove with a brush.
2. Rinse thoroughly with potable tap water.
3. Rinse twice with solvent (preferably pesticide grade isopropanol).
4. Triple-rinse the equipment thoroughly with organic-free water and allow to air dry as long as possible. Do not final rinse equipment with deionized or distilled water. Organic-free water can be processed on-site by purchasing or leasing a mobile deionization organic filtration system. In some cases when organic-free water is unavailable, it is permissible (with approval) to omit the organic-free water rinse and let the equipment air dry before use.
5. Wrap the equipment with aluminum foil, if appropriate, to prevent contamination if equipment is going to be stored or transported. Clean plastic may be used to wrap augers, drill stems, casings, etc., once they have air dried.
6. Well casing, tremie tubing, etc., that are made of plastic (PVC) shall not be solvent rinsed during the cleaning and decontamination process.

Used plastic materials that cannot be cleaned and are questionable should be discarded.

7. For all well casing, tremie tubing, etc., that arrive onsite with printing and/or writing on them, the printing and/or writing should be removed before Step 1 above. Emery cloth or sandpaper can be used to remove the printing and/or writing. Most well material suppliers can supply materials without printing and/or writing if it is specified when the materials are ordered.

5.12.2 Well Development and Aquifer Testing Equipment All equipment used for well development will be decontaminated before and after use at each well. This will include, but is not limited to, decontamination of all pumps, purging bailers, and downhole piping. A new rope will be used at each well location.

The decontamination procedures will be similar to those described for drilling equipment (steam clean, detergent wash, solvent rinse, and organic-free water triple-rinse).

5.12.3 Water Level Measurement Equipment The electrical (sounding) tape or steel tape used to measure water levels will be cleaned before and after use at each well to avoid chemical cross contamination between wells. The following procedures will be used.

1. Wash the tape with laboratory-grade detergent and tap water.
2. Rinse with tap water.
3. Triple-rinse with organic-free water.
4. Place the tape in a polyethylene bag for storage or transportation.

5.12.4 Water Sampling Equipment Teflon™ bailers will be decontaminated before and after each use as follows.

1. Wash with laboratory-grade detergent (Liquinox™) and tap water, using a brush if necessary to remove particulate matter and surface film.
2. Rinse thoroughly with tap water.
3. Rinse thoroughly with organic-free water.
4. Rinse with solvent (preferably pesticide-grade isopropanol)
5. Rinse thoroughly with organic-free water and allow to air dry as long as possible. If organic-free water is not available, allow equipment to air dry as long as possible. Do not rinse equipment with deionized or distilled water.
6. Wrap equipment in aluminum foil to prevent contamination during storage or transport.

The hoisting line for the bailer will be made of 1/4-inch nylon cord. A new piece of nylon cord will be used for each well. The nylon cord will then be disposed of when sampling is completed at each well. A Teflon™ coated wire leader will be attached to the bailer and the nylon cord to prevent the cord from contacting groundwater.

5.12.5 Sampling Jars and Containers The outside of sampling jars and containers used for sending samples to the contract laboratory will be decontaminated after the sample is taken and the lid is tight. Decontamination procedures will consist of the following.

1. Scrub the containers with detergent (Liquinox™) solution and brush them if the outside of the sample container is excessively contaminated with soil or sediment.
2. Rinse with potable water.
3. Rinse with organic-free water. Air dry.
4. Place container in a polyethylene bag and then in a cooler.

A separate decontamination tub will be set up for these samples.

5.12.6 Personnel Decontamination The personnel decontamination procedures to be used at the site will be performed at each drilling location or other sampling sites before leaving the investigation areas. The contractor and each subcontractor will provide all protective clothing for their own personnel and the equipment necessary to comply with decontamination procedures specified in the HASP.

The following personnel decontamination procedures will be followed.

1. Remove disposable booties (if used) and place into plastic bag for disposal.
2. Wash neoprene boots with detergent solution and rinse with clean water.
3. Wash outer gloves in detergent solution and rinse in clean water. Remove outer gloves and place into plastic bag for disposal or retain for subsequent reuse.
4. Take off the air purifying respirator belt (if used) or self-contained breathing apparatus straps (if used) and remove coveralls. Starting at the neck, roll the coveralls off the person from the inside out and down past the boots. Take care to prevent the release and dispersion of dusts, which may have accumulated on the coveralls, and do not contaminate clothing inside the coveralls during removal. Place coveralls into the disposable plastic bag. Remove boots and retain for subsequent reuse.

5. Remove the respirator (if used) and place the spent filters into the plastic bag destined for disposal. Place the respirator onto the reusable table or into a separate plastic bag for later cleaning and disinfection.
6. Remove surgeon's gloves.
7. Thoroughly wash hands and face.
8. Place all independent disposable bags that were not onsite into one larger bag. Any of the materials from wells with a greater than 5 parts per million (ppm) total organics field instrument reading will be placed in a 55-gallon drum with drummed solid wastes for eventual disposal by the Navy.

6.0 SAMPLE HANDLING

6.1 SAMPLE PAPERWORK

6.1.1 Chain-of-Custody (COC) After the sample is collected in the field and the outside of the sample container properly decontaminated, documentation for sample shipment is completed. A COC record must be prepared for every sample cooler to maintain the legal transfer of the sample from the field team to the laboratory. The COC lists each sample in that cooler. The COC record is used to record the custody of samples and will accompany samples at all times. The COC record will contain the following information:

- project name;
- signature of samplers;
- sampling station number or sample number, date and time of collection, grab or composite sample designation, and a brief description of the type of sample and sampling location;
- analysis to be performed;
- signatures of individuals involved in sample transfer (i.e., relinquishing and accepting samples) (individuals receiving the samples will sign, date, and note the time that they received the samples on the form);
- sample label number; and
- matrix.

The analyses listed on the COC serve as an official communication to the laboratory of the particular analyses required for each sample and provide further evidence that the COC is complete. COC records initiated in the field will be placed in a plastic cover and taped to the inside of the shipping container used for sample transport from the field to the laboratory. Copies of these COC records will be kept with the sampling team should questions arise. The laboratory will return the original signed COC records with the data packages. Figure 6-1 shows an example of the contractor COC record. This can be modified for use by the Navy. Figure 6-2 shows an example of a sample label.

6.1.2 Sample Labels Samples, other than those collected for field measurements or analyses, are identified by using a standard sample label attached to the sample container. The sample labels are sequentially numbered and are accountable (i.e., if a mistake is made, write "void" on the paperwork and keep it in the project files). The following information will be included on the sample label:

CLIENT _____	
DATE _____	
SAMPLE SITE _____	

SAMPLER _____	
PRES. _____	
FILTERED _____	
ABB Environmental Services INC.	

(ACTUAL SIZE IS 2"X3")

SAMPLE LABEL

FIGURE 6-2



**SAMPLING AND ANALYSIS
PLAN**

**NAS CECIL FIELD
JACKSONVILLE, FLORIDA**

- site name,
- field identification or sample station number,
- date and time of sample collection,
- designation of the sample as a grab or composite,
- type of sample (matrix) and a brief description of the sampling location,
- the signatures of the sampling team,
- sample preservation and preservative used, and
- the general types of analyses to be conducted.

If the sample is split with another party, sample labels with identical information will be attached to each of the sample containers. These labels can be completed prior to initiation of field work except for the signatures, sample date, and time. Figure 6-2 shows an example of a sample label.

6.2 SHIPPING REQUIREMENTS. After the sample labels are affixed to the sample container, the samples packed for shipment, and the COC completed, shipping containers can be prepared.

6.2.1 Shipping Containers Shipping containers (i.e., coolers) will be secured with nylon strapping tape and signed and dated custody seals to ensure that the samples are not disturbed during transport. The custody seals will be placed on the cooler so that the cooler cannot be opened without breaking the seal.

Samples that must be kept at 4 °C will be shipped in insulated containers with either freezer forms or ice. If ice is used, it will be placed in a container so that the water will not leak into the cooler as the ice melts. The sample will be shipped within 24 hours of collection to allow the laboratory to meet holding times. An overnight express company will be used. The Florida Department of Transportation (FDOT) regulations will be used for packaging, quantities of shipment, and shipping methods. This applies mostly to medium and high concentration samples. Samples for the NAS Cecil Field site are considered to be low concentration or environmental samples. Organic and inorganic parameter sample containers will be shipped in separate coolers to avoid cross-contamination because of the container types.

Upon sample receipt, the laboratory will sign and keep copies of the express air bill and COC. The temperature of the cooler will be measured and documented. The condition of the samples will be documented. If any breakage or discrepancy arises between COC, sample labels, and requested analysis, the sample custodian will notify the field personnel. The pH of the incoming sample will be checked and documented upon receipt. Any discrepancy or improper preservation will be noted by the laboratory as an out-of-control event and will be documented on an out-of-control form with the corrective action taken. The out-of-control form will be signed and dated by the custodian and any other person responsible for the corrective action.

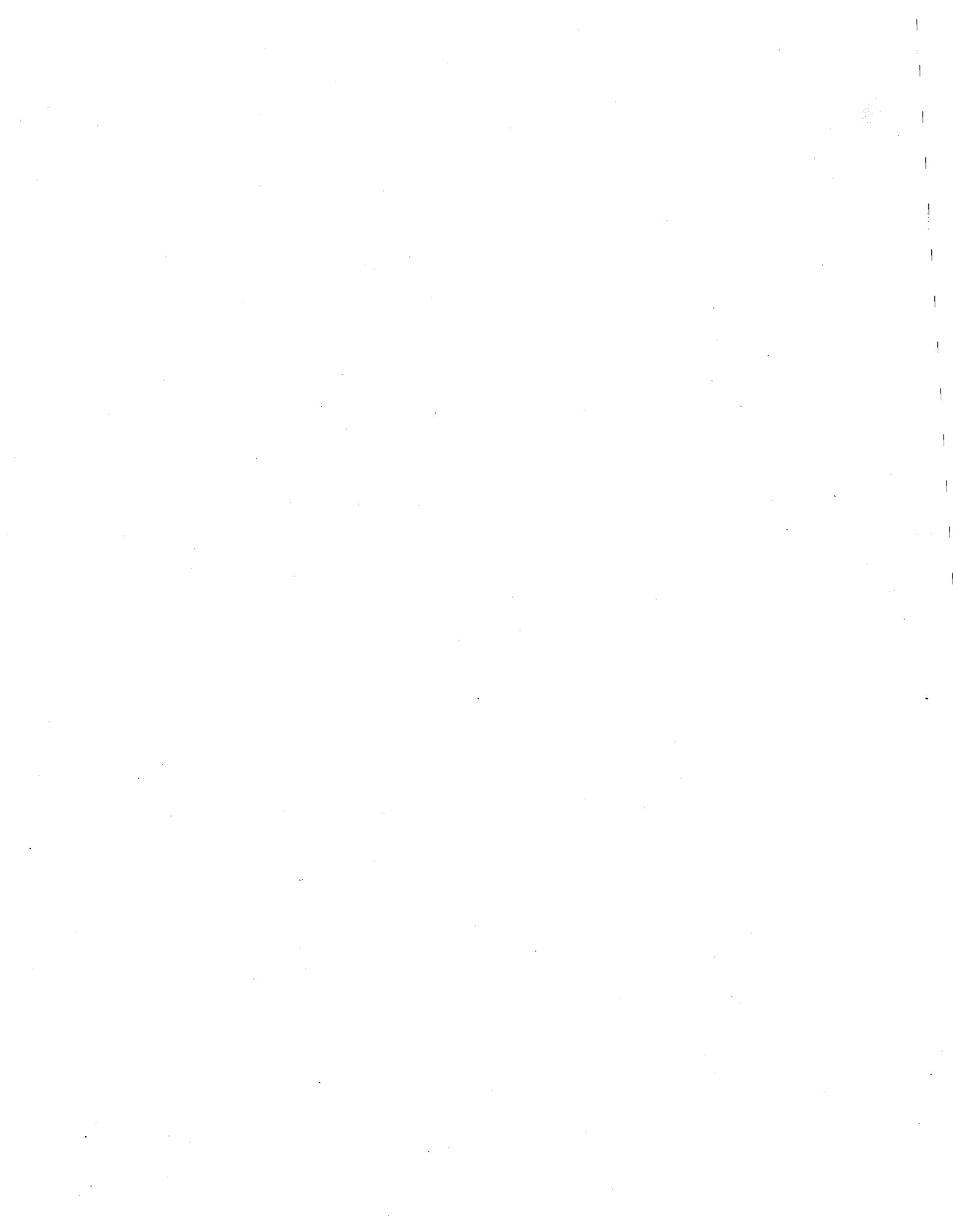
7.0 INVESTIGATION DERIVED WASTE HANDLING AND DISPOSAL

Wastes will be generated as a byproduct of the RI field investigations. The handling of waste generated onsite shall conform to all health and safety requirements, and all State, local, and Federal regulations. Types of wastes to be generated include:

- drill and auger cuttings,
- wastewater from decontamination,
- well development and purge water, and
- disposable health and safety clothing and sampling tools.

All borehole cuttings and development water from sites of known high concentrations of contaminants will be contained in DOT 17-C open-top, 55-gallon drums, permanently labeled by well number, and will be collected by the Navy for proper disposal. All other drill cuttings will be land applied in the immediate vicinity of the well being constructed. Decontamination and development and purge water produced during field work will be discharged at a controlled rate into the Navy's wastewater treatment plant. Care will be taken to ensure that potentially contaminated groundwater or decontamination water does not enter surface water bodies. All disposable protective clothing will be collected in plastic garbage bags and disposed of in Navy solid waste facilities.

The materials may be disposed as normal solid waste if contaminant concentrations do not exceed any State or Federal regulatory limits for the type of waste in question. The Navy is responsible for disposal of all hazardous waste (NEESA, 1988).



REFERENCES

- Brown and Caldwell, 1990a, Interim Final RI/FS Workplan, Naval Air Station, Cecil Field, Jacksonville, Florida, March.
- Brown and Caldwell, 1990b, Project Management Plan, March.
- Brown and Caldwell, 1990c, Interim Final Site Health and Safety Plan, March.
- Cooper, H.H., et. al., 1967, Response of a Finite Diameter Well to an Instantaneous Charge of Water, Water Resources Research, 3, 263-269.
- EPA, 1985, Laboratory Data Validation Functional Guidelines for Evaluating Pesticides/PCBs Analyses, R-582-5-5-01, Hazardous Site Control Division, May 28.
- EPA, 1986, Standard Operating Procedures and Quality Assurance Manual, Region IV, April 1.
- EPA, 1986, Test Methods for Evaluating Solid Wastes, SW-846.
- EPA, 1987, A Compendium of Superfund Field Operations Methods, EPA/540/P-87/001, December.
- EPA, 1988, Contract Laboratory Program Statement of Work for Organics Analysis.
- EPA, 1988, Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. (EPA/540/G-89/004)
- EPA, 1988, Contract Laboratory Program Statement of Work for Inorganics Analysis.
- EPA, 1979, Methods for Chemical Analyses of Water and Wastes, EPA-600/4-79-020, March.
- EPA, 1988, Guidance on Remedial Actions for Contaminated Groundwater at Superfund Sites, December.
- EPA, 1985, Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses, R-582-5-5-01, Hazardous Site Control Division, May 28.
- EPA, 1985, Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses, Office of Emergency and Remedial Response.
- Florida Administrative Code, 1989, Part III, Chapters 17-550, Maximum Contaminant Levels for Drinking Water Standards, January.
- Freeze, A.R., and J.A. Cherry, 1979, Groundwater, Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

REFERENCES (Continued)

Hvorslev, M.J. 1951, Time Lag and Soil Permeability in GroundWater Observations, U.S. Army Corps of Engineers Waterways Experiment Station Bulletin 36, Vicksburg, Mississippi.

Naval Energy and Environmental Support Activity (NEESA), 1988, Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program, June.

40 CFR, Part 136, July 1, 1987.

40 CFR, Parts 260, 261, 262, 264, 265, 268, and 270, January 23, 1989.

BIBLIOGRAPHY

Barcelona, Michael J., et. al., 1985, Practical Guide for GroundWater Sampling, ISWS Contract Report 374.

EPA, 1988, SOW for Organic Analysis Multi-Media, Multi-Concentration, February.

Mickam, James T., et. al., 1989, Groundwater Monitoring Review, U.S. EPA Guidance on Decontamination.

NIOSH, Manual of Analytical Methods, Vols. 1-7, April 1977 through August 1981.

Southern Division Naval Facilities Engineering Command (SOUTHNAVFACENCOM), 1989, Guidelines for Groundwater Monitoring Well Installation, March 27.

W.M. Telford, et. al., Applied Geophysics, 1976.

TABLE IA.—LIST OF APPROVED BIOLOGICAL TEST PROCEDURES

[Table IA revised by 56 FR 50759, October 8, 1991]

Parameter, units and method	Method ¹	EPA ²	Reference (method No. or page)		
			Standard methods 17th ed.	ASTM	USGS ³
Bacteria:					
1. Coliform (fecal), number per 100 ml....	MPN, 5 tube, 3 dilution; or, membrane filter (MF) ⁴ , single step.	p. 132 p. 124	9221C 9222D		
2. Coliform (fecal) in presence of chlorine, number per 100 ml.	MPN, 5 tube, 3 dilution; or, MF ⁴ , single step ⁵ .	p. 132 p. 124	9221C 9222D		B-0050-85.
3. Coliform (total, number per 100 ml.)....	MPN, 5 tube, 3 dilution; or, MF ⁴ , single step or two step.	p. 114 p. 108	9221B 9222B		B-0025-85.
4. Coliform (total), in presence of chlorine, number per 100 ml.	MPN, 5 tube, dilution; or MF ⁴ with enrichment.	p. 114 p. 111	9221B 9222B + B 5C		
5. Fecal streptococci, number per 100 ml.	MPN, 5 tube, 3 dilution; MF ⁴ ; or, plate count.	p. 139 p. 136 p. 143	9230B 9230C		B-0055-85.

Table IA notes:

¹ The method used must be specified when results are reported.

² Bordner, R.H., and J.A. Winter, eds. 1978. "Microbiological Methods for Monitoring the Environment, Water and Waste." Environmental Monitoring Systems Laboratory, U.S. Environmental Protection Agency. EPA-600/8-78-017.

³ Brinton, L.J., and P.E. Greeson, P.E., eds., 1989. "Methods for Collection and Analysis of Aquatic Biological and Microbiological Samples." Techniques of Water Resources Investigations of the U.S. Geological Survey, Techniques of Water Resources Investigations, Book 5, Chapter AA, Laboratory Analysis, U.S. Geographic Survey, U.S. Department of Interior, Reston, Virginia.

⁴ A 0.45 µm membrane filter (MF) or other pore size certified by the manufacturer to fully retain organisms to be cultivated, and to be free of extractables which could interfere with their growth.

⁵ Because the MF technique usually yields low and variable recovery from chlorinated wastewaters, the Most Probable Number method will be required to resolve any controversies.

TABLE IB.—LIST OF APPROVED INORGANIC TEST PROCEDURES

[Table IB revised by 56 FR 50759, October 8, 1991]

Parameter, units and method	EPA ¹	Reference (method No. or page)			Other
		Std. methods 17th Ed.	ASTM	USGS ²	
1. Acidity, as CaCO ₃ , mg/L; Electrometric and point or phenolphthalein and point.....	305.1.....	2310-B(4a).....	D1067-88.....		
2. Alkalinity, as CaCO ₃ , mg/L; Electrometric or colorimetric titration to pH 4.5 manual or.....	310.1.....	2320-B.....	D1067-88.....	I-1030-85.....	973 43. ³
Automated.....	310.2.....			I-2030-85.....	
3. Aluminum—Total ⁴ , mg/L; Digestion ⁴ followed by:					
AA direct aspiration.....	202.1.....	3111D.....		I-3051-85.....	
AA furnace.....	202.2.....	3113B.....			
Inductively coupled plasma (ICP).....	200.7 ⁵				
Direct current plasma (DCP), or.....			D4190-88.....		Note 34.
Colorimetric (Eriochrome cyanine R).....		3500-A1 D.....			
4. Ammonia (as N), mg/L; Manual distillation (at pH 9.5) ⁶ , followed by.....	350.2.....	4500-NH ₃ B.....			973 49. ³
Nesslerization.....	350.2.....	4500-NH ₃ C.....	D1426-79(A).....	I-3520-85.....	973 46. ³
Titration.....	350.2.....	4500-NH ₃ E.....			
Electrode.....	350.3.....	4500-NH ₃ G.....	D1426-79(D).....		
Automated phenate or.....	350.1.....	4500-NH ₃ H.....	D1426-79(C).....	I-4523.85.....	
Automated electrode.....					Note 7.
5. Antimony—Total ⁴ , mg/L; Digestion ⁴ followed by:					
AA direct aspiration.....	204.1.....	3111 B.....			
AA furnace, or.....	204.2.....	3111 B.....			
ICP.....	200.7 ⁵	3120 B.....			
6. Arsenic—Total ⁴ , mg/L; Digestion ⁴ followed by:					
AA gaseous hydride.....	206.5.....				
AA furnace.....	206.3.....	3114.....	D2972-84(B).....	I-3062.85.....	
ICP, or.....	206.2.....	3113-4d.....			
	200.7 ⁵				

TABLE IB.—LIST OF APPROVED INORGANIC TEST PROCEDURES—Continued

Parameter, units and method	EPA ¹	Reference (method No. or page)			Other
		Sid. methods 17th Ed.	ASTM	USGS ²	
Colorimetric (SDOC)	206.4	3500-As	D2972-84(A)	I-3060-85	
7. Barium—Total ⁴ , mg/L; Digestion ⁴ followed by:					
AA direct aspiration	208.1	3111 D		I-3064-85	
AA furnace	208.2	3113 B			
ICP, or	200.7 ⁵	3120 B			
DCP					Note 34
8. Beryllium—Total ⁴ , mg/L; Digestion ⁴ followed by:					
AA direct aspiration	210.1	3111 D	D3645-84-88(A)	I-3095-85	
AA furnace	210.2	3113 B			
ICP	200.7 ⁵	3120 B			
DCP, or			D4190-88		Note 34
Colorimetric (aluminum)		3500-Be D			
9. Biochemical oxygen demand (BOD ₅), mg/L; Dissolved Oxygen Depletion	405.1	5210		I-1578-78 ⁶	973.44 ² p. 17 ⁷
10. Boron—Total, mg/L; Colorimetric (curcumin)	212.3	4500-B B		I-3112-85	
ICP, or	200.7 ⁵	3120 B			
DCP			D4190-88		Note 34
11. Bromide, mg/L; Titrimetric	320.1		D1245-82 (C)(1988)	I-1125-85	p. 544 ¹⁰
12. Cadmium—Total ⁴ , mg/L; Digestion ⁴ followed by:					
AA direct aspiration	213.1	3111 B or C	D3557-90 (A or D)	I-3135-85 or I-3136-85	974.27 ² p. 37 ⁸
AA furnace	213.2	3113 B			
ICP	200.7 ⁵	3120 B		I-1472-85	
DCP			D4190-90		Note 34
Voltametry ¹¹ , or			D3557-90(C)		
Colorimetric (Dithizone)		3500-Cd D			
13. Calcium—Total ⁴ , mg/L; Digestion ⁴ followed by:					
AA direct aspiration	215.1	3111 B	D511-88(B)	I-3152-85	
ICP	200.7 ⁵	3120 B			
DCP, or					Note 34
Titrimetric (EDTA)	215.2	3500-Ca D	D511-88(A)		
14. Carbonaceous biochemical oxygen demand (CBOD ₅), mg/L ¹ Dissolved Oxygen Depletion with nitrification inhibitor		5210 B			
15. Chemical oxygen demand (COD), mg/L; Titrimetric, or	410.1	5220 B	D1252-88	I-3500 or I-3562-85	973.46 ² p. 17 ⁷
Spectrophotometric, manual or automated	410.2 or 410.3 410.4				Notes 13 or 14
16. Chloride, mg/L; Titrimetric (silver nitrate) or (Mercuric nitrate), or	325.3	4500-Cl B 4500-Cl C	D512-89(B) D512-89(A)	I-1183-85 I-1184-85	973.51 ²
Colorimetric, manual or Automated (Ferryanide)	325.1 or 325.2	4500-Cl C	D512-89(C)	I-2187-85	
17. Chlorine—Total residual, mg/L; Titrimetric:					
Amperometric direct	330.1	4500-Cl D	D1253-76(A)		
Starch end point direct	330.3	4500-Cl B	D1253-76(B) (1985) Part 18.3		
Back titration ether end point ¹² , or	330.2	4500-Cl C			
DPD-FAS	330.4	4500-Cl F			
Spectrophotometric, DPD or Electrode	330.5	4500-Cl G			Note 16
18. Chromium VI dissolved, mg/L; 0.45 micron filtration followed by:					
AA chelation-extraction, or	218.4	3111 A		I-1232-85	
Colorimetric (Diphenylcarbazide)				I-1230-85	307B ¹¹
19. Chromium—Total ⁴ , mg/L; Digestion ⁴ followed by:					
AA direct aspiration	218.1	3111 B	D1687-86(D)	I-3236-85	974.27 ²
AA chelation-extraction	218.3	3111 C			
AA furnace	218.2	3113 B			
ICP	200.7 ⁵	3120 B			
DCP, or			D4190-88		Note 34
Colorimetric (Diphenylcarbazide)		3500-Cr D	D1687-86(A)		
20. Cobalt—Total ⁴ , mg/L; Digestion ⁴ followed by:					
AA direct aspiration	219.1 or C	3111 B (A or B)	D3558-90	I-3239-85	p. 37 ⁸
AA furnace	219.2	3113 B			
ICP, or	200.7 ⁵	3120 B			
DCP			D4190-88		Note 34
21. Color platinum cobalt units or dominant wavelength, hue, Luminance purity:					
Colorimetric (ADM!), or	110.1	2120 E			Note 18
(Platinum cobalt), or	110.2	2120 B		I-1250-85	
Spectrophotometric	110.3	2120 C			

[Sec. 136.3(a)]

TABLE IB.—LIST OF APPROVED INORGANIC TEST PROCEDURES—Continued

Parameter, units and method	EPA ¹	Reference (method No. or page)			Other
		Std. methods 17th Ed.	ASTM	USGS ²	
22. Copper—Total ⁴ , mg/L; Digestion ⁴ followed by: AA direct aspiration	220.1	3111 B or C	D 688-90 (A or B)	I-3270-85 or I-3271-85	§74.27 ³ p. 39 ⁴
AA furnace	220.2	3113 B			
ICP	200.7 ⁵	3120 B			
DCP, or Colorimetric (Neocuproine), or (Bicinchoninate)		3500-Cu D or E	D4190-88 D 688-84 (58)(A)		Note 34. Note 19.
23. Cyanide—Total, mg/L: Manual distillation with MgCl ₂ followed by Titrimetric, or Spectrophotometric, manual or Automated ²⁰	335.2 335.3	4500-CN-C 4500-CN-D 4500-CN-E	D2036-89(A) D2036-89(A)	I-3300-85	p. 22 ⁶
24. Cyanide amenable to chlorination, mg/L: Manual distillation with MgCl ₂ followed by titrimetric or Spectrophotometric.	335.1	4500-CN-G	D2036-89(B)		
25. Fluoride—Total, mg/L: Manual distillation ⁴ followed by Electrode, manual or Automated Colorimetric (SPADNS)	340.2 340.1	4500-F-B 4500-F-C 4500-F-D	D1179-88(E) D 1179-80(A) (1988)	I-4327-85	
or Automated complexone	340.3	4500-F-E			
26. Gold—Total ⁴ , mg/L; Digestion ⁴ followed by: AA direct aspiration AA furnace, or DCP	221.1 221.2	3111 B			Note 34
27. Hardness—Total, as CaCO ₃ , mg/L: Automated colorimetric Titrimetric (EDTA), or Ca plus Mg as their carbonates, by inductively coupled plasma or AA direct aspiration. (See Parameters 13 and 33).	130.1 130.2	2340 C	D 1126-86 (1990)	I-1338-85	§73.52B ³
28. Hydrogen ion (pH), pH units: Electrometric, measurement of Automated electrode	150.1	4500-H ⁸	D 293-84 (A or B) (1990)	I-1566-85	§73.41 ³ Note 21
29. Iridium—Total ⁴ , mg/L; Digestion ⁴ followed by: AA direct aspiration or AA furnace	235.1 235.2	3111 B			
30. Iron—Total ⁴ , mg/L; Digestion ⁴ followed by: AA direct aspiration AA furnace ICP DCP, or Colorimetric (Phenanthroline)	236.1 236.2 200.7 ⁵	3111 B or C 3113 B 3120 B	D 1068-90 (A or B)	I-3361-85	§73.27 ³ Note 34 Note 22.
31. Kjeldahl nitrogen—Total, (as N), mg/L: Digestion and distillation followed by: Titration Nesslerization Electrode Automated phenate Semi-automated block digester, or Potentiometric	351.3 351.3 351.3 351.1 351.2 351.4	4500-NH ₃ E 4500-NH ₃ C 4500-NH ₃ F or G 4500-NH ₃ H	D3590-89(A) D3590-89(A) D3590-89(A) D3590-89(B) D3590-89(A)	I-4551-78 ⁹	§73.48 ³
32. Lead—Total ⁴ , mg/L; Digestion ⁴ followed by: AA direct aspiration AA furnace ICP DCP Voltametry ¹¹ , or Colorimetric (Dithizone)	239.1 239.2 200.7 ⁵	3111 B or C 3113 B 3120 B	D3559-90 (A or B)	I-3399-85	§74.27 ³ Note 34
33. Magnesium—Total ⁴ , mg/L; Digestion ⁴ followed by: AA direct aspiration ICP DCP, or Gravimetric	242.1 200.7 ⁵	3111 B 3120 B	D511-88(D)	I-3447-85	§74.27 ³ Note 34.

