WORK PLAN
for the
HTW INVESTIGATION
PLUM BROOK ORDINANCE WORKS
PLUM BROOK STATION/NASA
Sandusky, Ohio
for
U.S. Army Corps of Engineers, Nashville District
October 1994

Part I
SAMPLING & ANALYSIS PLAN

Part II
MONITORING WELL INSTALLATION PLAN

Part III
SITE-SPECIFIC SAFETY & HEALTH PLAN

DAMES & MOORE

US Army Corps of Engineers

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FINAL WORK PLAN

PART I - SAMPLING AND ANALYSIS PLAN

PART II - MONITORING WELL INSTALLATION PLAN

PART III - SITE-SPECIFIC SAFETY AND HEALTH PLAN

FOR

HAZARDOUS AND TOXIC WASTE INVESTIGATION
PLUM BROOK ORDNANCE WORKS
PLUM BROOK STATION/NASA
SANDUSKY, OHIO

Prepared for:

U.S. Army Corps of Engineers
Nashville District

Prepared by:

Dames & Moore, Inc.
Atlanta, Georgia

OCTOBER 1994

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LIST OF ACRONYMS AND ABBREVIATIONS

AOC	Area of Concern
ASI	Analytical Services, Inc.
ASTM	American Society for Testing and Materials
BioRenewal	BioRenewal Technologies, Inc.
BNAs	base neutral/acid compounds
CEORN	Corps of Engineers, Nashville District
COE	Corps of Engineers
CVAA	cold vapor atomic absorption spectrometry
DoD	Department of Defense
EPA	U.S. Environmental Protection Agency
FS	Feasibility Study
GC	gas chromatography/gas chromatograph
GPC	gel permeation chromatography
HPLC	high pressure liquid chromatography
HTW	Hazardous and Toxic Waste
ICP	inductively-coupled plasma atomic emission spectrometry
IT	IT Corporation
LC	laboratory control
LCD	laboratory control duplicate
MDLs	method detection limits
MS	mass spectrometer
MS	matrix spike
MSD	matrix spike duplicate
msl	mean seal level
NASA	National Aeronautics and Space Administration
ORD-L	Ohio River Division Laboratory
OVA	organic vapor analyzer
PBOW	Plum Brook Ordnance Works
QA	quality assurance
QC	quality control
RI	Remedial Investigation
RPD	relative percent difference
SAP	Sampling and Analysis Plan
SI	Site Investigation
SSHP	Site-Specific Safety and Health Plan
USDA	U.S. Department of Agriculture
UV	ultraviolet
VOCs	volatile organic compounds

FINAL WORK PLAN
PART I
SAMPLING AND ANALYSIS PLAN
FOR
HAZARDOUS AND TOXIC WASTE INVESTIGATION
PLUM BROOK ORDNANCE WORKS
SANDUSKY OHIO

1.0 INTRODUCTION

Chemical contamination caused by Department of Defense (DoD) activities may exist at the former Plum Brook Ordnance Works (PBOW), located in Sandusky, Ohio. The Corps of Engineers, Nashville District (CEORN) has issued Dames & Moore Delivery Order 0020 of Contract DACA62-92-D-0015 to perform a Hazardous and Toxic Waste (HTW) Investigation of selected Areas of Concern (AOCs) at the PBOW. The site investigations described in this Sampling and Analysis Plan (SAP) address the possible chemical contamination at two of the AOCs and of the groundwater in the bedrock aquifer underlying the site.

1.1 SITE BACKGROUND

1.1.1 Site History

The PBOW is located 4.7 miles south of Sandusky, Ohio and 59.0 miles west of Cleveland, Ohio in Erie County, Ohio. Figure 1-1 illustrates the site location. The original site consisted of 9,071.06 acres of land which was acquired by DoD in 1941. An ammunition plant was constructed on this site and operated by Trojan Powder Company for DoD until 1945. After operations ceased, the magazine area was renamed Plum Brook Depot and was used for ammunition storage. This area was also referred to as Erie Ordnance Depot. The facility was placed on inactive status in June 1961. The National Aeronautics and Space Administration (NASA) acquired PBOW and Plum Brook Depot on March 15, 1963. On April 18, 1978, NASA declared 2,152.15 acres of land as excess. Of this excess, 46.023 acres were conveyed to the Perkins Board of Education on June 2, 1978, which currently uses the area as a bus

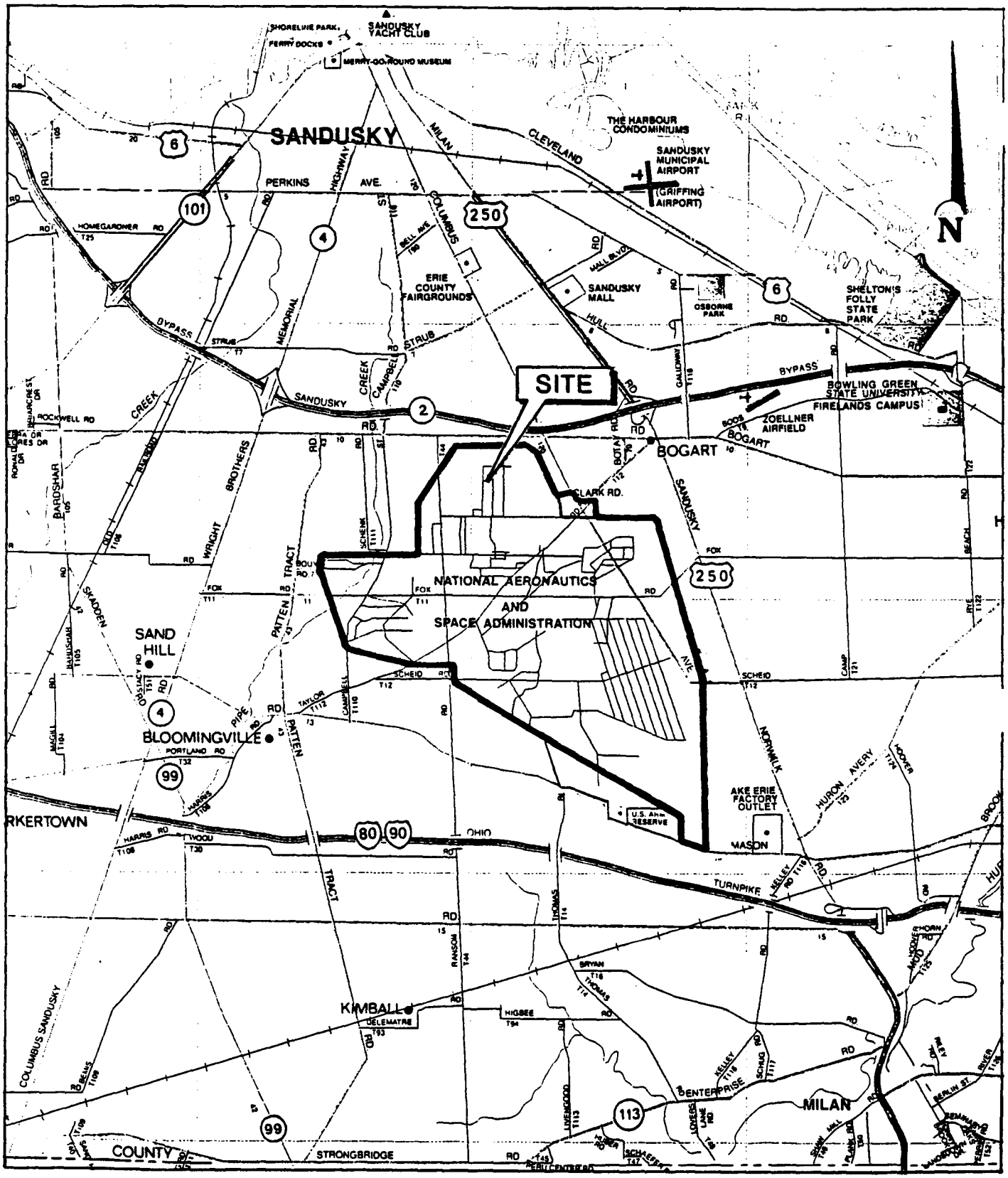


Figure 1-1
SITE LOCATION MAP
Plum Brook Ordnance Works
Sandusky, Ohio

DAMES & MOORE

transportation center. The Ohio National Guard currently uses 604 acres of the site for training.

NASA is currently using their site to conduct space research as a satellite operation of NASA, Lewis Research, Cleveland, Ohio. Most of the original structures from the PBOW were removed by NASA, and NASA has constructed numerous facilities on the site since its acquisition. Some of the original structures, power plants, and red water ponds have not been removed or remediated (COE, 1994).

Past disposal practices during the period of DoD control are unknown. Explosives manufacture and/or handling at the site resulted in the operation of holding ponds ("red water ponds") for process waste water. This process waste water may have contained residues of the explosive manufacturing process and may have been acidic in nature. Out-of-specification explosives and munitions may have been burned or buried on the facility. Several suspected burial and other disposal sites have been identified; however, specific materials buried are unknown. These areas are not part of this investigation. Possible effects of the buried materials on groundwater and surface water at the site are also unknown. The HTW Investigation involves the investigation of the remaining DoD structures and the contiguous groundwater, sediment, and soil for possible contamination by hazardous substances known to be associated with the operation, maintenance, and deactivation of the PBOW (COE, 1994). Additional information on site activities will be documented in the PBOW Records Review Report.

A number of environmental investigations have been conducted at the PBOW. In 1989, IT Corporation (IT) performed a limited investigation of areas of potential concern to the DoD. The field investigation activities included: collection of soil, surface water, sediment, and groundwater samples for geotechnical or chemical analysis; and conducting hydraulic conductivity tests. MK Ferguson performed a preliminary sitewide environmental investigation for NASA in 1993 (report dated 1994). Additional investigations have been performed by NASA (e.g., investigations of underground storage tanks) and other interested parties (the U.S. Army Reserve conducted a limited investigation of the West Area Red Water Ponds).

1.1.2 Site Soils, Geology, and Hydrogeology

In their Investigation report of areas at the PBOW, IT (1989) described the topography, soils, geology, and hydrogeology of the site. The following is exerpted from the IT report.

Topography and Physiography

The Plum Brook site is located on what was originally a flat lake bottom from glacial met waters. The ground surface slopes gradually northward toward Lake Erie at an average slope of less than six percent. Elevations at the site range from 675 feet above mean sea level (msl) at the southwest edge of the site to 625 feet msl in the northern portion of the property at Bogart Road.

The Plum Brook site derives its name from the major stream passing through its boundaries. Eleven streams, six of which originate with the site boundaries, flow northerly or northeasterly into Lake Erie. Plum Brook and Pipe Creek originate south of the site and flow independently into Lake Erie. Kuebeler Ditch, Ohlemacher Ditch, Scherer Ditch, and Zorn Beutal Ditch originate at the southwest edge of the property and connect into Harris Ditch south of Fox Road.

Soil Characterization

Most of the soils at the Plum Brook site were formed from deposits from glaciers or from glacial melt waters. The dominant soil material was deposited at glacial till, outwash, and lacustrine deposits.

Glacial till is material laid down directly from glaciers with minimum water action. Typically, it consists of particles of different sizes. Some smaller pebbles in glacial till have sharp corners, indicating that they have not been rounded or work by water.

Outwash materials were deposited by running water from melting glaciers. The size of the particles that make up the outwash material varies according to the speed of the water in which particles were carried. Outwash deposits generally consist of layers of particles of similar size, such as sand and gravel.

Lacustrine deposits, material settled from still, ponded glacial melt water, contain only the finer particles such as very fine sand, silt, and clay because the coarser material dropped out as outwash.

The U.S. Department of Agriculture (USDA) Soil Conservation Service Soil Survey (1971) identifies the majority of soils at the site as being from the Arkport-Galen association. Arkport soils consist of gently sloping to moderately sloping, well-drained soils formed in the sandy material deposited at the edge of a glacial lake. Arkport soils are generally loamy fine sand and fine sand. Galen soils are mostly level and moderately well-drained formed as small sandy deposits on outwash plains and deltas. Galen soils have a fine sand or sandy loam surface layer, a subsurface of fine sand and loamy fine sand that is underlain by silt or clay. Runoff is slow, permeability is rapid, and the available moisture capacity is low. Wind erosion is a problem in this soil association.

The southern portion of the site has soils in the Prout association. Prout soils are moderately deep to deep, nearly level to gently sloping, somewhat poorly drained soils that have a subsoil of heavy silt loam to silty clay loam. These soils are commonly on uplands, with runoff and permeability slow (USDA, 1971).

The Lewisburg association occupies a small isolated part of the Plum Brook site. The soils are moderately deep to deep, nearly level in depressions, and are narrow strips along natural drainageways. Runoff is slow, permeability is moderately slow (USDA, 1971), and the available moisture capacity is high.

Geologic Setting

In the Paleozoic Era, large tropical inland seas covered the Plum Brook site. As the seas began to recede, deposits of carbonate material slowly lithified into thick layers of limestone and dolomite. Likewise, deposits of mud and clay formed shales and quartz, while other silicate materials formed sandstone.

In recent geologic time, glacial ice scoured the area, cutting out the river valleys. The resistant bedrock that covers most of the area was not deeply cut by the glaciers.

The majority of the site is underlain by lacustrine glacial deposits making up the Huron shale. The shale is grayish black, hard, dense and abundantly carbonaceous. The area is also underlain by Plum Brook shale and Delaware and Prout limestones. The shales are low in porosity while the limestones are massive with carcareous shale partings and are moderately porous. The bedrock is limestone in the western part of the site and shale in the eastern part. The regional dip is easterly, and younger rocks crop out progressively from west to east (U.S. Geological Survey, 1954).

Hydrogeologic Setting

Groundwater in the area of the Plum Brook site has its source in local precipitation. The limestone beds underlying the site are the principal aquifer. Yields from limestone rocks range generally between 5 and 25 gallons per minute. Water in limestone beds occurs principally in joint cracks along bedding planes and in other openings. Most well in the limestone deposits in the vicinity of the station range between 50 and 80 feet in depth. The quality of the water deteriorates rapidly with increased depth, and wells deeper than approximately 100 feet generally yield sulfur water. There are no wells used as a source of water supply within the Plum Brook site.

Surface water leaves the site through naturally occurring surface creeks. All streams may have zero flow in severe winter freezes and extended summer

droughts. The existence of buildings, roads, parking lots, and other impervious areas has caused an insignificant increase in the amount of storm water runoff during rainfall events.

1.2 OBJECTIVES

The HTW Investigation of the PBOW includes four components: (1) Site Investigations (SIs) for AOC 1 (three TNT Areas); (2) a focused Remedial Investigation (RI) of AOC 2 (West Area Red Water Ponds and Pentolite Road Red Water Ponds); and (3) a sitewide groundwater investigation of the bedrock aquifer; and (4) assessment of background soil conditions. The investigation areas and work support areas are illustrated on Figure 1-2.

1.2.1 Objectives of the SI for TNT Areas (AOC 1)

The objectives of the SI at AOC 1 are to investigate the presence of contamination in soils and groundwater resulting from past DoD-related use of the site. Possible contaminants in TNT Areas A, B, and C are nitroaromatics (explosives) and metals.

This entails that all collected data be "Definitive Data." This level of analysis is characterized by rigorous QA/QC protocols and documentation and provides qualitative, as well as quantitative analytical results. The quality of data collected shall be such that it can be utilized in risk assessments and/or feasibility studies (FS) which may be performed for the TNT Areas in the future.

1.2.2 Objectives of RI at the Red Water Ponds (AOC 2)

The objectives of the focused RI of the Red Water Ponds (AOC 2) are to identify and evaluate the source, nature, and extent of contamination resulting from past DoD-related use of soils, surface water, groundwater, and sediment in both the West Area Red Water Ponds and Pentolite Road Red Water Ponds. Possible contaminants

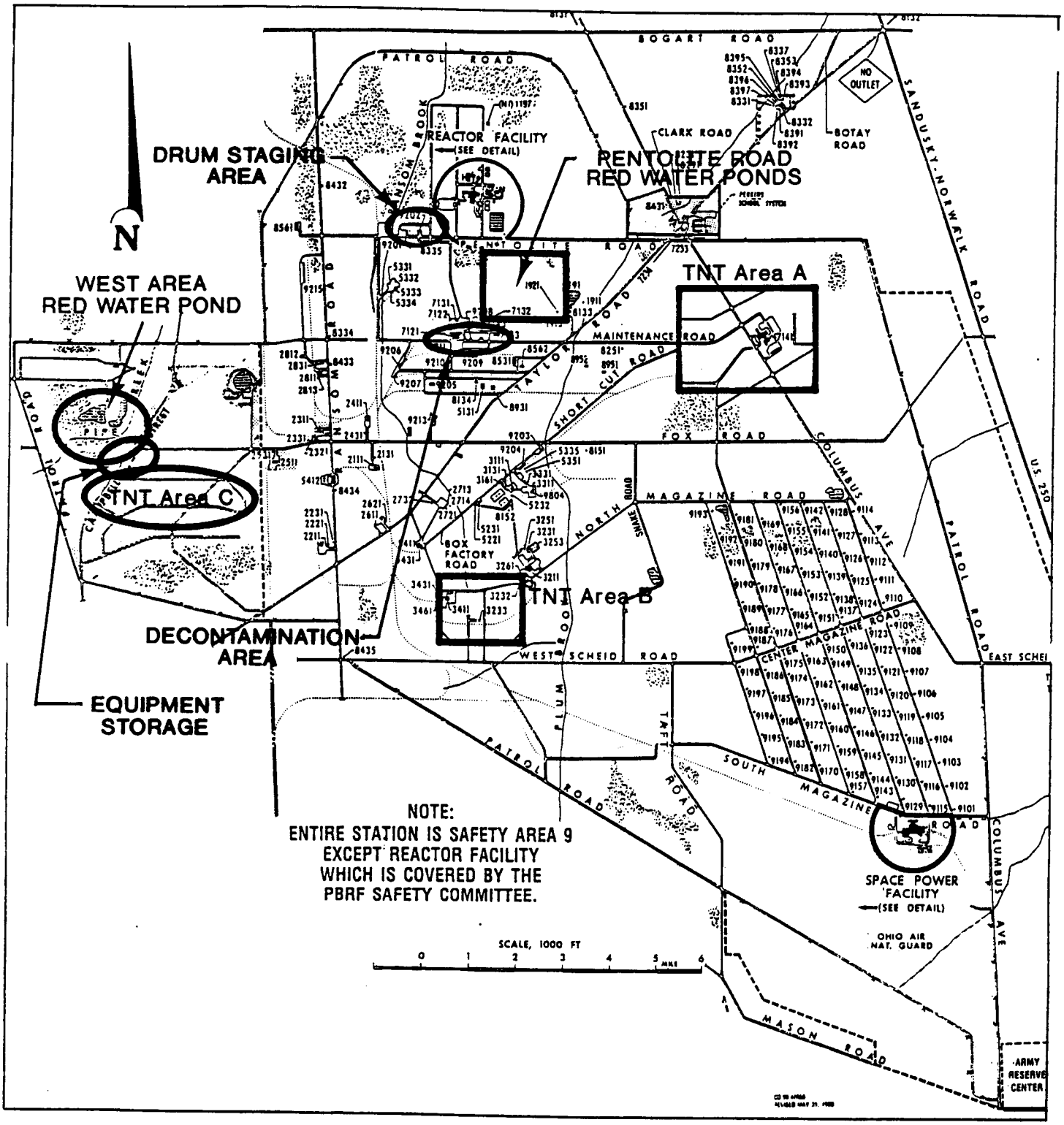


Figure 1-2

INVESTIGATION AND WORK SUPPORT AREAS

Plum Brook Ordnance Works

Sandusky, Ohio

in the Red Water Ponds are nitroaromatics (explosives) and metals and the RI is "focused" on these contaminants.

The quality of collected data during the focused RI shall be such that it can be utilized in the preparation of a risk assessment and/or feasibility study which may be prepared. Collected data will be "Definitive Data".

Dames & Moore performed an analysis of the laboratory quantitation limits for nitroaromatics proposed for this project. The results of the analysis indicate that the proposed quantitation limits are appropriate for use in quantitative risk assessment.

1.2.3 Objectives of Sitewide Groundwater Investigation

The objectives of the sitewide groundwater investigation are to evaluate the presence and nature of contamination in the bedrock aquifer underlying the site. Possible contaminants in sitewide groundwater include nitroaromatics (explosives), volatile organic compounds (VOCs), base neutral/acid compounds (BNAs), and metals.

Additionally, as part of the focused RI for the Red Water Ponds (AOC 2) and the SI of the TNT Areas (AOC 1), the presence and nature of contamination in the groundwater aquifer in the unconsolidated overburden materials will be assessed. The contaminants of concern in the overburden are nitroaromatics and metals.

1.2.4 Objectives of Background Soil Quality Assessment

The objective of collecting background soil samples is to establish background levels of constituents of concern in site soils, particularly levels of metals.

1.3 ORGANIZATION OF SAMPLING AND ANALYSIS PLAN

This plan consists of eight sections, as follows:

Section 1 describes the site background and project objectives.

Section 2 presents the project organization and personnel responsibilities.

Section 3 describes the sampling scheme and sample locations and lists the laboratory analyses to be performed.

Section 4 presents the investigation field sampling procedures.

Section 5 describes the procedures for sample packaging, shipping, and custody documentation.

Section 6 describes the chemical laboratory analyses to be performed.

Section 7 presents a description of the data management deliverables and the chemical data evaluation which will be performed.

Section 8 describes the physical and biological laboratory analyses to be performed.

Tables and figures are presented after the page on which they are first mentioned.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

2.1 PROJECT ORGANIZATION

The Atlanta office of Dames & Moore will perform and coordinate the field activities described herein for the CEORN. The CEORN Project Manager is Captain Michael Riebel. Dames & Moore will also coordinate the field activities through and in conjunction with Captain Riebel with Ms. Amy Bower of the NASA Plum Brook Station. Dames & Moore project management and/or field personnel will contact Captain Riebel, or in his absence Mr. Doug Webb of CEORN, in the field or at CEORN's office to coordinate changes from the procedures set forth in the Sampling and Analysis Plan which cannot be addressed by CEORN's on-site field representative.

Figure 2-1 illustrates the project organization of Dames & Moore and its subcontractors for the field portion of this project.

Dames & Moore has subcontracted with Analytical Services, Inc. (ASI) of Atlanta, Georgia to perform the chemical analyses of soil, surface water, sediment, and groundwater samples. During the field activities, ASI will coordinate with the Project Manager and the Site Supervisors, as described in Section 2.2.

Sieve samples will be tested by Dames & Moore's Salt Lake City geotechnical laboratory. The Drilling Supervisor will coordinate with the appropriate laboratory personnel.

Dames & Moore has subcontracted with BioRenewal Technologies, Inc. (BioRenewal) to perform the microbial quantification and enumeration. BioRenewal will coordinate with the Site Supervisors and Project Manager.

Dames & Moore will subcontract with a drilling contractor for installation of selected soil borings and monitoring wells. Drilling company personnel who are assigned to work on the PBOW project will meet the health and safety requirements outlined in the SSHP presented in Part III of the Work Plan. During the field activities they will report to the Drilling Supervisor, as described in Section 2.2.

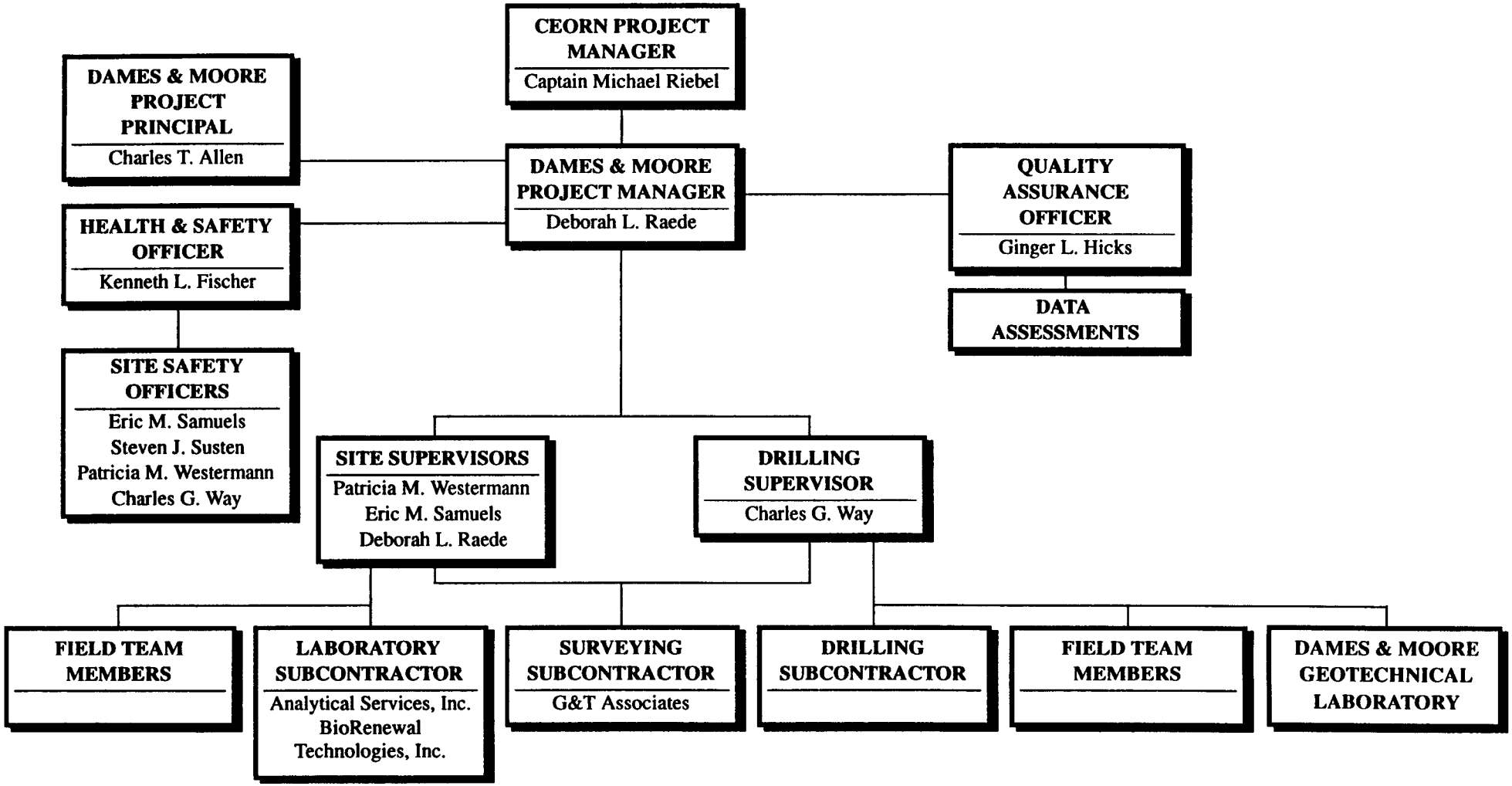


Figure 2-1
PROJECT ORGANIZATION
Plum Brook Ordnance Works
HTW Investigation

Dames & Moore has subcontracted with G&T Associates of Strongsville, Ohio to conduct surveying in connection with the site investigations. During the field work G&T Associates will coordinate with the Site Supervisors and Project Manager.

The COE QA laboratory for the project will be the Ohio River Division Laboratory (ORD-L). The Dames & Moore Project Manager will coordinate the sampling and shipping events with Mr. John Adams or Ms. Cindy Whitley of the ORD-L.

2.2 KEY INDIVIDUALS AT DAMES & MOORE

Key Dames & Moore participants for this project include the Project Principal, Project Manager, Health and Safety Officer, Site Supervisor(s), Drilling Supervisor, Site Safety Officer(s), and Quality Assurance Officer. The following paragraphs provide a description of the proposed project assignments and responsibilities.

Project Principal

The Dames & Moore Project Principal is Mr. Charles T. Allen. All work for the project will be performed under the supervision of Mr. Allen, who is a registered Professional Engineer and has over 30 years of experience in engineering management including geotechnical and hazardous waste investigations.

Project Manager

Ms. Deborah L. Raede is Dames & Moore's CEORN Program Manager and will serve as the Project Manager for this project. In this capacity, she will oversee the project activities and review all plans and reports prepared for the project to ensure their concurrence with the project objectives.

Health and Safety Officer

The Health and Safety Officer, Mr. Kenneth Fischer, C.I.H., will oversee the Health and Safety Program during site activities; conduct personnel training; administer the company's hazard assessment and surveillance medical program; and coordinate with the Site Supervisor(s) and Site Safety Officer(s), as needed during the field work.

Site Supervisor(s)

The Site Supervisor(s) will oversee implementation of the field activities described in this Sampling and Analysis Plan, coordinate with the analytical

laboratory, and serve as Dames & Moore's point-of-contact during the field activities. Individuals who may serve as the Site Supervisor include Ms. Patricia M. Westermann, Mr. Eric M. Samuels, and Ms. Deborah L. Raede. Each is experienced in directing field operations. Other personnel may be designated as Site Supervisors during the course of the field investigations as deemed necessary to meet the project objectives.

Drilling Supervisor

Mr. Charles G. Way will serve as the Drilling Supervisor during the field activities. Mr. Way will be responsible for set-up and operation of the on-site decontamination area, coordination with the drilling contractor including installation and development of all proposed monitoring wells, and collection of groundwater samples. Mr. Way is a geologist with extensive experience in both shallow and deep monitoring well installation. During the completion of well installation and the groundwater sampling, Mr. Way will also serve as a Site Safety Officer. An alternate Drilling Supervisor may be designated during the course of the field investigations as deemed necessary to meet project objectives.

Site Safety Officer(s)

Mr. Eric M. Samuels will be the Site Safety Officer for the majority of the field activities. Other Site Safety Officers may include Mr. Steve Susten, Ms. Patricia M. Westermann, and Mr. Charles G. Way. Each is experienced in field operations and the health and safety protocols applicable to this site. Alternate Site Safety Officers may be designated during the course of the field investigations as deemed necessary to meet project objectives.

Quality Assurance Officer

Ms. Ginger L. Hicks is Dames & Moore's firmwide Manager of Quality Assurance (QA) and will serve as the QA Officer for this project. Ms. Hicks reports directly to senior management within Dames & Moore and works in concert with, but does not report to, any of the project management for this project.

2.3 LABORATORY SUBCONTRACTORS

The three laboratories that will be utilized for data analyses for this project are described below.

2.3.1 Chemical Laboratory Analysis - ASI

ASI is a full service environmental laboratory established in 1979. ASI performs analyses on air, water, wastewater, soil, sediment and chemical waste samples for regulatory monitoring and hazardous characterization. ASI uses gas chromatography-mass spectrometry (GC-MS), ICP, and a variety of other instrumental and wet chemical techniques in strict accordance with (EPA) methodology and QA guidelines. ASI holds laboratory certifications in Tennessee, North Carolina, Georgia, Florida, South Carolina, and Wisconsin in addition to being a COE validated laboratory. A copy of ASI's Quality Assurance Plan has been previously submitted to the CEORN.

Ms. Denise S. Geier, Mr. Robert G. Owens, Jr. and Dr. Roy-Keith Smith will serve on the laboratory project team. They are responsible for handling and analysis of all samples received by the laboratory and will oversee sample travel through the laboratory, analytical procedures, quality control, reporting, and sample disposal.

Laboratory Director/PBOW Project Manager

Ms. Denise S. Geier has over 12 years experience as a laboratory chemist, the last 9 at ASI. She is a master's degree candidate in chemistry at Georgia State University and has three published papers in the environmental field. She is a Hewlett-Packard trained GC and GC-MS RTE-A operator and systems manager. She is a regular attendee at EPA conferences, the most recent being the 14th, 15th and 17th Annual Conferences on Analysis of Pollutants in the Environment. Ms. Geier is the Laboratory Director at ASI and will serve as the Laboratory Project Manager. She will be the chief point-of-contact at the laboratory.

Chief Chemist

Mr. Robert G. Owens, Jr. has 17 years laboratory experience in the environmental field and will serve as the Chief Chemist for this project. He is a Hewlett-Packard trained GC and GC-MS operator and systems manager. He attends EPA Conferences on a regular basis, the most recent being the 14th, 15th and 16th Annual EPA Conferences on Analysis of Pollutants in the Environment, and is author of three published papers on environmental analysis.

Analytical Methods and QA Manager

Dr. Roy-Keith Smith has over 20 years laboratory experience in the medical, entomological, agricultural, and environmental areas. A former college chemistry professor, he is Finnigan and Hewlett-Packard trained on GC and

GC-MS, and TJA trained on ICP. He is the author of 23 technical papers and one book, and a frequent participant at EPA Analytical Conferences. He is the Analytical Methods Manager and QA Manager at ASI and will address laboratory QA/QC issues.

2.3.2 Geotechnical Laboratory for Sieve Analysis

Dames & Moore's geotechnical laboratory in Salt Lake City, Utah will perform sieve analyses of soil samples collected during installation of groundwater monitoring wells.

2.3.3 Biological Laboratory

BioRenewal was founded in 1990 and has developed, and continues to research, cost-effective approaches to site remediation and environmental pollution monitoring. Their laboratory includes the complete range of scientific equipment needed for sterile manipulation, assessment and enumeration of microbial cultures under aerobic and anaerobic conditions. BioRenewal has strong links to the University of Wisconsin and maintains a Technology Advisory Board to facilitate and enhance BioRenewal's technical and scientific development. BioRenewal is also a member of the University of Wisconsin-Madison Bioremediation of Environmental Contaminants Consortium, a cooperative university-industry initiative that conducts basic and developmental research to improve bioremediation technologies. Ms. Lori L. Graham and Mr. Allen J. Dines will be the points-of-contact for this project. Qualifications of these personnel and other pertinent laboratory personnel are provided in Appendix A.

2.4 DRILLING COMPANY SUBCONTRACTOR - BELASCO DRILLING

Belasco Drilling of Columbus, Ohio will install the groundwater monitoring wells and drilled soil borings. Belasco Drilling has previous experience working at the NASA Plum Brook Station facility. Mr. Al Belasco is the point-of-contact.

2.5 SURVEYING SUBCONTRACTOR - G&T ASSOCIATES

G&T Associates has worked at the Plum Brook Station in the past and is familiar with the site grid system and NASA protocols for work conducted on-site. Mr. Kiran Patel will be the point-of-contact for this project.

3.0 SAMPLING SCHEME

This section presents the sampling scheme for the HTW Investigation at the PBOW. The HTW Investigation at the PBOW includes collection of soil and groundwater samples from the three TNT Areas (AOC 1); collection of soil, sediment, surface water, and groundwater samples from the two Red Water Pond Areas (AOC 2); collection of background soil samples; and the sitewide groundwater investigation which includes investigation of the bedrock aquifer at the site. Table 3-1 summarizes the overall sampling scheme for the various environmental media and lists the laboratory analyses to be performed.

Sections 3.1, 3.2, 3.3, and 3.4 discuss the sampling locations and rationale for their selection for the TNT Areas, the Red Water Pond Areas, the background soils, and the sitewide groundwater investigation, respectively. The QA/QC sampling program is described in Section 3.5. The sample identification scheme that will be used in this investigation is presented in Section 3.6.

3.1 SAMPLING SCHEME AT TNT AREAS

Minimal assessment of the TNT Areas has been included in the previous investigations performed at the PBOW. Therefore, the objective of the investigation at the TNT Areas is to identify whether contamination is present rather than to assess the extent of contamination. An attempt has been made to select sampling locations for which there is a high probability that contamination is present. This includes areas where process lines connected with buildings; tanks, basins, and ditches associated with disposal of waste products from the manufacturing process; areas outside doors where waste solids may have been discarded; and other areas which may have a high likelihood of being contaminated. Sample locations have been selected based on historical information about the operations at the site and the results of similar investigations at other TNT manufacturing facilities operated by DoD at the time the PBOW was in operation.

TABLE 3-1

COMPLETE INVESTIGATION SAMPLING SCHEME

Location	No. Field Samples	No. QC Samples Analyzed by ASI	No. QA Samples Analyzed by ORD-L	No. Equipment Blanks	No. Trip Blanks	Analysis[a]
Soils						
West Area Red Water Ponds	40	4	4	1	0	Explosives residues; Metals[a]
Pentolite Road Red Water Ponds	54	5	5	0	0	
TNT Area A	34	4	4	1	0	
TNT Area B	34	3	3	0	0	
TNT Area C	30	3	3	0	0	
West Area Red Water Ponds	1	0	0	0	0	Biological Activity
Pentolite Road Red Water Ponds	2	0	0	0	0	
Background	14	1	1	1	0	Explosives residues; Metals[a]; VOCs; BNAs
Shallow Monitoring Well Borings	12	0	0	0	0	Sieve
Pentolite Road	1	0	0	0	0	General Chemistry except extractable organic carbon

TABLE 3-1
(Continued)

Location	No. Field Samples	No. QC Samples Analyzed by ASI	No. QA Samples Analyzed by ORD-L	No. Equipment Blanks	No. Trip Blanks	Analysis[a]
West Area Red Water Ponds	1	1	1	0	0	Extractable TOC
Sediments						
West Area Red Water Ponds	12	1	1	1	0	Explosives residues; Metals[a]
Pentolite Road Red Water Ponds	4	1	1	0	0	
West Area Red Water Ponds	1	0	0	0	0	General Chemistry
West Area Red Water Ponds	2	0	0	0	0	Biological Activity
Surface Water						
West Area Red Water Ponds	6	1	1	1	0	Explosives residues (on both filtered and unfiltered samples)
	6	1	1	1	0	Total suspended solids; Total Metals[a]; Dissolved Metals[a]
	1	0	0	0	0	Biological Activity

TABLE 3-1
(Continued)

Location	No. Field Samples	No. QC Samples Analyzed by ASI	No. QA Samples Analyzed by ORD-L	No. Equipment Blanks	No. Trip Blanks	Analysis[a]
Groundwater						
West Area Red Water Ponds	3	1	1	0	0	Explosives residues (on both filtered and unfiltered samples); Total Metals[a]; Dissolved Metals[a]
Pentolite Road Red Water Ponds	4	0	0	1	0	
TNT Areas	12	1	1	1	0	Explosives residue; Total Metals[a]; Dissolved Metals[a]
Bedrock Wells	9	1	1	1	3	Explosives residues; VOCs; BNAs; Total Metals[a]; Dissolved Metals[a]

[a] Metals - to include Antimony, Arsenic, Beryllium, Cadmium, Chromium, Copper, Lead, Manganese, Mercury, Nickel, Selenium, Silver, Thallium, and Zinc.

VOCs = volatile organic compounds

BNAs = base neutral/acid compounds

General chemistry includes extractable sulfate, pH, extractable alkalinity, extractable nitrate, total Kjeldahl nitrogen, extractable phosphorous, potassium, cation exchange capacity, and moisture content (where applicable).

Table 3-2 presents the sampling scheme for the soil samples to be collected at TNT Areas A, B, and C. Groundwater samples to be collected in the TNT Areas are summarized on Table 3-3. The specific sampling schemes for each of the three TNT Areas are described in Sections 3.1.1, 3.1.2, and 3.1.3 below. The sampling locations for the TNT Area investigations are related to buildings and physical site features such as ditches that were part of the PBOW. These buildings are no longer present. The locations and conditions of physical site features such as ditches which were present during operation of the PBOW may have been altered with the passage of time. An effort will be made to collect samples at the locations indicated in this SAP; however, since many of the physical references are no longer present, these sample locations must be considered approximate.

Target depth intervals for collection of soil samples are specified in this SAP. To the extent practical, these sampling depth intervals will be satisfied. However, variations from the target depth intervals may occur due to site conditions or as necessary to collect the volume of sample material required for laboratory analysis.

3.1.1 Sampling Scheme at TNT Area A

Figure 3-1 illustrates the layout of TNT Area A. A total of 34 representative soil samples will be collected and analyzed from the Waste Water Settling Tanks and Pump House, Wash Houses (lines 3 and 4), Bi-Tri House, Fortifier House, Mono House, and DNT Sweating & Graining House. All soil samples will be analyzed for explosives residues and metals. Since no analysis for VOCs will be performed on any of the soil samples, the sample for an entire target depth interval will be composited.

Additionally, two overburden groundwater monitoring wells will be installed and sampled and three existing wells will be sampled. Samples will be analyzed for explosives residues and total and dissolved metals concentrations.

The specific sampling locations and the rationale for their selection are described below.

TABLE 3-2

TNT AREAS SOIL SAMPLING SCHEME

AOC #	Area	Bldg. No./ Designation	Location	Sampling Technique	No. of Borings	No. of Samples From Each Boring	Approximate Target Sampling Interval (feet below grade)	Analysis	
								Explos.	Metals[a]
1	TNT Area A	187	Waste Water Disposal Settling Tanks and Pump House	Hand Auger	4	2	0 to 1.5	✓	✓
							1.5 to 5.0	✓	✓
		146	Wash House, Line 4	Hand Auger	2	1	1.0 to 2.0	✓	✓
					4	1	2.5 to 3.5	✓	✓
		136	Wash House, Line 3	Hand Auger	3	2	1.0 to 2.0	✓	✓
							2.5 to 3.5	✓	✓
		142	Bi-Tri House	Hand Auger	3	1	0.5 to 1.5	✓	✓
		143	Fortifier House	Hand Auger	4	1	0 to 2.0	✓	✓
		141	Mono House	Hand Auger	3	1	0 to 2.0	✓	✓
		192	DNT Sweating & Graining House	Hand Auger	2	1	0 to 1.5	✓	✓
					1	2	0 to 1.5	✓	✓
							1.5 to 3.0	✓	✓
				TOTAL	26	34	-	✓	✓

TABLE 3-2
(Continued)

AOC #	Area	Bldg. No./ Designation	Location	Sampling Technique	No. of Borings	No. of Samples From Each Boring	Approximate Target Sampling Interval (feet below grade)	Analysis	
								Explos.	Metals[a]
1	TNT Area B	417	Waste Disposal Settling Tank and Pump House	Hand Auger	4	2	0 to 1.5	✓	✓
							1.5 to 5.0	✓	✓
		456	Wash House, Line 5	Hand Auger	2	1	1.0 to 2.0	✓	✓
					4	1	2.5 to 3.5	✓	✓
		466	Wash House, Line 6	Hand Auger	3	2	1.0 to 2.0	✓	✓
							2.5 to 3.5	✓	✓
		452	Bi-Tri House	Hand Auger	2	1	0.5 to 1.5	✓	✓
					1	1	0.5 to 2.0	✓	✓
		453	Fortifier House	Hand Auger	4	1	0 to 2.0	✓	✓
		451	Mono House	Hand Auger	3	1	0 to 2.0	✓	✓
		412	DNT Sweating & Graining House	Hand Auger	2	1	0 to 1.5	✓	✓
					1	2	0 to 1.5	✓	✓
							1.5 to 3.0	✓	✓
				TOTAL	26	34	--	✓	✓

TABLE 3-2
(Continued)

AOC #	Area	Bldg. No./ Designation	Location	Sampling Technique	No. of Borings	No. of Samples From Each Boring	Approximate Target Sampling Interval (feet below grade)	Analysis	
								Explos.	Metals[a]
1	TNT AREA C	657	Waste Water Disposal Settling Tank and Pump House	Hand Auger	4	2	0 to 1.5	✓	✓
							1.5 to 5.0	✓	✓
		626	Wash House, Line 12	Hand Auger	4	1	2.5 to 3.5	✓	✓
					2	1	1.0 to 2.0	✓	✓
		612	Bi-Tri House, Line 11	Hand Auger or Trowel	6	1	0.5 to 1.0	✓	✓
		613	Fortifier House, Line 11	Hand Auger or Trowel	2	1	0.5 to 1.0	✓	✓
		Area wide	Ditches	Hand Auger or Trowel	8	1	0.5 to 1.0	✓	✓
				TOTAL	26	30		✓	✓

[a] Includes Antimony, Arsenic, Beryllium, Cadmium, Chromium, Copper, Lead, Manganese, Mercury, Nickel, Selenium, Silver, Thallium, and Zinc.

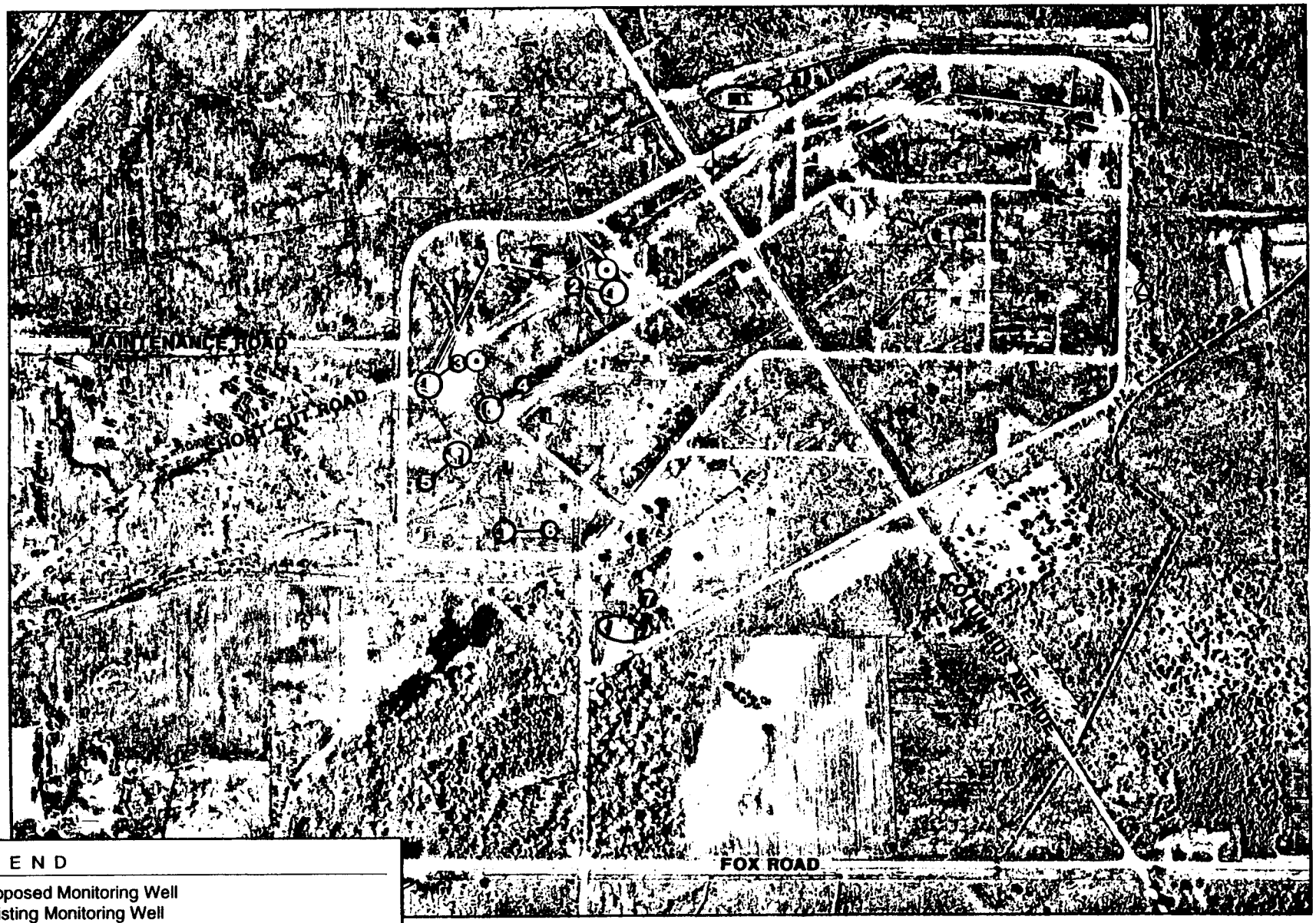
TABLE 3-3

GROUNDWATER FIELD SAMPLING SCHEME

Investigation Area	Number of Samples		Analysis					
			Explosives Residues	Total Metals[b]	Dissolved Metals[b]	BNAs	VOCs	Sieves
TNT Area A	New Wells	2	✓	✓	✓			✓
	Existing Wells	3	✓	✓	✓			
TNT Area B	New Wells	1	✓	✓	✓			✓
	Existing Wells	2	✓	✓	✓			
TNT Area C	New Wells	4	✓	✓	✓			✓
West Area Red Water Ponds	New Wells	2	✓[a]	✓	✓			✓
	Existing Wells	1	✓[a]	✓	✓			
Pentolite Road Red Water Ponds	New Wells	3	✓[a]	✓	✓			✓
	Existing Wells	1	✓[a]	✓	✓			
Bedrock	New Wells	8	✓	✓	✓	✓	✓	
	Existing Wells	1	✓	✓	✓	✓	✓	

[a] Analyses of explosives residues will be performed for both filtered and unfiltered samples.

[b] Includes Antimony, Arsenic, Beryllium, Cadmium, Chromium, Copper, Lead, Manganese, Mercury, Nickel, Selenium, Silver, Thallium, and Zinc.



LEGEND

- Proposed Monitoring Well
- Existing Monitoring Well
- Proposed Bedrock Well
- 1 Wastewater Disposal Settling Tanks & Pump House
- 2 Wash House-Line 3 (Bldg. 136)
- 3 Wash House-Line 4 (Bldg. 146)
- 4 Fortifier House (Bldg. 143)
- 5 Bi-Tri House (Bldg. 142)
- 6 Mono [illegible]se (Bldg. 141)
- 7 DNT [illegible]ting & Graining House (Bldg. 192)

Photo Date: 5-24-56

Figure 3-1

TNT AREA A LAYOUT

Plum Brook Ordnance Works

[illegible] & MOORE

3.1.1.1 Soil Borings

Waste Water Disposal Settling Tanks and Pump House (Building 187)

A total of four soil borings will be installed at the TNT Area A Waste Water Settling Tanks and Pump House (Building 187). The proposed boring locations are illustrated on Figure 3-2. Two samples will be collected from each boring providing a total of eight samples.

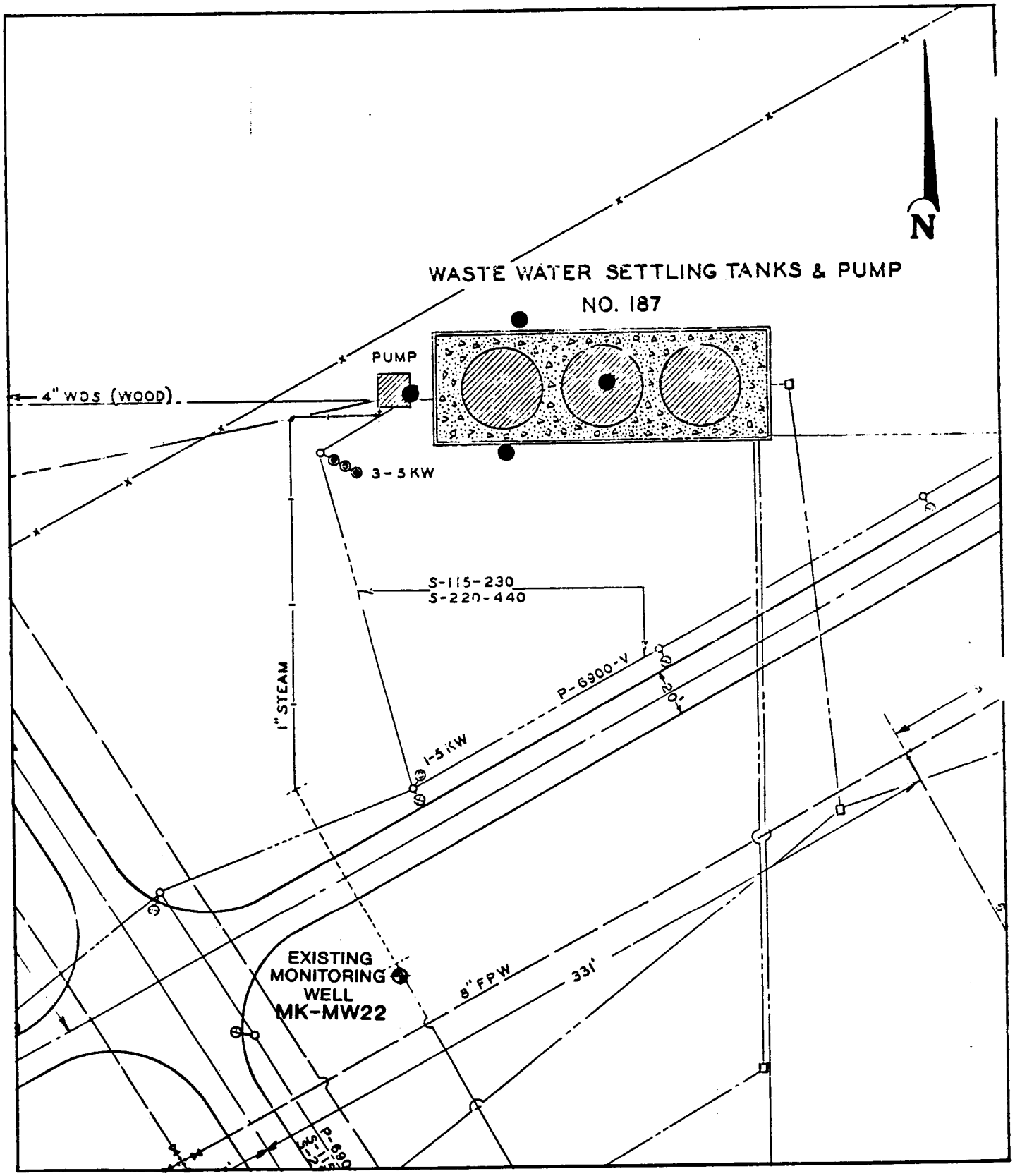
The sample location inside the settling tanks was selected to assess potential contamination which may have been released through the bottom of the tank. The sample location between the Pump House and the enclosure surrounding the settling tanks was selected to assess contamination which may have been released through the piping from the Pump House to the settling tanks. The sampling locations outside the enclosure surrounding the settling tanks, one on the north side and one on the south side, were selected to assess contamination which may have spilled or otherwise been released from the tanks.

Samples from each boring will be collected at depth intervals of 0 to 1.5 feet and 1.5 to approximately 5 feet.

Wash House (line 4) (Building 146)

Six soil borings will be installed in the vicinity of the Wash House for TNT line 4 (Building 146) as shown on Figure 3-3. One sample per boring will be collected.

Two samples locations were selected inside the "catch box" to assess contamination connected with releases into the "catch box." The sample location on the southeast side of the Wash House is between the Wash House and the "catch box" and was selected to assess contamination which may have been released if material was spilled as it was being discharged into the "catch box." The remaining three sample locations were selected because they are near doors or other features through which waste material may have been discarded from the Wash House.



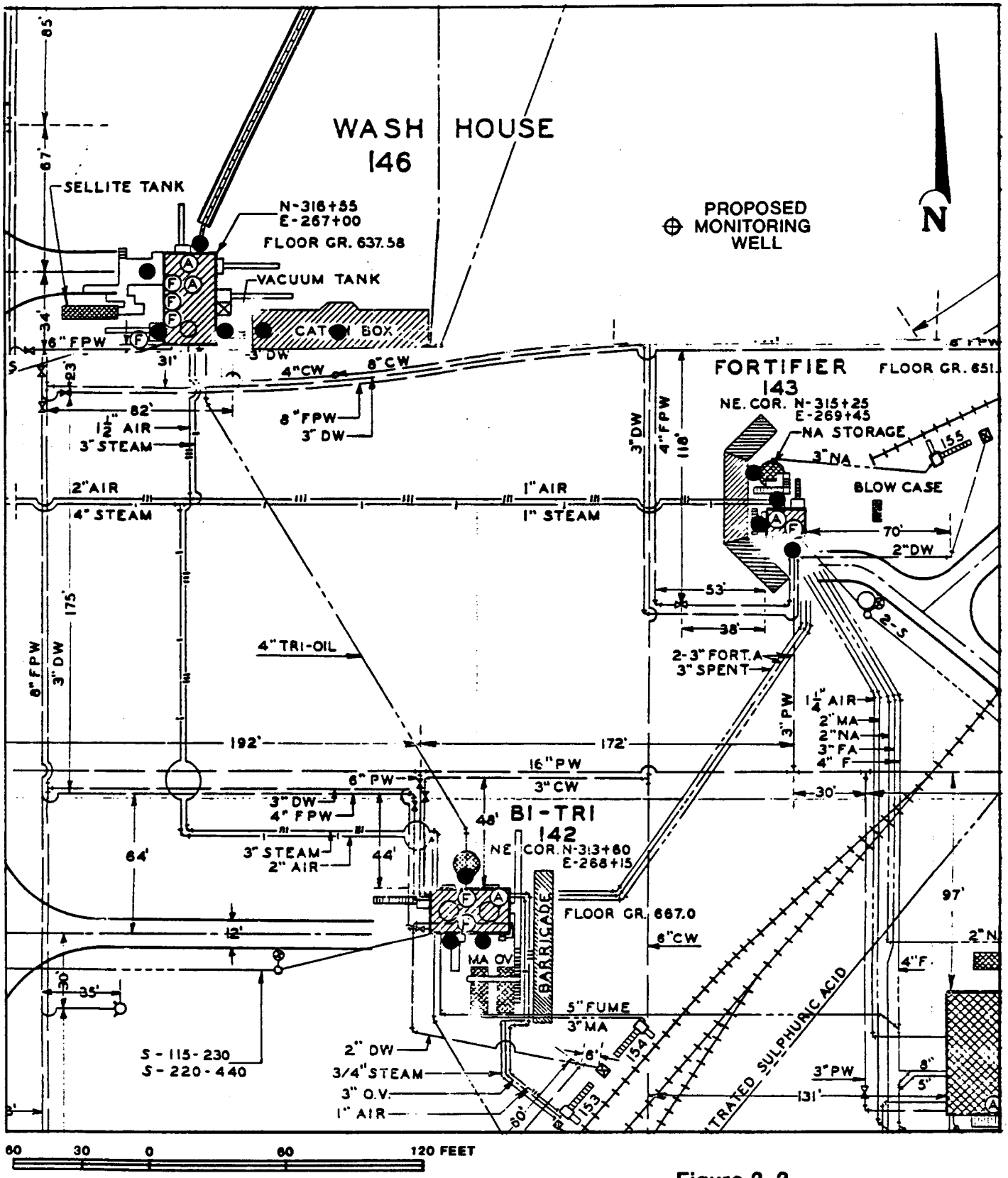
LEGEND:

- ● Proposed Soil Sampling Location
- ⊕ Existing Monitoring Well Location

Figure 3-2

PROPOSED SOIL SAMPLING LOCATIONS AT WASTE WATER DISPOSAL SETTLING TANKS AND PUMP HOUSE AND EXISTING MONITORING WELL
TNT Area A
Plum Brook Ordnance Works

DAMES & MOORE



LEGEND:

- ● Proposed Soil Sampling Location
- ⊕ Proposed Monitoring Well Location

Figure 3-3

PROPOSED SOIL SAMPLING LOCATIONS AT WASH HOUSE - LINE 4, BI-TRI HOUSE AND FORTIFIER HOUSE AND PROPOSED MONITORING WELL

TNT Area A

Plum Brook Ordnance Works

DAMES & MOORE

From the two borings located in the "catch box" a sample will be collected at a depth interval of 1 to 2 feet. From the remaining borings, one sample will be collected from each boring at a depth interval of 2.5 to 3.5 feet.

Wash House (line 3) (Building 136)

Three soil borings will be installed in the vicinity of the Wash House for TNT line 3 (Building 136) as shown on Figure 3-4. Two samples will be collected from each boring providing a total of six samples.

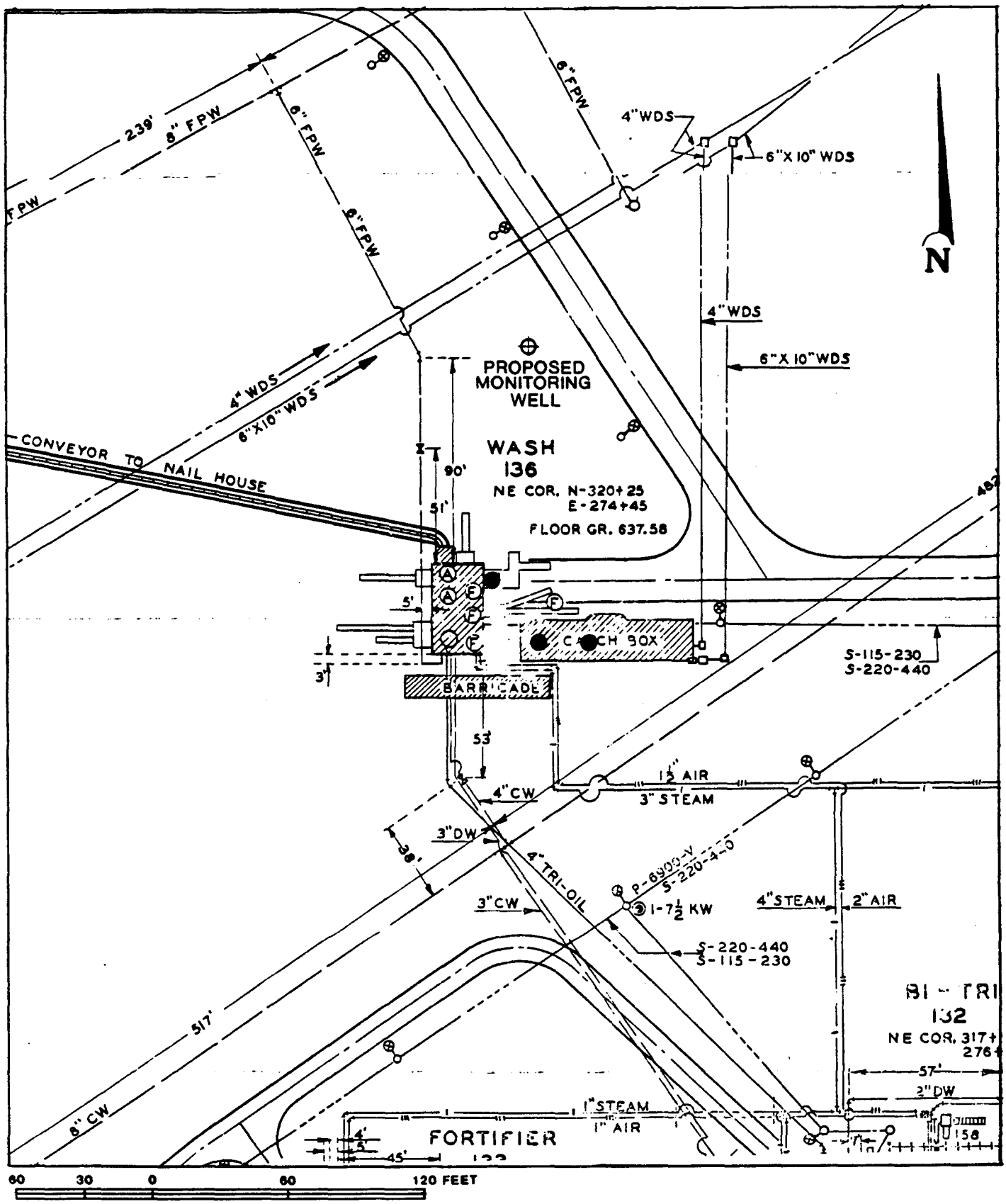
Two sampling locations were selected inside the "catch box" to assess potential contamination associated with releases into the "catch box." The sampling location on the northeast side of the Wash House was selected because it is near a door through which waste material may have been released or discarded from the Wash House.

The sample locations were selected to assess vertical extent of contamination in the Wash House area and two samples will be collected at each location. Target sample depth intervals will be 1 to 2 feet and 2.5 to 3.5 feet in both borings.

Bi-Tri House (Building 142)

A total of three soil borings will be installed in the vicinity of the Bi-Tri House (Building 142) at the approximate locations shown on Figure 3-3. One sample will be collected from each boring.

The sample location on the north side of the Bi-Tri House was selected to assess contamination which may have been released between the house and a large process tank. The sample location on the southwest side of the building was selected to assess the area near a door. The sample location on the southeast side of the building was selected to assess contamination in an area between the building and process-related tanks constructed outside the building.



LEGEND:

- ● Proposed Soil Sampling Location
- ⊕ Proposed Monitoring Well Location

Figure 3-4

PROPOSED SOIL SAMPLING LOCATIONS AT WASH HOUSE - LINE 3 AND PROPOSED MONITORING WELL
TNT Area A
Plum Brook Ordnance Works

DAMES & MOORE

One sample will be collected from each boring at a depth interval of approximately 0.5 to 1.5 feet.

Fortifier House (Building 143)

A total of four soil borings will be installed in the vicinity of the Fortifier House (Building 143) at the approximate locations shown on Figure 3-3. One sample will be collected from each boring.

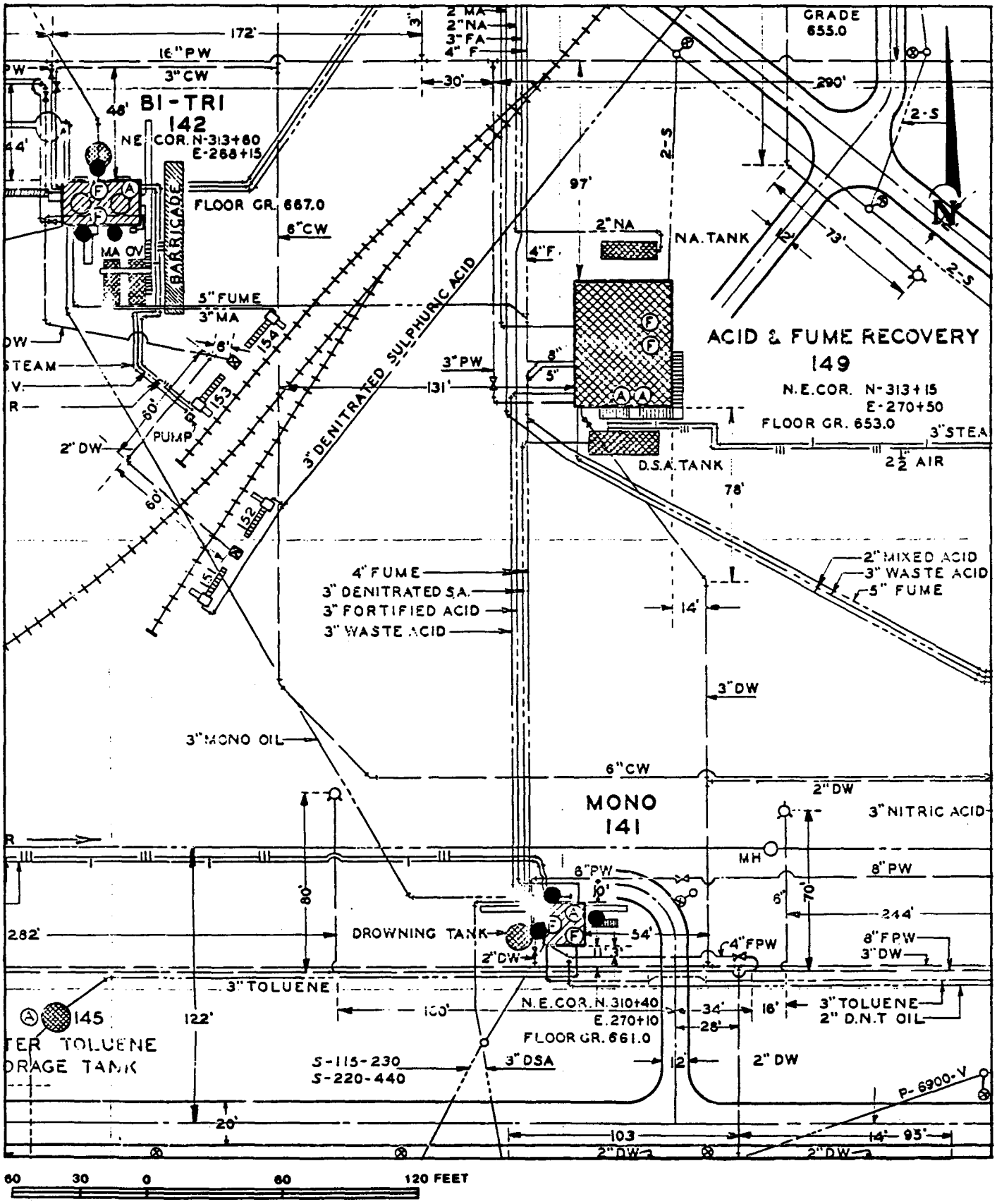
The sample location west of the nitric acid tank was selected to assess whether soil contamination resulted in this area related to the manufacturing process and the presence of this tank. The sampling locations immediately north of and west of the building are near doors through which waste materials may have been discarded. The sample location on the south side of the building was selected to assess the potential contamination in the area where process lines connect with the building.

One sample will be collected from each boring at a depth interval of approximately 0 to 2 feet.

Mono House (Building 141)

A total of three soil borings will be installed in the vicinity of the Mono House (Building 141) at the approximate locations shown on Figure 3-5. One sample will be collected from each boring.

The sample location on the north side of the building was selected to assess potential contamination in the area where process lines connect with the building. The sample location on the east side of the building is near a door through which waste material may have been discarded. The sample location on the west side of the building is proximate to another door and also to the drowning tank which may be a potential source of contamination due to leakage or overflow.



LEGEND:

● Proposed Soil Sampling Location

Figure 3-5

PROPOSED SOIL SAMPLING LOCATIONS AT MONO HOUSE

TNT Area A

Plum Brook Ordnance Works

DAMES & MOORE

One sample will be collected from each boring at a depth interval of approximately 0 to 2 feet.

DNT Sweating & Graining House (Building 192)

A total of three soil borings will be installed at the DNT Sweating & Graining House (Building 192) at the approximate locations shown on Figure 3-6. One sample will be collected from each of two borings and two samples will be collected from the third boring providing a total of four samples.

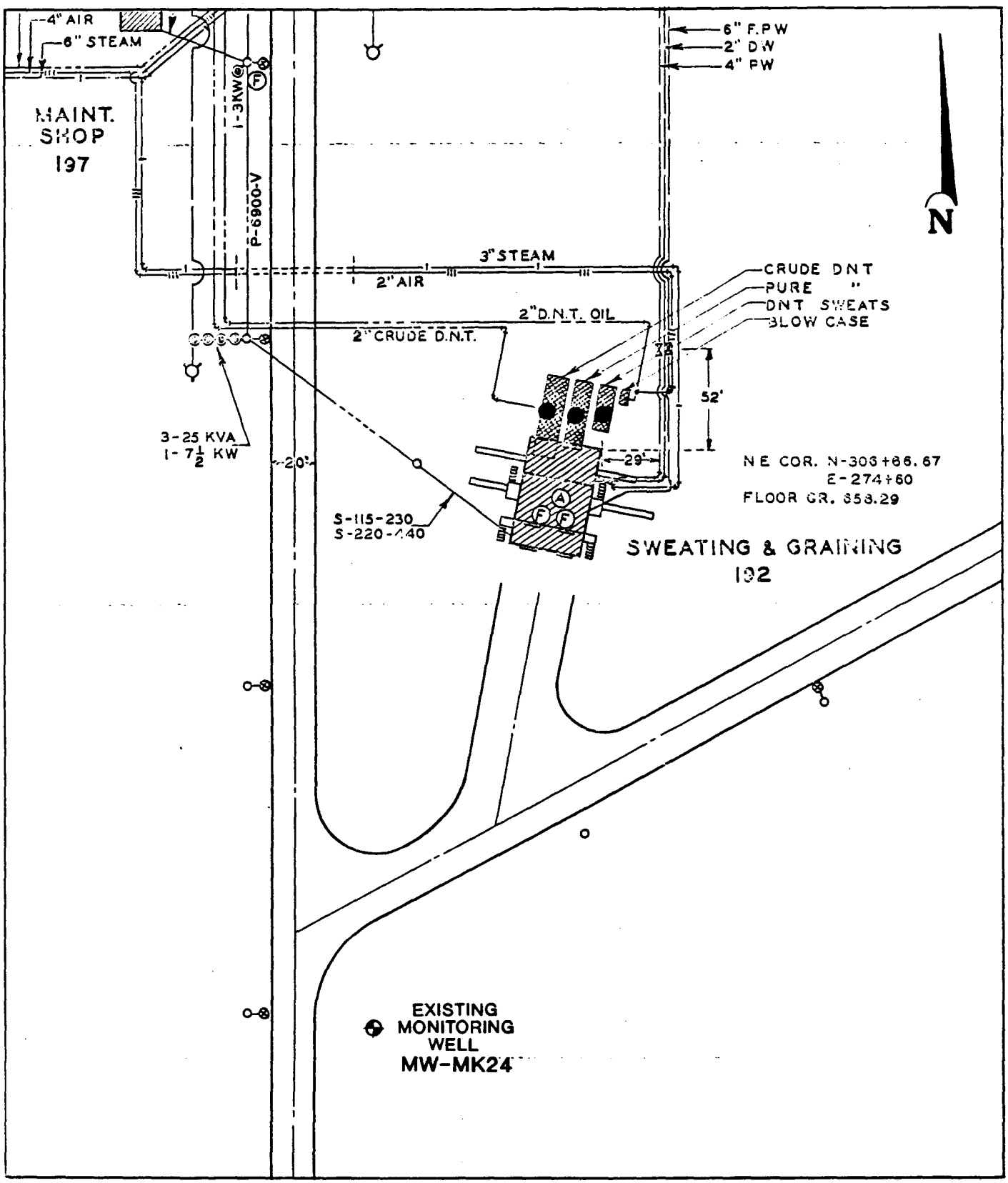
The sampling locations at the DNT Sweating & Graining House were selected to assess contamination in the vicinity of the three large tanks that were present on the north side of the building.

One sample will be collected from each boring at a depth interval of approximately 0 to 1.5 feet. A second sample will be collected from the boring installed in the crude DNT tank at a depth interval of approximately 1.5 to 3.0 feet.

3.1.1.2 Overburden Groundwater Monitoring Wells

Three overburden groundwater monitoring wells (MK-MW22, MK-MW24, and MK-MW23) are present in TNT Area A, as shown on Figures 3-2, 3-6, and 3-7, respectively. The wells are located on the north, south, and east sides of the area, respectively.

Two additional overburden monitoring wells will be installed in TNT Area A at the approximate locations shown on Figures 3-3 and 3-4. The wells are proposed for the west and northwest portions of the area near the Wash House for line 3 and the Wash House and Fortifier House for line 4. A sample of soil in the screened interval in each well will be collected for sieve analysis.



60 30 0 60 120 FEET

LEGEND:

- ● Proposed Soil Sampling Location
- ⊕ Existing Monitoring Well Location

Figure 3-6

PROPOSED SOIL SAMPLING LOCATIONS AT DNT SWEATING AND GRAINING HOUSE AND EXISTING MONITORING WELL LOCATION
TNT Area A
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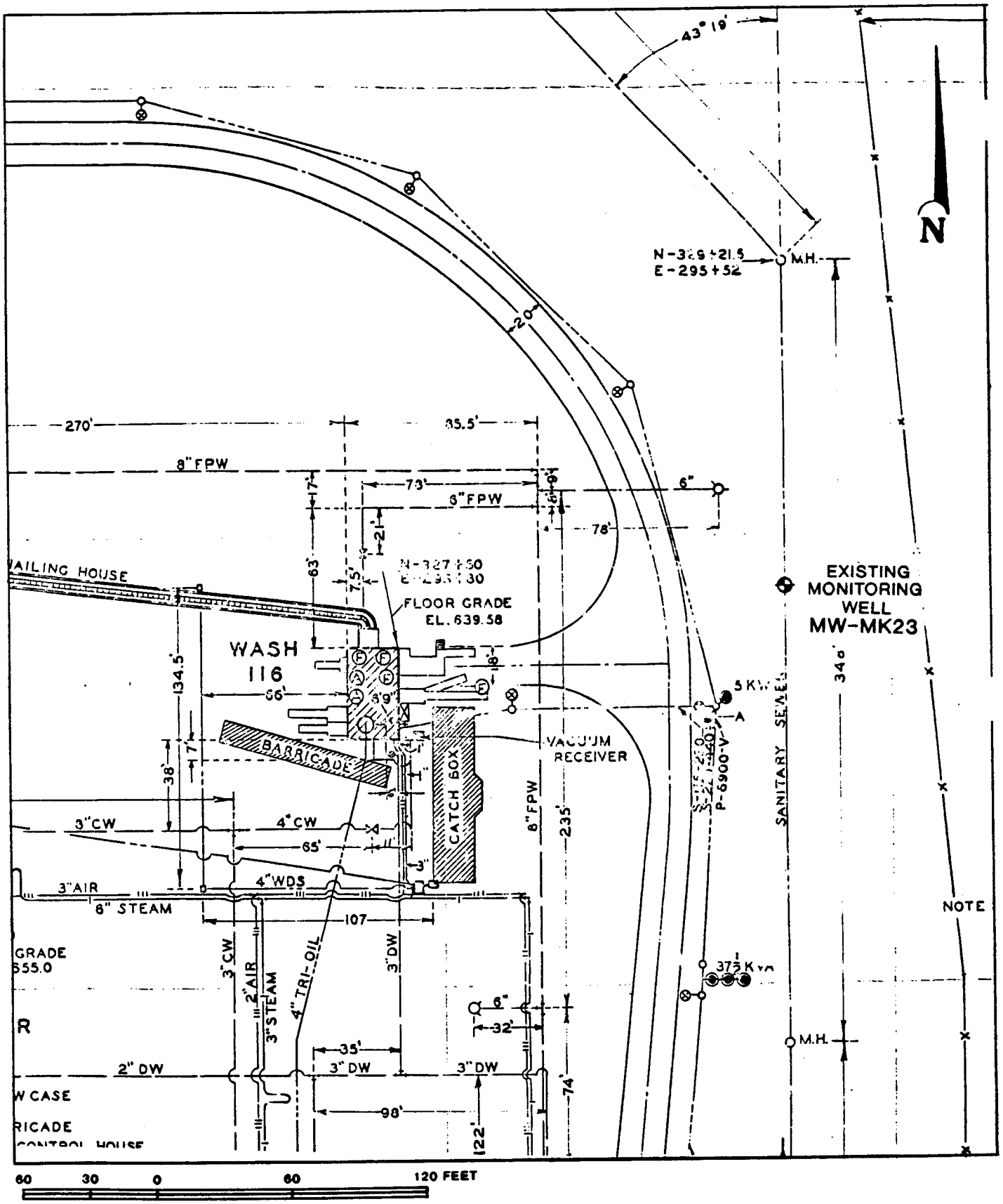

LEGEND:

⊕ **Existing Monitoring Well Location**

Figure 3-7

EXISTING MONITORING WELL LOCATION

TNT Area A

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Groundwater samples will be collected from the two newly installed monitoring wells and existing wells MK-MW22, MK-MW23, and MK-MW24. Samples will be analyzed for explosives residues and total and dissolved metals concentrations. The existing wells will be redeveloped prior to sampling.

3.1.2 Sampling Scheme at TNT Area B

Figure 3-8 illustrates the layout of TNT Area B. A total of 34 representative soil samples will be collected and analyzed from the Waste Disposal Tanks and Pump House, Wash House (line 5), Wash House (line 6), Bi-Tri House, Fortifier House, Mono House, and DNT Sweating & Graining House. All soil samples will be analyzed for explosives residues and metals. Since no analysis for VOCs will be performed on any of the soil samples, the sample for an entire target depth interval will be composited.

Additionally, one overburden groundwater monitoring well will be installed and sampled and two existing overburden groundwater monitoring wells will be sampled. Samples will be analyzed for explosives residues and total and dissolved metals concentrations.

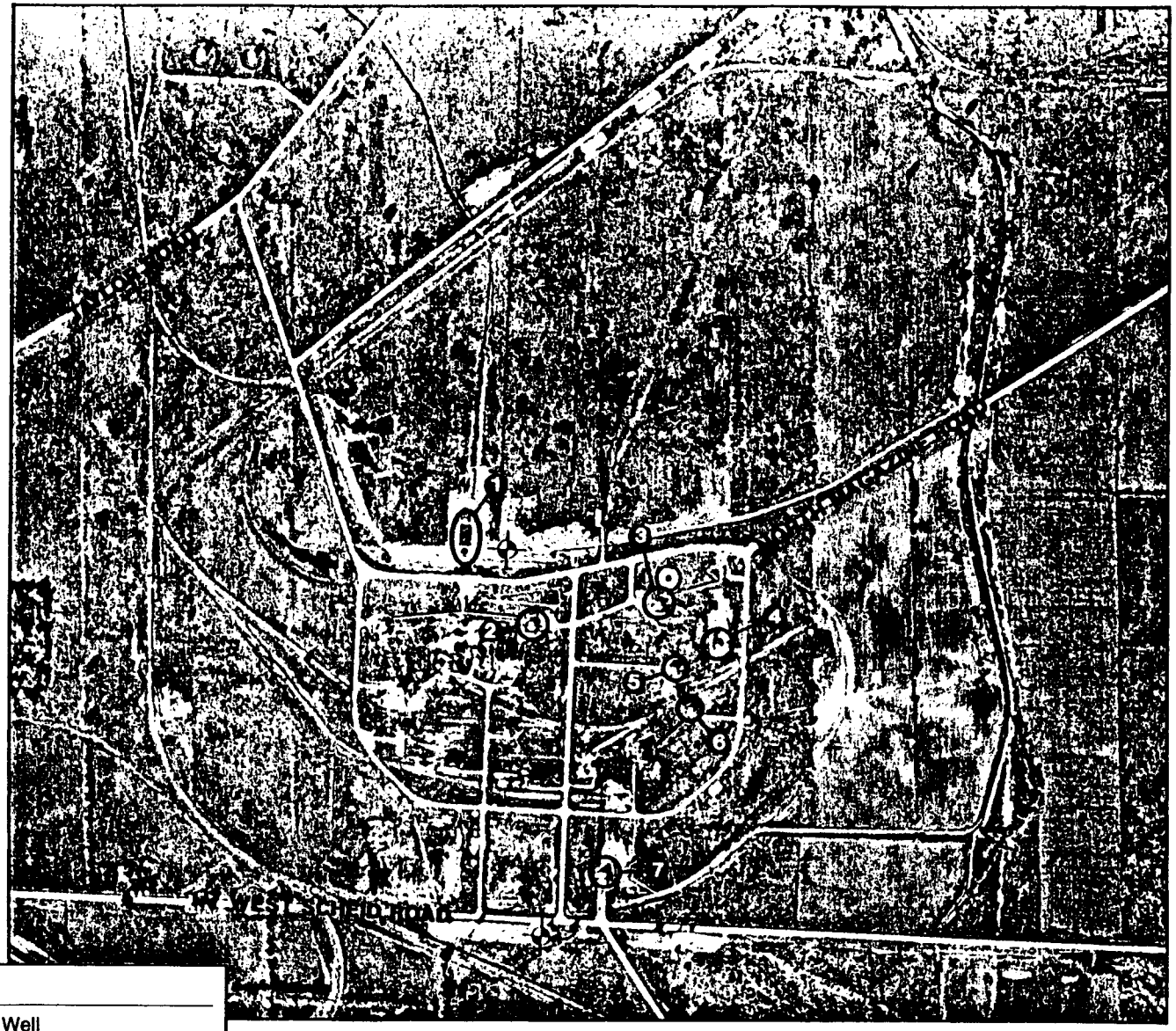
The specific sampling locations and the rationale for their selection are described below.

3.1.2.1 Soil Borings

<u>Waste Disposal Tanks and Pump House (Building 417)</u>

A total of four soil borings will be installed around the Pump House (Building 417) at the northern end of the waste disposal tanks, as shown on Figure 3-9. Two samples will be collected from each boring providing a total of eight samples.

An alternate configuration than that proposed for the Waste Water Disposal Settling Tanks and Pump House in TNT Area A was selected for TNT Area B in order to maximize the amount of data regarding the Waste Disposal Tanks gathered during this



LEGEND

- Proposed Monitoring Well
- Existing Monitoring Well
- 1 Wastewater Disposal Settling Tank
- 2 Wash House-Line 6 (Bldg. 466)
- 3 Wash House-Line 5 (Bldg. 456)
- 4 Fortifier House (Bldg. 453)
- 5 Bi-Tri House (Bldg. 452)
- 6 Mono House (Bldg. 451)
- 7 DNT S[illegible]ng & Graining House (Bldg. 412)

Photo Date: 10-19-50

Figure 3-8

TNT AREA B LAYOUT

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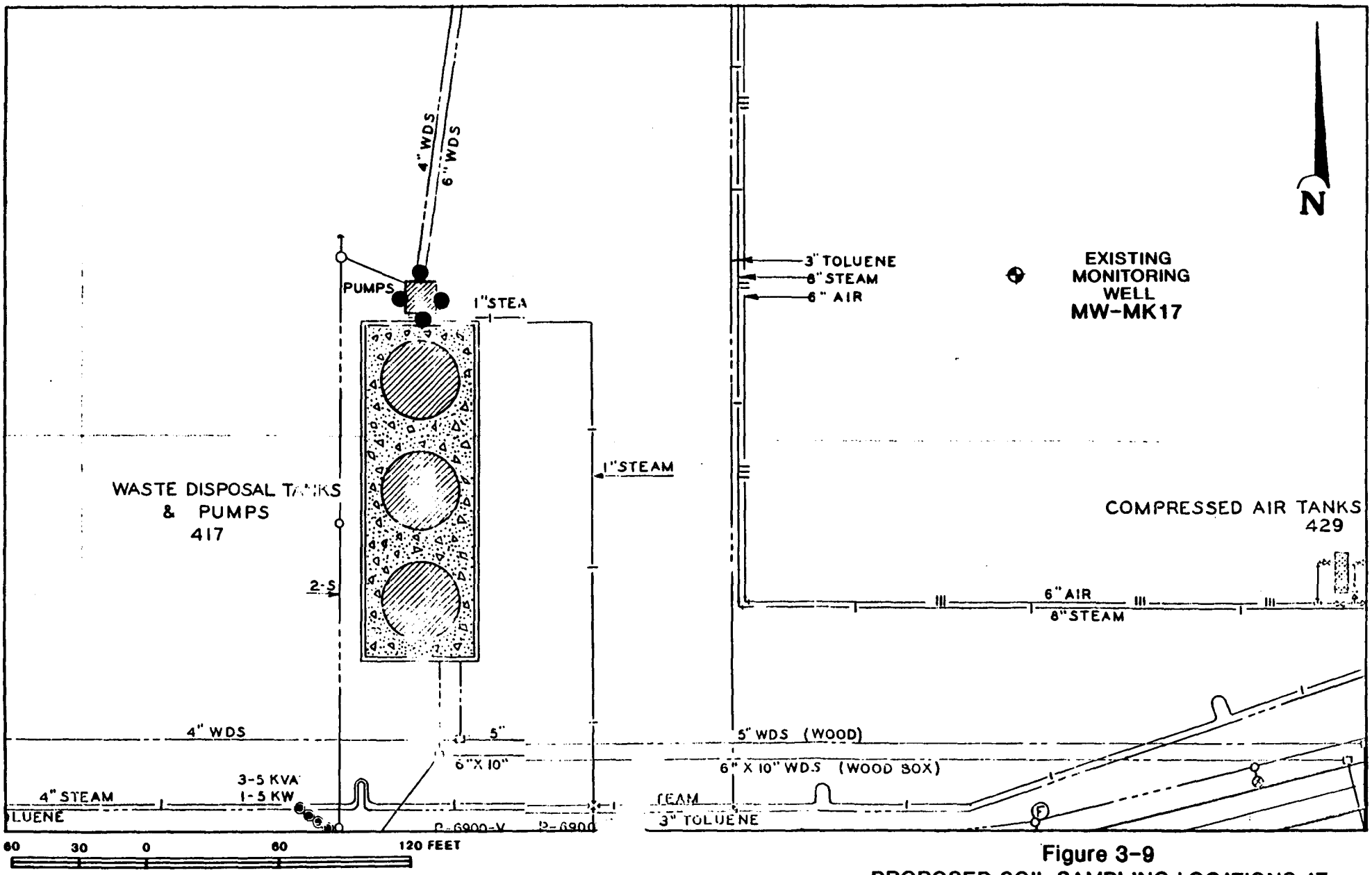

LEGEND:

- ● Proposed Soil Sampling Location
- ⊕ Existing Monitoring Well Location

Figure 3-9
PROPOSED SOIL SAMPLING LOCATIONS AT WASTE WATER DISPOSAL SETTLING TANK AND EXISTING MONITORING WELL LOCATION
TNT Area B
Plum Brook Ordnance Works
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investigation. The sampling scheme for TNT Area B is designed to assess contamination immediately around the Pump House on all sides. One boring will be installed on each side of the Pump House.

Two samples will be collected from each boring at approximate depth intervals of 0 to 1.5 feet and 1.5 to approximately 5.0 feet.

Wash House (line 5) (Building 456)

A total of six soil borings will be installed in the vicinity of the Wash House for line 5, as shown on Figure 3-10. One sample will be collected from each boring.

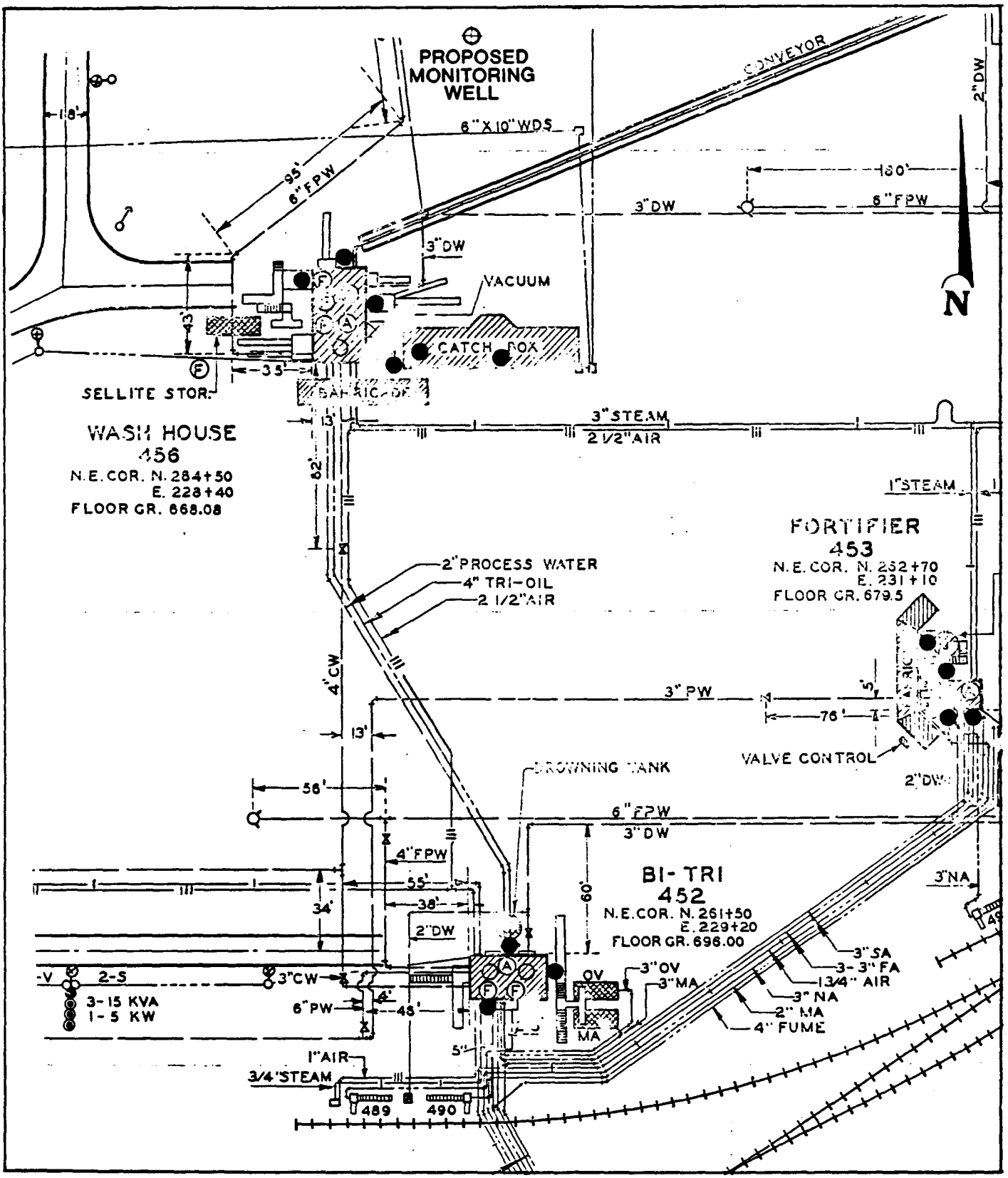
Two sample locations were selected inside the "catch box" to assess contamination connected with releases into the "catch box." The sample location on the southeast side of the Wash House is between the Wash House and the "catch box" and was selected to assess contamination which may have been released if material was spilled as it was being discharged into the "catch box." The remaining three sample locations were selected because they are near doors or other features through which waste material may have been discarded from the Wash House.

One sample per boring will be collected. From two borings located inside the "catch box" a sample will be collected at a depth interval of approximately 1 to 2 feet. The remaining samples will be collected at an approximate depth interval of 2.5 to 3.5 feet.

Wash House (line 6) (Building 466)

Three soil borings will be installed in the vicinity of the Wash House for TNT line 6 (Building 466) as shown on Figure 3-11. Two samples will be collected from each boring providing a total of six samples.

Two sampling locations were selected in the "catch box" to assess contamination associated with releases into the "catch box." The third sampling location was



60 30 0 60 120 FEET

LEGEND:

- ● Proposed Soil Sampling Location
- ⊕ Proposed Monitoring Well Location

Figure 3-10

PROPOSED SOIL SAMPLING LOCATIONS AT WASH HOUSE - LINE 5 AND BI-TRI HOUSE AND PROPOSED MONITORING WELL LOCATION
TNT Area B
Plum Brook Ordnance Works

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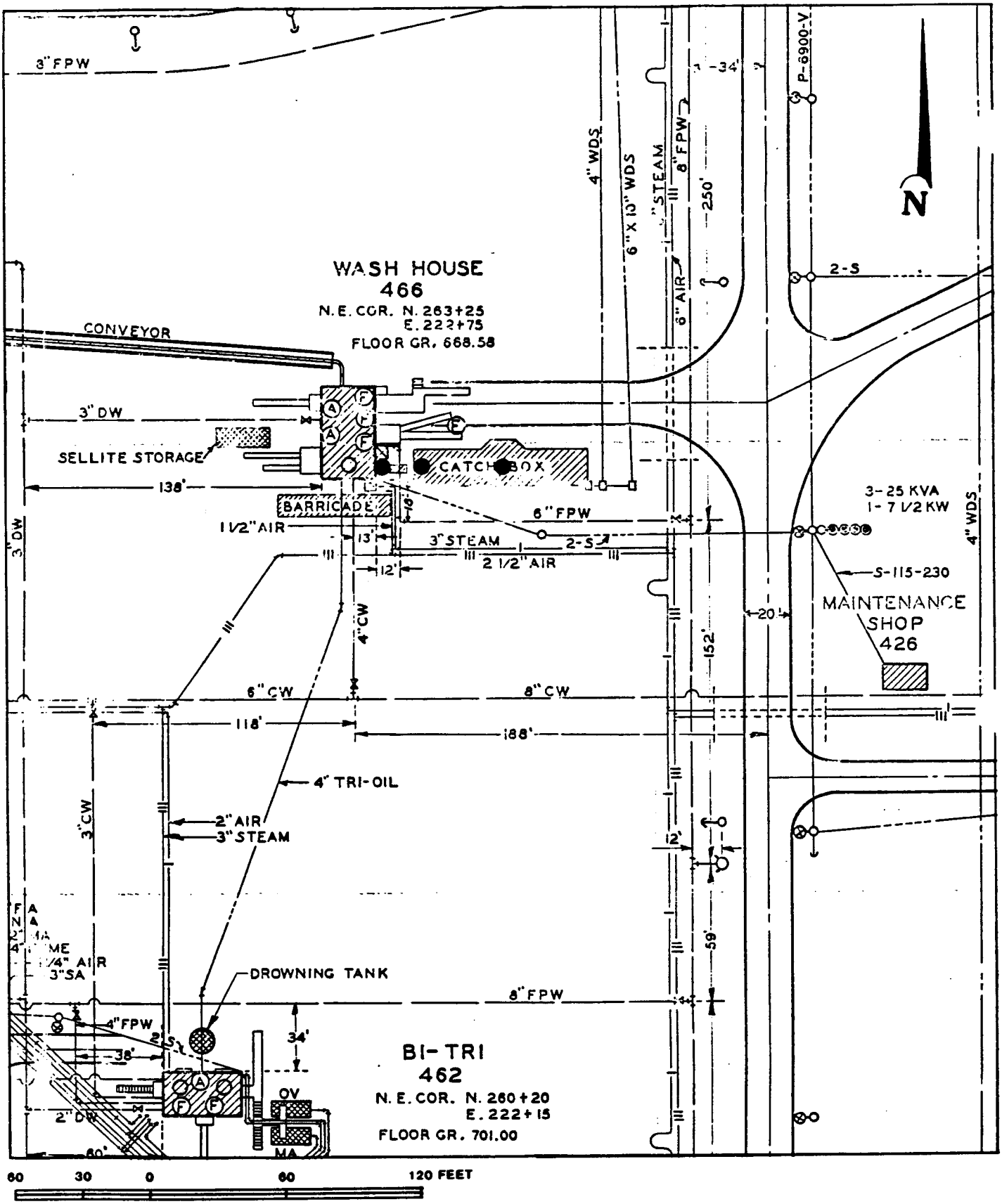

LEGEND:

● Proposed Soil Sampling Location

Figure 3-11

PROPOSED SOIL SAMPLING LOCATIONS AT WASH HOUSE - LINE 6

TNT Area B

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selected between the "catch box" and the building to assess contamination which may have resulted from spillage or releases as material moved from the building to the "catch box."

The sample locations were selected to assess vertical extent of contamination in the Wash House area. Target sample depth intervals will be 1 to 2 feet and 2.5 to 3.5 feet in both borings.

Bi-Tri House (Building 452)

A total of three soil borings will be installed in the vicinity of the Bi-Tri House (Building 462) at the approximate locations shown on Figure 3-10. One sample will be collected from each boring.

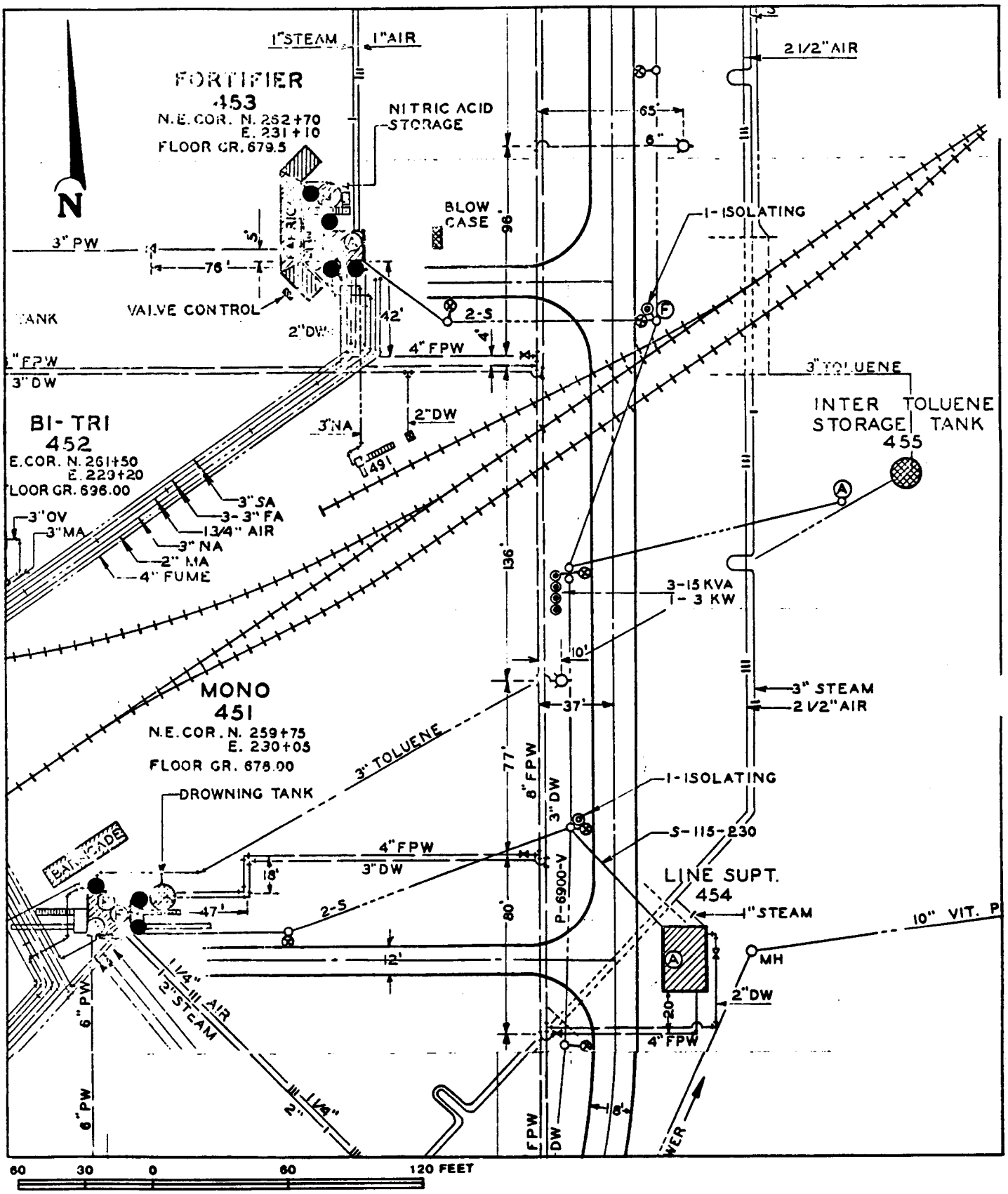
Two sampling locations were selected on the north and south sides of the Bi-Tri House where process lines formerly were present. The samples will be collected as close to the former building foundation location as possible. From each of these borings one sample will be collected from an approximate depth interval of 0.5 to 1.5 feet.

The third sampling location was selected on the east side of the building near the former locations of process-related storage tanks. One sample will be collected from this boring at an approximate depth interval of 0.5 to 2 feet.

Fortifier House (Building 453)

A total of four soil borings will be installed in the vicinity of the Fortifier House (Building 453), as shown in Figure 3-12. One sample will be collected from each boring.

The sample location west of the nitric acid tank was selected to assess whether soil contamination resulted in this area related to the manufacturing process and the presence of this tank. The sampling location immediately north of the building is near



LEGEND:

● Proposed Soil Sampling Location

Figure 3-12

PROPOSED SOIL SAMPLING LOCATIONS AT BI-TRI HOUSE, FORTIFIER HOUSE AND MONO HOU

TNT Area B
Plum Brook Ordnance Works

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a door through which waste materials may have been discarded. The sample locations on the south side of the building were selected to assess the potential contamination in the area where process lines connect with the building.

All four samples will be collected at an approximate depth interval of 0 to 2 feet.

Mono House (Building 451)

A total of three soil borings will be installed in the vicinity of the Mono House (Building 451) at the approximate locations shown on Figure 3-12. One sample will be collected from each boring.

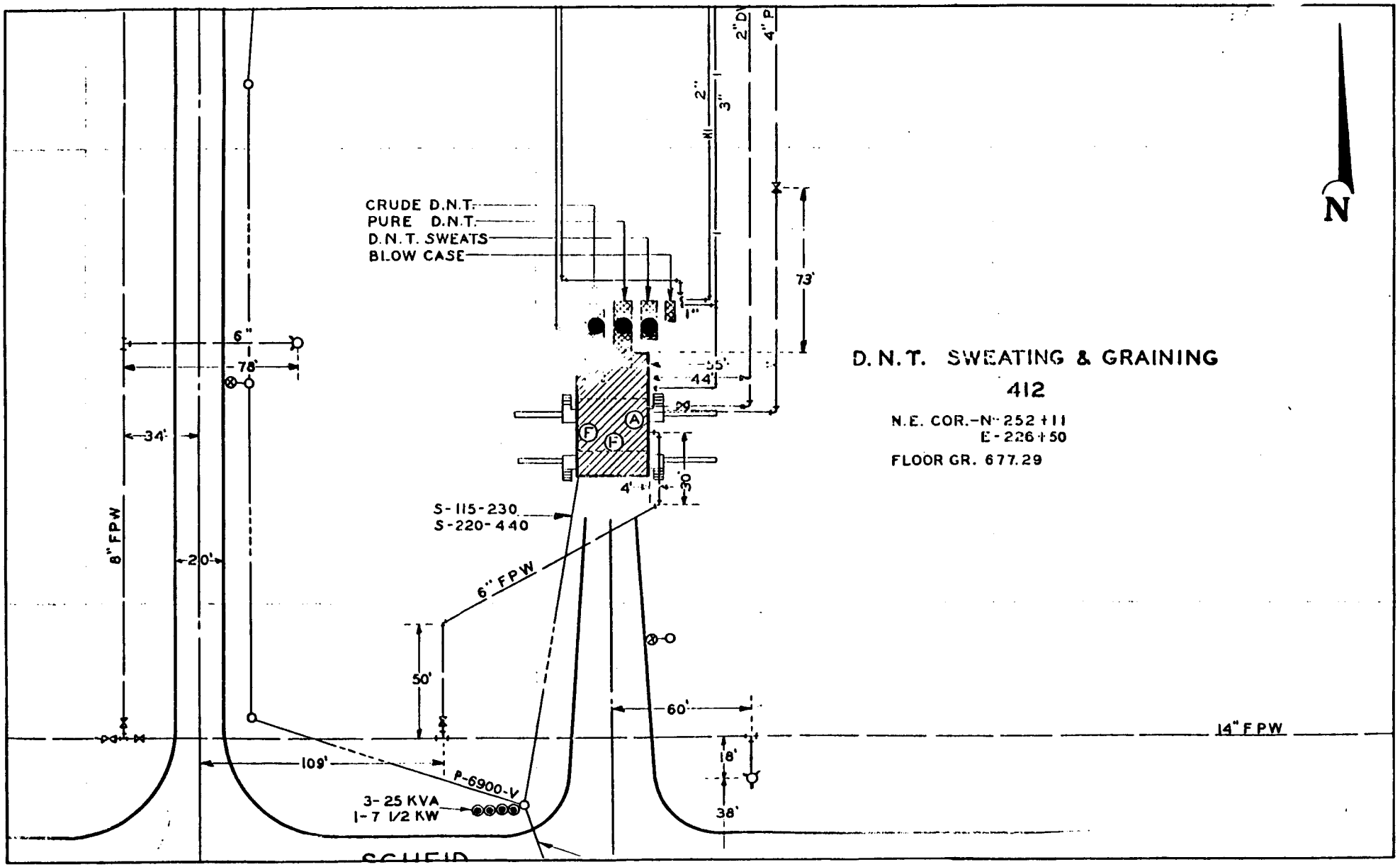
The sample location on the north side of the building was selected to assess potential contamination in the area where process lines connect with the building. The sample location on the southeast side of the building is near a door through which waste material may have been discarded. The sample location on the northeast side of the building is between the building and the drowning tank and was selected to assess the potential for contamination due to leakage or overflow from the drowning tank.

One sample will be collected from each boring at an approximate depth interval of 0 to 2 feet.

DNT Sweating & Graining House (Building 412)

A total of three soil borings will be installed at the DNT Sweating & Graining House (Building 412). The sampling locations are illustrated on Figure 3-13. One sample will be collected from each of two borings and two samples will be collected from the third boring providing a total of four samples.

The sampling locations at the DNT Sweating & Graining House were selected to assess contamination in the vicinity of the three large tanks that were present on the north side of the building.



LEGEND:

● Proposed Soil Sampling Location

Figure 3-13
PROPOSED SOIL SAMPLING LOCATIONS AT DNT SWEATING AND GRAINING HOUSE
TNT Area B
Plum Brook Ordnance Works

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One sample will be collected from each boring at a depth interval of approximately 0 to 1.5 feet. A second sample will be collected from the boring installed in the crude DNT tank at a depth interval of approximately 1.5 to 3.0 feet.

3.1.2.2 Overburden Groundwater Monitoring Wells

Two overburden groundwater monitoring wells (MK-MW17 and MK-MW16) are present in TNT Area B, as shown on Figures 3-9 and 3-14 respectively. The wells are located on the north and south sides of the area respectively.

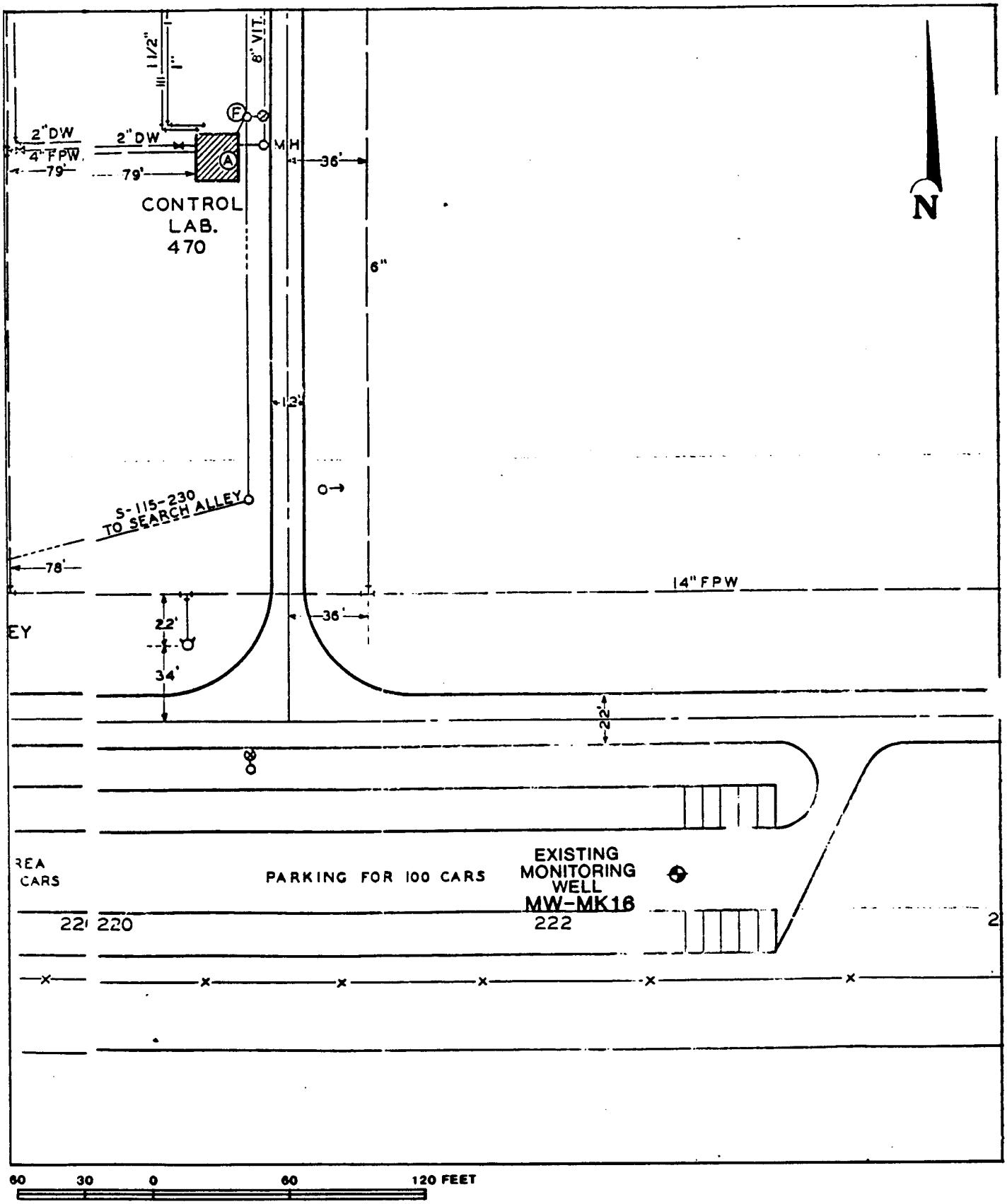
One additional overburden groundwater monitoring well will be installed in TNT Area B at the approximate location shown on Figure 3-10. A sample of soil in the screened interval in the well will be collected for sieve analysis. The well is proposed for the east side of the site north of Wash House 456.

Groundwater samples will be collected from the newly installed monitoring well and existing wells MK-MW16 and MK-MW17. Samples will be analyzed for explosives residues and total and dissolved metals concentrations. The existing wells will be redeveloped prior to sampling.

3.1.3 Sampling Scheme at TNT Area C

Figure 3-15 illustrates the layout of TNT Area C. A total of 30 representative soil samples will be collected and analyzed from the Waste Water Disposal Settling Tank, Wash House (line 1), Bi-Tri House (line 11), Fortifier House (line 11), and process waste water ditches. All soil samples will be analyzed for explosives residues and metals. Since no analysis for VOCs will be performed on any of the soil samples, the sample for an entire target depth interval will be composited.

Additionally, four overburden groundwater monitoring wells will be installed and sampled. Samples will be analyzed for explosives residues and total and dissolved metals concentrations.



LEGEND:

Existing Monitoring Well Location

Figure 3-14

EXISTING MONITORING WELL LOCATION
TNT Area B
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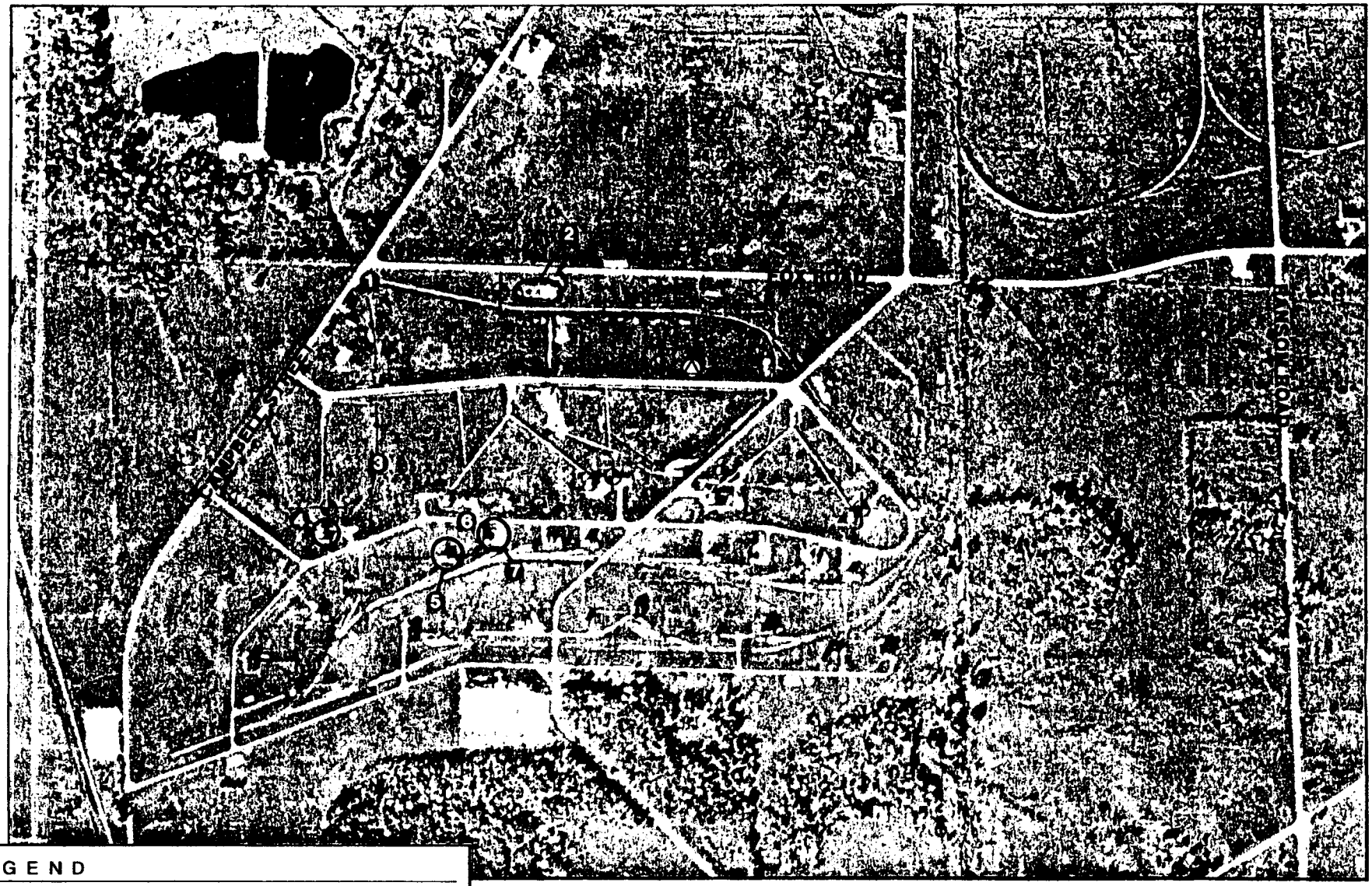

LEGEND

- Proposed Monitoring Well
- Proposed Bedrock Well
- 1 Ditch Intersection at Corner of Fox Road and Campbell St.
- 2 Wastewater Disposal Settling Tank
- 3 Ditch
- 4 Wash House-Line 12 (Bldg. 626)
- 5 Bi-Tri House (Bldg. 612)
- 6 Ditch
- 7 Fortifier House (Bldg. 613)

Photo Date: 10-19-50

Figure 3-15

TNT AREA C LAYOUT

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The specific sampling locations and the rationale for their selection are described below.

3.1.3.1 Soil Borings

Waste Water Disposal Settling Tanks and Pump House (Building 657)

A total of four soil borings will be installed at the Waste Water Disposal Settling Tanks and Pump House (Building 657) at the approximate locations shown on Figure 3-16. Two samples will be collected from each boring providing a total of eight samples.