TABLE IB.—LIST OF APPROVED INORGANIC TEST PROCEDURES—Continued

Parameter, units and method	EPA ¹	Reference (method No. or page)			Other
		Std methods 17th Ed.	ASTM	USGS ²	
34. Manganese—Total ⁴ , mg/L; Digestion ⁴ followed by:					
AA direct aspiration	243.1	3111 B or C	D658-90 (A or B)	I-3454-85	974.27. ³
AA furnace	243.2	3113 B			
ICP	200.7 ³	3120 B			
DCP, or			D4190-88		Note 34.
Colorimetric (Persulfate), or		3500-Mn D	D658-84(A) (1988)		920.203. ³
(Penodate)					Note 23.
35. Mercury—Total ⁴ , mg/L;					
Cold vapor, manual or	245.1	3112 B	D3223-86	I-3462-85	977.22. ³
Automated	245.2				
36. Molybdenum—Total ⁴ , mg/L; Digestion ⁴ followed by:					
AA direct aspiration	246.1	3111 D		I-3490-85	
AA furnace	246.2	3113 B			
ICP, or	200.7 ³	3120 B			
DCP					Note 34
37. Nickel—Total ⁴ , mg/L; Digestion ⁴ followed by:					
AA direct aspiration	249.1	3111 B or C	D1866-90 (A or B)	I-3499-85	
AA furnace	249.2	3113 B			
ICP	200.7 ³	3120 B			
DCP, or			D4190-88		Note 34.
Colorimetric (Heptoxime)		3500-Ni D			
38. Nitrate (as N), mg/L;					
Colorimetric (Brodine sulfate) or Nitrate-nitrite N minus Nitrite N (See parameters 39 and 40)	352.1		D992-71		973.50 ³ , 419D ¹¹ p. 28. ³
39. Nitrate-nitrite (as N), mg/L;					
Cadmium reduction, Manual or	353.3	4500-NO ₃ E	D3867-90(B)		
Automated, or	353.2	4500-NO ₃ F	D3867-90(A)	I-4545-85	
Automated hydrazine	353.1	4500-NO ₃ H			
40. Nitrite (as N), mg/L; Spectrophotometric:					
Manual or	354.1	4500-NO ₂ B	D1254-87		Note 25.
Automated (Diazotization)				I-4540-85	
41. Oil and grease—Total recoverable, mg/L;					
Gravimetric (extraction)	413.1	5520 B			
42. Organic carbon—Total (TOC), mg/L;					
Combustion or oxidation	415.1	5310-B	D2579-85 (A or B)		973.47 ³ , p. 1
43. Organic nitrogen (as N), mg/L;					
Total Kjeldahl N (Parameter 31) minus ammonia N (Parameter 4)					
44. Orthophosphate (as P), mg/L; Ascorbic acid method:					
Automated, or	365.1	4500-P F		I-4601-85	973.56. ³
Manual single reagent, or	365.2	4500-P E	D515-88(A)		973.55. ³
Manual two reagent	365.3				
45. Osmium—Total ⁴ , mg/L; Digestion ⁴ followed by:					
AA direct aspiration, or	252.1	3111 D			
AA furnace	252.2				
46. Oxygen dissolved, mg/L;					
Winkler (Azide modification), or	360.2	4500-O C	D888-81(C) (1988)	I-1575-78 ³	973.45B. ³
Electrode	360.1	4500-O G		I-1576-78 ³	
47. Palladium—Total ⁴ , mg/L; Digestion ⁴ followed by:					
AA direct aspiration, or	253.1	3111 B			p. S27. ¹⁰
AA furnace	253.2				p. S28. ¹⁰
DCP					Note 34.
48. Phenols, mg/L; Manual distillation ¹⁰	420.1		D1783-80 (A or B)		Note 27.
Followed by:					
Colorimetric (4AAP) manual, or	420.1				Note 27.
Automated ¹⁰	420.2				
49. Phosphorus (elemental), mg/L; Gas-liquid chromatography					Note 28.
50. Phosphorus—Total, mg/L;					
Persulfate digestion followed by:	365.2	4500-P-B.5			973.55. ³
Manual, or	365.2 or 365.3	4500-P-E	D515-88(A)		
Automated ascorbic acid reduction, or	365.1	4500-P-F		I-4600-85	973.56. ³
Semi-automated block digester	365.4				
51. Platinum—Total ⁴ , mg/L; Digestion ⁴ followed by:					
AA direct aspiration	255.1	3111 B			
AA furnace	255.2				
DCP					Note 34.

TABLE IB.—LIST OF APPROVED INORGANIC TEST PROCEDURES—Continued

Parameter, units and method	EPA ¹	Reference (method No. or page)			Other
		Std. methods 17th Ed.	ASTM	USGS ²	
52. Potassium—total ⁴ , mg/L; Digestion ⁴ followed by:					
AA direct aspiration	258.1	3111 B		I-3630-85	973.53. ⁹
ICP	200.7 ⁸				
Flame photometric, or		3500-K D	D1428-82(A)		317B. ¹⁷
Colorimetric (Cobalt/nitrate)					
53. Residue—Total, mg/L; Gravimetric, 103-105 ⁶	160.3	2540 B		I-3750-85	
54. Residue—filterable, mg/L; Gravimetric, 187 ⁷	160	2540-C		I-1750-85	
55. Residue—nonfilterable, (TSS), mg/L; Gravimetric, 103-105 ⁶ post washing of residue.	160.2	2540-D		I-3765-85	
56. Residue—settleable, mg/L; Volumetric, (Imhoff cone), or gravimetric.	160.5	2540 F			
57. Residue—Volatile, mg/L; Gravimetric, 550 ⁶	160.4	2540 E		I-3753-85	
58. Rhodium—Total ⁴ , mg/L; Digestion ⁴ followed by:					
AA direct aspiration, or	265.1	3111 B			
AA furnace	265.2				
59. Ruthenium—Total ⁴ , mg/L; Digestion ⁴ followed by:					
AA direct aspiration, or	267.1	3111 B			
AA furnace	267.2				
60. Selenium—Total ⁴ , mg/L; Digestion ⁴ followed by:					
AA furnace	270.2	3113 B			
ICP, or	200.7 ⁸				
AA gaseous hydride	270.3	3114 B	D3059-88(A)	I-3667-85	
61. Silica—Dissolved, mg/L; 0.45 micron filtration followed by:					
Colorimetric, Manual or	370.1	4500-Si D	D659-88(B)	I-1700-85	
Automated (Molybdosilicate), or				I-2700-85	
ICP	200.7 ⁸				
62. Silver—Total ²⁸ , mg/L; Digestion ⁴ followed by:					
AA direct aspiration	272.1	3111 B or C		I-3720-85	973.27 ⁹ , p. 37. ⁹
AA furnace	72.2	3113 B			319B. ¹⁷
Colorimetric (Dithizone)					
ICP, or	200.7 ⁸				
DCP					Note 34.
63. Sodium—Total ⁴ , mg/L; Digestion ⁴ followed by:					
AA direct aspiration	273.1	3111 B		I-3735-85	973.54. ⁹
ICP	200.7 ⁸	3120 B			
DCP, or					Note 34.
Flame photometric		3500-Na D	D1428-82(A)		
64. Specific conductance, micromhos/cm at 25° C:					
Wheatstone bridge	120.1	2510 B	D1125-82(A)	I-1780-85	973.40. ⁹
65. Sulfate (as SO ₄), mg/L:					
Automated colorimetric (barium chloranilate)	375.1				
Gravimetric, or	375.3	4500-SO ₄ ⁻² C or D	D516-82(A) (1988)		925.54. ⁹
Turbidimetric	375.4		D518-88		426C. ¹⁰
66. Sulfide (as S), mg/L:					
Titrimetric (iodine), or	376.1	4500-S ⁻² E		I-3840-85	226A. ¹¹
Colorimetric (methylene blue)	376.2	4500-S ⁻² D			
67. Sulfite (as SO ₃), mg/L:					
Titrimetric (iodine-iodate)	377.1	4500-SO ₃ ⁻² B	D1339-84(C)		
68. Surfactants, mg/L:					
Colorimetric (methylene blue)	425.1	5540 C	D2330-88		
69. Temperature:					
C.; Thermometric	170.1	2550 B			Note 32.
70. Thallium—Total ⁴ , mg/L; Digestion ⁴ followed by:					
AA direct aspiration	279.1	3111 B			
AA furnace, or	279.2				
ICP	200.7 ⁸				
71. Tin—Total ⁴ , mg/L; Digestion ⁴ followed by:					
AA direct aspiration, or	282.1	3111 B		I-3850-78 ⁹	
AA furnace	282.2	3113 B			
72. Titanium—Total ⁴ , mg/L; Digestion ⁴ followed by:					
AA direct aspiration	283.1	3111 D			
AA furnace	283.2				
DCP					Note 34.

TABLE IB.—LIST OF APPROVED INORGANIC TEST PROCEDURES—Continued

Parameter, units and method	EPA ¹	Reference (method No. or page)			Other
		Std. methods 17th Ed.	ASTM	USGS ²	
73. Turbidity, NTU: Nephelometric	180.1	2130 B	D1889-66a	I-3850-85	
74. Vanadium—Total ⁴ , mg/L; Digestion ⁴ followed by:					
AA direct aspiration	286.1	3111 D			
AA furnace	286.2				
ICP	200.7 ⁶	3120 B			
DCP, or			D4190-88		Note 34.
Colorimetric (Gallic acid)		3500-V D	D3373-64(A) (1988).		
75. Zinc—Total ⁴ , mg/L; Digestion ⁴ followed by:					
AA direct aspiration	289.1	3111 (B or C)	D1691-90 (A or B)	I-3900-85	874.27 ⁷ , p. 37. ⁸
AA furnace	289.2				
ICP	200.7 ⁶	3120 B			
DCP, or			D4190-88		Note 34.
Colorimetric (Dithizone) or		3500-Zn E			
(Zincon)		3500-Zn F			Note 33.

Table IB notes:

¹ "Methods for Chemical Analysis of Water and Wastes", Environmental Protection Agency, Environmental Monitoring Systems Laboratory-Cromwell (EML-CI), EPA-600/4-78-020, Revised March 1983 and 1979 where applicable.

² Fishman, M. J., et al., "Methods for Analysis of Inorganic Substances in Water and Fluvial Sediments," U.S. Department of the Interior, Techniques of Water—Resource Investigations of the U.S. Geological Survey, Denver, CO, Revised 1989, unless otherwise stated.

³ "Official Methods of Analysis of the Association of Official Analytical Chemists," methods manual, 15th ed. (1990).

⁴ For the determination of total metals the sample is not filtered before processing. A digestion procedure is required to solubilize suspended material and to destroy possible organic-metal complexes. Two digestion procedures are given in "Methods for Chemical Analysis of Water and Wastes, 1979 and 1983." One (Section 4.1.3), is a vigorous digestion using nitric acid. A less vigorous digestion using nitric and hydrochloric acids (section 4.1.4) is preferred, however, the analyst should be cautioned that this mild digestion may not suffice for all samples types. Particularly, if a colorimetric procedure is to be employed, it is necessary to ensure that all organic-metallic bonds be broken so that the metal is in a reactive state. In those situations, the vigorous digestion is to be preferred making certain that at no time does the sample go to dryness. Samples containing large amounts of organic materials would also benefit by this vigorous digestion. Use of the graphite furnace technique, inductively coupled plasma, as well as determinations for certain elements such as arsenic, the noble metals, mercury, selenium, and titanium require a modified digestion and in all cases the method write-up should be consulted for specific instruction and/or cautions.

NOTE: If the digestion included in one of the other approved references is different than the above, the EPA procedure must be used.

Dissolved metals are defined as those constituents which will pass through a 0.45 micron membrane filter. Following filtration of the sample, the referenced procedure for total metals must be followed. Sample digestion for dissolved metals may be omitted for AA (direct aspiration or graphite furnace) and ICP analyses provided the sample solution to be analyzed meets the following criteria:

- a. has a low COD (<20)
- b. is visibly transparent with a turbidity measurement of 1 NTU or less
- c. is colorless with no perceptible odor, and
- d. is of one liquid phase and free of particulate or suspended matter following acidification.

⁵ The full text of Method 200.7, "Inductively Coupled Plasma Atomic Emission Spectrometric Method for Trace Element Analysis of Water and Wastes," is given at Appendix C of this Part 136.

⁶ Manual distillation is not required if comparability data on representative effluent samples are on company file to show that this preliminary distillation step is not necessary; however, manual distillation will be required to resolve any controversies.

⁷ Ammonia, Automated Electrode Method, Industrial Method Number 379-75 WE, dated February 19, 1976, (Bran & Luebbe (Technicon) AutoAnalyzer II, Bran & Luebbe Analyzing Technologies, Inc., Elmstord, N.Y. 10523.

⁸ The approved method is that cited in "Methods for Determination of Inorganic Substances in Water and Fluvial Sediments", USGS TWRI, Book 5, Chapter A1 (1979).

⁹ American National Standard on Photographic Processing Effluents, Apr. 2, 1975. Available from ANSI, 1430 Broadway, New York, NY 10018.

¹⁰ "Selected Analytical Methods Approved and Cited by the United States Environmental Protection Agency," Supplement to the Fifteenth Edition of Standard Methods for the Examination of Water and Wastewater (1981).

¹¹ The use of normal and differential pulse voltage ramps to increase sensitivity and resolution is acceptable.

¹² Carbonaceous biochemical oxygen demand (CBOD₅) must not be confused with the traditional BOD₅ test which measures "total BOD." The addition of the nitrification inhibitor is not a procedural option, but must be included to report the CBOD₅ parameter. A discharger whose permit requires reporting the traditional BOD₅ may not use a nitrification inhibitor in the procedure for reporting the results. Only when a discharger's permit specifically states CBOD₅ is required, can the permittee report data using the nitrification inhibitor.

¹³ OIC Chemical Oxygen Demand Method, Oceanography International Corporation, 512 West Loop, P.O. Box 2980, College Station, TX 77840.

¹⁴ Chemical Oxygen Demand, Method 8000, Hach Handbook of Water Analysis, 1979, Hach Chemical Company, P.O. Box 389, Loveland, CO 80537.

¹⁵ The back titration method will be used to resolve controversy.

¹⁶ Orion Research Instruction Manual, Residual Chlorine Electrode Model 97-70, 1977, Orion Research Incorporated, 840 Memorial Drive, Cambridge, MA 02138.

The calibration graph for the Orion residual chlorine method must be derived using a reagent blank and three standard solutions, containing 0.2, 1.0, and 5.0 ml 0.00281 N potassium iodate/100 ml solution, respectively.

¹⁷ The approved method is that cited in Standard Methods for the Examination of Water and Wastewater, 14th Edition, 1978.

¹⁸ National Council of the Paper Industry for Air and Stream Improvement, (Inc.) Technical Bulletin 253, December 1971.

¹⁹ Cooper, Biocinchonate Method, Method 8506, Hach Handbook of Water Analysis, 1979, Hach Chemical Company, P.O. Box 389, Loveland, CO 80537.

²⁰ After the manual distillation is completed, the autoanalyzer manifolds in EPA Methods 335.3 (cyanide) or 420.2 (phenols) are simplified by connecting the sample line directly to the sampler. When using the manifold setup shown in Method 335.3, the buffer 6.2 should be replaced with the buffer 7.6 found in Method 335.2.

²¹ Hydrogen ion (pH) Automated Electrode Method, Industrial Method Number 378-75WA, October 1976, Bran & Luebbe (Technicon) AutoAnalyzer II, Bran & Luebbe Analyzing Technologies, Inc., Elmstord, N.Y. 10523.

²² Iron, 1,10-Phenanthroline Method, Method 8008, 1980, Hach Chemical Company, P.O. Box 389, Loveland, CO 80537.

²³ Manganese, Penodate Oxidation Method, Method 8034, Hach Handbook of Wastewater Analysis, 1979, pages 2-113 and 2-117, Hach Chemical Company, Loveland, CO 80537.

¹⁴ Wershaw, R.L., et al, "Methods for Analysis of Organic Substances in Water," Techniques of Water-Resources Investigation of the U.S. Geological Survey, Book 5, Chapter A3, (1972 Revised 1987) p. 14.
¹⁵ Nitrogen, Nitrite, Method 8507, Hach Chemical Company, P.O. Box 389, Loveland, CO 80537.
¹⁶ Just prior to distillation, adjust the sulfonic-acid-preserved sample to pH 4 with 1 + 9 NaOH.
¹⁷ The approved method is cited in Standard Methods for the Examination of Water and Wastewater, 14th Edition. The colorimetric reaction is conducted at a pH of 10.0±0.2. The approved methods are given on pp 576-81 of the 14th Edition: Method 510A for distillation, Method 510B for the manual colorimetric procedure, or Method 510C for the manual spectrophotometric procedure.
¹⁸ R.F. Addison and R.G. Ackman, "Direct Determination of Elemental Phosphorus by Gas-Liquid Chromatography," Journal of Chromatography, vol. 47, No. 3, pp. 421-426, 1970.
¹⁹ Approved methods for the analysis of silver in industrial wastewaters at concentrations of 1 mg/L and above are inadequate where silver exists as an inorganic halide. Silver halides such as the bromide and chloride are relatively insoluble in reagents such as nitric acid but are readily soluble in an aqueous buffer of sodium thiosulfate and sodium hydroxide to pH of 12. Therefore, for levels of silver above 1 mg/L, 20 mL of sample should be diluted to 100 mL by adding 40 mL each of 2 M Na₂S₂O₃ and NaOH. Standards should be prepared in the same manner. For levels of silver below 1 mg/L the approved method is satisfactory.
²⁰ The approved method is that cited in Standard Methods for the Examination of Water and Wastewater, 15th Edition.
²¹ The approved method is that cited in Standard Methods for the Examination of Water and Wastewater, 13th Edition.
²² Stevens, H.H., Ficks, J.F., and Smoot, G.F., "Water Temperature—Influential Factors, Field Measurement and Data Presentation", Techniques of Water-Resources Investigations of the U.S. Geological Survey, Book 1, Chapter D1, 1975.
²³ Zinc, Zincon Method, Method 8009, Hach Handbook of Water Analysis, 1979, pages 2-231 and 2-333, Hach Chemical Company, Loveland, CO 80537.
²⁴ "Direct Current Plasma (DCP) Optical Emission Spectrometric Method for Trace Elemental Analysis of Water and Wastes, Method AES0029," 1986—Revised 1991, Applied Research Laboratories, Inc., 24911 Avenue Stanford, Valencia, CA 91355.

TABLE 1C.—LIST OF APPROVED TEST PROCEDURES FOR NON-PESTICIDE ORGANIC COMPOUNDS

[Table 1C revised by 56 FR 50759, October 8, 1991]

Parameter ¹	GC	EPA Method Number ^{2,3}			ASTM	Other
		GC/MS	HPLC	Standard methods 17th Ed.		
1. Acenaphthene.....	610	625, 1625	610	6410 B, 6440 B	D4657-87	
2. Acenaphthylene.....	610	625, 1625	610	6410 B, 6440 B	D4657-87	
3. Acrolein.....	603	* 604, 1624				
4. Acrylonitrile.....	603	* 624, 1624	610			
5. Anthracene.....	610	625, 1625	610	6410 B, 6440 B	D4657-87	
6. Benzene.....	602	624, 1624		6210 B, 6220 B		
7. Benzidine.....		* 625, 1625	605			Note 3, p 1
8. Benzo(a)anthracene.....	610	625, 1625	610	6410 B, 6440 B	D4657-87	
9. Benzo(a)pyrene.....	610	625, 1625	610	6410 B, 6440 B	D4657-87	
10. Benzo(b)fluoranthene.....	610	625, 1625	610	6410 B, 6440 B	D4657-87	
11. Benzo(g,h,i)perylene.....	610	625, 1625	610	6410 B, 6440 B	D4657-87	
12. Benzo(k)fluoranthene.....	610	625, 1625	610	6410 B, 6440 B	D4657-87	
13. Benzyl chloride.....						Note 3, p 130. Note 6, p S102
14. Benzyl butyl phthalate.....	606	625, 1625		6410 B		
15. Bis(2-chloroethoxy) methane.....	611	625, 1625		6410 B		
16. Bis(2-chloroethyl) ether.....	611	625, 1625		6410 B		
17. Bis (2-ethylhexyl) phthalate.....	606	625, 1625		6410 B, 6230 B		
18. Bromodichloromethane.....	601	624, 1624		6210 B, 6230 B		
19. Bromoform.....	601	624, 1624		6210 B, 6230 B		
20. Bromomethane.....	601	624, 1624		6210 B, 6230 B		
21. 4-Bromophenylphenyl ether.....	611	625, 1625		6410 B		
22. Carbon tetrachloride.....	601	624, 1624		6230 B, 6410 B		Note 3, p 130
23. 4-Chloro-3-methylphenol.....	604	625, 1625		6410 B, 6420 B		
24. Chlorobenzene.....	601, 602	624, 1624		6210 B, 6220 B 6230 B		Note 3, p 130
25. Chloroethane.....	601	624, 1624		6210 B, 6230 B		
26. 2-Chloroethylvinyl ether.....	601	624, 1624		6210 B, 6230 B		
27. Chloroform.....	601	624, 1624		6210 B, 6230 B		Note, p 130
28. Chloromethane.....	601	624, 1624		6210 B, 6230 B		
29. 2-Chloronaphthalene.....	612	625, 1625		6410 B		
30. 2-Chlorophenol.....	604	625, 1625		6410 B, 6420 B		
31. 4-Chlorophenylphenyl ether.....	611	625, 1625		6410 B		
32. Chrysene.....	610	625, 1625	610	6410 B, 6440 B	D4657-87	
33. Dibenzo(a,h)anthracene.....	610	625, 1625	610	6410 B, 6440 B	D4657-87	
34. Dibromochloromethane.....	601	624, 1624		6210 B, 6230 B		
35. 1, 2-Dichlorobenzene.....	601,602,612	624,625,1625		6410 B, 6230 B, 6220 B		
36. 1, 3-Dichlorobenzene.....	601,602,612	624,625,1625		6410 B, 6230 B, 6220 B		
37. 1, 4-Dichlorobenzene.....	601,602,612	625,1624,1625		6410 B, 6230 B 6220B		

TABLE 1C.—LIST OF APPROVED TEST PROCEDURES FOR NON-PESTICIDE ORGANIC COMPOUNDS—Continued

Parameter ¹	GC	EPA Method Number ^{2,3}			ASTM	Other
		GC/MS	HPLC	Standard methods 17th Ed.		
38. 3, 3-Dichlorobenzidine.....		625, 1625	605	6410 B		
39. Dichlorodifluoromethane.....	601			6230 B		
40. 1, 1-Dichloroethane.....	601	624, 1624		6230 B, 6210 B		
41. 1, 2-Dichloroethane.....	601	624, 1624		6230 B, 6210 B		
42. 1, 1-Dichloroethene.....	601	624, 1624		6230 B, 6210 B		
43. trans-1, 2-Dichloroethene.....	601	624, 1624		6230 B, 6210 B		
44. 2, 4-Dichlorophenol.....	604	625, 1625		6420 B, 6410 B		
45. 1, 2-Dichloropropane.....	601	624, 1624		6230 B, 6210 B		
46. cis-1, 3-Dichloropropene.....	601	624, 1624		6230 B, 6210 B		
47. trans-1, 3-Dichloropropene.....	601	624, 1624		6230 B, 6210 B		
48. Diethyl phthalate.....	606	625, 1625		6410 B		
49. 2, 4-Dimethylphenol.....	604	625, 1625		6420 B, 6410 B		
50. Dimethyl phthalate.....	606	625, 1625		6410 B		
51. Di-n-butyl phthalate.....	606	625, 1625		6410 B		
52. Di-n-octyl phthalate.....	606	625, 1625		6410 B		
53. 2, 3-Dinitrophenol.....	604	625, 1625		6420 B, 6410 B		
54. 2, 4-Dinitrotoluene.....	609	625, 1625		6410 B		
55. 2, 6-Dinitrotoluene.....	609	625, 1625		6410 B		
56. Epichlorohydrin.....						Note 3, p 130 Note 6, p S102.
57. Ethylbenzene.....	602	624, 1624		6220 B, 6210 B		
58. Fluoranthene.....	610	625, 1625	610	6410 B, 6440 B	D4657-87	
59. Fluorene.....	610	625, 1625	610	6410 B, 6440 B	D4657-87	
60. Hexachlorobenzene.....	612	625, 1625		6410 B		
61. Hexachlorobutadiene.....	612	625, 1625		6410 B		
62. Hexachlorocyclopentadiene.....	612	625, 1625		6410 B		
63. Hexachloroethane.....	618	625, 1625		6410 B		
64. Ideno (1,2,3-cd)pyrene.....	610	625, 1625	610	6410 B, 6440 B	D4657-87	
65. Isophorone.....	609	625, 1625		6410 B		
66. Methylene chloride.....	601	624, 1624		6230 B		Note 3, p.130.
67. 2-Methyl-4, 6-dinitrophenol.....	604	625, 1625		6420 B, 6410 B		
68. Naphthalene.....	610	625, 1625	610	6410 B, 6440 B		
69. Nitrobenzene.....	609	625, 1625		6410 B	D4657-87	
70. 2-Nitrophenol.....	604	625, 1625		6410 B, 6420 B		
71. 4-Nitrophenol.....	604	625, 1625		6410 B, 6420 B		
72. N-Nitrosodimethylamine.....	607	625, 1625		6410 B		
73. N-Nitrosodi-n-propylamine.....	607	625, 1625		6410 B		
74. N-Nitrosodiphenylamine.....	607	625, 1625		6410 B		
75. 2,2-Oxybis(1-chloropropane).....	611	625, 1625		6410 B		
76. PCB-1016.....	608	625		6410 B		Note 3, p 43
77. PCB-1221.....	608	625		6410 B		Note 3, p 43
78. PCB-1232.....	608	625		6410 B		Note 3, p 43
79. PCB-1242.....	608	625		6410 B		Note 3, p 43
80. PCB-1248.....	608	625		6410 B		
81. PCB-1254.....	608	625		6410 B		Note 3, p 43
82. PCB-1260.....	608	625		6410 B, 6630 B		Note 3, p 43
83. Pentachlorophenol.....	604	625, 1625		6410 B, 6630 B		Note 3, p.140
84. Phenanthrene.....	610	625, 1625	610	6410 B, 6440 B	D4657-87	
85. Phenol.....	604	625, 1625		6420 B, 6410 B		
86. Pyrene.....	610	625, 1625	610	6410 B, 6440 B	D4657-87	
87. 2,3,7,8-Tetrachlorodibenzo-p-dioxin.....		613				
88. 1,1,2,2-Tetrachloroethane.....	601	624, 1624		6230 B, 6210 B		Note 3, p 130
89. Tetrachloroethene.....	601	624, 1624		6230 B, 6210 B		Note 3, p.130
90. Toluene.....	602	624, 1624		6210 B, 6220 B		
91. 1,2,4-Trichlorobenzene.....	612	625, 1625		6410 B		Note 3, p.130.
92. 1,1,1-Trichloroethane.....	601	624, 1624		6210 B, 6230 B		
93. 1,1,2-Trichloroethane.....	601	624, 1624		6210 B, 6230 B		Note 3, p 130.
94. Trichloroethene.....	601	624, 1624		6210 B, 6230 B		
95. Trichlorofluoromethane.....	601	624		6210 B, 6230 B		
96. 2,4,6-Trichlorophenol.....	604	625, 1625		6410 B, 6240 B		
97. Vinyl chloride.....	601	624, 1624		6210 B, 6230 B		

Table 1C notes:

- ¹ All parameters are expressed in micrograms per liter ($\mu\text{g/L}$).
- ² The full text of Methods 601-613, 624, 625, 1624, and 1625, are given at Appendix A, "Test Procedures for Analysis of Organic Pollutants," of this Part 136. The standardized test procedure to be used to determine the method detection limit (MDL) for these test procedures is given at Appendix B, "Definition and Procedure for the Determination of the Method Detection Limit" of this Part 136.
- ³ "Methods for Benzidine, Chlorinated Organic Compounds, Pentachlorophenol and Pesticides in Water and Wastewater," U.S. Environmental Protection Agency, September, 1978.
- ⁴ Method 624 may be extended to screen samples for Acrotoin and Acrylonitrile. However, when they are known to be present, the preferred method for these two compounds is Method 603 or Method 1624.
- ⁵ Method 625 may be extended to include benzidine, hexachlorocyclopentadiene, N-nitrosodimethylamine, and N-nitrosodiphenylamine. However, when they are known to be present, Methods 605, 607, and 612, or Method 1625, are preferred methods for these compounds.
- ⁶ 625, Screening only.
- ⁷ "Selected Analytical Methods Approved and Cited by the United States Environmental Protection Agency," Supplement to the Fifteenth Edition of Standard Methods for the Examination of Water and Wastewater (1961).
- ⁸ Each analyst must make an initial, one-time demonstration of their ability to generate acceptable precision and accuracy with Methods 601-603, 624, 625, 1624, and 1625 (See Appendix A of this Part 136) in accordance with procedures each in section 8.2 of each of these Methods. Additionally, each laboratory, on and on-going bases must spike and analyze 10% (5% for Methods 624 and 625 and 100% for Methods 1624 and 1625) of all samples to monitor and evaluate laboratory data quality in accordance with sections 8.3 and 8.4 of these Methods. When the recovery of any parameter falls outside the warning limits, the analytical results for that parameter in the unspiked sample are suspect and cannot be reported to demonstrate regulatory compliance.
- NOTE: These warning limits are promulgated as an "interim final action with a request for comments."

TABLE 1 D.—LIST OF APPROVED TEST PROCEDURES FOR PESTICIDES¹

[Table 1D revised by 56 FR 50759, October 8, 1991]

Parameter $\mu\text{g/L}$	EPA method number				Other
	Method	EPA ^{2,7}	Standard methods 17th Ed.	ASTM	
1. Aldrin.....	GC	608	6630 B & C	D3086-90	Note 3, p. 7, Note 4, p. 30.
2. Aroclor.....	GC/MS GC	625	6410 B		Note 3, p. 83, Note 6, p. S68.
3. Aminocarb.....	TLC				Note 3, p. 84, Note 6, p. S16.
4. Atraton.....	GC				Note 3, p. 63, Note 6, p. S68.
5. Atrazine.....	GC				Note 3, p. 83, Note 6, p. S68.
6. Azinphos methyl.....	GC				Note 3, p. 25, Note 6, p. S51.
7. Barban.....	TLC				Note 3, p. 104, Note 6, p. S64.
8. α -BHC.....	GC	608	6630 B & C	D3086-90	Note 3, p. 7.
9. β -BHC.....	GC/MS GC	625 608	6410 B 6630 C	D3086-90	
10. δ -BHC.....	GC/MS GC	625 608	6410 B 6630 C	D3086-90	
11. γ -BHC (Lindane).....	GC/MS GC	625 608	6410 B 6630 B & C	D3086-90	Note 3, p. 7, Note 4, p. 30.
12. Captan.....	GC/MS GC	625	6410 B 6630 B	D3086-90	Note 3, p. 7.
13. Carbyl.....	TLC				Note 3, p. 84, Note 6, p. S60.
14. Carbophenothion.....	GC				Note 4, p. 30, Note 6, p. S73.
15. Chlordane.....	GC	606	6630 B & C	D3086-90	Note 3, p. 7.
16. Chlorpropham.....	GC-MS TLC	625	6410 B		Note 3, p. 104, Note 6, p. S64.
17. 2,4-D.....	GC		6640 B		Note 3, p. 115, Note 4, p. 35.
18. 4,4'-D-DDD.....	GC	608	6630 B & C	D3086-90	Note 3, p. 7, Note 4, p. 30.
19. 4,4'-DDE.....	GC-MS GC	625 608	6410B 6630 B & C	D3086-90	Note 3, p. 7, Note 4, p. 30.