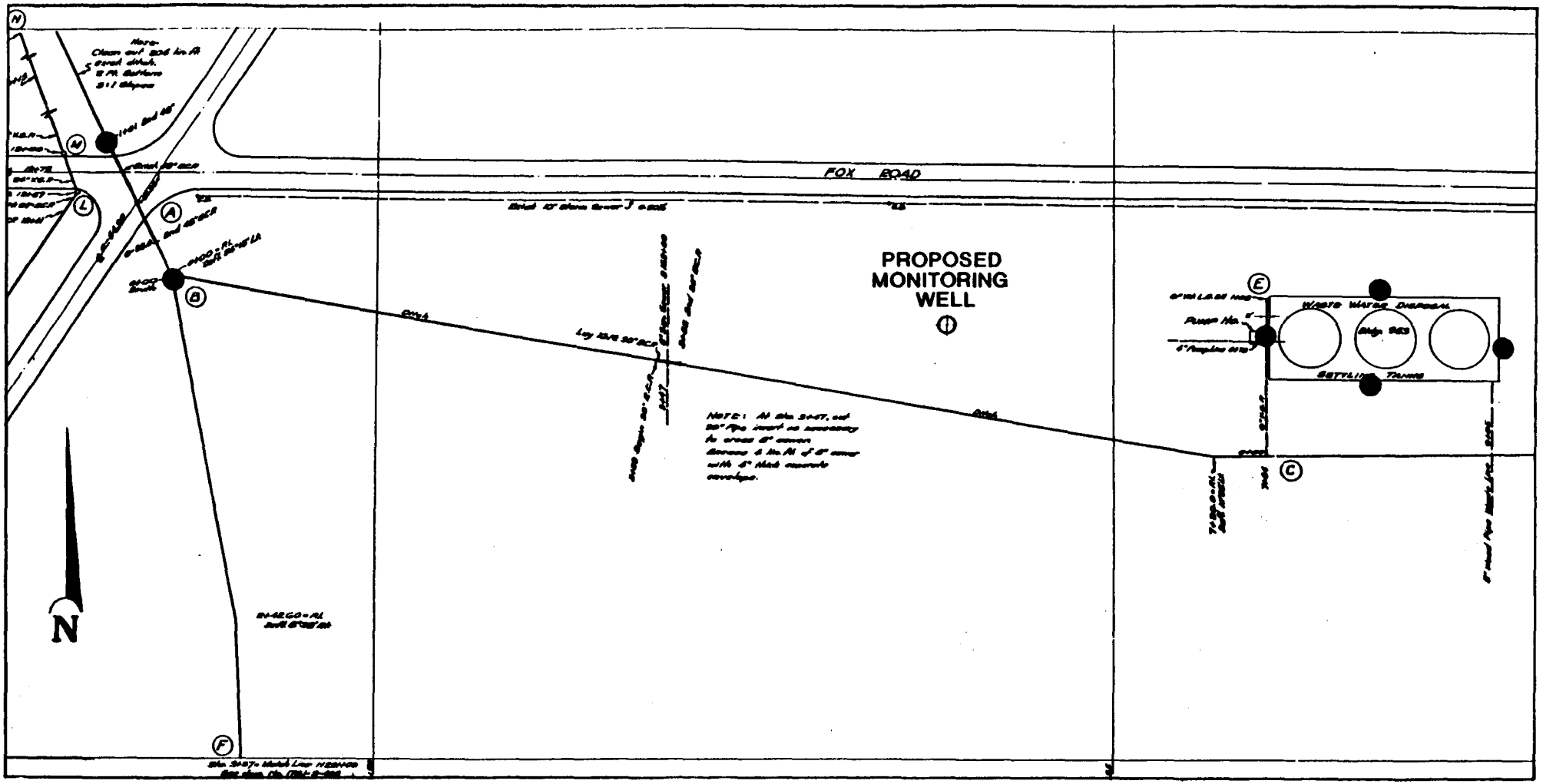
An alternate configuration than that proposed for the Waste Water Disposal Settling Tanks and Pump House in TNT Areas A and B was selected for TNT Area C. The sampling scheme for TNT Area C is designed to assess contamination in the soils outside the enclosure surrounding the settling tanks. One boring will be installed on each side of the enclosure. The boring on the west side of the enclosure will be installed between the enclosure and the Pump House.

Two samples will be collected from each boring at approximately 0 to 1.5 feet and approximately 1.5 to 5.0 feet.

Wash House (line 12) (Building 626)

Six soil borings will be installed in the vicinity of the Wash House for TNT line 12 (Building 626). One sample will be collected from each of six borings. The proposed boring locations are illustrated on Figure 3-17.

Two samples locations were selected inside the "catch box" to assess contamination connected with releases into the "catch box." The sample location on the southeast side of the Wash House is between the Wash House and the "catch box" and was selected to assess contamination which may have been released if material was spilled as it was being discharged into the "catch box." The remaining three sample locations



LEGEND:

- ● Proposed Soil Sampling Location
- ⊕ Proposed Monitoring Well Location

Figure 3-16

PROPOSED SOIL SAMPLING LOCATIONS AT WASTE WATER DISPOSAL SETTLING TANK AND ASSOCIATED DITCHES AND PROPOSED MONITORING WELL LOCATION

TNT Area C

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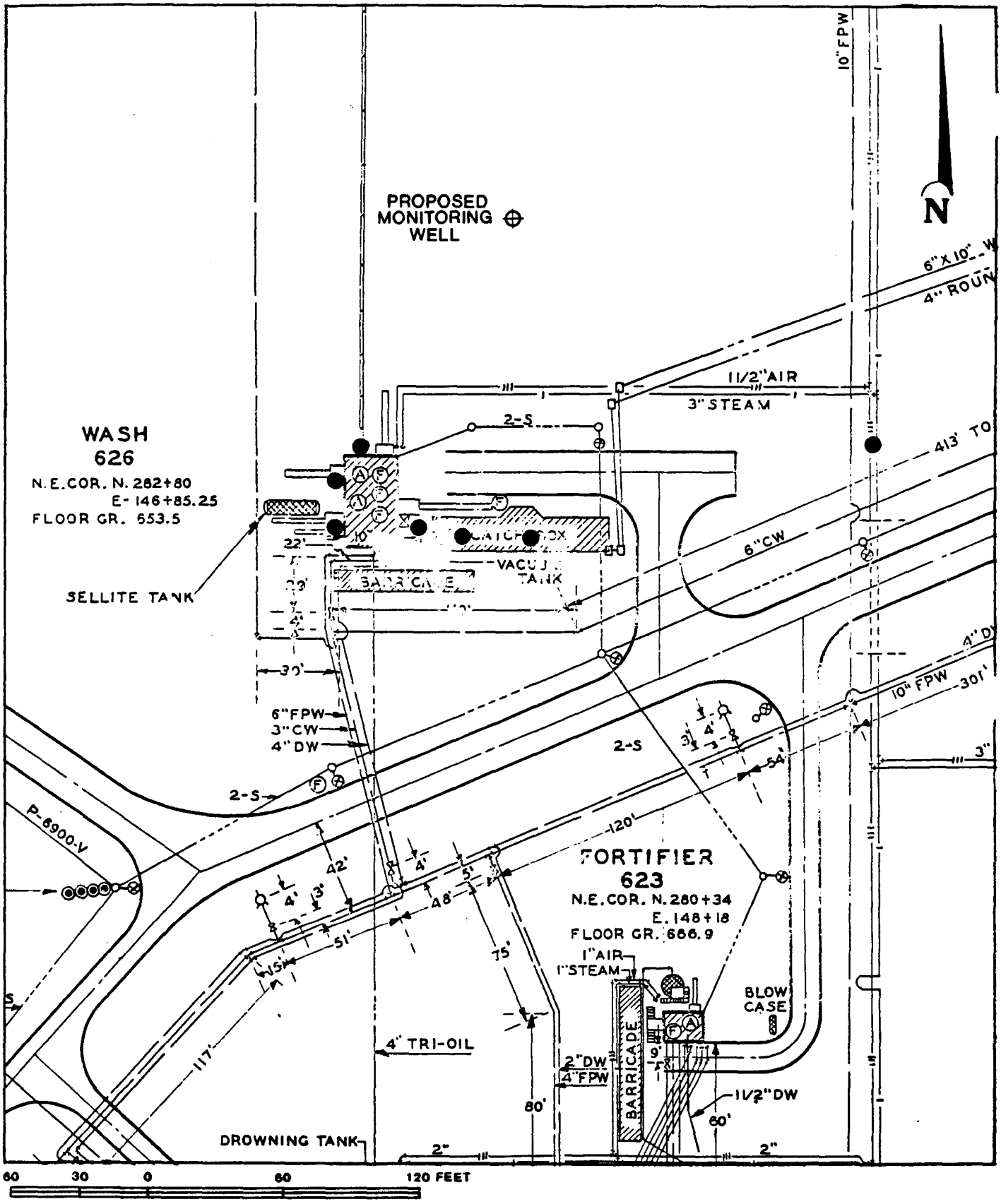

LEGEND:

- ● Proposed Soil Sampling Location
- ⊕ Proposed Monitoring Well Location

Figure 3-17

PROPOSED SOIL SAMPLING LOCATIONS AT WASH HOUSE - LINE 12 AND ASSOCIATED DITC AND PROPOSED MONITORING WELL LOCATION

TNT Area C

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at the Wash House were selected because they are near doors or other features through which waste material may have been released or discarded from the Wash House.

Samples from the "catch box" will be collected at an approximate depth interval of 1 to 2 feet. The remaining samples will be collected at an approximate depth interval of 2.5 to 3.5 feet.

Bi-Tri House (Building 612)

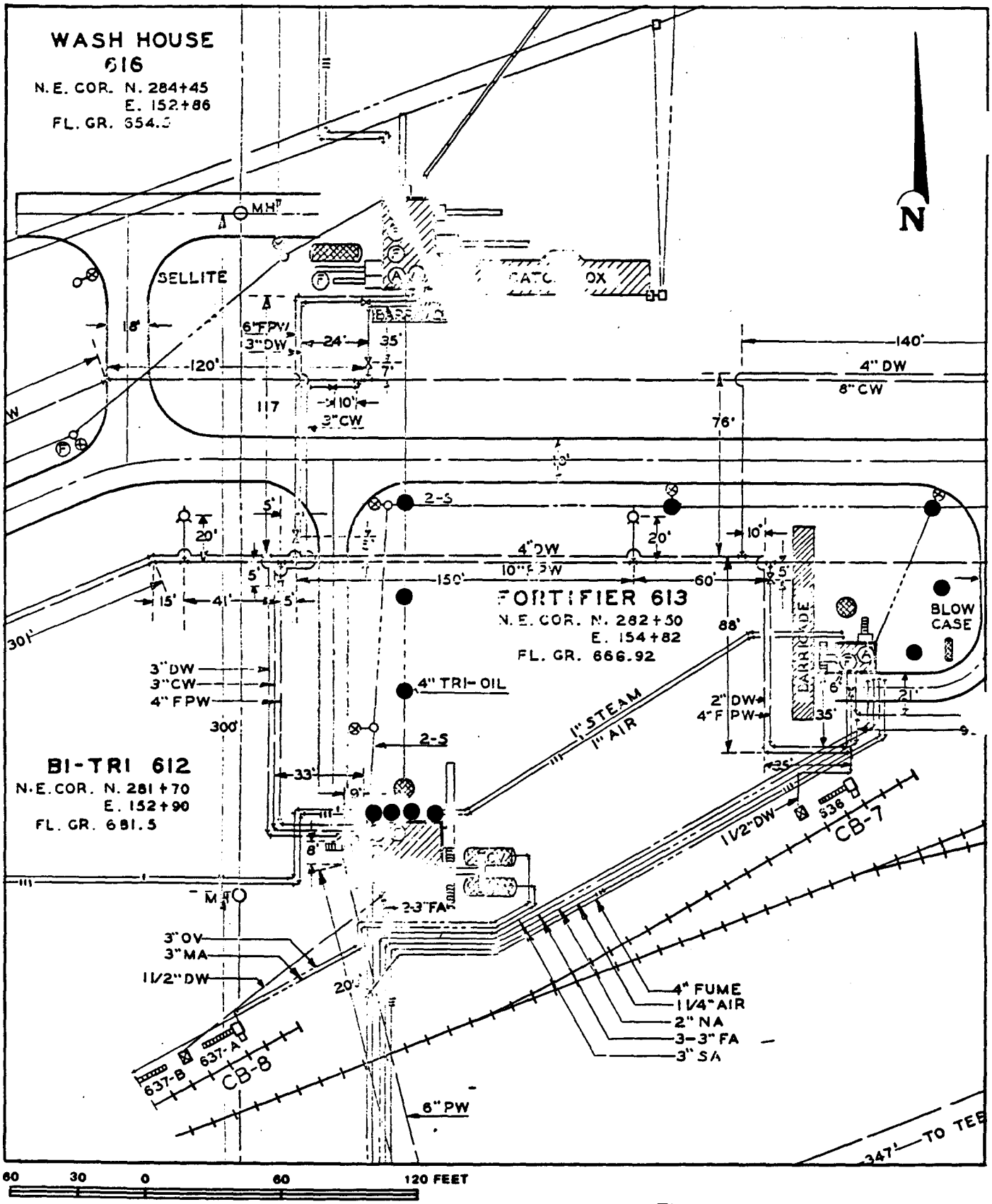
A total of six borings will be installed in the vicinity of the Bi-Tri House (Building 612) at the approximate locations shown on Figure 3-18. One sample will be collected from each of borings.

The sampling locations at the Area C Bi-Tri House were selected to assess contamination in the area adjacent to the building and also in the site soils in ditches which carried waste process water from the manufacturing areas to the waste disposal areas. Four borings will be installed on the north side of the house. The remaining two borings will be installed along the drainage ditch that runs north of the Bi-Tri House.

Samples from the borings installed near the building will be collected at an approximate depth equal to the depth of the bottom of the ditch located north of the building. Samples from the ditch itself will be collected at a depth interval of approximately 0.5 to 1 feet out of the bottom of the ditch.

Fortifier House (Building 613)

Two borings will be installed at the Fortifier House (Building 613) at the approximate locations shown on Figure 3-18. One sample will be collected from each location.



LEGEND:

● Proposed Soil Sampling Location

Figure 3-18

PROPOSED SOIL SAMPLING LOCATIONS AT BI-TRI HOUSE, FORTIFIER HOUSE AND ASSOCIATED DITCHES
TNT Area C
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The sampling locations at the TNT Area C Fortifier House were selected to assess potential contamination to site soils in ditches which carried waste process water from the manufacturing areas to the waste disposal areas. The first boring will be installed along the ditch that runs east of the Fortifier House. The second boring will be installed along the connecting ditch that runs north.

Both of these samples will be collected from the bottom of the ditch a at depth interval of approximately 0.5 to 1 feet.

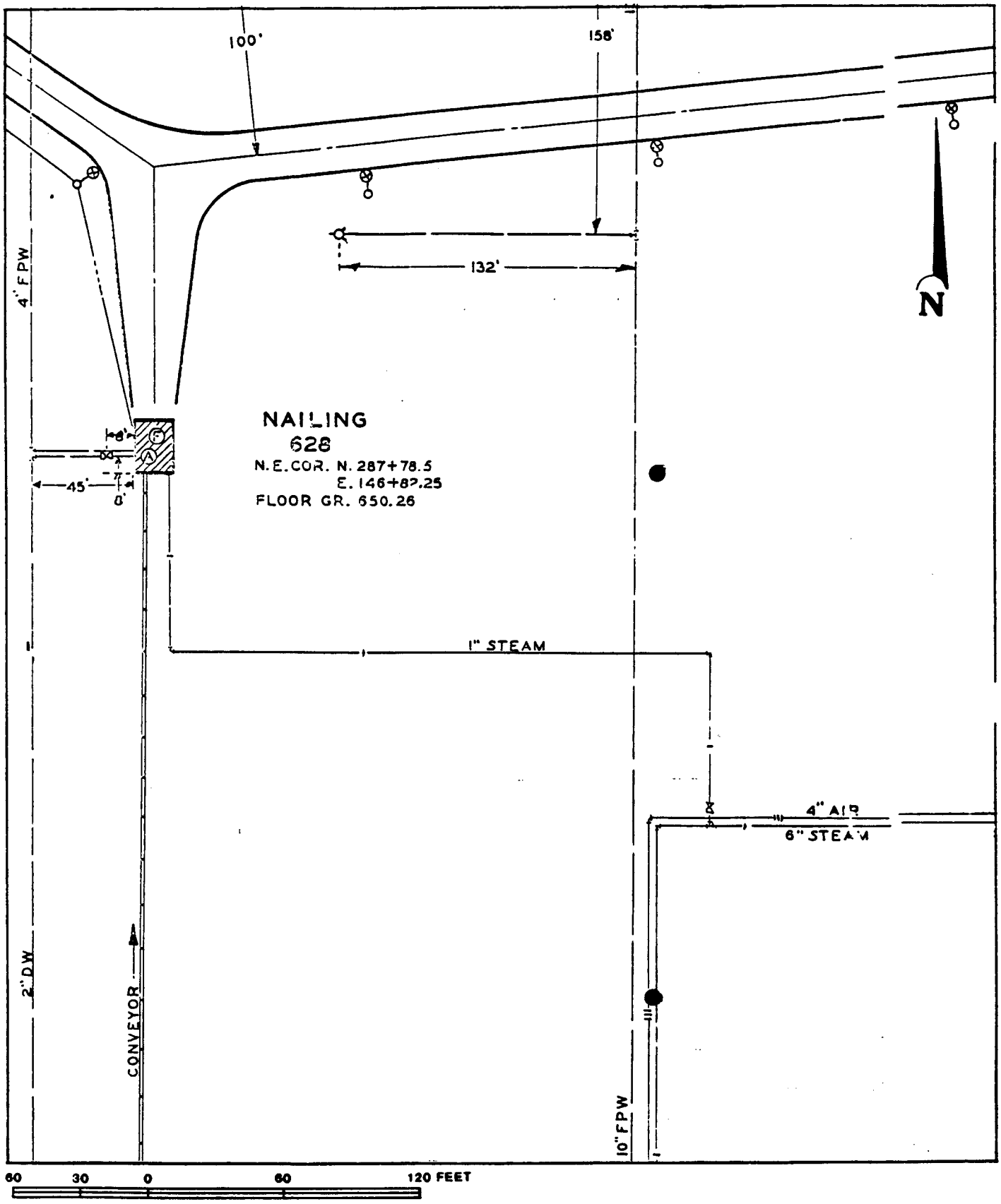
Ditches

At TNT Area C, sampling locations were selected to assess the potential for contamination to site soils in ditches which carried waste process water from the manufacturing areas to the waste disposal areas. Sampling locations associated with the Bi-Tri House and the Fortifier House have been described previously. In addition to these samples, eight additional ditch samples will be collected at the approximate locations shown on Figures 3-16, 3-17, 3-18, and 3-19.

Three samples will be collected from the main ditch that trends east-west to the north of the Bi-Tri House and the Fortifier House for line 11. The proposed locations of these samples are illustrated on Figure 3-18.

Three samples will be collected from the ditch that is located east of the Wash House and Fortifier House (line 11) and trends north-south from the Fortifier House and Wash House, past the Nailing House (Building 628), toward the intersection of Fox and Campbell Roads. The proposed sampling locations for these three samples are shown on Figures 3-17 and 3-19.

Two samples will be collected at the Waste Water Disposal Settling Tank ditch and the main ditch (intersection which contains the flow from the three Wash House lines). This intersection is located at the junction of Campbell and Fox Roads. One of these samples will be collected on the south side of the intersection and the other sample



LEGEND:

● Proposed Soil Sampling Location

Figure 3-19

PROPOSED SOIL SAMPLING LOCATIONS AT ASSOCIATED DITCH

TNT Area C

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will be collected on the north side of the intersection at the mouth of Pipe Creek. The proposed sampling locations are shown on Figure 3-16.

One sample will be collected from each location at an approximate depth interval of 0.5 to 1.0 feet.

3.1.3.2 Overburden Groundwater Monitoring Well Samples

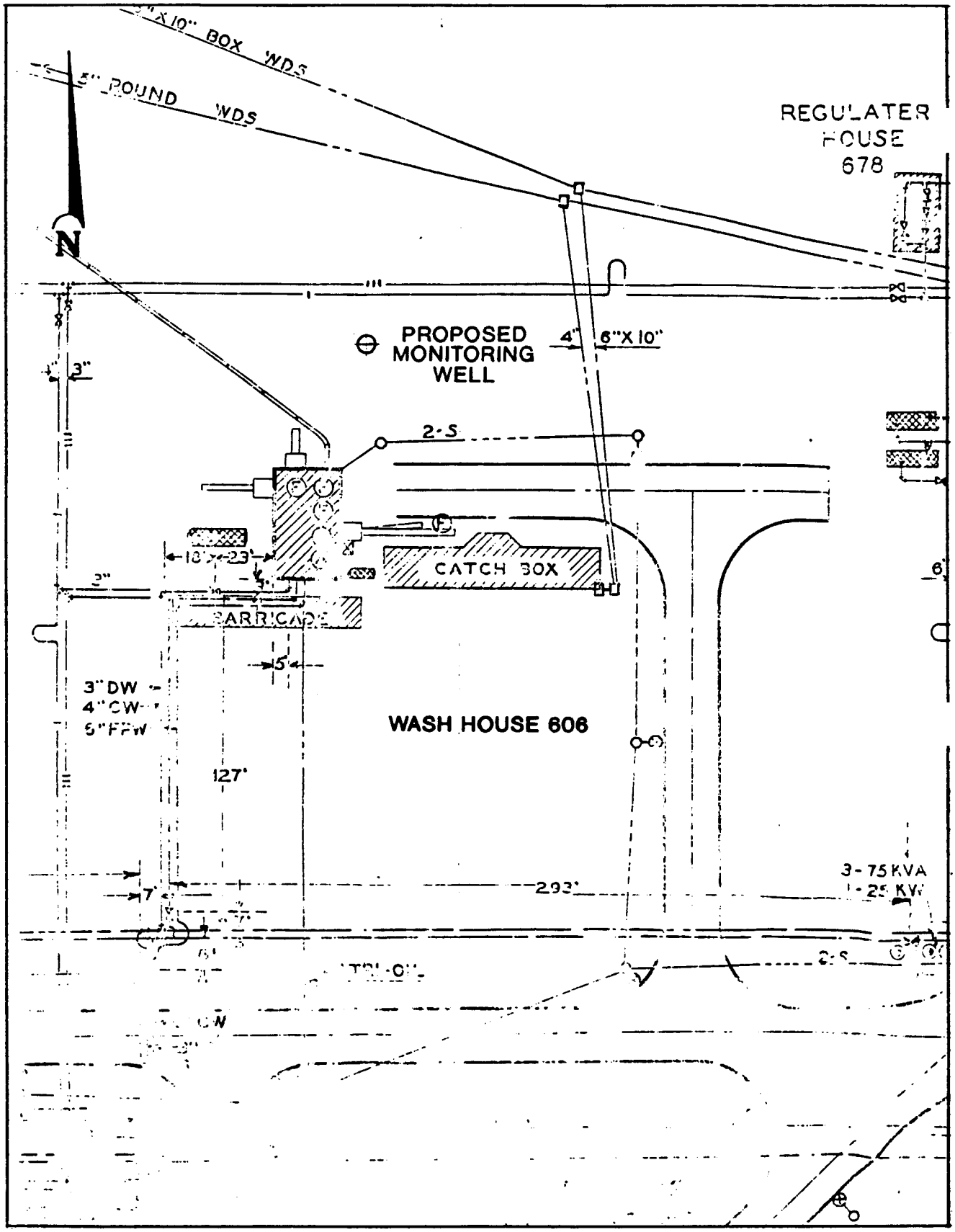
No overburden groundwater monitoring wells have previously been installed in the vicinity of TNT Area C.

Four overburden shallow monitoring wells will be installed in TNT Area C. The proposed well locations are shown on Figures 3-16, 3-17, 3-20, and 3-21. Three of the wells are proposed for areas near Wash Houses. One well is proposed to be installed north of the Wash House for line 12, the second north of the Wash House for line 10, and the third north of the Wash House for line 9. The overall direction of groundwater flow at the site is assumed to be northward. The Wash House is the northernmost structure in these two manufacturing lines. Therefore, these wells could potentially detect contamination in the groundwater in the overburden which resulted from manufacturing at these lines. A fourth well is proposed for the northern portion of TNT Area C near the waste water settling tanks along Fox Road. A sample of soil in the screened interval in each well will be collected for sieve analysis.

Groundwater samples will be collected from the four newly installed monitoring wells. Samples will be analyzed for explosives residues and total and dissolved metals concentrations.

3.2 SAMPLING SCHEME AT THE RED WATER PONDS

During operation of the PBOW, process waste water was disposed of in Red Water Ponds located in two areas of the site. This process waste water, referred to as "red water" results from the final washing of TNT. It is acidic, and generally contains



50 25 0 50 100 FEET

Figure 3-20

PROPOSED MONITORING WELL LOCATION

TNT Area C
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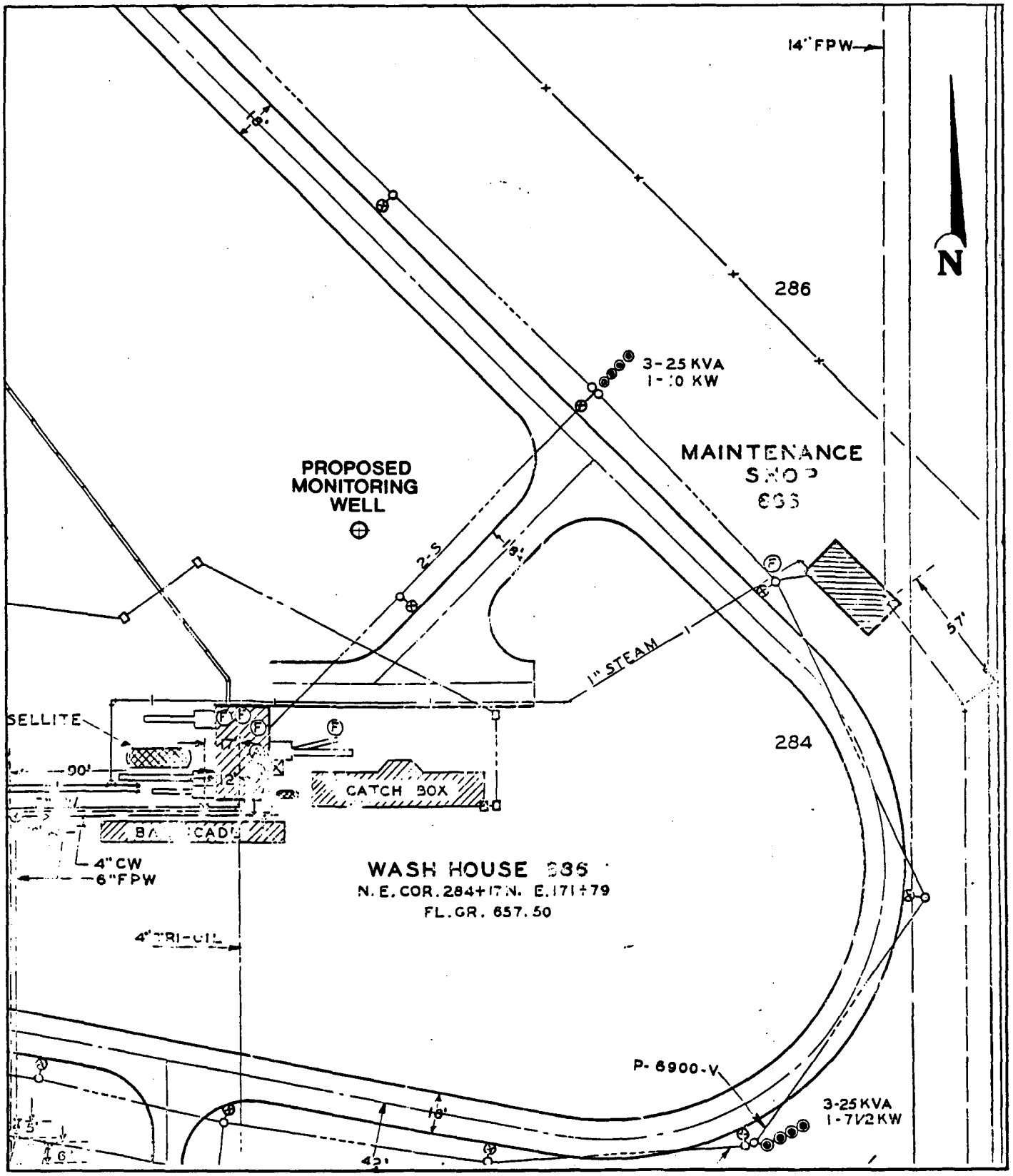

60 30 0 60 120 FEET

LEGEND:

⊕ Proposed Monitoring Well Location

Figure 3-21

PROPOSED MONITORING WELL LOCATION
TNT Area C
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elevated concentrations of nitroaromatics and, possibly, lead. The ponds in both areas were constructed by excavating a shallow pond and then detonating explosives in the bottom of the pond to enhance the permeability of the subsurface.

Previous investigations and field observations at the two Red Water Pond Areas indicate that contamination by explosives residues is present. Therefore, the objective of the investigation at the Red Water Pond Areas is to develop sufficient information to complete a RI leading to a FS of options for remediation of the contamination present in these areas. The sampling scheme has been designed in an attempt to delineate the nature and extent of contamination in the environmental media which may have been impacted by use of the Red Water Ponds during operation of the PBOW. The sampling locations have been selected based on review of historical information documenting the areal extent of the ponds from their creation to the present. Further, the sampling scheme is designed to obtain preliminary information which may be required during development of a FS or Baseline Risk Assessment, should these be needed. The specific data to be developed are discussed in the descriptions of the sampling schemes for the two Red Water Pond Areas presented below.

Tables 3-4 and 3-5 present the sampling scheme for the soil, sediment, and surface water samples to be collected at the West Area and Pentolite Road Red Water Ponds. Groundwater samples to be collected in the Red Water Pond Areas are summarized on Table 3-3 which was presented previously. The specific sampling schemes for the West Area and the Pentolite Road Red Water Pond Areas are described in Sections 3.2.1 and 3.2.2, respectively.

The sampling locations for the investigations of the Red Water Ponds Areas are related to the configurations of the ponds when they were in use as part of the PBOW. The original shapes of the ponds have altered, in some cases significantly, since the ponds were constructed and used. Historical records indicate that the shape of the ponds changed even during operation of the PBOW.

- One of the ponds at the West Area Red Water Ponds Area retains generally the same shape as the pond used during operation of the

TABLE 3-4

RED WATER PONDS
SOIL, SEDIMENT, AND SURFACE WATER FIELD SAMPLING SCHEME (CHEMICAL ANALYSIS)

AOC #	Area	Bldg. No./ Designation	Media	Sampling Technique	No. of Borings/ Sampling Locations	No. of Samples From Each Boring/Location	Approximate Target Sampling Interval (feet below grade)	Analysis		
								Explos.	Metals[a]	TSS
2	Red Water Ponds	West Area	Pond Seepage Surface Soil	Trowel	4	1	Surface	✓	✓	
			Subsurface Soil	Drill Rig (10-ft borings)	4	3	0 to 3.0	✓	✓	
							3.0 to 5.0	✓	✓	
							5.0 to 10.0	✓	✓	
			Subsurface Soil	Hand Auger (5-ft borings)	12	2	0 to 2.0	✓	✓	
							2.0 to 5.0	✓	✓	
			Sediment	Boat/Shelby Tube or Other Approved Method	6	2	2" to below bottom of sediment	✓	✓	
			Surface Water	Kemmerer Sampler[b]	3	2	various	✓	✓	✓
2	Red Water Ponds	Pentolite Road	Subsurface Soil	Drill Rig (10-ft borings)	14	3	0 to 3.0	✓	✓	
							3.0 to 5.0	✓	✓	
							5.0 to 10.0	✓	✓	
			Subsurface Soil	Hand Auger (5-ft borings)	6	2	0 to 2.0	✓	✓	
							2.0 to 5.0	✓	✓	
			Sediment	Trowel	4	1	surface	✓	✓	
				TOTAL:	60[b]	116	—	✓	✓	

(a) Metals includes Antimony, Arsenic, Beryllium, Cadmium, Chromium, Copper, Lead, Manganese, Mercury, Nickel, Selenium, Silver, Thallium, and Zinc
TSS = Total Suspended Solids

(b) Or other appropriate sampling device

TABLE 3-5

RED WATER PONDS
SOIL, SEDIMENT, AND SURFACE WATER FIELD SAMPLING SCHEME (BIOLOGICAL ACTIVITY AND GENERAL CHEMISTRY)

AOC #	Area	Location	Media	Sampling Technique	No. of Borings/ Sampling Locations	No. of Samples From Each Boring/Location	Approximate Target Sampling Interval (feet below grade)	Analysis[a]	
								Biological Activity	General Chemistry
2	Red Water Ponds	West Area	Subsurface Soil	Hand Auger (5-ft borings)	1	1	3.0 to 5.0	✓	
			Sediment	Boat/Shelby Tube or Other Approved Method	1	1	2" to bottom of sediment	✓	✓
					1	1	2" to bottom of sediment	✓	
			Surface Water	Kemmerer Sampler[b]	1	1	surface	✓	
		Pentolite Road	Subsurface Soil	Hand Auger (5-ft borings)	1	1	3.0 to 5.0	✓	✓
					1	1	3.0 to 5.0	✓	
					TOTAL:	—	—	6	2

(a) General Chemistry includes Extractable Sulfate, pH, Extractable Alkalinity, Extractable Nitrate, Total Kjeldahl Nitrogen, Extractable Phosphorous, Potassium, Cation Exchange Capacity, Moisture Content, and Extractable Organic Carbon.

(b) Or other appropriate sampling device

PBOW. However, with the passage of time the second pond has become a wetland area rather than an extant pond.

- The ponds in the Pentolite Road Red Water Pond Area have been filled in. Actual ponds are no longer present in this area.

An effort will be made to collect samples at the locations indicated in this SAP; however, since the physical shapes of the features being investigated have changed with time and since reference points are generally not present, these sample locations must be considered approximate.

Target depth intervals for collection of soil samples are specified in this SAP. To the extent practical, these sampling depth intervals will be satisfied. However, variations from the target depth intervals may occur due to site conditions or as necessary to collect the volume of sample material required for laboratory analysis.

3.2.1 West Area Red Water Ponds

Two ponds, referred to herein as the East Pond and the West Pond, were present at the West Area Red Water Ponds Area during operation of the PBOW. An earthen berm which separated the East Pond from the West Pond is still present at the site. The East Pond is generally dry and appears to have been filled in. In March 1994, shallow red-tinted ponded water was observed in the East Pond area adjacent to the berm. The West Pond contains water. The depth of the water is not known but is assumed to be approximately 3 feet. Based upon review of aerial photographs, it does not appear that the shape of the pond has changed since the 1950s.

A total of 40 subsurface and surface soil samples will be collected at the West Area Red Water Ponds. Soil samples submitted to the laboratory for chemical analysis will be analyzed for explosives residues and metals. Since no analysis for VOCs will be performed on any of the soil samples, the sample for an entire target depth interval will be composited. One of the soil samples will also be submitted for laboratory analysis of biological activity.

A total of 12 sediment samples will be collected at the West Area Red Water Ponds. Sediment samples submitted to the laboratory for chemical analysis will be analyzed for explosives residues and metals. Since no analysis for VOCs will be performed on any of the soil samples, the sample for an entire target depth interval will be composited. Two sediment samples will also be submitted for laboratory analysis of biological activity.

Six surface water samples will be collected at the West Area Red Water Ponds Area. Surface water samples submitted to the laboratory for chemical analysis will be analyzed for explosives residues (both filtered and unfiltered), total metals, dissolved metals, and total suspended solids concentrations. One surface water sample will also be submitted for laboratory analysis of biological activity.

Additionally, three groundwater samples will be collected, two from wells installed as part of this investigation and one from an existing well. Samples will be analyzed for explosives residues and total and dissolved metals concentrations.

The specific sampling locations and the rationale for their selection are described below. Approximate sampling locations are shown on Figure 3-22.

3.2.1.1 Soil Samples

Sixteen soil borings will be installed in the vicinity of the West Area Red Water Ponds. The proposed boring locations are illustrated on Figure 3-22. Four borings will be advanced to a target depth of 10 feet; three samples will be collected from each of these borings. Twelve borings will be advanced to a target depth of 5 feet and two samples will be collected from each of these borings. Surface soil samples will be collected at four locations. This will provide a total of 40 samples.

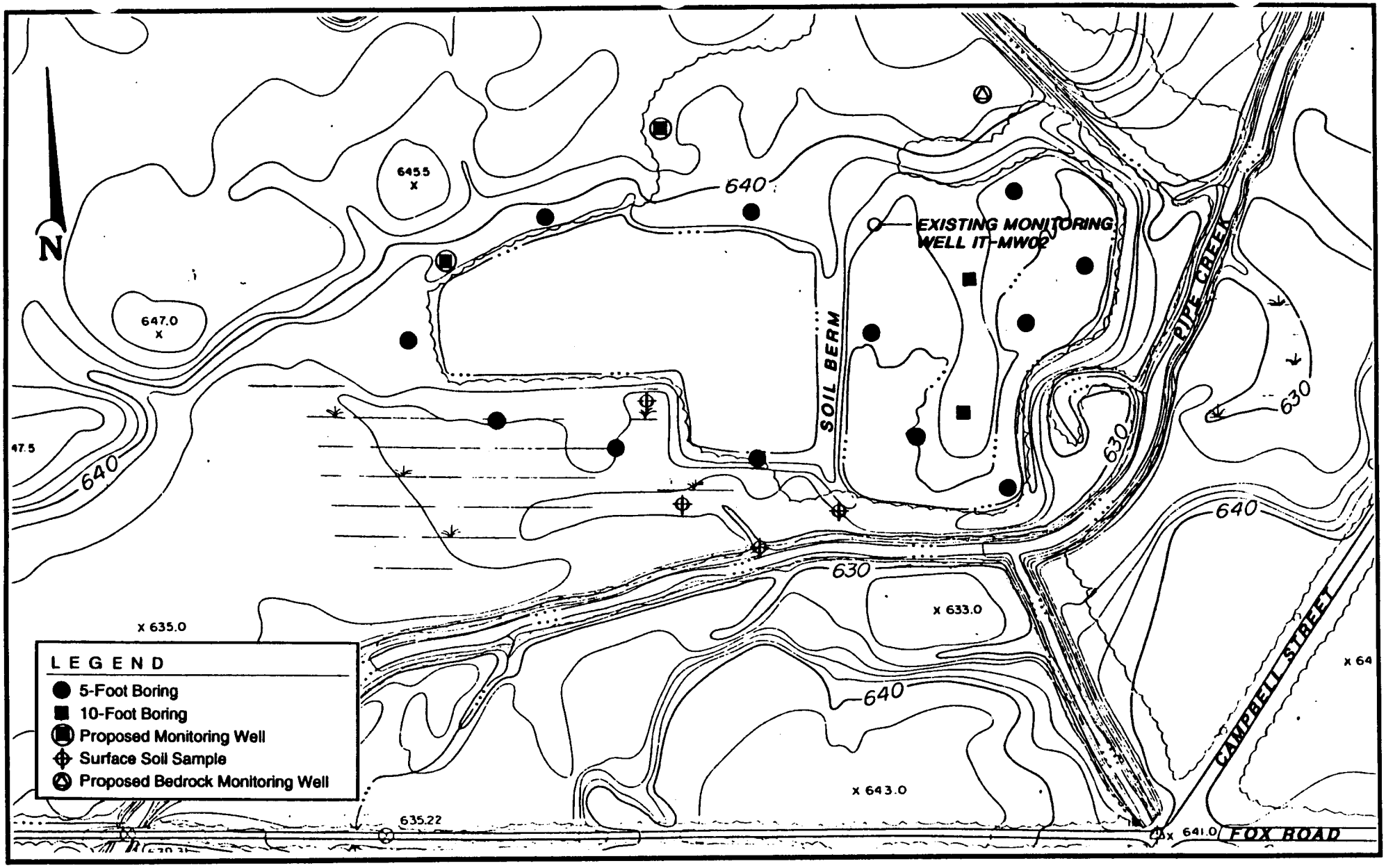

Figure 3-22

PROPOSED SOIL SAMPLING LOCATIONS AND PROPOSED AND EXISTING MONITORING WELL LOCATIONS

West Area Red Water Ponds

Plum Brook Ordnance Works

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10-Foot Borings

At four locations, borings will be advanced to a depth of 10 feet. Two of the 10-foot borings will be located in the vicinity of East Pond which has been filled in. Two of the 10-foot borings will be located on the north and northwestern side of the West Pond. The purpose of the borings in the vicinity of East Pond is to establish the historical areal extent of the pond and associated contamination. The purpose of the borings in the vicinity of West Pond is to evaluate the areal extent of contamination that may have been released from this pond. Approximate boring locations are illustrated on Figure 3-22. Final boring locations will be selected in the field based on site conditions.

From each boring, three soil samples will be collected and submitted for laboratory analysis, one from 0 to 3 feet, one from 3 to 5 feet, and one from 5 to 10 feet for a total of 12 samples. These samples will be analyzed for explosives residues and metals.

5-Foot Borings

At 12 locations, borings will be advanced to a depth of 5 feet. The approximate boring locations are illustrated on Figure 3-22. The locations at which the 5-foot borings will be installed were selected to assess whether use and/or releases from the ponds have resulted in contamination of the surrounding soils along the perimeter of the ponds. These samples will be analyzed for explosives residues and metals.

From each boring, two soil samples will be collected and submitted for laboratory analysis, one from 0 to 2 feet and one from 2 to 5 feet for a total of 24 samples.

Surface Soil Sampling

Four surface soil samples will be collected between the West Area Ponds and Pipe Creek from locations where seepage from the ponds has been documented. Each of the samples will be analyzed for explosives residues and metals.

Two of the surface samples will be collected on the stream bank of Pipe Creek at locations where red water was observed seeping from the stream bank in March 1994. If other seepage areas from the West Area Red Water Ponds are observed prior to collection of the samples, the remaining two surface samples will be collected in these areas. If no other seepage areas are observed along Pipe Creek or from the berm of the West Area Red Water Ponds, the remaining two samples will be collected in areas which were recently observed to be wet between Pipe Creek and the ponds.

Soil Sample for Biological Activity

At one location in the area surrounding the ponds, a sample will be collected for analysis of biological activity as discussed in Section 8.2. The sample will be collected from a depth of approximately 3 to 5 feet.

3.2.1.2 Sediment Sampling

The West Area Red Water Ponds sediment investigation is designed to evaluate the horizontal extent and thickness of sediment and to collect samples of the sediment and underlying natural soils for laboratory testing. Based on available subsurface information, the natural soils are anticipated to consist of a yellow sandy clay.

Sediment Samples for Physical Characteristics and Chemical Analysis

A grid map of the pond will be developed and penetrometer testing will be performed at each grid location to evaluate the sediment horizontal extent and thickness. Portable penetrometer testing will be performed at grid locations to aid in identifying

the sediment-natural soil interface (i.e., soft sediment and stiff natural layers). The penetrometer rate of penetration should differ significantly between the sediment and natural layers. The height of the water column (above the sediment) and sediment thickness will be measured.

Sediment cores will be collected at ten locations. These locations will be selected in the field based on the results of the penetrometer testing. Intact sediment cores will be collected and sediment composition will be documented.

At six of the locations where sediment cores are collected, samples will be obtained for laboratory chemical analysis. From each of these six locations, two samples will be submitted for laboratory chemical analysis to try to assess the vertical extent of contamination providing a total of 12 field samples. The portions of the core to be submitted for laboratory analysis will be selected in the field based on the condition of the core; however, the uppermost 2 inches of sediment will not be included in any sample. Each of the 12 samples will be analyzed for explosives residues and metals.

One of the samples will also be analyzed for extractable sulfate, pH, extractable TOC extractable alkalinity, extractable nitrate, total Kjeldahl nitrogen, extractable phosphorous, potassium, cation exchange capacity, and moisture content.

The portion of the core to be submitted for analysis will be selected in the field based on assessment of the sediment cores.

Sediment Samples for Biological Activity

At two locations in West Pond where sediment core samples are collected, sediment samples will be collected for analysis of biological activity as discussed in Section 8.2. The portion of the core sample to be submitted for analysis will be selected in the field based on assessment of the sediment cores collected from West Pond.

3.2.1.3 Surface Water Sampling

Surface Water Samples for Chemical Analysis

A total of six surface water samples will be collected from West Pond. A portion of each of the samples will be filtered and both filtered and unfiltered samples will be submitted for explosives residues and metals analysis. The unfiltered samples will also be tested for total suspended solids.

Surface Water Sample for Biological Activity

One sample of the water from West Pond will be collected for analysis of biological activity. The samples will be analyzed for biological activity as discussed in Section 8.2.

3.2.1.4 Overburden Groundwater Monitoring Wells

One overburden groundwater monitoring well (IT-MW02) is present in the vicinity of the West Area Red Water Ponds at the location shown on Figure 3-22. This well is located in the vicinity of the East Pond.

Two additional overburden groundwater monitoring wells will be installed at the locations (coincident with the two 10-foot boring locations north and northwest of the West Pond) as indicated on Figure 3-22. The purpose of these wells is to establish a local flow direction in the groundwater in the overburden and evaluate whether there is groundwater contamination. The locations of these wells were selected north of the West Pond to assess groundwater conditions in the vicinity of this pond as one well was previously installed near the East Pond. A sample of soil in the screened interval of each well will be collected for sieve analysis.

Groundwater samples will be collected from each of the two newly installed overburden monitoring wells and the existing monitoring well MW-IT02. Samples will

be analyzed for explosives residues (both filtered and unfiltered samples) and total and dissolved metals concentrations. The existing well will be redeveloped prior to sampling.

3.2.2 Sampling Scheme at Pentolite Road Red Water Ponds

The Pentolite Road Red Water Ponds have been filled in during the years since operation of the PBOW.

A total of 58 subsurface and surface soil samples will be collected at the Pentolite Road Red Water Ponds. Soil samples submitted to the laboratory for chemical analysis will be analyzed for explosives residues and metals. Since no analysis for VOCs will be performed on any of the soil samples, the sample for an entire target depth interval will be composited. Two of the soil samples will also be submitted to the laboratory for analysis of biological activity.

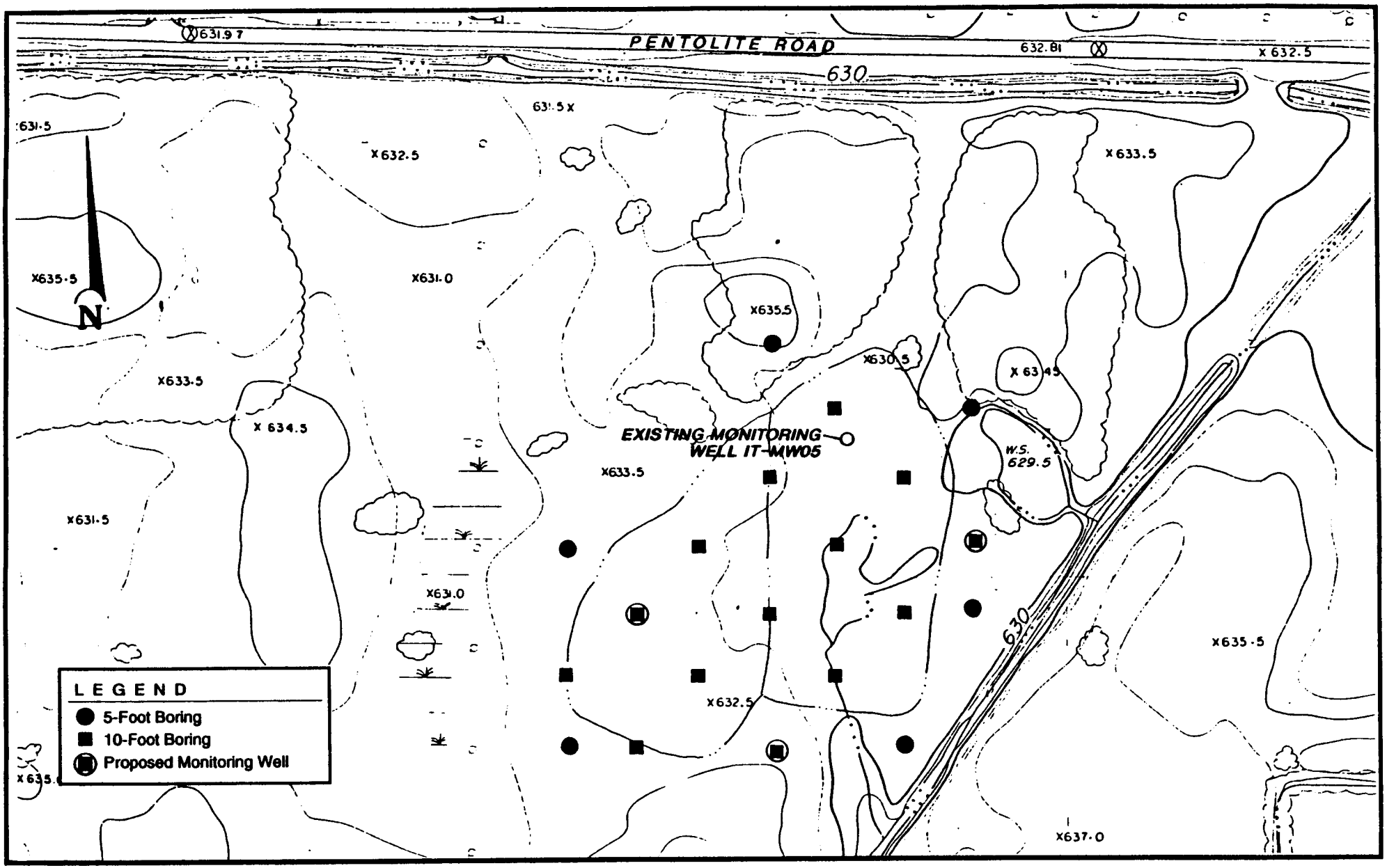
Additionally, four groundwater samples will be collected, three from wells installed as part of this investigation and one from an existing well. Samples will be analyzed for explosives residues and total and dissolved metals concentrations.

The specific sampling locations and the rationale for their selection are described below.

3.2.2.1 Soil Samples

The U.S. Geological Survey topographic map was used to estimate the area encompassing the former ponds. A grid was placed over the area encompassed by the former ponds and approximate boring locations were selected at grid points within and around the pond areas. The proposed sampling scheme is illustrated on Figure 3-23.

Twenty soil borings will be installed in the vicinity of the Pentolite Road Red Water Ponds. Fourteen of the borings will be advanced to a target depth of 10 feet; three



NOTE: Location and size of former pond area was derived from a 1956 aerial photograph.

Figure 3-23
PROPOSED SOIL SAMPLING LOCATIONS AND EXISTING AND PROPOSED MONITORING WELL LOCATIONS

Pentolite Road Red Water Pond Area
Plum Brook Ordnance Works

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samples will be collected from each of these borings. Six borings will be advanced to a target depth of 5 feet and two samples will be collected from each of these borings. Sediment and/or surface soils samples will be collected in four locations. This will provide a total of 58 samples.

10-Foot Borings

At 14 locations, soil borings will be advanced to a depth of 10 feet. These borings locations were selected in areas that were historically part of the ponds. The purpose of these borings is to establish the historical areal extent of the ponds and associated contamination. From each boring, three soil samples will be collected and submitted for laboratory analysis, one from 0 to 3 feet, one from 3 to 5 feet, and one from 5 to 10 feet.

5-Foot Borings

At six locations, 5-foot borings will be installed. The locations selected for these shallower borings are around the perimeter of the ponds. The purpose of these borings is to assess the areal extent of contamination and evaluate whether use and/or releases from the ponds have resulted in contamination of the soils surrounding the ponds.

Two soil samples will be collected from each boring at approximate depth intervals of 0 to 2 feet and 2 to 5 feet.

Sediment (Surface Soil) Sampling

Sediment and/or surface soil samples will be obtained from four locations within the pond area. The sample locations will be chosen in the field based upon site conditions. Areas which are denuded and/or areas of stressed vegetation will be selected for

collection of these samples. One sample will be obtained from each of the four locations for a total of four samples.

Soil Samples for Biological Activity

At two locations within the pond area, samples will be collected for analysis of biological activity as discussed in Section 8.2. One sample will be obtained from each area where a pond was present during operation of the PBOW. Both samples will be analyzed for biological activity. One of the samples will be analyzed for extractable sulfate, pH, extractable TOC, extractable alkalinity, extractable nitrate, total Kjeldahl nitrogen, extractable phosphorous, potassium, cation exchange capacity, and moisture content. Samples will be collected from a depth of approximately 3 to 5 feet.

3.2.2.2 Overburden Groundwater Monitoring Wells

One overburden groundwater monitoring well (MW-IT05) is present in the vicinity of the Pentolite Road Red Water Ponds at the location illustrated on Figure 3-23.

Three additional overburden groundwater monitoring wells will be installed at the locations (coincident with three of the 10-foot boring locations) indicated on Figure 3-23. The purpose of these wells is to establish a local flow direction in the groundwater in the overburden and to evaluate whether there is groundwater contamination. The existing well, IT-MW05 is located on the north side of the Pentolite Road Red Water Ponds Area. The three additional wells locations are in the central portion of the pond area and on the western and southern sides of the area. Due to the presence of the drainage ditch on the east side of the pond area, a well is not proposed in this area. A soil sample from the screened interval in each well will be collected for sieve analysis.

Groundwater samples will be collected from each of the three newly installed monitoring wells and the existing well IT-MW05. Samples will be analyzed for

explosives residues (both filtered and unfiltered samples) and total and dissolved metals concentrations. The existing well will be redeveloped prior to sampling.

3.3 BACKGROUND SOIL SAMPLES

Seven soil borings will be installed in areas of the site where contamination is least likely to be present based on known historical uses of the property. Two samples will be collected from each boring.

General areas from which background samples may be collected are shown on Figure 3-24. These areas were screened using Drawing 1661-S-3 entitled "Key to Acquired Buildings on Plum Brook Ordnance Works Reservation" to try to identify areas where buildings were historically present. Additionally, no DoD or NASA AOCs have been identified in these areas.

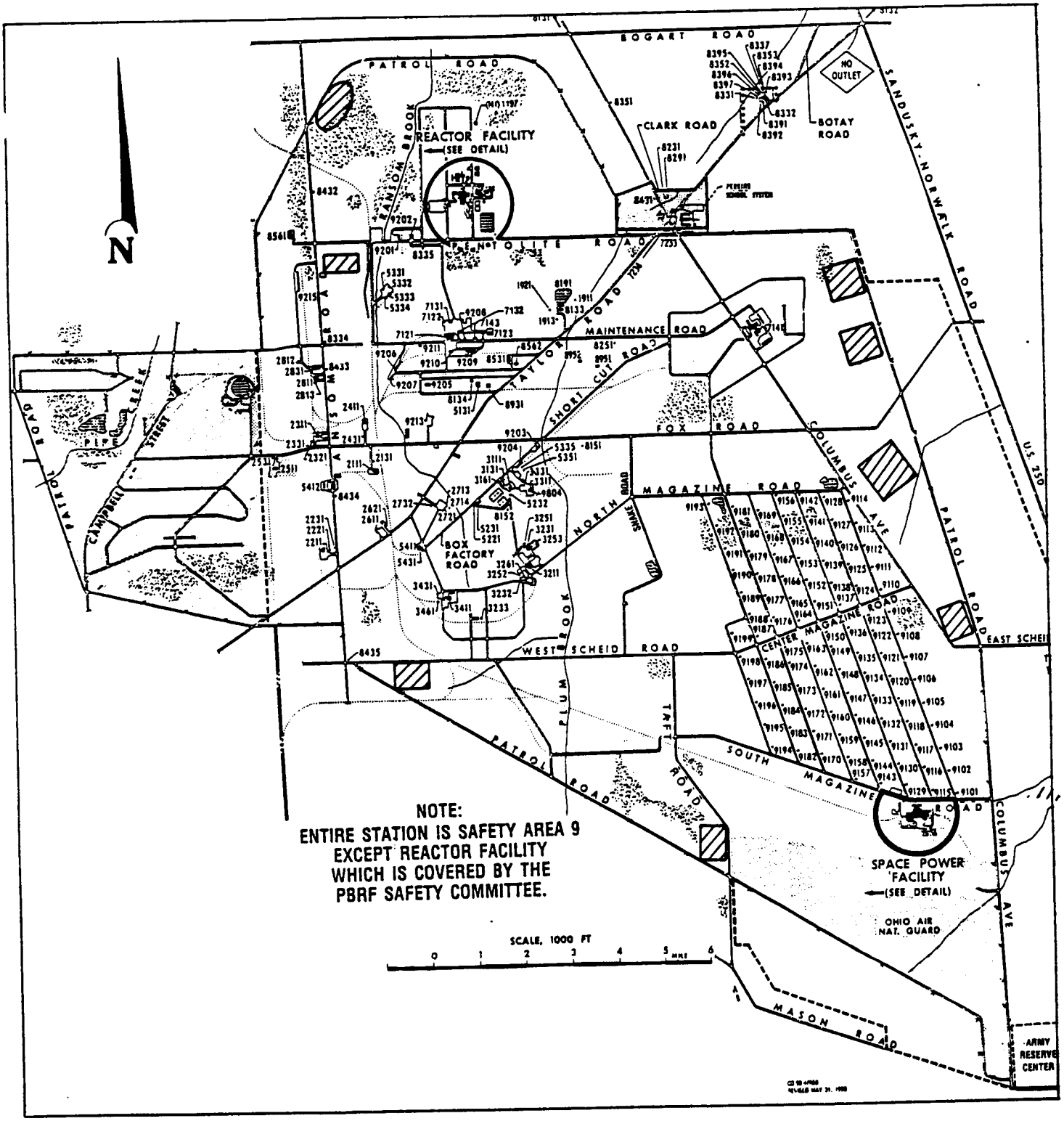
Two samples will be collected from each boring from depth intervals of approximately 0.5 to 3 feet and from 3 to 5 feet.

Background soil samples will be analyzed for explosives residues, metals, BNAs, and VOCs concentrations.

3.4 SITEWIDE GROUNDWATER INVESTIGATION

The HTW Investigation includes an investigation of the sitewide groundwater at the PBOW. The groundwater investigation is designed to assess the potential for contamination in both the unconsolidated overburden materials and the consolidated limestone and shale bedrock. Table 3-3 summarizes the groundwater sampling scheme for this investigation.

The monitoring wells that will be used to evaluate contamination in the overburden materials are being installed and sampled in conjunction with the investigations of the TNT Areas and the Red Water Pond Areas as described in Sections 3.1 and 3.2 above.



LEGEND:

Potential Areas Where Soil Background Samples May Be Collected

Figure 3-24

PROPOSED BACKGROUND SOIL SAMPLING LOCATIONS

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Samples collected from 19 wells completed in the overburden will be sampled and analyzed for concentrations of explosives residues and total and dissolved metals.

The investigation of the groundwater aquifer in the bedrock includes installation and sampling of eight new wells. Additionally, one of the wells at the Plum Brook Station Reactor Area will be redeveloped and sampled if permission is granted by NASA. Locations for the new bedrock monitoring wells were selected based on the results of an aerial photograph fracture trace analysis. A fracture trace analysis was performed to try to identify areas of the site at which bedrock wells would produce higher yields of groundwater. These areas would be prone to be conduits for migration of contamination in the bedrock aquifer to off-site locations.