TABLE 1 D.—LIST OF APPROVED TEST PROCEDURES FOR PESTICIDES¹—Continued

Parameter µg/L	EPA method number			Other
	Method	EPA ^{2,3}	Standard methods 17th Ed.	
20. 4,4'-DDT.....	GC-MS GC	625 608	6410 B 6630 B & C	D3086-90 Note 3, p. 7; Note 4, p. 30.
21. Demeton-O.....	GC-MS GC	625	6410 B	Note 3, p. 25; Note 6, p. S51.
22. Dementon-S.....	GC			Note 3, p. 25; Note 6, p. S51.
23. Dazinin.....	GC			Note 3, p. 25; Note 4, p. 30; Note 6, p. S51.
24. Dicamba.....	GC			Note 3, p. 115.
25. Dichlofenthion.....	GC			Note 4, p. 30; Note 6, p. S73.
26. Dichloran.....	GC		6630 B & C	Note 3, p. 7.
27. Dicolof.....	GC			D3086-90
28. Dieldrin.....	GC	608	6630 B & C	Note 3, p. 7; Note 4, p. 30.
29. Dioxathion.....	GC-MS GC	625	6410 B	Note 4, p. 30; Note 6, p. S73.
30. Disulfoton.....	GC			Note 3, p. 25; Note 6, p. S51.
31. Diuron.....	TLC			Note 3, p. 104; Note 6, p. S64.
32. Endosulfan I.....	GC	608	6630 B & C	D3086-90 Note 3, p. 7
33. Endosulfan II.....	GC-MS GC	*625 608	6410 B 6630 B & C	D3086-90 Note 3, p. 7.
34. Endosulfan Sulfate.....	GC-MS GC	*625 608	6410 B 6630 C	
35. Endrin.....	GC-MS GC	625 608	6410 B 6630 B & C	D3086-90 Note 3, p. 7; Note 4, p. 30.
36. Endrin; aldehyde.....	GC-MS	*625	6410 B	
37. Ethion.....	GC	GC	608	Note 4, p. 30; Note 6, p. S73.
38. Fenuron.....	TLC			Note 3, p. 104; Note 6, p. S64.
39. Fenuron-TCA.....	TLC			Note 3, p. 104; Note 6, p. S64.
40. Heptachlor.....	GC	608	6630 B & C	D3086-90 Note 3, p. 7; Note 4, p. 30.
41. Heptachlor epoxide.....	GC/MS GC	625 608	6410 B 6630 B & C	D3086-90 Note 3, p. 7; Note 4, p. 30; Note 6, p. S73.
42. Isodrin.....	GC/MS GC	625	6410 b	Note 4, p. 30; Note 6, p. S73.
43. Linuron.....	GC			Note 3, p. 104; Note 6, p. S64.
44. Malathion.....	GC		6630 C	Note 3, p. 25; Note 4, p. 30; Note 6, p. S51.
45. Methiocarb.....	TLC			Note 3, p. 94; Note 6, p. S60.
45. Methoxychlor.....	GC		6630 B & C	D3086-90 Note 3, p. 7; Note 4, p. 30.
47. Mexacarbale.....	TLC			Note 3, p. 94; Note 6, p. S60.

TABLE 1 D.—LIST OF APPROVED TEST PROCEDURES FOR PESTICIDES¹—Continued

Parameter µg/L	EPA method number			Other	
	Method	EPA ^{2,3}	Standard methods 17th Ed.		ASTM
48. Mirex.....	GC		6630 B & C		Note 3, p. 7.
49. Monuron.....	TLC				Note 3, p. 104, Note 6, p. S64.
50. Monuron.....	TLC				Note 3, p. 104; Note 6, p. S64.
51. Nuburon.....	TLC				Note 3, p. 104; Note 6, p. S64.
52. Parathion methyl.....	GC		6630 C		Note 3, p. 25; Note 4, p. 30.
53. Parathion ethyl.....	GC		6630 C		Note 3, p. 25.
54. PCNB.....	GC		6630 B & C		Note 3, p. 7.
55. Perthane.....	GC			D3086-90	
56. Prometon.....	GC				Note 3 p. 83, Note 6, p. S68.
57. Prometryn.....	GC				Note 3, p. 83, Note 6, p. S68.
58. Propazine.....	GC				Note 3, p. 83, Note 6, p. S68.
59. Propam.....	TLC				Note 3, p. 104, Note 6, p. S64.
60. Propoxur.....	TLC				Note 3, p. 94, Note 6, p. S60.
61. Seccbumeton.....	TLC				Note 3, p. 83, Note 6, p. S68.
62. Siduron.....	TLC				Note 3, p. 104, Note 6, p. S64.
63. Simazine.....	GC				Note 3, p. 83, Note 6, p. S68.
64. Strobane.....	GC		6630 B & C		Note 3, p. 7.
65. Swep.....	TLC				Note 3, p. 104, Note 6, p. S64.
66. 2,4,5-T.....	GC		6640 B		Note 3, p. 115, Note 4, p. 35.
67. 2,4,5-TP (Silvex).....	GC		6640 B		Note 3, p. 115.
68. Terbutylazine.....	GC				Note 3, p. 83, Note 6, p. S68.
69. Toxaphene.....	GC	608	6630 B & C	D3086-90	Note 3, p. 7, Note 4, p. 30.
70. Trifluralin.....	GC/MS	625	6410 B		
	GC		6630 B		Note 3, p. 7.

Table 1D Notes:

¹ Pesticides are listed in this table by common name for the convenience of the reader. Additional pesticides may be found under Table 1C, where entries are listed by chemical name.

² The full text of Methods 608 and 625 are given at appendix A, "Test Procedures for Analysis of Organic Pollutants," of this part 136. The standardized test procedure to be used to determine the method detection limit (MDL) for these test procedures is given at appendix B, "Definition and Procedure for the Determination of the Method Detection Limit," of this part 136.

³ "Methods for Benzidine, Chlorinated Organic Compounds, Pentachlorophenol and Pesticides in Water and Wastewater," U.S. Environmental Protection Agency, September, 1978. This EPA publication includes thin-layer chromatography (TLC) methods.

⁴ "Methods for Analysis of Organic Substances in Water and Fluvial Sediments," Techniques of Water-Resources Investigations of the U.S. Geological Survey Book 5, Chapter A3 (1987).

⁵ The method may be extended to include α -BHC, δ -BHC, endosulfan I, endosulfan II, and endrin. However, when they are known to exist, Method 608 is the preferred method.

⁶ "Selected Analytical Methods Approved and Cited by the United States Environmental Protection Agency," Supplement to the Fifteenth Edition of Standard Methods for the Examination of Water and Wastewater (1981).

⁷ Each analyst must make an initial, one-time, demonstration of their ability to generate acceptable precision and accuracy with Methods 608 and 625 (See appendix A of this part 136) in accordance with procedures given in section 8.2 of each of these methods. Additionally, each laboratory, on an on-going basis, must spike and analyze 10% of all samples analyzed with Method 608 or 5% of all samples analyzed with Method 625 to monitor and evaluate laboratory data quality in accordance with Sections 8.3 and 8.4 of these methods. When the recovery of any parameter falls outside the warning limits, the analytical results for that parameter in the unspiked sample are suspect and cannot be reported to demonstrate regulatory compliance. These quality control requirements also apply to the Standard Methods, ASTM Methods, and other Methods cited.

NOTE: These warning limits are promulgated as an "Interim final action with a request for comments."

TABLE IE.—LIST OF APPROVED RADIOLOGICAL TEST PROCEDURES

[Table IE revised by 56 FR 50759, October 8, 1991]

Parameter and units	Method	EPA ¹	Reference (method number or page)		
			Standard methods 17th Ed.	ASTM	USGS ²
1. Alpha-Total, pCi per liter	Proportional or scintillation counter	900	703	D1943-81	pp. 75 and 78. ³
2. Alpha-Counting error, pCi per liter	Proportional or scintillation counter	Appendix B	703	D1943-81	p. 79.
3. Beta-Total, pCi per liter	Proportional counter	900.0	703	D1890-81	pp. 75 and 78. ³
4. Beta-Counting error, pCi per liter	Proportional counter	Appendix B	703	D1890-81	p. 79.
5. (a) Radium Total, pCi per liter	Proportional counter	903.0	705	D2460-70	
(b) ²²⁶ Ra, pCi per liter	Scintillation counter	903.1	706	D3454-79	p. 81.

Table IE Notes:
¹ "Prescribed Procedures for Measurement of Radioactivity in Drinking Water," EPA-600/4-80-032 (1980). U.S. Environmental Protection Agency, August 1980.
² Fishman, M.J. and Brown, Eugene, "Selected Methods of the U.S. Geological Survey of Analysis of Wastewaters," U.S. Geological Survey, Open-File Report 76-177 (1976).
³ The method found on p. 75 measures only the dissolved portion while the method on p. 78 measures only the suspended portion. Therefore, the two results must be added to obtain the "total".

[136.3(b) revised by 56 FR 50759, October 8, 1991]

(b) The full texts of the methods from the following references which are cited in Tables IA, IB, IC, ID, and IE are incorporated by reference into this regulation and may be obtained from the sources identified. All costs cited are subject to change and must be verified from the indicated sources. The full texts of all the test procedures cited are available for inspection at the Environmental Monitoring Systems Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, 26 West Martin Luther King Dr., Cincinnati, OH 45268 and the Office of the Federal Register, room 8301, 1110 L Street, NW., Washington, DC 20408.

References, Sources, Costs, and Table Citations:

(1) The full text of Methods 601-613, 624, 625, 1624, and 1625 are printed in appendix A of this part 136. The full text for determining the method detection limit when using the test procedures is given in appendix B of this part 136. The full text of Method 200.7 is printed in appendix C of this part 136. Cited in: Table IB, Note 5; Table IC, Note 2; and Table ID, Note 2.

(2) "Microbiological Methods for Monitoring the Environment, Water and

Wastes," U.S. Environmental Protection Agency, EPA-600/8-78-017, 1978. Available from: ORD Publications, CERL, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268. Table IA, Note 2.

(3) "Methods for Chemical Analysis of Water and Wastes," U.S. Environmental Protection Agency, EPA-600/4-79-020, March 1979, or "Methods for Chemical Analysis of Water and Wastes," U.S. Environmental Protection Agency, EPA-600/4-79-020, Revised March 1983. Available from: ORD Publications, CERL, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268. Table IB, Note 1.

(4) "Methods for Benzidine, Chlorinated Organic Compounds, Pentachlorophenol and Pesticides in Water and Wastewater," U.S. Environmental Protection Agency, 1978. Available from: ORD Publications, CERL, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268. Table IC, Note 3; Table D, Note 3.

(5) "Prescribed Procedures for Measurement of Radioactivity in Drinking Water," U.S. Environmental Protection Agency, EPA-600/4-80-032, 1980. Available from: ORD Publications, CERL, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268. Table IE, Note 1.

(6) "Standard Methods for the Examination of Water and

Wastewater," Joint Editorial Board, American Public Health Association, American Water Works Association, and Water Pollution Control Federation, 17th Edition, 1989. Available from: American Public Health Association, 1015 Fifteenth Street, NW., Washington, DC 20036. Cost: \$90.00. Tables IA, IB, and IE.

(7) Ibid, 15th Edition, 1980. Table IB, Note 30; Table ID.

(8) Ibid, 14th Edition, 1975. Table IF, Notes 17 and 27.

(9) Ibid, 13th Edition, 1971. Table IB, Note 31.

(10) "Selected Analytical Methods Approved and Cited by the United States Environmental Protection Agency," Supplement to the 15th Edition of Standard Methods for the Examination of Water and Wastewater, 1981. Available from: American Public Health Association, 1015 Fifteenth Street NW., Washington, DC 20036. Cost available from publisher. Table IB, Note 10; Table IC, Note 6; Table ID, Note 6.

(11) "Annual Book of Standards—Water," Section 11, Parts 11.01 and 11.02. American Society for Testing and Materials, 1991, 1916 Race Street, Philadelphia, PA 19103. Cost available from publisher. Tables IB, IC, ID, and IF.

(12) "Methods for Collection and Analysis of Aquatic Biological and Microbiological Samples," edited by Britton, L.J. and P.E. Gresson, Techniques of Water Resources Investigations, of the U.S. Geological Survey, Book 5, Chapter A4 (1989).

[Sec. 136.3(b)(12)]

Available from: U.S. Geological Survey, Denver Federal Center, Box 25425, Denver, CO 80225. Cost: \$9.25 (subject to change). Table IA.

(13) "Methods for Determination of Inorganic Substances in Water and Fluvial Sediments," by M.J. Fishman and Linda C. Friedman, Techniques of Water-Resources Investigations of the U.S. Geological Survey, Book 5 Chapter A1 (1989). Available from: U.S. Geological Survey, Denver Federal Center, Box 25425, Denver, CO 80225. Cost: \$108.75 (subject to change). Table IB, Note 2.

(14) "Methods for Determination of Inorganic Substances in Water and Fluvial Sediments," N.W. Skougstad and others, editors. Techniques of Water-Resources Investigations of the U.S. Geological Survey, Book 5, Chapter A1 (1979). Available from: U.S. Geological Survey, Denver Federal Center, Box 25425, Denver, CO 80225. Cost: \$10.00 (subject to change). Table IB, Note 8.

(15) "Methods for the Determination of Organic Substances in Water and Fluvial Sediments," Wershaw, R.L., et al., Techniques of Water-Resources Investigations of the U.S. Geological Survey, Book 5, Chapter A3 (1987). Available from: U.S. Geological Survey, Denver Federal Center, Box 25425, Denver, CO 80225. Cost: \$0.90 (subject to change). Table IB, Note 24; Table ID, Note 4.

(16) "Water Temperature—Influential Factors, Field Measurement and Data Presentation," by H.H. Stevens, Jr., J. Ficke, and G.F. Smoot, Techniques of Water-Resources Investigations of the U.S. Geological Survey, Book 1, Chapter D1, 1975. Available from: U.S. Geological Survey, Denver Federal Center, Box 25425, Denver, CO 80225. Cost: \$1.60 (subject to change). Table IB, Note 32.

(17) "Selected Methods of the U.S. Geological Survey of Analysis of Wastewaters," by M.J. Fishman and Eugene Brown; U.S. Geological Survey Open File Report 76-77 (1976). Available from: U.S. Geological Survey, Branch of Distribution, 1200 South Eads Street, Arlington, VA 22202. Cost: \$13.50 (subject to change). Table IE, Note 2.

(18) "Official Methods of Analysis of the Association of Official Analytical Chemists", Methods manual, 15th

Edition (1990). Price: \$240.00. Available from: The Association of Official Analytical Chemists, 2200 Wilson Boulevard, Suite 400, Arlington, VA 22201. Table IB, Note 3.

(19) "American National Standard on Photographic Processing Effluents," April 2, 1975. Available from: American National Standards Institute, 1430 Broadway, New York, New York 10018. Table IB, Note 9.

(20) "An Investigation of Improved Procedures for Measurement of Mill Effluent and Receiving Water Color," NCASI Technical Bulletin No. 253, December 1971. Available from: National Council of the Paper Industry for Air and Stream Improvements, Inc., 260 Madison Avenue, New York, NY 10016. Cost available from publisher. Table IB, Note 18.

(21) Ammonia, Automated Electrode Method, Industrial Method Number 379-75WE, dated February 19, 1976. Technicon Auto Analyzer II. Method and price available from Technicon Industrial Systems, Tarrytown, New York 10591. Table IB, Note 7.

(22) Chemical Oxygen Demand, Method 8000, Hach Handbook of Water Analysis, 1979. Method price available from Hach Chemical Company, P.O. Box 389, Loveland, Colorado 80537. Table IB, Note 14.

(23) OIC Chemical Oxygen Demand Method, 1978. Method and price available from Oceanography International Corporation, 512 West Loop, P.O. Box 2980, College Station, Texas 77640. Table IB, Note 13.

(24) ORION Research Instruction Manual, Residual Chlorine Electrode Model 97-70, 1977. Method and price available from ORION Research Incorporation, 840 Memorial Drive, Cambridge, Massachusetts 02138. Table IB, Note 16.

(25) Bicinchoninate Method for Copper, Method 8506, Hach Handbook of Water Analysis, 1979. Method and price available from Hach Chemical Company, P.O. Box 300, Loveland, Colorado 80537. Table IB, Note 19.

(26) Hydrogen Ion (pH) Automated Electrode Method, Industrial Method Number 378-75WA, October 1976. Bran

& Luebbe (Technicon) Auto Analyzer II. Method and price available from Bran & Luebbe Analyzing Technologies, Inc. Elmsford, N.Y. 10523. Table IB, Note 21.

(27) 1,10-Phenanthroline Method using FerroVer Iron Reagent for Water, Hach Method 8008, 1980. Method and price available from Hach Chemical Company, P.O. Box 389 Loveland, Colorado 80537. Table IB, Note 22.

(28) Periodate Oxidation Method for Manganese, Method 8034, Hach Handbook for Water Analysis, 1979. Method and price available from Hach Chemical Company, P.O. Box 389, Loveland, Colorado 80537. Table IB, Note 23.

(29) Nitrogen, Nitrite—Low Range, Diazotization Method for Water and Wastewater, Hach Method 8507, 1979. Method and price available from Hach Chemical Company, P.O. Box 389, Loveland, Colorado 80537. Table IB, Note 25.

(30) Zincon Method for Zinc, Method 8009, Hach Handbook for Water Analysis, 1979. Method and price available from Hach Chemical Company, P.O. Box 389, Loveland, Colorado 80537. Table IB, Note 33.

(31) "Direct Determination of Elemental Phosphorus by Gas-Liquid Chromatography," by R.F. Addison and R.G. Ackman, Journal of Chromatography, Volume 47, No. 3, pp. 421-426, 1970. Available in most public libraries. Back volumes of the Journal of Chromatography are available from Elsevier/North-Holland, Inc., Journal Information Centre, 52 Vanderbilt Avenue, New York, NY 10164. Cost available from publisher. Table IB, Note 28.

(32) "Direct Current Plasma (DCP) Optical Emission Spectrometric Method for Trace Elemental Analysis of Water and Wastes, Method AES0029," 1988, revised 1991, (with appendix), Applied Research Laboratories, Inc., 24911 Avenue Stanford, Valencia, CA 91355. Table IB, Note 34.

(c) Under certain circumstances the Regional Administrator or the Director in the Region or State where the discharge will occur may determine for a particular discharge that additional

parameters or pollutants must be reported. Under such circumstances, additional test procedures for analysis of pollutants may be specified by the Regional Administrator, or the Director upon the recommendation of the Director of the Environmental Monitoring Systems Laboratory Cincinnati.

[136.3(c) amended by 56 FR 50759, October 8, 1991]

(d) Under certain circumstances, the Administrator may approve, upon recommendation by the Director, Environmental Monitoring Systems Laboratory—Cincinnati, additional alternate test procedures for nationwide use.

[136.3(d) amended by 56 FR 50759, October 8, 1991]

(e) Sample preservation procedures, container materials, and maximum allowable holding times for parameters cited in Tables IA, IB, IC, ID, and IE are prescribed in Table II. Any person may apply for a variance from the prescribed preservation techniques, container materials, and maximum holding times applicable to samples taken from a specific discharge. Applications for variances may be made by letters to the Regional Administrator in the Region in which the discharge will occur. Sufficient data should be provided to assure such variance does not adversely affect the integrity of the sample. Such

data will be forwarded, by the Regional Administrator, to the Director of the Environmental Monitoring Systems Laboratory—Cincinnati, Ohio for technical review and recommendations for action on the variance application. Upon receipt of the recommendations from the Director of the Environmental Monitoring Systems Laboratory, the Regional Administrator may grant a variance applicable to the specific charge to the applicant. A decision to approve or deny a variance will be made within 90 days of receipt of the application by the Regional Administrator.

[136.3(e) amended by 56 FR 50759, October 8, 1991]

TABLE II.—REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES

[Table II amended by 55 FR 33439, August 15, 1990]

Parameter No./name	Container ¹	Preservation ^{2,3}	Maximum holding time ⁴
Table IA—Bacterial Tests:			
1-4 Coliform, fecal and total	P, G	Cool, 4°C, 0.008% Na ₂ S ₂ O ₃ ⁵	6 hours
5 Fecal streptococci	P, G	do	Do.
Table IB—Inorganic Tests:			
1 Acidity	P, G	Cool, 4°C	14 days
2 Alkalinity	P, G	do	Do.
4 Ammonia	P, G	Cool, 4°C, H ₂ SO ₄ to pH < 2	28 days
9 Biochemical oxygen demand	P, G	Cool, 4°C	48 hours
11 Bromide	P, G	None required	28 days
14 Biochemical oxygen demand, carbonaceous	P, G	Cool, 4°C	48 hours
15 Chemical oxygen demand	P, G	Cool, 4°C, H ₂ SO ₄ to pH < 2	28 days
16 Chloride	P, G	None required	Do.
17 Chlorine, total residual	P, G	do	Analyze immediately
21 Color	P, G	Cool, 4°C	48 hours
23-24 Cyanide, total and amenable to chlorination	P, G	Cool, 4°C, NaOH to pH > 12, 0.6g ascorbic acid ⁶	14 days ⁷
25 Fluoride	P	None required	28 days
27 Hardness	P, G	HNO ₃ to pH < 2, H ₂ SO ₄ to pH < 2	6 months
28 Hydrogen ion (pH)	P, G	None required	Analyze immediately
31, 43 Kjeldahl and organic nitrogen	P, G	Cool, 4°C, H ₂ SO ₄ to pH < 2	28 days
Metals:⁸			
18 Chromium VI	P, G	Cool, 4°C	24 hours
35 Mercury	P, G	HNO ₃ to pH < 2	28 days
3, 5-8, 10, 12, 13, 19, 20, 22, 26, 29, 30, 32-34, 36, 37, 45, 47, 51, 52, 58-60, 62, 63, 70-72, 74, 75 Metals, except chromium VI and mercury	P, G	do	6 months
38 Nitrate	P, G	Cool, 4°C	48 hours
39 Nitrate-nitrite	P, G	Cool, 4°C, H ₂ SO ₄ to pH < 2	28 days
40 Nitrite	P, G	Cool, 4°C	48 hours
41 Oil and grease	G	Cool to 4°C, HCl or H ₂ SO ₄ to pH < 2	28 days
42 Organic carbon	P, G	Cool, 4°C, HCl or H ₂ SO ₄ to pH < 2	Do.
44 Orthophosphate	P, G	Filter immediately, Cool, 4°C	48 hours
46 Oxygen, Dissolved Probe	G Bottle and top	None required	Analyze immediately

TABLE II.—REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES—Continued

Parameter No./name	Container ¹	Preservation ^{2,3}	Maximum holding time ⁴
47. Winkler	do	Fix on site and store in dark	8 hours
48. Phenols	G only	Cool, 4°C, H ₂ SO ₄ to pH < 2	28 days
49. Phosphorus (elemental)	G	Cool, 4°C	48 hours
50. Phosphorus, total	P, G	Cool, 4°C, H ₂ SO ₄ to pH < 2	28 days
53. Residue, total	P, G	Cool, 4°C	7 days
54. Residue, Filterable	P, G	do	7 days
55. Residue, Nonfilterable (TSS)	P, G	do	7 days
56. Residue, Settleable	P, G	do	48 hours
57. Residue, volatile	P, G	do	7 days
61. Silica	P	do	28 days
64. Specific conductance	P, G	do	Do
65. Sulfide	P, G	do	Do
66. Sulfide	P, G	Cool, 4°C add zinc acetate plus sodium hydroxide to pH > 9.	7 days
67. Sulfite	P, G	None required	Analyze immediately
68. Surfactants	P, G	Cool, 4°C	48 hours
69. Temperature	P, G	None required	Analyze
73. Turbidity	P, G	Cool, 4°C	48 hours
Table IC—Organic Tests ⁵			
13, 18-20, 22, 24-28, 34-37, 39-43, 45-47, 56, 66, 68, 69, 92-95, 97. Purgeable Halocarbons	G, Teflon-lined septum	Cool, 4°C, 0.008% Na ₂ S ₂ O ₃ ⁶	14 days
6, 57, 90. Purgeable aromatic hydrocarbons	do	Cool, 4°C, 0.008% Na ₂ S ₂ O ₃ , HCl to pH 2 ⁶	Do
3, 4. Acrolien and acrylonitrile	do	Cool, 4°C, 0.008% Na ₂ S ₂ O ₃ , Adjust pH to 4-5 ¹⁰	Do
23, 30, 44, 49, 53, 67, 70, 71, 83, 85, 96 Phenols ¹¹	G, Teflon-lined cap	Cool, 4°C, 0.008% Na ₂ S ₂ O ₃ ⁶	7 days until extraction 40 days after extraction
7, 38 Benzidines ¹¹	do	do	7 days until extraction ¹¹
14, 17, 48, 50-52 Phthalate esters ¹¹	do	Cool, 4°C	7 days until extraction 40 days after extraction
72-74. Nitrosamines ^{11, 12}	do	Cool, 4°C, store in dark, 0.008% Na ₂ S ₂ O ₃ ⁶	Do
76-82 PCBs ¹¹ acrylonitrile	do	Cool, 4°C	Do
54, 55, 65, 69. Nitroaromatics and isophorone ¹¹	do	Cool, 4°C, 0.008% Na ₂ S ₂ O ₃ ⁶ store in dark	Do
1, 2, 5, 8-12, 32, 33, 58, 59, 64, 68, 84, 86 Polynuclear aromatic hydrocarbons ¹¹	do	do	Do
15, 16, 21, 31, 75. Haloothers ¹¹	do	Cool, 4°C, 0.008% Na ₂ S ₂ O ₃ ⁶	Do
29, 35-37, 60-63, 91. Chlorinated hydrocarbons ¹¹	do	Cool, 4°C	Do
87. TCOD ¹¹	do	Cool, 4°C, 0.008% Na ₂ S ₂ O ₃ ⁶	Do
Table ID—Pesticides Tests			
1-70. Pesticides ¹¹	do	Cool, 4°C, pH 5-9 ¹³	Do
Table IE—Radiological Tests:			
1-5. Alpha, beta and radium	P, G	HNO ₃ to pH < 2	6 months

Table II Notes

- ¹ Polyethylene (P) or Glass (G).
- ² Sample preservation should be performed immediately upon sample collection. For composite chemical samples each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by maintaining at 4°C until compositing and sample splitting is completed.
- ³ When any sample is to be shipped by common carrier or sent through the United States Mails, it must comply with the Department of Transportation Hazardous Materials Regulations (48 CFR Part 172). The person offering such material for transportation is responsible for ensuring such compliance. For the preservation requirements of Table II, the Office of Hazardous Materials, Materials Transportation Bureau, Department of Transportation has determined that the Hazardous Materials Regulations do not apply to the following materials: Hydrochloric acid (HCl) in water solutions at concentrations of 0.04% by weight or less (pH about 1.96 or greater); Nitric acid (HNO₃) in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater); Sulfuric acid (H₂SO₄) in water solutions at concentrations of 0.35% by weight or less (pH about 1.15 or greater); and Sodium hydroxide (NaOH) in water solutions at concentrations of 0.080% by weight or less (pH about 12.30 or less).
- ⁴ Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid. Samples may be held for longer periods only if the permittee, or monitoring laboratory, has data on file to show that the specific types of samples under study are stable for the longer time, and has received a variance from the Regional Administrator under § 136.3(e). Some samples may not be stable for the maximum time period given in the table. A permittee, or monitoring laboratory, is obligated to hold the sample for a shorter time if knowledge exists to show that this is necessary to maintain sample stability. See § 136.3(e) for details.
- ⁵ Should only be used in the presence of residual chlorine.
- ⁶ Maximum holding time is 24 hours when sulfide is present. Optionally all samples may be tested with lead acetate paper before pH adjustments in order to determine if sulfide is present. If sulfide is present, it can be removed by the addition of cadmium nitrate powder until a negative spot test is obtained. The sample is filtered and then NaOH is added to pH 12.

APPENDIX III—CHEMICAL ANALYSIS
TEST METHODS

Tables 1, 2, and 3 specify the appropriate analytical procedures, described in "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," (incorporated by reference, see § 260.11) which shall be used to determine whether a sample contains a given Appendix VII or VIII toxic constituent.

Table 1 identifies each Appendix VII or VIII organic constituent along with the approved measurement method. Table 2 identifies the corresponding methods for inorganic species. Table 3 summarizes the contents of SW-846 and supplies specific section and method numbers for sampling and analysis methods.

Prior to final sampling and analysis method selection the analyst should consult the specific section or method described in SW-846 for additional guidance on which of the approved methods should be employed for a specific sample analysis situation.

TABLE 1—ANALYSIS METHODS FOR ORGANIC
CHEMICALS CONTAINED IN SW-846

[Amended by 51 FR 5330, February 13, 1986; 51 FR 6541, February 25, 1986; 51 FR 37728, October 24, 1986; 54 FR 41407, October 6, 1989; 55 FR 18505, May 2, 1990; 55 FR 50482, December 6, 1990]

Compound	Method Numbers
Acetonitrile	8030, 8240
Acrolein	8030, 8240
Acrylamide	8015, 8240
Acrylonitrile	8030, 8240
2-Amino-1-methylbenzene (o-Toluidine)	8250
4-Amino-1-methylbenzene (p-Toluidine)	8250
Aniline	8250
Benzene	8020, 8024
Benz[a]anthracene	8100, 8250, 8310
Benzo[a]pyrene	8100, 8250, 8310
Benzo[k]fluoranthene	8100, 8250, 8270, 8310

Compound	Method Numbers	Compound	Method Numbers
Benzotrichloride	8120, 8250	Methyl bromide	8010, 8240, 8260
Benzyl chloride	8120, 8250	Methyl ethyl ketone	8015, 8240
Benzo(b)fluoranthene	8100, 8250, 8310	Methyl isobutyl ketone	8015, 8240
Bis(2-chloroethoxymethane)	8010, 8240	Naphthalene	8100, 8250
Bis(2-chloroethyl)ether	8010, 8240	Naphthoquinone	8090, 8250
Bis(2-chloroisopropyl)ether	8010, 8240	Nitrobenzene	8090, 8250
Carbon disulfide	8015, 8240	4-Nitrophenol	8040, 8240
Carbon tetrachloride	8010, 8240	1,1-Dimethylhydrazine (UDMH)	8250
Chloridane	8080, 8250	2-Nitropropane	8030, 8240
Chlorinated biphenyls	8080, 8250	Paraldehyde (trimer of acetaldehyde)	8015, 8240
Chlorinated dibenzo-p-dioxins	8280	Pentachlorophenol	8040, 8250
Chlorinated dibenzofurans	8280	Phenol	8040, 8250
Chloroacetaldehyde	8010, 8240	Phorate	8140
Chlorobenzene	8020, 8240	Phosphorodithioic acid esters	8140
Chloroform	8010, 8240	Phthalic anhydride	8090, 8250
Chloromethane	8010, 8240	2-Picoline	8090, 8250
2-Chlorophenol	8040, 8250	Pyridine	8090, 8250
Chrysene	8100, 8250, 8310	Tetrachlorobenzene(s)	8120, 8250
Creosote ¹	8100, 8250	Tetrachloroethane(s)	8010, 8240
Cresol(s)	8040, 8250	Tetrachloroethene	8040, 8250
Cresylic Acid(s)	8040, 8250	Toluene	8020, 8024
Dichlorobenzene(s)	8010, 8120, 8250	Toluene diisocyanate(s)	8250
Dichloroethane(s)	8010, 8240	Toluenediamine	8250
Dichloromethane	8010, 8240	2,4-Toluenediamine	8250
Dichlorophenoxyacetic acid	8150, 8250	2,6-Toluenediamine	8250
Dichloropropanol	8120, 8250	3,4-Toluenediamine	8250
2,4-Dimethylphenol	8040, 8250	Toxaphene	8080, 8250
Dimethyl sulfate	8250, 8270	Trichloroethane	8010, 8240
Dinitrobenzene	8090, 8250	Trichloroethene(s)	8010, 8240
4,6-Dinitro-o-cresol	8040, 8250	Trichlorofluoromethane	8040, 8250
2,4-Dinitrotoluene	8090, 8250	Trichlorophenol(s)	8150, 8250
2,6-Dinitrotoluene	8060, 8250	2,4,5-Trichlorophenoxy propionic acid	8010, 8240
Endrin	8080, 8250	Trichloropropane	8010, 8240
2-Ethoxyethanol	8030, 8240	Vinyl chloride	8010, 8240
Ethyl ether	8015, 8240	Vinylidene chloride	8010, 8240
Ethylene dibromide	8010, 8240	Xylene	8020, 8240
Ethylene thiourea	8250, 8330		
Formaldehyde	8015, 8240		
Formic acid	8250		
Heptachlor	8080, 8250		
Hexachlorobenzene	8120, 8250		
Hexachlorobutadiene	8120, 8250		
Hexachloroethane	8010, 8240		
Hexachlorocyclopentadiene	8120, 8250		
Lindane	8080, 8250		
Maleic anhydride	8250		
Methanol	8010, 8240		
Methylol	8250		

¹ Analyte for phenanthrene and carbazole; if these are present in a ratio between 1.4:1 and 5:1 creosote should be considered present.

TABLE 2 — ANALYSIS METHODS FOR INORGANIC CHEMICALS AND MISCELLANEOUS GROUPS OF ANALYTES CONTAINED IN SW-846*

Compound	Third Edition Method(s)		Second Edition Method(s)
Aluminum	6010		
Antimony	6010		7040, 7041
Arsenic	6010		7060, 7061
Barium	6010		7080, 7081
Beryllium	6010, 7090, 7091		
Boron	6010		
Cadmium	6010		7130, 7131
Calcium	6010		
Chromium	6010		7190, 7191
Chromium, Hexavalent	7198		7195, 7196, 7197
Cobalt	6010		
Copper	6010, 7210, 7211		
Iron	6010, 7380, 7381		
Lead	6010		7420, 7421
Magnesium	6010		
Manganese	6010, 7460, 7461		
Mercury			7470, 7471
Molybdenum	6010		
Nickel	6010		7520, 7521
Osmium	7550		
Potassium	6010		
Selenium	6010		7740, 7741
Silicon	6010		
Silver	6010		7760, 7761
Sodium	6010, 7770		
Thallium	6010, 7840, 7841		
Vanadium	6010, 7910, 7911		
Zinc	6010, 7950, 7951		
Cyanides			9010
Total Organic Halides	9022		9020
Sulfides			9030
Sulfates	9035, 9036, 9038		
Total Organic Carbon	9060		
Phenolics	9065, 9066*, 9067		
Oil and Grease	9070, 9071		
Total Coliform	9131, 9132		
Nitrate	9200		
Chlorides	9250, 9251, 9252		
Gross Alpha and Gross Beta	9310		
Alpha-Emitting Radium Isotopes	9315		
Radium-228	9320		

* The Third Edition of SW-846 and its Revision I are available from the Government Printing Office, Superintendent of Documents, Washington, DC 20402, (202) 783-3238, document number 955-001-00000-1.

* When Method 9066 is used it must be preceded by the manual distillation specified in procedure 7.1 of Method 9065. Just prior to distillation in Method 9065, adjust the sulfuric acid-preserved sample to pH 4 with 1 + 9 NaOH. After the manual distillation is completed, the autoanalyzer manifold is simplified by connecting the re-sample line directly to the sampler.

[Table 2 revised by 54 FR 40266, September 29, 1989; amended by 55 FR 8949, March 9, 1990]

TABLE 3 — SAMPLING AND ANALYSIS METHODS CONTAINED IN SW-846*

[Table 3 revised by 54 FR 40266, September 29, 1989; amended by 55 FR 8949, March 9, 1990]

Title	Third Edition		Second Edition	
	Section No.	Method No.	Section No.	Method No.
Quality Control	1.0		10.0	
Introduction	1.1		10.1	
Quality Control	1.2			
Method Detection Limit	1.3			
Data Reporting	1.4			
Quality Control Documentation	1.5			
References	1.6			
Choosing the Correct Procedure	2.0			
Purpose	2.1			
Required Information	2.2			
Implementing the Guidance	2.3			
Characteristics	2.4			

TABLE 3 — SAMPLING AND ANALYSIS METHODS CONTAINED IN SW-646^a — Continued

Title	Third Edition		Second Edition	
	Section No.	Method No.	Section No.	Method No.
Ground Water	2.5			
References	2.6			
Metallic Analytes	3.0			
Sampling Considerations	3.1			
Sample Preparation Methods	3.2			
Acid Digestion of Waters for Total Recoverable or Dissolved Metals for Analysis by Flame AAS or ICP	3.2	3005		
Acid Digestion of Aqueous Samples and Extracts for Total Metals for Analysis by Flame AAS or ICP	3.2	3010	4.1	3010
Acid Digestion of Aqueous Samples and Extracts for Total Metals for Analysis by Furnace AAS	3.2	3020	4.1	3020
Dissolution Procedure for Oils, Greases, or Waxes	3.2	3040	4.1	3040
Acid Digestion of Sediments, Sludges and Soils	3.2	3050	4.1	3050
Methods for the Determination of Metals	3.3			
Inductively Coupled Plasma Atomic Emissions Spectroscopy	3.3	*6010		
Atomic Absorption Methods	3.3	7000		
Aluminum, Flame AAS	3.3	7020		
Antimony, Flame AAS	3.3	7040	7.0	7040
Antimony, Furnace AAS	3.3	7041	7.0	7041
Arsenic, Furnace AAS	3.3	7060	7.0	7060
Arsenic, Gaseous Hydride AAS	3.3	7061	7.0	7061
Barium, Flame AAS	3.3	7080	7.0	7080
Barium, Furnace AAS	3.3	7081	7.0	7081
Beryllium, Flame AAS	3.3	*7090		
Beryllium, Furnace AAS	3.3	*7091		
Cadmium, Flame AAS	3.3	7130	7.0	7130
Cadmium, Furnace AAS	3.3	7131	7.0	7131
Calcium, Flame AAS	3.3	7140		
Chromium, Flame AAS	3.3	7190	7.0	7190
Chromium, Furnace AAS	3.3	7191	7.0	7191
Chromium, Hexavalent, Coprecipitation	3.3	7195	7.0	7195
Chromium, Hexavalent, Colorimetric	3.3	7196	7.0	7196
Chromium, Hexavalent, Chelation/Extraction	3.3	7197	7.0	7197
Chromium, Hexavalent, Differential Pulse Polarography	3.3	*7198		
Cobalt, Flame AAS	3.3	7200		
Cobalt, Furnace AAS	3.3	7201		
Copper, Flame AAS	3.3	*7210		
Copper, Furnace AAS	3.3	*7211		
Iron, Flame AAS	3.3	*7360		
Iron, Furnace AAS	3.3	*7361		
Lead, Flame AAS	3.3	7420	7.0	7420
Lead, Furnace AAS	3.3	7421	5.0	7421
Magnesium, Flame AAS	3.3	7450		
Manganese, Flame AAS	3.3	*7460		
Manganese, Furnace AAS	3.3	*7461		
Mercury in Liquid Waste, Manual Cold Vapor Technique	3.3	7470	7.0	7470
Mercury in Solid or Semisolid Waste, Manual Cold Vapor Technique	3.3	7471	7.0	7471
Molybdenum, Flame AAS	3.3	7480		
Molybdenum, Furnace AAS	3.3	7481		
Nickel, Flame AAS	3.3	7520	7.0	7520
Osmium, Flame AAS	3.3	*7550		
Potassium, Flame AAS	3.3	7610		
Selenium, Furnace AAS	3.3	7740	7.0	7740
Selenium, Gaseous Hydride AAS	3.3	7741	7.0	7741
Silver, Flame AAS	3.3	7760	7.0	7760
Silver, Furnace AAS	3.3	7761	7.0	7761
Sodium, Flame AAS	3.3	*7770		
Thallium, Flame AAS	3.3	*7840		
Thallium, Furnace AAS	3.3	*7841		
Tin, Flame AAS	3.3	7870		
Vanadium, Flame AAS	3.3	*7910		
Vanadium, Furnace AAS	3.3	*7911		
Zinc, Flame AAS	3.3	*7950		
Zinc, Furnace AAS	3.3	*7951		
Organic Analytes	4.0		8.0	
Sampling Considerations	4.1			
Sample Preparation Methods	4.2			
Extractions and Preparations	4.2.1			
Organic Extraction and Sample Preparation	4.2.1	3500		

[Appendix III]

TABLE 3 — SAMPLING AND ANALYSIS METHODS CONTAINED IN SW-846^a — Continued

Title	Third Edition		Second Edition	
	Section No.	Method No.	Section No.	Method No.
Separatory Funnel Liquid-Liquid Extraction	4.2.1	3510	4.2	3510
Continuous Liquid-Liquid Extraction	4.2.1	3520	4.2	3520
Soxhlet Extraction	4.2.1	3540	4.2	3540
Ultrasonic Extraction	4.2.1	3550	4.2	3550
Waste Dilution	4.2.1	3580		
Purge-and-Trap	4.2.1	5030	5.0	5030
Protocol for Analysis of Sorbent Cartridges from VOST	4.2.1	*5040		
Cleanup	4.2.2			
Cleanup	4.2.2	3600		
Alumina Column Cleanup	4.2.2	3610		
Alumina Column Cleanup and Separation of Petroleum Wastes	4.2.2	*3611		
Florisil Column Cleanup	4.2.2	3620		
Silica Gel Cleanup	4.2.2	3630		
Gel-Permeation Cleanup	4.2.2	3640		
Acid-Base Partition Cleanup	4.2.2	3650	4.2	3530
Sulfur Cleanup	4.2.2	3660		
Determination of Organic Analyses	4.3			
Gas Chromatographic Methods	4.3.1		8.1	
Gas Chromatography	4.3.1	8000		
Halogenated Volatile Organics	4.3.1	8010	8.1	8010
EDB and DBCP	4.3.1	8011		
Nonhalogenated Volatile Organics	4.3.1	8015	8.1	8015
Aromatic Volatile Organics	4.3.1	8020	8.1	8020
Volatile Organic Compounds in Water by Purge-and-Trap Capillary Column GC with PID and Electrolytic Conductivity Detector in Series	4.3.1	8021		
Acrolein, Acrylonitrile, Acetonitrile	4.3.1	8030	8.1	8020
Phenols	4.3.1	8040	8.1	8040
Phthalate Esters	4.3.1	8050	6.1	*8060
Nitrosamines	4.3.1	8070		
Organochlorine Pesticides and PCBs as Arochlor	4.3.1	8080	8.1	8030
Nitroaromatics and Cyclic Ketones	4.3.1	8090	8.1	8090
Polynuclear Aromatic Hydrocarbons	4.3.1	8100	8.1	8100
Haloethers	4.3.1	8110		
Chlorinated Hydrocarbons	4.3.1	8120	8.1	8120
Organophosphorus Pesticides	4.3.1	8140	8.1	8140
Organophosphorus Pesticides: Capillary Column	4.3.1	8141		
Chlorinated Herbicides	4.3.1	8150	8.1	8150
Gas Chromatographic/Mass Spectroscopic Methods	4.3.2		8.2	
GC/MS Volatiles	4.3.2	8240	8.2	8240
GC/MS Semivolatiles, Packed Column	4.3.2	8250	8.2	8250
GC/MS for Volatiles Capillary Column	4.3.2	8260		
GC/MS Semivolatiles, Capillary Column	4.3.2	8270	8.2	8270
Analysis of Chlorinated Dioxins and Dibenzofurans	4.3.2	8280		
High Performance Liquid Chromatographic Methods (HPLC)	4.3.3		8.3	
Polynuclear Aromatic Hydrocarbons	4.3.3	8310	8.3	8210
Miscellaneous Screening Methods	4.4			
Headspace	4.4	3810	5.0	5020
Hexadecane Extraction and Screening of Purgeable Organics	4.4	3820		
Miscellaneous Test Methods	5.0		9.0	
Total and Amenable Cyanide (Colorimetric, Manual)	5.0	9010	9.0	9010
Total and Amenable Cyanide (Colorimetric, Automated)	5.0	9012		
Total Organic Halides (TOX)	5.0	9020	9.0	9020
Purgeable Organic Halides (POX)	5.0	9021		
Total Organic Halides (TOX) by Neutron Activation Analysis	5.0	9022		
Acid Soluble and Acid-Insoluble Sulfides	5.0	9030	9.0	9030
Extractable Sulfides	5.0	9031		
Sulfate, (Colorimetric, Automated Chloranilate)	5.0	*9035		
Sulfate, (Colorimetric, Automated, Methylthymol Blue, AA II)	5.0	*9036		
Sulfate, (Turbidimetric)	5.0	*9038		
Total Organic Carbon	5.0	*9060		
Phenolics, (Spectrophotometric, Manual 4-AAP)	5.0	*9065		
Phenolics, (Colorimetric, Automated 4-AAP)	5.0	*9066		
Phenolics, (Spectrophotometric, MBTH)	5.0	9067		
Total Recoverable Oil and Grease (Gravimetric, Separatory Funnel Extraction)	5.0	*9070		
Oil and Grease Extraction Method for Sludge Samples	6.0	*9071		
Total Coliform: Multiple Tube Fermentation	5.0	*9131		
Total Coliform: Membrane Filter	5.0	*9132		
Nitrate	5.0	*9200		
Chloride (Colorimetric, Automated Ferricyanide AA1)	5.0	*9250		
Chloride (Colorimetric, Automated Ferricyanide AAII)	5.0	*9251		
Chloride (Titrimetric, Mercuric Nitrate)	5.0	*9252		

[Appendix III]

TABLE 3 — SAMPLING AND ANALYSIS METHODS CONTAINED IN SW-846^a — Continued

Title	Third Edition		Second Edition	
	Section No.	Method No.	Section No.	Method No.
Properties	6.0			
Multiple Extraction Procedure	6.0	*1320		
Extraction Procedure for Oily Wastes	6.0	*1330		
pH Electrometric Measurement	6.0	9040	9.0	9040
pH Paper Method	6.0	9041		
Soil pH	6.0	9045		
Specific Conductance	6.0	9050		
Cation-Exchange Capacity of Soils (Ammonium Acetate)	6.0	*9080		
Cation-Exchange Capacity of Soils (Sodium Acetate)	6.0	*9081		
Compatibility Test for Wastes and Membrane Liners	6.0	9090		
Paint Filter Liquids Test	6.0	9095	9.0	9095
Saturated Hydraulic Conductivity, Saturated Leachate Conductivity, and Intrinsic Permeability	6.0	*9100		
Gross Alpha and Gross Beta	6.0	*9310		
Alpha-Emitting Radium Isotopes	6.0	*9315		
Radium-228	6.0	*9320		
Introduction and Regulatory Definitions	7.0		2.0	
Ignitability	7.1		2.1.1	
Corrosivity	7.2		2.1.2	
Reactivity	7.3		2.1.3	
Test Method to Determine Hydrogen Cyanide Released from Wastes	7.3			
Test Method to Determine Hydrogen Sulfide Released from Wastes	7.3			
Extraction Procedure Toxicity	7.4		2.1.4	
Methods for Determining Characteristics	8.0		2.0	
Ignitability	8.1		2.1.1	
Pensky-Martens Closed-Cup Method	8.1	1010	2.1.1	1010
Setafash Closed-Cup Method	8.1	1020	2.1.1	1020
Corrosivity	8.2		2.1.2	
Corrosivity Toward Steel	8.2	1110	2.1.2	1110
Reactivity	8.3		2.1.3	
Toxicity	8.4		2.1.4	
Extraction Procedure (EP) Toxicity Method and Structural Integrity Test	8.4	1310	2.1.4	1310
Sampling Plan	9.0		1.0	
Design and Development	9.1		1.0.1.1	
Implementation	9.2		1.2.3.4	
Sampling Methods	10.0			
Modified Method 5 Sampling Train, Appendix A and B	10.0	*0010		
Source Assessment Sampling System (SASS)	10.0	*0020		
Volatile Organic Sampling Train	10.0	*0030		
Ground Water Monitoring	11.0			
Background and Objectives	11.1			
Relationship to the Regulations and to Other Documents	11.2			
Revisions and Additions	11.3			
Acceptable Designs and Practices	11.4			
Unacceptable Designs and Practices	11.5			
Land Treatment Monitoring	12.0			
Background	12.1			
Treatment Zone	12.2			
Regulatory Definition	12.3			
Monitoring and Sampling Strategy	12.4			
Analysis	12.5			
References and Bibliography	12.6			
Incineration	13.0			
Introduction	13.1			
Regulatory Definition	13.2			
Waste Characterization Strategy	13.3			
Stack-Gas Effluent Characterization Strategy	13.4			
Additional Effluent Characterization Strategy	13.5			
Selection of Specific Sampling and Analysis Methods	13.6			
References	13.7			

^a The Third Edition of SW-846 and its Revision I are available from the Government Printing Office, Superintendent of Documents, Washington, DC 20402, (202) 763-3238, document number 955-001-00000-1.

^b This method may be used in conjunction with or in addition to the methods found in the Second Edition of SW-846 as amended by Updates I and II.
 * When Method 9066 is used it must be preceded by the manual distillation specified in procedure 7.1 of Method 9065. Just prior to distillation in Method 9065, adjust the sulfuric acid-preserved sample to pH 4 with 1 + 9 NaOH. After the manual distillation is completed, the autoanalyzer manifold is simplified by connecting the re-sample line directly to the sampler.

[Appendix III]

APPENDIX B

FIELD INSTRUMENTATION SOPs

SECTION 15

FIELD INSTRUMENTATION

15.0 INTRODUCTION

Section 15 provides basic information on operating various pieces of equipment that are typically used in the field. The purpose of this section is not to provide standard operating procedures or to establish performance criteria for field instruments. The purpose is to provide a narrative description of some instrument use approaches and techniques that have been tested on certain projects. In Fall 1987, the Contract Laboratory Program (CLP) will publish a "Field Screening Methods Catalog" that will contain detailed discussions of field analytical methods, including use of field instruments for analysis. The CLP catalog will provide a consolidated reference for use by EPA, contractors, state and local agencies, and potentially responsible parties (PRPs) who will be conducting field analysis. When this compendium is updated, it will reflect the information contained in the CLP catalog. The updated compendium will also contain information on any additional instruments that were found useful by contractors but were not included in the catalog. Field monitoring instruments are used whenever the data quality objectives specify Level I and II analytical support as adequate.

The objective of Level I analysis is to generate data that are generally used in refining sampling plans and in estimating the extent of contamination at the site. This type of support provides real-time data for health and safety purposes. Additional data that can be obtained effectively by Level I analyses include pH, conductivity, temperature, salinity, and dissolved oxygen for water (see Sections 8 and 10), as well as some measurement of contamination using various kits (see Subsection 7.6).

Level I analyses are generally effective for total vapor readings using portable photoionization of flame ionization meters that respond to a variety of volatile inorganic and organic compounds (see Section 15).

Level I analysis provides data for onsite, real-time total vapor measurement, evaluation of existing conditions, refinement of sampling location, and health and safety evaluations. Data generated from Level I support are generally considered qualitative in nature, although limited quantitative data also can be generated. Data generated from this type of analysis provide the following:

- Identification of soil, water, air, and waste locations that have a high likelihood of showing contamination through subsequent analysis
- Real-time data to be used for health and safety consideration during site reconnaissance and subsequent intrusive activities
- Quantitative data if a contaminant is known and the instrument is calibrated to that substance

On the other hand, field analysis (see Section 7) involves the use of portable or transportable instruments that are based at or near a sampling site. Field analysis should not be confused with the process of obtaining total organic readings using portable meters. These instruments typically are used in obtaining data that is defined by data quantity objectives as Level I. (See Section 7 for a discussion of DQO data levels.) The analytical techniques associated with these instruments are derived from the experiences of a number of contractors and EPA personnel.

Equipment users also should consult the applicable manufacturer's operating manuals, which will provide a more comprehensive guide to all facets of using field equipment. Several of the procedures discussed below refer to sections of the manufacturer's manual that are too voluminous to reproduce here. Finally, all equipment calibrations and readings that occur in the field must be recorded in the site-specific logbook.

Exhibit 15-1, modified from Tables 7-1 and 7-2 of "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities," NIOSH / OSHA / USCG / EPA, October 1985, presents a summary of the characteristics of classes of instruments, specific examples of which are discussed in detail below.

15.1 PHOTOVAC 10A10

15.1.1 Scope and Purpose

Subsection 15.1 discusses the use, calibration, and maintenance of the Photovac 10A10.

15.1.2 Definitions

Carrier Gas

The gas used to transport a gaseous sample through the chromatographic column and on to the detector of a gas chromatograph. In the Photovac, the carrier gas is ultra-pure air.

Photolization Detector (PID)

The detector uses an ultraviolet light source to ionize individual molecules that have an ionization potential less than or equal to that rated for the ultraviolet light source. Gaseous contaminants are ionized as they emerge from the column, and the ions are then attracted to an oppositely charged electrode, causing a current and finally an electric signal to the strip chart recorder.

Retention Time

The total time required for a volatile chemical to traverse and emerge from chromatographic column into the detector, measured from the time of injection onto the column.

Site Manager (SM)

The individual responsible for the successful completion of a work assignment within budget and schedule. The person is also referred to as the Site Project Manager or the Project Manager and is typically a contractor's employee (see Subsection 1.1).

Standard

This is a known concentration of a known chemical that is used to perform quantitative analysis. Either the chemical constituent(s) can be in a solution with distilled water so that a headspace is present, or it can be completely vaporized in the volatile organic analysis (VOA) vial. A syringe can be used to withdraw some of the headspace gas after the vial is agitated, and this gas can be injected into the column for chromatographic analysis. The retention times of the standard are then compared to the retention times of unknown peaks in a sample.

Volatile Contaminants

Chemicals that are characterized by low boiling points and high vapor pressures.

**Exhibit 15-1
FIELD INSTRUMENTS***

<u>Instrument</u>	<u>Hazard Monitored</u>	<u>Application</u>	<u>Detection Method</u>	<u>Limitations</u>	<u>Ease of Operation</u>	<u>General Care and Maintenance</u>	<u>Typical Operating Times</u>
<p>Ultraviolet (UV) Photoionization Detector (PID)</p> <p>(Photovac 10A10)</p> <p>(HNU PI-101)</p>	<p>Many organic and some inorganic gases and vapors.</p>	<p>Detects total concentrations of many organic and some inorganic gases and vapors.</p> <p>Some identification of compounds is possible if more than one probe is used.</p>	<p>Ionizes molecules using UV radiation; produces a current that is proportional to the number of ions.</p>	<p>Does not detect methane.</p> <p>Does not detect a compound if the probe used has a lower energy level than the compound's ionization potential.</p> <p>Response may change when gases are mixed.</p> <p>Other voltage sources may interfere with measurements.</p> <p>Readings can only be reported relative to the calibration standard used.</p> <p>Response is affected by high humidity.</p>	<p>Effective use requires that the operator understands the operating principles and procedures, and is competent in calibrating, reading, and interpreting the instrument.</p>	<p>Recharge or replace battery.</p> <p>Regularly clean and maintain the instrument and accessories.</p>	<p>10 hours; 5 hours with strip chart recorder.</p>
<p>Flame Ionization Detector (FID) with Gas Chromatography Option</p> <p>(OVA 128)</p>	<p>Many organic gases and vapors.</p>	<p>In survey mode, detects the total concentrations of many organic gases and vapors. In gas chromatography (GC) mode, identifies and measures specific compounds.</p> <p>In survey mode, all the organic compounds are</p>	<p>Gases and vapors are ionized in a flame. A current is produced in proportion to the number of carbon atoms present.</p>	<p>Does not detect inorganic gases or some synthetics. Sensitivity depends on the compound.</p> <p>Should not be used at temperatures less than 40°F (4°C)</p> <p>Difficult to absolutely identify compounds.</p>	<p>Requires experience to interpret data correctly, especially in the GC mode.</p> <p>Specific identification requires calibration with specific analyte of interest.</p>	<p>Recharge or replace battery.</p> <p>Monitor fuel and/or combustion air supply gauges.</p> <p>Perform routine maintenance as described in the manual.</p> <p>Check for leaks.</p>	<p>8 hours; 3 hours with strip chart recorder.</p>

Exhibit 15-1
(continued)

<u>Instrument</u>	<u>Hazard Monitored</u>	<u>Application</u>	<u>Detection Method</u>	<u>Limitations</u>	<u>Ease of Operation</u>	<u>General Care and Maintenance</u>	<u>Typical Operating Times</u>
		are ionized and detected at the same time. In GC mode, volatile species are separated.		High concentrations of contaminants or oxygen-deficient atmospheres require system modification. In survey mode, readings can be only reported relative to the calibration standard used.			
Combustible Gas Indicator (CGI) (MSA Explosimeter)	Combustible gases and vapors.	Measures the concentration of a combustible gas or vapor.	A filament, usually made of platinum, is heated by burning the combustible gas or vapor. The increase in heat is measured.	Accuracy depends, in on the difference between the the calibration and sampling temperatures. Sensitivity is a function of the differences in the chemical and physical properties between the calibration gas and the gas being sampled. The filament can be damaged by certain compounds such as silicones, halides, tetraethyl lead, and oxygen-enriched atmospheres. CGI does not provide a valid reading under oxygen-deficient conditions.	Effective use requires that the operator understands the operating principles and procedures.	Recharge or replace battery. Calibrate immediately before use.	Can be used for as long as the battery lasts, or for the recommended interval between calibration which-ever is less.

Exhibit 15-1
(continued)

Instrument	Hazard Monitored	Application	Detection Method	Limitations	Ease of Operation	General Care and Maintenance	Typical Operating Times
Oxygen Meter (MSA Oxygen Meter)	Oxygen (O ₂).	Measures the percentage of O ₂ in air.	Uses an electrochemical sensor to measure the partial pressure of O ₂ in the air and converts that reading to O ₂ concentration.	Must be calibrated before use to compensate for altitude and barometric pressure. Certain gases, especially oxidants such as ozone, can affect readings. Carbon dioxide (CO ₂) poisons the detector cell.	Effective use requires that operator understands the operating principles and procedures.	Replace detector 8 to 12 hours, call according to manufacturer's recommendations. Recharge or replace batteries before expiration of the specified interval. If the ambient air is more than 0.5% CO ₂ , replace or rejuvenate the O ₂ detector cell frequently.	
Direct-Reading Colorimetric Indicator Tube (Draeger)	Specific gases and vapors.	The compound reacts with the indicator chemical in the tube, producing a stain whose length or color change is proportional to the compound's concentration.	The measured concentration of the same compound may vary among different manufacturer's tubes. Many similar chemicals interfere. Greatest sources of error are (1) how the operator judges stain's end-point and (2) the tube's limited accuracy. Affected by high humidity.	Minimal operator training and expertise required.	Do not use a previously opened tube even if the indicator chemical is not stained. Check pump for leaks before and after use. Refrigerate before use to maintain shelf life of about 2 years. Check expiration date of tubes. Calibrate pump volume at least quarterly. Avoid rough handling that may cause channeling.		

Exhibit 15-1
(continued)

Instrument	Hazard Monitored	Application	Detection Method	Limitations	Ease of Operation	General Care and Maintenance	Typical Operating Times
Gamma Radiation Survey Instrument (Thyac III)	Gamma radiation.	Environmental radiation monitor.	Scintillation detector.	Does not measure alpha or beta radiation.	Extremely easy to operate, but requires experience to interpret data. Rugged, good in field use.	Must be calibrated annually at a specialized facility.	Can be used for as long as the battery lasts, or for the recommended interval between calibrations, whichever is less.
Portable Infrared (IR) Spectrophotometer	Many gases and vapors.	Measures concentration of many gases and vapors in air. Designed to quantify one- or two-component mixtures.	Passes different frequencies of IR through the sample. The frequencies adsorbed are specific for each compound.	In the field, must make repeated passes to achieve reliable results. Requires 115-volt AC power. Not approved for use in a potentially flammable or explosive atmosphere. Interference by water vapor and carbon dioxide. Certain vapors and high moisture may attach the instrument's optics, which must then be replaced.	Requires personnel with extensive experience in IR spectrophotometry.	As specified by manufacturer.	

*Source: Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, Tables 7-1 and 7-2, HIOSII/OSHA/USCG/EPA, October 1985.

15.1.3 Applicability

This procedure is applicable to Photovac 10A10s used for field and laboratory analysis.

15.1.4 Responsibilities

The SM is responsible for monitoring the implementation of these procedures.

15.1.5 Records

Training records, maintenance records, and calibration records will be generated and maintained by the responsible organization. Maintenance, calibration, and results obtained in the field will be recorded in the site logbook.