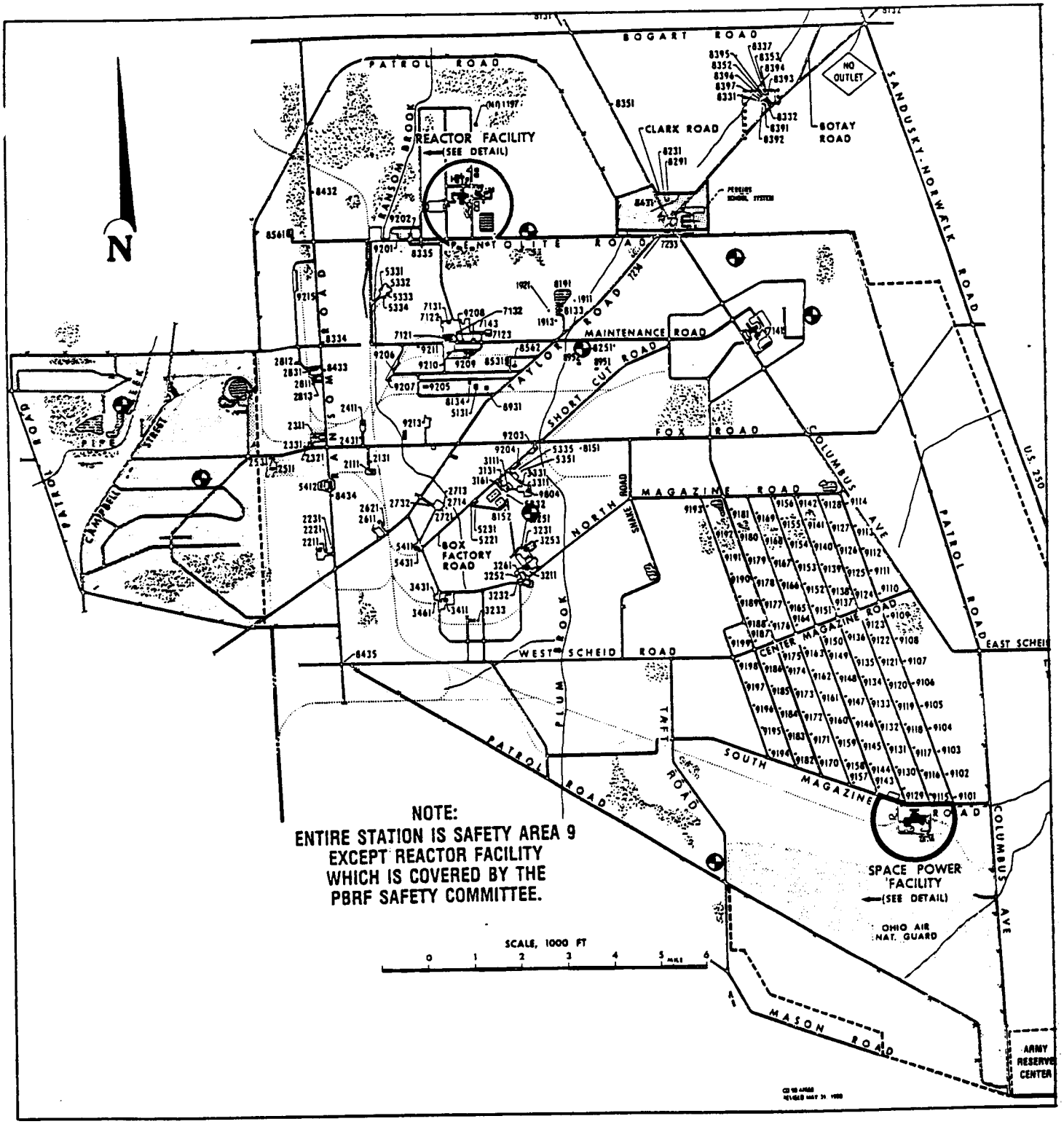
Locations for installation of bedrock groundwater monitoring wells are listed below and are illustrated on Figure 3-25.

- North of TNT Area A
- East of TNT Area A
- North of TNT Area B
- North of TNT Area C
- North of the Pentolite Road Red Water Ponds
- North of the West Area Red Water Ponds
- Near the Intersection of Patrol Road and Taft Road
- In the Vicinity of Toluene Tanks 255 and 265

The samples collected from the bedrock monitoring wells will be analyzed for explosives residues, VOCs, BNAs, and total and dissolved metals concentrations.

3.5 QUALITY ASSURANCE/QUALITY CONTROL SAMPLING

The QA/QC program is an integral part of the HTW Investigation at the PBOW. QA/QC samples will be collected and submitted for chemical laboratory analysis at a rate of approximately 10 percent of the number of field samples collected. This section of the SAP describes the QA/QC program for this investigation. Section 3.5.1 presents



LEGEND:

⊕ Proposed Bedrock Monitoring Well

Figure 3-25

PROPOSED BEDROCK MONITORING WELL LOCATIONS

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QA/QC definitions used in HTW Investigations. The QA/QC sampling and analytical scheme is described in Section 3.5.2.

3.5.1 Types of Samples

Some commonly used definitions describing types of samples collected and analyzed during HTW Investigations are provided below:

- Split Samples - Samples that are collected as a single sample, homogenized, divided into two or more equal parts, and placed into separate containers. The sample will be split in the field prior to delivery to a laboratory.

- Replicate (duplicate, triplicate, etc.) Samples - Multiple grab samples, collected separately, that equally represent a medium at a given time and location. This is the required type of collocated sample for volatile organic analyses and most groundwater and surface water samples.

- QC and QA Samples - Samples analyzed for the purpose of assessing the quality of the sampling effort and of the analytical data. QC and QA samples include splits or duplicates of field samples (replicates), equipment blanks, and trip blanks.

- QC Samples - Samples analyzed by Dames & Moore's subcontracted laboratory (ASI). The purpose of QC samples is to provide field originated checks that the data generated by the laboratory are of suitable quality. Duplicate and split QC samples represent approximately 10 percent of the field samples. A QC sample will be assigned a different sample identification than the field sample.

- QA Samples - Samples analyzed by the COE QA laboratory (ORD-L) to evaluate the contractor laboratory's performance. Duplicate and split QA samples represent approximately 10 percent of the field samples.

- Equipment (Rinsate) Blank - Samples consisting of reagent water collected from a final rinse of sampling equipment after the decontamination procedure has been performed. The purpose of equipment blanks is to evaluate whether the sampling equipment is causing cross-contamination of samples.

- Trip Blank - Containers of analyte-free reagent water that are kept with the field sample containers from the time they leave the laboratory until the time they are returned to the laboratory. The purpose of the trip blank is to evaluate whether samples are being contaminated during transit or sample collection. Trip blanks pertain only to volatile organic

analyses; therefore, the containers must contain no headspace. Only one trip blank is needed for one day's sampling and will satisfy trip blank requirements for all matrices for that day if the volatile samples are shipped in the same cooler.

3.5.2 QA/QC Sampling Scheme

The QA/QC program for the HTW Investigation at the PBOW includes collection and analysis of split and duplicate samples of the various environmental media being investigated. It also includes analysis of blank samples including equipment (rinsate) samples and trip blanks. At least one equipment blank will be prepared for each environmental media being sampled for chemical laboratory analysis. Trip blanks will be submitted with water samples which will be analyzed for VOCs.

Table 3-6 lists all the QA and QC samples which will be collected and analyzed. As Table 3-6 indicates, QA/QC samples will be collected from each investigation area and for each environmental media to be sampled. Collection of QA/QC samples will be performed throughout the field work. If possible, QA/QC samples will be collected during each day that field samples are collected.

A written record of the locations at which QA/QC samples are collected will be maintained during the field investigation.

3.6 SAMPLE IDENTIFICATION

All sample locations will be given a unique sample location identification and each sample collected will be identified with a unique sample designation. Prior to collection of samples, each container will be labeled with the following information: unique sample designation, project name, analysis requested, and preservation. At the time of sample collection, the date and time of sampling and initials of the person collecting the sample will be added to the label. Pertinent information will be recorded in the field notebook or on the appropriate field form, and all chain-of-custody documents will be completed.

TABLE 3-6

QA/QC SAMPLES

Investigation Area	Media	# Field Samples	# QA/QC Samples				Analysis[a]
			Splits	Duplicates	Equipment Blanks	Trip Blanks	
TNT Areas	Soils	98	10	---	---	---	Explosives, Metals
	Groundwater	12	---	1	1	---	Explosives, Dissolved Metals, Total Metals
West Area Red Water Ponds	Soils	40	4	---	---	---	Explosives, Metals
	Sediments	12	1	---	1	---	Explosives, Metals
	Sediments	1	1	---	---	---	Extractable Organic Carbon
	Surface water	6	1	---	1	---	Filtered Explosives, Unfiltered Explosives, Dissolved Metals, Total Metals, TSS
	Groundwater	3	---	1	---	---	Filtered Explosives, Unfiltered Explosives, Dissolved Metals, Total Metals
Pentolite Road Red Water Ponds	Sediment	4	1	---	---	---	Explosives, Metals
	Soil	54	5	---	1	---	Explosives, Metals
	Groundwater	4	---	---	1	---	Filtered Explosives, Unfiltered Explosives, Dissolved Metals, Total Metals
Sitewide/ Bedrock	Groundwater	9	---	1	2[b]	---	Dissolved Metals, Total Metals, BNAs, Explosives, VOCs
	Groundwater	---	---	---	---	3	VOCs
Background	Soils	14	1	---	1	---	Explosives, Metals, BNAs, VOCs

(a) Metals = Antimony, Arsenic, Beryllium, Cadmium, Chromium, Copper, Lead, Manganese, Mercury, Nickel, Selenium, Silver, Thallium, and Zinc
VOCs = Volatile Organic Compounds
BNAs = Base Neutral/Acid Compounds
TSS = Total Suspended Solids

(b) One of the two equipment blanks listed is a sample of the water that will be used during the bedrock well installation process.

3.6.1 Identification of Soil, Surface Water, and Sediment Samples

The sample identifications for soils, surface water, and sediments will be composed of four parts:

- The first part will be a project identifier "PB."
- The second part will denote the AOC, followed by a dash:

AOC/Location	Sample Location Designation
AOC 1 - TNT Area A	TNTA-
AOC 1 - TNT Area B	TNTB-
AOC 1 - TNT Area C	TNTC-
AOC 2 - West Area Red Water Ponds	WA-
AOC 2 - Pentolite Road Red Water Ponds	PR-
Background	BG-

- The third part will indicate the environmental medium being sampled as follows:

  Surface water = SW
  Soil = S
  Sediment = SED

  along with the sample number for that environmental media (1, 2, 3, etc.).

- The fourth part will indicate sample depth. If the depth is an interval (e.g., for soils and sediments) the top and bottom depths will be indicated separated by a slash.

The following examples are provided.

- The first boring installed at TNT Area A will be designated PB-TNTA-S1. If two samples are collected from this boring they would have the following designations: PB-TNTA-S1-0/1.5 and PB-TNTA-S1-1.5/3.
- The first sediment sample collected at the West Area Red Water Pond will be designated PB-WA-SED1-2/24.

3.6.2 Identification of Groundwater Samples

Monitoring wells installed as part of this HTW Investigation will be numbered in accordance with the numbering scheme which is currently in use at the NASA Plum Brook Station. Monitoring well designations that have been assigned in previous site investigations will not be reused for this investigation.

Groundwater samples collected from monitoring wells installed in the bedrock will be designated by the project identifier, the letters "BED" followed by "MW" and then the number of the well as designated by NASA (e.g., PB-BED-MW14, PB-BED-MW24, etc.).

Groundwater and sieve samples collected from monitoring wells installed in the overburden will be identified by the project identifier, the designation for the AOC near which they are installed, followed by the number of the well as designated by NASA (e.g. PB-TNTA-MK-MW22)

3.6.3 Identification of Trip Blanks

Trip blanks will be identified by the project identifier, the letter "T" followed by the date on which they were sent to the laboratory. For example, PB-T-10/25 would indicate a trip blank submitted to the laboratory on October 25.

3.6.4 Identification of Equipment Blanks

Equipment blanks will be identified by the project identifier, the letter "E" followed by the designation of the sample location sampled with the equipment immediately after the equipment blank is collected. For example: PB-E-WA-SED1 would denote the equipment blank of the first sediment sample collected at the West Area Red Water Ponds.

3.6.5 Identification of QC Samples

QC samples ("splits" of soil and sediment samples or "duplicates" of the groundwater and surface water samples) which will be submitted to the same laboratory as the field samples will be assigned a sample identification consistent with the project sample identification scheme but which does not duplicate an identifier for a field sample.

3.6.6 Identification of QA Samples

QA samples ("splits" of soil and sediment samples or "duplicates" of the groundwater and surface water samples) which will be submitted to the ORD-L will be identified by adding the letter "S" to the end of the sample identification for the QC sample collected at the same location.

4.0 FIELD ACTIVITIES

The field investigation will include collection of soil, surface water, and sediment samples; installation of groundwater monitoring wells and collection of groundwater samples; and chemical analyses of the samples. The following sections describe the general sampling procedures for these field investigations. Installation of the monitoring wells is detailed in Part II of the Work Plan entitled, "Monitoring Well Installation Plan" (Dames & Moore, 1994).

4.1 PRELIMINARY ACTIVITIES

QC is an important aspect of environmental sampling activities, and proper preparation is a key to proper QC. Thus, a number of preliminary activities will be completed before the field personnel mobilize. The following eight steps will be accomplished prior to commencement of field activities to ensure that the sampling is carried out correctly and safely.

1. The Project Manager will notify the laboratory of the upcoming sampling event so that the laboratory can prepare the appropriate type and number of sample containers. The anticipated number of sampling sites, the list of parameters to be analyzed for at each site, the replicate requirements, and the number of extra bottles needed for QC testing will be specified to the Laboratory Project Manager.

2. Digging and Excavation Permit forms included in Appendix B will be completed and provided to NASA site management for approval.

3. Equipment and supplies to be used during the field work will be assembled. All equipment to be used during the sampling events will be inspected.

4. Field equipment and supplies and sample containers will be shipped to the PBOW site. NASA will provide a building (gray barn) near Campbell Road and an igloo for storage of equipment, field staging, and sample packaging during the field activities.

5. Field meters to be used during sampling (i.e., the specific conductance meters, explosimeters and organic vapor analyzers [OVA] or HNu) will be checked to ensure proper calibration and precision response. Buffer solutions and standard potassium chloride solutions will be laboratory-checked or purchased from a manufacturer to ensure their accuracy.

6. All forms to be used in the field (including the field log book, chain-of-custody sheets, sample analyses request forms, boring log forms, monitor well installation forms, and A-E Daily QC Report forms) will be assembled.

7. If appropriate, bottles will be "pre-labeled" during the preliminary phase of the sampling event. Certain information (e.g., project name, requested analysis, preservative, and type of parameters) will be affixed to the label with permanent ink during the pre-field activities. Other information (e.g., sample designation, sample time and date, sampler's name, etc.) will be added to the label once the sample has been collected. A cross-reference to the information contained on the label will be documented in the field notebook to correspond with the well number or sample location.

8. The Project Manager and Site Supervisors will review proper sampling protocols and QC requirements with the sampling personnel. In addition, proper health and safety protocols will be reviewed in accordance with the SSHP.

4.2 DOCUMENTATION

Several field forms will be used during the sampling and well construction activities. Field notebooks will be used during the field work to document daily activities, including decontamination of equipment, set-up, sampling, sample packaging and shipment, and health and safety issues. Mistakes on the forms and notebooks will be crossed out and initialed. Copies of the forms will be provided to the CEORN at the completion of the field work.

4.2.1 Soil Sampling

The HTRW Drilling Log (Figure 4-1) will be used to document soil and sampling conditions at each soil sampling and monitoring well location. Borings installed by drill rig will be logged by a qualified geologist or engineer and will include information outlined in Chapter 5 of the COE document EM-1110-7-XX (FR) (draft).

HTRW DRILLING LOG

1. COMPANY NAME	2. DRILLING SUBCONTRACTOR	HOLE NUMBER SHEET OF SHEETS
3. PROJECT	4. LOCATION	
5. NAME OF DRILLER	6. MANUFACTURER'S DESIGNATION OF DRILL	
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	8. HOLE LOCATION	
	9. SURFACE ELEVATION	
	10. DATE STARTED	11. DATE COMPLETED
12. OVERBURDEN THICKNESS	15. DEPTH GROUNDWATER ENCOUNTERED	
13. DEPTH DRILLED INTO ROCK	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR

LOCATION SKETCH/COMMENTS SCALE:

PROJECT	HOLE NO.

Figure 4-1
HTRW DRILLING LOG
Plum Brook Ordnance Works

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HTRW DRILLING LOG

HOLE NUMBER	
PROJECT	INSPECTOR
SHEET	OF SHEETS

ELEV. (3)	DEPTH (1)	DESCRIPTION OF MATERIALS (2)	FIELD SCREENING RESULTS (7)	GEOTECH SAMPLE OR CORE BOX NO. (8)	ANALYTICAL SAMPLE NO. (9)	REMARKS (10)

PROJECT

HOLE NO.

Figure 4-1 (cont'd)

4.2.2 Sediment Sampling

The HTRW Drilling Log (Figure 4-1) will be used to document sediment characteristics and depths.

4.2.3 Surface Water Sampling

A Surface Water Sampling Form (Figure 4-2) will be completed at each sampling location.

4.2.4 Monitoring Well Construction

A Monitoring Well Construction Diagram similar to that shown as Figure 4-3 will be completed for each of the newly installed overburden and bedrock monitoring wells.

4.2.5 Well Development Record

A Well Development Record (Figure 4-4) will be completed for each of the newly installed overburden and bedrock monitoring wells.

4.2.6 Groundwater Sampling

A Groundwater Sampling Form (Figure 4-5) will be used during purging and sampling of each of the wells to be sampled.

FIELD SHEET

SURFACE WATER SAMPLING

PROJECT: Plum Brook Ordnance Works HTW Investigation

Date: _____ Weather: _____

Field Team: _____ _____

_____ PPE: _____

_____ _____

Sample ID	Time	Water Depth	Temp.	pH	Spec. Conduct.	Comments

Figure 4-2
Surface Water Sampling Form

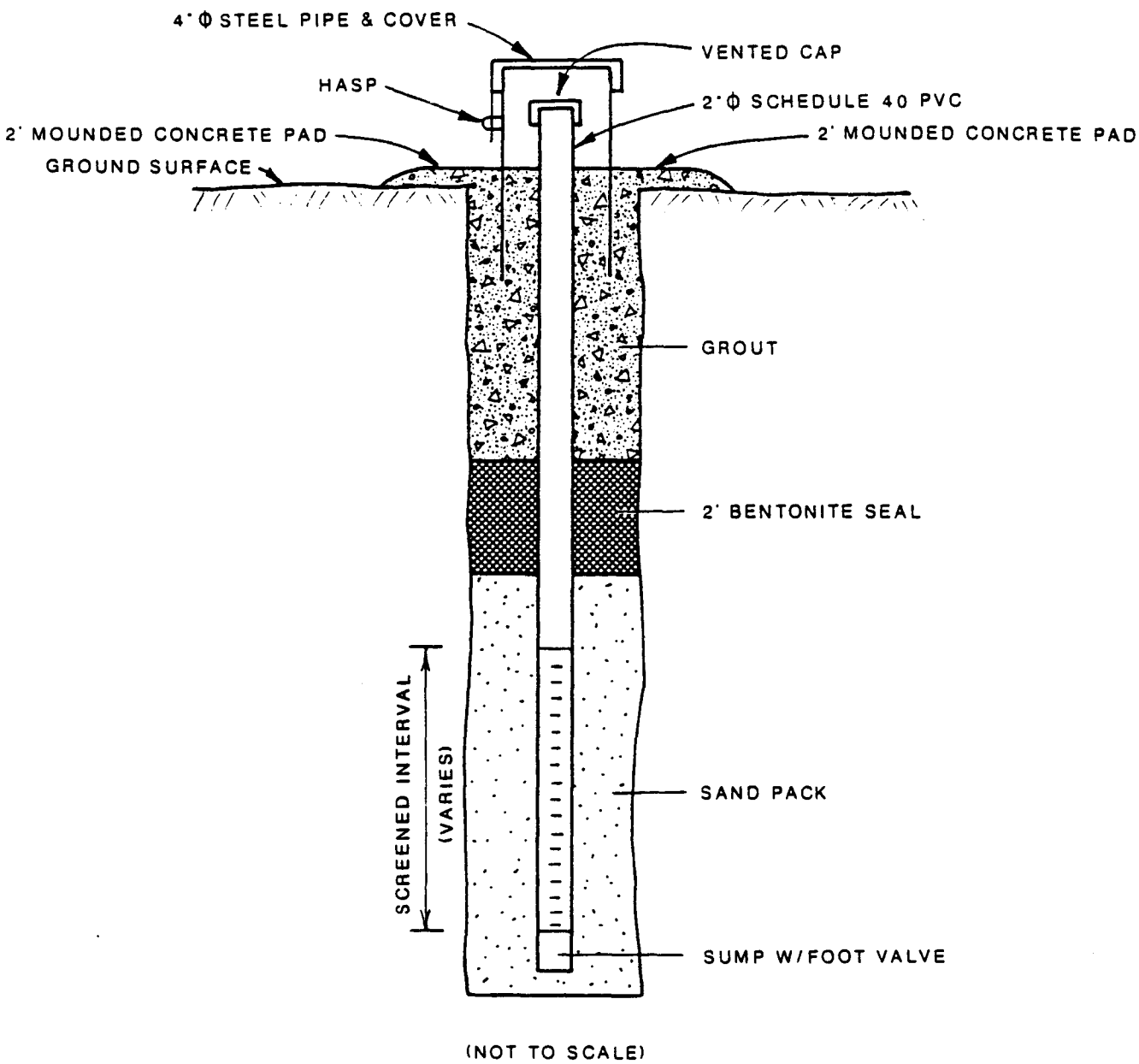

Figure 4-3

TYPICAL MONITORING WELL INSTALLATION

Plum Brook Ordnance Works

WELL DEVELOPMENT RECORD

1. Project Name: _____

   Location: _____

2. Well Designation: _____

   Location: _____

3. Well Installation:
   Date(s) and Time(s): _____

4. Well Development:
   Date(s) and Time(s): _____

5. Elevation of top of casing (if available) _____ft msl

6. Depth from top of well casing to bottom of well: _____ ft

7. Static Water Level

   Before Development: _____ ft below top of casing
   24 Hours After Development: _____ ft below top of casing

8. Quantity of Water
   Added During Filter Placement: _____ gallons
   Added during drilling: _____ gallons

9. Quantity of Fluid in Well
   Prior to Development:

   a. Standing in Well: _____ gallons
      (_____ ft x.17 gal)
   b. Contained in Annulus
      (assuming 30% porosity): _____ gallons

10. Total amount of water to be purged from well: Add amounts from 6 and 7 and multiply by 5 (_____ gals x 5 = _____ gals to be purged).

11. Field Measurements of pH, Conductivity, and Temperature:

    a. Before Development:

       pH: _____ conductivity:_____ temperature:_____°C/°F

Figure 4-4
WELL DEVELOPMENT RECORD
Plum Brook Ordnance Works

DAMES & MOORE

b. During Development:

pH: _____ conductivity: _____ temperature: _____ °C/°F

pH: _____ conductivity: _____ temperature: _____ °C/°F

c. After Development:

pH: _____ conductivity: _____ temperature: _____ °C/°F

12. Screen length: _____ ft

13. Depth from top of well casing to top of sediment inside well

    a. Before development: _____ ft

    b. After development: _____ ft

14. Physical character of removed water

    a. Clarity _____

    b. Color _____

    c. Particulates _____

    d. Odor _____

15. Type and size/capacity of pump and/or bailor used:_____

16. Depth of well casing below ground surface (since flush-mount):_____ft

17. Typical pumping rate (if applicable): _____gpm

18. Estimated recharge rate: _____gpm

19. Quantity of water removed: _____ gal.

20. Quantity of sediment removed: _____ gal.

Figure 4-4 (cont'd)

GROUND-WATER SAMPLING RECORD

CLIENT: JOB NO:

LOCATION: SAMPLED BY:

SWMU NO. & NAME: _____

DATE: _____ TIME: _____

WELL TYPE: Monitoring ☐ Potable ☐ Supply ☐

Other ☐ _____

WELL NO.: _____ WELL SIZE (I.D., inches) _____

TOP OF CASING (TOC) ELEVATION (ft., msl): _____

DEPTH TO STATIC WATER LEVEL (ft. below TOC): _____

STATIC WATER LEVEL ELEVATION (ft., msl): _____

DEPTH TO BOTTOM OF WELL (ft. below TOC): _____

SCREENED INTERVAL (ft. below TOC): _____

VOLUME OF WATER TO BE EVACUATED (gallons)*: _____

EVACUATION METHOD: Submersible Pump ☐ Centrifugal Pump ☐

Positive Displacement Pump ☐ Bailer ☐

Other _____

SAMPLING METHOD: Submersible Pump ☐ Positive Displ. Pump ☐

Stainless Steel Bailer ☐

Other _____

SAMPLE NO.: _____ SAMPLE DEPTH (ft. below TOC): _____

SAMPLE TREATMENT: Field Filtered ☐ Preservative Added ☐

SAMPLE APPEARANCE, ODOR, ETC.: _____

FIELD TESTS:

SAMPLE TEMP. (°C): _____ pH: _____

CONDUCTIVITY (µmhos/cm): _____ PID (ppm) _____

LABORATORY ANALYSES: _____

NO. OF CONTAINERS AND I.D. _____

FIELD BLANK I.D.NO.: _____ TRIP BLANK I.D. NO. _____

DUPLICATE SAMPLE I.D. NO.: _____

COMMENTS: _____

*2-inch casing has 0.16 gallons/ft.
4-inch casing has 0.65 gallons/ft.
6-inch casing has 1.47 gallons/ft.

Figure 4-5
GROUNDWATER SAMPLING RECORD
Plum Brook Ordnance Works

4.3 SAMPLE CONTAINERS AND PRESERVATION

The types of containers and preservatives to be used to collect soil, sediment, surface water, and groundwater samples at the site are listed in Tables 4-1 and 4-2. In addition, the preservation requirements and the maximum holding times for the extraction and/or analysis are listed for each matrix and category of parameters.

ASI will provide sample bottles containing the required preservatives, if any. Some sample bottles will not contain preservative. All samples will be preserved by placing them in a cooler with ice immediately after sample collection.

The efficacy of the preservation will be checked at the laboratories upon sample receipt for all preserved samples, with the exception of VOCs. Necessary adjustments will be made and recorded in a laboratory notebook. The pH of the VOC samples will be checked upon analysis.

4.4 FIELD EQUIPMENT CALIBRATION

During the sampling activities, the following equipment will require calibration: specific conductance meter, explosimeters, and OVAs/HNus.

The specific conductance meter will be checked once daily during the previously mentioned activities with a commercially available reference solution. Conductance measurements will be made at the same time as temperature measurements to allow for temperature correction of the specific conductance readings. Operating instructions for the YSI Model 33 S-C-T meter are included in Appendix C.

The explosimeter will be calibrated at the beginning of each field day and as required by field and instrument conditions. The manufacturer's calibration procedures specific to the instruments used during the field work will be followed and will be kept with the field instruments while in the field.

TABLE 4-1

SOIL AND SEDIMENT SAMPLE
CONTAINERS, PRESERVATION, AND HOLDING TIMES
PLUM BROOK ORDNANCE WORKS
SANDUSKY, OHIO

Parameter	EPA Method	Container [1]	Preservation	Maximum Holding Times	
				Extraction	Analysis
Explosives Residues	8330 modified	(1) 120-mL WM Glass	Cool to 4°C	14 days	40 days
Total Metals[2]	6010A	(1) 250-mL WM HDPE	None	not required	180 days
Arsenic	7060			not required	180 days
Lead	7421			not required	180 days
Mercury	7471			not required	28 days
Selenium	7740			not required	180 days
Thallium	7841			not required	180 days
Volatile Organics	8240	(2) 120-mL WM Glass	Cool to 4°C	not required	14 days
Semivolatile Organics (BNAs)	8270	(1) 250-mL WM Glass	Cool to 4°C	14 days	40 days
Extractable Organic Carbon	9060	(4) 250-mL WM Glass	Cool to 4°C	not required	28 days
Extractable Sulfate	9038	(1) 120-mL WM glass	Cool to 4°C	not required	28 days
pH	9045			not required	28 days
Extractable alkalinity	310.1 modified			not required	28 days
Extractable nitrate	353.2 or 353.3			not required	28 days
Total Kjeldahl nitrogen	351 modified			not required	28 days
Extractable phosphorous	365 modified			not required	28 days
Cation exchange capacity	9081			not required	28 days
Moisture content	ASTM D2216		None	not required	28 days
Potassium	3050/6010	(1) 250-mL WM HDPE	Cool to 4°C	not required	180 days

1) Number in parenthesis indicates the number of sample containers required per sample.
WM = Wide mouth
HDPE = High density polyethylene
2) Includes Antimony, Beryllium, Cadmium, Chromium, Copper, Manganese, Nickel, Silver, and Zinc.

TABLE 4-2

SURFACE WATER AND GROUNDWATER SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIMES PLUM BROOK ORDNANCE WORKS SANDUSKY, OHIO

Parameter	EPA Method	Container[1]	Preservation	Maximum Holding Times	
				Extraction	Analysis
Explosives Residues	8330 Modified	(2) 1-L amber glass	Cool to 4°C	7 days	40 days
Volatile Organics	8240	(3) 40-mL glass vial	Cool to 4°C HCL to pH<2	not required	14 days
Semivolatile Organics	8270	(2) 1-L amber glass	Cool to 4°C	7 days	40 days
Total Metals[2]	6010A	(1) 1-L HDPE	Cool to 4°C HNO_3 to pH <2	not required	180 days
Arsenic	7060			not required	180 days
Lead	7421			not required	28 days
Mercury	7470			not required	180 days
Selenium	7740			not required	180 days
Thallium	7841			not required	180 days
Total Suspended Solids	160.2	(1) 1-L plastic squat	Cool to 4°C	not required	7 days

1 Number in parenthesis indicates the number of sample containers required per sample.
WM = wide mouth
HPDE = high density polyethylene

2 Includes Antimony, Beryllium, Cadmium, Chromium, Copper, Manganese, Nickel, Silver, and Zinc

The OVA (or HNu) will be calibrated at the beginning of each field day and prior to beginning field work at a new site. Calibration procedures for both instruments are provided in Appendix C.

4.5 DECONTAMINATION PROCEDURES

4.5.1 Decontamination Area and Storage of Wastewater

NASA personnel have approved usage of the Maintenance Area at the PBOW for set-up and operation of a decontamination area, as shown on Figure 4-6. A source of potable water for decontamination will be available at the Maintenance Area. Telephones and restroom facilities will also be available in the vicinity.

The decontamination area will consist of plastic sheeting spread between and overlapping hay bales placed in a "U" shape. Wastewater will be contained within the "decon" area and periodically pumped to 55-gallon labeled steel drums. The drums will be placed on wooden pallets and temporarily stored at the site until the field activities have been completed. The drums subsequently will be moved to and stored at a parking area located north of Pentolite Road, as shown on Figure 4-6.

Decontamination of all drilling equipment will occur in the designated decontamination area. During the sediment and surface water sampling, decontamination of equipment will either occur in the decon area or on the boat. Decontamination rinses will be temporarily stored in 5-gallon buckets with lids when performing sediment and surface water sampling. The contents of the buckets will be emptied into the appropriate 55-gallon drums stored at the drum staging/storage area.

4.5.2 Sampling Equipment

Decontamination of sampling equipment will be conducted prior to each use. The following decontamination procedures will apply to hand augers, sediment and surface water samplers, bailers, and stainless steel bowls, trowels, and spoons:

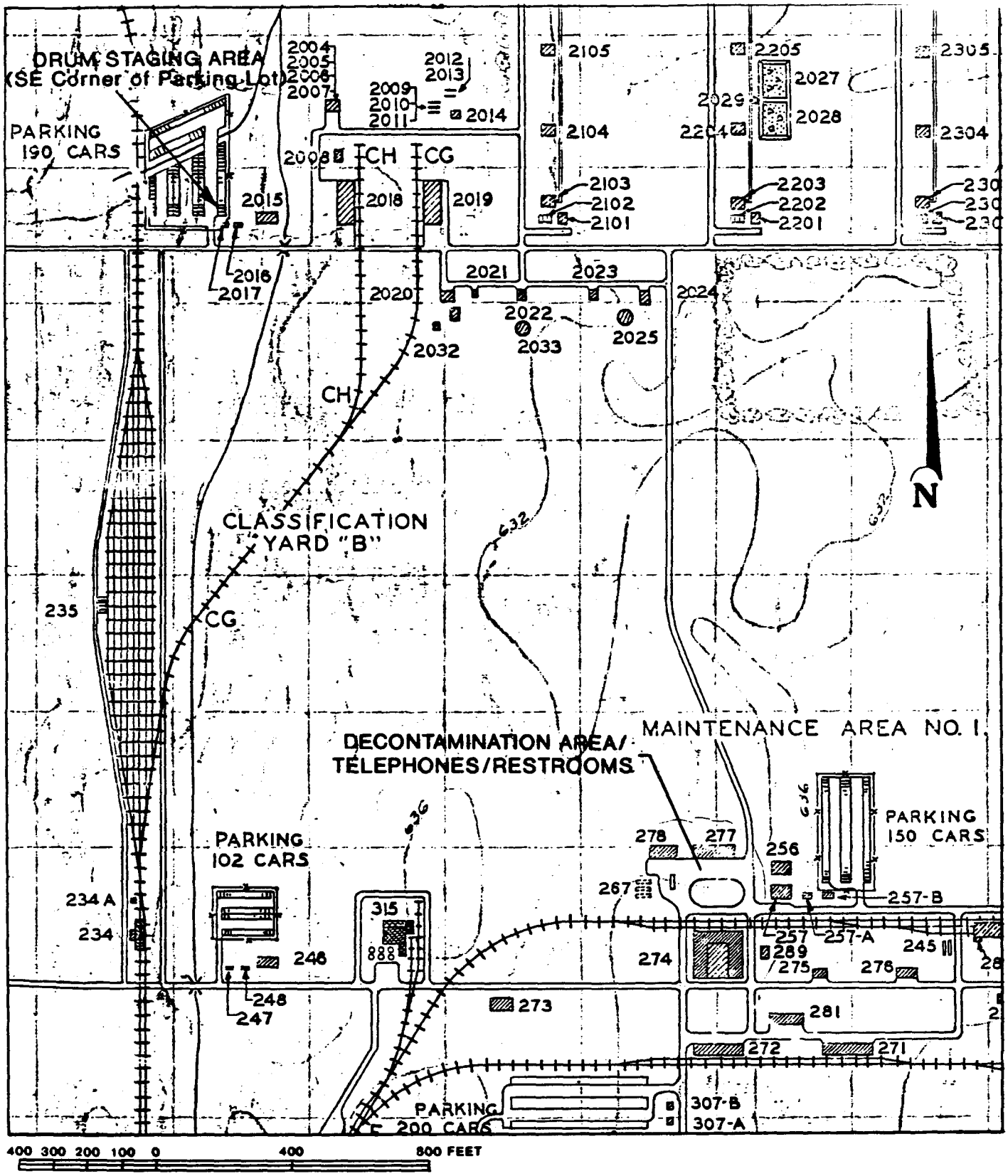

Figure 4-6

DECON AREA AND DRUM STORAGE AREA
Plum Brook Ordnance Works

1) Hand wash with a bristle brush and a solution of Liquinox (or equivalent);

2) Rinse with potable water;

3) Spray-rinse with isopropyl alcohol;

4) Spray-rinse with hexane;

5) Spray-rinse with isopropyl alcohol;

6) Final rinse with distilled water;

7) Air dry; and

8) Wrap in aluminum foil until use.

4.5.3 Drilling Equipment

As stated in the COE's guidance document EM 1110-7-XX(FR)(draft), all drilling equipment will be decontaminated prior to commencement of field activities. The drilling equipment includes rigs, support vehicles, water tanks (inside and out), augers, drill casings, rods, samplers, tools, recirculation tanks, etc.

After arrival at the PBOW site, but prior to commencement of field work, the drill rods, augers, and sampling equipment will be cleaned with steam or pressurized water. A similar cleaning of the drilling and sampling equipment will also occur between each boring/well location. After the initial cleaning, only the equipment used or soiled at a particular boring or well will need to be recleaned between sites.

Prior to use, all casings, augers, recirculation and water tanks, etc., will be devoid both inside and out of any asphaltic, bituminous, or other encrusting or coating materials, grease, grout, soil, etc. Paint, applied by the equipment manufacturer, will not be removed from drilling equipment. All equipment will be decontaminated before it is removed from the project area.

4.5.4 Water Level Indicator

A water level indicator will be used during the well installation and groundwater sampling tasks. The probe of the instrument will be cleaned with new disposable wipes and then rinsed with distilled water.

4.6 STORAGE OF INVESTIGATION - DERIVED WASTE

All soil cuttings and decontamination, purge, and development water will be collected and containerized. 55-gallon drums will be used for storage of wastewater and drill cuttings from installation of the monitoring wells. Smaller containers may be used for soil cuttings from the shallow soil sampling activities. Wastes from each well will be containerized separately and labeled with the well identification. Soil cuttings from borings in each investigation area will be placed together in either 55-gallon drums or smaller containers and labelled with the AOC/site designation.

As previously mentioned, all containers of investigation-derived waste will be stored at the parking area located north of Pentolite Road (See Figure 4-6). NASA has approved storage of the drums and containers in this area for up to 90 days. The drums will be sealed, labeled, covered with a tarp, and secured with a chain and padlock.

4.7 COLLECTION OF FIELD QA/QC SAMPLES

Proper sampling protocols will be used to ensure that samples are representative of the location being sampled, cross-contamination is not occurring, and that the samples are properly preserved and shipped to maintain sample integrity. Standard procedures will include using decontaminated sampling equipment for each sample; wearing a new pair of disposable latex gloves for each sample and during the decontamination process; placing the samples on ice in an ice chest immediately after sample collection; and following strict chain-of-custody procedures and packaging guidelines described in

Section 5.0 of this SAP. Table 3-2, 3-3, and 3-4 list all field and QA/QC samples to be collected at the site.

The QC samples (sent to the contractor laboratory, ASI) and QA samples (sent to ORD-L) will consist of field splits, field duplicates, equipment blanks, and trip blanks.

4.7.1 Split and Duplicate Samples

The soil, sediment, and surface water duplicates and splits will be samples taken from the same sampling location as the primary field sample. The replicates for soil and sediments will be collected by obtaining enough sample volume to fill three sets of sample containers and (except for soil samples to be analyzed for VOCs) mixing the media using stainless steel spoons, trowels, and bowls until the media are thoroughly homogenized. The sample will then be divided into three portions and three sets of sample containers will be filled. Two samples will be splits for analysis by the contractor laboratory; one will be a split sample for the QA laboratory (ORD-L). The replicate water samples will be collected by assembling all three sets of sample containers and then alternately filling the containers with the sample until all containers are filled. The groundwater sample bottles for VOC analysis will be filled completely before another VOC sample bottle is filled.

One field split (for sediment and soil samples) or field duplicate (for water samples) will be taken for every ten field samples.

4.7.2 Equipment Blanks

Equipment blanks will be collected by pouring laboratory-supplied reagent water over the decontaminated sampling equipment and directly into the sample containers.

4.7.3 Trip Blanks

Trip blanks for water samples will consist of analyte-free Type II water in 40 ml vials (analyzed for volatiles only). All trip blanks will be prepared by ASI in the same type of container as the field samples and will travel to and from the sampling site with the VOC sample containers.

4.8 SURFACE SOIL SAMPLING

4.8.1 List of Equipment

- Latex gloves
- Stainless steel trowels or spoons
- Stainless steel mixing bowls
- Plastic sheeting
- Sample bottles/indelible marker
- Ice chests
- Tape measure
- Wooden stakes/flagging
- Containers for waste soils, decontamination materials, and disposable supplies.

4.8.2 Procedures

1. Spread a clean piece of plastic sheeting on the ground; place the sample bottle(s) and mixing apparatus on the sheeting.

2. Remove any surface vegetation.

3. Using a stainless steel trowel or spoon, remove the soil to the desired depth (to be selected during the field work based upon site conditions will be a maximum depth of 0.5 feet). Place the soil in a stainless steel mixing bowl and composite it.

4. Return any unused soil to the sampling location.

5. Place a labeled wooden stake with flagging at the sample location.

4.9 HAND-AUGERED SOIL SAMPLES

4.9.1 List of Equipment

- Latex gloves
- Plastic sheeting
- Stainless steel hand auger
- Stainless steel bowl
- Stainless steel spoons or trowels
- Tape measure
- Sample bottles/indelible markers
- Ice chest
- Wooden stakes/flagging
- Containers for waste soils, decontamination materials, and disposable supplies.

4.9.2 Procedures

1. Spread two clean pieces of plastic sheeting on the ground; place the sample bottle(s) and mixing apparatus on one piece of plastic. The other piece of plastic will be used to collect the unused soil cuttings.

2. Remove any surface vegetation.

3. Insert the hand auger vertically into the soil; advance the auger approximately 6 inches and retrieve the soil collected in the auger.

4. Using a trowel or spoon, remove the soil from the auger and place a portion of the soil into a stainless steel mixing bowl. The remainder of the soil will be placed on the plastic sheeting.

5. Repeat steps 3 and 4, above until the hole has been advanced to the proper sample interval depth. For samples collected for VOC analysis, the sample material will be retrieved directly from the auger bucket and quickly placed directly into the appropriate sample container.

6. Mix the soils in the bowl. Place the soils into the laboratory prepared bottles, and label as necessary.

7. For subsequent sampling intervals, repeat the steps above until the hole has been advanced to the proper depth.

8. Grout the borehole to the surface with cement grout.

9. Place a labeled wooden stake with flagging at the sample location.

10. Transfer the unused soil cuttings to an appropriately labeled waste container in the drum staging/storage area.

4.10 SURFACE WATER SAMPLING

4.10.1 List of Equipment

- Latex gloves
- Plastic water pitchers
- Kemmerer water sampler with line or other suitable sampling device such as clear PVC Van Dorn water sampler
- Sample bottles/indelible markers
- Ice chests
- YSI S-C-T meter
- pH paper
- Sampler decontamination supplies
- 0.45-micron filters
- Tygon tubing
- Peristaltic pump
- Sample holding container

- Containers for decontamination materials and disposable supplies.

4.10.2 Procedures - Surface Water

Surface water samples will be collected at three of the sediment sampling locations in the West Area Red Water Ponds. At each location, two samples will be collected, one near the surface and one near the bottom. The surface water samples will be collected before the sediment sample is collected at each location. Surface and potentially subsurface water samples will be collected depending on the depth of the water in the pond at the time of sampling. A total of 12 samples will be collected at six locations and/or depths. The exact locations and/or depths will be selected during the field work in concurrence with the on-site CEORN field representative. The depth of the water at each sampling location will be measured in coordination with sample collection.

4.10.2.1 Water Quality/Physical Characteristic Measurements

pH measurements will be made in the field using pH paper. A sample of water will be obtained from the sample location and placed in a disposable cup. A piece of pH paper will be held in the water for at least 10 seconds. The pH paper will be compared to the color chart provided by the manufacturer, and the pH will be estimated.

Specific conductance and temperature will be measured using an YSI Model 33 S-C-T meter. The Instruction Manual for the S-C-T meter is included in Appendix C.

4.10.2.2 Sampling Procedure

1. Each sampling location will be noted and recorded. The depth of water at the location will also be noted.

2. Pre-label the appropriate sample bottles to the extent possible prior to sample collection. Information will be written on each label in indelible ink,

including sampling location, date, time collected, and collectors' names/initials.

3. Grab surface water samples will be collected from the surface of the ponds by using a plastic water pitcher which has been decontaminated per the procedure outlined in Section 4.5.2.

4. Subsurface water samples will be collected with a Kemmerer or Van Dorn water sampler.

5. The water samples will be poured directly from the sampling device into each sample container. Grab samples will be collected at the same location until all the sample bottles have been filled.

6. After sample collection, the in situ physical water measurements will be taken (see Section 4.10.2.1).

4.10.2.3 Field Filtering Surface Water Samples

1. Use a new 0.45 micron filter, tygon tubing, and sample holding container (preservative free) for each sample. Cut two 2-foot long sections of tygon tubing.

2. Connect both sections of the tygon tubing to the field filter. Place one section of the tygon tubing in the peristaltic pump such that water is pulled through the filter. The filter has an arrow showing the prescribed direction of flow.

3. Transfer the water from the sampling device into the holding container and place the tygon tubing in the holding container.

4. Turn on the peristaltic pump and fill the sample bottles according to laboratory protocol.

4.11 SEDIMENT SAMPLING

4.11.1 List of Equipment

- Latex gloves
- Life preservers
- Waders

- Boat with two anchors and line
- PVC tube sediment sampler
- Shelby tube corer and tubes (back-up)
- Split-spoon sampler (back-up)
- Dames & Moore Type U soil sampler (back-up)
- Sample extruder
- Sample holding tray
- Aluminum foil
- Stainless steel mixing bowls
- Stainless steel spoons
- Disposable spoons and knives
- Plastic sheeting
- Sample containers/indelible markers
- Ice chests
- Sounding line
- Measuring tapes
- Rope
- Miscellaneous hardware (O-rings, couplings, carabiniers, etc.)
- Sampler decontamination supplies
- Camera/film
- 1 ½- to 2-inch diameter standard and slotted PVC piping
- 4-inch diameter PVC piping
- 1 ½-inch diameter threaded steel piping
- Peristaltic pump and tygon tubing
- 40-lb hammer device

- Container for waste sediments, decontamination materials, and disposable supplies.

4.11.2 Description of Samplers

PVC Tube Sediment Sampler - The use of a PVC tube sediment sampler is planned as the primary sampling device for collection of the sediment cores. The PVC tube sediment sampler consists of a 5-foot section of 1 to 2-inch diameter threaded PVC pipe. Threaded PVC extension piping will be connected to the sampler when necessary. The threaded PVC tube sediment sampler can be capped to prevent loss of the sample because of water pressure derived from the extension piping. Alternately, if significant extension piping (greater than 5 feet) is required, the water column overlying the sampled sediment can be removed using a peristaltic pump and tygon (or equivalent) tubing prior to capping the sampler.

Use of the PVC tube sediment sampler is a generally effective method of obtaining samples of relatively soft sediment samples. This sampler will be advanced through the sediments and underlying natural soils using manual pressure. After the sampler has been removed from the sediments, the sample will be extruded onto clear plastic sheeting.

If sampling with the PVC tube sediment sampler is unsuccessful, sampling of the sediment will be attempted with a Shelby tube, split-spoon, or Dames & Moore Type U sampling device.

Shelby Tube Sampler - The Shelby tube underwater sampler is constructed of stainless steel and is attached to a sampler head that includes a water check valve to prevent loss of the sample because of water pressure derived from the extension piping. The Shelby tube is 3 inches in diameter. The sampler head will be attached to either slotted or threaded PVC piping 1 ½ to 2 inches in diameter, or to threaded steel piping.

The use of the PVC piping is preferred because of its light weight and ease of handling. The slotted piping will permit the water column inside of the pipe to drain

as the sampler is removed from the bottom. PVC piping will be used if the sediment will permit hand pushing of the sampler into the sediment to the required depth.

Threaded steel piping approximately 1 ½ inches in diameter will be used if difficulty is encountered penetrating the bottom sediment with the sampler. A portable 40-pound hammer device can be adapted to the top of the steel extension piping, and the sampler hammered into the sediment. The most likely sediment conditions requiring the use of a hammer will be very dense sand, gravel, or very stiff/hard clay.

If sampling with the Shelby or PVC tube sampler tube is unsuccessful, sampling of the sediment will be attempted with a split-spoon sampler or a Dames & Moore Type U sampler.

Split-Spoon Sampler - The split spoon sampler is a simple 2 inch diameter split-spoon that can be used very effectively in some types of sediment. The sampler includes a ball valve to effectively prevent loss of the sample because of water pressure in the extension piping. Additionally, a bottom catcher can be attached to the sampler, if the sediment characteristics permit. The split-spoon sampler will use the same type of extension piping as that described for the Shelby tube sampler. The sampling procedures will also be the same, except that the sample will not have to be extruded because of the split barrel design.

Dames & Moore Type U Sampler - A Dames & Moore Type U underwater sampler is a steel split barrel sampler with an inside diameter of 2.42 inches. This sampler is more effective in retaining samples in difficult sampling conditions, but is heavy and may have to be driven by a hammer device. A detailed drawing of the Dames & Moore Type U sampler is provided as Figure 4-7. A leaf-type catcher is used in the sample bit that is very effective with both hard and soft sample materials, and with both sand and silt/clay soils or sediments. The sampler containing rings shown in the drawing will not be used for this project since they are not required (typically used for geotechnical laboratory testing). The large water check valves effectively prevent loss of the sample because of water pressure in the extension piping. The Dames & Moore sampler was specifically designed for the sampling of a wide variety of materials at underwater locations.

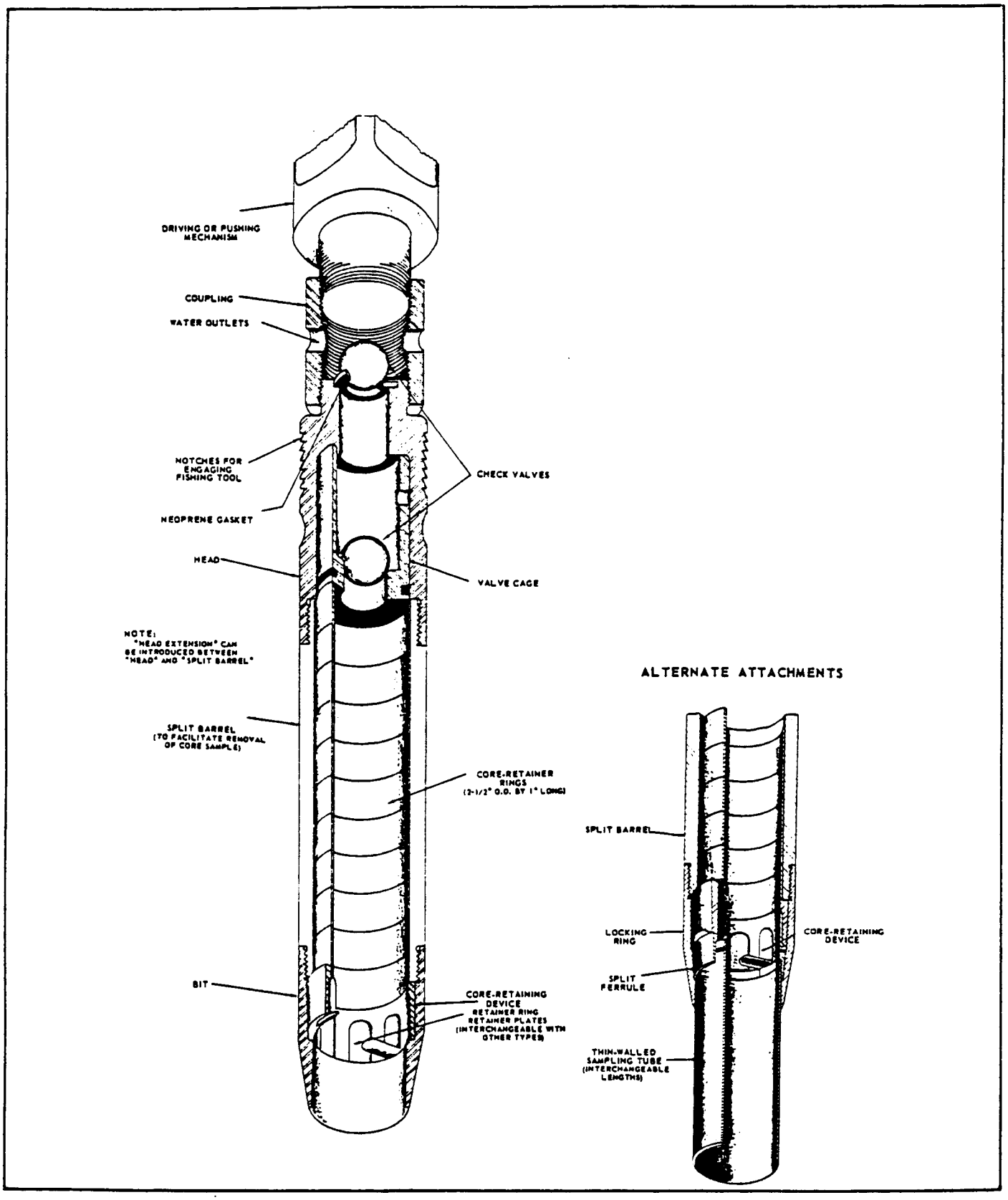

Figure 4-7

DAMES & MOORE TYPE U SAMPLER
Plum Brook Ordnance Works

DAMES & MOORE

The Dames & Moore sampler will use the same type of extension piping as that described for the Shelby tube sampler. The sampling procedures will also be the same, except that the sample will not have to be extruded because of the split barrel design.

4.11.3 Procedures - Sediment Sampling

Sediment sample locations may be reached by boat (for locations where the water is deeper than 2 feet) or by wading (for locations where the water is less than 2 feet deep).

Sediment Sampling Procedures - Boat

1. Anchor the boat at the sampling location using both bow and stern anchors to maintain a reasonably stable sampling platform.

2. Lower the sampler and extension piping until the bottom sediment is contacted. Push or hammer the sampler through the sediment until the underlying natural soils are encountered. Advance sampler approximately 6 additional inches. Carefully mark the initial sediment bottom contact position, the indicated sediment bottom location, and the final penetration position on the extension pipe adjacent to the boat, to provide documentation of the depth of various portions of the core recovered.

3. Carefully extract the sampler with the recovered core and return it to the boat. Maintain the sampler in a vertical position until the sample is ready to be removed. The sample will be removed either on the boat or on shore, depending upon the site conditions encountered.

4. Extrude the sample from the sampler from the top down, and place it in a sample tray covered with a sheet of aluminum foil.

5. Characterize the sediment and record observations on the HTRW Drilling Log.

6. When sufficient sediment and soil quantities have been obtained, photograph the core. Measure the length of the sediment and soil cores. Divide the core between the sediment and the underlying soil.

7. Remove and discard excess water, sticks, rocks, and other debris. Discard sample material touching the sampler and the top and bottom portions of the sample which may not be representative of the undisturbed sample. Thoroughly homogenize the remaining sample material in a bowl using a

stainless steel spoon or trowel and place the material in appropriately labeled sample containers. Mix the soil in the second bowl and place those materials in the appropriately labeled sample bottles.

8. Decontaminate the sediment sampler in accordance with procedures described in Section 4.5.2. The decontamination procedures will be completed prior to relocating to the next sampling location.

Sampling procedures using the Shelby tube, split-spoon, and Dames & Moore Type U samplers are similar to the above procedures, except for details included in the description of the sampler.

Sediment Sampling Procedures - Wading

Delete Step 1, above. Follow procedures 2 through 8.

4.12 BIOLOGICAL ACTIVITY SAMPLE COLLECTION

Soil, sediment, and surface water will be collected for microbiological enumeration. Procedures for collection of the samples are provided in Appendix A.

4.13 HOLLOW-STEM AUGERING AND SPLIT SPOON SAMPLING

Hollow-stem augering and split spoon sampling will be conducted continuously for the 10-foot borings and the shallow monitoring wells.

4.13.1 List of Equipment

- Plastic sheeting
- Latex gloves
- Stainless steel trowel or spoon

- Stainless steel split spoon samplers
- Tape measure
- Aluminum foil
- Sample bottles/indelible markers
- Ice chest
- Containers for waste soils, decontamination materials, and disposable supplies.

4.13.2 Procedures - Hollow-Stem Augering and Split Spoon Sampling

1. Measure, mark, and advance the hollow-stem augers in 2-foot increments.
2. Measure and record the length of the spoon and drill rods to ensure correct depths when sampling.
3. Lower the spoon into the borehole and mark the drill rod at 6-inch increments.
4. Record the number of blows per 6 inches of penetration.
5. Retrieve the split spoon and open in the clean area selected for sample preparation.
6. Record the length of the recovered sample and the interval of depths sampled.
7. Discard the soil at the very ends of the sampler. Also discard any soil in contact with the spoon.
8. Extract and bottle the soil in laboratory jar(s) as quickly as possible with a minimum of headspace.
9. Classify the sample according to the Unified Soil Classification System, and provide a detailed description of the soil sample on the HTRW Boring Log Form.
10. Repeat steps 1 through 10 until borehole is terminated. Backfill the borehole with grout to the ground surface.

Procedures - Collection of Sieve Samples During Installation of Monitoring Wells

1. Obtain a portion of soil from each split spoon sampler. Place in a plastic ziploc baggie.

2. Select the depth interval for the well screen.

3. Place soils obtained from the screened interval in a clean mason jar.

4.14 GROUNDWATER SAMPLING

4.14.1 List of Equipment

- Electronic water level indicator
- Latex gloves
- Plastic sheeting
- Disposable bailers
- Conductivity and temperature meters
- pH paper
- 55-gallon drums for purge water
- Disposable cups
- Nylon rope
- Electric-powered submersible pump
- Gasoline-powered generator
- Waterra power pump
- ½- to ¾-inch outside diameter PVC riser
- Foot valves
- Sample containers/indelible markers
- Ice chests

- 0.45 micron filters
- Tygon tubing
- Peristaltic pump
- Sample holding container
- Containers for waste water, decontamination materials, and disposable supplies.

4.14.2 Procedures - Groundwater Sampling

4.14.2.1 Preparation

1. Place a sheet of plastic on the ground of adequate size to hold the bailer and a length of new nylon rope sufficient to extend the total depth of the well.
2. Locate and place empty 55-gallon drums adjacent to the well to contain the purge water.
3. Assemble all necessary equipment.

4.14.2.2 Static Water-Level Measurement Procedures

One set of static water-level measurements will be made over a single, consecutive 10 to 12 hour period for all newly installed and specified, existing wells prior to purging and sampling. Water level measurements will proceed from (perceived) clean wells to contaminated wells.

1. Clean and decontaminate the water level indicator in accordance with the procedures specified in Section 4.5.2.
2. Lower the indicator probe into the well and take the measurement at the place at the top of the casing which has been notched as the measurement point. Measure to the nearest 0.01 foot.
3. Remove probe from the well and decontaminate the lower section of the wire and the probe (per procedures specified in Section 4.5.2).

4. Calculate the purge volume of the well by subtracting the depth to water from the total depth of the well to figure the height of water column in the well. Multiply height of the water column by a known or calculated factor to calculate five bore volumes of water standing in the well and the filter pack.

4.14.2.3 Purging of Monitoring Wells

1. New disposable bailers and/or the Waterra Power Pump (for overburden wells) and a precleaned submersible pump (for deep wells) will be used to purge the well water into 55-gallon drums. If the Waterra Power Pump is used to purge the overburden wells, off-the-shelf ½- or ¾-inch diameter PVC pipe with foot valve will be used as a standpipe in each well for purging. The PVC pipe will be steam cleaned before insertion into the wells. The joints will be glued with quick-drying PVC glue. The solvent weld should cure within one minute. Since the purpose of the study is to determine gross contamination, any potential contribution of solvents from uncured glue would be inconsequential to the study, as approximately 50 gallons of water must be purged from the overburden wells and about 350 gallons from the deep wells.