15.1.6 Procedures

Before beginning the set-up and operation of 10A10, the following precautions should be carefully reviewed. Because of its special capabilities, 10A10 requires special treatment.

1. NEVER remove the top panel with the instrument connected to the MAINS (electrical supply); always disconnect the instrument first because of the danger of electric shock.
2. The 10A10 must always be connected to the carrier gas supply, and a continuous stream of carrier gas must be passed through the column. This arrangement maintains the column in peak condition and ready for use with a minimum of delay.
3. NEVER inject liquid samples, however small, into the 10A10. It is an all-gas system and is not designed to accept liquids, which will cause gross contamination and necessitate a thorough overhaul.
4. Read carefully the section in the manufacturer's manual on battery care. Avoid overcharging the batteries; otherwise, their life will be impaired.
5. Except when charging batteries, always unplug the unit from the MAINS (electrical supply) when it is not in use.
6. When transferring the unit from extremely cold environments into warm, humid conditions, be alert to the likelihood of condensation; if possible, allow some time for the instrument to warm up before using.
7. Establish that the Photovac 10A10 can detect the contaminate being tested for (see Exhibit 15-2). Two criteria can be followed:
 - a. The ionization potential of the compound must be less than 11 electron volts (eV).

- b. The boiling point of the compound must allow for its elution through an ambient temperature column. Higher boiling points will not allow this to occur.

15.1.6.1 Startup Procedure

1. The preferred carrier gas is Linde Air Ultra Zero or its equivalent (with less than 0.1 ppm total organic contamination). Fit the supply cylinder with a high-quality, two-stage gas chromatograph (GC) regulator. Connect the regulator to the CARRIER IN fitting with 1/8-inch Teflon tubing and a brass, quick-disconnect fitting.
2. Set the flowrate to 10 ± 1 ml/min by adjusting the CARRIER FLOW adjustment. Make a note of the setting for future use. Check the flowrate by attaching a flow meter with 1 ml/min or better accuracy to the OUT gas fitting.
3. Check that the electrical controls are set as follows:
 - a. Move POWER SWITCH to OFF.
 - b. Move CHARGE SWITCH to OFF.
 - c. Move ATTENUATION SWITCH to 100 (least sensitive).
 - d. Move OFFSET dial to zero.
 - e. Connect chart recorder to the coaxial OUTPUT connector, using the lead provided.
 - f. Set the chart recorder to 100 mV full scale and chart speed to 2 cm/min.
 - g. Plug the POWER CORD into the panel socket and connect to the 115V 60 Hz AC supply; the red AC indicator light will come on.

The instrument is now in its POWER DOWN condition and is ready for starting.

4. With the chart recorder off, switch on the POWER switch. The red source OFF indicator may light and stay on for up to 5 minutes. During this time, the lamp-start sequence is being automatically initiated. If more than 5 minutes is required, an adjustment must be made to the screw next to the lamp (under the aluminum housing).
5. As soon as the SOURCE OFF light is extinguished, the meter will show a high reading that should fall rapidly as conditions in the photoionizing chamber stabilize. The reading should become steady after approximately 5 minutes.
6. Establish an acceptable baseline on the chart recorder.
7. The instrument is now ready for calibration and use.
8. The user may now make sample injections from 1 to 1,000 l (can be larger in certain situations, i.e., low-level air monitoring).
9. **Reminder:** NEVER inject liquid samples into the Photovac.

Exhibit 15-2
SOME COMPOUNDS THAT CAN BE DETECTED USING
THE PHOTOVAC 10S SERIES OF PORTABLE GCs

	eV		eV
Acetaldehyde	10.21	2,3-Butadione	9.23
Acetic acid	10.37	N-Butanal	9.83
Acetone	9.69	2-Butanal	9.73
Acetylene	11.41	N-Butane	10.63
Acetylene dichloride	9.80	1-Butanethiol	9.14
Acetylene tetrabromide		2-Butanone	9.53
Acrolein	10.10	Iso-butanol	10.47
Acrylonitrile	10.91	Sec-butanol	10.23
Allene	9.83	Tert-butanol	10.25
Allyl alcohol	9.67	2-Butanol	10.1
Allyl chloride	10.20	1-Butene	9.58
Aminoethanol	9.87	Cis-2-butene	9.13
Ammonia	10.15	Trans-2-butene	9.13
Aniline	7.70	3-Butene nitrile	10.39
Anisole	8.22	N-butyl acetate	10.01
Arsine	9.89	Sec-butyl acetate	9.91
		N-butyl alcohol	10.04
		N-butyl amine	8.71
Benzaldehyde	9.53	I-butyl amine	8.70
Benzene	9.25	S-butyl amine	8.70
Benzenethiol	8.33	T-butyl amine	8.64
Benzyl chloride	10.16	N-butyl benzene	8.69
Benzonitrile	9.71	I-butyl benzene	8.68
Benzotrifluoride	9.68	T-butyl benzene	8.68
Bromobenzene	8.98	Butyl cellosolve	8.68
1-Bromobutane	10.13	N-butyl mercaptan	9.15
2-Bromobutane	9.98	I-butyl ethanoate	9.95
1-Bromobutanone	9.54	Iso-butyl mercaptan	9.12
1-Bromo-2-chloroethane	10.63	I-butyl methanoate	10.46
Bromochloromethane	10.77	1-Butyne	10.18
Bromodichloromethane		2-Butyne	9.85
1-Bromo-3-chloropropane		N-butyraldehyde	9.86
Bromoethane	10.28		
Bromoethene	9.80	Carbon disulfide	10.13
Bromoform	10.48	Carbon tetrachloride	11.28
1-Bromo-3-hexanone	9.26	Cellosolve acetate	
Bromoethane	10.53	Chlorobenzene	9.07
Bromoethyl ethyl ether	10.08	Chlorobromomethane	
1-Bromo-2-methylpropane	10.09	1-Chloro-2-bromoethane	10.63
2-Bromo-2-methylpropane	9.89	1-Chlorobutane	10.67
1-Bromopentane	10.10	2-Chlorobutane	10.65
1-Bromopropane	10.18	1-Chlorobutanone	9.54
2-Bromopropane	10.08	1-Chloro-2,3 epoxy propane	10.60
1-Bromopropene	9.30	Chloroethane (ethyl chloride)	10.97
2-Bromopropene	10.06	Chlorethene	10.00
3-Bromopropene	9.70	2-Chloroethoxyethene	10.61
2-Bromothiophene	8.63	1-Chloro-2-fluorobenzene	9.16
O-bromotoluene	8.79	1-Chloro-3-fluorobenzene	9.21
M-bromotoluene	8.81	1-Chloro-2-fluoroethene (cis)	9.87
P- bromotoluene	8.67	1-Chloro-2-fluoroethene(trans)	9.87
1,3-Butadiene	9.07	Chloroform	11.37

Exhibit 15-2
(continued)

	eV		eV
O-chloriodobenzene	8.35	Dichlorodifluoromethane	11.75
1-Chloro-2-methylbenzene	8.72	1,1-Dichloroethane	11.06
1-Chloro-3-methylbenzene	8.61	1,2-Dichloroethane	11.04
1-Chloro-4-methylbenzene	8.78	Cis-dichloroethene	9.65
Chloromethylethyl ether	10.08	Trans-dichloroethene	9.66
Chloromethylmethyl ether	10.25	Dichloroethyl ether	
1-chloro-2-methylpropane	10.66	Dichloromethane	11.35
Chloroprene		1,2-Dichloropropane	10.87
1-Chloropropane	10.82	1,3-Dichloropropane	10.85
2-Chloropropane	10.78	1,1-Dichloropropanone	9.71
3-Chloropropene	10.04	2,3-Dichloropropene	9.82
P-chlorostyrene		Dicyclopentadiene	7.74
2-Chlorothiophene	8.68	Dibutyl amine	7.69
O-chlorotoluene	8.83	Diethoxymethane	9.70
M-chlorotoluene	8.83	Diethyl amine	8.01
P-chlorotoluene	8.70	Diethyl ether	9.53
Cumene (1-propyl benzene)	8.75	N-diethyl formamide	8.89
Crotonaldehyde	9.73	Diethyl ketone	9.32
Cyanoethene	10.91	Diethyl sulfide	8.43
Cyanogen bromide	10.91	1,2-Difluorobenzene	9.31
3-Cyanopropene	10.39	1,4-Difluorobenzene	9.15
Cyclobutane	10.50	Difluorodibromomethane	11.18
Cyclohexane	9.98	Difluoromethylbenzene	9.45
Cyclohexanone	9.14	1,1-Dimethoxyethane	9.65
Cyclohexene	8.95	Dimethoxymethane	10.00
Cyclo-octatetraene	7.99	Dilodomethane	9.34
Cyclopentadiene	8.55	Diliosobutyl ketone	9.04
Cyclopentane	10.52	Dilisopropylamine	7.73
Cyclopentanone	9.26	Dimethyl amine	8.24
Cyclopentene	9.01	2,3-Dimethylbutadiene	8.72
Cyclopropane	10.06	2,2-Dimethyl butane	10.06
		2,2-Dimethyl butane-3-one	9.18
2-Decanone	9.40	2,3-Dimethyl butane	10.02
1,3-Dibromobutane		2,3-Dimethyl-2-butene	8.30
1,4-Dibromobutane		3,3-Dimethyl butanone	9.17
Dibromochloromethane	10.59	Dimethyl disulfide	8.46
Dibromochloropropane		Dimethyl ether	10.00
1,1-Dibromoethane	10.19	Dimethylformamide	9.45
Dibromomethane	10.49	3,5-Dimethyl-4-heptanone	9.04
1,2-Dibromopropane	10.26	2,2-Dimethyl-3-pentanone	8.98
2,2-Dibromopropane		2,2-Dimethyl-propane	10.35
1,2-Dichlorobenzene	9.07	Dimethyl sulfide	8.69
1,3-Dichlorobenzene	9.12	Di-n-propyl disulfide	8.27
1,4-Dichlorobenzene	8.94	Di-n-propyl ether	9.27
1,3-Dichlorobutane		Di-n-propyl ether	9.20
1,4-Dichlorobutane		Di-n-propyl amine	7.84
1,4-Dichloro-2-butene (cis)		Di-n-propyl sulfide	8.30
2,2-Dichlorobutane			
2,3-Dichlorobutane		Epichlorohydrin	10.60
3,4-Dichlorobutene (Freon 12)		Ethane	11.65
		Ethanal	10.21

Exhibit 15-2
(continued)

	eV		eV
Ethanol	10.62	Hexanone	
Ethanethiol (ethyl mercaptan)	9.29	Hexamethylbenzene	7.85
Ethene (ethylene)	10.52	Hydrazine	
Ethyl acetate	10.11	Hydrogen cyanide	13.91
Ethyl amine	8.86	Hydrogen selenide	9.88
Ethyl amyl ketone	9.10	Hydrogen sulfide	10.46
Ethyl benzene	8.76	Hydrogen telluride	9.14
Ethyl bromide	10.29		
Ethyl butyl ketone	9.02	Iodine	9.28
Ethyl chloride (chloroethane)	10.98	Iodobenzene	8.73
Ethyl chloroacetate	10.20	1-Iodobutane	9.21
Ethyl ethanoate	10.10	2-Iodobutane	9.09
Ethyl disulfide	8.27	Iodoethane (ethyl iodide)	9.33
Ethylene chlorohydrin	10.90	Iodomethane (methyl iodide)	9.54
Ethylene dibromide (EDB)	10.37	1-Iodo-2-methylpropane	9.18
Ethylene glycol dinitrate		1-Iodo-2-methylpropane	9.02
Ethylene oxide	10.56	1-Iodopentane	9.19
Ethyl formate	10.61	1-Iodopropane	9.26
Ethyl iodide	9.33	2-Iodopropane	9.17
Ethyl methanoate	10.61	O-iodotoluene	8.62
Ethyl isothiocyanate	9.14	M-iodotoluene	8.61
Ethyl methyl sulfide	8.55	P-iodotoluene	8.50
Ethyl propanoate	10.00	Isoamyl acetate	9.90
Ethyl trichloroacetate	10.44	Isoamyl alcohol	10.16
Ethylidene chloride		Isobutane	10.57
Ethynylbenzene	8.82	Isobutyl amine	8.70
		Isobutyl acetate	9.97
Mono-fluorobenzene	9.20	Isobutyl alcohol	10.47
Mono-fluoroethene	10.37	Isobutyl formate	10.46
Mono-fluoromethanal	11.4	Isobutyraldehyde	9.74
Fluorotribromomethane	10.67	Isopentane	10.32
O-fluorotoluene	8.92	Isoprene	8.85
M-fluorotoluene	8.92	Isopropyl acetate	9.99
P-fluorotoluene	8.79	Isopropyl alcohol	10.16
Freon 11 (CFCl ₃)	11.77	Isopropyl amine	8.72
Freon 12 (CF ₂ Cl ₂)	12.91	Isopropyl benzene	8.75
Freon 13 (CF ₃ Cl)	12.91	isopropyl ether	9.20
Freon 13 B-1 ³	12.08	Isovaleraldehyde	9.71
Freon 14 (neat)	16.25		
Freon 22 (CHClF ₂)	12.45	Mesitylene	8.40
Freon 113 (CF ₃ CCl ₃)	11.78	Mesityl oxide	9.08
2-Furaldehyde	9.21	Methanol	10.85
Furan	8.89	Methyl acetate	10.27
Furfuryl alcohol		Methyl acrylate	10.72
Furfural	9.21	Methyl amine	8.97
		Methyl bromide	10.53
Hexachloroethane		2-Methyl-1,3-butadiene	8.85
N-hexane	10.18	2-Methylbutanal	9.71
N-heptane	10.07	2-Methylbutane	10.31
2-Heptanone	9.33		
4-Heptanone	9.12		
1-Hexene	9.46		

Exhibit 15-2
(continued)

	eV		eV
2-Methyl-1-butene	9.12	N-pentane	10.35
3-Methyl-1-butene	9.51	Pentachloroethane	11.28
3-Methyl-2-butene	8.67	1,3-Pentadiene (cis)	8.59
Methyl n-butyl ketone	9.34	1,3-Pentadiene (trans)	8.56
Methyl butyrate	10.07	Pentafluorobenzene	9.84
Methyl cellosolve		Pentamethylbenzene	7.92
Methyl chloroacetate	10.35	N-pentanal	9.82
Methyl chloride	11.28	2,4-Pentanedione	8.87
Methyl chloroform	11.25	2-Pentanone	9.39
Methylcyclohexane	9.85	3-Pentanone	9.32
4-Methylcyclohexene	8.91	1-Pentene	9.50
Methylcyclopropane	9.52	Perchloroethylene	9.32
Methyl dichloroacetate	10.44	Perfluoro-2-butene	11.25
Methyl ethanoate	10.27	Perfluoro-1-heptene	10.48
Methyl ethyl ketone	9.53	N-perfluoropropyl iodide	10.36
Methyl ethyl sulfide	8.55	(N-perfluoropropyl)- iodomethane	9.96
2-Methyl furan	8.39	(N-perfluoropropyl)- methyl ketone	10.58
Methyl iodine	9.54	Phenol	8.69
Methyl isobutyl ketone	9.30	Phenyl ether	8.09
Methyl isobutyrate	9.98	Phenyl isocyanate	8.77
1-Methyl-4-isopropylbenzene		Phosphine	9.96
Methyl isopropyl ketone	9.32	Pinene	8.07
Methyl methacrylate	9.74	Propadiene	10.19
Methyl methanoate	10.82	N-propanal	9.95
Methyl mercaptan	9.44	Propane	11.07
2-Methylpentane	10.12	1-Propanethiol	9.20
3-Methylpentane	10.08	N-propanol	10.51
2-Methylpropane	10.56	Propanone	9.69
2-Methylpropanal	9.74	Propenal (acrolein)	10.10
2-Methyl-2-propanol	9.70	Propene	9.73
2-Methylpropene	9.23	Prop-1-ene-2-ol	8.2
Methyl n-propyl ketone	9.39	Prop-2-ene-1-ol	9.67
Methyl styrene	8.35	Propionaldehyde	9.98
Morpholine	8.88	N-propyl acetate	10.04
Naphthalene	8.10	N-propyl alcohol	10.20
Nitric oxide	9.25	N-propyl amine	8.78
Nitrobenzene	9.92	N-propyl benzene	8.72
Nitrotoluene	9.43	Propylene	9.73
N-nonane		Propylene dichloride	
5-Nonanone	9.10	Propylene oxide	10.22
N-octane		N-propyl ether	9.27
3-Octanone	9.19	N-propyl formate	10.54
4-Octanone	9.10	Propyne	10.36
1-Octene	9.52	Pyridine	9.32
		Styrene	8.47

Exhibit 15-2
(continued)

	eV		eV
Tetrabromoethane		4-Vinylcyclohexene	8.93
Tetrachloroethene	9.32	Vinyl ethanoate	9.19
1,1,1,2-Tetrachloroethane		Vinyl fluoride	10.37
1,1,2,2-Tetrachloroethane		Vinyl methyl ether	8.93
1,2,3,4-Tetrafluorobenzene	9.61		
1,2,3,5-Tetrafluorobenzene	9.55	O-xylene	8.56
1,2,3,5-Tetrafluorobenzene	9.39	M-xylene	8.56
Tetrafluoroethene	10.12	P-xylene	8.45
Tetrahydrofuran	9.54		
Tetrahydropyran	9.26		
1,2,4,5-Tetramethylbenzene	8.03		
2,2,4,4-Tetramethyl-3-pentanone	8.65		
1,1,1,2-Tetrachloropropane			
1,2,2,3-Tetrachloropropane			
Thioethanol	9.29		
Thiomethanol	9.44		
Thiophene	8.86		
1-Thiopropanol	9.20		
Toluene	8.82		
Tribromoethene	9.27		
1,1,1-Trichlorobutanone	9.54		
1,1,1-Trichloroethane	11.25		
1,1,2-Trichloroethane			
Trichloroethene	9.45		
Trichloromethyl ethyl ether	10.08		
1,1,2-Trichloropropane			
1,2,3-Trichloropropane			
Triethylamine	7.50		
1,2,4-Trifluorobenzene	9.37		
1,3,5-Trifluorobenzene	9.32		
Trifluoroethene	10.14		
1,1,1-Trifluoro-2-iodoethane	10.10		
Trifluoroiodomethane	10.40		
Trifluoromethylbenzene	9.68		
Trifluoromethylcyclohexane	10.46		
1,1,1-Trifluoropropene	10.9		
Trimethyl amine	7.82		
1,2,3-Trimethylbenzene	8.48		
1,2,4-Trimethylbenzene	8.27		
1,3,5-Trimethylbenzene	8.39		
2,2,4-Trimethyl pentane	9.86		
2,2,4-Trimethyl-3-pentanone	8.82		
N-valeraldehyde	9.82		
Vinyl acetate	9.19		
Vinyl benzene (styrene)	8.47		
Vinyl bromide	9.80		
Vinyl chloride	10.00		

Source: Photovac Technical Bulletin No. 11

* Many compounds with an ionization potential of 10.6 eV or less will also be detected by the Photovac TIP (Total Ionizables Present) Monitor.

15.1.6.2 Field Operation

1. Before any field analyses, use the following steps to determine that the instrument is operational. This should occur before the instrument is taken into the field.
2. Check that the lecture bottle carrier gas supply is adequate (charge supply is 1,800 psi and should last approximately 3 days).
3. Set the pressure regulator to zero (fully counter clockwise) and turn on the main valve of the lecture bottle.
4. Slowly turn the regulator control clockwise until air begins to escape from the quick disconnect connection. Allow the line to purge for a few seconds.
5. Plug the quick-disconnect fitting into the free CARRIER IN port. Shut off and disconnect the air supply in use (usually a laboratory supply). Adjust the lecture bottle regulator to approximately 40 pounds per square inch gauge (psig). Set the required flowrate by using a bubble tube.
6. With the instrument in the power-down mode, disconnect the AC power supply. Allow 15 minutes for the effect of the gas line switchover to subside. This lack of AC power automatically switches the instrument to battery power. The instrument is now completely self-contained and, together with a battery powered recorder, may be taken into the field. Check the battery charge on the Photovac.
7. The instrument is now ready to be run through the startup procedures as discussed in Sub-section 15.1.6.1.
8. If there are significant changes in ambient temperature (greater than 10F) when the instrument is moved from place to place, the column will require time to stabilize thermally. At higher sensitivities, a nonthermally stabilized column will manifest itself as baseline drift.
9. DO NOT conduct analyses while batteries are charging because heat generated during battery recharge will affect column retention times and may cause baseline drift.

15.1.6.3 Shutdown Procedure

1. Turn the POWER SWITCH to OFF.
2. Reduce the carrier gas flow to 2 cc/min.
3. If the instrument is being returned from the field, be sure to store the instrument hooked up to a larger laboratory carrier-gas supply.
4. Maintain the battery as indicated in the manufacturer's manual.
5. Unplug the unit except when charging batteries.

15.1.6.4 Maintenance and Calibration Schedule*

<u>Function</u>	<u>Frequency</u>
• Battery charge when Instrument has been operating exclusively on WALL current with no use of battery.	Every 3 months for 10 hours on LOW
• Battery charge when Instrument has been operated off batteries	After each use, 1-1/2 hours of HIGH charge for every hour of use (DO NOT OVERCHARGE)
• Calibration (running standards)	With each use
• Septum change	After approximately 50 injection
• Column reconditioning	Every 3 months or after heavy use, or when installing a new column

* The maintenance and calibration functions must be documented

15.1.6.5 Calibration Procedure

1. Photovac Incorporated conducts an instrument calibration and includes the chromatogram as a component of that instrument's instruction manual. A check of the instrument's performance can be accomplished by duplicating the factory calibration check and comparing the results. Since the Photovac is not a direct read out instrument and instrument response can be checked by running standards and comparing retention times on different days, a calibration should be performed by running standards only. This should be done before, during, and after an analysis. The concentration and identity of the standards are left up to the user, but it is recommended that an aromatic (i.e., benzene) and a chlorinated hydrocarbon (i.e., trichloroethylene) be included. The calibration can be performed as follows:

- Prepare a standard for water or air analysis. Most standards run on the Photovac range from 0.5 to 1.0 ppm.
- Obtain a syringe and withdraw an aliquot of headspace gas that will result in peaks that are large enough to see and not so large that they do not fit on the chart paper. (Note: Water standards should be vigorously shaken for approximately 2 minutes before an aliquot is taken for injection.)
- Compare peaks of identical standard injections made before, during, and after analyses.
- If peak heights of the above injections change significantly, note the sensitivity lost or gained on the chart paper and include this information on the resulting report.

15.1.6.6 Column Maintenance

1. The standard Photovac 10A10 is equipped with two columns. Column #1 is a 1-foot long, 1/8-inch outside diameter (OD) Teflon tube packed with CSP-20M. Column #2 is a 4-foot long, 1/8-inch OD Teflon tube packed with 5 percent SE-30 on 60-80 mesh Chromosorb G. Column

#1 is suitable for running blanks and other quick scans but will not achieve significant separation. Column #2 is suitable for running field surveys and analyses requiring detailed separations.

2. New columns must be conditioned overnight with ultra-high purity helium (FR) or nitrogen at a temperature of 100°C at a maximum flowrate of 100 cc/min. Reconditioning of older columns is accomplished under the same conditions.

3. To gain access to the columns, use the following procedure:

- a. Disconnect the AC cord.
- b. Disconnect the chart recorder lead.
- c. Disconnect the lecture bottle carrier gas supply.
- d. Remove the four Phillips screws securing the panel to the case, and remove the screw attaching the lid retainer to the lid. (Never remove the panel while the instrument is connected to the main power supply.)
- e. Grasp the panel assembly by the cylinder clamp. Gently lift the rear of the panel clear of the case rim, and ease the panel assembly backward from the front rim. Lift the panel assembly clear.
- f. Gently unplug the circuit board from the wire harness connection. Remove the nine Phillips screws from the gold box, and lift clear the lid / circuit board subassembly. The interior of the column/ ion cell chamber is now accessible.
- g. To remove the column, locate the two fittings at each end of the column (ion cell body and injection part). Using a 5/6 inch open-ended wrench, loosen these fittings. Unscrew the fitting with the finger and remove the column.
- h. To replace the column, reverse the previous steps and take special care not to damage the thread on the fitting. Make the fittings finger tight, and use the 5/16-inch open-ended wrench to give an additional 1/8 turn to assure that the fittings seat.

15.1.6.7 Septum Change

The 10A10 contains a Teflon-faced, silicone-rubber, 0.25-inch diameter septum. Hamilton "Micro Sep" F-138 is suitable. The septum can easily be replaced as follows:

1. Unscrew the septum retainer.
2. Extract the old septum with a fine pair of tweezers.
3. Insert the new septum with the Teflon face down.
4. Carefully screw the retainer back into place firmly, but without overtightening.

5. A 10- to 20-minute stabilization period may be required because the carrier gas flow is temporarily interrupted when the septum is changed.

15.1.6.8 Troubleshooting

A list of common troubleshooting techniques for the Photovac 10A10 is provided in Exhibit 15-3.

15.1.7 Region-Specific Variances

No region-specific variances have been identified; however, all future variances will be incorporated in subsequent revisions to this compendium. Information on variances may become dated rapidly. Thus, users should contact the regional EPA RPM for full details on current regional practices and requirements.

15.1.8 Information Sources

Horgan, L. Proposed Guidelines for Photovac 10A10 for the Surveillance and Analysis Division. U.S. Environmental Protection Agency. 1983.

Photovac Incorporated. *Photovac 10A10 Operating Manual*.

15.2 HNU PI-101

15.2.1 Purpose

Subsection 15.2 discusses the use, maintenance, and calibration of the HNU PI-101.

15.2.2 Definitions

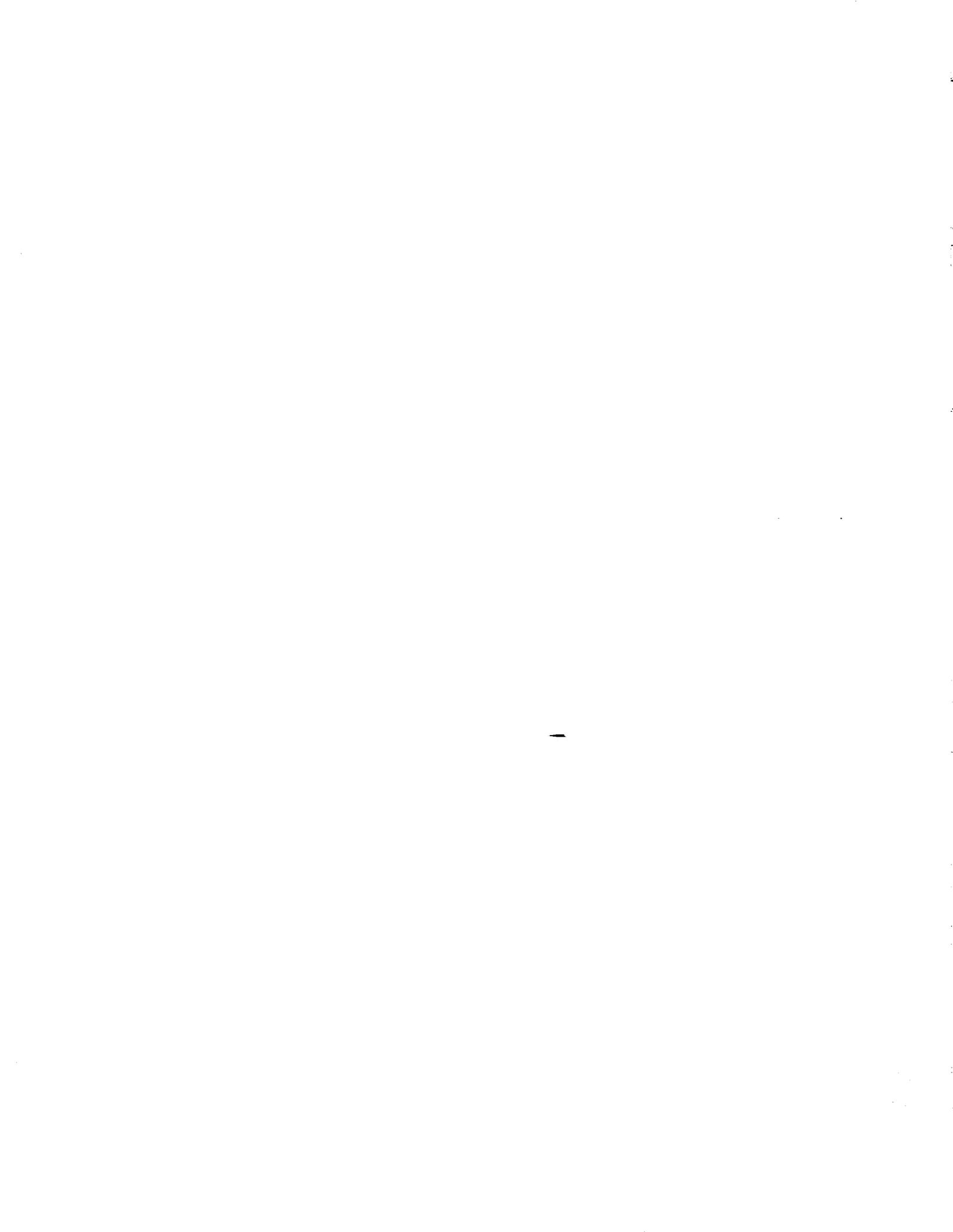
None.

15.2.3 Theory and Limitations

15.2.3.1 Theory

The HNU is a portable, nonspecific, vapor / gas detector employing the principle of photoionization to detect a variety of chemical compounds, both organic and inorganic.

The HNU contains an ultraviolet (UV) light source within its sensor chamber. Ambient air is drawn into the chamber with the aid of a small fan. If the ionization potential (IP) of any molecule present in the ambient air is equal to or lower than the energy of the UV light source, ionization will take place, causing a deflection in the meter. Response time is approximately 90 percent at 3 seconds. The meter reading is expressed in parts per million (ppm). All readings must be stated as equivalent readings that depend on the calibration gas being used. For example, the standard gas used to calibrate the HNU is benzene, which allows the instrument to provide results in benzene equivalence. Exhibit 15-4, modified from the *Instruction*



**Exhibit 15-3
TROUBLESHOOTING PROCEDURES
FIELD EQUIPMENT: PHOTOVAC 10A10**

<u>Problem</u>	<u>Probable Cause</u>	<u>Remedy</u>
1. No chromatographic response	There is no carrier gas flow.	Check at OUT port with flow gauge.
	Batteries are flat (if on battery operation).	Plug into AC and check again.
	Electrometer is saturated.	Turn ATTENUATION to 10, set meter to 0. If OFFSET reads 10 or more, the instrument is saturated. Allow to self-purge until clear.
	Syringe is plugged.	Try a new syringe.
	UV source is not on.	Check SOURCE ON light; if it is on, see item 9 in this exhibit.
2. Unacceptable baseline drift	Unit has been subjected to large temperature change.	Allow to stabilize.
	A very concentrated sample has recently been introduced, resulting in excessive tailing.	Allow to self-purge until clear.
Unacceptable baseline drift	Unacceptable contamination levels are in carrier gas supply.	Change carrier gas supply, and allow instrument to stabilize.
	The unit is charging, and the resulting heat is affecting the column.	Turn CHARGE switch to OFF.

Exhibit 15-3
(continued)

<u>Problem</u>	<u>Probable Cause</u>	<u>Remedy</u>
3. Deterioration of sensitivity	Syringe has leaky plunger.	Try a new syringe.
	Column needs conditioning.	Condition column.
	Septum is leaking.	Change septum.
	Column fittings leak.	Disassemble and check for leaks around fittings, while under pressure, with soap solution.
4. Unacceptable low frequency noise	Column needs conditioning.	Condition column.
5. Peaks elute very slowly	Carrier flowrate is too slow.	Adjust flowrate.
6. Peaks eluting too fast	Carrier flowrate is too high.	Adjust flowrate.
7. Peak has flat top	Electrometer has saturated.	Dilute sample and repeat.
8. Peak is misshapen, with considerable tailing	Flow is too slow. —	Adjust flow.
	There is an improper injection technique.	Repeat.
	Compound is wrongly matched to column; perhaps too polar.	Select appropriate column.
	Peak is developing from an earlier injection (overlap of peaks).	Allow greater time between injections, or install shorter column.

Exhibit 15-3
(continued)

<u>Problem</u>	<u>Probable Cause</u>	<u>Remedy</u>
Source OFF light stays on after 5 min.	Batteries are low (if battery operation). Tube driver is mismatched.	Plug in AC connector. Contact Photovac for advice (416/881-8225)
9. Electrometer does not return to zero after startup	Electrometer is saturated.	Allow to self-purge.

If problems persist after trying all suggested remedies, contact Photovac Incorporated for advice.

Photovac Inc.
Unit 2
134 Doncaster Avenue
Thornhill, Ontario, Canada L3T 1L3
416/881-8225 Telex: 066-964634

Manual for Model PI-101 Photoionization Analyzer HNU Systems Inc., 1975, lists the relative sensitivities of various gases.

15.2.3.2 Limitations

1. If the IP of a chemical contaminant is greater than the UV light source, this chemical will not be recorded. Some contaminants cannot be determined by any sensor / probes.
2. It should be noted, specifically, that the HNU will not detect methane.
3. During cold weather, condensation may form on the UV light source window, resulting in erroneous results.
4. Instrument readings can be affected by humidity and powerlines, making it difficult to interpret readings.
5. Total concentrations are relative to the calibration gas (usually benzene) used. Therefore, true contaminants and their quantities cannot be identified. Also, while the instrument scale reads 0 to 2,000 ppm, response is linear (to benzene) from 0 to about 600 ppm. Greater concentrations may be "read" at a higher or lower level than the true value.
6. Wind speeds of greater than 3 miles an hour may affect fan speed and readings, depending on the position of the probe relative to wind direction.

15.2.4 Applicability

This procedure is applicable to HNU PI-101 Instruments used for air monitoring.

15.2.5 Responsibilities

The SM is responsible for monitoring the implementation of these procedures.

15.2.6 Records

Training records, maintenance records, and calibration records will be generated and maintained by the responsible organization. The maintenance, calibration, and results obtained in the field will be recorded in the site logbook.

15.2.7 Procedure

15.2.7.1 Maintenance and Calibration Responsibilities

The instrument user is responsible for properly calibrating and operating the instrument. When the instrument is scheduled for or requires maintenance, these functions should be conducted only by qualified individuals. If possible, maintenance responsibilities should be restricted to one or two individuals who will also bear responsibilities for logging the equipment in and out. Documentation of instrument user, dates of

Exhibit 15-4
RELATIVE SENSITIVITIES FOR VARIOUS GASES
(10.2 eV Lamp)

<u>Species</u>	<u>Photoionization Sensitivity*</u>
P-xylene	11.4
M-xylene	11.2
Benzene	10.0 (reference standard)
Toluene	10.0
Diethyl sulfide	10.0
Diethyl amine	9.9
Styrene	9.7
Trichloroethylene	8.9
Carbon disulfide	7.1
Isobutylene	7.0
Acetone	6.3
Tetrahydrofuran	6.0
Methyl ethyl ketone	5.7
Methyl isobutyl ketone	5.7
Cyclohexanone	5.1
Naptha (86% aromatics)	5.0
Vinyl chloride	5.0
Methyl isocyanate	4.5
Iodine	4.5
Methyl mercaptan	4.3
Dimethyl sulfide	4.3
Allyl alcohol	4.2
Propylene	4.0
Mineral spirits	4.0
2,3-Dichloropropene	4.0
Cyclohexene	3.4
Crotonaldehyde	3.1
Acrolein	3.1
Pyridine	3.0
Hydrogen sulfide	2.8
Ethylene dibromide	2.7
N-octane	2.5
Acetaldehyde Oxime	2.3

Exhibit 15-4
(continued)

Species	Photoionization Sensitivity*
Hexane	2.2
Phosphine	2.0
Heptane	1.7
Allyl chloride (3-chloropropene)	1.5
Ethylene	1.0
Ethylene oxide	1.0
Acetic anhydride	1.0
Alpha pinene	.07
Dibromochloropropane	0.7
Epichlorohydrin	0.7
Nitric oxide	0.6
Beta pinene	0.5
Citral	0.5
Ammonia	0.3
Acetic Acid	0.1
Nitrogen dioxide	0.02
Methane	0.0
Acetylene	0.0
Ethylene	0.0

*Expressed in ppm (v/v).

Source: *Instruction Manual for Model PI-101*
Photoionization Analyzer, HNU Systems, Inc., 1975.

use, instrument identification number, maintenance and calibration functions, and project identification should be maintained.

15.2.7.2 Operator Qualifications

The HNU, although a relatively simple instrument to use, can be incorrectly operated if the user is not thoroughly familiar with its operation. An appropriate training and certification procedure must be developed and incorporated into the responsible organization's training procedures. The users must complete the training and be certified for HNU operation before using the instrument in the field. Refresher courses should be obligatory every 6 months. Courses are given by the manufacturer, by commercial entities, and by EPA at their Cincinnati, Ohio, and Edison, New Jersey, facilities.

15.2.7.3 Startup / Shutdown Procedures

Startup

1. Check the FUNCTION switch on the control panel to make sure it is in the OFF position. Attach the probe to the readout unit. Match the alignment key, and twist the connector clockwise until a distinct locking is felt.
2. Turn the FUNCTION switch to the BATTERY CHECK position. Check that the indicator reads within or beyond the green battery arc on the scale plate. If the indicator is below the green arc, or if the red LED comes on, the battery must be charged before using.
3. To zero the instrument, turn the FUNCTION switch to the STANDBY position and rotate the ZERO POTENTIOMETER until the meter reads zero. Wait 15 to 20 seconds to confirm that the zero adjustment is stable. If it is not, then readjust.
4. Check to see that the SPAN POTENTIOMETER is set at the appropriate setting for the probe being used (5.0 for 9.5 eV probe, 9.8 for 10.2 eV, and 5.0 for 11.7 eV).
5. Set the FUNCTION switch to the desired ppm range. A violet glow from the UV lamp source should be observable at the sample inlet of the probe / sensor unit. (Do not look directly at the glow, since eye damage could result.)
6. Listen for the fan operation to verify fan function.
7. Check instrument with an organic point source, such as a "magic marker," before survey to verify instrument function.

Shutdown

1. Turn FUNCTION switch to OFF.
2. Disconnect the probe connector.
3. Place the instrument on the charger.

15.2.7.4 Maintenance and Calibration Schedule

<u>Function</u>	<u>Frequency</u>
• Perform routine calibration	Prior to each use*
• Initiate factory checkout and calibration	Yearly or when malfunctioning or after changing UV light source
• Wipe down readout unit	After each use
• Clean UV light source window	Every month or as use and site conditions dictate
• Clean the ionization chamber	Monthly
• Recharge battery	After each use

* During extended field use, the HNU P1-101 must be calibrated at least once every three days.

15.2.7.5 Calibration Procedure No. 1

For HNU calibration canisters without regulators:

1. Run through startup procedures as in Subsection 15.2.7.3.
2. Fill a sampling bag with HNU calibration gas of known contents.
3. Connect HNU probe to sampling bag by using flexible tubing.
4. Allow sample bag contents to be drawn into the probe, and check response in ppm.
5. Adjust the span potentiometer to produce the concentration listed on the span gas cylinder. This procedure shall be followed only until the span potentiometer reaches the following limits:

<u>Probe</u>	<u>Initial Span Pot. Setting</u>	<u>Maximum Acceptance Span Pot. Setting</u>
9.5 eV	5.0	1.0
10.2 eV	9.8	8.5
11.7 eV	5.0	2.0

6. If these limits are exceeded, the instruments must be returned for maintenance and recalibration. This maintenance will be done only by qualified individuals.

7. Each responsible organization must develop a mechanism for the documentation of calibration results. This documentation includes the following:

- a. Date inspected
- b. Person who calibrated the instrument
- c. The instrument number (Serial number or other ID number)
- d. The results of the calibration (ppm, probe eV, span potentiometer setting)
- e. Identification of the calibration gas (source, type, concentration)

15.2.7.6 Calibration Procedure No. 2

For HNU calibration canisters equipped with a regulator:

1. Run through startup procedures as described in Subsection 15.2.6.3.
2. Connect a sampling hose to the regulator outlet and the other end to the sampling probe the HNU.
3. Crack the regulator valve.
4. Take a reading after 5 to 10 seconds.
5. Adjust span potentiometer using the steps outlined in step No. 5 of Subsection 15.2.7.5.
6. Calibration documentation should be as in step No. 7 in Subsection 15.2.7.5.

15.2.7.7 Cleaning the UV Light-Source Window

1. Turn the FUNCTION switch to the OFF position, and disconnect the sensor / probe from the Readout / Control unit.
2. Remove the exhaust screw located near the base of the probe. Grasp the end cap in one hand and the probe shell in the other. Separate the end cap and lamp housing from the shell.
3. Loosen the screws on the top of the end cap, and separate the end cap and ion chamber from the lamp and lamp housing, taking care that the lamp does not fall out of the lamp housing.
4. Tilt the lamp housing with one hand over the opening so that the lamp slides out of the housing into your hand.
5. The lamp window may now be cleaned using lens paper with any of the following compounds:
 - a. Use HNU Cleaning Compound on all lamps except the 11.7 eV.

b. Clean the 11.7 eV lamp with a freon or chlorinated organic solvent. Do not use HNU cleaner, water, or water miscible solvents (i.e., acetone and methanol).

6. Following cleaning, reassemble by first sliding the lamp back into the lamp housing. Place the ion chamber on top of the housing, making sure the contacts are properly aligned.

7. Place the end cap on top of the ion chamber, and replace the two screws. Tighten the screws only enough to seal the O-ring. Do not overtighten.

8. Line up the pins on the base of the lamp housing with pins inside the probe shell, and slide the housing assembly into the shell. It will fit only one way.

9. Replace the exhaust screw.

15.2.7.8 Cleaning the Ionization Chamber

1. Turn the FUNCTION switch to the OFF position, and disconnect the sensor/probe from the Readout / Control unit.

2. Remove the exhaust screws located near the base of the probes. Grasp the end cap in one hand and the probe shell in the other. Separate the end cap and lamp housing from the shell.

3. Loosen the screws on the top of the end cap, and separate the end cap and ion chamber from the lamp and lamp housing, taking care that the lamp does not fall out of the lamp housing.

4. The ion chamber may now be cleaned according to the following sequence:

a. Clean with methanol using a Q-tip.

b. Dry gently at 50°C to 60°C for 1/2 hour.

5. Place the ion chamber on top of the housing, making sure the contacts are properly aligned.

6. Place the end cap on top of the ion chamber and replace the two screws. Tighten the screws only enough to seal the O-ring. Do not overtighten.

7. Line up the pins on the base of the lamp housing with pins inside the probe shell, and slide the housing assembly into the shell. It will fit only one way.

15.2.7.9 Troubleshooting

The following steps should be performed only by a qualified technician:

1. The meter does not respond in any switch position (Including BATT CHK).

a. Meter movement is broken.

(1) Tip instrument rapidly from side to side. Meter needle should move freely and return to zero.

b. Electrical connection to meter is broken

(1) Check all wires leading to meter.

(2) Clean the contacts of quick-disconnects.

c. Battery is completely dead.

(1) Disconnect battery.

(2) Check voltage with a volt-ohm meter.

d. Check 2 mp fuse.

e. If none of the above solves the problem, consult the factory.

2. Meter responds in BATT CHK position, but reads zero or near zero for all others.

a. Power supply is defective.

(1) Check power supply voltages as shown in Figure 11 of the HNU *Instruction Manual*. If any voltage is out of specification, consult the factory.

b. Input transistor or amplifier has failed.

(1) Rotate zero control; meter should deflect up or down as control is turned.

(2) Open probe. Both transistors should be fully seated in sockets.

c. Input signal connection is broken in probe or readout.

(1) Check input connector on printed circuit board. The input connector should be firmly pressed down.

(2) Check components on back of printed circuit board. All connections should be solid, and no wires should touch any other object.

(3) Check all wires in readout for solid connections.

3. Instrument responds correctly in BATT CHK and STBY but not in measuring mode.

a. Check to see that the light source is on. Do not look directly at UV light source, since eye damage could result.

(1) Check high-voltage power supply.

(2) Open end of probe, remove lamp, and check high voltage on lamp ring.

(3) If high voltage is present at all above points, light source has probably failed. Consult the factory.

4. Instrument responds correctly in all positions, but signal is lower than expected.
 - a. Check span setting for correct value.
 - b. Clean window of light source.
 - c. Double check preparation of standards.
 - d. Check power supply 180 V output.
 - e. Check for proper fan operation. Check fan voltage.
 - f. Rotate span setting. Response should change if span potentiometer is working properly.
5. Instrument responds in all switch positions, but is noisy (erratic meter movement).
 - a. Open circuit in feedback circuit. Consult the factory.
 - b. Open circuit in cable shield or probe shield. Consult the factory.
6. Instrument response is slow and/or irreproducible.
 - a. Fan is operating improperly. Check fan voltage.
 - b. Check calibration and operation.
7. The battery indicator is low.
 - a. Indicator comes on if battery charge is low.
 - b. Indicator also comes on if ionization voltage is too high.

15.2.8 Region-Specific Variances

No region-specific variances have been identified; however, all future variances will be incorporated in subsequent revisions to this compendium. Information on variances may become dated rapidly. Thus, users should contact the regional EPA RPM for full details on current regional practices and requirements.

15.2.9 Information Sources

HNU Systems, Inc. *Instruction Manual for Model PI-101 Photoionization Analyzer*. 1975.

Ecology and Environment. *FIT Operation and Field Manual: HNU Systems PI-101 Photoionization Detector and Century Systems (Foxboro) Model OVA-128 Organic Vapor Analyzer*. 1981.

Personal Communication with Fran Connel, HNU Systems, Inc. 4 January 1984.

CH2M HILL. *Field Surveillance Equipment*. 1984.

Rabin, Linda J. "Selective Application of Direct-Reading Instruments at Hazardous Waste Sites," presented at American Industrial Hygiene Conference, Dallas, Texas. 1986.

15.3 ORGANIC VAPOR ANALYZER (OVA-128)

15.3.1 Scope and Purpose

The purpose of this subsection is to discuss the use, maintenance, and calibration of the OVA-128.

15.3.2 Definitions

None.

15.3.3 Theory and Limitations

15.3.3.1 Theory

The OVA uses the principle of hydrogen flame ionization for the detection and measurement of organic compounds. The OVA contains a diffusion flame of hydrogen and air that is free of ions and is nonconducting. When a sample of organic material is introduced into the flame, ions are formed, causing the flame to become conductive. Eventually this conductivity provides a meter reading because of a change in current.

15.3.3.2 Limitations

1. The OVA will not see any inorganics.
2. The OVA will "see" methane, which is explosive but relatively nontoxic. The user should determine if the contaminant involved is or is not methane.
3. DOT shipping regulations are strict for the OVA when shipped containing pressurized hydrogen.
4. A relative humidity greater than 95 percent will cause inaccurate and unstable responses.

5. A temperature less than 40°F will cause slow and poor response.

6. Actual contaminant concentrations are measured relative to the calibration gas used. Therefore, specific contaminants and their quantities cannot easily be identified.

7. As with the HNU Photolonizer, the OVA responds differently to different compounds. The table below is a list, provided by the manufacturer, of the relative sensitivities of the OVA to some common organic compounds. Since the instrument is factory calibrated to methane, all relative responses are given in percent, with methane at 100.

<u>Compound</u>	<u>Relative Response</u>
Methane	100
Ethane	90
Propane	64
N-butane	61
N-pentane	100
Ethylene	85
Acetylene	200
Benzene	150
Toluene	120
Acetone	100
Methyl ethyl ketone	80
Methyl isobutyl ketone	100
Methanol	15
Ethanol	25
Isopropyl alcohol	65
Carbon tetrachloride	10
Chloroform	70
Trichloroethylene	72
Vinyl chloride	35

8. When operated in the gas chromatography (GC) mode, chemical standards of known constituents and concentration must be analyzed by the GC. These standards must be run at the same operating conditions used in the sampling procedure, i.e., carrier gas flowrate, column type and temperature, and ambient conditions. The purpose of running standards is to determine retention times, concentrations (or instrument response), and optimal instrument operating conditions.

15.3.4 Applicability

This procedure is applicable to all OVA-128s used for field or laboratory applications.

15.3.5 Responsibilities

The SM is responsible for monitoring the implementation of these procedures.

15.3.6 Records

Training records, maintenance records, and calibration records will be generated and maintained by the responsible organization. The maintenance, calibration, and results obtained in the field will be recorded in the site logbook.

15.3.7 Procedure

15.3.7.1 Maintenance and Calibration Responsibilities

It is preferable to minimize the number of people responsible for maintenance and calibration of the OVA. These people should also be responsible for logging the equipment in and out. Documentation of instrument user, dates of use, instrument identification number, maintenance and calibration procedures, and project identification should be maintained.

15.3.7.2 Operator Qualifications

Although it is a relatively simple instrument to use, the OVA can be incorrectly operated if the user is not thoroughly familiar with its operation. An appropriate training and certification procedure must be developed and incorporated into the responsible organization's training procedures. The user must complete the training and be certified for OVA use before taking the instrument into the field. Refresher courses should be obligatory every 6 months. Courses are offered by the manufacturer, various commercial entities, and by EPA at their Cincinnati, Ohio, and Edison, New Jersey, facilities.

15.3.7.3 Startup Procedures

1. Connect the probe / readout connectors to the side-pack assembly.
2. Check battery condition and hydrogen supply.
3. For measurements taken as methane equivalent, check that the GAS SELECT dial is set at 300.
4. Turn the electronics on by moving the INST switch to the ON position, and allow 5 minutes for warm-up.
5. Set CALIBRATE switch to X10; use CALIBRATE knob to set indicator at 0.

6. Open the H₂ tank valve all the way and the H₂ supply valve all the way. Check that the hydrogen supply gauge reads between 8.0 and 12.0 psig.
7. Turn the PUMP switch ON, and check the flow system according to the procedures in Sub-section 15.3.7.6.
8. Check that the BACKFLUSH and INJECT valves are in the UP position.
9. To light the flame, depress the igniter switch until a meter deflection is observed. The igniter switch may be depressed for up to 5 seconds. Do not depress for longer than 5 seconds, as it may burn out the igniter coil. If the instrument does not light, allow the instrument to run several minutes and repeat ignition attempt.
10. Confirm OVA operational state by using an organic source, such as a "magic marker."
11. Establish a background level in a clean area or by using the charcoal scrubber attachment to the probe (depress the sample inject valve) and by recording measurements referenced to background.
12. Set the alarm level, if desired.

15.3.7.4 Shutdown Procedure

1. Close H₂ supply valve and H₂ tank valve (do not overtighten valves).
2. Turn INST switch to OFF.
3. Wait until H₂ supply gauge indicates system is purged of H₂; then switch off pump (approximately 10 seconds).
4. Put instrument on electrical charger at completion of day's activities.

15.3.7.5 Maintenance and Calibration Schedule

Check particle filters	Weekly or as needed
Check quad rings	Monthly or as needed
Clean burner chamber	Monthly or as needed
Check secondary calibration	Prior to project startup
Check primary calibration	Monthly, or if secondary check is off by more than ± 10 percent
Check pumping system	Before project startup
Replace charcoal in scrubber attachment	120 hours of use, or when background readings are higher with the inject valve down than with the inject valve up in a clean environment
Factory service	At least annually

Note: Instruments that are not in service for extended periods of time need not meet the above schedule. However, they must be given a complete checkout before their first use, addressing the maintenance items listed above.

Calibration Procedures

The following steps are to be used only by qualified service technicians:

Primary Calibration

1. Remove instrument components from the instrument shell.
2. Turn on ELECTRONICS and ZERO INSTRUMENT on X10 scale. Gas select dial to 300.
3. Turn on PUMP and HYDROGEN. Ignite flame. Go to SURVEY MODE.
4. Introduce a methane standard near 100 parts per million (ppm).
5. Adjust R-32 Trimpot on circuit board to make meter read to standard.
6. Turn off hydrogen flame, and adjust meter needle to read 40 ppm (calibrate @ X10) using the calibration adjust knob.
7. Switch to X100 scale. The meter should indicate 0.4 on the 1-10 meter markings (0.4 x 100 = 40 ppm). If the reading is off, adjust with R33 Trimpot.
8. Return to X10 scale, and adjust meter needle to 40 ppm with calibration; adjust knob, if necessary.
9. At the X10 scale, adjust meter to read 0.4 on the 1 to 10 meter markings using the calibration adjust. Switch to X1 scale. The meter should read 4 ppm. If the reading is off, adjust using the R31 Trimpot.

Secondary Calibration

1. Fill an air sampling bag with 100 ppm (certified) methane calibration gas.
2. Connect the outlet of the air-sampling bag to the air-sampling line of the OVA.
3. Record the reading obtained from the meter on the calibration record.

Documentation

Each responsible organization should develop a system whereby the following calibration information is recorded:

- 1. Instrument calibrated (I.D. or serial number)
- 2. Date of calibration
- 3. Method of calibration

- 4. Results of the calibration
- 5. Identification of person who calibrated the instrument
- 6. Identification of the calibration gas (source, type, concentration, lot number)

15.3.7.6 Pump System Checkout

The following steps are to be used only by qualified technicians:

1. With the pump on, hold unit upright and observe flow gauge.
2. See if ball level is significantly below a reading of 2; if so, flow is inadequate.
3. Check connections at the sample hose.
4. Clean or replace particle filters if flow is impaired or if it is time for scheduled service.
5. Reassemble and retest flow.
6. If flow is still inadequate, replace pump diaphragm and valves.
7. If flow is normal, plug air intake. Pump should slow and stop.
8. If there is no noticeable change in pump, tighten fittings and retest.
9. If there is still no change, replace pump diaphragm and valves.
10. Document this function in the maintenance records.

15.3.7.7 Burner Chamber Cleaning

1. Remove plastic exhaust port cover.
2. Unscrew exhaust port.
3. Use wire brush to clean burner tip and electrode. Use wood stick to clean Teflon.
4. Brush inside of exhaust port.
5. Blow out chamber with a gentle air flow.
6. Reassemble and test unit.
7. Document this function in the maintenance records.

15.3.7.8 Quad Ring Service

1. Remove OVA instruments from protective shell.
2. Remove clip ring from bottom of valve.
3. Unscrew nut from top of valve.
4. Gently pull valve shaft upward and free of housing.
5. Observe rings for signs of damage; replace as necessary.
6. Lightly grease rings with silicone grease.
7. Reassemble valve; do not pinch rings during shaft insertion.
8. Document this function in the maintenance records.

15.3.7.9 Troubleshooting

<u>Indication</u>	<u>Possible Causes</u>
<ul style="list-style-type: none">• High background reading (More than 10 ppm)	Contaminated hydrogen Contaminated sample line
<ul style="list-style-type: none">• Continual flameout	Hydrogen leak Dirty burner chamber Dirty air filter
<ul style="list-style-type: none">• Low air flow	Dirty air filter Pump malfunction Line obstruction
<ul style="list-style-type: none">• Flame will not light	Low battery Igniter broken Hydrogen leak Dirty burner chamber Air flow restricted
<ul style="list-style-type: none">• No power to pump	Low battery Short circuit
<ul style="list-style-type: none">• Hydrogen leak (Instrument not in use)	Leak in regulator Leak in valves

15.3.7.10 Hydrogen Recharging

1. High-grade hydrogen (99.999 percent) is required. Maximum pressure the instrument can handle is 2,300 psig.
2. Connect the fill hose to the REFILL FITTING on the side pack assembly with the FILL/BLEED valve in the OFF position.
3. Open H₂ SUPPLY BOTTLE valve.
4. Place FILL/BLEED valve on fill hose in BLEED position momentarily to purge any air out of the system.
5. Open the instrument TANK valve.
6. Open REFILL valve on instrument.
7. Place FILL/BLEED valve in FILL position until the instrument pressure gauge equalizes with the H₂ SUPPLY BOTTLE pressure gauge.
8. Shut REFILL valve, FILL/BLEED valve, and H₂ SUPPLY BOTTLE valve, in quick succession.
9. Turn FILL/BLEED valve to BLEED until hose pressure equalizes to atmospheric pressure.
10. Turn FILL/BLEED valve to FILL position; then turn the valve to the BLEED position; then turn to OFF.
11. Close TANK on instrument.
12. Disconnect the FILL HOSE, and replace protective nut on the REFILL FITTING.

15.3.7.11 Particle Filter Servicing

Filters have been placed at two points in the air sampling line of the OVA to keep particulates from entering the instrument. The first filter is located in the probe assembly, and the second filter (primary filter) is located on the side pack assembly. Cleaning procedures are as follows:

1. Detach the probe assembly from the readout assembly.
2. Disassemble the probe (unscrew the components).
3. Clean the particle filter located within the probe by blowing air through the filter.
4. Reassemble the probe.
5. Gain access to the primary filter, located behind the sample inlet connector on the side pack assembly, by removing the sample inlet connector with a thin-walled, 7/16-inch socket wrench. Remove the filter, and clean as above.

6. Reassemble the sample inlet fitting and filter to the side pack assembly.
7. Check sample flowrate.

15.3.7.12 Region-Specific Variances

No region-specific variances have been identified; however, all future variances will be incorporated in subsequent revisions to this compendium. Information on variances may become dated rapidly. Thus, users should contact the regional EPA RPM for full details on current regional practices and requirements.

15.3.7.13 Information Sources

The following references were used in generating this subsection of the compendium:

Region II FIT. *Proposed Guidelines for the Organic Vapor Analyzer*. 1984.

Ecology and Environment. *FIT Operation and Field Manual: HNU Systems PI-101 Photoionization Detector and Century Systems (Foxboro) Model OVA-128 Organic Vapor Analyzer*. 1981.

Century Systems (Foxboro). *Service Procedures: Organic Vapor Analyzer, 128GC*.

CH2M HILL. *Field Surveillance Equipment*. 1984.

15.4 EXPLOSIMETER

15.4.1 Scope and Purpose

This subsection provides general guidance for the understanding, use, and application of an explosimeter. The methodologies refer to explosimeters manufactured by Mine Safety Appliances Company.

15.4.2 Definitions

Explosimeter

An instrument used to test an atmosphere for concentration of combustible gases and vapors.

Lower Explosive Limit (LEL)

The lowest concentration of a gas or vapor in air, by volume, that will explode or burn when there is an ignition source present.

Upper Explosive Limit (UEL)

The maximum concentration of a gas or vapor in air, by volume, that will explode or burn when there is an ignition source present.

15.4.3 Applicability

Explosimeters have been used during installation of monitoring wells and in and around landfills where methane gas is of primary concern. Once a monitoring well is installed, methane gas can accumulate inside the well casing and can create a potentially explosive environment.

Explosimeters have also proved useful during the excavation of buried drums and tanks. In what can sometimes seem like an innocuous situation because of the adequate ventilation around the trench, heavier-than-air vapors can collect at the bottom of the trench to produce an explosive environment. Additionally, the explosimeter has provided service when investigative work has discovered abandoned warehouses and storage sheds containing drums of volatile substances. The explosimeter is typically used when entering any confined space or for initial entry on hazardous waste sites.

15.4.4 Responsibilities

Before the instrument is taken into the field, it should be inspected and calibrated to ensure that it is operating properly. If possible, maintenance and calibration should be restricted to one or two qualified individuals.

15.4.5 Records

Logbooks should contain records of the instrument checkout and calibration procedures. Although a relatively simple instrument to use, the explosimeter can be incorrectly operated if the user is not thoroughly familiar with its operation. An appropriate training and certification procedure must be developed and incorporated. The users must complete the training and be certified for operation before using the explosimeter in the field. Refresher courses should be obligatory every 6 months. Courses are offered by the manufacturer, various commercial entities, and by EPA at their Cincinnati, Ohio, and Edison, New Jersey, facilities.

15.4.6 Procedures

15.4.6.1 Theory

A typical explosimeter draws a sample of the atmosphere over a heated catalytic filament that forms a balanced electrical circuit. Combustibles that are present in the atmosphere are burned on the filament, which raises its resistance in proportion to the concentration of the combustibles in the atmosphere. The resulting imbalance of the circuit causes a deflection of the meter needle on the instrument.

15.4.6.2 Operation

The instrument must be calibrated before each field use. Calibration is performed by using a known concentration of a combustible gas that can be obtained from Mine Safety Appliances Company. Once the calibration gas is introduced to the instrument, adjustments can be made on an internal span control inside the explosimeter. If the explosimeter cannot be adjusted to read the standard, then the detector filament must be replaced.