2. Remove five bore volumes of water contained in the casing, screen, and filter pack at each well.

3. If the well does not contain a sufficient quantity of water to remove five bore volumes, the well should be bailed dry and sampled with a disposable bailer after a time period for sufficient recharge for sample collection.

4. Time, date, quantity of generated purge water, and any observations of contamination within or floating on the purge water will be recorded.

4.14.2.4 Groundwater Sampling

1. Calibrate and rinse the conductivity meter at each sampling site using the instructions and solutions provided by the manufacturer.

2. Use a new dedicated PVC bailer or disposable bailer, new nylon rope, and new latex gloves to collect water at each well.

3. Gently lower and remove the bailer from the well. Gently transfer water into the bottle for those samples requiring VOC analysis. VOC sample bottles should be gently filled to overflowing, capped, and inverted to insure the bottle is free of air bubbles. Samples requiring other analyses will be filled according to the laboratory protocol.

4. Place a water sample in a disposable cup and record the pH, conductivity, and temperature.

5. Place water samples in an iced cooler for preservation.

4.14.2.5 Field Filtering of Groundwater Samples

1. Use a new .45 micron field filter, tygon tubing, and sample holding container (preservative free) for each sample. Cut two 2-foot long sections of tygon tubing.

2. Connect both sections of the tygon tubing to the field filter. Place one section of the tygon tubing in the peristaltic pump such that water is pulled through the filter. The filter has an arrow showing the prescribed direction of flow.

3. Transfer the water from the sampling device into the holding container and place the tygon tubing in the holding container.

4. Turn on the peristaltic pump and fill the sample bottles according to laboratory protocol.

4.15 SURVEYING

All monitoring wells installed during the field investigation and all sampling locations within the West Area Red Water Ponds and Pentolite Road Red Water Ponds areas will be surveyed. The coordinates will be to the closest 0.1 foot and referenced to the State Plane Coordinate System. If the State Plane Coordinate System is not readily available, an existing local grid system will be used. These elevations will be referenced to the National Geodetic Vertical Datum of 1929. If the 1929 Datum is not readily available, the existing local vertical Datum will be used.

4.15.1 Surveying of Monitoring Wells

Both top of casing and ground surface elevations and coordinates will be surveyed and recorded for each monitoring well. A notch will be filed into the top of each monitoring well riser pipe to serve as a measurement point.

4.15.2 Surveying of Sample Locations

After sampling is completed at each location within the two Red Water Pond complexes, a wooden stake will be hammered into the ground at the sample location. The sample location designation will be written on the stake with an indelible marker and colored flagging will be tied to the top of the stake. The ground surface elevation and coordinates at each location will be surveyed.

4.15.3 Reporting

The location, identification, coordinates, and elevations of the wells and sample locations will be plotted on maps with a scale large enough to show their location with reference to other structures at the individual sites.

For the monitoring wells, the exact point of the ground surface and top of casing elevations will be indicated on the Monitoring Well Construction Diagrams. A tabulated list will be prepared of the monitoring wells and sample locations that will include their coordinates and elevations. The tabulation will consist of the designated number of the well, boring, and/or sample, the X and Y coordinates, and all the required elevations.

Sampling locations in the TNT Areas and background soil sample locations will not be surveyed. However, measurements to these sample locations will be taken from suitable landmarks and the locations will be recorded on Page 1 of the HTRW Drilling Log (Figure 4-1).

5.0 SAMPLE PACKAGING, SHIPPING, AND DOCUMENTATION OF CUSTODY

After their collection, the samples will be transported to Dames & Moore's subcontracted laboratory, (ASI) and to the QA laboratory (ORD-L) in such a manner as to preserve their integrity. The samples will be sent to the laboratories by an overnight courier service as soon as possible after collection, generally within 24 hours. Dames & Moore will coordinate the sample collection and shipping schedule with ASI so that samples which cannot be shipped within 24 hours of collection will be extracted and/or analyzed within the required holding times. All water samples will be shipped within 24 hours of collection.

Dames & Moore will also notify ORD-L at least 2 days prior to the initial sample collection and shipment to apprise them of the sample shipment schedule. Dames & Moore will also notify ORD-L prior to any sample shipments which are scheduled for Saturday delivery.

The samples to be collected for this investigation are expected to be low-concentration environmental samples. This section describes the procedures to be used to maintain sample integrity during shipments to the chemical analytical laboratory, including sample packaging, sample transportation, and documentation of sample custody during shipment.

5.1 PACKAGING AND SHIPPING OF SAMPLES COLLECTED FOR CHEMICAL ANALYSIS

Samples will be packaged and shipped per the requirements for low concentration samples which are outlined in "Chemical Data Quality Management for Hazardous Waste Remedial Activities" (ER 1110-1-263).

5.1.1 List of Equipment

- Clear wide shipping tape
- Custody seals
- Heavy-strength plastic coolers
- Ziplock bags (quart and 1-gallon size)
- Vermiculite
- Sharpie pens (indelible ink)
- "This Side Up" labels
- "Fragile" labels
- Federal Express or other overnight delivery shipping labels
- Adhesive label forms (for lab destination and return address on outside of cooler)
- Grease pencils
- Ice
- Water/temperature vials

5.1.2 Water Samples (Organics)

1. Use heavy strength plastic cooler or ice chest only.

2. Make sure all sample containers are labeled and properly sealed. With a grease pencil, mark the volume level onto the outside of the sample bottle.

3. Place 3 to 4 inches of vermiculite in the bottom of the cooler. Cat litter as a filler will not be used.

4. Wrap the containers in bubble wrap. Place sample containers in clear plastic ziplock bags (one container per bag). Eliminate air in baggies before sealing shut.

5. Place containers upright in the cooler so each container is not touching another sample or the side of the cooler.

6. Fill an empty vial with water and place it in the cooler with the sample containers. The temperature of the water in the vial should equalize with the temperature inside the cooler during shipment. The laboratory will measure the temperature of the water upon receipt of the cooler at the laboratory.

7. Place vermiculite around each sample container (more than halfway).

8. Place ice in 1-gallon ziplock bags. Double-bag the ice. This will greatly reduce water seepage from ice onto samples and prevent labels from floating off containers and potential water leakage from the cooler. Eliminate air from baggies before sealing shut.

9. Place ice bags around, among, and on top of the sample containers.

10. Fill any remaining cooler space with vermiculite or "bubble wrap." Enough space will be left for the cooler lid to close shut without pressure.

11. Place the sample paperwork (chain-of-custody form) in a ziplock bag and tape the bag to the inside of the cooler lid. One copy of the chain-of-custody form will be retained by the Site Supervisor.

12. Tape the cooler drain shut.

13. Secure the lid by taping with clear tape at a minimum of two locations.

14. Attach the completed shipping label to the top of the cooler.

15. Place "This Side Up" labels on all four sides of the cooler and fragile labels on at least two sides of the cooler. The labels will not be overlapped or taped over.

16. Affix signed custody seals on the front right and back left of the cooler.

5.1.3 Water Samples (Inorganics)

Follow the packaging and shipping requirements listed above for organics. Fragile labels are optional for coolers not containing glass bottles.

5.1.4 Soils/Sediments (Organics and Inorganics)

Follow the packaging and shipping requirements listed for water samples analyzed for organics. The shippers' weight limits must not be exceeded. If the cooler is so heavy that they exceed these limits, the samples are not packaged properly and will be repackaged.

5.2 PACKAGING AND SHIPPING OF SAMPLES COLLECTED FOR BIOLOGICAL ANALYSIS

Packaging and shipping procedures for the samples collected for biological analysis are provided in Appendix A.

5.3 PACKING AND SHIPPING OF SIEVE SAMPLES

Sieve sample containers will be placed inside ziploc baggies and shipped to the geotechnical laboratory in a cooler filled with vermiculite.

5.4 DOCUMENTATION OF SAMPLE CUSTODY

Documentation of the chain-of-custody of the samples is necessary to demonstrate that the integrity of the samples has not been compromised between collection and receipt by the laboratory. Each cooler will be accompanied by a chain-of-custody record to document the transfer of custody from the field to the contractor or QA laboratories. Figure 5-1 presents an example of the form to be used. All information requested by the chain-of-custody record will be completed. One copy of the chain-of-custody form will be retained by the Site Supervisor. The remaining pages will be sealed in a plastic bag and placed inside of the cooler. Upon receipt at the laboratories, the chain-of-custody forms will be completed. It is the responsibility of the individual laboratories to maintain and document sample integrity upon receipt.

Field Sample Custody — Field personnel are responsible for the custody of samples until the time they are transferred to the shipper or the laboratory. As few people as possible will handle the samples to minimize the number of transfers. A chain-of-custody form (Figure 5-1) will accompany the sample from the field for sample containment and preservation, through its receipt at the laboratory.

Laboratory Sample Custody — Receipt, storage, and tracking of samples submitted to the laboratory are conducted according to strict protocol to prevent sample

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CHAIN OF CUSTODY RECORD

PROJECT NUMBER	PROJECT NAME	# OF CONTAINERS	CLIENT ADDRESS AND PHONE NUMBER	LAB ID	FOR LAB USE ONLY
CLIENT NAME			ANALYSES REQUESTED		LAB#
PROJECT MANAGER	COPY TO:				LAB #
REQUESTED COMP. DATE	SAMPLING REQUIREMENTS: SDWA ☐ NPDES ☐ RCRA ☐ OTHER ____				PROJECT NO.
					ACK / VERIFIED
					QUOTE# / BS
					NO. OF SAMP / PG / OF

STA NO.	DATE	TIME	COMP	GRAB	SOIL	SAMPLE DESCRIPTIONS	REMARKS

SAMPLED BY AND TITLE	DATE/TIME	RELINQUISHED BY	DATE/TIME	HAZWRAP/NEESA Y N
				QC LEVEL 1 2 3
RECEIVED BY:	DATE/TIME	RELINQUISHED BY:	DATE/TIME	COC / ICE
				ANA REQ / TEMP
RECEIVED BY:	DATE/TIME	RELINQUISHED BY:	DATE/TIME	CUST SEAL / PH
				SAMPLE COND.
RECEIVED BY LAB:	DATE/TIME	SAMPLE SHIPPED VIA UPS BUS FED-EX HAND OTHER ____	AIR BILL #	
REMARKS				ENTERED INTO LIMS ____ COC REVIEWD ____

Figure 5-1

CHAIN-OF-CUSTODY FORM

Plum Brook Ordnance Works

DAMES & MOORE

contamination or loss, and to prevent the production of invalid data as a result of sample deterioration or tampering.

6.0 CHEMICAL ANALYSIS

The purpose of this section is to present the chemical analytical program. The acquisition of chemical data is the focus of the field investigations. Analyses will be performed at the contractor laboratory, ASI, as described in Section 2.0. Section 3.0 presents the parameters for analyses. The analytical and laboratory QC procedures to be followed are presented in the following sections. A copy of ASI's Comprehensive Quality Assurance Plan is provided as Appendix D.

6.1 DEFINITIONS

The following sections provide definitions for some of the terms utilized with respect to the chemical analysis procedures and the associated QC procedures to be performed.

6.1.1 Method Blank

The method blank is a blank sample created by the laboratory that is carried through all stages of the sample preparation and analysis procedures. It is designed to demonstrate that contamination of the samples by the laboratory has not occurred. Possible sources of such an analytical bias are reagents, glassware, and/or the analytical system itself.

6.1.2 Matrix Spike/Matrix Spike Duplicate

The matrix spike (MS) and matrix spike duplicate (MSD) are QC samples prepared by the laboratory to assess accuracy and precision. During sample preparation, two additional aliquots of a field sample are spiked with known amounts of specified analytes along with the original sample aliquot. The MS and MSD are then prepared and analyzed as any other sample. Bias can be assessed by calculating the amount of the spiked analyte that is recovered. Precision can be assessed by calculating the

relative percent difference (RPD) between the results for the spiked analytes in the MS and MSD. If unspiked analytes are present in measurable quantities, the MS and MSD data can provide additional precision information. Laboratory controls (LCs) and laboratory control duplicates (LCDs) will also be analyzed where appropriate. These controls are similar to MS/MSDs, but are performed on reagent water.

6.1.3 Surrogate Spike

A surrogate spike is similar to a matrix spike in that a known amount of an analyte is added to the sample during sample preparation. For those analyses for which surrogate spikes are performed (organic analyses utilizing gas chromatography separation techniques), each sample is spiked with a compound that behaves in a similar manner to that of the analytes of interest. Surrogate recoveries are calculated and are used to evaluate the sample preparation.

6.1.4 Confirmation Analysis

For analyses of organic compounds by gas chromatography (GC), or high pressure liquid chromatography (HPLC), a confirmation analysis is required to verify the identity of the target analyte. This consists of a second analysis using a chromatography column with differing retention characteristics. If the target analyte is detected in the expected elution windows on both columns, the presence of the target analyte is considered to be established with a reasonable degree of confidence.

6.1.5 Laboratory Duplicate

A laboratory duplicate is the analysis of a second aliquot of a sample. ASI will perform sample duplicates with every batch of samples (except explosives) at a rate of one per ten samples. All procedures followed for the original analysis are also to be followed. The results of the two analyses can be utilized to assess the analytical precision

through the calculation of the RPD. Laboratory duplicates are performed as part of every batch.

6.2 CHEMICAL ANALYSIS PROCEDURES

The samples specified in Section 3.0 will be submitted to the subcontracted laboratory for chemical analysis. The analytical parameters to be tested for, and the associated QC practices to be adhered to, are specified in the following sections. The soils and sediment samples to be collected will be considered the same matrix, and the surface water and groundwater samples will be considered the same matrix, for sample preparation and analysis purposes.

The analytical procedures used for this project are EPA and American Society for Testing and Materials (ASTM) methods, as described in the subsequent sections.

The analytical parameter groups to be tested for are listed below:

1) Physical Properties and Inorganic Non-metal Parameters

2) Metals Analysis

3) Organic Parameters

The following sections provide brief descriptions of the methodologies and QC procedures associated with these analyses. Tables 6-1 and 6-2 present a summary of the analytical parameters to be analyzed, container types, preservation requirements, and holding times. Tables 1 through 9 in Appendix E list the target analytes and method detection limits (MDLs) for each of the metals and organic parameter methods employed.

TAbLE 6-1

SOIL AND SEDIMENT SAMPLE
CONTAINERS, PRESERVATION, AND HOLDING TIMES
PLUM BROOK ORDNANCE WORKS
SANDUSKY, OHIO

Parameter	EPA Method	Container [1]	Preservation	Maximum Holding Times	
				Extraction	Analysis
Explosives Residues	8330 modified	(1) 120-mL WM Glass	Cool to 4°C	14 days	40 days
Total Metals[2]	6010A	(1) 250-mL WM HDPE	None	not required	180 days
Arsenic	7060			not required	180 days
Lead	7421			not required	180 days
Mercury	7471			not required	28 days
Selenium	7740			not required	180 days
Thallium	7841			not required	180 days
Volatile Organics	8240	(2) 120-mL WM Glass	Cool to 4°C	not required	14 days
Semivolatile Organics (BNAs)	8270	(1) 250-mL WM Glass	Cool to 4°C	14 days	40 days
Extractable Organic Carbon	9060	(4) 250-mL WM Glass	Cool to 4°C	not required	28 days
Extractable Sulfate	9038	(1) 120-mL WM glass	Cool to 4°C	not required	28 days
pH	9045			not required	28 days
Extractable alkalinity	310.1 modified			not required	28 days
Extractable nitrate	353.2 or 353.3			not required	28 days
Total Kjeldahl nitrogen	351 modified			not required	28 days
Extractable phosphorous	365 modified			not required	28 days
Cation exchange capacity	9081			not required	28 days
Moisture content	ASTM D2216		None	not required	28 days
Potassium	3050/6010	(1) 250-mL WM HDPE	Cool to 4°C	not required	180 days

1) Number in parenthesis indicates the number of sample containers required per sample.
WM = Wide mouth
HDPE = High density polyethylene

2) Includes Antimony, Beryllium, Cadmium, Chromium, Copper, Manganese, Nickel, Silver, and Zinc.

TABLE 6-2

SURFACE WATER AND GROUNDWATER SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIMES PLUM BROOK ORDNANCE WORKS SANDUSKY, OHIO

Parameter	EPA Method	Container[1]	Preservation	Maximum Holding Times	
				Extraction	Analysis
Explosives Residues	8330 Modified	(2) 1-L amber glass	Cool to 4°C	7 days	40 days
Volatile Organics	8240	(3) 40-mL glass vial	Cool to 4°C HCL to pH<2	not required	14 days
Semivolatile Organics	8270	(2) 1-L amber glass	Cool to 4°C	7 days	40 days
Total Metals[2]	6010A	(1) 1-L HDPE	Cool to 4°C HNO_3 to pH <2	not required	180 days
Arsenic	7060			not required	180 days
Lead	7421			not required	28 days
Mercury	7470			not required	180 days
Selenium	7740			not required	180 days
Thallium	7841			not required	180 days
Total Suspended Solids	160.2	(1) 1-L plastic squat	Cool to 4°C	not required	7 days

1 Number in parenthesis indicates the number of sample containers required per sample.
WM = wide mouth
HPDE = high density polyethylene

2 Includes Antimony, Beryllium, Cadmium, Chromium, Copper, Manganese, Nickel, Silver, and Zinc

6.2.1 Physical Properties and Inorganic Non-Metal Parameters

The physical properties and inorganic non-metal parameters to be tested for are listed below:

- pH
- Total suspended solids
- Moisture content
- Extractable organic carbon
- Cation exchange capacity
- Extractable Sulfate
- Extractable alkalinity
- Extractable nitrate
- Total Kjeldahl nitrogen
- Extractable phosphorous
- Potassium

The method numbers for these physical properties and inorganic non-metal parameters are summarized on Tables 6-1 and 6-2.

6.2.2 Metals Analysis

Water, soil, and sediment samples are to be analyzed for 13 priority pollutant metals and manganese. Nine metals will be analyzed by inductively-coupled plasma atomic emission spectrometry (ICP). Mercury will be analyzed utilizing cold vapor atomic absorption spectrometry (CVAA). Four of the metals will be analyzed by graphite furnace technique. These techniques are presented in more detail in the following section.

6.2.2.1 ICP

Nine metals, antimony, beryllium, cadmium, chromium, copper, manganese, nickel, silver, and zinc, will be analyzed using EPA Methods 6010A in combination with microwave digestion by EPA Methods 3015 for aqueous samples and EPA Method 3051 for soil/sediment samples. This method uses an ICP to measure element-emitted light by optical spectrometry. The digested sample is nebulized and the resulting aerosol is transmitted to a plasma torch where an element-specific atomic line emission spectrum is produced. The spectra are dispersed and the intensities of the lines are monitored by photomultiplier tubes. The required QC samples, QC acceptance criteria and corrective actions are summarized in ASI's Comprehensive Quality Assurance Plan.

6.2.2.2 Cold Vapor Atomic Absorption

Mercury will be tested for using CVAA by EPA Methods 7470 and 7471. These methods measures mercury by aerating elemental mercury from the sample and passing it through a cell positioned in the light path of an atomic absorption spectrometer. The methods include the sample preparation procedures. An aliquot of sample is acidified and then undergoes a heated, oxidative digestion with potassium permanganate and potassium persulfate. To measure the mercury content of the digested sample, stannous chloride, a reducing agent, is added to form elemental mercury. The required QC samples, QC acceptance criteria and corrective actions are summarized in ASI's Comprehensive Quality Assurance Plan.

6.2.2.3 Graphite Furnace

Methods 7421, 7841, 7740, and 7060 are employed to analyze for lead, thallium, selenium, and arsenic in soil and water samples, respectively. These methods use a graphite furnace with Zeeman background correction. A representative aliquot of a digested sample is placed in the graphite tube, evaporated to dryness, charred to break

down any complex matrix components, and atomized. The analyte then absorbs the source radiation and is measured by a photosensitive device.

6.2.3 Organic Parameters

The organic parameters to be tested for are listed below:

- Explosives Residues
- Volatile Organics
- Semivolatile Organics (BNAs)

The following sections provide additional details concerning each of these parameters.

6.2.3.1 Explosives Residues

EPA Method 8330, as modified by CRREL Special Report 92-25, "Comparison of Cartridge and Membrane Solid-Phase Extraction With Salting-Out Solvent Extraction for Preconcentration of Nitroaromatic and Nitramine Explosives from Water," will be used for analysis of explosives residues. The solid matrix samples are extracted with solvent in an ultrasonic bath and filtered. The target analytes are isolated from water samples by absorption on a membrane filter, then desorbed with solvent. Extracts are analyzed by HPLC with ultraviolet (UV) absorption detection. QC will consist of calibration verification, blanks, and a MS, MSD, and sample duplicate each batch of 20 samples.

6.2.3.2 Volatile Organic Compounds

Analyses for VOCs will be performed utilizing EPA Method 8240 (modified to achieve drinking water detection limits for the groundwater samples). This method is performed by purging the volatile organic compounds out of the sample and capturing them using a purge-and-trap apparatus. The volatile organics are then desorbed from

the trap into the gas chromatograph (GC), where they are qualitatively separated and quantitatively detected with a mass spectrometer (MS). At least ten tentatively identified compounds of greater than 10 percent abundance compared to the nearest internal standard will be reported in addition to the target compound list for all samples. The required QC samples, QC acceptance criteria and corrective actions are summarized in ASI's Comprehensive Quality Assurance Plan.

6.2.3.3 BNAs (Semivolatile Organics)

Semivolatile organics including BNAs will be analyzed for using EPA Method 8270. This method will be modified to obtain Method 525 detection limits for the groundwater samples. The sample preparation will be performed in accordance with EPA Method 3510 and 3540 for water and soil/sediment, respectively. The sample extract is dried, concentrated, and then analyzed by GC-MS. Sample extracts which contain significant amounts of interferences will be subject to clean-up by EPA Method 3640, gel permeation chromatography (GPC) and/or dilution. At least 20 tentatively identified compounds of greater than 10 percent abundance compared to the nearest internal standard will be reported in addition to the target compound list for all samples. The required QC samples, QC acceptance criteria and corrective actions are summarized in ASI's Comprehensive Quality Assurance Plan.

6.2.4 Non-metal Inorganics

6.2.4.1 Total Suspended Solids

Total suspended solids are analyzed by filtering a well-mixed sample through a dried and tared glass fiber filter. The residue on the filter is dried to constant weight at 103 to 105°C, then the total suspended solids concentration is computed from the difference between the final and tare weights, corrected for the size of the sample.

6.2.4.2 Extractable Sulfate

Extractable sulfate is analyzed by suspending 10.0 grams of solid in 100 milliliters of reagent water, then filtering and measuring the amount of sulfate in the filtrate. Sulfate ion is converted to a barium sulfate suspension under controlled conditions. The resulting turbidity is measured by a nephelometer and compared to a curve prepared from standard sulfate solutions. The value is corrected back to the amount of soil used.

6.2.4.3 Extractable Nitrate

Extractable nitrate is analyzed by suspending 10.0 grams of solid in 100 milliliters of reagent water, then filtering and measuring the amount of nitrate in the filtrate. The sample is passed through a column containing granulated copper-cadmium to reduce nitrate to nitrite. The nitrite (that originally present plus reduced nitrate) is measured by diazotizing with sulfanilamide and coupling with N-(1-naphthyl)-ethylenediamine dihydrochloride to form a highly colored azo dye which is measured colorimetrically against standards. The nitrite analysis is repeated without the initial copper-cadmium reduction. The difference between the two values is the amount of nitrate in the filtrate. This value is corrected back to the original soil sample.

6.2.4.4 Extractable Alkalinity

Extractable alkalinity is analyzed by suspending 10.0 grams of solid in 100 milliliters of reagent water, then filtering and measuring the amount of alkalinity in the filtrate. The filtrate is titrated to an electrometrically measured end-point of pH 4.5. The volume and concentration of the titrant is used to calculate the alkalinity of the filtrate which is corrected back to the original soil sample.

6.2.4.5 Total Kjeldahl Nitrogen

Total Kjeldahl nitrogen is analyzed by heating the sample in the presence of concentrated sulfuric acid, potassium sulfate and mercuric sulfate and evaporated until sulfur trioxide fumes are obtained and the solution becomes colorless or pale yellow. The residue is cooled, diluted, and is treated and made alkaline with a hydroxide-thiosulfate solution. The ammonia is distilled and analyzed calorimetrically by addition of Nessler's reagent and comparison with a curve made from ammonia standard solutions. The results are corrected back to the original sample.

6.2.4.6 Extractable Phosphorous

Extractable phosphorous is analyzed by suspending 10.0 grams of solid in 100 milliliters of reagent water, then filtering and measuring the amount of phosphorous in the filtrate. The sample is hydrolyzed by heating with sulfuric acid-persulfate digestion. Ammonium molybdate and antimony potassium tartrate react with the phosphorous in an acid solution to form an antimony-phosphomolybdate complex. Ascorbic acid reduces the complex to an intense blue heteropoly acid. Colorimetric measurement gives the amount of phosphorous in solution by comparison with a curve made from phosphorous standard solutions. The results are corrected back to the contents of the original soil sample.

6.2.4.7 Cation Exchange Capacity

Cation exchange capacity is analyzed by mixing the sample with an excess of either ammonium or sodium acetate solution. This results in an exchange of the sodium or ammonium cations for other cations in the sample. The excess sodium or ammonium is removed and analyzed. The difference between the original concentration of ammonium or sodium and the excess amount is the cation exchange capacity of the sample.

6.2.4.8 Moisture Content

The moisture content of the sample is analyzed by drying a weighed amount of the solid in a 103 to 105°C oven until constant weight is obtained. The difference between the initial and final weights is the moisture content of the sample.

6.2.4.9 Potassium

Potassium is analyzed as under ICP above in Section 6.2.2.

6.2.4.10 pH

pH of the sample is analyzed by mixing the sample in reagent water, then measuring the pH of the resulting aqueous suspension with a pH electrode.

6.2.4.11 Extractable Organic Carbon

Extractable organic carbon is analyzed by suspending 10.0 grams of soil in 100 milliliters of water, then filtering and measuring the amount of total organic carbon in the filtrate. The sample is combined with acidified persulfate reagent. The sample is then transferred to a quartz ultraviolet reaction coil where the organics are subjected to intense ultraviolet radiation in the presence of the acidified persulfate reagent. The nonpurgeables are converted to carbon dioxide which is measured by indirect IR. The solution total organic carbon is measured by comparison of the IR reading to a curve prepared from total organic carbon standard solutions. The solution total organic carbon value is corrected to the original soil sample.

7.0 CHEMICAL DATA VALIDATION AND DATA MANAGEMENT DELIVERABLES

The chemical data quality management deliverables are reports concerning the quality of the data acquired. These reports will be prepared for submittal as required by the Scope of Work.

7.1 DAILY QUALITY CONTROL REPORTS

An A-E Daily Quality Control Report (Figure 7-1) will be prepared daily by the Site Supervisor or his/her designee during the field activities. These reports will briefly summarize the activities performed, the samples collected, and the associated QC activities. It will also provide a description of any problems encountered, the corrective actions taken, and the effectiveness of the corrective actions. Copies of the completed forms will be provided to the on-site CEORN field representative as soon as practicable during the field work. A complete set will be provided to CEORN after the completion of the field work.

7.2 COOLER RECEIPT FORMS

Upon receipt of each sample cooler at ASI, laboratory personnel will complete a COE Cooler Receipt Form. Copies of these forms will be provided with the analytical data reports.

7.3 DATA REPORTING

Data reports for all samples received by ASI will be submitted to Dames & Moore to provide the results of the analyses for all parameters along with additional information to identify unequivocally how the data point was produced. The following sections present the reporting format to be used and the QC data to be reported.

DATE _____

A-E DAILY QUALITY CONTROL REPORT

DAY	S	M	T	W	TH	F	S

COE PROJECT MANAGER _____

PROJECT _____

JOB NO. _____

CONTRACT NO. _____

WEATHER	BRIGHT SUN	CLEAR	OVERCAST	RAIN	SNOW
TEMP	TO 32	32-50	50-70	70-85	85-UP
WIND	STILL	MODER	HIGH	REPORT NO.	
HUMIDITY	DRY	MODER	HUMID		

SUBCONTRACTORS ON-SITE:

EQUIPMENT ON-SITE:

WORK PERFORMED (INCLUDING SAMPLING):

COE

Figure 7-1
A-E DAILY QUALITY CONTROL REPORT
Plum Brook Ordnance Works

PROJECT _____ REPORT NO. _____

JOB NO. _____ DATE _____

QUALITY CONTROL ACTIVITIES (INCLUDING FIELD CALIBRATIONS):

HEALTH AND SAFETY LEVELS AND ACTIVITIES:

PROBLEMS ENCOUNTERED/CORRECTIVE ACTION TAKEN:

SPECIAL NOTES:

TOMORROW'S EXPECTATIONS:

BY _____ TITLE _____

COE

Figure 7-1 (cont'd)

7.3.1 Reporting Format

Each data package will include the following information:

1. Laboratory-assigned Identification Code
2. Field-assigned Sample Designation
3. Sample Matrix
4. Date of Sampling
5. Date of Receipt at the Laboratory
6. Code for Applicable Chain-of-custody Documents
7. Description of Methods Used (reference to specified methods is acceptable)
8. Date of Preparation
9. Date of Analysis
10. Signature of Person(s) Authorized to Release Data

Dames & Moore will provide ASI with the information necessary to complete the data report requirements listed above. Copies of raw data will not be required.

The chain-of-custody documentation associated with each sample will be returned with the data. The chain-of-custody documentation shall be completed to indicate the status of sample integrity upon receipt at the analytical laboratory. As previously mentioned, COE Cooler Receipt Forms will also be provided with the data.

7.3.2 QC Data To Be Reported

Documentation of the QC performed will be provided with each data package for the field samples. Such documentation shall allow an assessment of the accuracy of the data to be made. The following information will be provided:

1. Method Blank Data

2. Method Blank Summaries (indicating which samples are associated with each method blank)

3. Recovery and Precision of MS/MSDs (where applicable)

4. Surrogate Recoveries (where applicable)

5. Recovery and Precision of LC/LCDs (where applicable)

ASI will provide a "case narrative" to discuss any problems encountered, the corrective actions taken, and the effectiveness of the corrective actions. In addition to the responsibilities listed above, the contractor laboratory will also provide faithful and conscientious performance of the specified methods.

7.3.3 COE Submittals

Copies of the laboratory result reports generated by ASI will be provided to CEORN-ER-M and CEORD-PE-GL in accordance with the Scope of Work.

7.4 CORRECTIVE ACTION

The QC procedures specified above are designed to prevent problems before they occur as well as provide a means for assessing the quality of the data. Where the QC data indicate that a problem has occurred, appropriate corrective action will be taken. For the analytical methods, the steps to be taken are specified in the applicable EPA method. Problems that can not be corrected without compromising data quality (i.e. exceeded holding times, broken samples, etc...) will be communicated to Dames & Moore within 48 hours of their occurrence. This will be followed up with a written record of the problem with a discussion of the corrective actions taken, their effectiveness, and the qualitative and quantitative effect on the quality of the data. The COE Project Manager will be notified of any problems which occur which cannot be corrected without compromising data quality.

7.5 EVALUATION OF DATA QUALITY

Dames & Moore will perform a Data Quality Assessment of the data gathered during the field investigation. The Data Quality Assessment will be performed in accordance with the guidance provided in the National Functional Guidelines for Organic Data Review (U.S. Environmental Protection Agency (EPA), 1991) and Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analysis (EPA, 1988).

The objective of the evaluation of the quality of the chemical data is to assess whether qualifications to the data quality are necessary.

Approximately 10 percent of the samples submitted for chemical laboratory analyses will be validated. Laboratory data packages will be selected for validation at random. However, the packages selected will include both solid and aqueous sample matrices. The Data Quality Assessment will consist of two parts. The first will be to perform an evaluation of the laboratory QC data, a process often termed "data validation." This will provide a rating of the quality of the data produced by the analytical laboratory. The second part will draw upon the first to provide an overall rating of the data points based upon the review of the field QC data. The overall result of the data quality assessment is to evaluate whether the data can be used to satisfy the objectives of the project. The data points will be graded as one of the following:

- Usable as reported,
- Usable with qualifications, or
- Unusable.

Data for which the laboratory and field QC data are all within acceptance limits will be assigned the grade "usable as reported." Data for which slight QC problems are indicated but the QC data are still within the action limits will be assigned the grade "usable with qualifications." These data may still be used as part of the site investigation if the QC problems are not excessive. Data for which the corresponding QC data are outside the action limits will be assigned the grade "unusable" and will not be used.

The evaluator will use their judgement based upon established principles and the guidelines established in this document in the assignment of qualifications to the data. All data are to be used if at all possible. Precision will be evaluated calculating by the RPDs for the field duplicates/splits and the MS/MSDs or LC/LCDs. The method blank, MS/MSD, LC/LCD, and surrogate recovery, and MSD data will be used to evaluate the accuracy of the data. The completeness parameter will be determined after the evaluation of the usability of the data. Completeness will be evaluated by comparing the project objectives with the acquired data and identifying data gaps and deficiencies in the data base with respect to the project objectives.

8.0 PHYSICAL AND BIOLOGICAL ANALYSES

The purpose of this section is to describe the physical and biological laboratory analyses that will be performed to supplement the chemical analytical program presented in Sections 7.0 and 8.0. The physical laboratory analysis consists of grain size analyses of sieve samples collected during installation of groundwater monitoring wells. The biological analysis will be performed to assess biological activity of soils and sediments collected in and around the two red water ponds complexes.

8.1 SIEVE ANALYSIS

Physical testing will be performed by Dames & Moore's Salt Lake City geotechnical laboratory using standard (ASTM) procedures. Grain size distribution of select soil samples from the monitoring well boreholes and of the filter pack used in construction of the monitoring wells will be determined using ASTM Test Procedure D422, "Particle Size Distribution in Soils".

8.2 BIOLOGICAL ACTIVITY ANALYSIS

Microbial characterization will include enumeration of total microbes and contaminant specific degraders. Total microbes shall be determined by the "Agar Plate Method for Total Microbial Count" as described by Clark in "Agar Plate Method for Total Microbial Count," Methods of Soil and Analysis, American Society of Agronomy, Madison, WI, Volume 2, pp. 1460-1465 (1965). The preliminary screen for contaminant-specific degraders is performed in a medium that provides only the necessary inorganic nutrients required for microbial growth and the required carbon source indicated by the procedure. The complete methodology for the preliminary screening of contaminant specific degraders is contained in "Screening Test and Isolation Procedure for TNT-Degrading Microorganism", by Douglas Gunnison, USACE Waterways Experiment Station (WES). Results of the total microorganisms and contaminant specific degraders will provide an indication of microbial activity for the soil for existing

(unamended site conditions) and also if amended whether the soil will overcome potential toxicity constraints.

APPENDIX A

BIORENEWAL TECHNOLOGIES, INC

Vitae of Key BioRenewal Technologies, Inc. Personnel

Allen J. Dines -- President and Chief Executive Officer. Allen is co-founder of BioRenewal with 20 years of experience in environmental management, consulting and biotechnology commercialization. This experience encompasses having initiated and conducted new product development projects, executed international biotechnology marketing agreements and served as operation and administrative manager for a consulting group of more than 100 staff members.

Formerly Mr. Dines was Director of Business Development at Agracetus, Inc., a research unit of W.R. Grace & Co. focused on agricultural applications of biotechnology, where he was responsible for commercial planning, government, and regulatory and public affairs. Prior experience also includes: six years of environmental consulting focusing on wastewater management, solid and hazardous waste management, air and water quality planning, pesticides, and food safety; and three years working at the Energy and Environment Division of Booz, Allen & Hamilton, Inc. in Bethesda, Maryland, where he managed projects covering a variety of resource utilization and business management issues including policy development, compliance management, organizational design, facility siting, public relations, market planning, competitor analysis and product re-positioning in response to regulatory actions.

He holds a Master of Business Administration degree (1980) and Master of Regional Planning degree (1974) and a Bachelor of Science degree (1965) from the University of Michigan.

Alan D. Bettermann -- Vice President, Director of Technical Development. Alan is a biochemist with 12 years of laboratory research experience in the biotechnology and pharmaceutical industries. His work has focused on development of methods for characterization, purification, and measurement of biochemical and microbial samples. At BioRenewal, Alan manages a variety of treatability analyses associated with petroleum-contaminated underground storage tank and hazardous waste sites. At present, he has primary technical responsibility for the development and commercialization of BioRenewal's Submitochondrial Particle (SMP) toxicity testing products. He is also the principal developer of BioRenewal's Comparative Enumeration Assay for bioremediation feasibility.

Prior to joining BioRenewal, as a Biochemist and Research Specialist at the University of Wisconsin Biopulping Consortium, Alan's research involved the development of methods for the quantitative extraction of active fungal enzymes from solid substrate fermentations and characterization of their physical and enzymatic properties.

Prior positions also include that of Analytical Biochemist at Agrigenetics Advanced Science Company in Madison, Wisconsin, and Microbiologist at Armour Pharmaceutical Company in Kankakee, Illinois, a subsidiary of Revlon. Alan has a broad technical experience base, including work in the isolation and characterization of proteins from native and recombinant bacteria and plants, biochemical characterization of microbial contaminants, and challenge testing of automated filling equipment to meet GMP requirements.

He holds a Bachelor of Science degree from Western Illinois University (1982).

Lori L. Graham -- Associate Scientist and Communications Manager. Lori has expertise and training in communications combined with nine years of industrial microbiology research experience. She contributes to BioRenewal's laboratory research efforts as well as serve in a marketing and communications role. She is largely responsible for the development of promotional and technical materials and provides client technical support. She also manages prospective client prospects through bid responses and an inquiry database.

She was previously a Research Associate at Agracetus, Inc., of Madison, Wisconsin, focusing on the development of microbial products for controlling plant disease. This research involved; the culture, maintenance and formulation of a large collection of fungi and bacteria; the culture of plant parasitic nematodes and insects for product screening; the development of innovative laboratory testing procedures; coordination of large-scale agricultural field testing of microbial products; and management of laboratory staff and technical service support. She is also co-developer of a patented microbial inoculant for soybean.

Immediately prior to joining BioRenewal, she was an Outreach and Communication Specialist for two years at the University of Wisconsin-Madison. There, she wrote and designed science educational materials and promotional literature for three national science educational programs. She was co-editor for two nationally distributed agriscience instructional manuals.

She holds a Masters of Science degree in Agricultural Journalism from the University of Wisconsin-Madison (1994), and a Bachelor of Science in Bacteriology from the University of Wisconsin-Madison (1982).

M. Lynn Haugh -- Manager of Microbial Services. Lynn has 13 years of laboratory experience focused in the areas of isolation, selection and formulation of soil-dwelling microorganisms. At BioRenewal, she supervises the microbiology laboratory and is responsible for QA/QC for all microbial analyses. She is a co-developer of the Comparative Enumeration Assay for determining total and degrader populations in soil or groundwater samples from sites undergoing remedial investigation. During the last year, she co-developed and implemented the company's laboratory information management system. This system automates BioRenewal's client data reporting while accumulating sample data for the company's database.

Lynn was formerly a Senior Research Assistant at Agracetus, Inc., of Madison, Wisconsin, where she was responsible for the isolation, screening and production of microbial biocontrol agents for prevention of soil-borne plant disease. There she also carried out formulation research directed at optimization of microbial activity in varied soil environments, and co-developed a patented microbial formulation technology production.

Additional technical experience includes: the analysis of competitiveness and persistence of candidate microbial strains for use as crop yield enhancement products; development and implementation of protocols for characterization of field-isolated microbial strains; protein separations; DNA isolations; and enzyme restriction digests. She holds a Bachelor of Science in Bacteriology and Plant Pathology from The University of Wisconsin-Madison (1981).

Soil Sampling Protocol

For the Comparative Microbiological Enumeration Assay

Two 4-ounce jars are required per sample. An additional 4-ounce jar is required if particle size analysis is requested. An intact core sample of known volume is required for analysis for oxygen (based on porosity), soil moisture holding capacity, and bulk density. Aseptic sample handling procedures are very similar to requirements for samples sent to an analytical laboratory for contaminant analysis.

Aseptic Microbial Sampling Guidelines

1. Preserve sample integrity by avoiding skin contact with the interior of the sterile sample container and the sample. The use of sterile disposable latex gloves is recommended. Fresh gloves should be put on immediately before manipulating the sample.

2. Split spoon cores should be dissected so as to remove the disturbed top and bottom portions, using an alcohol-sterilized spatula.

3. Avoid contact of the sample with soils from other parts of the site.

4. Minimize open air exposure of the sample container and sample.

5. Do not use a soiled or dirty wipe cloth to dry equipment used for sampling. The use of a clean, previously unexposed section of paper toweling is acceptable.

6. Minimize head space in the sample container by filling full with sample.

7. Between samples, equipment contacting the sample should be:

   A. Washed with water containing a mild detergent (Alconox®) and 4 oz. of bleach per 5 gal. of water
   B. Rinsed 3X with clean water
   C. Dried using clean paper toweling
   D. Sprayed with 70% isopropyl (rubbing) alcohol
   E. Dried using clean paper toweling.

   Steam cleaning is also a suitable sanitizing method. As above, equipment should be dried using clean toweling prior to use.

Sample Storage Prior to Delivery to BioRenewal

1. Use waterproof tape to seal jar lid interface, and place in a ziplock® bag to prevent sample leakage or saturation if exposed to water during shipment.

2. Samples should be packed on ice at all times, including during shipment. **Do not freeze samples.** The use of "blue ice" is not encouraged.

3. Samples should be shipped to arrive at BioRenewal within 24 hours of sampling.

BTI 315 Comparative Enumeration Assay Methodology

There are a variety of techniques and methods used to enumerate and characterize microbial populations. The comparative enumeration assay (CEA) has been developed by BioRenewal Technologies, Inc. for use specifically in site remedial investigations. The assay is a microbiological technique that provides tangible evidence of relevant microbial degradation activity at a site.

CEAs will be carried out to provide information about the indigenous microbial populations existing in the samples obtained from the site. Specifically, the assay enumerates:

- The total heterotrophic population capable of utilizing complex carbon sources.
- The "degrader" population capable of utilizing the site contaminant as a sole carbon source.

The CEA is a modified viable plate count method, based on the AWWA standard method No. 9215C. The modifications are intended to minimize the effects of unknowns and variability associated with soil and groundwater samples, as well as difficulty in incorporating contaminant compounds into microbial medium.

A complete low-nutrient media, specifically designed for recovery of damaged or stressed organisms, is used to determine the total heterotrophic populations present. The "degrader" population is the microbial population capable of utilizing a specified contaminant of interest at the site. Degrader populations are enumerated using a defined minimal media containing the required macro and micro-nutrients plus the requested contaminant as a sole source of carbon at 1.0% v/v final concentration (for most compounds). The specific contaminant and concentration used to determine degrader populations is indicated on the data report as "carbon source" and "% carbon."

Upon receipt, the samples submitted for microbial enumeration are subjected to a preliminary range-finding procedure to assure that the microbial numbers resulting from the dilutions selected for the replicated plating fall within a countable range. Following this, a total of five replicates are plated from each of two selected serial dilutions on the two types of media described above. Incubation of the samples is typically carried out at 22°C, under aerobic or microaerophillic conditions, depending on site specifications.

After an appropriate period of incubation, the colonies are counted and the data recorded. Based on established conventions and the specific protocol, the number of viable colony forming microorganisms per gram dry soil weight (CFU/g_{DSW}) for soil samples, or CFU/ml for groundwater samples, are calculated.

The mean population value reported is a best estimate of the true population. The 95% confidence interval provides the range of population values that are 95% likely to include the true population mean based on the probability distributions of the concentrations of the microbial populations from the raw data. The 95% confidence interval is a well-established statistical measure of sampling error inherent in any laboratory enumerating procedure. There is a 95% certainty that the populations within a particular sample that you submit for analysis lie within this interval. Thus, if the population intervals between two different samples do not overlap, then there is a 95% certainty that the concentrations of microorganisms in those two samples are truly different. In this way the CEA provides a basis for estimating of the amount of biological heterogeneity within the site.

NOTE: An artificial medium that is capable of supporting *every* soil organism present in nature has never been developed. Virtually every soil sample contains a heterogeneous mix of organisms, most of which have never been characterized or studied (scientists estimate, for example that fewer than 10% of soil microorganisms have been specifically identified). Thus, any enumeration technique that utilizes artificial culturing of microorganisms is inherently biased to some degree in favor of known populations.

Method Reference Summary

I. Methods of the University of Wisconsin Soil and Plant Analysis Laboratory, Madison, Wisconsin, (subcontractor to BioRenewal Technologies, Inc.) as published in Wisconsin Procedures for Soil Testing, Plant Analysis and Feed and Storage Analysis, No. 6 Soil Fertility Series, Editors: E.E. Schulte, J.B. Peters and P.R. Hodgson, Revised 1987, Department of Soil Science, University of Wisconsin-Extension, Madison, Wisconsin.

Parameter	Matrix	Method Reference No. *
Total Kjeldahl nitrogen (TKN)	Soil/Water	UW87-35
Ammonium nitrogen	Soil/Water	UW87-41
Available phosphorus	Soil/Water	UW87-6
Available potassium	Soil/Water	UW87-8
pH	Soil/Water	UW87-4
Percent organic matter	Soil	UW87-9
Cation exchange capacity	Soil	UW87-17
Particle size analysis (hydrometer)	Soil	UW87-21
Sieve size analysis	Soil	UW87-unpub.
Total organic carbon (TOC)	Soil	UW87-unpub.
Nitrate nitrogen	Soil/Water	UW87-42
Sulfate-sulfur	Soil/water	UW87-19
Soluble salts	Soil/Water	UW87-20
Total minerals	Soil/Water	UW87-31
Heavy metals	Soil/Water	UW87-31
Exchangeable calcium	Soil	UW87-14
Exchangeable magnesium	Soil	UW87-14
Total solids	Water	UW87-unpub.
Alkalinity	Water	UW87-unpub.
Hardness	Water	UW87-unpub.

*Method numbers reflect revision date and page reference.

II. Methods of BioRenewal Technologies, Inc., Madison, Wisconsin.

Parameter	Matrix	Method Reference No.
Comparative Enumeration Assay	Soil/water	BTI 315
Methanotroph Enumeration Assay	Soil/water	BTI 325
Analysis for Putative TCE Degraders	Soil/water	BTI 326.1
Percent air-filled pore space	Soil	BTI 528.3
Moisture holding capacity	Soil	BTI 528.2
Bulk density	Soil	BTI 528.1
Percent solids	Soil	BTI 515

APPENDIX B

NASA DIGGING AND EXCAVATION PERMIT

DIGGING AND EXCAVATING PERMIT

NASA PLUM BROOK STATION
SANDUSKY, OHIO

CONTRACT NO.: N/A CONTRACTOR: Dames & Moore, Inc.

INSPECTOR: N/A WORK ORDER NO.: N/A

INITIATOR: Deborah L. Raede DATE: Sept. 13, 1994

SITE LOCATION: TNT Areas, Red Water Pond Areas, and Various Background Locations

REFERENCE DRAWINGS: Figures 3-1 through 3-22 of Dames & Moore's Sampling and Analysis Plan Dated September 1994

REMARKS:

CLEARANCES:

PLUM BROOK MANAGEMENT OFFICE AND SERVICE CONTRACTOR:

Mechanical: _____ Date: _____

Electrical: _____ Date: _____

Safety: _____ Date: _____

CLEARANCE (AS APPLICABLE):

NASA PLUM BROOK REACTOR MANAGER:

_____ Date: _____

APPENDIX C

INSTRUCTION MANUALS FOR FIELD EQUIPMENT

INSTRUCTIONS FOR YSI MODEL 33 S-C-T METER

YELLOW SPRINGS INSTRUMENT CO.
YSI
YELLOW SPRINGS, OHIO 45387

INSTRUCTIONS FOR YSI MODEL 33 S-C-T METER

A-03309-A SEPT. 73

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GENERAL DESCRIPTION

The YSI Model 33 S-C-T Meter is a portable, battery powered, transistorized instrument designed to accurately measure salinity, conductivity and temperature. It uses a probe consisting of a rugged, plastic conductivity cell and a precision YSI thermistor temperature sensor combined in a single probe.

Conductivity in umhos/cm is the measurement of electrical conductance a sample would have shown if measured between opposite faces of a 1 cm cube. Salinity is the number of grams of salt/kilogram of sample (‰ = parts per thousand). This measurement assumes the sample contains a "standard" sea water salt mixture. The sample temperature is measured in degrees Celsius.

Knowing temperature permits temperature correction of the conductivity and salinity measurements. Also, when just temperature and conductivity are known it is possible to calculate salinity, and when only temperature and salinity are known it is possible to calculate conductivity.

SPECIFICATIONS

Conductivity

Ranges:	0-500, 0-5,000, 0-50,000 umhos/cm with YSI 3300 Series Probes. (Note: The "umho" designations on the instrument are a shorthand form for "umho/cm".)
Accuracy:	± 2.5% max. error at 500, 5,000 and 50,000 plus probe ± 3.0% max. error at 250, 2,500 and 25,000 plus probe See Error Section

Readability:	2.5 umhos/cm on 500 umho/cm range 25 umhos/cm on 5000 umho/cm range 250 umhos/cm on 50000 umho/cm range

Salinity

Range:	0-40 ‰ (parts per thousand) over temperature range -2 to +45°C.
Accuracy:	Above 4°C, ± 0.9 ‰ at 40 ‰ and ± 0.7 ‰ at 20 ‰ plus conductivity probe. Below 4°C, ±1.1 ‰ at 40 ‰ and ± 0.9 ‰ at 20 ‰ plus conductivity probe. See Error Section.
Readability:	0.2 ‰ on 0-40 ‰ range

Temperature

Range:	+ 50 to -2°C
Accuracy:	± 0.1°C at -2°C, ± 0.6°C at 45°C plus probe. See Error Section.
Readability:	± 0.15°C at -2°C to ± 0.37°C at 45°C

Power Supply	Two D size alkaline batteries, Eveready E95 or equivalent, provide approximately 200 hrs. of operation.

Probe	YSI 3300 Series Conductivity/Temperature Probe Nominal Probe Constant: K =5
Accuracy:	Max. error ±2% of reading for conductivity and salinity. Max. error of ±0.1°C for temperature.
Instrument	
Ambient Range:	Satisfactory operation -5 to +45°C. A maximum error of ± 0.1% of the reading per °C change in instrument temperature can occur. This error is negligible if the instrument is readjusted to redline for each reading.

OPERATION PROCEDURE

1. **Setup**
   (a) Adjust meter zero (if necessary) by turning the bakelite screw on the meter face so that the meter needle coincides with the zero on the conductivity (umhos/ cm) scale.
   (b) Calibrate the meter by turning the switch to redline and adjusting the meter needle with the redline control to the red line on the scale. If this cannot be accomplished, replace the batteries.
   (c) Plug the probe into the probe jack on the side of the instrument.
   (d) Put the probe in the solution to be measured (See Probe Use).

2. **Temperature**
   Set the switch to temperature. Read the temperature on the bottom scale of the meter in degrees Celsius. Allow time for the probe temperature to come to equilibrium with that of the water before reading.
3. **Salinity**
   (a) Transfer the temperature reading from Step 2 to the temperature knob on the instrument.
   (b) Switch the instrument to the SALINITY position and read salinity on the red 0-40 ‰ meter range.
   (c) Depress the CELL TEST button. The meter reading should fall less than 2%; if greater, the probe is fouled and the measurement is in error. Clean the probe and re-measure.
4. **Conductance**
   (a) Switch the meter to the X100 umhos/cm range. If the reading is below 50 on the 0-500 meter scale, switch to the next lower range (X10 umhos/cm). If the reading is still below 50, switch to the next lower range (X1 umhos/cm). Read the meter scale and multiply that reading by the range (X100, etc.) The answer is the reading in umhos/cm.

Example:	Meter Reading	247
	Reading	X10
	Answer	2470 umhos/cm or
		.00247 mhos/cm

(b) When measuring on the X100 and X10 ranges, depress the CELL TEST button. The meter reading should fall less than 2%; if greater, the probe is fouled and the measurement is in error. Clean the probe and re-measure.

NOTE: The CELL TEST does not function on the X1 range.

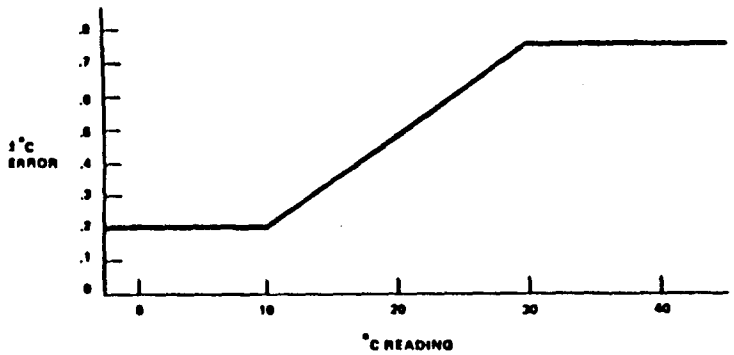
5. Error

The maximum error in a reading can be calculated by using the graphs in the following sections.

(1) Temperature

The temperature scale is designed to give the minimum salinity error when the temperature readings are used to compensate salinity measurements.

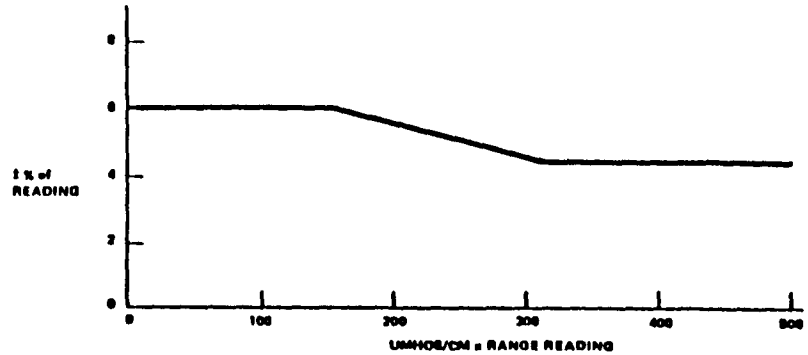
Figure 1 shows total error for probe and instrument versus °C reading.



Example:	Reading	25°C
	Error	.6°C
	Accuracy	25°C ± 0.6°C for probe and instrument combined

(2) Conductivity

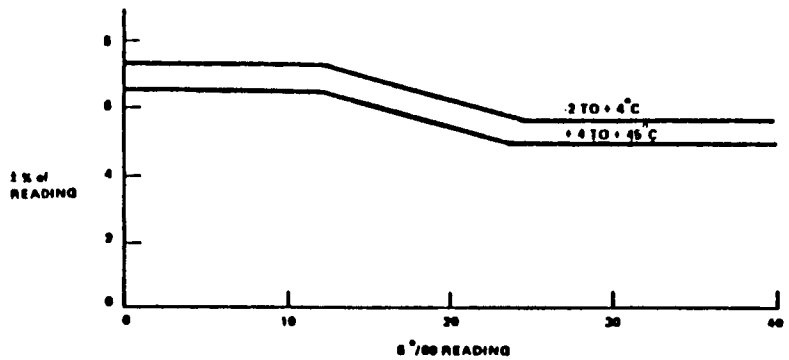
Figure 2 shows the worst case conductivity error as a function of the conductivity reading for the probe and instrument combined.



Example:	Reading	360 umhos/cm
	Range	X10
	% Reading Error	± 4.5%
	Accuracy	3600 ± 162 umhos/cm for probe and instrument

(3) Salinity

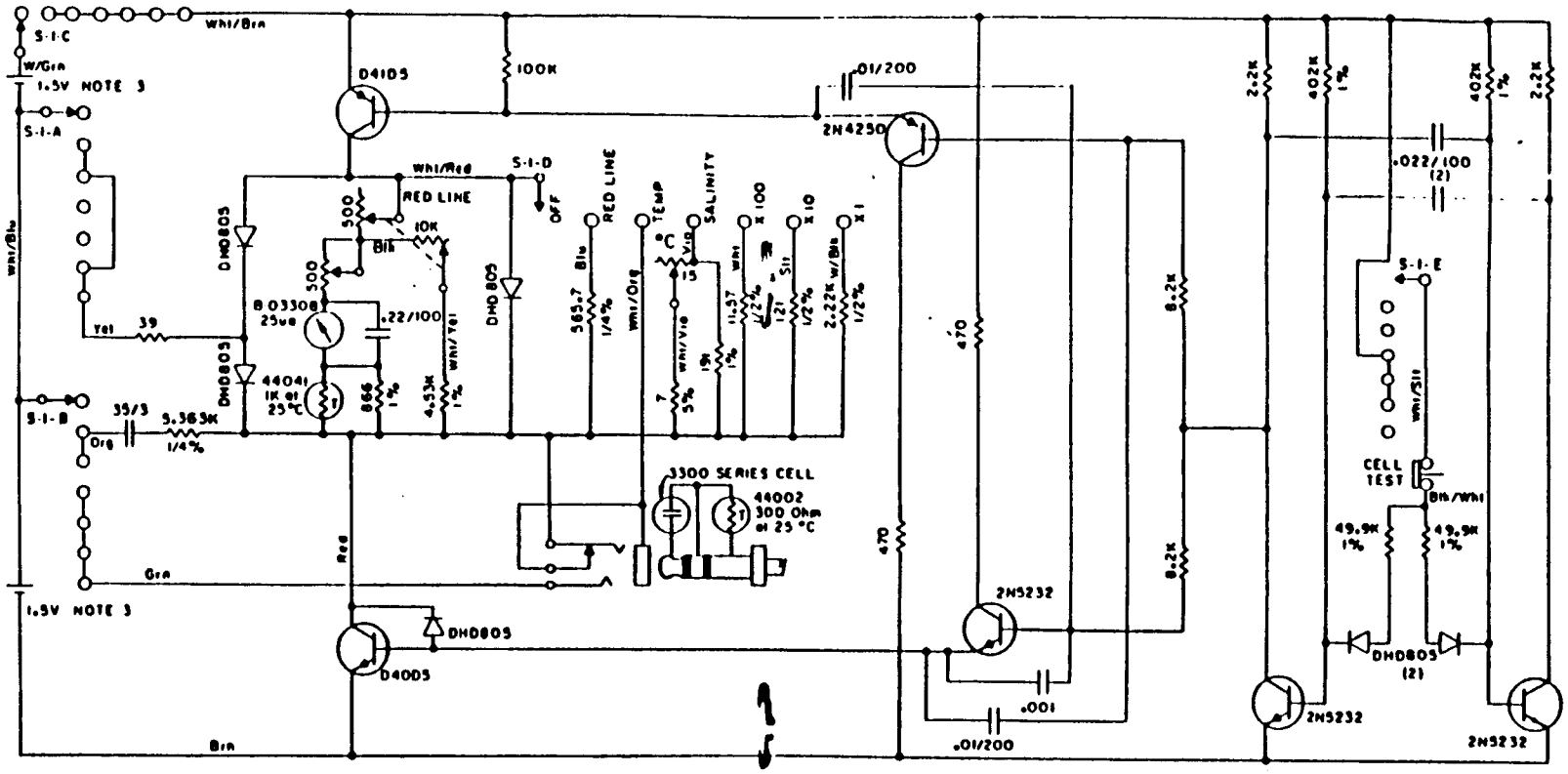
The salinity readings are a function of temperature and conductivity, therefore the accuracy is a function of both. The temperature scale and temperature control have been designed to minimize the temperature error contribution to the salinity error. The error shown in Figure 3 is the total of the temperature and conductivity probe, the temperature scale and the salinity scale errors.