To establish a zero background reading, the explosimeter should be prepared for operation in an area known to be free of combustible gases and vapors. A flush of fresh air should be passed through the in-

strument to zero the meter needle. The sampling line should then be placed at the point where the sample is to be collected, and the highest reading on the meter should be recorded. The graduations on the scale of the meter are in percentages of the lower explosive limit. A deflection of the meter needle between zero and 100 percent shows how closely the atmosphere being tested approaches the minimum concentration required for an explosion. When the needle deflects to the extreme right side of the meter during a test, the person performing the test can reasonably assume that the atmosphere being tested is explosive. If the needle deflects to the extreme right side and then quickly returns to a position within the scale or below zero, this movement indicates that the atmosphere tested has exceeded the concentration of the UEL. This means that an overabundance of the gas or vapor has displaced or consumed the "normal" air (oxygen levels of about 21 percent), creating an environment that will not explode but could explode if the oxygen levels return to normal; therefore, it is important to continue monitoring. The user should always have the instrument on until the field team has left the atmosphere being tested and a final flush of fresh air has passed through the explosimeter to be sure that the atmosphere has been thoroughly analyzed.

15.4.6.3 Limitations and Warnings Associated with an MSA Explosimeter

As with all instruments, the user should appreciate the limits of the explosimeter's capabilities and should be sure to operate the instrument within those limits. The following represents several important limitations:

1. The instrument is not designed to work in an oxygen-enriched environment (oxygen above 25 percent), nor will it function properly in an oxygen-deficient atmosphere (below 19.5 percent). Therefore, it must be used in conjunction with an atmospheric oxygen indicator.
2. The instrument will not indicate the presence of explosive or combustible mists or sprays, such as lubrication oil, or explosive dusts, such as grain or coal dusts.
3. Care should be taken when sampling over liquids so the liquid is not drawn into the instrument.
4. The following substances may poison the detection filament: leaded gasoline, silanes, silicones, silicates, or any silicon-containing compound.
5. The relative humidity must be in the range of 10 to 90 percent.
6. The instrument has a tolerance of 40 percent. For example, a reading of 20 percent LEL could be as high as 28 percent or as low as 12 percent.
7. The instrument must not be switched on or off unless the user is in a known combustible-free atmosphere.
8. The explosive limits for many gases and vapors are far above the threshold limit values (TLVs) for those substances.
9. Fuming acids, such as sulfuric acid and nitric acid, will also poison the detection filament.
10. The instrument is typically calibrated with methane gas. Many other materials are explosive at concentrations below that of methane. Care must be used in a test atmosphere that may contain these types of materials. The readings obtained by the instrument are not specific. The readings indicate only that the atmosphere being measured is some percentage of the LEL of the calibration atmosphere. Therefore, the National Institute for Occupational

Safety and Health criteria shown below must be used in interpreting the readings when using the instrument in an atmosphere of unknown contaminants.

15.4.6.4 NIOSH Criteria

NIOSH guidelines on the use of the explosimeter are as follows:

1. Ten percent LEL – Limit activities in area to those that do not generate sparks; wear non-sparking gear; use spark-proof equipment.
2. Twenty percent LEL – Limit all activities in area.

15.4.7 Region-Specific Variances

No region-specific variances have been identified; however, all future variances will be incorporated in subsequent revisions to this compendium. Information on variances may become dated rapidly. Thus, users should contact the regional EPA RPM for full details on current regional practices and requirements.

15.4.8 Information Sources

Mine Safety Appliances Company. "Instruction Manual, Model 260, Combustible Gas and Oxygen Alarm." Pittsburgh, Pennsylvania.

U.S. Environmental Protection Agency. *Standard Operating Guides*. December 1984.

NIOSH / OSHA / USCG / EPA. *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*. October 1985.

15.5 OXYGEN INDICATOR

15.5.1 Scope and Purpose

This subsection provides general guidance for the understanding, use, and application of an oxygen indicator. The methodologies that are described refer to oxygen indicators manufactured by Mine Safety Appliances Company.

15.5.2 Definitions

Oxygen Indicator

An instrument that provides a means to measure atmospheric oxygen concentrations. The volume percent for atmospheric oxygen is 20.95 percent.

Partial Pressure

The pressure that each gas exerts in a gas mixture (i.e., oxygen is 159 mmHg at sea level). Partial pressure is also temperature dependent.

15.5.3 Applicability

Wherever contaminants have been detected, a certain percentage of the atmosphere has been displaced, subsequently lowering the partial pressure of oxygen. In respiration, it is not the percentage of oxygen in the air, but rather its partial pressure that is important in sustaining life.

Oxygen-deficient atmospheres at hazardous waste sites often include confined spaces, such as abandoned warehouses where solvent drums are typically stored. Oxygen-deficient atmospheres could possibly be created during drum excavation in test pits where heavier-than-air vapors accumulate at the bottom of the test pit.

15.5.4 Responsibilities

Before taking the oxygen indicator into the field, the user should inspect and calibrate it to ensure its proper operation. If possible, maintenance and calibration should be restricted to one or two qualified individuals.

15.5.5 Records

Logbooks should record the oxygen indicator's checkout and calibration procedures. Although it is a relatively simple instrument to use, the oxygen indicator can be incorrectly operated if the user is not thoroughly familiar with its operation. An appropriate training and certification procedure must be developed and incorporated. The users must complete the training and be certified for operation before using the instrument in the field. Refresher courses should be obligatory every 6 months. Courses are offered by the manufacturer, by various commercial entities, and by EPA at their Cincinnati, Ohio, and Edison, New Jersey, facilities.

15.5.6 Procedures

15.5.6.1 Theory

The MSA Oxygen Indicator tests the partial pressure of oxygen in the atmosphere. The actual sensing device consists of an oxygen-specific permeable membrane that allows oxygen to pass into the sensor until the partial pressures equalize on both sides of the membrane. Inside the sensor is an electrolyte solution that surrounds two electrodes. An oxidation-reduction reaction occurs in which the amount of current generated is directly proportional to the oxygen concentration. The change in current is detected by the meter circuit, and the needle is calibrated to indicate oxygen concentration in percentage, which is read out directly. The sensor is temperature compensated from 32°F to 104°F. The indicator response time is increased in temperatures beyond the compensated range, partially below 32°F.

The instrument must be calibrated before using it in the field. Calibration is performed by adjusting a calibration screw when the probe is exposed to fresh air. Readings should be checked every hour in sampling areas where the temperature is not constant to attain the greatest accuracy possible.

15.5.6.2 Limitations and Warnings Associated with an MSA Oxygen Indicator

As with all instruments, the user should appreciate the limits of the oxygen indicator's capabilities and should be sure to operate it within those limits. The following represents several of the important limitations:

1. Condensation of moisture on the sensor face will cause low oxygen readings. To avoid this problem, allow the sensor to reach ambient temperature before taking readings.
2. Strong oxidants such as fluorine, chlorine, and ozone will lead to erroneously high oxygen readings when these oxidants are present in concentrations exceeding 5,000 ppm or 0.5 percent.
3. Concentrations of CO₂ greater than 1 percent will reduce sensor life.
4. Changes in barometric pressure because of altitude will also affect the meter reading. The instrument is calibrated for 20.8 percent oxygen at sea level (one atmosphere).
5. Relative humidity operating range is 10 to 90 percent.
6. The sensor must not be touched by hands or other objects; the membrane is easily damaged.
7. Fuming acids, such as sulfuric acid or nitric acid, will poison the probe.
8. Once exposed to air, the oxygen sensor has a shelf life of approximately 1 year.

15.5.6.3 Recommended Action Levels

If the oxygen level is less than 19.5 percent, the inspection should be continued only with a self-contained breathing apparatus (SCBA) or a similar unit; the oxygen-deficient area should be identified.

If the oxygen level is more than 19.5 percent, the inspection can continue without breathing apparatus. If the cartridge will provide adequate sorbent efficiency, a cartridge respirator is acceptable. Also, the contaminant must have good warning properties, and must not react with the sorbent material in the cartridge.

If the oxygen level exceeds 25 percent, the area should be vacated, since an oxygen-rich atmosphere exists and an explosion or fire is possible.

15.5.6.4 NIOSH Criteria

Oxygen levels lower than 19.5 percent require the use of supplied-air respirators.

15.5.7 Region-Specific Variances

No region-specific variances have been identified; however, all future variances will be incorporated in subsequent revisions to this compendium. Information on variances may become dated rapidly. Thus, users should contact the regional EPA RPM for full details on current regional practices and requirements.

15.5.8 Information Sources

Mine Safety Appliances Company. *"Instruction Manual, Model 260, Combustible Gas and Oxygen Alarm."* Pittsburgh, Pennsylvania.

U.S. Environmental Protection Agency. *Standard Operating Guides.* December 1984.

NIOSH / OSHA / USCG / EPA. *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities.* October 1985.

15.6 COMBINED COMBUSTIBLE GAS (EXPLOSIMETER) AND OXYGEN ALARM

15.6.1 Scope and Purpose

This subsection provides general guidance for the understanding, use, and application of a combined combustible gas and oxygen alarm. The methodologies refer to combined combustible gas and oxygen alarm instruments manufactured by Mine Safety Appliances Company.

15.6.2 Definitions

Explosimeter

An instrument used to test an atmosphere for concentration of combustible gases and vapors.

Lower Explosive Limit (LEL)

The minimum concentration of a gas or vapor in air by volume that will explode or burn when there is an ignition source.

Upper Explosive Limit (UEL)

The maximum concentration of a gas or vapor in air by volume that will explode or burn when there is an ignition source.

Oxygen Indicator

An instrument that provides a means to measure atmospheric oxygen concentrations. The volume percent for atmospheric oxygen is 20.95 percent.

Partial Pressure

The pressure that each gas exerts in a gas mixture (i.e., oxygen is 159 mmHg at sea level). Partial pressure is also temperature dependent.

15.6.3 Applicability

The combined combustible gas and oxygen alarm can be extremely useful, since both the combustible gas and oxygen alarm are incorporated into one unit. For example, when combustible vapors are present in sufficient concentrations to displace a certain percentage of the atmosphere, this condition should be reflected as a low reading on the oxygen indicator and an elevated reading on the explosimeter. In turn,

the oxygen indicator also establishes the limits of oxygen concentration (19.5 percent to 25 percent) which the explosimeter can function properly.

This instrument has been useful during installation of monitoring wells in and around landfills where methane gas is of concern. Confined spaces at hazardous waste sites, such as abandoned warehouses and storage sheds containing drums of volatile substances, pits, trenches, or sewers are prime examples of where the instrument has provided service.

15.6.4 Responsibilities

Before the instrument is taken into the field, it should be inspected and calibrated to ensure that it is operating properly. If possible, maintenance and calibration should be restricted to one or two qualified individuals.

15.6.5 Records

Logbooks should record the instrument checkout and calibration procedures. Although a relatively simple instrument to use, the oxygen alarm can be incorrectly operated if the user is not thoroughly familiar with its operation. An appropriate training and certification procedure must be developed and incorporated. The users must complete the training and be certified for operation before using the instrument in the field. Courses are offered by the manufacturer, various commercial entities, and by EPA at their Cincinnati, Ohio, and Edison, New Jersey, facilities.

15.6.6 Procedures

The procedures for the confined explosimeter and oxygen indicators are the same as for the separate instruments. The reader should refer to Subsections 15.4 and 15.5.

15.6.7 Region-Specific Variances

No region-specific variances have been identified; however, all future variances will be incorporated in subsequent revisions to this compendium. Information on variances may become dated rapidly. Thus, users should contact the regional EPA RPM for full details on current regional practices and requirements.

15.6.8 Information Sources

Mine Safety Appliances Company. "Instruction Manual, Model 260, Combustible Gas and Oxygen Alarm." Pittsburgh, Pennsylvania.

U.S. Environmental Protection Agency. *Standard Operating Guides*. December 1984.

NIOSH / OSHA / USCG / EPA. *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*. October 1985.

15.7 VAPOR DETECTION TUBES - DRAEGER GAS DETECTOR MODEL 21/31

15.7.1 Scope and Purpose

This procedure discusses the use of Draeger tubes to determine the concentrations of specific gaseous pollutants in the field.

15.7.2 Definitions

None.

15.7.3 Theory and Limitations

15.7.3.1 Theory

A known volume of air is drawn through a reagent by using the pump and tube. The length of the color change observed in the tube translates to a ppm value.

15.7.3.2 Limitations

1. Cross sensitivity is typical.
2. Readings are not specific; there is a large degree of error (35% at 1/2 the permissible exposure limit (PEL) to 25% at 1 to 5 times the PEL).
3. A slow response time is typical.
4. Shelf life can be maintained for 2 years by refrigerating tubes.
5. Operator error in "reading" the jagged edge where the contaminant meets the indicator chemical (end point) is a major source of inaccuracy.

15.7.4 Applicability

The colorimetric tube and pump measure the concentrations of specific inorganic and organic vapors and of gases that cause a discoloration which is proportional to the amount of material present. The detector tubes are specific for individual compounds, or groups of compounds, and require specific sampling techniques. This information is supplied with the tubes; it details the required sample volume, the proper tube preparation and insertion into the pump, and the applicability and limitations of the individual tube. Since several hundred different tubes are available, the user must consult the specific instructions for each tube.

15.7.5 Responsibilities

The SM is responsible for determining when the use of the Draeger tube is appropriate and for monitoring that the tube is properly set up for field sampling.

Personnel must be trained in the use of the detector tubes. Refresher courses should be obligatory every 6 months. Courses are offered by the manufacturer, various commercial entities, and by EPA at their Cincinnati, Ohio, and Edison, New Jersey, facilities.

15.7.6 Records

The comments dealing with the Draeger tube sampling episode should be detailed in the field logbook.

15.7.7 Procedures -

15.7.7.1 Operation

A pump check should be performed each operational day. To complete this check, place an unbroken tube into the suction inlet of the pump and completely depress the bellows. The bellows should not completely extend (taut chain) in fewer than 30 minutes.

15.7.7.2 Field Use

- Break off both tips of the Draeger tube(s) in the break-off eyelet located on the front pump plate.
- Tightly insert the tube into the pump head with the arrow pointing toward the pump head. If multiple tubes are used (e.g., vinyl chloride), join the tubes with the rubber tube provided, then insert the tube into the pump head.
- Fully compress the bellows and allow the bellows to re-extend until the chain is taut. Repeat as often as specified in the tube operating instructions.
- Evaluate the tube according to instructions.

15.7.7.3 In-House Handling Procedures (Check In)

- Each unit on return from the field should be subjected to the following tests with results being entered in the logbook.
- The unit will be visually examined for surface dirt, deformities, cracks, and cuts.
- The pump integrity will be checked in the following manner:
 - Block the inlet with an unopened tube.
 - Fully compress; then release the pump bellows. If the bellows do not completely fill (limit chain slack) in 30 minutes, the unit is operating properly. If the unit does not pass the leak test, proceed as follows:

- Remove the pump plate.
- Unscrew the valve with the special wrench.
- Clean the valve in water and dry.
- Replace the disc if it is sticky, brittle, hard, or cracked.
- Reassemble and retest.

15.7.8 Region-Specific Variances

No region-specific variances have been identified; however, all future variances will be incorporated in subsequent revisions to this compendium. Information on variances may become dated rapidly. The users should contact the regional EPA RPM for full details on current regional practices and requirements.

15.7.9 Information Sources

Manual of Calibration, Maintenance, Service and Operation of NUS H&S Equipment and Monitoring Instruments. November 1984.

U.S. Environmental Protection Agency. *Characterization of Hazardous Waste Sites, Volume II, Available Sampling Methods.* EPA 600/X-83-018. March 1983.

15.8 FIELD EQUIPMENT – RADIATION MONITORS

15.8.1 Scope and Purpose

This subsection provides guidance in the use and implementation rationale in determining possible exposure(s) to ionizing radiation by radiation monitors. Radiation or radioactivity is the property of the nucleus of an atom to spontaneously emit energy in the form of high-energy electromagnetic waves or particles. Types of radiation that are of concern are alpha particles, beta particles, and gamma and X-radiation.

Stable atoms of an element are composed of a dense nucleus containing an equal number of protons and neutrons. Surrounding the nucleus are clouds or orbits of electrons. The number of electrons in the atom of an element equals the number of protons. The number of neutrons in the atom can vary and, if it does, the atom is known as an isotope. Most isotopes are synthetic although some, such as Cs-137 and U-238, occur naturally in nature. In addition, most isotopes are radioactive; they are unstable and tend to transform into an atom of a different element called a "daughter" by releasing a particle (either alpha or beta particles) or by emission of gamma and X-rays. The type of energy released and the rate of this release (decay rate or half life) is particular to each isotope. If desired, the isotope can be identified by determining the type of energy released and by measuring the decay rate.

Radiation, unlike other chemical and physical exposures, has no real-time warning properties that are detectable by the human senses. However, reliable radiation detectors are available.

All radiation detectors other than passive dosimeters (radiation badges) operate on the same principle: radiation causes ionization in the detection media. The ions produced are counted electronically, and a relationship is established between the number of ionizing events and the quantity of radiation present. Types of radiation detectors include the following:

- Ionization detection tubes are used primarily in high-range instruments, predominantly for detection of gamma and X-radiation.
- Proportional detection tubes inherently do not detect beta or gamma radiation; they are used primarily for detection of alpha radiation.
- Geiger-Mueller detection tubes are very sensitive to gamma and beta radiation.
- Scintillation detection media are crystal media that interact with radiation; they are highly sensitive to alpha and gamma radiation.

15.8.2 Definitions

Radiation Alert – Mini

Portable unit that detects ionizing radiation and that indicates, by using three-level scales, the actual radiation onsite with sound and light warnings and a level indicator.

ROENTGEN

The amount of gamma or X-radiation that will produce one electrostatic unit of charge in 1 cubic centimeter of dry air.

Radiation Absorbed Dose (RAD)

The quantity of radiation required for 100 ergs of energy to be absorbed by 1 gram of body tissue.

Radiation Dose Equivalent in Humans (REM)

A measure of the dose received in terms of its estimated biological effect(s) on humans.

Thermoluminescent Dosimeter (TLD) Badge

A clip-on badge containing a substrate impregnated with either lithium or calcium fluoride. These materials are phosphors that store energy when exposed to ionizing radiation. When the phosphor is heated to several hundred degrees centigrade, energy is released in the form of visible light that is measured with a photometer, providing an exposure reading.

15.8.3 Applicability

For the purpose of field work and site investigations, field teams should use several types of exposure monitors during field activities. It is conceivable that during different activities (recon versus sampling), disturbing different areas of a site may expose previously undetected radiation sources.

The cross conversion of ROENTGEN, REM, and RAD depends on a "quality factor" that is specific to each radioisotope and on the energy level of the radiation. With various forms of radiation, each has a "quality factor" that is based on its estimated biological effect on humans. It, therefore, stands to reason that each radioisotope has its own respective "quality factor."

Survey-type radiation detectors are normally calibrated against a cesium-137 gamma source. In essence, the detector is not calibrated for other isotopes. It does, however, serve as a good reference and relative indicator for other radioisotopes. The results of survey-type radiation detectors are usually displayed by a counter or audio response, along with a readout of milliroentgen per hour (mR/hr).

15.8.4 Responsibilities

The SM should see that field personnel are equipped with TLD badges and a Radiation Alert-M. (similar unit) during any aspect of field work. Health and safety personnel are responsible for addressing these safety subjects in the safety plan and for seeing that TLD badges are issued and collected quarterly.

15.8.5 Records

15.8.5.1 Thermoluminescent Dosimeter (TLD) Badge

The responsible health and safety manager or designee will maintain records of TLD issuance results, as well as badges that are lost or exposed through nonfield (airport or dentist) activity.

15.8.5.2 Other Radiation Monitors

Health and safety personnel or their designees maintain records relative to the following:

1. Periodic calibration (according to factory specifications).
2. Major repairs (in which case the unit is to be labeled "Out of Service").
3. Usage in the field.
4. Site safety personnel will keep records of any above background readings and action taken (to be noted on the site safety follow-up report or by emergency phone call) to be submitted to the responsible health and safety manager.

15.8.6 Procedures

15.8.6.1 Radiation Alert - Mini

An example of a survey-type radiation detector is the Radiation Alert-Mini, manufactured by Solo Electronics, which uses a miniature geiger detector tube with a thin mica end window called the alpha window. This arrangement makes the Radiation Alert-Mini sensitive to all forms of radiation. The detector indicates all incoming radiation with an audio response and counter. The level of radiation is measured in milliroentgens per hour (mR/hr). At lower elevations natural background radiation can produce 10 to 20 counts per minute. The detector has three ranges (X1, X10, and X100) with two alarm lights that indicate counts of 10 and 30 percent for each range, e.g., .1 mR/hr and .3 mR/hr for the X1 range, and 1 mR/hr and 3 mR/hr for the X10 range, and so on. Checkout procedures are as follows:

1. Check to see the unit is "field-ready."
2. Check battery by switching to ON position. (Note: Field teams should bring extra batteries, especially for lengthy projects.)
3. Switch unit to AUDIO. A periodic beep and flash will indicate the unit is working, especially because of background radiation. (.01-.02 mR/hr) (Note: 10 to 20 CPM on unit.)

4. Set the scale on the unit so it falls within precautionary guidelines as follows:

- If less than 2 mR/hr, continue investigation with caution.
- If greater than 2 mR/hr, stop work and evacuate site.

(Note: Exact readings cannot be determined with most alert-minis. If readings above background are determined with the alert-mini, a radiation survey meter or equivalent must be used to determine exact readings before continuing operations.)

5. Note any areas that display above-background readings. If any site evacuation is needed, contact the responsible health and safety manager upon reaching an offsite "safe zone."

6. Limitations and precautions:

- When testing for alpha radiation, be sure to position the alpha window about 1.4 inch from the material under test. Alpha particles will not penetrate more than about 1 inch of air and can be shielded by thin paper or similar material.
- Avoid exposing the Radiation Alert-Mini directly to liquids and corrosive gases; also avoid extreme temperatures and direct sunlight.
- Avoid contamination by not touching the surface of material being tested.
- Calibration must be checked and performed by the factory. Annual calibration is recommended, although its operation should be checked periodically with a low-emission source such as mantles used in gas lanterns.

15.8.8.2 Thermoluminescent Dosimeter (TLD) Badge

(Note: The TLD badge measures total quarterly cumulative dosage to the body. It is by no means to be used as a substitute for Radiation Alert-Mini or Thyac III, which measures actual site radiation.)

Radiation badges are commonly based on film dosimetry or chemical dosimetry. It is important to understand the usefulness and limitation of passive radiation dosimeters.

The conditions under which one must work are generally complex, ill defined, and irregular. Perhaps the most practical method, although less accurate than real-time monitors, is to monitor radiation exposure by using dosimeters. The dosimeter, or radiation badge, usually provides enough information that the absorbed dose can be inferred from the data. The dosimeter serves as a reliable assessment of radiation exposure on a time-weighted average and activity basis. Dosimetry is a convenient method of monitoring exposure for a whole crew of individuals where other methods would otherwise be impractical, if not impossible.

Upon receipt of TLD badges for each quarter, the responsible health and safety personnel implement the following procedures:

1. Distribute TLD badges to personnel subject to potential radiation exposure during field and laboratory activities.
2. Personnel who are issued a TLD badge wear the badge on their front pockets while onsite or performing laboratory work.

3. Field team members required to go through airport baggage checks (en route to or from the site) **MUST WEAR THE BADGE**. (Badges packed in luggage may become exposed if passed through X-ray machines.) **Do not** wear badges during visits to the dentist.

4. At the end of each quarter, health and safety personnel collect the badges and return them (including the control badge) to the manufacturer (or the designated company representative) and issue new badges for the coming quarter.

5. Limitations and precautions

- Dosimetry is a measure of after-the-fact exposures.
- Badges that are not worn by workers provide little information; compliance must be monitored.
- Badges that are exposed to direct sunlight for extended periods produce false readings.
- Badges that are exposed to ionizing radiation when not in use, as in the case of security checks at airports and in the presence of color TV and microwave ovens, will produce false positive readings.

15.8.6.3 Model 490 Victoreen Thyac III Survey Meter

The Model 490 is a pulse-count ratemeter and power supply. With the pancake detector probe, it acts as a survey meter for alpha-beta-gamma radiation. Its range of operation is 0-80,000 cpm or 0-20 mR/hr approximate radiation intensity with appropriate detector.

Use and Operation

The instrument should be used only by persons who have been trained in the proper interpretation of its readings and in the appropriate safety procedures to be followed in the presence of radiation. Training courses are mandatory for all field personnel, and refresher courses should be obligatory every 6 months. Failure to follow instructions may result in inaccurate readings and/or user hazard. Indicated battery and operational (check source) tests must be performed before each use to ensure that the instrument is functioning properly. Failure to conduct periodic performance tests in accordance with ANSI N323-1978, paragraphs 4.6 and 5.4, and failure to keep records thereof in accordance with paragraph 4.5 of the same standard could result in erroneous readings of potential danger. Do not connect or disconnect any detector while the instrument is on. Wait 2 minutes after the instrument is turned off before connecting or disconnecting any detector. Failure of transistors will occur if these instructions are not followed.

The Thyac III is designed for 100 hours of continuous use on two "D" cell batteries and longer with intermittent use. Trained personnel are required to interpret its readings. The user must be sure to read the instruction manual before using. The instrument is in a weatherproof case, which contains the two operating controls (the function switch, and the response switch) on top.

A low-intensity beta check source is provided on the case. Temperature limits are -30° to +50°C (limits for batteries may be different). The check source may be used with a headset or an audio speaker; it may be put in a plastic bag, when appropriate, to prevent contamination.

Maintenance

Do not store the instrument with the batteries inside. Replace the batteries as indicated during the battery check performed before each use. Recalibrate the instrument periodically according to manufacturer's specifications.

15.8.6.4 Eberline Model E-120 Radiation Monitor

The Model E-120 is a gamma response radiation monitor that has dual scales (0-5 mR/hr and 0-6 CPM). This unit has three range multipliers (x0.1, x1.0, and x10.0) and has adjustable response times. The general operating procedures are as follows:

Field Operation

- Switch to the battery check position to indicate the battery condition.
- Check the instrument's operation by placing a check source in a repeatable position adjacent to the detector. Move the selector switch to a range that will give an upscale reading greater than 10 percent of scale. Adjust the response control to minimize the erratic meter movements.
- Log the instrument's response value on the green tag.

In-House Handling Procedures (Check In)

- When each instrument returns from the field or at alternate 6-month maximum storage intervals,
 - Clean and visually examine the instrument for defects
 - Check its battery status
 - Validate its response to an operation check source
 - Enter the above data and any green tag data into the appropriate logbook
- At least once per year, ship each instrument to the manufacturer for recalibration.

15.8.7 Region-Specific Variances

No region-specific variances have been identified; however, all future variances will be incorporated in subsequent revisions to this compendium. Information on variances may become dated rapidly. Thus, users should contact the regional EPA RPM for full details on current regional practices and requirements.

15.8.8 Information Sources

Sax, N.I.. *Dangerous Properties of Industrial Material*. 6th ed. New York: Van Nostrand Reinhold Co. 1984

CH2M HILL *Field Surveillance Equipment*. 1984.

15.9 PERSONAL SAMPLING PUMPS

15.9.1 Scope and Purpose

This subsection provides general guidance regarding the plans for, method of selection, and use of personal sampling pumps for field investigations of hazardous waste sites.

15.9.2 Definition

Personal Sample

An air sample that is collected by a device worn on the worker; the device measures actual exposure during the work routine.

15.9.3 Applicability

This subsection discusses the use of sampling pumps for personal monitoring purposes. These guidelines are based on the objective of determining the potential exposure to a worker of air contaminants. Subsection 11.6 contains information on area sampling of ambient air.

15.9.4 Responsibilities

Field personnel must be adequately trained in the operation of personal sampling pumps. Refresher courses should be obligatory every 6 months. Courses are offered by the manufacturer, various commercial entities, and by EPA at their Cincinnati, Ohio, and Edison, New Jersey, facilities.

15.9.5 Records

Training records, maintenance records, and calibration records must be generated and maintained by the responsible organization. Specific records of field use should be noted in field notebooks as suggested in Sections 6 and 17.

15.9.6 Procedures

15.9.6.1 Preliminary Considerations

The planning, selection, and implementation of any monitoring program using personal sampling pumps require clearly defined objectives. The following considerations must be examined to define what the user wants to measure:

- Worker exposure versus ambient air
- Long-term (8 hours) versus acute (momentary releases) exposure

- Vapors versus particulates

The sampling pump that is selected must also be lightweight, portable, and not affected by motion or position.

15.9.6.2 Description and Application

Personal sampling pumps come in various models. Several models offered by MSA include the Monitaire Samplers; Models S and TD; Model C-210 Portable Pump; and the Fixt-Flo Pump, Model 1. All these models consist of a compact pump that may be clipped to the worker's belt or carried in a shirt pocket so that continuous air sampling can be made. A sampling head containing the sorbent tube, filter, or other collection medium is clipped to the lapel of the worker as close to the breathing zone as possible.

The contaminant(s) of interest will determine the type of collection medium used with the pump. Organic and inorganic vapors, as well as particulate in the breathing zone of the worker, may be measured.

MSA Colorimetric Detector Tubes are available for measuring toxic concentrations of ammonia, carbon dioxide, carbon monoxide, chlorine, hydrogen chloride, hydrogen cyanide, hydrogen sulfide, mercury vapor, nitrogen dioxide, ozone, sulfur dioxide.

Charcoal sampling tubes are also available to provide efficient collection of organic and mercury vapors for subsequent analysis using laboratory instrumentation.

The organic vapor tube will collect compounds such as benzene, carbon tetrachloride, chloroform, dioxane, ethylene dichloride, trichloroethylene, and xylene. The mercury vapor sampling tube collects both elemental and chemically bound mercury vapors, plus particulates containing mercury.

All the above-mentioned MSA sampling pumps are rechargeable battery-operated diaphragm pump. Flowrates may be adjusted on all models.

As general guidance, the following procedures should be followed when using personal sampling pumps:

1. Fully charge the pump.
2. Calibrate the pump.
3. Make sure assembly does not leak by assembling the unit, covering the inlet to the sampling device, and drawing a vacuum on the assembly.
4. If no leaks occur, the sampler is ready for use.

Manufacturer's instructions should be followed for more complete guidance on using a specific model.

Certain information should be recorded in a field notebook when a personal sampling pump is used. This may include, but not be limited to the following:

- Date
- Name

- Site
- Pump number
- Type of sample
- Time sampler started
- Time sampler turned off
- Flowrate
- Weather conditions

15.9.7 Region-Specific Variances

No region-specific variances have been identified; however, all future variances will be incorporated in subsequent revisions to this compendium. Information on variances may become dated rapidly. Thus, users should contact the regional EPA RPM for full details on current regional practices and requirements.

15.9.8 Information Sources

MSA Safety Equipment Catalog. 600 Penn Center Boulevard, Pittsburgh, Pennsylvania 15235.

Cralley and Cralley. *Part's Industrial Hygiene and Toxicology, Volume III*. 1979.

U.S. Steel Corporation. Environmental Health Services. *Environmental Health Monitoring Manual*. 1973.

15.10 OTHER MONITORING DEVICES

15.10.1 Electrochemical Gas Detector

There are many manufacturers of gas detector monitors that use electrochemical cells for detection of toxic inorganic gases. Many of these detectors are mixed oxide semiconductors (MOS) of a proprietary design, although many are of a galvanic cell type, as previously described for the MSA oxygen indicator, but specific to the analyt gas.

Typically, one manufacturer may provide a monitor with one or more replaceable cells. In certain instances, MOS cells for different gases can be interchanged in the same monitor. Electrochemical gas detectors are quite compact, are battery operated, have lower explosive detection (LED) readouts, and have audio alarms for present concentrations.

The Monitor Compur 4100 is an example of the MOS-based electrochemical gas detection system. The monitor offers MOS cells for hydrogen sulfide (H₂S), hydrogen cyanide (HCN), nitrogen dioxide (NO₂), and phosgene (COCl₂).

The monitor system is designed in particular to monitor and alert the user when threshold limit values (TLV) are exceeded as follows:

H ₂ S	—	10 ppm
HCN	—	10 ppm
NO ₂	—	5 ppm
COCl ₂	—	0.1 ppm

Of greatest consequence many times to site investigations are phosgene and hydrogen cyanide. Electrochemical gas detection such as the monitox system offers a real-time measure of phosgene and hydrogen cyanide. Neither of these chemicals has warning properties (i.e., odor, taste) at TLV levels.

15.10.1.1 Limitations and Precautions

- Cross sensitivity to other gases can trigger false alarms.
- Chemical filter (activated charcoal) for the COCl₂ cell needs to change frequently if monitoring is in the presence of H₂S, HCl, and Cl₂.
- High concentration of analyt gas, typically 100 times the TLV, can irreparably change the sensor cell.
- Sensor cells must be protected from excessive moisture and dust-laden air.
- Service life of sensor cells is typically 6 months during normal use.

15.10.2 Passive Dosimeters

The use of passive dosimeters or gas badges is a recent development in sampling. No energy or action is required to take the sample. Currently badges are available to sample from 15 minutes to 8 hours. These badges can be used for sampling organic vapors, formaldehyde, mercury vapor, ammonia, sulphur dioxide, and nitrogen dioxide.

Most passive dosimeters work on the principle of diffusion. Gases and vapors enter the monitor by diffusion and are absorbed by a sorbent medium in the interior of the badge. The amount of gas or vapor adsorbed is determined by exposure time and concentration present in the monitored environment. A measured volume of an eluent is added to the monitor to desorb and dissolve the contaminants. An aliquot of the eluent solution is then analyzed by analytical procedure specific to the contaminant. The weight of the contaminant is used in conjunction with the diffusion constant, as determined by the badge manufacturer, to calculate the time-weighted average worker exposure.

15.10.3 Miniram Monitor

The MINIRAM (Miniature Real-Time Aerosol Monitor) is a compact, personal size, airborne particulate monitor whose operating principle is based on the detection of scattered (nephelometric principle) electromagnetic radiation in the near infrared. The radiation scattered by airborne particles passing freely through the open sensing chamber of the monitor is sensed by a photovoltaic detector. An optical interference filter screens out light whose wavelength differs from the narrow-band pulsed source. Aerosol con-

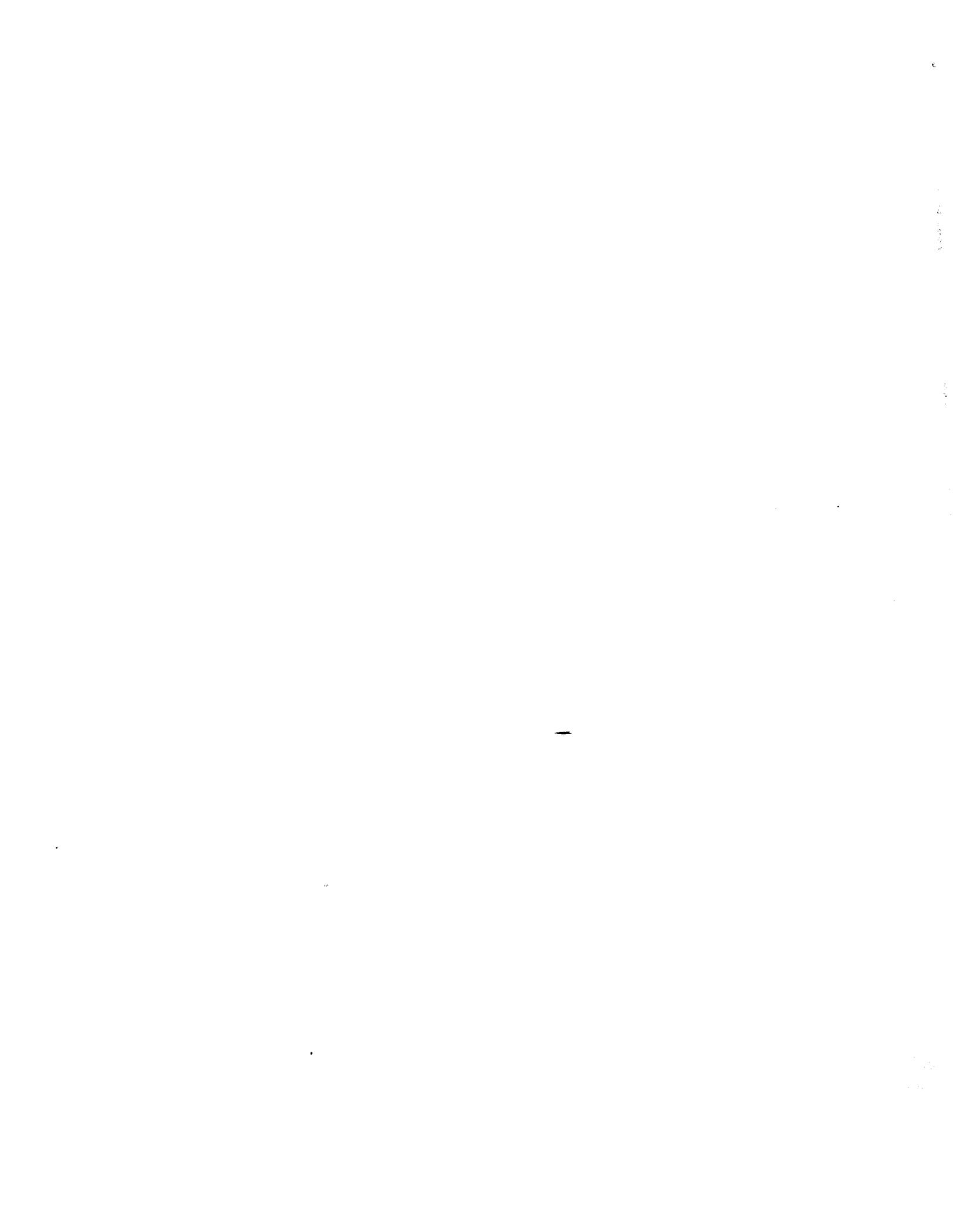
centration is displayed as milligrams per cubic meter every 10 seconds. The readings are stored and integrated to provide time-weighted averages.

Calibration of the monitor is performed by the factory against a filter gravimetric reference. The MINIRAM has application to measuring all forms of aerosols: dusts, fumes, smokes, fogs, etc. The MINIRAM is unique in that it provides real-time semi-quantitative measurements of aerosol concentrations, unlike filtration-gravimetric methods, which require both time and laboratory facilities to complete.

The MINIRAM has particular application in monitoring ambient air for toxic aerosols or toxic elements associated or transported by aerosols.



APPENDIX C
TECHNICAL MEMORANDA



TECHNICAL MEMORANDUM

TITLE: *IN-SITU* HYDRAULIC CONDUCTIVITY TEST

PREPARED BY: R. Michael Nugent

DATE: July 1989

PURPOSE: The purpose of this technical memorandum is to provide technical guidance pertaining to slug tests. These procedures are intended to establish baseline practices to assist Technical Directors and Site Managers in preparing and implementing site-specific workplans. The procedures as presented are not to be construed as a rigorous standard and slight deviations are anticipated based upon site conditions.

SCOPE: Slug tests are a quick and inexpensive means to estimate the hydraulic conductivity (K) of many aquifers. Slug tests generally work in aquifers where K is less than or equal to 10^{-3} cm/sec. In aquifers with a greater hydraulic conductivity, the water level may return to static level prior to obtaining sufficient time versus head readings. Slug tests are generally a reliable field method to determine hydraulic conductivity in the range of 10^{-4} to 10^{-7} cm/sec.

The advantages of using slug test to estimate hydraulic conductivities are:

- (1) Estimates are made in situ and errors incurred in laboratory testing of small or disturbed overburden samples are avoided.
- (2) Tests are performed quickly at a relatively low costs in that a pumping well and observation wells are not required.
- (3) The hydraulic conductivity of discrete portions of an aquifer can be made.
- (4) Treatment and disposal of contaminated groundwater as with a pumping test is not a consideration.

However, there are disadvantages in using slug tests which are to be considered. These include:

- (1) Only the hydraulic conductivity of the aquifer in the immediate vicinity of the well is estimated. This estimate, by itself, may not be representative of the aquifer in toto.
- (2) Often only a range of hydraulic conductivity values rather than an average estimate can be deduced from test results.
- (3) Certain assumptions are made in the analysis process. If geologic and test conditions do not approximate the assumptions, the subsequent results may be erroneous.

- (4) The aquifer storage coefficient, S, cannot be determined under most conditions.
- (5) As noted previously, there exists constraints in the applicable range for aquifer K values. Beyond these limits the test procedure is either invalid (i.e., $K < 10^{-7}$ cm/sec) or data is difficult to obtain (i.e., $K > 10^{-3}$ cm/sec).

DEFINITIONS:

Hydraulic Conductivity (K) - A quantitative measure of the ability of porous material to transmit water. Hydraulic conductivity is depended upon properties of the medium and fluid. Also referred to as "permeability".

Transmissivity (T) - A quantitative measure of the ability of an aquifer to transmit water. The product of the hydraulic conductivity multiplied by the aquifer's saturated thickness.

Slug-Test - A rising head or falling head test. A slug test consists of adding a slug (of water or a solid cylinder) of known volume to the boring or well to be tested or removing a known volume and measuring the rate of recovery of water level inside the well. The slug of known volume acts to raise or lower the water level in the well.

Rising-Head Test - A test used in an individual borehole or well within the saturated zone to estimate the hydraulic conductivity of the surrounding formation by lowering the water level in the boring or well and measuring the rate of recovery of the water level. The water level may be lowered by pumping or bailing. Also known as a bail test.

Falling-Head Test - A test used in an individual borehole or well to estimate the hydraulic conductivity of the surrounding formation by raising the water level in the boring or well and measuring the rate of drop in the water level. A constant head test is a variation of the falling head test in which water is constantly added to borehole or well to be tested, and the flow rate required to maintain hydraulic head at a constant level above the static water level is measured.

Packer Test - A hydraulic conductivity test using inflatable packers to isolate a discrete zone within the borehole for testing purposes.

Packer - A sealing device installed in a well or borehole which isolates intervals within the boring or well for testing purposes.

EQUIPMENT:

- (1) Electric water-level indicator
- (2) Solid or ballast filled "slug" cylinders of 4-inch, 3-inch, and 2-inch diameter each 4 or 5 feet in length.
- (3) Single-strand stainless steel on PTFE (teflon) coated line to lower or raise slug
- (4) Ten psi, 15 psi, or 25 psi pressure transducer with appropriate length of cable
- (5) Data logger for recording pressure (head) changes from transducer
- (6) Field notebook
- (7) Pen
- (8) Five-foot folding, engineer rule
- (9) Duct or electrical tape

PROCEDURE:

The test consists of measuring the rate at which the water level within the monitoring well declines after a known volume (slug) is "instantaneously" introduced or the rate at which the water level rises after the slug is removed.

Prior to initiating the test, the following information is to be recorded in the field notebook.

- Test procedure (reference this technical memorandum) plus any deviations from the test procedure;
- Serial number, pressure range, and voltage output range of pressure transducer;
- Well or borehole identification code;
- Location and elevation of measuring (reference) point at which depth to water level measurements are made;
- Date and time of test;
- Well depth, screen length, screen slot size, riser pipe inside radius, well screen inside radius, sand/gravel pack size ranges and borehole radius;
- Aquifer or groundwater zone being tested;
- Slug volume;
- Type of measuring device used; and
- Names of personnel conducting slug test

CONDUCTING THE SLUG TEST:

1. Water level indicator, transducer and cable, and the slug will be cleaned using a nonphosphate detergent wash and a distilled water rinse followed by a pesticide grade isopropanol rinse and allowed to air dry. Prior to use, the equipment shall undergo a distilled water rinse. Water level indicator probe shall be cleaned after each use.
2. Wells will be opened, allowed to equilibrate, and depth to water level measured and recorded.
3. A slug will be selected based on well diameter and a line attached. The line will be marked at a distance from the bottom of the slug equal to the measured depth to water level plus the length of the slug.
4. The transducer will be lowered into the well to a depth of 10 feet below the static water level or as close to this depth as allowed by well/water level configuration. (Note: Pressure transducer must lie at least 2 feet below the depth of the slug to dampen pressure waves and must be at least 1 foot above the bottom or sump section of the well to prevent silting.) Tape the pressure transducer to the well casing to fix the depth of the transducer in the well.
5. The following is specific to operation of the Model EL-200 data logger.
 - (a) Function B0 - Enter a two digit station ID number (00-99) and press <E> (Enter).
 - (b) Function B1 - Enter the date in format YY/MM/DD and press <E>.
 - (c) Function B2 - Enter time in format HH:MM:SS and press <E>
 - (d) Function B4 - Press <E> until appropriate pressure transducer channel is reached and enter appropriate scale factor for transducer. Press <E> and then <F>.

Analog Channel Scale Factors (s/f)

S/F	0%	100%	1 LSB	Remarks
000	--	--	--	Channel is off.
001	0.000		2.307 .001	Input in psi
002	0.000		4.61 .01	Scaled output (ft)
005	0.000		11.53 .01	
010	0.000		23.07 .01	
015	0.000		34.60 .01	
025	0.00		57.67 .01	
050	0.00		115.3 .1	
100	0.00		230.7 .1	
250	0.00	576,700	.1	

- (e) Function B6 - Check probe calibration by raising transducer in 0.5 foot intervals. Record depth to probe (below water surface) and displayed values.
 - (f) Function A3 - Places data logger in SILOG II status.
 - (g) Function 5 - Editing SILOG II Segments.
 - (h) Press 01200001 then <E> - will result in readings being taken at 1 second intervals (01200001) for 120 seconds (01200001).
 - (i) Press 00360005 then <E> will result in readings being taken at 5 second intervals for the next 3 minutes (i.e., 36 5-second intervals).
 - (j) Press <F> to exit editing mode
6. Lower the slug until the static water level is reached and then raise slug slightly above this mark. Secure slug line to well casing leaving sufficient slack so that slug can be completely submerged when test begins.
 7. Press <3> then to start data logger and after 5 seconds lower slug into water. Slug must be lowered into water as quickly as possible. However do not allow slug to drop into the water but glide it in. This will prevent compression waves and faulty readings during the initial part of the test.
 8. Press any key and then <B6> to display pressure head readings.
 9. Upon termination of the test and the return of the water level to static conditions, press <A3>, <3>, then wait 5 seconds, and remove slug. This begins the rising head portion of the test.
 10. Press any key and then <B6> to display pressure head readings. Terminate test when pressure head reading indicates 90 to 100 percent recovery.
 11. Press any key and then <AC> to power down. Remove power cord.
 12. Decontaminate slug, pressure transducer, and slug line as outlined in Step 1.

- NOTE:
- (A) For situations where static water level is within screen interval, only perform the rising head portion of the test.
 - (B) RAM only holds 12,000 data points.

DATA ANALYSIS:

The analysis of slug test data is based on the modification of well known groundwater flow equations (either the Theis equation, the Theim equation, or subsequent modification). Several authors have presented analytical solutions for the analysis of slug test data. Most solutions require a semi-logarithmic plot of the data collected: dimensionless head (logarithmic scale) or residual head (logarithmic scale) versus time (arithmetic scale).

Hvorslev (1951) was one of the first researchers to publish techniques of analysis of either constant or slug (falling head) tests in near-surface saturated soils. His analysis of slug tests involves a semi-logarithmic plot of the falling head (or water level) divided by the initial head against time. Basic algebraic equations are presented for different configurations of the soil relative to the test hole. In general, the permeability is proportional to a "shape factor" and inversely proportional to a "time lag." The "shape factor" is determined from the test well characteristics or dimensions. "Time lag" is determined from the semi-logarithmic plot.

Cooper et al. (1967) and Papadopoulos et al. (1973) developed a set of type curves for analyzing slug test data, particularly for tests run in materials which are confined (under artesian pressure). The field data are plotted as dimensionless head (arithmetic scale) versus time (logarithmic scale) and matched to a set of type curves. The match point values are substituted into simple algebraic formulations to obtain a value for K.

Bouwer and Rice (1976) and Bouwer (1978) developed a technique for analyzing slug test data collected from completely or partially penetrating wells in unconfined aquifers. Their analysis involves a plot of residual head (logarithmic scale) versus time (arithmetic scale). A straight line is applied to the early-time data and used to calculate a value for K.

Pressurized slug test methods have been developed for testing extremely low hydraulic conductivity (10^{-8} cm/sec or lower) materials (Bredehoeft and Papadopoulos, 1980). Basically, the pressurized slug technique is a modification of the conventional slug test previously discussed. The advantage of the pressurized slug technique is the reduction of time required to perform a test in tight formations. This method involves creating an instantaneous pressure surge on drawdown in the test zone, then closing a valve to shut in the well. Based on the rate of decay of the pressure slug and the geometry of the test zone, the transmissivity, hydraulic conductivity, and storativity may be calculated.

APPENDIX D

ALTERNATE WELL CASING MATERIAL JUSTIFICATION



Southern Division Naval Facilities Engineering Command (SOUTHNAVFACENGCOM) is committed to using only the most reliable methods to obtain the data used in its investigations. Therefore, SOUTHNAVFACENGCOM recommends the use of well casings made of Polyvinyl chloride (PVC) material for monitoring wells installed at NAS Cecil Field. After reviewing the literature, SOUTHNAVFACENGCOM has concluded that PVC is a superior well casing material when monitoring a plume consisting of both metals and organics. Attached are two recent publication supportive of SOUTHNAVFACENGCOM's position: "Influence of Casing Materials on Trace-Level Chemicals in Well Water" (Parker, 1990) and "Leaching of metal pollutants from four well casing used for ground-water monitoring" (Hewitt, 1989).

SOUTHNAVFACENGCOM requests USEPA consider the following information as required in the "Alternate Well Casing Material Justification" form.

1. The Data Quality Objectives (DQO) for the samples to be collected from wells with PVC casing per EPA/540/G-87/003., "Data Quality Objectives for Remedial Response Activities."

Response: The DQOs for the remedial investigation (RI) at Cecil Field are to provide information of sufficient quality to support risk assessment and feasibility study conclusions. The quality assurance and quality control (QA/QC) procedures are specified in the Sampling and Analysis Plan (SAP). Sample collection and accompanying QA/QC procedures are designed to meet USEPA level 4 criteria.

2. The anticipated compounds and their concentration range.

Response: The following is a list of the contaminants that exceeded an existing maximum contaminant level (MCL) and the highest contaminant concentration detected: Lead at 385 ug/l, Chromium at 425 ug/l, benzene at 4 ug/l, Trichlorethylene at 400 ug/l, and 1,1-Dichloroethane at 210 ug/l.

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

Response: Each well will be purged immediately before the sample is collected. The anticipated residence time of the water prior to sampling should be less than twenty minutes. The surficial aquifer is estimated to have a transmissivity range of 0.05 to 3.93 m²/day.

4. The reason for not using a hybrid well.

Response: SOUTHNAVFACENGCOM feels that PVC is the preferred material when sampling mixed waste plumes. Stainless steel may absorb or adsorb heavy metals such as lead, chromium and arsenic. Also, the cutting oils used in the manufacturing of stainless-steel riser and screen are difficult to remove. These oils, if not completely removed by the decontamination cleaning, may contaminate the well. Hybrid wells introduce additional problems, such as, the junction is usually a weak point subject to breakage or is a place for down-hole equipment to become ensnared.

5. Literature on adsorption/desorption characteristics of the compounds and elements of interest for the type of PVC to be used.

Response: Two reprints are attached that evaluate the sorptive characteristics of stainless steel and PVC. The study titled "Influence of Casing Materials on Trace-level Chemicals in Well Water" (Parker, 1990), evaluated all the chemicals of concern identified in previous Cecil Field studies except benzene and 1,1-dichloroethane.

6. If an anticipated increase in thickness of the wall thickness will require a larger annular space.

Response: No change in the annular space is required.

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

Response: The PVC will comply with American Society of Testing and Materials (ASTM) F480 and D1785.

SOUTHNAVFACENGCOM strongly believes that the quality of data obtained by using PVC well construction materials will be equal to or an improvement over the use of stainless steel as a general purpose well construction material.



DEPARTMENT OF THE ARMY
COLD REGIONS RESEARCH AND ENGINEERING LABORATORY, CORPS OF ENGINEERS
HANOVER, NEW HAMPSHIRE 03755-1290
February 25, 1991

Applied Research Branch

Ms. Peggy Lane
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2571 Executive Center Circle, East
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Tallahassee, Florida 32301

Dear Ms. Lane:

I have enclosed a copy of our journal article that compares the sorption of organics and metals by four well casing materials (PVC, PFTE, and stainless steel types 304 and 316). I have also included a more recent study that compares the leaching of metals from these materials; this study was conducted by Alan Hewitt. It is our opinion that since you are monitoring for both VOC's and metals that PVC is the best material to use in your monitoring wells, provided that you do not anticipate encountering an undiluted solvent of PVC. Stainless steel is not a good casing material to use when monitoring for metals. Also, stainless steel should not be placed in any environment that is corrosive. "The Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells," by Linda Aller et al. (1989, published by the National Water Well Association, Dublin, Ohio) has an excellent discussion on corrosion of steel products.

If you would like any additional questions answered, please do not hesitate to call me at 603-646-4393. Alan Hewitt can answer any questions on our metals studies. He can be reached at 603-646-4388.

29 FEB 91 2:19

I hope you find this material useful.

Sincerely,

A handwritten signature in cursive script that reads "Louise Parker".

Louise V. Parker
Research Physical Scientist
Applied Research Branch

2 enclosures





LEGEND

 WASTE DISPOSAL SITE

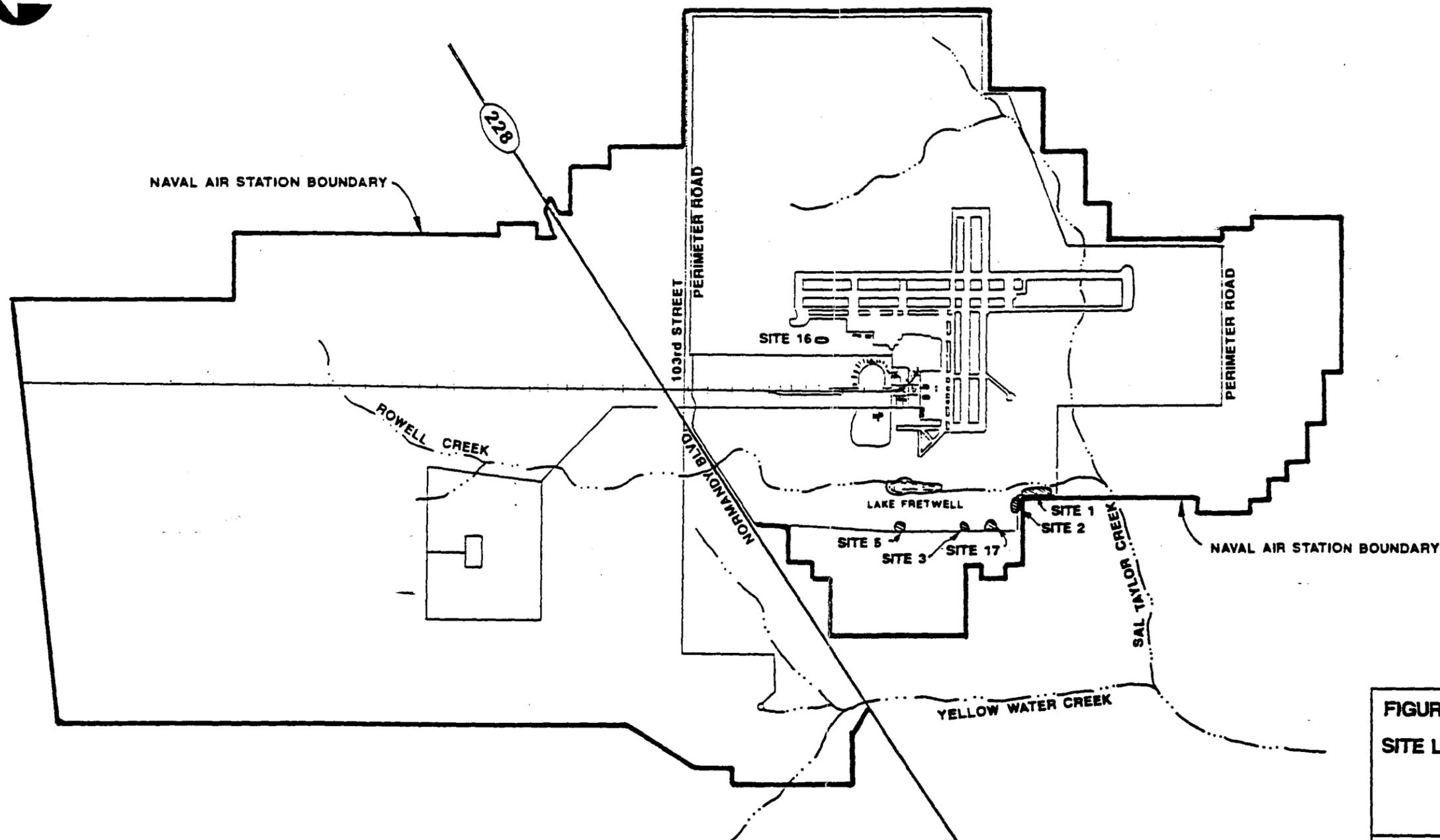


FIGURE 1-2
SITE LOCATION MAP



SAMPLING AND ANALYSIS PLAN
NAS CECIL FIELD
JACKSONVILLE, FLORIDA

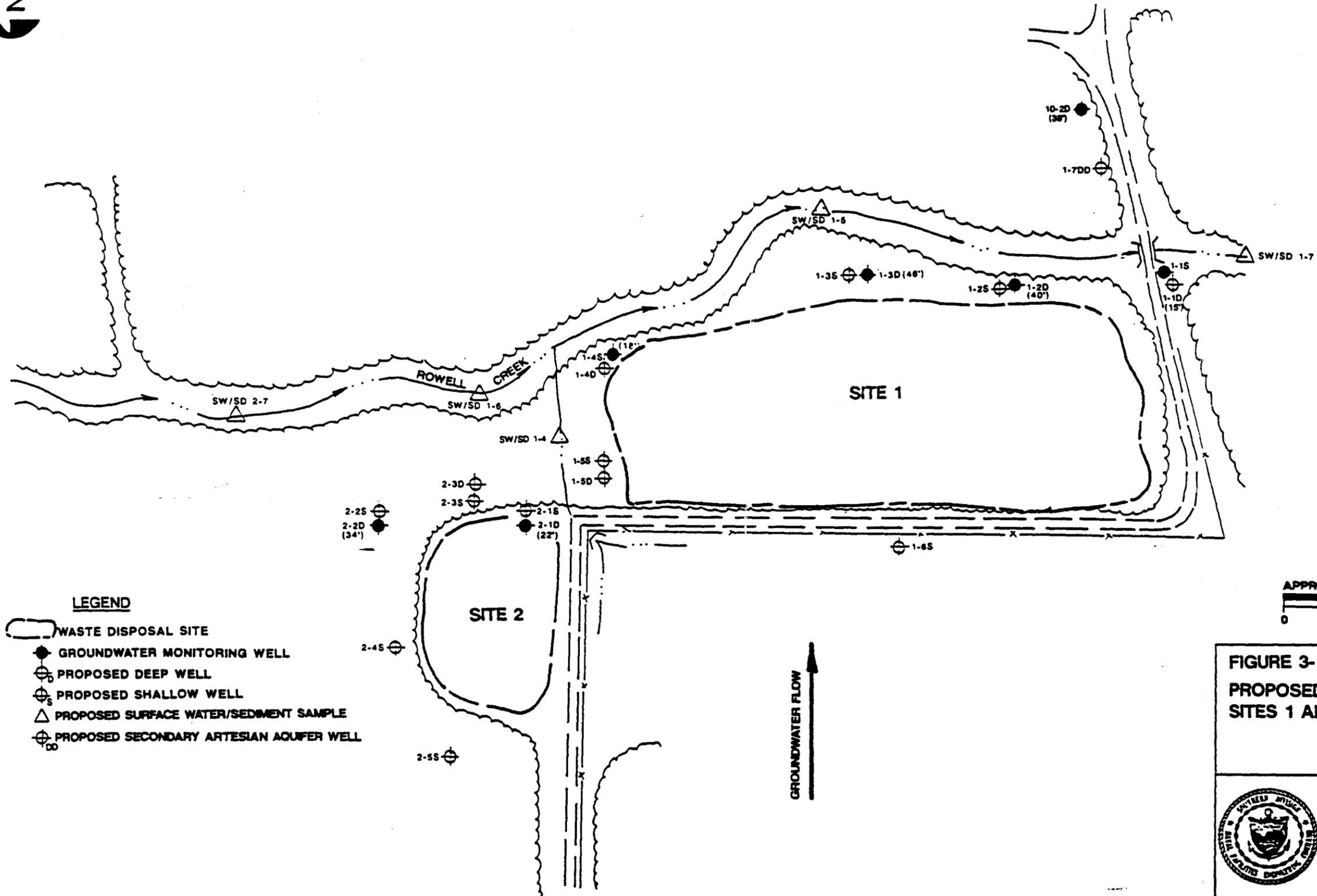


FIGURE 3-1
PROPOSED SAMPLING LOCATIONS
SITES 1 AND 2

SAMPLING AND ANALYSIS
PLAN
NAS CECIL FIELD
JACKSONVILLE, FLORIDA