Example: Reading 10 part/thousand, @ 10°C

% of Reading Error 6.5%

Accuracy 10 ‰ ± 0.65 ‰ for all errors, combined worst case.



YSI MODEL 33

B-03321-D

NOTE:

1. Resistance values in ohms, K=1,000; resistors are ¼W, 10% unless otherwise specified.
2. The values shown on the schematic may differ from those in the instrument; if so, either value can be used for replacement purposes.
3. Battery is "D" size, alkaline only, Eveready E 95 or equal.

CIRCUIT DESCRIPTION, MAINTENANCE AND CALIBRATION

1. Description

The circuit is composed of two parts; a multivibrator and switching transistors. The multivibrator produces a square waveform voltage. The square wave is applied to two switching transistors. They alternately apply two batteries of opposite polarity to the probe thus providing AC power which minimizes polarization effects. The meter is in series with one battery and measures the current from it. The current from the battery is proportional to the conductance of the cell. Salinity is measured in a special range conductivity circuit which includes a customer-adjusted temperature compensator. In the temperature, redline and X1 positions the multivibrator operated at 100 Hz. In the salinity, X100 and X10 positions the multivibrator operates at 600 Hz and on these ranges pushing the CELL TEST button drops the frequency to 100 Hz allowing the operator to judge the degree of probe polarization.

2. Maintenance

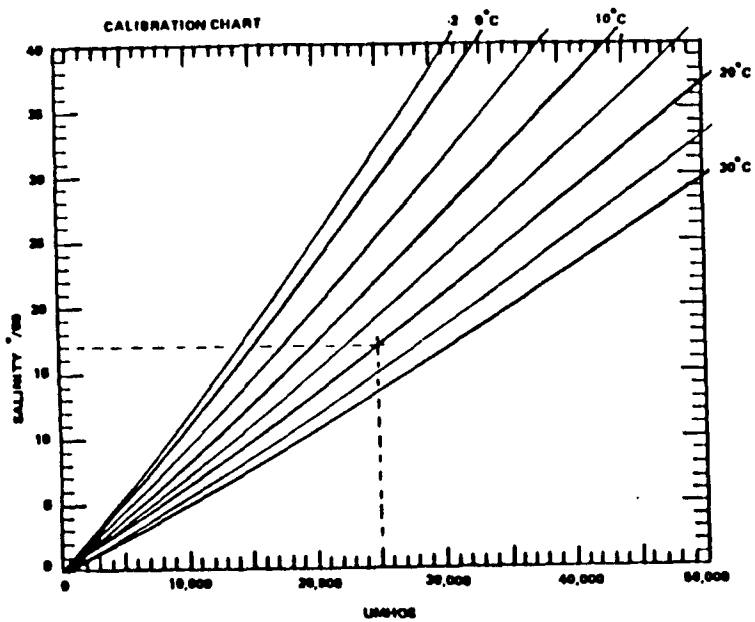
The only maintenance required is battery replacement. Two "D" size alkaline flashlight cells, such as Eveready E95 or equivalent batteries will provide 200 hrs. of operation. Accuracy will not be maintained if zinc-carbon "D" cells are used. Battery replacement is indicated when the redline adjustment cannot be accomplished.
Replace batteries every six months to reduce the danger of corrosion due to leaky batteries. To replace batteries, remove the six screws from the bottom plate. The battery holders are color coded. The Positive (+ button) end must go on red.

3. Calibration

It is possible for the temperature knob to become loose or slip from its normal position. In an emergency the dial can be re-positioned. It must be emphasized that this is an emergency

procedure only, and that the instrument should be returned to the factory for proper recalibration at the earliest opportunity.

(a) Read the temperature and conductance of the solution. Determine the salinity of the solution by running a line vertically on the graph from this conductance value until it intersects the appropriate °C line (interpolate as required for



temperatures between the given °C lines). From this intersection extend a line horizontally to the edge of the graph. This determines the salinity for this sample.
Example: 25000 umhos and 20°C gives a salinity of 17.

(b) Remove the °C knob, switch to SALINITY, and turn the control shaft until the meter needle indicates the salinity value determined in Step (a). In the example given, the value is 17.

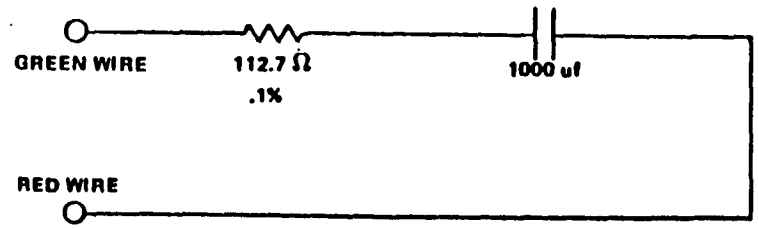
(c) Switch to TEMPERATURE (Note: This temperature reading must be the same as Step (a); if not, begin again at Step (a).) Place the knob on the control shaft (without turning the control shaft) with the knob pointer at the same temperature as the meter reading and tighten both set screws securely.

At earliest opportunity recalibrate using the following procedure or return the instrument to factory for service.

(a) Set the instrument for a salinity measurement as normal.

(b) Substitute a 1000 uf capacitor and 112.7 ohm 0.1% tolerance resistor for the probe.

Connect the resistor and capacitor between the green wire and red wire on the jack connections inside the instrument.



(c) Turn the temperature dial until the meter reads redline. Now install the temperature knob with the arrow at 25°C. This is a temporary calibration only. Return the instrument to the factory for proper recalibration.

PROBE

1. Description of YSI 3300 Series Conductivity/Temperature Probe

The YSI 3300 Series Conductivity Probes are designed for fieldportability embodying construction and design for rugged, accurate service.

Each probe features a built-in cell constant of 5.00 ± 0.1, a precision YSI thermistor temperature sensor of ± 0.1°C accuracy, and a low capacitance cable assembly terminating in a three terminal 0.25 dia. phone type connector.

The 3310 has a 10 ft. cable and the 3311 is a 50 ft. version. Other lengths are available on special order.

The probe has a rigid P.V.C. body, platinized pure nickel electrodes, and a chrome-vinyl jacket cable, providing resistance to a wide range of water-borne substances.

2. Maintenance

(a) Cleaning

When the cell test indicates low readings the probable cause is dirty electrodes. Hard water deposits, oils and organic matter are the most likely contaminants.

For convenient normal cleaning soak the electrodes for 5 minutes with a locally available bathroom tile cleaning preparation such as: Dow Chemical "Bathroom Cleaner"; Horizon Industries "Rally, Tile, Porcelain, and Chrome Cleaner"; Johnson Wax "Envy, Instant

Cleaner"; or Lysol Brand "Basin, Tub, Tile Cleaner."

For stronger cleaning a 5 minute soak in a solution made of 10 parts distilled water, 10 parts isopropyl alcohol and 1 part HC1 can be used.

Always rinse the probe after cleaning and before storage.

CAUTION: Do not touch the electrodes inside the probe. Platinum black is soft and can be scraped off.

If cleaning does not restore the probe performance, re-platinizing is required.

(b) Re-Platinizing

Equipment Required –

(1) YSI #3140 Platinizing Solution, 2 fl. oz. (3% Platinum Chloride dissolved in .025% lead acetate solution).
(2) YSI Model 33 S-C-T Meter.
(3) 50 ml glass beaker or equivalent bottle.
(4) Distilled water.

Procedure –

(1) Clean the probe as in Section (a) – either method.
(2) Place the cell in the beaker and add sufficient solution to cover the electrodes. Do not cover the top of the probe.
(3) Plug the probe into the Model 33, switch to the X100 range to platinize the electrode. Move the probe slightly to obtain the highest meter reading and continue platinizing for the approximate time shown below:

Meter Reading (umhos)	Time (minutes)
30,000	5
25,000	6
20,000	8
15,000	11
10,000	16

(4) After the elapsed time remove the probe and rinse in fresh water.

(5) Return the solution to its container. 2 oz. of solution should be sufficient for 50 treatments.

3. Probe Use

(a) Obstructions near the probe can disturb readings. At least two inches of clearance must be allowed from non-metallic underwater objects. Metallic objects such as piers or weights should be kept at least 6 inches from the probe.

(b) Weights are attached to the cable of the YSI 3310 and 3311 Probes. The YSI 3327 Weights are supplied in pairs with a total weight of 4 ounces per pair. Should it become necessary to add more weight to overcome water currents, we suggest limiting the total weight to two pounds (8 pairs). For weights in excess of two pounds use an independent suspension cable. In either case, weights must be kept at least 6 inches away from the probe.

(c) Agitations

Gentle raising and lowering of the probe several times during a measurement insures flow of specimen solution through the probe and improves the time response of the temperature sensor.

4. Cell Calibration & Standard Solutions

The YSI #3300 Series Cells are calibrated to absolute accuracy of ± 1-1/2% based on a standard solution. Since the literature on conductivity does not indicate a consistently accepted standardization methods, we have chosen the .01 demal KCl solution method as determined by Jones and Bradshaw in 1937 as our standard. Recent textbooks, as well as the ASTM standards, concur with this choice.

The solution is prepared by diluting .745 grams of pure dry KC1 with distilled water until the solution is 1 kilogram. The table below

shows the values of conductivity this solution would have if the distilled water were non-conductive. However, since even high purity distilled water is slightly conductive, the measured conductivity will be higher by an amount equal to the water's conductivity.

Temperature °C	Conductivity (Absolute Micromhos/cm³)
15	1141.5
16	1167.5
17	1193.6
18	1219.9
19	1246.4
20	1273.0
21	1299.7
22	1326.6
23	1353.6
24	1380.8
25	1408.1
26	1436.5
27	1463.2
28	1490.9
29	1518.7
30	1546.7

The operator may use the standard solution and the table to check accuracy of a cell's constant or to determine an unknown constant. The formula is shown below:

$$K = \frac{R(C_1 + C_2)}{10^6}$$

where: K = Cell Constant
R = measured resistance in ohms
C_1 = conductivity in absolute micromhos
C_2 = conductivity in absolute micromhos of the distilled water used in making solution

R, C_1 and C_2 must either be determined at the same temperature or corrected to the same temperature to make the equation valid.

Note: For further information on conductivity and the above standard information, refer to ASTM Standards Part 23 – Standard Methods of Test for Electrical Conductivity, or Water and Industrial Waste Water – ASTM Designation D1125-64.

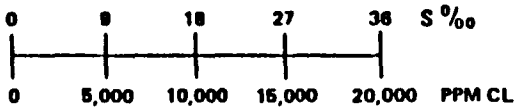
YSI MODEL 33 USED WITH YSI 51A or 54 OXYGEN METER

If the Model 33 salinity measurement is to be used for salinity correction on the 51A, the reading should be converted to Chlorosity. The formula is:

$$\text{PPMChlorosity} = \frac{\text{Salinity } ‰ - 0.03}{1.8} \times 10^3$$

For these instruments the 0.03 can be neglected so the equation simplifies to:

$$\text{PPMCl} = \frac{S\ ‰}{1.8} \times 10^3$$



REPAIR FACILITIES

If you are experiencing difficulty with a YSI product, it may be returned to the YSI Customer Service Department for repair, even if the guarantee has expired. YSI maintains complete facilities for prompt servicing of all YSI products.

GUARANTEE

The Model 33 S-C-T Meter carries a one year unconditional guarantee on all workmanship and components. Damage through accident, misuse, or tampering will be repaired at a nominal charge when the instrument is returned to our plant. Cells are similarly guaranteed.

Note: In communications regarding this instrument, please mention model number and serial number.

CALIBRATION PROCEDURES FOR HNu METER

HNU PI-101 Calibration. [Appropriate manufacturer's instructions should be inserted if a different PID is used.]

- Battery check--The function switch should be turned to BATT. The needle should be in the green region; if not, recharge the battery.

- Zero set--The function switch should be turned to STANDBY. In this position, the lamp is OFF and no signal is generated. The zero point should be set with the ZERO set control.

- Gas standard--The standard should be connected to the probe. The function switch should be turned to the range position of the standard and the meter reading should be noted. The SPAN control setting should be adjusted, as required, to read the parts per million (ppm) concentration of the standard. The zero setting should be rechecked.

- Lamp cleaning--If the span setting from calibration is 0.0 or calibration cannot be achieved, then the lamp must be cleaned.

- Lamp replacement--If the lamp output is too low or if the lamp has failed, it must be replaced.

CALIBRATION PROCEDURES FOR OVA

Foxboro Organic Vapor Analyzer Calibration [Appropriate manufacturer's instructions should be inserted if a different OVA is used.]

- Start up OVA according to factory procedure; warm it up for 10 minutes prior to calibration.

- Fill a small (2 liter) Tedlar bag with 100 ppm Methane/balance air calibration gas.

- Set the calibrate switch to X10.

- Sample the gas from the Tedlar bag. Use the "gas select" potentiometer to adjust the reading on the readout scale to near 100 (10 x 10). The reading should stabilize in 20 to 30 seconds.

- Lock the knob on the gas select potentiometer; the OVA is now ready to use.

APPENDIX D

ANALYTICAL SERVICES, INC.
COMPREHENSIVE QUALITY ASSURANCE PLAN

ASI

COMPREHENSIVE QUALITY ASSURANCE PLAN

for

Analytical Services, Inc.
390 Trabert Avenue
Atlanta, GA 30309
(404) 892-8144

Robert G. Owens, Jr., Chief Chemist	12/15/93 Date
Denise S. Geier, Laboratory Director	12/15/93 Date
Roy-Keith Smith, Ph. D., QA Officer	15 Dec 93 Date

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STATEMENT OF POLICY

Analytical Services, Inc., offers a complete line of laboratory testing procedures for the analysis of Environmental Samples, along with the ability to procure samples in the field, in conformity with established EPA and state environmental regulatory agency guidelines.

Analytical Services, Inc., is committed to the use of good Quality Control procedures for all field and laboratory operations in order to insure both the analytical validity and the legal defensibility of all reported data. The specific Quality Control procedures are governed by strict adherence to the Quality Assurance program, which details the techniques utilized to achieve the maximum accuracy, precision, completeness, representativeness and comparability of results reported from this organization.

The Quality Assurance program is detailed in the Comprehensive Quality Assurance Plan. The Plan is a written document which is updated at regular intervals or as necessary to incorporate expansions to the capabilities of Analytical Services, Inc., or changes in accepted Quality Control methods as promulgated by EPA and/or state environmental regulatory agencies. Implementation of the Quality Control methods detailed in the Comprehensive Quality Assurance Plan is overseen by the Quality Assurance Manager, who reports directly to the Laboratory Chief Chemist.

ORGANIZATION AND RESPONSIBILITY

Organization Capabilities

Analytical Services, Inc., is a full-service laboratory performing chemical and biological testing of a wide variety of environmental samples, including laboratory water, drinking water, surface, ground and waste water, chemical wastes, soils and sediments, and air samples. ASI also provides sampling containers, automated and manual sampling instruments and qualified personnel to obtain samples, who are trained in proper EPA and appropriate state environmental regulatory agency sampling protocols.

Key Personnel

Chief Chemist - Robert G. Owens, Jr.

The Chief Chemist serves as the director of ASI. His responsibilities include but are not limited to the following functions. Stays up-to-date on current legislation and environmental regulations to determine the demand for specific lab services, and determines the need for ASI to expand it's analytical capabilities to meet the projected demand. Maintains liaison between ASI and potential lab users through attendance at industry and government forums which address environmental laboratory issues. Presents papers and reports at these forums, if appropriate. Receives and reviews reports from the Laboratory Director, Chemical Hygiene Officers and the Quality Assurance Officer and takes appropriate action. Keeps ASI employees aware of upcoming projects, regulations and laws which may have an effect on their job. Hires key personnel and recruits professional talent. Develops and administrates company budget. Represents ASI as an expert witness or responsible officer in legal cases.

Laboratory Director - Denise S. Geier

The Laboratory Director serves as the person responsible for oversight of the day-to-day operations of ASI. Her duties include, but are not limited to the following functions. Maintains sample turnaround time and insures proper flow of samples through the laboratory. Controls costs and orders all supplies through approval of purchase orders. Oversees the training of new employees and checks on the training level of established employees. Oversees the operations of the various laboratory sections and receives reports from the Laboratory Supervisors. Checks analytical reports from the laboratory sections for proper parameter testings and values prior to sending reports to customers. Oversees laboratory work scheduling to eliminate bottlenecks. Advises Chief Chemist and suggests areas which need his attention.

Quality Assurance Officer - Roy-Keith Smith, Ph. D.

The Quality Assurance Officer/Analytical Methods Manager serves to insure that the prescribed protocols in the Comprehensive Quality Assurance Plan (CQAP) are implemented. His responsibilities include, but are not limited to the following functions. Collects data for inclusion in the CQAP, and insures that the included data is correct and documented. Oversees and maintains preparation of control charts and supporting data for each analytical procedure and sampling procedure used in ASI's operations. Provides technical review of data prior to release to clients to insure proper QA/QC samples are analyzed, determine that prescribed QA/QC acceptance criteria are met, to insure that the reported data makes "sense", to identify out of control tests, and to spot check bench sheets for QA/QC accuracy and precision. Prepares weekly, quarterly and annual QA reports. Insures updated revisions to the CQAP are prepared and provided to appropriate regulatory agencies on at least an annual basis. Provides QA/QC procedures and data to requesting clients. Serves as the in-house technical consultant in QA/QC matters to the laboratory sections. Oversees equipment maintenance and repair. Administers performance evaluation samples, check samples and calibration standards. Performs internal QA/QC audits and assists with external audits. As Analytical Methods Manager he is responsible for keeping the lab technicians up-to-date insofar as approved analytical

methods are concerned. He is also responsible for investigating new technologies and proposed equipment acquisitions by the laboratory.

Chemical Hygiene Officer - Danny Brookshire

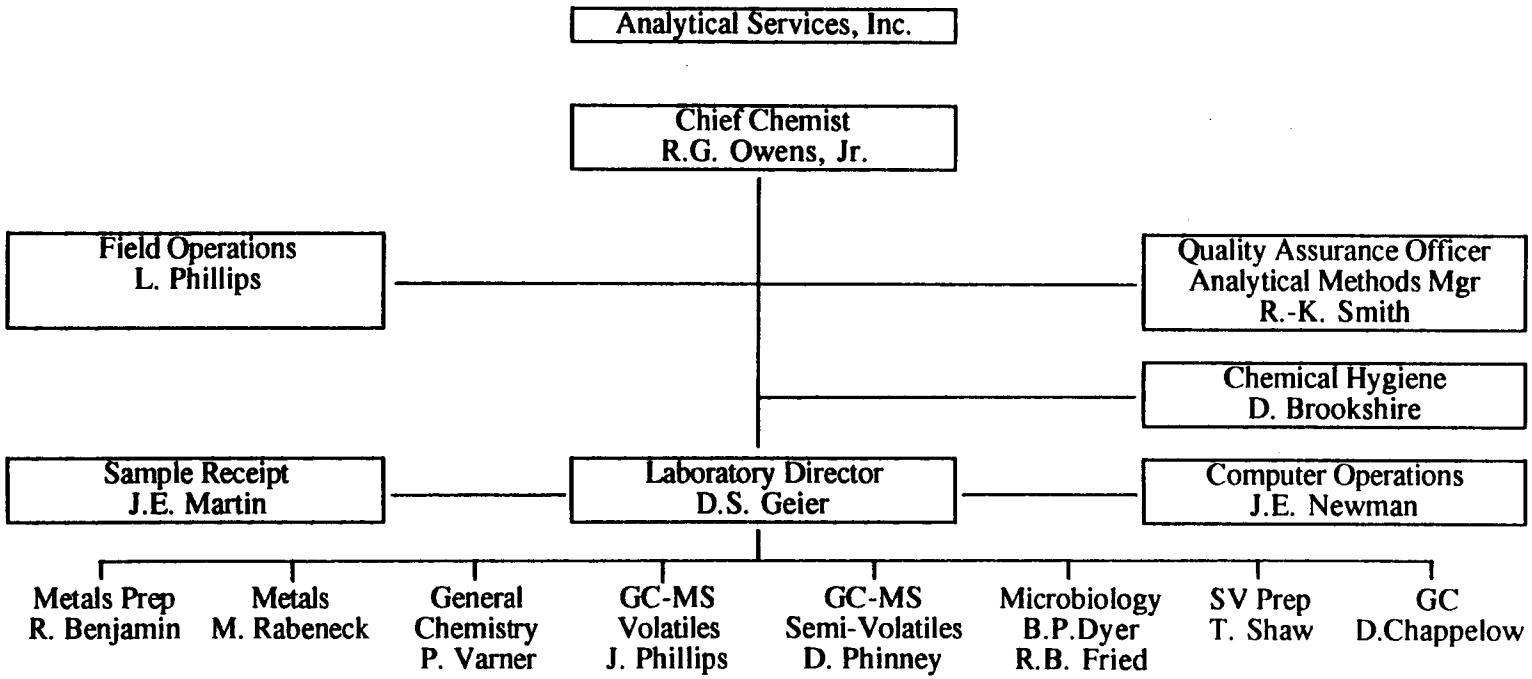
The Chemical Hygiene Officer serves to insure a safe workplace at ASI for the employees. The function is especially important in light of the number of hazardous substances which are either used in the analytical procedures or present in the samples analyzed. The responsibilities include, but are not limited to the following functions. Work with management and employees to develop and implement appropriate chemical hygiene policies and practices. Monitor procurement, use and disposal of laboratory chemicals. Insure that all laboratory employees are familiar with and practice chemical hygiene policies. Conduct regular chemical hygiene and housekeeping inspections of laboratory and emergency equipment. Determine and implement required use of protective clothing and equipment in the laboratory and field operations. Schedule regular medical surveillance examinations for employees with Atlanta Medical Associates and keep records of employee compliance. Keep abreast of current regulations and policies promulgated by federal and state government as pertains to workplace safety.

Laboratory Section Supervisors

Computer Operations - J.E. Newman
Field Operations - L. Phillips
Sample Receipt - J.E. Martin
General Chemistry - P. (Owens) Varner
GC-MS Volatiles - J. Phillips
GC-MS Semivolatiles- D. Phinney
Metals - M. Rabeneck
Microbiology - B.P. Dyer
Metals Preparation - R. Benjamin
Semivolatiles Preparation - T. Shaw
GC - D. Chappelow

Each of the Laboratory Section Supervisors serves to oversee and participate in the day-to-day operations of their respective section. Their duties include, but are not limited to the following functions. Organizes and distributes the workload within the section. Oversees maintenance of the section's machines and instruments and troubleshoots problems when they arise. Prepares purchase request for supplies and equipment. Provides data to the Quality Assurance Officer and maintains control charts for each analytical procedure in the section. Trains new employees in their duties. Maintains personnel control of the employees in the section. Evaluates technicians in the section with respect to job performance, job description, goals and other key factors. Insures that QA/QC procedures are being followed as specified in each analytical procedure. Maintains, reviews and files analytical bench sheets or field notebooks. Maintains instrument logs. Implements new methodologies and technologies in the section. Reports parameter test results on samples to Laboratory Manager. Insures that samples are analyzed in a timely manner and schedules section work to avoid bottlenecks in sample throughput.

Figure 4.1 Analytical Services, Inc. Organizational Chart



QUALITY ASSURANCE OBJECTIVES

Table 5.1. QA Objectives for Analysis of Laboratory Water Samples[1]

Component / Parameter	Analytical Methods EPA[2]	SM[3]	Other[4]	Precision %RSD	Accuracy % Recovery	MDL ug/L
Growth ratio		902A		NA	NA	0.8-3.0 ratio
Cadmium	200.7			0-20	75-125	2
Chromium	200.7			0-20	75-125	5
Copper	200.7			0-20	75-125	2
Nickel	200.7			0-20	75-125	10
Lead	200.7			0-20	75-125	25
Zinc	200.7			0-20	75-125	4
Inhibitory Residue (Detergent)		902A		NA	NA	NA
Permanganate Time Test			ASTM D1193-77, Std No. 7916	NA	NA	NA

[1] QA objectives are obtained from published data. Historical data is being generated and will replace the literature data in the first annual update following approval.

[2] Methods for Chemical Analysis of water and wastes, EPA-600/4-79-020, revised March, 1983.

[3] Standard Methods for the Examination of Water and Wastewater, 17th Edition, 1989.

[4] ASTM Annual Book of Standards, 1977.

Table 5.2. QA Objectives for Analysis of Drinking Water Samples.[1]

Component / Parameter	Analytical Methods EPA[2]	SM[3]	Other	Precision %RSD	Accuracy % Recovery	MDL ug/L
Alkalinity	310.1			0-30	75-125	1000
Ammonia	350.2			0-20	75-125	100
Bacteria (Fecal Coliform)		9221B		0-30	75-125	1 organism /100 mL
		9221C		0-30	75-125	1 organism /100 mL
Bacteria (Total Coliform)		9221 B		0-30	75-125	1 organism /100 mL
		9221 C		0-30	75-125	1 organism /100 mL
Chloride	325.2			0-30	75-125	1000
	325.3			0-30	75-125	1000
Chlorine, residual	330.2			0-30	75-125	100
Color	110.2			0-50	NA	5 Pt-Co Units
Cyanide	335.2			0-20	75-125	
Fluoride	340.2			0-30	75-125	100
Hardness	200.7			0-30	75-125	1000
Nitrate	353.2			0-30	75-125	10
	353.3			0-30	75-125	10
Nitrite	353.2			0-30	75-125	10
pH	150.1			0-20	80-120	N/A
Solids, Total Dissolved	160.1			0-40	60-140	5000
Surfactants (MBAS)	425.1			0-30	75-125	40
Sulfate	375.4			0-30	75-125	1000
Turbidity	180.1			0-30	75-125	0.05 NTU
Metals						
Antimony	200.7			0-20	75-125	50
	204.2			0-20	75-125	3
Arsenic	206.2			0-20	75-125	10
Barium	200.7A			0-20	75-125	1
	208.2			0-20	75-125	2
Beryllium	200.7			0-20	75-125	1
Cadmium	200.7A			0-20	75-125	1
	213.2			0-20	75-125	0.1
Chromium	200.7A			0-20	75-125	5
	218.2			0-20	75-125	1
Copper	200.7			0-20	75-125	2
	220.2			0-20	75-125	1
Iron	200.7			0-20	75-125	5
Lead	200.7A			0-20	75-125	25
	239.2			0-20	75-125	5
Manganese	200.7			0-20	75-125	1
Mercury	245.1			0-20	75-125	0.2
Nickel	200.7			0-20	75-125	10
	249.2			0-20	75-125	1
Selenium	270.2	304		0-20	75-125	2

[1] QA objectives drawn from published data. Historical data is under preparation and will replace the literature data in the first annual update following approval.

[2] Method numbers 100-499 are in Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020, revised March, 1983. 500 series methods are in Methods for the Determination of Organic Compounds in Drinking Water, EPA 600/4-88/039, December 1988 and supplements.

[3] Standard Methods for the Examination of Water and Wastewater, 17th Edition, 1989.

Table 5.2. (continued) QA Objectives for Analysis of Drinking Water Samples.[1]

Component / Parameter	Analytical Methods EPA[2]	Other	Precision %RSD	Accuracy % Recovery	MDL ug/L
Silver	200.7A		0-20	75-125	3
	272.2		0-20	75-125	0.2
Thallium	200.7		0-20	75-125	100
	279.2		0-20	75-125	10
Zinc	200.7		0-20	75-125	4
	289.2		0-20	75-125	0.05
Organic Internal Standards					
Acenaphthene -d10	525				
Chrysene-d12	525				
Phenanthrene-d10	525				
Fluorobenzene	524.2				
Organic Surrogates					
4-Bromofluorobenzene	524.2		0-40	86-115	
1,2-Dichloroethane-d4	524.2		0-40	76-114	
Perylene-d12	525		0-40	ID	
Pesticides/Herbicides					
2,4-D	515.1		0-40	60-140	0.1
2,4,5-TP (Silvex)	515.1		0-40	41-227	0.2
Alachlor	505		0-30	48-156	0.2
	507		0-30	51-139	0.38
Aldrin	505,508		0-30	48-124	0.075
	525		0-40	37-125	0.1
Atrazine	505		0-40	20-159	0.1
	525		0-50	43-177	0.3
Butachlor	507		0-30	56-136	0.4
Chlordane	505		0-40	31-141	0.1
	508		0-30	51-147	0.002
Dalapon	515.1		0-40	40-160	1.3
1,2-Dibromo-3-chloropropane	504		0-40	60-140	0.02
Dicamba	515.1		0-40	40-144	0.08
Dieldrin	508		0-30	47-127	0.02
Dinoseb	515.1		0-40	49-129	0.19
Endrin	508		0-30	48-128	0.015
Ethylene dibromide	504		0-40	60-140	0.01
Heptachlor	505,508		0-30	50-146	0.04
Heptachlor epoxide	505,508		0-30	47-127	0.02
Hexachlorobenzene	505		0-40	34-164	0.002
	525		0-40	6-144	0.2
Hexachlorocyclopentadiene	505		0-40	26-120	0.13
	525		0-50	9-140	0.1
Lindane	505,508		0-30	49-129	0.02
Methoxychlor	505,508		0-40	37-163	0.1
Metolachlor	507		0-30	53-133	0.75

[1] QA objectives drawn from published data. Historical data is under preparation and will replace the literature data in the first annual update following approval.

[2] Method numbers 100-499 are in Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020, revised March, 1983. 500 series methods are in Methods for the Determination of Organic Compounds in Drinking Water, EPA 600/4-88/039, December 1988 and supplements.

Table 5.2. (continued) QA Objectives for Analysis of Drinking Water Samples.[1]

Component / Parameter	Analytical Methods EPA[2]	Other	Precision %RSD	Accuracy % Recovery	MDL ug/L
Metribuzin	507		0-30	61-141	1.0
p,p'-DDT	508		0-40	45-179	0.06
Pentachlorophenol	515.1		0-40	36-224	0.04
	525		0-50	10-140	3
Picloram	515.1		0-40	44-138	0.14
Propachlor	508		0-30	58-131	1.0
Simazine	505		0-40	56-132	6.8
	507		0-30	0-140	0.075
	525		0-50	40-167	0.2
Toxaphene	505,508		0-40	60-168	1.0
Semi-volatile Organics					
2-Chlorobiphenyl	525		0-40	38-142	0.1
2,3-Dichlorobiphenyl	525		0-40	34-136	0.2
Acenaphthylene	525		0-40	49-131	0.1
Anthracene	525		0-40	20-150	0.1
Benzo(a)anthracene	525		0-50	30-150	0.2
Benzo(a)pyrene	525		0-40	20-160	0.1
Benzo(b)fluoranthene	525		0-40	20-128	0.3
Benzo(ghi)perylene	525		0-50	10-140	0.1
Benzo(k)fluoranthene	525		0-40	30-150	0.3
Benzylbutylphthalate	525		0-40	30-130	0.5
bis(2-ethylhexyl)adipate	525		0-50	27-125	0.5
bis(2-ethylhexyl)phthalate	525		0-50	28-142	0.8
Chrysene	525		0-40	30-150	0.3
di-n-Butyl phthalate	525		0-50	20-164	4.0
Dibenzo(a,h)anthracene	525		0-50	10-110	0.1
Diethyl phthalate	525		0-50	22-188	0.6
Dimethyl phthalate	525		0-40	20-150	0.3
Fluorene	525		0-50	36-184	0.1
2,2',3,3',4,4',6-Heptachlorobiphenyl	525		0-50	10-150	0.04
2,2',4,4',5,6'-Hexachlorobiphenyl	525		0-50	10-150	0.1
Indeno(1,2,3-cd)pyrene	525		0-50	16-150	0.02
2,2',3,3',4,5',6,6'-Octachlorobiphenyl	525		0-50	10-150	0.1
2,2',3',4,6-Pentachlorobiphenyl	525		0-50	10-150	0.1
Phenanthrene	525		0-40	45-138	0.2
Pyrene	525		0-30	31-139	0.2
2,2',4,4'-Tetrachlorobiphenyl	525		0-50	10-150	0.1
2,4,5-Trichlorobiphenyl	525		0-50	10-150	0.12
Volatile Organics					
2-Chlorotoluene	524.2		0-40	50-150	0.04
4-Chlorotoluene	524.2		0-40	50-150	0.06
1,1-Dichloroethane	524.2		0-30	65-135	0.04

[1] QA objectives drawn from published data. Historical data is under preparation and will replace the literature data in the first annual update following approval.

[2] Method numbers 100-499 are in Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020, revised March, 1983. 500 series methods are in Methods for the Determination of Organic Compounds in Drinking Water, EPA 600/4-88/039, December 1988 and supplements.

Table 5.2. (continued) QA Objectives for Analysis of Drinking Water Samples.[1]

Component / Parameter	Analytical Methods EPA[2]	Other	Precision %RSD	Accuracy % Recovery	MDL ug/L
1,1-Dichloroethene	524.2		0-30	59-139	0.12
1,1-Dichloropropene	524.2		0-40	50-150	0.10
1,2-Dibromo-3-chloropropane	524.2		0-40	46-154	0.26
1,2-Dibromoethane	524.2		0-30	51-135	0.06
1,2-Dichlorobenzene	524.2		0-30	60-130	0.03
1,2-Dichloroethane	524.2		0-30	57-127	0.06
1,2-Dichloropropane	524.2		0-30	61-131	0.04
1,3-Dichlorobenzene	524.2		0-40	50-150	0.12
1,3-Dichloropropane	524.2		0-30	60-130	0.04
1,4-Dichlorobenzene	524.2		0-30	63-151	0.03
2,2-Dichloropropane	524.2		0-40	50-150	0.35
1,1,1-Trichloroethane	524.2		0-30	65-135	0.08
1,1,2-Trichloroethane	524.2		0-40	50-150	0.10
1,2,3-Trichlorobenzene	524.2		0-40	50-150	0.03
1,2,3-Trichloropropane	524.2		0-40	50-150	0.32
1,2,4-Trichlorobenzene	524.2		0-40	50-150	0.04
1,2,4-Trimethylbenzene	524.2		0-40	50-150	0.13
1,3,5-Trimethylbenzene	524.2		0-40	50-150	0.05
1,1,1,2-Tetrachloroethane	524.2		0-40	50-150	0.05
1,1,2,2-Tetrachloroethane	524.2		0-30	62-150	0.04
Benzene	524.2		0-30	67-127	0.04
Bromobenzene	524.2		0-30	62-122	0.03
Bromochloromethane	524.2		0-40	50-150	0.04
Bromodichloromethane	524.2		0-40	49-151	0.08
Bromoform	524.2		0-30	60-130	0.12
Bromomethane	524.2		0-40	50-150	0.11
n-Butylbenzene	524.2		0-40	50-150	0.11
Chlorobenzene	524.2		0-30	62-132	0.04
Chloroethane	524.2		0-40	50-150	0.10
Chloromethane	524.2		0-40	50-150	0.13
cis-1,2-Dichloroethene	524.2		0-40	50-150	0.12
cis-1,3-Dichloropropene	524.2		0-40	50-150	0.2
Dibromochloromethane	524.2		0-40	47-137	0.05
Dibromomethane	524.2		0-30	58-130	0.24
Dichlorodifluoromethane	524.2		0-30	60-132	0.10
Dichloromethane	524.2		0-50	40-160	0.03
Ethylbenzene	524.2		0-40	50-150	0.06
Hexachlorobutadiene	524.2		0-40	50-150	0.11
Isopropylbenzene	524.2		0-40	50-150	0.15
4-Isopropyltoluene	524.2		0-40	50-150	0.12
m-Xylene	524.2		0-40	50-150	0.05
Naphthalene	524.2		0-40	50-150	0.04
o-Xylene	524.2		0-30	62-132	0.11
p-Xylene	524.2		0-30	61-141	0.13
n-Propylbenzene	524.2		0-40	50-150	0.04
sec-Butylbenzene	524.2		0-40	50-150	0.13
Styrene	524.2		0-30	50-150	0.04

[1] QA objectives drawn from published data. Historical data is under preparation and will replace the literature data in the first annual update following approval.

[2] Method numbers 100-499 are in Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020, revised March, 1983. 500 series methods are in Methods for the Determination of Organic Compounds in Drinking Water, EPA 600/4-88/039, December 1988 and supplements.

Table 5.2. (continued) QA Objectives for Analysis of Drinking Water Samples.[1]

Component / Parameter	Analytical Methods EPA[2]	Other	Precision %RSD	Accuracy % Recovery	MDL ug/L
tert-Butylbenzene	524.2		0-40	50-150	0.14
Tetrachloroethene	524.2		0-30	60-126	0.14
Tetrachloromethane	524.2		0-40	55-121	0.21
Toluene	524.2		0-30	65-135	0.11
trans-1,2-Dichloroethene	524.2		0-30	58-128	0.06
trans-1,3-Dichloropropene	524.2		0-40	50-150	0.50
Trichloroethene	524.2		0-30	51-129	0.19
Trichlorofluoromethane	524.2		0-30	69-139	0.08
Trichloromethane	524.2		0-30	63-133	0.03
Vinyl chloride	524.2		0-30	62-132	0.17

[1] QA objectives drawn from published data. Historical data is under preparation and will replace the literature data in the first annual update following approval.

[2] Method numbers 100-499 are in Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020, revised March, 1983. 500 series methods are in Methods for the Determination of Organic Compounds in Drinking Water, EPA 600/4-88/039, December 1988 and supplements.

Table 5.3. QA Objectives for the Analysis of Ground, Surface and Waste Water Samples[1].

Component / Parameter	Analytical Methods EPA[2]	SM[3]	EPA[4]	Precision %RSD	Accuracy % Recovery	MDL ug/L
Acidity	305.1			0-30	75-125	1000
Alkalinity	310.1			0-30	75-125	1000
Ammonia	350.2			0-30	75-125	100
		4500-NH3		0-30	75-125	100
Ash	160.4			0-20	80-110	1000
Bicarbonate		4500-CO2		0-30	75-125	500
BOD 5-day	405.1			0-30	75-125	5000
Carbonate		4500-CO2		0-30	75-125	500
COD	410.1			0-30	75-125	5000
Chloride	325.2		9252	0-30	75-125	1000
	325.3		9252	0-30	75-125	1000
Chlorine demand		4500-Cl		0-30	75-125	1000
Chlorine residual	330.2			0-30	75-125	100
CTAS		5540-D		0-30	75-125	40
Color	110.2			0-50	NA	5 Pt-Co units
Conductivity	120.1			0-30	75-125	1.0 mmhos/cm
Cyanide, Total	335.2		9010	0-20	75-125	20
Cyanide, amenable to chlorination	335.1		9010	0-30	75-125	20
Dissolved Oxygen		4500-O		0-30	75-125	1000
Fluoride	340.2			0-30	75-125	100
Hardness, Total	130.2			0-30	75-125	1000
MBAS	425.1	5540-C		0-30	75-125	40
Nitrate	352.1		9200	0-30	75-125	100
Nitrate-Nitrite	353.3			0-30	75-125	100
Nitrite	354.1			0-30	75-125	5
Nitrogen, Kjeldahl	351.3			0-30	75-125	100
Oil & Grease (gravimetric)	413.1		9070	0-40	60-140	5000
pH	150.1		9040	0-20	80-120	N/A
Phenols, Total	420.1		9065	0-25	78-126	50
	420.2			0-30	75-125	50
Phosphate, Ortho	365.1			0-30	75-125	20
Phosphorous, Total	365.4			0-30	75-125	20
				0-30	75-125	20
Silica, Dissolved	370.1			0-30	75-125	100
	200.7			0-20	75-125	100
Solids, Total	160.3			0-40	60-140	5000
Solids, Total Dissolved	160.1			0-40	60-140	5000
Solids, Total Suspended	160.2			0-40	60-140	5000
Solids, Total Volatile	160.4			0-40	60-140	5000
Solids, Settleable		2540-F		0-40	ID	5000
Sulfate	375.4		9038	0-30	75-125	100
Sulfide, Total	376.2		9030	0-40	60-140	100
Sulfite	377.1			0-30	75-125	1000

[1] QA objectives obtained from literature sources. Historical data is being generated and will replace the literature data in the first annual update following approval.

[2] 100 through 400 series methods are from Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, revised March, 1983. 600 series methods are from 40 CFR Part 136, Appendix A, as revised 1 July, 1992.

[3] Standard Methods for the Examination of Water and Wastewater, 17th Edition, 1989.

[4] 6000 through 9000 series methods are from Test Methods for Evaluating Solid Waste Physical Chemical Methods, EPA SW-846, 3rd Edition, Revision 1, July, 1992.

Table 5.3. (continued) QA Objectives for the Analysis of Ground, Surface and Waste Water Samples[1].

Component / Parameter	Analytical Methods EPA[2]	SM[3]	EPA[4]	Precision %RSD	Accuracy % Recovery	MDL ug/L
TOC	415.2			0-20	80-120	1000
Turbidity	180.1			0-30	75-125	0.05 NTU
Metals						
Aluminum	200.7		6010	0-20	75-125	25
	202.2			0-20	75-125	10
Antimony	200.7		6010	0-20	75-125	50
	204.2		7041	0-20	75-125	3
Arsenic	206.2		7060	0-20	75-125	10
	206.3		7061	0-40	60-140	2
Barium	200.7		6010	0-20	75-125	1
	208.2		7081	0-20	75-125	2
Beryllium	200.7		6010	0-20	75-125	1
	210.2		7091	0-20	75-125	0.2
Boron	200.7			0-20	75-125	50
Cadmium	200.7		6010	0-20	75-125	2
	213.2		7131	0-20	75-125	0.1
Calcium	200.7		6010	0-20	75-125	20
Chromium, Total	200.7		6010	0-20	75-125	5
	218.2		7191	0-20	75-125	1
Chromium, Hexavalent	218.4		7197	0-20	75-125	20
Cobalt	200.7		6010	0-20	75-125	3
	219.2		7201	0-20	75-125	1
Copper	200.7		6010	0-20	75-125	2
	220.2		7211	0-20	75-125	1
Gold	231.1			0-20	75-125	100
	231.2			0-20	75-125	1
Iron	200.7		6010	0-20	75-125	5
	236.2		7381	0-20	75-125	1
Lead	200.7		6010	0-20	75-125	25
	239.2		7421	0-20	75-125	5
Magnesium	200.7		6010	0-20	75-125	15
Manganese	200.7		6010	0-20	75-125	1
	243.2		7461	0-20	75-125	0.2
Mercury	245.1		7470	0-20	75-125	0.5
Molybdenum	200.7		6010	0-20	75-125	5
	246.2		7481	0-20	75-125	1
Nickel	200.7		6010	0-20	75-125	10
	249.2			0-20	75-125	1
Osmium	252.1			0-20	75-125	300
	252.2			0-20	75-125	20
Potassium	200.7		6010	0-20	75-125	200

[1] QA objectives obtained from literature sources. Historical data is being generated and will replace the literature data in the first annual update following approval.

[2] 100 through 400 series methods are from Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, revised March, 1983. 600 series methods are from 40 CFR Part 136, Appendix A, as revised 1 July, 1992.

[3] Standard Methods for the Examination of Water and Wastewater, 17th Edition, 1989.

[4] 6000 through 9000 series methods are from Test Methods for Evaluating Solid Waste Physical Chemical Methods, EPA SW-846, 3rd Edition, Revision 1, July, 1992.

Table 5.3. (continued) QA Objectives for the Analysis of Ground, Surface and Waste Water Samples[1].

Component / Parameter	Analytical Methods EPA[2]	EPA[3]	Precision %RSD	Accuracy % Recovery	MDL ug/L
Selenium	270.2	7741	0-20	75-125	5
Silver	200.7	6010	0-20	75-125	3
	272.2	7761	0-20	75-125	0.2
Sodium	200.7	6010	0-20	75-125	10
Thallium	200.7	6010	0-20	75-125	100
	279.2	7841	0-20	75-125	10
Tin	282.1	7870	0-20	75-125	800
	282.2		0-20	75-125	5
Titanium	283.1		0-20	75-125	400
	283.2		0-20	75-125	10
Vanadium	200.7	6010	0-20	75-125	2
	286.2	7911	0-20	75-125	4
Zinc	200.7	6010	0-20	75-125	4
	289.2	7951	0-20	75-125	0.05
Organic Internal Standards					
Acenaphthene -d10	8270		0-40		
Chrysene-d12	8270		0-40		
Perylene-d12	8270		0-40		
Phenanthrene-d10	8270		0-40		
1-Bromo-4-fluorobenzene	8260		0-40		
1,2-Dichlorobenzene-d4	8260		0-40		
Fluorobenzene	8260		0-40		
Organic Surrogates					
2-Fluorophenol	8270		0-40	21-100	
Phenol-d6	8270		0-40	10-94	
2,4,6-Tribromophenol	8270		0-40	10-123	
2-Fluorobiphenyl	8270		0-40	43-116	
Nitrobenzene-d5	8270		0-40	35-114	
Terphenyl-d14	8270		0-40	33-141	
4-Bromofluorobenzene	8260		0-40	86-115	
1,2-Dichloroethane-d4	8260		0-40	76-114	
Toluene-d8	8260		0-40	88-110	
Decachlorobiphenyl	8080		0-40	10-150	
2,4,5,6-Tetrachloro-m-xylene	8270		0-40	60-150	
Bromochloromethane	8260		0-30	50-150	
2-Bromo-1-chloropropane	8260		0-40	50-150	
1,4-Dichlorobutane	8260		0-40	50-150	
Dibutychlorendate	8080		0-40	24-154	
Herbicides					
2,4-D	8150		0-40	40-140	1.2
2,4-DB	8150		0-40	40-140	0.91

[1] QA objectives obtained from literature sources. Historical data is being generated and will replace the literature data in the first annual update following approval.

[2] 100 through 400 series methods are from Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, revised March, 1983. 600 series methods are from 40 CFR Part 136, Appendix A, as revised 1 July, 1992.

[3] 6000 through 9000 series methods are from Test Methods for Evaluating Solid Waste Physical Chemical Methods, EPA SW-846, 3rd Edition revised 1992.

Table 5.3. (continued) QA Objectives for the Analysis of Ground, Surface and Waste Water Samples[1].

Component / Parameter	Analytical Methods EPA[2]	Precision %RSD	Accuracy % Recovery	MDL ug/L
2,4,5-T	8150	0-40	40-140	0.20
2,4,5-TP	8150	0-40	40-140	0.17
Dalapon	8150	0-80	10-160	5.8
Dicamba	8150	0-80	10-150	0.27
Dichloroprop	8150	0-80	10-150	0.65
Dinoseb	8150	0-80	10-150	0.07
MCPA	8150	0-80	10-150	250
MCPP	8150	0-80	10-150	190
Pesticides\PCB's				
4,4'-DDD	8080	0-40	31-141	0.020
4,4'-DDE	8080	0-40	30-145	0.020
4,4'-DDT	8080	0-40	25-160	0.050
a-BHC	8080	0-40	37-134	0.010
Aldrin	8080	0-40	42-122	0.010
Aroclor 1016	8080	0-40	50-114	0.5
Aroclor 1221	8080	0-40	15-178	0.5
Aroclor 1232	8080	0-40	10-215	0.5
Aroclor 1242	8080	0-40	39-150	0.5
Aroclor 1248	8080	0-40	38-158	0.5
Aroclor 1254	8080	0-40	29-131	0.5
Aroclor 1260	8080	0-40	8-127	0.5
b-BHC	8080	0-40	17-147	0.010
Chlordane	8080	0-40	45-119	0.100
d-BHC	8080	0-40	19-140	0.010
Dieldrin	8080	0-40	36-146	0.020
Endosulfan I	8080	0-40	45-153	0.020
Endosulfan II	8080	0-40	D-202	0.050
Endosulfan Sulfate	8080	0-40	26-144	0.10
Endrin	8080	0-40	30-147	0.020
Endrin aldehyde	8080	0-40	10-150	0.10
Endrin ketone	8080	0-50	10-150	0.10
g-BHC (Lindane)	8080	0-40	32-127	0.010
Heptachlor	8080	0-40	34-111	0.010
Heptachlor epoxide	8080	0-40	37-142	0.020
Methoxychlor	8080	0-40	50-140	0.50
Toxaphene	8080	0-40	41-126	1.0
Phenols				
2-Chlorophenol	8270	0-40	27-123	10
2-Methyl-4,6-dinitrophenol	8270	0-93	10-181	50
2-Methylphenol	8270	0-50	10-150	10
2-Nitrophenol	8270	0-40	29-182	50
3-Methylphenol	8270	0-50	10-150	10

[1] QA objectives obtained from literature sources. Historical data is being generated and will replace the literature data in the first annual update following approval.

[2] 100 through 400 series methods are from Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, revised March, 1983. 600 series methods are from 40 CFR Part 136, Appendix A, as revised 1 July, 1992. 6000 through 9000 series methods are from Test Methods for Evaluating Solid Waste Physical Chemical Methods, EPA SW-846, 3rd Edition revised 1992.

Table 5.3. (continued) QA Objectives for the Analysis of Ground, Surface and Waste Water Samples[1].

Component / Parameter	Analytical Methods EPA[2]	Precision %RSD	Accuracy % Recovery	MDL ug/L
4-Chloro-3-methylphenol	8270	0-42	23-97	10
4-Methylphenol	8270	0-50	10-150	10
4-Nitrophenol	8270	0-50	10-80	50
2,4-Dichlorophenol	8270	0-40	39-135	10
2,4-Dimethylphenol	8270	0-40	32-119	10
2,4-Dinitrophenol	8270	0-50	10-191	50
2,6-Dichlorophenol	8270	0-50	10-150	10
2,4,5-Trichlorophenol	8270	0-50	10-150	10
2,4,6-Trichlorophenol	8270	0-40	37-144	10
2,3,4,6-Tetrachlorophenol	8270	0-50	10-150	10
Hexachlorophene	8270	0-50	10-150	100
Pentachlorophenol	8270	0-50	9-103	50
Phenol	8270	0-42	12-89	10
Phthalates				
bis(2-Ethylhexyl)phthalate	8270	0-40	10-158	10
Butylbenzylphthalate	8270	0-40	10-152	10
Diethylphthalate	8270	0-40	10-114	10
Dimethylphthalate	8270	0-40	10-112	10
Di-n-butylphthalate	8270	0-50	10-118	10
Di-n-octylphthalate	8270	0-50	10-146	10
Semi-volatile Organics				
1-Naphthylamine	8270	0-50	10-150	10
2-Acetylaminofluorene	8270	0-50	25-150	10
2-Chloronaphthalene	8270	0-40	60-118	10
2-Methylnaphthalene	8270	0-50	10-150	10
2-Naphthylamine	8270	0-50	10-150	10
2-Nitroaniline	8270	0-50	10-150	50
3-Methylcholanthene	8270	0-50	10-150	10
3-Nitroaniline	8270	0-50	10-150	50
3,3'-Dichlorobenzidine	8270	0-100	10-262	10
3,3'-Dimethylbenzidine	8270	0-100	10-200	10
4-Aminobiphenyl	8270	0-50	10-150	10
4-Bromophenylphenyl ether	8270	0-40	53-127	10
4-Chloroaniline	8270	0-50	10-150	10
4-Chlorophenylphenyl ether	8270	0-33	25-158	10
4-Nitroaniline	8270	0-50	10-150	50
4-Nitroquinoline-1-oxide	8270	0-50	10-150	10
5-Nitro-o-toluidine	8270	0-50	10-150	10
1,2-Dichlorobenzene	8270	0-40	32-129	10
1,2-Diphenylhydrazine	8270	0-50	10-150	10
1,3-Dichlorobenzene	8270	0-40	10-172	10
1,3-Dinitrobenzene	8270	0-50	10-150	10

[1] QA objectives obtained from literature sources. Historical data is being generated and will replace the literature data in the first annual update following approval.

[2] 100 through 400 series methods are from Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, revised March, 1983. 600 series methods are from 40 CFR Part 136, Appendix A, as revised 1 July, 1992. 6000 through 9000 series methods are from Test Methods for Evaluating Solid Waste Physical Chemical Methods, EPA SW-846, 3rd Edition revised 1992.

Table 5.3. (continued) QA Objectives for the Analysis of Ground, Surface and Waste Water Samples[1].

Component / Parameter	Analytical Methods EPA[2]	Precision %RSD	Accuracy % Recovery	MDL ug/L
1,4-Dichlorobenzene	8270	0-28	36-97	10
1,4-Naphthoquinone	8270	0-50	10-150	10
2,4-Dinitrotoluene	8270	0-38	24-96	20
2,6-Dinitrotoluene	8270	0-40	50-158	20
1,2,4-Trichlorobenzene	8270	0-28	44-142	10
7,12-Dimethylbenzo(a)anthracene	8270	0-50	10-150	10
1,2,4,5-Tetrachlorobenzene	8270	0-50	10-150	10
Acenaphthene	8270	0-31	46-118	10
Acenaphthylene	8270	0-40	33-145	10
Acetophenone	8270	0-50	10-150	20
Aniline	8270	0-50	10-150	10
Anthracene	8270	0-40	27-133	10
Benzidine	8270	0-100	10-200	80
Benzo(a)anthracene	8270	0-40	33-143	10
Benzo(a)pyrene	8270	0-40	17-163	10
Benzo(b)fluoranthene	8270	0-40	24-159	10
Benzoic acid	8270	0-50	10-150	50
Benzo(ghi)perylene	8270	0-56	10-219	10
Benzo(k)fluoranthene	8270	0-42	11-162	10
Benzyl alcohol	8270	0-50	10-150	10
bis(2-Chloroethoxy)methane	8270	0-43	33-184	10
bis(2-Chloroethyl)ether	8270	0-50	10-150	10
bis(2-Chloroisopropyl)ether	8270	0-46	36-166	10
Chlorobenzilate	8270	0-50	10-150	50
Chrysene	8270	0-48	17-168	10
Diallate	8270	0-50	10-150	20
Dibenzo(a,h)anthracene	8270	0-70	10-227	10
Dibenzofuran	8270	0-50	10-150	10
Dimethylphenethylamine	8270	0-50	10-150	30
Diphenyl amine	8270	0-50	10-150	10
Ethyl methanesulfonate	8270	0-50	10-150	20
Fluoranthene	8270	0-40	26-137	10
Fluorene	8270	0-40	59-121	10
Hexachlorobenzene	8270	0-40	10-152	10
Hexachlorobutadiene	8270	0-40	24-116	10
Hexachlorocyclopentadiene	8270	0-50	10-150	20
Hexachloroethane	8270	0-40	40-113	2
Hexachloropropene	8270	0-50	10-150	30
Indeno(1,2,3-cd)pyrene	8270	0-45	10-171	10
Isophorone	8270	0-60	21-196	10
Isosafrole	8270	0-50	10-150	10
Methapyrilene	8270	0-50	10-150	10
Methyl methanesulfonate	8270	0-50	10-150	20
N-Nitrosodi-n-butylamine	8270	0-50	10-150	10

[1] QA objectives obtained from literature sources. Historical data is being generated and will replace the literature data in the first annual update following approval.

[2] 100 through 400 series methods are from Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, revised March, 1983. 600 series methods are from 40 CFR Part 136, Appendix A, as revised 1 July, 1992. 6000 through 9000 series methods are from Test Methods for Evaluating Solid Waste Physical Chemical Methods, EPA SW-846, 3rd Edition revised 1992.

Table 5.3. (continued) QA Objectives for the Analysis of Ground, Surface and Waste Water Samples[1].

Component / Parameter	Analytical Methods EPA[2]	EPA[2]	Precision %RSD	Accuracy % Recovery	MDL ug/L
N-Nitrosodi-n-propylamine	8270		0-38	41-116	10
N-Nitrosodiethylamine	8270		0-50	10-150	10
N-Nitrosodimethylamine	8270		0-50	10-150	10
N-Nitrosodiphenylamine	8270		0-50	10-150	10
N-Nitrosomethylethylamine	8270		0-50	10-150	20
N-Nitrosomorpholine	8270		0-50	10-150	10
N-Nitrosopiperidine	8270		0-50	10-150	20
N-Nitrosopyrrolidine	8270		0-50	10-150	20
Naphthalene	8270		0-40	21-133	10
Nitrobenzene	8270		0-40	35-180	10
o-Toluidine	8270		0-50	10-150	20
p-Benzoquinone	8270		0-50	10-150	10
p-Dimethylaminoazobenzene	8270		0-50	10-150	10
Pentachlorobenzene	8270		0-50	10-150	10
Pentachloronitrobenzene	8270		0-50	10-150	10
Phenacetin	8270		0-50	10-150	100
Phenanthrene	8270		0-40	54-120	10
Phenylenediamine	8270		0-50	10-150	10
Pronamide	8270		0-50	10-150	10
Pyrene	8270		0-31	26-127	10
Safrole	8270		0-50	10-150	50
Volatile Organics					
2-Chloroethylvinyl ether	624	8260	0-94	10-199	10
2-Hexanone		8260	0-40	49-151	2
2-Picoline		8260	0-50	10-150	10
3-Chloropropene		8260	0-50	10-140	10
4-Methyl-2-pentanone		8260	0-40	46-152	2
1,1-Dichloroethane	624	8260	0-43	10-169	2
1,1-Dichloroethene	624	8260	0-14	61-145	2
1,1-Dichloropropene		8260	0-50	10-150	10
1,2-Dibromo-3-chloropropane		8260	0-40	55-140	10
1,2-Dibromoethane		8260	0-65	10-170	5
1,2-Dichloroethane	624	8260	0-40	56-146	2
1,2-Dichloropropane	624	8260	0-55	10-162	2
1,3-Dichloropropane		8260	0-55	10-162	2
cis-1,3-Dichloropropene	624	8260	0-62	10-162	2
trans-1,3-Dichloropropene	624	8260	0-45	26-160	2
1,4-Dichloro-2-butene		8260	0-40	50-150	5
1,4-Dioxane		8260	0-50	10-150	100
2,2-Dichloropropane		8260	0-50	10-150	10
1,1,1-Trichloroethane	624	8260	0-40	55-150	1
1,1,2-Trichloroethane	624	8260	0-40	53-152	1
1,2,3-Trichloropropane		8260	0-40	60-140	3

[1] QA objectives obtained from literature sources. Historical data is being generated and will replace the literature data in the first annual update following approval.

[2] 100 through 400 series methods are from Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, revised March, 1983. 600 series methods are from 40 CFR Part 136, Appendix A, as revised 1 July, 1992. 6000 through 9000 series methods are from Test Methods for Evaluating Solid Waste Physical Chemical Methods, EPA SW-846, 3rd Edition revised 1992.

Table 5.3. (continued) QA Objectives for the Analysis of Ground, Surface and Waste Water Samples[1].

Component / Parameter	Analytical Methods EPA[2]	EPA[2]	Precision %RSD	Accuracy % Recovery	MDL ug/L
1,1,1,2-Tetrachloroethane		8260	0-40	60-140	10
1,1,2,2-Tetrachloroethane	624	8260	0-40	54-142	2
Acetone		8260	0-40	47-143	25
Acetonitrile		8260	0-65	10-170	50
Acrolein		8260	0-40	60-140	25
Acrylonitrile		8260	0-40	60-145	3
Benzene	624	8260	0-11	76-127	2
Bromodichloromethane	624	8260	0-40	35-155	10
Bromoform	624	8260	0-40	46-169	10
Bromomethane	624	8260	0-65	10-170	10
Carbon disulfide		8260	0-40	53-148	10
Carbon tetrachloride	624	8260	0-40	71-140	2
Chlorobenzene	624	8260	0-13	75-130	2
Chloroethane	624	8260	0-80	10-160	2
Chloroform	624	8260	0-40	60-140	2
Chloromethane	624	8260	0-60	10-140	2
cis-1,2-Dichloroethene		8260	0-40	56-146	2
Dibromochloromethane	624	8260	0-40	56-142	2
Dibromomethane		8260	0-40	50-150	1
Dichlorodifluoromethane		8260	0-40	65-140	3
Dichloromethane	624	8260	0-40	41-177	2
Ethanol		8260	0-40	40-160	1000
Ethyl benzene	624	8260	0-40	38-152	2
Ethyl methacrylate		8260	0-40	45-140	1
Iodomethane		8260	0-40	35-150	2
Isobutyl alcohol		8260	0-60	10-170	1000
Isopropylbenzene		8260	0-50	10-150	10
Methacrylonitrile		8260	0-60	10-170	50
Methyl ethyl ketone		8260	0-40	46-153	10
Methyl isobutyl ketone		8260	0-40	46-152	2
Methyl methacrylate		8260	0-60	10-170	10
Pentachloroethane		8260	0-40	55-140	10
Propionitrile		8260	0-50	10-110	50
Pyridine		8260	0-50	10-150	10
Styrene		8260	0-42	34-176	2
Tetrachloroethene	624	8260	0-40	70-140	2
Toluene	624	8260	0-13	76-125	2
trans-1,2-Dichloroethene	624	8260	0-40	56-146	2
Trichloroethene	624	8260	0-14	71-120	1
Trichlorofluoromethane	624	8260	0-48	20-160	3
Vinyl acetate		8260	0-50	39-151	1
Vinyl chloride	624	8260	0-87	10-181	2
Xylene (o + m)		8260	0-40	50-150	3
Xylene (p)		8260	0-40	50-150	2

[1] QA objectives obtained from literature sources. Historical data is being generated and will replace the literature data in the first annual update following approval.

[2] 100 through 400 series methods are from Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, revised March, 1983. 600 series methods are from 40 CFR Part 136, Appendix A, as revised 1 July, 1992. 6000 through 9000 series methods are from Test Methods for Evaluating Solid Waste Physical Chemical Methods, EPA SW-846, 3rd Edition revised 1992.

Table 5.4. QA Objectives for Analysis of Soil, Sludge and Sediment Samples[1].

Component / Parameter	Analytical Methods EPA[2]	Precision %RSD	Accuracy % Recovery	MDL mg/Kg
Chloride	9252	0-30	75-125	20
Coliform Bacteria, Total	9131	0-30	75-125	1 organ/g
	9132	0-30	75-125	1 organ/g
Conductivity	9050	0-30	75-125	1.0 mmhos/cm
Cyanide, Total and amenable	9010	0-30	75-125	0.30
Flashpoint (P-M)	1010	0-20	80-120	70°F
Flashpoint (Closed Cup)	1020	0-20	80-120	70°F
Sulfide	9030	0-30	75-125	2.5
Nitrate	9200	0-30	75-125	5.0
Oil & Grease (Sludge)	9071	0-25	50-135	20
Paint filter test	9095	ID	ID	ID
pH (soil)	9045	0-10	80-120	NA
Phenols, Total	9065	0-25	60-130	0.40
Solids, Total	160.3	0-30	75-125	50
Sulfate	9038	0-25	75-125	100
Metals				
Aluminum	7020	0-30	75-125	10
	6010	0-30	75-125	2.5
Antimony	7040	0-30	75-125	20
	7041	0-30	75-125	0.30
	6010	0-30	75-125	5
Arsenic	7060	0-30	75-125	1
	7061	0-30	75-125	0.2
	6010	0-30	75-125	5
Barium	7080	0-30	75-125	10
	7081	0-30	75-125	0.2
	6010	0-30	75-125	0.1
Beryllium	7090	0-30	75-125	1
	7091	0-30	75-125	0.2
	6010	0-30	75-125	0.1
Cadmium	7130	0-30	75-125	1
	7131	0-30	75-125	0.01
	6010	0-30	75-125	0.2
Calcium	7140	0-30	75-125	5
	6010	0-30	75-125	2
Chromium (Total)	7190	0-30	75-125	5
	7191	0-30	75-125	0.1
	6010	0-30	75-125	0.5
Chromium, Hexavalent	7197	0-30	75-125	50
Cobalt	7200	0-30	75-125	5
	7201	0-30	75-125	0.1
	6010	0-30	75-125	0.3
Copper	7210	0-30	75-125	2
	7211	0-30	75-125	0.1

[1] QA objectives are drawn from the literature. Historical data is in preparation and will replace the literature values in the first annual update following approval.

[2] 1000 through 9000's series methods are from Test Methods for Evaluating Solid Waste Physical/Chemical Methods, EPA SW-846, 3rd Edition, revised 1992.

Table 5.4. (continued) QA Objectives for Analysis of Soil, Sludge and Sediment Samples[1].

Component / Parameter	Analytical Methods EPA[2]	Precision %RSD	Accuracy % Recovery	MDL mg/Kg
Copper	6010	0-30	75-125	0.2
Iron	7380	0-30	75-125	4
	7381	0-30	75-125	0.1
	6010	0-30	75-125	0.5
Lead	7420	0-30	75-125	10
	7421	0-30	75-125	0.5
	6010	0-30	75-125	2.5
Magnesium	7450	0-30	75-125	0.1
	6010	0-30	75-125	1.5
Manganese	7460	0-30	75-125	1
	7461	0-30	75-125	0.02
	6010	0-30	75-125	0.1
Mercury	7471	0-30	75-125	0.1
Molybdenum	7480	0-30	75-125	10
	7481	0-30	75-125	0.1
	6010	0-30	75-125	0.5
Nickel	7520	0-30	75-125	4
	6010	0-30	75-125	1
Osmium	7550	0-30	75-125	10
Potassium	7610	0-30	75-125	1
	6010	0-30	75-125	20
Selenium	7740	0-30	75-125	0.5
	7741	0-30	75-125	0.5
	6010	0-30	75-125	5
Silver	7760	0-30	75-125	1
	7761	0-30	75-125	0.02
	6010	0-30	75-125	0.3
Sodium	7770	0-30	75-125	0.2
	6010	0-30	75-125	1
Thallium	7840	0-30	75-125	10
	7841	0-30	75-125	1
	6010	0-30	75-125	10
Tin	7870	0-30	75-125	80
Vanadium	7910	0-30	75-125	20
	7911	0-30	75-125	0.4
	6010	0-30	75-125	0.2
Zinc	7950	0-30	75-125	0.5
	7951	0-30	75-125	0.005
	6010	0-30	75-125	0.4
Chlorinated Herbicides				ug/kg
2,4-D	8150	0-34	13-130	24
2,4-DB	8150	0-40	20-160	18
2,4,5-T	8150	0-56	13-169	4.0
2,4,5-TP (Silvex)	8150	0-56	13-169	3.4

[1] QA objectives are drawn from the literature. Historical data is in preparation and will replace the literature values in the first annual update following approval.

[2] 1000 through 9000's series methods are from Test Methods for Evaluating Solid Waste Physical/Chemical Methods, EPA SW-846, 3rd Edition, revised 1992.

Table 5.4. (continued) QA Objectives for Analysis of Soil, Sludge and Sediment Samples[1].

Component / Parameter	Analytical Methods EPA[2]	Precision %RSD	Accuracy % Recovery	MDL ug/Kg
Dalapon	8150	0-40	10-170	12
Dicamba	8150	0-40	20-160	5.4
Dichloroprop	8150	0-40	30-170	13
Dinoseb	8150	0-40	30-170	1.4
MCPA	8150	0-40	30-170	5000
MCPP	8150	0-40	30-170	3800
Chlorinated Pesticides/PCB's				ug/kg
Aldrin	8080	0-40	10-166	2.2
a-BHC	8080	0-50	10-150	1.9
b-BHC	8080	0-40	24-149	3.3
g-BHC (Lindane)	8080	0-50	10-150	2.0
d-BHC	8080	0-40	10-110	1.1
4,4'-DDD	8080	0-40	10-145	4.2
4,4'-DDE	8080	0-40	10-136	2.5
4,4'-DDT	8080	0-62	10-203	3.6
Dieldrin	8080	0-40	29-136	1.0
Endosulfan I	8080	0-50	10-150	2.1
Endosulfan II	8080	0-50	10-150	2.4
Endosulfan sulfate	8080	0-50	10-107	3.6
Endrin	8080	0-50	10-150	3.6
Endrin aldehyde	8080	0-50	10-209	1.6
Endrin ketone	8080	0-50	10-150	5.0
Heptachlor	8080	0-37	10-192	2.0
Heptachlor epoxide	8080	0-55	26-155	2.1
Methoxychlor	8080	0-50	10-150	5.7
Chlordane	8080	0-50	10-150	1.5
Toxaphene	8080	0-50	10-150	5.7
Aroclor 1016	8080	0-50	10-150	50
Aroclor 1221	8080	0-50	10-150	57
Aroclor 1232	8080	0-50	10-150	50
Aroclor 1242	8080	0-50	10-150	50
Aroclor 1248	8080	0-50	10-150	50
Aroclor 1254	8080	0-50	10-150	50
Aroclor 1260	8080	0-50	10-150	70
Aroclor 1262	8080	0-50	10-150	50
Organic Internal Standards				
1-Bromo-4-fluorobenzene	8260	0-40		
1,2-Dichlorobenzene-d4	8260	0-40		
Acenaphthene -d10	8270	0-40		
Chrysene-d12	8270	0-40		
Fluorobenzene	8260	0-40		
Perylene-d12	8270	0-40		

[1] QA objectives are drawn from the literature. Historical data is in preparation and will replace the literature values in the first annual update following approval.

[2] 1000 through 9000's series methods are from Test Methods for Evaluating Solid Waste Physical/Chemical Methods, EPA SW-846, 3rd Edition, revised 1992.

Table 5.4. (continued) QA Objectives for Analysis of Soil, Sludge and Sediment Samples[1].

Component / Parameter	Analytical Methods EPA[2]	Precision %RSD	Accuracy % Recovery	MDL ug/Kg
Phenanthrene-d10	8270	0-40		
Organic Surrogates				
2-Bromo-1-chloropropane	8260	0-40		
2-Fluorobiphenyl	8270	0-40	30-115	
2-Fluorophenol	8270	0-40	25-121	
4-Terphenyl-d14	8270	0-40	18-137	
1,2-Dichloroethane-d4	8260	0-40	70-121	
2,4,6-Tribromophenol	8270	0-40	19-122	
2,4,5,6-Tetrachloro-m-xylene	8270	0-40	50-150	
Dibromofluoromethane	8260	0-40	80-120	
4-Bromofluorobenzene	8260	0-40	74-121	
Decachlorobiphenyl	8270	0-40	50-150	
Nitrobenzene-d5	8270	0-40	23-120	
Phenol-d6	8270	0-40	24-113	
Toluene-d8	8260	0-40	81-117	
Semi-volatile Organics				ug/kg
1-Naphthylamine	8270	0-50	10-150	330
2-Acetylaminofluorene	8270	0-50	25-150	330
2-Chloronaphthalene	8270	0-40	60-118	330
2-Chlorophenol	8270	0-50	25-102	330
2-Methyl naphthalene	8270	0-50	10-150	330
2-Methyl-4,6-Dinitrophenol	8270	0-93	10-181	1700
2-Methylphenol	8270	0-50	10-150	330
2-Naphthylamine	8270	0-50	10-150	330
2-Nitroaniline	8270	0-5-	10-150	1700
2-Nitrophenol	8270	0-35	29-182	330
2-Picoline	8270	0-50	10-150	330
2-s-Butyl-4,6-dinitrophenol	8270	0-50	10-150	330
3-Methylphenol	8270	0-50	10-150	330
3-Nitroaniline	8270	0-50	10-150	1700
3,3'-Dichlorobenzidine	8270	0-100	10-262	660
3,3'-Dimethylbenzidine	8270	0-100	10-200	330
4-Aminobiphenyl	8270	0-50	10-150	330
4-Bromophenylphenyl ether	8270	0-40	53-127	330
4-Chloro-3-methylphenol	8270	0-33	26-103	330
4-Chloroaniline	8270	0-50	10-150	330
4-Chlorophenylphenyl ether	8270	0-33	25-158	330
4-Methylphenol	8270	0-50	10-150	330
4-Nitroaniline	8270	0-50	10-150	1700
4-Nitrophenol	8270	0-50	11-114	1700
4-Nitroquinoline-N-oxide	8270	0-50	10-150	330
5-Nitro-o-toluidine	8270	0-50	10-150	330

[1] QA objectives are drawn from the literature. Historical data is in preparation and will replace the literature values in the first annual update following approval.

[2] 1000 through 9000's series methods are from Test Methods for Evaluating Solid Waste Physical/Chemical Methods, EPA SW-846, 3rd Edition, revised 1992.

Table 5.4. (continued) QA Objectives for Analysis of Soil, Sludge and Sediment Samples[1].

Component / Parameter	Analytical Methods EPA[2]	Precision %RSD	Accuracy % Recovery	MDL ug/Kg
1,2-Dichlorobenzene	8270	0-40	32-129	330
1,3-Dichlorobenzene	8270	0-41	10-172	330
1,3-Dinitrobenzene	8270	0-50	10-150	330
1,4-Dichlorobenzene	8270	0-27	28-104	330
1,4-Naphthoquinone	8270	0-50	10-150	330
1,4-Phenylenediamine	8270	0-50	10-150	330
2,4-Dimethylphenol	8270	0-26	32-119	330
2,4-Dinitrophenol	8270	0-50	10-191	1700
2,4-Dinitrotoluene	8270	0-47	28-89	330
2,6-Dichlorophenol	8270	0-50	10-150	330
2,6-Dinitrotoluene	8270	0-29	50-158	330
1,2,4-Trichlorobenzene	8270	0-23	38-107	330
1,3,5-Trinitrobenzene	8270	0-50	10-150	330
2,4,6-Trichlorophenol	8270	0-40	37-144	330
2,4,5-Trichlorophenol	8270	0-50	10-150	330
7,12-Dimethylbenzanthracene	8270	0-50	10-150	330
1,2,4,5-Tetrachlorobenzene	8270	0-50	10-150	330
2,3,4,6-Tetrachlorophenol	8270	0-50	10-150	330
a,a-Dimethylphenethylamine	8270	0-50	10-150	1700
Acenaphthene	8270	0-19	31-137	330
Acenaphthylene	8270	0-40	33-145	330
Acetophenone	8270	0-50	10-150	660
Aniline	8270	0-50	10-150	330
Anthracene	8270	0-25	27-133	330
Benzidine	8270	0-100	10-200	3300
Benzo(a)anthracene	8270	0-32	33-143	330
Benzo(a)pyrene	8270	0-38	17-163	330
Benzo(b)fluoranthene	8270	0-40	24-159	330
Benzo(ghi)perylene	8270	0-56	10-219	330
Benzo(k)fluoranthene	8270	0-42	11-162	330
Benzyl alcohol	8270	0-50	10-150	330
Benzyl butyl phthalate	8270	0-40	10-152	330
bis(2-Chloroethoxy)methane	8270	0-43	33-184	330
bis(2-Chloroethyl)ether	8270	0-50	10-150	330
bis(2-Chloroisopropyl)ether	8270	0-46	36-166	330
bis(2-Ethylhexyl)phthalate	8270	0-40	10-158	330
Chrysene	8270	0-48	17-168	330
Di-n-butyl phthalate	8270	0-50	10-118	330
Di-n-octyl phthalate	8270	0-50	10-146	330
Dibenzo(a,h)anthracene	8270	0-70	10-227	330
Dibenzofuran	8270	0-50	10-150	330
Diethyl phthalate	8270	0-40	10-114	330
Dimethoate	8270	0-50	10-150	330
Dimethyl pthalate	8270	0-27	10-112	330
Dinoseb	8270	0-50	10-150	1700

[1] QA objectives are drawn from the literature. Historical data is in preparation and will replace the literature values in the first annual update following approval.

[2] 1000 through 9000's series methods are from Test Methods for Evaluating Solid Waste Physical/Chemical Methods, EPA SW-846, 3rd Edition, revised 1992.

Table 5.4. (continued) QA Objectives for Analysis of Soil, Sludge and Sediment Samples[1].

Component / Parameter	Analytical Methods EPA[2]	Precision %RSD	Accuracy % Recovery	MDL ug/Kg
Diphenylamine	8270	0-50	10-150	330
Disulfoton	8270	0-50	10-150	330
Famphur	8270	0-50	10-150	330
Fluoranthene	8270	0-40	26-137	330
Fluorene	8270	0-21	59-121	330
Hexachlorobenzene	8270	0-25	10-152	330
Hexachlorobutadiene	8270	0-26	24-116	330
Hexachlorocyclopentadiene	8270	0-50	10-150	330
Hexachloroethane	8270	0-40	40-113	330
Hexachloropropylene	8270	0-32	10-150	1300
Indeno(1,2,3-cd)pyrene	8270	0-45	10-171	330
Isophorone	8270	0-60	21-196	330
Methapyrilene	8270	0-50	10-150	330
Methyl parathion	8270	0-50	10-150	330
N-Nitrosodi-n-butylamine	8270	0-50	10-150	330
N-Nitrosodi-n-propylamine	8270	0-38	41-126	330
N-Nitrosodimethylamine	8270	0-50	10-150	330
N-Nitrosodiphenylamine	8270	0-50	10-150	330
N-Nitrosomethylethylamine	8270	0-50	10-150	660
N-Nitrosomorpholine	8270	0-50	10-150	330
N-Nitrosopiperidine	8270	0-50	10-150	660
N-Nitrosopyrrolidine	8270	0-50	10-150	660
N-Nitrosodiethylamine	8270	0-50	10-150	330
Naphthalene	8270	0-40	21-133	330
Nitrobenzene	8270	0-39	35-180	330
o-Toluidine	8270	0-50	10-150	660
p-Dimethylaminoazobenzene	8270	0-50	10-150	330
Pentachlorobenzene	8270	0-50	10-150	330
Pentachloronitrobenzene	8270	0-50	10-150	330
Pentachlorophenol	8270	0-47	17-109	1700
Phenacetin	8270	0-50	10-150	3300
Phenanthrene	8270	0-21	54-120	330
Phenol	8270	0-35	26-90	330
Phorate	8270	0-50	10-150	330
Pyrene	8270	0-36	35-142	330
Pyridine	8270	0-50	10-150	330
Thionazin	8270	0-50	10-150	330
O,O,O-Triethylphosphorothioate	8270	0-50	10-150	330
Volatile Organics				ug/kg
2-Butanone	8260	0-38	37-161	10
2-Chlorotoluene	8260	0-50	10-150	10
4-Chlorotoluene	8260	0-50	10-150	10
4-Methyl-2-pentanone	8260	0-49	40-163	10
1,1-Dichloroethane	8260	0-38	58-161	5

[1] QA objectives are drawn from the literature. Historical data is in preparation and will replace the literature values in the first annual update following approval.

[2] 1000 through 9000's series methods are from Test Methods for Evaluating Solid Waste Physical/Chemical Methods, EPA SW-846, 3rd Edition, revised 1992.

Table 5.4. (continued) QA Objectives for Analysis of Soil, Sludge and Sediment Samples[1].

Component / Parameter	Analytical Methods EPA[2]	Precision %RSD	Accuracy % Recovery	MDL ug/Kg
1,1-Dichloroethene	8260	0-22	59-172	5
1,1-Dichloropropene	8260	0-50	10-150	10
1,2-Dibromo-3-chloropropane	8260	0-40	55-140	10
1,2-Dibromoethane	8260	0-65	10-170	5
1,2-Dichlorobenzene	8260	0-43	49-150	5
1,2-Dichloroethane	8260	0-37	47-143	5
1,2-Dichloropropane	8260	0-46	10-178	5
1,3-Dichlorobenzene	8260	0-41	24-158	5
cis-1,3-Dichloropropene	8260	0-53	10-163	5
trans-1,3-Dichloropropene	8260	0-49	21-139	5
1,4-Dichlorobenzene	8260	0-39	68-172	5
2,2-Dichloropropane	8260	0-50	10-150	10
1,1,1-Trichloroethane	8260	0-28	42-147	5
1,1,2-Trichloroethane	8260	0-34	41-183	5
1,2,3-Trichloropropane	8260	0-40	60-140	10
1,1,1,2-Tetrachloroethane	8260	0-40	60-140	10
1,1,2,2,-Tetrachloroethane	8260	0-38	47-138	5
Benzene	8260	0-21	66-142	5
Bromodichloromethane	8260	0-42	37-160	5
Bromoform	8260	0-33	48-152	5
Bromomethane	8260	0-61	10-160	10
Carbon tetrachloride	8260	0-36	67-138	5
Chlorobenzene	8260	0-21	60-133	5
Chloroethane	8260	0-72	12-147	10
Chloroform	8260	0-43	51-139	5
Chloromethane	8260	0-87	10-130	10
cis-1,2-Dichloroethene	8260	0-40	56-146	5
Dibromochloromethane	8260	0-49	53-140	5
Dibromomethane	8260	0-32	50-150	10
Dichlorodifluoromethane	8260	0-28	65-130	50
Dichloromethane	8260	0-39	40-162	5
Ethanol	8260	0-40	40-160	1000
Ethylbenzene	8260	0-40	27-161	5
Hexachlorobutadiene	8260	0-50	10-150	10
Isopropylbenzene	8260	0-50	10-150	10
m-Xylene	8260	0-39	38-137	5
n-Butylbenzene	8260	0-50	10-150	10
n-Propylbenzene	8260	0-50	10-150	10
o-Xylene	8260	0-39	38-137	5
p-Isopropyltoluene	8260	0-50	10-150	10
p-Xylene	8260	0-39	38-137	5
Pyridine	8260	0-50	10-150	10
sec-Butylbenzene	8260	0-50	10-150	10
Styrene	8260	0-40	37-163	5
tert-Butylbenzene	8260	0-50	10-150	10

[1] QA objectives are drawn from the literature. Historical data is in preparation and will replace the literature values in the first annual update following approval.

[2] 1000 through 9000's series methods are from Test Methods for Evaluating Solid Waste Physical/Chemical Methods, EPA SW-846, 3rd Edition, revised 1992.

Table 5.4. (continued) QA Objectives for Analysis of Soil, Sludge and Sediment Samples[1].

Component / Parameter	Analytical Methods EPA[2]	Precision %RSD	Accuracy % Recovery	MDL ug/Kg
Tetrachloroethene	8260	0-29	52-139	5
Toluene	8260	0-21	59-139	5
Trichloroethene	8260	0-24	62-137	5
Trichlorofluoromethane	8260	0-41	29-173	5
Vinyl chloride	8260	0-69	10-168	10

[1] QA objectives are drawn from the literature. Historical data is in preparation and will replace the literature values in the first annual update following approval.

[2] 1000 through 9000's series methods are from Test Methods for Evaluating Solid Waste Physical/Chemical Methods, EPA SW-846, 3rd Edition, revised 1992.

Table 5.5. Sample preparation methods

Sample preparation method number†	Description	Matrix	Applicable analytical methods†
1311	Toxic Characteristic Leaching Procedure	Solid, semi-solid and liquid wastes	6010, 8080, 8150, 8260, 8270, 7471
3005	Nitric acid digestion	Water	6010, 7020, 7040, 7041, 7080, 7090, 7130, 7140, 7190, 7200, 7210, 7380, 7420, 7450, 7460, 7480, 7520, 7610, 7760, 7770, 7840, 7910, 7950
3010	Nitric Hydrochloric acid digestion	Water, soil	6010, 7020, 7080, 7090, 7130, 7140, 7190, 7200, 7210, 7380, 7420, 7450, 7460, 7480, 7520, 7610, 7770, 7840, 7910, 7950
3020	Nitric acid digestion	Water, solids	7091, 7131, 7191, 7201, 7421, 7481, 7841, 7911
3040	Oil, grease or wax dissolution	Oil, wax or grease samples	6010, 7040, 7090, 7130, 7190, 7210, 7380, 7460, 7520, 7910
3050	Acid digestion	Sediments, sludges and soils	6010, 7020, 7060, 7080, 7090, 7091, 7130, 7131, 7140, 7190, 7191, 7200, 7201, 7210, 7380, 7381, 7420, 7421, 7450, 7460, 7480, 7481, 7520, 7550, 7610, 7760, 7770, 7840,7841, 7950, 7740
3500	Organic extraction general		8080, 8150, 8270
3510	Separatory funnel liquid-liquid extraction	water	8080, 8270, 8150
3520	Continuous liquid-liquid extraction	water	8080, 8270, 8150
3540	Soxhlet extraction	Sediments, sludges and soils	8270, 8080, 8150
3550	Sonification	solids	8270, 8080, 8150
3580	Waste dilution	Wastes and solids	8270, 8080, 8150
3600	Sample clean-up general		8080, 8270
3611	Alumina column	Petroleum wastes	8270
3620	Florisil column		8080, 8270
3640	Gel-permeation clean-up		8080, 8270
3650	Acid-base partition		8270
3660	Sulfur cleanup		8080
5030	Purge and Trap	Liquids and solids	8260

† Test Methods for Evaluating Solid Waste, Physical Chemical Methods, Third Edition (EPA SW-846), 1986 and revision I dated July 1992. Method 1311 is drawn from the Federal Register, Friday 29 June, 1990, 55(126):26986-26998, and SW-846, Revision 1, July 1992.

Table 5.6. Field measurement QA objectives[1]

Component / Parameter	Analytical Methods EPA[2]	Precision %RSD	Accuracy % Recovery	MDL
pH	150.1	0-0.1 pH unit (SD)	±0.1 pH unit	NA
Specific conductivity	120.1	0-9	81-119	ID
Temperature	170.1	ID	ID	NA
Dissolved oxygen	360.1	±0.05 mg/L	±0.1 mg/L	0.05 mg/L
Residual chlorine	330.5	0-28	45-155	10 ppb

[1] QA objectives are obtained from published data. Historical data is being generated and will replace the literature data in the first annual update following approval..

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

SAMPLING PROCEDURES

Analytical Services, Inc. provides a field sampling service to customers, however most clients chose to perform sampling themselves. In such cases ASI will provide appropriate pre-cleaned sample containers, if requested. Preservatives are not included due to transportation regulations. For clients who request ASI to perform the sampling, the field sampling operations are performed in accordance with EPA Region IV Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual, 1991, and Florida DER Sampling SOP QA 001/92, 1992 and guidance documents. Refer to the specific sampling operation below to find the specific reference. The field sampling operations include, but are not limited to providing certified clean sample containers, sampling equipment, correct preservatives, coolers for temperature control, prompt transport to the laboratory and trained personnel with proper safety equipment to perform field measurements and sampling.

1. Sampling Capabilities

Table 6.1 presents the sampling capabilities of ASI.

2. Descriptive list of sampling equipment.

A descriptive list of sampling equipment is presented in Table 6.2. Restrictions and permissible parameter groups for use of the equipment is in accordance with Florida DER QAS.

3. Routinely used equipment.

Table 6.3 discusses the following types of equipment: sample storage and transport, field instrumentation, miscellaneous equipment, sample preservation reagents and equipment, decontamination equipment and materials, and standards, reagents and cleaning reagents.

4. Specific decontamination protocols.

Equipment groups are cleaned in accordance with Florida DER SOP for cleaning and decontaminating sampling equipment.

All sample containers are obtained as certified pre-cleaned in accordance with Florida DER-QAS and Florida DER SOP for cleaning and decontaminating sampling equipment. In addition to the specified documentation (lot numbers, certification statements, date of receipt and intended use), ASI performs and maintains data files of blank analyses on randomly selected containers from each lot for the intended target analytes. ASI field operations never use sample containers from sources other than that stated above. Pre-cleaned sample containers are supplied to customers without preservation reagents in order to assure compliance with DOT regulations. Sample containers are packed for shipment to customers in accordance with the procedures stated in EPA Region IV Environmental Compliance Branch SOP & QAM, Appendix C.3, as revised 1 February, 1991.

5. Sampling protocols.

General considerations of sampling are as described in the Florida DER SOP for general sampling protocols.

Wastewater influent and effluent sampling is performed in accordance with Florida DER SOP for General Sampling Protocols and Florida DER sampling procedures for wastewater and surface water SOP.

Surface water sampling is performed in accordance with Florida DER SOP for General Sampling Protocols and Florida DER sampling procedures for wastewater and surface water SOP.

Potable water sampling is performed in accordance with Florida DER SOP for groundwater and EPA Region IV Environmental Compliance Branch QAM & SOP, Section 4.10.2, as revised 1 February, 1991.

Groundwater sampling is performed in accordance with Florida DER General Sampling Protocols and Florida DER SOP for groundwater sampling.

Sediments are sampled in accordance with Florida DER General Sampling Protocols and EPA Region IV Environmental Compliance Branch QAM & SOP, Section 4.8.3.3, as revised 1 February, 1991.

Soils are sampled in accordance with Florida DER General Sampling Protocols and DER Soil Sampling Procedures.

Sludges - domestic waste residuals are sampled in accordance with EPA POTW sludge sampling and analysis guidance document, August, 1989.

Sludges - solid and hazardous waste sites are sampled in accordance with EPA Region IV Environmental Compliance Branch QAM & SOP, Sections 4.12.3 and 4.12.5, as revised 1 February, 1991.

6. Special considerations

Sample compositing/mixing is performed in compliance with Florida DER General Sampling Protocols.

Sample duplicates and split samples are performed in compliance with Florida DER General Sampling Protocols.

Field filtration is performed in compliance with Florida DER General Sampling Protocols.

Volatile organics are sampled in compliance with Florida DER General Sampling Protocols.

Oil and grease is sampled in compliance with Florida DER General Sampling Protocols.

Microbiologicals are sampled in compliance with Florida DER General Sampling Protocols.

7. Sample preservation, holding times, container types and required sample volumes/amounts

Tables 6.4 through 6.11 provide information on sample preservation, holding times, container specifications and suggested volumes or amounts. These Tables are copied from the referenced EPA or USACE publications.

8. Sample preservation protocols

On-site preservation is performed in accordance with Florida DER General Sampling Protocols.

On-site pH checks are performed in compliance with Florida DER General Sampling Protocols.

9. Special preservation concerns

Volatile organics are preserved when chlorine is present following the procedure in Florida DER General Sampling Protocol, or as detailed in the appropriate method.

Cyanide is preserved in accordance with Florida DER General Sampling Protocol or as detailed in the appropriate method.

10. Sample dispatch

Sample dispatch is performed in accordance with Florida DER General Sampling Protocols.

11. Waste disposal.

Waste disposal practices used by ASI are in compliance with Florida DER General Sampling Protocols and relevant Federal and State regulations.

Table 6.1 Routine Sampling Capabilities

Parameter Group	Sample Source
Semi-volatile Organics	Drinking, surface, ground, and waste waters, soils, sediments, sludges
Volatile Organics	Drinking, surface, ground, and waste waters, soils, sediments, sludges
Pesticides/PCB's/Herbicides	Drinking, surface, ground, and waste waters, soils, sediments, sludges
Metals	Laboratory, drinking, surface, ground, and waste waters, soils, sediments, sludges
Nutrients: Nitrogen, Phosphorous, BOD	Drinking, surface, ground, and waste waters, soils, sediments, sludges
Classics: Solids, Conductance, Chloride, Sulfate, Dissolved Oxygen, TOC, etc.	Laboratory, drinking, surface, ground, and waste waters, soils, sediments, sludges
RCRA Hazard Characterization	Ground and waste water, soils, sediments, sludges
Microbiologicals	Laboratory, drinking, surface, and ground waters, food, soils, sediments, sludges

Table 6.2. Sampling equipment used in Field Operations[1]

Equipment type	Use and matrix	Construction	Notes
ISCO AutoSampler	sampling waste water and surface water	Teflon® and silastic tubing for parts which contact samples	
Hand pump	purging ground water	PVC for all parts which contact water	
Bailer	purging and sampling ground water	All Teflon construction	
Bucket with 1/4 gal markings	purging ground water	No parts contact samples	
Hand auger	sampling sediments, soils and sludges	stainless steel construction	
Shovel	sampling soils, sediments and sludges	stainless steel construction	
Mixing bowl	mixing soil and sediment samples	stainless steel construction	
Spoon	mixing soil and sediment samples	stainless steel construction	
Sludge bucket	sampling sediment and sludge	stainless steel construction	
Mechanical pump	Purging and sampling ground water	stainless steel and Teflon wetted parts	

[1] Per Table 4.1 in Florida DER SOP Section 4.0, September, 1992 DER-QA-001/92.

Table 6.3. Routinely used equipment in Field Operations

Equipment	Use	Construction and notes
Sample storage and transport		
Ice chests	sample preservation and transport	polyethylene construction
Plastic bags	sample transport	Use once and discard
Vehicle	sample transport	Jeep Comanche
Bubble-out wrap	sample transport	use once and discard
Field instruments		
ISCO flow meter	Flow Measurement	No parts contact sample
Thermometer	Temperature Measurement	Stainless steel jacketed, glass construction
DO meter	Dissolved oxygen Measurement	meter and probe type
pH meter	pH Measurement	handheld pen type
Specific conductivity meter	Conductivity Measurement	handheld pen type
pH and conductivity meter	pH and conductivity Measurement	meter and combination probe
Miscellaneous equipment		
Water level indicator	purging	Stainless steel and Teflon parts in contact with samples
measuring tape	purging	stainless steel construction
filtration apparatus	sampling	Polystyrene, disposable
disposable cups	field measurements	polyethylene
graduated cylinder	calibrate autosampler	glass
lanyard	purging and sampling	hauling and lifting, nylon
Latex gloves	all field operations	a new pair is used for each operation
camera	site documentation	visual record of sampling site
Sample preservation reagents and equipment		
sodium thiosulfate	sample preservation	VOC, microbiology, semi-volatile organics prepare daily
nitric acid	sample preservation	Metals, hardness
sulfuric acid	sample preservation	Ammonia, COD, hardness, oil & grease nitrate-nitrite, TOH, phenols, phosphorous
hydrochloric acid	sample preservation	TOC, volatile aromatic hydrocarbons
sodium hydroxide	sample preservation	cyanide, sulfide
Cadmium carbonate	sample preservation	cyanide
zinc acetate	sample preservation	sulfide
ascorbic acid	sample preservation	cyanide

Table 6.3. (continued) Routinely used equipment in Field Operations

Equipment	Use	Construction and notes
Equipment decontamination and materials		
Sprayer	decontamination	polyethylene construction, refill daily with analyte-free laboratory water
Analyte-free water	decontamination	brought fresh from the lab each sampling trip
Liquinox®	decontamination	soap solution
Acetone	decontamination	reagent grade
Hexane	decontamination	reagent grade
isopropanol	decontamination	Pesticide grade
Kimwipes	decontamination	used once and discarded
Standards and reagents		
KI-starch papers	residual chlorine detn	Fisher
1 *M* KCl solution	increase ionic strength for pH detn	Prepared from primary standard grade KCl
pH buffers	calibrate pH meters	Fisher
KCl conductivity stds.	calibrate conductivity meters	Fisher
sulfide test papers	sulfide presence detn	EM

Table 6.4. Drinking water requirements from *Manual for the Certification of Laboratories Analyyzing Drinking Water - Criteria and Procedures Quality Assurance* Third Edition, Change 2 EPA-814B-92-002, September 1992

Parameter	Container 1	Sample volume mL	Preservation	Max. Holding Time
Bacterial Tests				
Coliform, Fecal and Total	Sterile P	100	Cool 4°C, 0.1 mL of 10% $Na_2S_2O_3$	30 hours from time of collection
Inorganic Tests				
Alkalinity	P, G	200	Cool, 4°C	14 days
Antimony	P, G	500	Conc HNO_3 to pH<2	6 months
Arsenic	P, G	500	Conc HNO_3 to pH<2	6 months
Asbestos	P, G	1000	Cool, 4°C	-
Barium	P, G	500	Conc HNO_3 to pH<2	6 months
Beryllium	P, G	500	Conc HNO_3 to pH<2	6 months
Cadmium	P, G	500	Conc HNO_3 to pH<2	6 months
Calcium	P, G	500	Conc HNO_3 to pH<2	6 months
Chloride	P, G	200	None	28 days
Chromium	P, G	500	Conc HNO_3 to pH<2	6 months
Copper	P, G	500	Conc HNO_3 to pH<2	6 months
Cyanide	P, G	500	NaOH to pH>12, cool 4°C, 0.6 g ascorbic acid	14 days
Fluoride	P, G	500	None	1 month
Free Chlorine Residual	P, G	100	None	Analyze immediately
Lead	P, G	500	Conc HNO_3 to pH<2	6 months
Mercury	P, G	500	Conc HNO_3 to pH<2	28 days
Nickel	P, G	500	Conc HNO_3 to pH<2	6 months
Nitrate N	P, G	500	Cool, 4°C	28 days
Total Nitrate/Nitrite	P, G	500	Cool, 4°C, H_2SO_4 to pH<2	28 days
Nitrite N	P, G	500	Cool 4°C	48 hours
o-Phosphate	P, G	500	Filter immediately, Cool 4°C	48 hours
pH	P, G	500	None	Analyze immediately
Selenium	P, G	500	Conc HNO_3 to pH<2	6 months
Silica	P	500	Cool 4°C	28 days
Sodium	P, G	500	Conc HNO_3 to pH<2	6 months
Temperature	P, G	500	None	Analyze immediately
Thallium	P, G	500	Conc HNO_3 to pH<2	6 months
Total FilterableResidue (TDS)	P, G	500	Cool 4°C	7 days
Turbidity	P, G	500	Cool 4°C	48 hours

Table 6.4 (continued). Drinking water requirements from *Manual for the Certification of Laboratories Analyyzing Drinking Water - Criteria and Procedures Quality Assurance* Third Edition, Change 2 EPA-814B-92-002, September 1992

Parameter	Container 2	Sample volume mL	Preservation	Max. Holding Time
Organic Tests (method)				
EDB & DBPC (504)	40 mL glass with Teflon cap liner		3 mg sodium thiosulfate, HCl to pH <2, Cool 4°C	28 days to extraction, analyze immediately
Chlorinated pesticides (505)	40 mL glass with Teflon cap liner		3 mg sodium thiosulfate, Cool 4°C	14 days to extraction, analyze immediately
Phthalates and Adipates (506)	1L amber glass with Teflon cap liner		60 mg/L sodium thiosulfate, Cool 4°C	14 days to extraction, 14 days to analysis
NP pesticides (507)	1L amber glass with Teflon cap liner		10 mg/L mercuric chloride, 80 mg/L sodium thiosulfate, Cool 4°C	7 days to extraction, 14 days to analysis
Chlorinated pesticides (508)	1L glass with Teflon cap liner		10 mg/L mercuric chloride, 80 mg/L sodium thiosulfate, Cool 4°C	7 days to extraction, 14 days to analysis
PCB (508A)	1L glass with Teflon cap liner		Cool 4°C	14 days to extraction, 30 days to analysis
Herbicides (515.1)	1L amber glass with Teflon cap liner		10 mg/L mercuric chloride, 80 mg/L sodium thiosulfate, Cool 4°C	14 days to extraction, 28 days to analysis
BNA (525.1)	1L glass with Teflon cap liner		40-50 mg/L sodium sulfite, HCl to pH <2, Cool 4°C	7 days to extraction, 30 days to analysis
Carbamates (531.1)	1L glass with Teflon cap liner		Monochloroacetic acid to pH 3, 80 mg/L sodium thiosulfate, Cool 4°C until storage at -10°C	28 days with storage at -10°C
Glyphosate (547)	1L amber glass with Teflon cap liner		100 mg/L sodium thiosulfate, Cool 4°C	14 days
Endothall (548 and 548.1)	1L glass with Teflon cap liner		Cool 4°C	7 days to extraction, 1 day to analysis
Diquat & Paraquat (549)	1L amber high density PVC or silanized amber glass		100 mg/L sodium thiosulfate, sulfuric acid to pH <2, Cool 4°C	7 days to extraction, 21 days to analysis
PAH (550 or 550.1)	1L amber glass with Teflon cap liner		100 mg/L sodium thiosulfate, 6N HCl to pH <2, Cool 4°C	7 days to extraction, 40 days to analysis
Dioxins (1613)	1L amber glass with Teflon cap liner		80 mg/L sodium thiosulfate,Cool 4°C	40 days
TTHM (501.1 or 501.2)	40 mL glass with Teflon lined septa		3 mg sodium thiosulfate or sodium sulfite	14 days
VOC (502.1, 502.1, or 503.1)	40 mL glass with Teflon lined silicon septa		25 mg ascorbic acid or 3 mg sodium thiosulfate, 1:1 HCl to pH<2, Cool 4°C	14 days
VOC (524.1 or 524.2)	40 mL glass with Teflon lined silicon septa		25 mg ascorbic acid, 1:1 HCl to pH<2, Cool 4°C	14 days

Table 6.4 (continued). Drinking water requirements from *Manual for the Certification of Laboratories Analyyzing Drinking Water - Criteria and Procedures Quality Assurance* Third Edition, Change 2 EPA-814B-92-002, September 1992

Parameter	Container [3]	Sample volume mL	Preservation	Max. Holding Time
Radiological Tests[4]				
Gross alpha	1L P, G		Conc. HCl or HNO_3 to pH <2	-
Gross beta	1L P, G		Conc. HCl or HNO_3 to pH <2	-
Strontium-89	1L P, G		Conc. HCl or HNO_3 to pH <2	-
Strontium-90	1L P, G		Conc. HCl or HNO_3 to pH <2	-
Radium-226	1L P, G		Conc. HCl or HNO_3 to pH <2	-
Radium-228	1L P, G		Conc. HCl or HNO_3 to pH <2	-
Cesium-134	1L P, G		Conc. HCl to pH <2	-
Iodine-131	2L P, G		None	-
Tritium	1L P, G		None	-
Uranium	1L P, G		Conc. HCl or HNO_3 to pH <2	-
Photon emitters	P, G		Conc. HCl or HNO_3 to pH <2	-

[1] Polyethylene (P) or Glass (G).
[2] Polyethylene (P) or Glass (G).
[3] Polyethylene (P) or Glass (G).
[4] "Prescribed Procedures for Measurement of Radioactivity in Drinking Water", EPA-600/4-80-032 (1980).

Table 6.5. Holding times, containers and preservatives for wastewater samples. From 40 CFR 136, Table II, 1 July, 1992.

Parameter	Container [1]	Sample volume mL	Preservation[2,3]	Max. Holding Time[4]
Bacterial Tests				
Coliform, Fecal and Total	Sterile P or G	100	Cool 4°C, 0.008% $Na_2S_2O_3$[5]	6 hours from time of collection
Fecal streptococci	Sterile P or G	100	Cool 4°C, 0.008% $Na_2S_2O_3$[5]	6 hours from time of collection
Inorganic Tests				
Acidity	P, G	500	Cool 4°C	14 days
Alkalinity	P, G	500	Cool 4°C	14 days
Ammonia	P, G	500	Cool 4°C, H_2SO_4 to pH <2	28 days
BOD	P, G	1000	Cool, 4°C	48 hours
Bromide	P, G	500	None required	28 days
CBOD	P, G	1000	Cool, 4°C	48 hours
COD	P, G	500	Cool 4°C, H_2SO_4 to pH <2	28 days
Chloride	P, G	500	None required	28 days
Chlorine, total residual	P, G	500	None required	Analyze immediately
Color	P, G	500	Cool 4°C	48 hours
Cyanide, total and amenable to chlorination	P, G	1000	Cool 4°C, NaOH to pH >12, 0.6 g ascorbic acid[5]	14 days[6]
Fluoride	P	1000	None required	28 days
Hardness	P, G	500	HNO_3 to pH <2, H_2SO_4 to pH < 2	6 months
Hydrogen ion (pH)	P, G	500	None required	Analyze immediately
Kjeldahl and organic nitrogen	P, G	500	Cool 4°C, H_2SO_4 to pH <2	28 days
Metals[7]				
Chromium VI	P, G	500	Cool 4°C	24 hours
Mercury	P, G	500	HNO_3 to pH <2,	28 days
Metals, other	P, G	500	HNO_3 to pH <2,	6 months
Nitrate	P, G	500	Cool 4°C	48 hours
Nitrate-nitrite	P, G	500	Cool 4°C, H_2SO_4 to pH <2	28 days
Nitrite	P, G	500	Cool 4°C	48 hours
Oil and grease	G	1000	Cool 4°C, HCl or H_2SO_4 to pH <2	28 days
Organic carbon	P, G	500	Cool 4°C, HCl or H_2SO_4 to pH <2	28 days
Orthophosphate	P, G	500	Filter immediately, Cool 4°C	48 hours
Oxygen, dissolved probe	G	500	None required	Analyze immediately
Oxygen, dissolved Winkler	G	300	Fix on site and store in dark	8 hours

Table 6.5 (continued). Holding times, containers and preservatives for wastewater samples. From 40 CFR 136, Table II, 1 July, 1992.

Parameter	Container [8]	Sample volume mL	Preservation[9,10]	Max. Holding Time[11]
Phenols, total	G	500	Cool 4°C, H_2SO_4 to pH <2	28 days
Phosphorous (elemental)	G	500	Cool 4°C	48 hours
Phosphorous, total	P, G	500	Cool 4°C, H_2SO_4 to pH <2	28 days
Residue, total (TS)	P, G	500	Cool 4°C	7 days
Residue, Filterable (TDS)	P, G	500	Cool 4°C	7 days
Residue, Nonfilterable (TSS)	P, G	500	Cool 4°C	7 days
Residue, settleable	P, G	1000	Cool 4°C	48 hours
Residue, volatile	P, G	500	Cool 4°C	7 days
Silica	P	500	Cool 4°C	28 days
Specific conductance	P, G	500	Cool 4°C	28 days
Sulfate	P, G	500	Cool 4°C	28 days
Sulfide	P, G	1000	Cool 4°C, add zinc acetate and NaOH to pH >9	7 days
Sulfite	P, G	500	None required	Analyze immediately
Surfactants	P, G	1000	Cool 4°C	48 hours
Temperature	P, G	500	None required	Analyze immediately
Turbidity	P, G	500	Cool 4°C	48 hours
Organic Tests (method)				
Purgeable halocarbons (601, 624, or 1624)	40 mL glass, Teflon lined silicon septum		Cool 4°C, 0.008% $Na_2S_2O_3$[5]	14 days
Purgeable aromatic hydrocarbons (602, 624, or 1624)	40 mL glass, Teflon lined silicon septum		Cool 4°C, 0.008% $Na_2S_2O_3$[5], HCl to pH 2[12]	14 days
Acrolein and acrylonitrile (603, 624, or 1624)	40 mL glass, Teflon lined silicon septum		Cool 4°C, 0.008% $Na_2S_2O_3$[5], adjust pH to 4-5[13]	14 days
Phenols[14] (604, 625, or 1625)	1L glass with Teflon lined cap		Cool 4°C, 0.008% $Na_2S_2O_3$[5]	7 days until extraction, 40 days after extraction
Benzidine[15] (605, 625, or 1625)	1L glass with Teflon lined cap		Cool 4°C, 0.008% $Na_2S_2O_3$[5]	7 days until extraction[16]
Phthalates (606, 625, or 1625)	1L glass with Teflon lined cap		Cool 4°C	7 days until extraction, 40 days after extraction
Nitrosamines[17] (607, 625, or 1625)	1L glass with Teflon lined cap		Cool 4°C, 0.008% $Na_2S_2O_3$[5], store in dark	7 days until extraction, 40 days after extraction
PCB (608 or 625)	1L glass with Teflon lined cap		Cool 4°C	7 days until extraction, 40 days after extraction

Table 6.5 (continued). Holding times, containers and preservatives for wastewater samples. From 40 CFR 136, Table II, 1 July, 1992.

Parameter	Container[18]	Sample volume mL	Preservation[19,20]	Max. Holding Time[21]
Nitroaromatics and isophorone (609, 625 or 1625)	1L glass with Teflon lined cap		Cool 4°C, 0.008% $Na_2S_2O_3$[5], store in dark	7 days until extraction, 40 days after extraction
PAH (610, 625 or 1625)	1L glass with Teflon lined cap		Cool 4°C, 0.008% $Na_2S_2O_3$[5], store in dark	7 days until extraction, 40 days after extraction
Haloethers (611, 625 or 1625)	1L glass with Teflon lined cap		Cool 4°C, 0.008% $Na_2S_2O_3$[5]	7 days until extraction, 40 daysafter extraction
Chlorinated hydrocarbons (612, 625 or 1625)	1L glass with Teflon lined cap		Cool 4°C	7 days until extraction, 40 days after extraction
TCDD (613)	1L glass with Teflon lined cap		Cool 4°C, 0.008% $Na_2S_2O_3$[5]	7 days until extraction, 40 days after extraction
Chlorinated pesticides[22] (608 or 625)	1L glass with Teflon lined cap		Cool 4°C, pH 6-9	7 days until extraction, 40 days after extraction
Radiological Tests				
Alpha, beta and radium[23]	1L P or G		HNO_3 to pH <2	6 months

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 US Mails, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR 172). The person offering such material for transportation is responsible for ensuring such compliance. For the preservation requirements of the Table, 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 in water solutions of 0.15% by weight or less (pH about 1.62 or greater); Sulfuric acid (H_2SO_4) 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 of less (pH about 12.30 or less).

4 Samples should be analyzed as soon as possible after collection. The times listed are the amximum 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 longer time, and has received a variance from the Regional Administrator under 40 CFR 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 40 CFR 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.

7 Samles should be filtered immediately on-site before adding preservative for dissolved metals.

8 Polyethylene (P) or Glass (G).

9 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.

[10] When any sample is to be shipped by common carrier or sent through the US Mails, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR 172). The person offering such material for transportation is responsible for ensuring such compliance. For the preservation requirements of the Table, 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 in water solutions of 0.15% by weight or less (pH about 1.62 or greater); Sulfuric acid (H_2SO_4) 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 of less (pH about 12.30 or less).

[11] Samples should be analyzed as soon as possible after collection. The times listed are the amximum 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 longer time, and has received a variance from the Regional Administrator under 40 CFR 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 40 CFR 136.3(e) for details.

[12] Sample receiving no pH adjustment must be analyzed within 7 days of sampling.

[13] The pH adjustment is not required if acrolein will not be measured. Samples for acrolein receiving no pH adjustment must be analyzed within 3 days of sampling.

[14] When the extractable analytes of concern fall within a single chemical category, the specified preservative and maximum holding time should be observed for optimum safeguard of sample integrity. When the analytes of concern fall within two or more chemical categories, the sample may be preserved by cooling to 4°C, reducing residual chlorine with 0.008% sodium thiosulfate, storing in the dark, and adjusting the pH to 6-9; samples preserved in this manner may be held for 7 days before extraction and for 40 days after extraction. Exceptions to this optional preservation and holding time procedure are noted in footnote 5 (re the requirement for thiosulfate reduction of residual chlorine) and footnotes 11 and 12 (re the analysis of benzidine).

[15] If 1,2-diphenylhydrazine is likely to be present, adjust the pH of the sample to 4.0 ± 0.2 to prevent rearrangement to benzidine.

[16] Extracts may be stored for up to 7 days if storage is conducted under an inert (oxidant-free) atmosphere.

[17] For the analysis of diphenylnitrosamine, add 0.008% sodium thiosulfate and adjust pH to 7-10 with sodium hydroxide within 24 hours of sampling.

[18] Polyethylene (P) or Glass (G).

[19] 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.

[20] When any sample is to be shipped by common carrier or sent through the US Mails, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR 172). The person offering such material for transportation is responsible for ensuring such compliance. For the preservation requirements of the Table, 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 in water solutions of 0.15% by weight or less (pH about 1.62 or greater); Sulfuric acid (H_2SO_4) 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 of less (pH about 12.30 or less).

[21] Samples should be analyzed as soon as possible after collection. The times listed are the amximum 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 longer time, and has received a variance from the Regional Administrator under 40 CFR 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 40 CFR 136.3(e) for details.

[22] The pH adjustment may be performed upon receipt at the laboratory and may be omitted if samples are extracted within 72 hours of collection. For the analysis of aldrin, add 0.008% sodium thiosulfate.

[23] "Prescribed Procedures for Measurement of Radioactivity in Drinking Water", EPA-600/4-80-032 (1980).

Table 6.6. Preservation, holding times and containers for aqueous matrices, Table 2-21 from Chapter 2, SW-846, Third Edition, Revision 1, July, 1992.

Parameter	Container[1]	Preservation	Max. Holding Time
Bacterial Tests			
Coliform, total	P, G	Cool 4°C, 0.008% $Na_2S_2O_3$	6 hours
Inorganic Tests			
Chloride	P, G	None required	28 days
Cyanide, total and amenable to chlorination	P, G	If oxidizing agents are present add 0.6 g ascorbic acid per liter; adjust pH >12 with 10N NaOH, Cool 4°C	14 days
Hydrogen ion (pH)	P, G	None required	Analyze immediately
Nitrate	P, G	Cool 4°C	48 hours
Sulfate	P, G	Cool 4°C	28 days
Sulfide	P, G	Cool 4°C, add zinc acetate	7 days
Metals			
Chromium VI	P, G	Cool 4°C	28 hours
Mercury	P, G	HNO_3 to pH <2	38 days glass 13 days plastic
Other metals	P, G	HNO_3 to pH <2	6 months
Organic Tests			
Oil & Grease	G	Cool 4°C; adjust pH to <2 with HCl, H_2SO_4 or solid $NaHSO_4$	28 days
TOC	P, G	Cool 4°C; adjust pH to <2 with HCl, H_2SO_4 or solid $NaHSO_4$	28 days
Purgeable halocarbons	Glass with Teflon lined septum	Cool 4°C[2]	14 days
Purgeable aromatic hydrocarbons	Glass with Teflon lined septum	Cool 4°C; adjust pH to <2 with HCl, H_2SO_4 or solid $NaHSO_4$[3]	14 days
Acrolein and acrylonitrile	Glass with Teflon lined septum	Cool 4°C, 0.008% $Na_2S_2O_3$, adjust pH to 4-5	14 days
Phenols	Glass with Teflon lined cap	Cool 4°C, 0.008% $Na_2S_2O_3$	7 days until extraction, 40 days after extraction
Benzidines	Glass with Teflon lined cap	Cool 4°C, 0.008% $Na_2S_2O_3$	7 days until extraction, 40 days after extraction
Phthalate esters	Glass with Teflon lined cap	Cool 4°C	7 days until extraction, 40 days after extraction
Nitrosamines	Glass with Teflon lined cap	Store in dark, Cool 4°C, 0.008% $Na_2S_2O_3$	7 days until extraction, 40 days after extraction
PCBs	Glass with Teflon lined cap	Cool 4°C	7 days until extraction, 40 days after extraction
Nitroaromatics and cylic ketones	Glass with Teflon lined cap	Store in dark, Cool 4°C, 0.008% $Na_2S_2O_3$	7 days until extraction, 40 days after extraction

Table 6.6 (continued). Preservation, holding times and containers for aqueous matrices, Table 2-21 from Chapter 2, SW-846, Third Edition, Revision 1, July, 1992.

Parameter	Container[4]	Preservation	Max. Holding Time
PAH	Glass with Teflon lined cap	Store in dark, Cool 4°C, 0.008% $Na_2S_2O_3$	7 days until extraction, 40 days after extraction
Haloethers	Glass with Teflon lined cap	Cool 4°C, 0.008% $Na_2S_2O_3$	7 days until extraction, 40 days after extraction
Chlorinated hydrocarbons	Glass with Teflon lined cap	Cool 4°C, 0.008% $Na_2S_2O_3$	7 days until extraction, 40 days after extraction
Dioxins and furans	Glass with Teflon lined cap	Cool 4°C, 0.008% $Na_2S_2O_3$	7 days until extraction, 40 days after extraction
TOX	Glass with Teflon lined cap	Cool 4°C; adjust pH to <2 with HCl, H_2SO_4 or solid $NaHSO_4$	28 days
Pesticides	Glass with Teflon lined cap	Cool 4°C, pH 5-9	7 days until extraction, 40 days after extraction
Radiological Tests			
Alpha, beta and radium	P, G	HNO_3 to pH <2	6 months

[1] Polyethylene (P) or Glass (G).
[2] Free chlorine must be removed by appropriate addition of sodium thiosulfate.
[3] Free chlorine must be removed by appropriate addition of sodium thiosulfate, prior to acidification.
[4] Polyethylene (P) or Glass (G).

Table 6.7. Containers, preservatives and holding times for hazardous waste samples analyzed by SW-846 methods.

Parameter	Container [1]	Sample volume	Preservation	Max. Holding Time
Metals[2]				
Aqueous, Total	P, G	600 mL	Cool 4°C, HNO_3 to pH <2	6 months
Aqueous, Dissolved	P, G	600 mL	Filter on site, Cool 4°C, HNO_3 to pH <2	6 months
Aqueous, Suspended	P, G	600 mL	Filter on site, Cool 4°C	6 months
Solid, Total	P, G	200 g	Cool 4°C	6 months
Chromiun VI, aqueous	P, G	400 mL	Cool 4°C	24 hours
Chromium VI, Solid	P, G	200 g	Cool 4°C	As soon as possible
Mercury, aqueous, total	P, G	400 mL	Cool 4°C, HNO_3 to pH <2	38 days G 13 days P
Mercury, aqueous, dissolved	P, G	400 mL	Filter, Cool 4°C, HNO_3 to pH <2	38 days G 13 days P
Mercury, solid	P, G	200 g	Cool 4°C	28 days
Organic Tests[3]				
VOA, concentrated waste samples	8 oz (125 mL) wide mouth glass with Teflon cap liner		None	14 days
VOA, liquid sample	2 x 40 mL glass with Teflon lined septum cap		Adjust to pH <2 with H_2SO_4, HCl or solid $NaHSO_4$, Cool 4°C	14 days
VOA, liquid ample, chlorine residual present	2 x 40 mL glass with Teflon lined septum cap		Collect sample in 4 oz container with 4 dps 10% $Na_2S_2O_3$, dispense into 40 mL vials, Adjust to pH <2 with H_2SO_4, HCl or solid $NaHSO_4$, Cool 4°C	14 days
VOA, soil, sediment or sludge	4 oz (125 mL) wide mouth glass with Teflon cap liner		Cool 4°C	14 days
Acrolein and acrylonitrile, liquid sample	2 x 40 mL glass with Teflon lined septum cap		Adjust to pH 4-5, Cool 4°C	14 days
Semivolatile, concentrated waste	8 oz (125 mL) wide mouth glass with Teflon cap liner		None	14 days before extraction, analyzed within 40 days after extraction
Semivolatile, water sample	1 gal or 2 x 0.5 gal amber glass with Teflon cap liner		Cool 4°C	7 days before extraction, analyzed within 40 days after extraction
Semivolatile, water sample, chlorine residual present	1 gal or 2 x 0.5 gal amber glass with Teflon cap liner		3 mL 10% $Na_2S_2O_3$, per gal, Cool 4°C	7 days before extraction, analyzed within 40 days after extraction

Table 6.7 (continued). Containers, preservatives and holding times for hazardous waste samples analyzed by SW-846 methods.

Parameter	Container[4]	Sample volume	Preservation	Max. Holding Time
Semivolatile, soil, sediment or sludge sample	8 oz (125 mL) wide mouth glass with Teflon cap liner		Cool 4°C	14 days before extraction, analyzed within 40 days after extraction
TCLP, Method 1311[5]				
Volatiles	Glass with Teflon lined septum		Cool 4°C and minimal headspace before and after TCLP	14 days to TCLP, 14 days after TCLP to analysis
Semi-volatiles	Glass with Teflon lined cap		Cool 4°C before and after TCLP	14 days to TCLP, 7 days after TCLP to extraction, 40 days after extraction to analysis
Mercury	P, G		Preserve with HNO_3 to pH <2 after TCLP	28 days to TCLP, 28 days after TCLP to analysis
Other metals	P, G		Preserve with HNO_3 to pH <2 after TCLP	180 days to TCLP, 180 days after TCLP to analysis

[1] Polyethylene (P) or Glass (G).
[2] Table 3-1, Chapter 3, page 3, SW-846, Revision 1, July, 1992 and proposed Revision 2, November, 1992
[3] Table 4-1, Chapter 4, page 6-7, SW-846, Revison 1, July, 1992.
[4] Polyethylene (P) or Glass (G).
[5] Method 1311, SW-846, Third Edition, Revision 0, July, 1992.

Table 6.8. Sampling and preservation procedures for groundwater detection monitoring, Table 11-1, Chapter 11, page 7, SW-846, Third Edition, Revision 0, September, 1986.

Parameter	Container [1]	Sample volume	Preservation	Max. Holding Time
pH	T, P, G	25 mL	None	Analyze immediately
Specific Conductance	T, P, G	100 mL	None	Analyze immediately
TOC	Glass, Teflon lined cap	4 x 15 mL	Cool 4°C, HCl to pH <2	28 days
TOX	Amber glass, Teflon lined cap	4 x 15 mL	Cool 4°C, 1 mL of 1.1 M sodium sulfite	7 days
Chloride	T, P, G	50 mL	Cool 4°C	28 days
Metals, Total[2]	T, P[3]	1000 mL	Field acidified to pH <2 with HNO_3	6 months
Metals, Dissolved[4]	T, P[5]	1000 mL	Field filtration (0.45 µm) then acidify to pH <2 with HNO_3	6 months
Phenols	G	500 mL	Cool 4°C, H_2SO_4 to pH <2	28 days
Sulfate	T, P, G	50 mL	Cool 4°C	28 days
Fluoride	T, P	300 mL	Field acidified to pH <2 with HNO_3	28 days
Nitrate	T, P, G	1000 mL	Cool 4°C, H_2SO_4 to pH <2	14 days
Chlorinated pesticides and herbicides	T, G	2000 mL	Cool 4°C	7 days
Radium, Gross alpha, and Gross beta	P, G	1 gal	Field acidified to pH <2 with HNO_3	6 months
Coliform bacteria	Sterilized PP or G	200 mL	Cool 4°C	6 hours
Cyanide	P, G	500 mL	NaOH to pH >12, Cool 4°C	14 days
Oil & Grease	G	100 mL	H_2SO_4 to pH <2, Cool 4°C	28 days
Semivolatile, volatile organics	T, G	1000 mL	Cool 4°C	7 days

[1] Teflon (T), Polyethylene (P), Polypropylene (PP) or Glass (G).
[2] Includes iron, manganese, arsenic, barium, cadmium, chromium, lead, mercury, selenium, sodium and silver.
[3] Silver sample is collected in a dark bottle.
[4] Includes iron, manganese, arsenic, barium, cadmium, chromium, lead, mercury, selenium, sodium and silver.
[5] Silver sample is collected in a dark bottle.

Table 6.9. Sample container, preservation and holding time requirements in CLP-SOW

Parameter	Container[1]	Preservative[2]	Max. Holding Time
Inorganic Tests[3]			
Metals, other than mercury, aqueous samples	P, G	HNO_3 to pH <2	180 days
Metals, other than mercury, soil/sediment samples	P, G	Cool 4°C	180 days
Mercury, aqueous samples	P, G	HNO_3 to pH <2	26 days
Mercury, soil/sediment samples	P, G	Cool 4°C	26 days
Cyanide, total and amenable to chlorination, aqueous samples	P, G	0.6 g ascorbic acid[4], NaOH to pH >12, Cool 4°C	12 days
Cyanide, total and amenable to chlorination, soil/sediment samples	P, G	Cool 4°C	12 days
Organic Tests[5]			
VOA, all samples	Glass	Protected from light and Cool 4°C	10 days of sample receipt
SV, water samples	Glass	Protected from light and Cool 4°C	Extraction begun within 5 dyas of receipt, analysis within 40 days from extraction
SV, soil/sediment samples	Glass	Protected from light and Cool 4°C	Sonication complete within 10 days of receipt, analysis within 40 days from extraction
Pesticides, water samples	Glass	Protected from light and Cool 4°C	Extraction started within 5 days of receipt, analysis completed within 40 days of extraction
Pesticide, soil/sediment samples	Glass	Protected from light and Cool 4°C	Sonication complete within 10 days of receipt, analysis complete within 40 days of extraction.

[1] Polyethylene (P), or Glass (G).
[2] Sample preservation is performed by the sampler immediately upon sample collection.
[3] USEPA CLP-SOW for inorganic analysis, multi-media, multi-concentration, Document Number ILM03.0.
[4] Only used in the presence of residual chlorine.
[5] USEPA CLP-SOW for organics analysis, multi-media, multi-concentration, Document Number OLM01.8, August 1991.

Table 6.10. USACE Sample Containers, Preservatives and Holding Times, Low Concentration Samples[1].

Parameter	Container[2]	Preservative[3]	Max. Holding Time
Water Matrix			
Volatiles	2 x 40 mL[4] G, Septa vial	Ice to 4°C, 4 drops conc. HCl or $NaHSO_4$ to pH <2	14 days
BNA	2 x 1L[4,5] amber G	Ice to 4°C	7 days to extraction, 40 days after extraction to analysis
PCBs, Pesticides	2 x 1L[4,5] amber G	Ice to 4°C	7 days to extraction, 40 days after extraction to analysis
Metals[6]	1 x 1L P	HNO_3 to pH <2	6 months[6]
Total Recoverable Petroleum Hydrocarbons (TRPH)	2 x 1L G	Ice to 4°C, HCl to pH <2	28 days
Common anions[7]	1 x 1L G	Ice to 4°C	28 days
Explosives	2 x 1L G (amber)	Ice to 4°C	7 days to extraction, 40 days after extraction to analysis
Cyanide	1 x 1L P	NaOH to pH >12, Ice to 4°C	14 Days
Soil/Sediment Matrix			
Volatiles	2 x 40 mL G or 2 x 125 mL G Septa vial	Ice to 4°C	14 days
BNA, PCB, Pesticides	1 x 8 oz G	Ice to 4°C	14 days to extraction, 40 days after extraction to analysis
Metals, Cyanide, TRPH	1 x 8 oz G	Ice to 4°C (Cyanide & TRPH)	6 months[6] (TRPH: 28 days)
Explosives	1 x 4 oz G	Ice to 4°C	14 days to extraction, 40 days after extraction to analysis

[1] Table F-1, USACE Chemical Data Quality Management for Hazardous Waste Remediation Activities, ER 1110-1-263, 1 October, 1990, pg F-9.

[2] All containers must have Teflon-lined seals (Teflon-lined septa for VOA vials). G = Glass; P = High density polyethylene

[3] Sample preservation will be done in the field immediately upon sample collection. If water samples are filtered in the field, differential pressure methods using 45 micron filters will be used, and preservative added after filtration. VOA samples should never be filtered.

[4] Samples with residual chlorine present will be dechlorinated with sodium thiosulfate as specified in SW-846 (Third Edition).

[5] Three bottles are required on at least 5-10% (but at least one) sample so that the laboratory can perform all method QC checks for SW-846 method.

[6] Total Recoverable Metals for water samples. Holding time for mercury is 28 days in glass; for hexavalent chromium is 24 hours.

[7] Cl^-, Br^-, F^-, NO_3^-, NO_2^-, PO_4^{3-}, SO_4^{2-}; 1 L for each method; orthophosphate requires filtration. Holding time for extraction is 48 hrs for NO_2^-, NO_3^-, and PO_4^{3-} if not preserved with H_2SO_4 to pH <2.

Table 6.11. USACE Sample Containers, Preservatives and Holding Times, Medium and High Concentration Samples[1].

Parameter	Container[2]	Preservative[3]	Max. Holding Time
Medium ConcentrationWater Matrix			
Volatiles	2 x 40 mL[4] G, Septa vial	Ice to 4°C	14 days
BNA	2 x 32 oz wide mouth jars[4,5] G	Ice to 4°C	7 days to extraction, 40 days after extraction to analysis
PCBs, Pesticides	2 x 32 oz wide mouth jars[4,5] G	Ice to 4°C	7 days to extraction, 40 days after extraction to analysis
Metals[6]	1 x 16 oz wide mouth jar, G	HNO_3 to pH <2	6 months[6]
Explosives	2 x 1L G (amber)	Ice to 4°C	7 days to extraction, 40 days after extraction to analysis
Cyanide	1 x 16 oz wide mouth jar, G	Ice to 4°C	14 Days
Medium Concentration Soil/Sediment Matrix			
Volatiles	2 x 40 mL G or 2 x 125 mL G	Ice to 4°C	14 days
BNA, PCB, Pesticides	1 x 8 oz G	-	14 days to extraction, 40 days after extraction to analysis
Metals, Cyanide, TRPH	1 x 8 oz G	Ice to 4°C (Cyanide & TRPH)	6 months[6] (TRPH: 28 days)
Explosives	1 x 4 oz G	Ice to 4°C	14 days to extraction, 40 days after extraction to analysis
High Concentration Samples			
Liquid - all organic and inorganic analyses	1 x 8 oz wide mouth jar, G	-	Same as above for individual analytes
Solid - all organic and inorganic analyses	1 x 8 oz wide mouth jar, G	-	Same as above for individual analytes

[1] Table F-2, USACE Chemical Data Quality Management for Hazardous Waste Remediation Activities, ER 1110-1-263, 1 October, 1990, pg F-9.

[2] All containers must have Teflon-lined seals (Teflon-lined septa for VOA vials). G = Glass; P = High density polyethylene

[3] Sample preservation will be done in the field immediately upon sample collection. If water samples are filtered in the field, differential pressure methods using 45 micron filters will be used, and preservative added after filtration. VOA samples should never be filtered.

[4] Samples with residual chlorine present will be dechlorinated with sodium thiosulfate as specified in SW-846 (Third Edition).

[5] Three bottles are required on at least 5-10% (but at least one) sample so that the laboratory can perform all method QC checks for SW-846 method.

[6] Total Recoverable Metals for water samples. Holding time for mercury is 28 days in glass; for hexavalent chromium is 24 hours.

SAMPLE CUSTODY

Sample Custody Objectives

1. Sample custody provides documentation for a sample container from the point of departure from ASI to the field, back to ASI, through storage and analysis to final disposal.
2. Sample custody provides documentation beginning with the procurement of a sample, and traces it through delivery to ASI, storage, and analysis and ends with either disposal of the sample or return of the unanalyzed portion of the sample to the client.
3. Sample custody identifies every person who had contact with the sample and/or container and over what time period.
4. Sample custody also includes documentation of the analytical results as they pass from the analyst to the client. ASI uses a Laboratory Information Management System (LIMS) for preparation of parameter test reports. Therefore sample custody also includes the security system on the computer network for insuring data integrity, electronic storage of test data and results, and how hardcopies of interim and final reports are reviewed and stored.
5. Overall sample custody is the responsibility of the Sample Custody Laboratory Section Supervisor. Sample custody as it pertains to the electronic data records is the responsibility of the Computer Operations Laboratory Section Supervisor.

Field Custody

Legal custody

If ASI provides the cleaned sample containers, legal custody begins at the laboratory for both samples sent in by the client and samples collected by ASI field operators. Otherwise, ASI's legal custody begins at the time the sample arrives at the laboratory.

Individual samples are identified by field numbers. Field numbers are listed in the Field Logbook (Appendix C, Figure C.4) along with exact sampling location and other data (see below). Field logbooks are kept in the Field Operations Building when not in use or after the completion of the project. The entries in the Field logbook are mirrored as far as field ID number, sampling location, requested parameter analyses, and persons with custody in the chain-of-custody form (Appendix C, Figure C.5). The movements of the sample from point of collection in the field to the laboratory can be traced through the entries in the chain-of-custody form.

Procedures for identifying & labeling samples

1. As soon as a sample is collected, a self-adhesive Sample Label (Appendix C, Figure C.1) is attached to the sample container. The information on the Sample Label includes the Field ID number, date and time of collection, person performing the sampling, sampling site, type of sample, parameters requested and preservatives added.
2. A self-adhesive perforated Sample Custody Seal (Appendix C, Figure C.3) is used to seal the lid to the sample container. Information on the Custody Seal includes the date and person attaching the seal.
3. The sample is bagged in a plastic bag which is taped shut with electrician's tape and a Sample Tag (Appendix C, Figure C.2) is attached to the bag with a wire, string or tape. The Sample Tag has space for project number, Field ID number, sampling site data, time and date of sampling, person performing the sampling, requested parameters, and preservatives.
4. The information on these labels and tags is repeated in the Field logbook along with the field ID number and other information (see below).

Forms and Field Records

ASI has a number of forms and records for use in field operations. Examples of each of the documents are found in Appendix C. A list of the documents follows:

Figure C.4. Page from a field logbook.
Figure C.5. Chain-of-custody form.
Figure C.11. Request for sample containers.
Figure C.12. Field Sampling Information Sheet.
Figure C.15. Water Monitoring Report on Solid Waste Disposal Site.
Figure C.16. Groundwater Monitoring worksheet.
Figure C.18. Report of Analytical Results.

The tracking of a sample through these documents can be accomplished beginning with the project, the Report of Analytical Results or the name of the client. The client's name allows access to the client's file which is a complete listing of all services performed for the client to date. The services are listed by request date, project, and analytical group. Any of the three can give the laboratory number or the field ID number of the sample and the number of the project file. The project file contains all of the worksheets and field logbooks along with copies of the Report of Analytical Results. These reports and documents also allow access to the laboratory and field ID numbers of the sample. The field ID number is also cross indexed to the laboratory number in the Laboratory logbook by the name of the client, the lab sample number and the purchase order/billing information.

Field Logs

Maintenance & storage of field records: Field logs are bound 6.5 x 8.5 inch books, one to each field operation. The books consist of resin impregnated, waterproof graph paper. Information is recorded in the books with waterproof ink. Field logbooks are stored in the project file, in the Field Operations Building.

Information content of field logs:

Date of sample collection

Specific description of sampling site (site Name, street address, city, county, monitor well number, key landmarks around site, *etc.*). A diagram of the site is always included.

Name of sampler

Weather/site conditions

Purging & sampling equipment

Field ID number & parameters requested

Sampler program

Sample sequence number

Time of sample collection

Signature of sampler

Preservation & pH checks

Field measurement data (pH, conductivity, DO, temperature)

Types, number, & specific location of QC samples collected

Monitor well data (construction material, diameter, water table depth, well depth, calculations of purge volume, purge volume, date & time of purging, pH, conductivity and temperature measurements which establish stabilization after or during purging)

In-place plumbing data (plumbing & tap construction materials, purge flow rate, purge time, sampling flow rate)

Depth of sample collection for surface water, soils & sediments

Drum sampling (type of drum, contents, mixing of layers), the label information on the drum which identify the contents

Common carrier transport protocols

Clients sending samples by common carrier to ASI are expected to comply with all state and federal DOT regulations. ASI does not use common carriers for transport of samples during ASI managed field operations.

Sample Transmittal Forms

The chain-of-custody form (Appendix C, Figure C.5) serves for recording sample transmittal during ASI operations. All applicable parts of the form are required to be completed at all times.

Laboratory Custody

Sample receipt

The receiving clerk checks first to insure the custody seal is intact. The sample label and sample tag information is checked against the chain-of-custody form. Items examined include field ID number, requested parameters and preservatives.

Sample log-in

Sample log-in is performed on the laboratory computer system by the receiving clerk. Information which is entered includes client name and address, collection date, field ID number, project number, analytical parameters requested, sample matrix, observations on the physical state of the sample, and a priority code. The computer automatically logs the time, date and access code of the clerk, assigns a laboratory sample number, and laboratory storage number and prints a bar-coded laboratory sample label. The self-adhesive bar-coded laboratory sample label (Appendix C, Figure C.7) is attached to the sample container by the clerk. The sample is scheduled for analysis by the computer based on the priority code and type of analysis. Finally, the computer prints a sample log-in sheet (Appendix C, Figure C.6) as hardcopy for data entry verification and storage in a binder.

Sample security and accessibility

ASI operates a secured building. No unauthorized personnel are allowed entry or movement within the building without being accompanied by an ASI employee. As such the entire facility constitutes secured storage. The sample storage room is adjacent to the sample reception area and access to the room is controlled by the sample log-in technicians who have the internal parts of the storage room under constant visual surveillance. The laboratory storage number is used to specify where in the sample storage room the sample is stored when not in active use by the analysts. The number specifies the cabinet or refrigerator and the shelf. Samples are signed out from storage by bar-code scanner by the analyst and returned in the same fashion.

Sample distribution & tracking

Work assignments are made and samples are tracked by the laboratory computer system. A sample computer analytical scheduling sheet is shown (Appendix C, Figure C.17.). Information on each sample is up-dated immediately on data entry by the bar-code scanner and entry of analytical results. The status of any sample can be ascertained through the computer at any moment.

Documentation of sample disposition

After the completion of requested parameter analyses, the samples are either returned to the originator if they are hazardous, or if they are benign, stored by completion date in a set of cabinets in

the longterm sample storage room. Sample movement from stortterm to longterm storage is indicated to the computer by entry of bar-codes. After 30 days from the date of completion, the samples are disposed by heat assisted volume reduction in a vented hood followed by packaging the resulting sludge in a Labpak and landfilled. Sample disposal is documented within the computer by bar-code entry and in some cases by the letter which accompanies the samples returned to the originator.

Procedures & documentation for transport of samples and/or extracts to other laboratories.

ASI subcontracts a few parameter determinations to other laboratories. A bound log is kept of the samples sent for subcontracting. Information included in the log is lab sample number, date received at ASI, client, type of sample matrix, subcontractor, test requested, date sent, initials of clerk, means of transport, and date results received (Appendix C, Figure C.13). A purchase order (Appendix C, Figure C.14) accompanies the sample to the subcontractor which describes the sample and details the requested analysis. If warranted, a chain-of-custody form (Appendix C, Figure C.5) will accompany the sample.

Electronic Data Records

Security system

The security system for the Laboratory Information Management System (LIMS) is dual level password entry to data by authorized persons. Entry of a Technician's level password allows the user to check-out a work schedule for a particular analysis, then later the same password is the only one accepted on the technician's level to enter results data for that work assignment. Sample log-in is on the Technician's level. Once results or sample data are entered, they can no longer be accessed at the Technician's level. The Chief Chemist, Laboratory Manager, and Laboratory Director have general access to all laboratory data through their passwords, including editing capabilities.

Forms and Records

The only forms regularly printed for verification and/or signature are the daily sample log-in (Appendix C, Figure C.6), the Laboratory Results Worksheet (Appendix C, Figure C.10) and the Report of Analytical Results (Appendix C, Figure C.18). The daily log-in hardcopy is kept in a loose leaf binder and filed on a daily basis. The Laboratory Results Worksheet serves as a summary sheet and coversheet for the raw data file and is filed with the raw data by sample number. Hardcopy files of all Reports of Analytical Results are maintained in file cabinets by client, project number and laboratory sample number.

System

The system software for the LIMS is still under development by the Computer Operations Supervisor. It is fully documented in hardcopy. Revisions will be fully documented as they occur.

Data entry is verified by immediate on-screen repeat of the entered data for visual checking by the data entry personnel. Hardcopy is also generated of the daily sample log-in, Laboratory Results Worksheet and Final Analytical Results for verification against the chain-of-custody or worksheets by the Sample Custody Supervisor, the Laboratory Manager, and the Laboratory Director.

ANALYTICAL PROCEDURES

Laboratory Operations

Laboratory ware cleaning:

A. Organics (glassware, pipets, teflon® ware, *etc.*)

1. Removal of surface particulates and soluble contaminants immediately after use. The item is rinsed with methanol for this purpose.

2. Hot detergent (Liquinox®) soak

3. Hot water rinse

4. Soak with oxidizing agent to reduce and solubilize stubborn organics and contaminants. A 40-50°C chromic acid bath is used for this purpose.

5. Hot water rinse

6. Laboratory water rinse

7. Methanol or acetone (organic solvent) rinse

8. Drying. All glass items which are used in VOC analysis are oven dried at 105°C. Lab ware used in other procedures are dried either in an oven at 105°C, or in the open air on a neoprene coated metal rack. Pipets are dried in an oven.

9. Storage. Small items are wrapped in aluminum foil for storage in glass-fronted cabinets. Larger items such as separatory funnels are stored unwrapped in glass-fronted cabinets. Cabinets are located in an organic vapor and contaminant-free area

10. Except for items used in VOC analyses, glassware is rinsed immediately before use with the solvent to be used.

B. Metals and general chemistry (polyethylene and teflon® containers, glassware, pipets, teflon® ware, *etc.*)

1. Rinse with water to remove surface particulates and contaminants immediately after use.

2. Hot detergent (Liquinox®) soak

3. Hot water rinse

4. Soak in 3:1 nitric acid:hydrochloric acid

5. Hot water rinse

6. Laboratory water rinse

7. Drying. Items used in metals analyses are air dried on wood racks.

8. Storage. Items are stored in glass-fronted cabinets.

C. Microbiology (glassware and pipets)

1. Item is immediately rinsed with water after use.

2. Hot detergent (Liquinox®) soak

3. Hot water rinse

4. Laboratory water rinse

5. Cover glassware opening with aluminum foil, place pipets in metal pipet holder and sterilize

6. Storage. Items are stored covered in a glass-fronted cabinet in the Microbiology Room.

Reagent Storage:

The storage of reagents is outined in Table 8.1.

Waste disposal:

Laboratory wastes are subjected to volume reduction under a hood, then the residues collected and stored in LabPac® containers by class of waste, labeled as to contents and consigned to the contractor for hazardous waste management or landfilled if benign.

Microbiological waste is sterilized, then landfilled.

Table 8.1. Reagent Storage

Reagent	Storage	Documentation
Microbiology		
Dehydrated broths	Broth cabinet in Micro. Rm.	File of packing slips and order forms / MSDS file
Dehydrated agars	Agar cabinet in Micro. Rm.	File of packing slips and order forms / MSDS file
Suitability nutrients	Suitability cabinet in Micro. Rm..	File of packing slips and order forms / MSDS file
Bottled water (Ultrapure)	Cabinet in Micro. Rm.	File of packing slips and order forms
Chemistry		
Mineral acids (Reagent Gr)	Acids cabinet under hood in wet lab	File of packing slips and order forms / MSDS file
Mineral acids (Ultrapure)	Acids cabinet in AA room	File of packing slips and order forms / MSDS file
Organic acids	Acids cabinet under hood in wet lab	File of packing slips and order forms / MSDS file
Mineral bases	Bases cabinet under hood in wet lab	File of packing slips and order forms / MSDS file
Organic solvents (Pesticide Gr)	Solvent cabinet in extraction lab	File of packing slips and order forms / MSDS file
Buffers (Reagent Gr)	Buffer cabinet in BOD room	File of packing slips and order forms / MSDS file
Heavy metal salts (Reagent Gr)	Inorganic salt cabinet in wet lab	File of packing slips and order forms / MSDS file
Matrix modifiers (Ultrapure)	Modifiers cabinet in AA room	File of packing slips and order forms / MSDS file

CALIBRATION PROCEDURES AND FREQUENCY

Table 9.1. Laboratory Instrumentation
Table 9.2. Field Operations Equipment
Table 9.3. Standard Sources and Preparation
Table 9.4. Initial Instrument Calibration
Table 9.5. Continuing Instrument Calibration
Table 9.6. Standardization of Titration Solutions

Standard Receipt and Traceability

Standards are received as either neat compounds or prepared stock solutions. Standards are stamped with the receipt date and given to the appropriate section for storage. The documents provided by the manufacturer certifying the standard along with the date of receipt and expiration date are stored in a log kept in the QA Manager's files.

Standard sources and preparation

Standards are received by the various laboratory sections as either neat compounds or prepared stock solutions from suppliers (see Table 9.3). The standards are stored in cabinets or refrigerators as appropriate. Neat compounds are weighed on analytical balances, then diluted with the appropriate solvent to known volumes to form stock solutions. The lot number of the standard, manufacturer, date of receipt, expiration date, person performing the preparation and date of preparation, weights and dilution are documented in the standard preparation logbook. Dilutions are prepared from the stock solutions using volumetric pipets and flasks to obtain working solutions in the appropriate concentration ranges. The dilutions are labeled with a number and the expiration date, and their preparation documented in the standard preparation logbook. The concentration of each standard is verified by co-analysis against an independent check standard.

Equipment calibration

Balances: Checked weekly against Fisher Class S weights
Ovens: Temperature is checked twice daily
Refrigerators: Temperature is checked twice daily
Incubators: Temperature is checked twice daily

Field instrument calibration

All field instruments are calibrated in accordance with the procedures and frequencies detailed in Florida DER SOP QA 001/92, Section 7.5, December, 1992. Instruments covered by this SOP include pH meters, temperature measurement, dissolved oxygen meters, specific conductivity meters, residual chlorine measurement and automatic wastewater samplers.

Table 9.1. Laboratory Instrumentation

Metals

Thermo Jarrell Ash Enviro 36 Simultaneous Plasma Emission Spectrophotometer w/ Autosampler
Hitachi Model Z-8100 Polarized Zeeman Atomic Absorption Spectrophotometer w/ Graphite furnace and Autosampler
Thermo Jarrell Ash Smith/Hieftje 8000 AA/Graphite furnace
Instrumentation Laboratories 457 AA/AE Spectrophotometer w/ Graphite Furnace
Bacharach 50B Mercury Analyzer
Floyd RMS microwave digestor with pressure transducer controller

Organics

Hewlett-Packard Model 5890 Series II with MSD 5970 GC-MS w/ Autosampler (3)
Hewlett-Packard Model 5890 Series II with MSD 5971 GC-MS w/ Autosampler (1)
Hewlett-Packard Model RTE A-series Data System (2)
Hewlett-Packard Model 5890 Series II dual channel GC w/ ECD and Autosampler
Hewlett-Packard Model 5890 Series II GC with FID and ECD and Autosampler.
Tekmar Models LSC 2 and LSC 2000 Liquid Sample Concentrators
Tekmar ALS 2016 Autosampler (2)
Varian Model 3700 GC w/ FID, EC andAutosampler
Tekmar Sonic Disruptor (3)
ABC Model 1002B GPC Autoprep
Zymark Turbovap® Evaporator
Nucleopore TCLP Pressure filtration apparatus Model 425910
Analytical Testing and Consulting Svc. Model C-102 ZHE (3)
Analytical Testing and Consulting Svc. Model DC-20 rotator
Associated Design and manufacturing Co. 3740-24-BRE-TM rotator
Astro 2001 System 2 TOC analyzer with autosampler and data system.

General Equipment

Perkin Elmer Model 1330 IR Spectrophotometer
Fisher/TAG Model 13-497-5 Pensky-Martens Flash Tester
Orion Model 920A pH/ISE meter
Hach Ratio Turbidimeter
Parr Oxygen Bomb Calorimeter
Tecator Kjeltec System Model 1002 Distillation Unit (2)
Tecator Digestion System 20 Model 1015 Digester
Temco Furnace w/ Thermodyne Controller
Blue M Box Type Muffle Furnace
Sequoia-Turner Model 690 UV-VIS Spectrometer
Skalar Model 8708/16 8-Channel Auto Analyzer (2)
DO Meter YSI Model 50
pH Meter Fisher 620
Conductivity Meter YSI Model 31
Buck HC404 oil in water analyzer (2)
Skalar SP100 BOD analyzer
Fisher K-F Titrimeter 391
Hach DR/1A Colorimeter

Table 9.1 (continued). Laboratory Instrumentation

Orion Model 920A ISE/pH meter
Horiba IT-330 Infrared Thermometer
Blue M water bath incubator
Precision Scientific 1485 incubator
Blue M dry type incubator
American Sterilizer Company autoclave with American Cyclomatic Control
Labline Imperial IV waterbath
Labline Imperial III radient heat oven
Buchi RE111 Rotavapor with Model 461 waterbath
Fisher Isotemp Model 126G oven
Fisher Isotemp Model 655F oven
Precision Model 185 waterbath (3)
Fisher Model 9101 recirculating chiller (3)

Analytical Balances

Mettler H180 Analytical Balance
Sartorius 1006MP9 top-loader
Precisa 160 A top-loader
Precisa 160M top-loader
Precisa 40SM-200A 5-place analytical balance
Ohaus trip balance

Table 9.2. Field Operations Equipment

Bailer	3'x1.75" Teflon	Norwell Model # TF-30150
	2'x1.75" Teflon	Norwell Model # TF-30140
	Standard Teflon top	Norwell Model # TF-30110
	Standard Teflon bottom	Norwell Model # TF-30120
	Controlled flow bottom	Norwell Model # TF-30520
Mechanical Pump	2" mechanical pump	Fultz Model # SP-202
	Portable generator	Model # QEG-300
	1.7" Hand Pump	Brainerd-Kilman Model # T-125
Hand Auger	Stainless steel	Brainerd-Kilman S-111
Automated sampler	ISCO Sampler	Model # 2700
	ISCO Sampler	Model # 3700
Flow Meter	ISCO Bubble tube meter	Model # 3230
Camera	Polaroid Impulse SE	
pH/Conductivity meters		
	Meter and probes	Cole-Palmer Model 1484-44
DO meters	Meter and probe	Cole-Palmer Model L-05509-00
pH meter	Handheld pen	Cole-Palmer Model L-05830-00
Conductivity meter	Handheld pen	Corning PS17
Thermometer	Field model	NSC T3024-3
Water Level Indicator	meter and probe	Slope Indicator Co. Model # 51453
Measuring Tape	300'	Model # ORT-10-300
Sludge Buckets	w/ flap valve	Brainerd-Kilman
Decontamination Sprayer		
	3 gal. polyethylene	Ace Hardware Model # 71968
	1 gal. polyethylene	Ace Hardware Model # 71967

Table 9.3. Standard Sources and Preparation

Instrument Group	Standard Source(s)	How Received	Source Storage	Preparation of Primary and Working Standard	Primary and Working Standard Storage	Preparation Frequency
Gas Chromatographs						
Pesticides	Supelco Ultra Scientific	Solutions	Freezer	Serial dilution with iso-octane	Freezer	Weekly
Herbicides	Supelco Ultra Scientific	Solutions	Freezer	Serial dilution with iso-octane	Freezer	Weekly
PCB's	Supelco Ultra Scientific	Solutions	Freezer	Serial dilution with iso-octane	Freezer	Weekly
GC-MS Spectrometers						
VOC	Supelco Ultra Scientific	Solutions	Freezer	Serial dilutions with Methanol	Freezer	Weekly
Base/Neutrals	Supelco Ultra Scientific	Solutions	Freezer	Serial dilutions with Methylene chloride	Freezer	Weekly
Acids	Supelco Ultra Scientific	Solutions	Freezer	Serial dilutions with Methylene chloride	Freezer	Weekly
AA-flame						
Metals	Fisher, RICCA	1000 ppm in acidified water	Standards Cabinet @ room temp	Serial dilution with 2% HNO_3	Standards Cabinet @ room temp.	Each month

Table 9.3 (continued). Standard Sources and Preparation

Instrument Group	Standard Source(s)	How Received	Source Storage	Preparation of Primary and Working Standard	Primary and Working Standard Storage	Preparation Frequency
AA-furnace Metals	Spex, Fisher, RICCA, ERA	1000 ppm in acidified water	Standards Cabinet @ room temp	Serial dilution with 2%HNO_3	Standards Cabinet @ room temp.	Each run
AA-cold vapor Mercury	Fisher, RICCA	1000 ppm in acidified water	Standards Cabinet @ room temp	Serial dilution with 2%HNO_3	Standards Cabinet @ room temp.	Each run
ICP Metals	VHG Labs, ERA Plasmachem	10 ppm multi-element in 1% HNO_3/5% HCl	Standards Cabinet @ room temp	Used as received	N/A	Every 3 months
pH meters pH	Fisher, ERA	Solution	Standards Cabinet @ room temp	Used as received	N/A	Every 6 months
Turbidimeters	Fisher, ERA	Solution	Refrigerator	Serial dilutions with water	Refrigerator	Every 6 months
Specific Conductivity meters	YSI, Inc, ERA	Solution	Standards Cabinet @ room temp	Used as received	N/A	Every 6 months

Table 9.3 (continued). Standard Sources and Preparation

Instrument Group	Standard Source(s)	How Received	Source Storage	Preparation of Primary and Working Standard	Primary and Working Standard Storage	Preparation Frequency
IR Spectrometer	Fisher	Neat liquid	Standards Cabinet @ room temp	Used as received	N/A	Every 2 years
Bomb Calorimeter	Fisher	Solid	Standards Cabinet @ room temp	Used as received	N/A	Every 2 years
ST Spectrometer	Fisher	Neat liquid	Standards Cabinet @ room temp	Used as received	N/A	Every 2 years
		Solid	Standards Cabinet @ room temp	Serial dilution with laboratroy water	NA	Prepared daily
Hardness	ERA, Inc.	Acidified solution	Standards Cabinet @ room temp	Used as received	N/A	Every 6 months
Thermometers Temperature	ERTCO NBS certified thermometer surety # 198692	N/A	Safe drawer in Microbiology	Used as received	N/A	N/A
Autoanalyzer	CMS	Solids	Standards cabinet @ room temp	Serial dilution with laboratory water	NA	Prepared daily

Table 9.4. Initial Instrument Calibration

Instrument/ Analyte Group	Standard Source	Calibration Levels	Curve Type	Frequency	Acceptance / rejection criteria	QC check frequency and control criteria
Gas Chromatographs						
Pesticides	Supelco Ultra Scientific	5	Linear	Quarterly	±30% on ICV	Daily/20 samples ±30% CCV
Herbicides	Supelco Ultra Scientific	5	Linear	Quarterly	±30% on ICV	Daily/20 samples ±30% CCV
PCB's	Supelco Ultra Scientific	5	Linear	Quarterly	±30% on ICV	Daily/20 samples ±30% CCV
GC-MS Spectrometers						
VOC	Supelco Ultra Scientific	5	Linear	Quarterly	±30% on ICV	Daily/20 samples ±30% CCV
Base/Neutrals	Supelco Ultra Scientific	5	Linear	Quarterly	±30% on ICV	Daily/20 samples ±30% CCV
Acids	Supelco Ultra Scientific	5	Linear	Quarterly	±30% on ICV	Daily/20 samples ±30% CCV
AA-flame						
Metals	Fisher, RICCA	Blank + 5	Linear	Daily	Correlation >0.995 ± 10% on ICV	Each 10 samples ± 10% on CCV

Table 9.4 (continued). Initial Instrument Calibration

Instrument/ Analyte Group	Standard Source	Calibration Levels	Curve Type	Frequency	Acceptance / rejection criteria	QC check frequency and control criteria
AA-furnace						
Metals	Fisher, RICCA	Blank + 5	Linear	Daily	Correlation >0.995 ± 10% on ICV	Each 10 samples ± 10% on CCV
AA-cold vapor						
Mercury	Fisher, RICCA	Blank +4	Linear	Daily	Correlation >0.995 ± 10% on ICV	Each 10 samples ± 10% on CCV
ICP						
Metals	VHG Labs	2	Linear	Daily and each 10 samples	Correlation >0.995 ± 10% on ICV	Each 10 samples ± 10% on CCV
pH meters						
pH	Fisher	2	Linear	Prior to each use	±0.05 on ICV	Prior to each use
Fluoride	Fisher	9	Linear	Prior to each use	±10% on ICV	Prior to each use
Turbidimeters						
Turbidity	Fisher	3	Linear	Prior to each use	±10% on ICV	NA
Specific Conductivity meters	YSI, Fisher	1	Linear	Prior to each use	NA	NA
IR Spectrometer						
TPH	Fisher	3	Linear	Daily	±10% on ICV	NA

Table 9.4 (continued) Initial Instrument Calibration

Instrument/ Analyte Group	Standard Source	Calibration Levels	Curve Type	Frequency	Acceptance / rejection criteria	QC check frequency and control criteria
Bomb Calorimeter						
BTU	Fisher	1	Linear	Daily	NA	NA
ST Spectrometer						
Cyanide	CMS	Blank + 6	Linear	Quarterly	±10% on ICV	Daily/10 samples ±10% on CCV
TKN	CMS	Blank + 6	Linear	Quarterly	±10% on ICV	Daily/10 samples ±10% on CCV
Silica	Fisher	Blank + 6	Linear	Quarterly	±10% on ICV	Daily/10 samples ±10% on CCV
MBAS	Fisher	Blank + 9	Linear	Daily	±10% on ICV	NA
Phosphorus	CMS	Blank + 4	Linear	Quarterly	±10% on ICV	every 10 samples
Ammonia	CMS	Blank + 4	Linear	Quarterly	±10% on ICV	every 10 samples
Total phenols	CMS	Blank + 4	Linear	Quarterly	±10% on ICV	every 10 samples
Sulfate	CMS	Blank + 4	Linear	Daily	±10% on ICV	every 10 samples
DO meter						
Dissolved O_2	O_2 saturated air	1	Linear	Prior to each use		
Thermometers						
Temperature	NBS Certified Thermometer					

Table 9.4 (continued). Initial Instrument Calibration

Instrument/ Analyte Group	Standard Source	Calibration Levels	Curve Type	Frequency	Acceptance / rejection criteria	QC check frequency and control criteria
Autoanalyzer						
Sulfate	CMS	Blank + 4	Linear	Hourly	±10% on ICV	NA
Chloride	CMS	Blank + 4	Linear	Prior to each use	±10% on ICV	Every 10 samples
Cyanide	CMS	Blank + 6	Linear	Prior to each use	±10% on ICV	Every 10 samples
Phosphorus	CMS	Blank + 4	Linear	Prior to each use	±10 % on ICV	Every 10 samples
Nitrite	CMS	Blank + 4	Linear	Prior to each use	±10% on ICV	Every 10 samples
Nitrate/nitrite	CMS	Blank + 4	Linear	Prior to each use	±10% on ICV	Every 10 samples
Ammonia	CMS	Blank + 4	Linear	Prior to each use	±10% on ICV	Every 10 samples ±10% on CCV
Total phenols	CMS	Blank + 4	Linear	Hourly	±10% on ICV	Every 10 samples ±10% on CCV
TKN	CMS	Blank + 6	Linear	Prior to each use	±10% on ICV	Every 10 samples ±10% on CCV

Table 9.5. Continuing Instrument Calibration

Instrument Analyte Group	Standard Source	Continuing Calibration Levels	Concentration Range	Frequency	Acceptance / rejection criteria
Gas Chromatographs					
Pesticides	Supelco Ultra Scientific	1	mid-level	every 12 hrs	±25%
Herbicides	Supelco Ultra Scientific	1	mid-level	every 12 hrs	±25%
PCB's	Supelco Ultra Scientific	1	mid-level	every 12 hrs	±25%
GC-MS Spectrometers					
VOC	Supelco Ultra Scientific	1	mid-level	every 12 hrs	±25%
Base/Neutrals	Supelco Ultra Scientific	1	mid-level	every 12 hrs	±25%
Acids	Supelco Ultra Scientific	1	mid-level	every 12 hrs	±25%
IR Spectrometer TPH	Fisher / CMS	1	mid-level	Daily/every 10 samples	±10%
ST Spectrometer	CMS	1	mid-level	Daily/every 10 samples	±10%

Table 9.6. Standardization of Titration Solutions

Standardized Solutions	Primary Standard	Source	Standardization Frequency
Sodium hydroxide	Potassium Hydrogen Phthalate	Fisher	Monthly
Hydrochloric acid	Standardized NaOH	Fisher	Monthly
Sulfuric acid	Standardized NaOH	Fisher	Monthly
Sodium thiosulfate	Potassium biiodate	Fisher	Daily
Phenyl arsine oxide	Potassium biiodate	Fisher	Weekly
Karl-Fisher titrant	Lab water in anhydrous Methanol	Fisher	Daily
EDTA	Calcium carbonate	Fisher	Weekly
Ferrous ammonium sulfate	Potassium dichromate	Fisher	Weekly
Silver nitrate	Sodium chloride	Fisher	Daily
Mercuric nitrate	Sodium chloride	Fisher	Daily

PREVENTATIVE MAINTENANCE

The routine preventative maintenance activities which take place are listed by instrument in Table 10.1. Each non-portable instrument has a logbook which is kept with the instrument. Information in the logbook includes preventative maintenance activities by both the instrument operator and the contract PM specialist. Instrument failures and repairs are also documented in the instrument logbook. Work orders from instrument repair and/or upgrades are kept in a folder with the instrument. In the event of major instrument failure the following procedures are followed:

1. Repair Service/Manufacturer contacted at once and appointment made for repair.

2. Most recent samples analyzed and QC check results are scrutinized for reliability before the data is released as accurate.

3. Work load shifted to the other instrument. (ASI has two of each instrument needed for high volume analyses).

Table 10.1 Routine preventative maintenance activities

Instrument	Specific activity	Frequency
Field Operations		
Autosampler	Check operation of pump	daily
	Check dessicant	daily
	Check batteries	daily
	Replace silastic tubing	daily
	Check tubing	daily
Flow meter	Check dessicant	daily
	Check batteries	daily
	Bubble line checked	daily
	Check chart paper and pen	daily
	Full service check and calibration	annual
DO Dunker	Check seals	daily
Bladder pump	Check operation and seals	daily
Hand pump	Check operation and seals	daily
Sprayer	Check operation	daily
Thermometer	Check for cracks and mercury column separation	daily
DO meter	Check operation and calibration	daily
pH meter	Check operation and linearity of calibration	daily
Conductivity meter	Check operation and clean cell	daily
Camera	Check operation and film	daily
Measuring tape	Check for breaks	daily
Bailer	Check for cracks and seals	daily
Auger	Check for breaks	daily
Flow poke	Check operation	daily
Laboratory Operations		
ICP	Check aspirator tubing	daily
	Check spray chamber	daily
	Clean spray chamber	weekly
	Check compressor	daily
	Check torch	daily
	Clean torch	weekly
	Check gases	daily
	Replace gases	pressure <300 psi
	Contract PM	annual
Graphite furnace AA	Check autosampler	daily
	Check furnace	each sample set
	Replace furnace tube	after 200 heating cycles
	Clean optics	weekly
	Check compressor	daily
	Check plumbing	daily
	Contract PM	annual

Table 10.1 (continued) Routine preventative maintenance activities

Instrument	Specific activity	Frequency
Mercury analyzer	Check tubing and connections	daily
	Calibrate reagent pump	weekly
Gas Chromatographs	Change septa	daily/weekly
	Check gas cylinders	daily
	Gas cylinder replacement	pressure <300 psi
	Change inline gas traps	quarterly
	Detectors cleaned	deteriorating response/semi-annual
	Remove 1' of column	as need arises
	Column replacement	retention times deteriorate or baseline contamination increases
	Injector sleeve and seal replacement	decreasing sensitivity/missing compounds/weekly
	Check integrator paper	daily
	Check integrator ink/ribbon	daily
	Contract PM	semi-annual
GC/MS	(all above applicable activities)	
	Auto-tune	every 12 hrs
	Blank water boiled and purged	daily
	Vacuum and vacuum pumps	daily
	Ion source cleaned	semi-annual
	Quadrupole rods cleaned	semi-annual
	Computer paper checked	daily
	Contract PM	semi-annual
Analytical balances	Accuracy checked	daily/weekly
	Contract cleaned and calibrated	annual
IR spectrophotometer	Clean and check optics	daily
Sonic disruptor	Clean probe	each sample
Flash tester	Check gas	daily
	Check thermometer	daily
Turbidimeter	Clean and check optics	daily
Bomb calorimeter	Check water level	daily
	Check gas	daily
	Check filament	each sample
	Check thermometer	daily
Autoclave	Check for sterilization	each sample w/ indicating tape
	Log time and temp	Each sample set
Refrigerator	Check temperature	twice daily
Incubator	Check temperature	twice daily
Water bath	Check temperature	twice daily
	Check water level	daily
UV-Vis spectrometer	Clean and check optics	daily
	Check paper and ink supply	daily
	Check recorder response	daily

Table 10.1 (continued) Routine preventative maintenance activities

Instrument	Specific activity	Frequency
Autoanalyzer	Clean and check optics	daily
	Check reagent reservoirs	daily
	Check pumps	daily
	Check tubing	daily
	Check recorder paper and pen	daily
	Check recorder response	daily
DO meter	Check operation	daily
	Clean probe	daily
pH meter	Check operation	daily
	Clean probe	daily
Conductivity meter	Check operation	daily
	Clean cell	daily
Oil in water analyzer	Clean and check optics	daily
	Check operation	daily
BOD analyzer	Check tubing and pumps	daily
	Clean DO probe	daily
GPC autoprep	Check pump	daily
	Check solvent reservoir	daily
	Check waste receptical	daily
	Check fittings for leaks	daily
Evaporator	Check water bath	daily
	Check cooling water	daily
	Check vacuum	daily
	Check tubing	daily
K-F titrimeter	Check drying tube	daily
	Check potentiometer operation	daily
	Check reagents	daily
	Check fittings for leaks	daily
Dr/1A colorimeter	Clean and check optics	daily
Recirculating Coolers	Check coolant level	daily
	Check for leaks	daily

QUALITY CONTROL CHECKS AND ROUTINES TO ASSESS PRECISION, ACCURACY AND MDL'S

Quality Control Checks

Field Quality Control Checks:

Field quality control checks are performed in compliance with the frequency and procedures detailed in Florida DER QA 001/92, 1992.

Laboratory Quality Control Checks (Chemistry):

The types and frequency of quality control checks performed as routine for each analytical method are outlined in Table 11.1.

ASI follows the following guidelines (where applicable) for minimum quality control procedures in cases where the performed method lacks or has insufficient quality control. These minimums are:

1. Method reagent blanks at a rate of one each sample set
2. Matrix spikes at a rate of one per sample set or 5% of the samples, whichever is greater. If a set contains samples from different matrices, matrix spikes are prepared and analyzed for each matrix type.
3. Reagent water or reagent matrix spikes are analyzed at a rate of 5% of the samples in a sample set
4. Quality control check samples are analyzed in duplicate semianually as blind samples. If the data are not acceptable, the analytical results are reported in the QA report to the responsible agency or party issuing the check samples.
5. Quality control check standards are analyzed at a rate equal to 5% of the samples in a sample set The QC standards are obtained from a different manufacturer than that of the calibration standards.
6. Sample duplicates and matrix spike duplicates are analyzed at a rate of 5% of the samples in a sample set. If the set contains samples from differing matrices, then duplicates and matrix spike duplicates are analyzed for each matrix.
7. Continuing calibration standards are analyzed at a rate of 5% of the samples in a sample set.

In cases where the required quality control measures in a method are additions to or more stringent than the above guidelines, the quality control measures specified in the method are followed in addition to the above guidelines. Examples of these added measures are internal standards, surrogate spikes, system performance check compounds, interference checks, calibration blanks, tuning compounds, tailing factor calculations, *etc.*.

Laboratory Quality Control Checks (Microbiology):

ASI performs sufficient quality control checks to insure the veracity of reported data from the microbiology section. The quality control checks which are performed on a routine basis are blanks, duplicates and positive/negative controls. Further, ASI participates in a regular interlaboratory water quality check program. The frequency of these checks are as follows:

1. Blanks

Membrane filter tests - A lab water blank is run as the first sample, every tenth sample and as the last sample on a daily basis.

MPN tests - A sample of sterile buffered dilution water is run with each set as a control.

2. Duplicates

At least one of every 10 positive samples is performed as a duplicate, or at least one duplicate every week, whichever is more frequent.

3. Positive/negative Controls

ASI orders from and maintains cultures from the American Type Culture Collection for positive and negative culture controls. These are used with each new bottle of media and monthly to access and verify the morphological and biochemical responses of the organisms to the media.

4. Water quality

Water quality is determined by the following tests. Residual chlorine (monthly), pH (monthly), conductivity (monthly), standard plate count (monthly), 6 metals (annual; cadmium, chromium, copper, nickel, lead and zinc), inhibitory residue (once for each new lot of detergent), and suitability (annual).

5. Equipment monitoring

Autoclaves: Heat-sensitive autoclave tape is used on all samples to insure proper sterilization. A log is kept of date, contents, sterilization time and temperature for each cycle. A service contract is maintained for each autoclave. The automatic timing mechanism accuracy is checked against a stopwatch quarterly.

Incubators: the temperature of the incubator is read and logged twice daily, with readings separated by a minimum of 4 hours. Acceptable temperature readings are 35 ± 0.5°C or 44.5 ± 0.2°C depending on the use of the incubator.

Thermometers: Mercury thermometers are calibrated annually against an NBS traceable thermometer. Dial thermometers are calibrated quarterly. Both are calibrated at the temperature used.

Dissecting microscope

pH meter: standardized before each use with pH 7.0 and 4.0 buffers.

Balances: Calibrated monthly *vs.* Class S reference weights. Annual service contract is maintained.

Hot air oven: date, sterilization time and temperature of each use cycle are logged.

Conductivity meter: Conductivity meter is calibrated monthly with a 0.01 *M* KCl standard solution.

Refrigerators: Temperature is logged twice daily with readings separated by at least 4 hours.

In cases where a method requires additional or more stringent quality control checks than those specified above, ASI performs the method QC measures in addition to the above procedures.

ASI performs species identification very infrequently. When the requirement arises for identification, an outside expert is consulted on each occassion.

<u>Methods used to Assess Precision and Accuracy</u>

The specific methods and concentration levels used to evaluate accuracy and precision for each analyte group is presented in Table 11.2.

Accuracy is calculated as follows for spikes into laboratory water:

$$\%R = 100 \times \frac{\text{Observed value}}{\text{Known value}}$$

where: %R is the percentage recovery
Observed value is the analytical result, and
Known value is the concentration of the spike.

For calculation of accuracy of spikes into natural matrices:

$$\%R = 100 \times \frac{\text{Observed value - Background value}}{\text{Known value}}$$

where: %R is the percentage recovery
Observed value is the analytical result after spiking
Background value is the analytical result of the matrix before spiking, and
Known value is the concentration of the spike.

A control chart for accuracy is generated through the following calculations:

$$\%R_{ave} = \frac{\sum_{i=1}^{n} \%R_i}{n}$$

where: $\%R_{ave}$ is the average percent recovery,
$\%R_i$ is the percent recovery of observation *i*, and
n is the number of observations.

$$S_{\%R} = \sqrt{\frac{\sum_{i=1}^{n} \%R_i^2 - [\sum_{i=1}^{n} \%R_i]^2 / n}{n-1}}$$

where: $S_{\%R}$ is the standard deviation for percent recovery,
$\%R_i$ is the percent recovery of observation *i*, and
n is the number of observations.

Precision is accessed through the following calculations:

$$RPD = \frac{2\,[A - B]}{A + B} \times 100$$

where: RPD is the relative percent difference between duplicate determinations,
A and B are the analytical results for the duplicate determinations, and
[A - B] is the absolute difference between the determinations.

$$\%RSD = 100 \times \frac{S_{\%R}}{\%R_{ave}}$$

where: %RSD is the percent relative standard deviation,
$S_{\%R}$ is the standard deviation of $\%R_{ave}$, and
$\%R_{ave}$ is the average recovery of a calibration mid-level check sample.
%RSD is determined for the mid-range of a calibration, then generalized to the whole calibration.

Control charts are generated for each analytical procedure. The median normal value is obtained from the $\%R_{ave}$ statistic above. The warning and control levels are established at $\%R_{ave} \pm$

$2S_{\%R}$ and $\%R_{ave} \pm 3S_{\%R}$ respectively, based on results from mid-level matrix spikes and duplicates. Control charts, warning and control limits are updated monthly.

Instrument Detection Limits

Instrument detection limits (IDL) are a measure of the maximum capability of an analytical instrument to perform an analysis. They are set at 3 times the instrument noise level. They are determined by the following procedure (EPA SW-846):

1. Prepare a calibration curve for the test with standards.
2. Analyze seven (7) laboratory water blanks.
3. Record the response of the test for the blanks.
4. Prepare the mean of the results and standard deviation of the results from the blanks as above.
5. The IDL is 3 times the standard deviation on the calibration curve.

Method Detection Limits

Method detection limits (MDL) are the minimum level of an analyte which can be determined with 99% confidence. The procedure that follows is again drawn from EPA SW-846, and 40 CFR 136, Appendix B:

1. Prepare a spike of the analyte into laboratory water that is very close (2 - 5 times) to the IDL obtained above.
2. Take 7 aliquots of this spiked solution and process each through the sample clean-up and preparation procedure.
3. Analyze each of the prepared aliquots in the same manner as prescribed in the Method used.
4. Calculate the standard deviation (sd) of the aliquot results as described above.
5. The MDL is equal to the one tailed t-statistic for the 99% confidence level for the performed number of samples times the standard deviation:

$$MDL = t_{0.99,n} \times sd \text{ or in this case } MDL = 3.143\ sd$$

This method of calculation of the MDL has recently come under some criticism as representing a value essentially free from a Type I (false positive) error but at the same time only representing only a 50% probability of eliminating a Type II (false negative) error. [L. Keith, *Environmental Lab*, June/July 1992, pg 58-61] EPA has announced that a *Federal Register* entry will attempt to redefine MDL in light of these considerations. ASI will immediately adopt the new definitions as soon as EPA promulgates the changes.

Table 11.1. Laboratory routine quality control check frequency.

EPA Method	Reagent Blanks	Matrix Spikes	QC Check Samples†	QC Check Standard	Duplicate Sample	Spike Duplicate	Cont. Cal. Standards	Other
110.2 Color	NA	NA	Semi-annual in duplicate	NA	Every 20 samples	NA	NA	
120.1, 9050 conductivity	NA	NA	Semi-annual in duplicate	Every 15 samples	Every 10 samples	NA	NA	
130.2 Hardness	Each sample set	NA	Semi-annual in duplicate	Every 15 samples	Every 10 samples	NA	NA	Standardize EDTA before each sample set
150.1, 9040 pH	NA	NA	Semi-annual in duplicate	Every 15 samples	Every 10 samples	NA	NA	
160.1 TDS	NA	NA	Semi-annual in duplicate	NA	5% of samples	NA	NA	
160.2 TSS	NA	NA	Semi-annual in duplicate	Monthly	5% of samples	NA	NA	
160.3 TS	NA	NA	Semi-annual in duplicate	NA	5% of samples	NA	NA	
160.4 VS	NA	NA	Semi-annual in duplicate	NA	5% of samples	NA	NA	
180.1 Turbidity	Each sample set	NA	Semi-annual in duplicate	Each sample set	5% of samples	NA	5% of samples	
200.7, 6010 ICP metals	Each sample set and every 10 samples	Every 20 samples or New Matrix	Semi-annual in duplicate	Each batch or 20 samples	Each sample set and every 20 samples	Each sample set and every 20 samples	Every 10 samples	Cal Blanks every 20 samples, Interference samples every batch, serial dilutions quarterly

† QC check sample failures are reported in QA reports to originating agency.

Table 11.1. (continued) Laboratory routine quality control check frequency.

EPA Method	Reagent Blanks	Matrix Spikes	QC Check Samples†	QC Check Standard	Duplicate Sample	Spike Duplicate	Cont. Cal. Standards	Other
202.2, 7021 Al	Each sample set and every 20 samples	Every 20 samples or new matrix	Semi-annual in duplicate	Each batch or 20 samples	Each sample set and every 20 samples	Each sample set and every 20 samples	Each batch or 20 samples	
204.2 Sb	Each sample set and every 20 samples	Every 20 samples or new matrix	Semi-annual in duplicate	Each batch or 20 samples	Each sample set and every 20 samples	Each sample set and every 20 samples	Each batch or 20 samples	
206.2, 7060 As	Each sample set and every 20 samples	Every 20 samples or new matrix	Semi-annual in duplicate	Each batch or 20 samples	Each sample set and every 20 samples	Each sample set and every 20 samples	Each batch or 20 samples	
206.3, 7061 AsH_3	Each sample set and every 20 samples	Every 20 samples or new matrix	Semi-annual in duplicate	Each batch or 20 samples	Each sample set and every 20 samples	Each sample set and every 20 samples	Each batch or 20 samples	
208.2, 7081 Ba	Each sample set and every 20 samples	Every 20 samples or new matrix	Semi-annual in duplicate	Each batch or 20 samples	Each sample set and every 20 samples	Each sample set and every 20 samples	Each batch or 20 samples	
210.2, 7091 Be	Each sample set and every 20 samples	Every 20 samples or new matrix	Semi-annual in duplicate	Each batch or 20 samples	Each sample set and every 20 samples	Each sample set and every 20 samples	Each batch or 20 samples	

† QC check sample failures are reported in QA reports to originating agency.

Table 11.1. (continued) Laboratory routine quality control check frequency.

EPA Method	Reagent Blanks	Matrix Spikes	QC Check Samples†	QC Check Standard	Duplicate Sample	Spike Duplicate	Cont. Cal. Standards	Other
213.2, 7131 Cd	Each sample set and every 20 samples	Every 20 samples or new matrix	Semi-annual in duplicate	Each batch or 20 samples	Each sample set and every 20 samples	Each sample set and every 20 samples	Each batch or 20 samples	
215.2, 7141 Ca	Each sample set and every 20 samples	Every 20 samples or new matrix	Semi-annual in duplicate	Each batch or 20 samples	Each sample set and every 20 samples	Each sample set and every 20 samples	Each batch or 20 samples	
218.2, 7191 Cr	Each sample set and every 20 samples	Every 20 samples or new matrix	Semi-annual in duplicate	Each batch or 20 samples	Each sample set and every 20 samples	Each sample set and every 20 samples	Each batch or 20 samples	
219.2, 7201 Co	Each sample set and every 20 samples	Every 20 samples or new matrix	Semi-annual in duplicate	Each batch or 20 samples	Each sample set and every 20 samples	Each sample set and every 20 samples	Each batch or 20 samples	
220.2, 7211 Cu	Each sample set and every 20 samples	Every 20 samples or new matrix	Semi-annual in duplicate	Each batch or 20 samples	Each sample set and every 20 samples	Each sample set and every 20 samples	Each batch or 20 samples	
231.1 Au	Each batch	Every 20 samples or new matrix	Semi-annual in duplicate	Each batch or 20 samples	Each sample set and every 20 samples	Each sample set and every 20 samples	Each batch or 20 samples	

† QC check sample failures are reported in QA reports to originating agency.

Table 11.1. (continued) Laboratory routine quality control check frequency.

EPA Method	Reagent Blanks	Matrix Spikes	QC Check Samples†	QC Check Standard	Duplicate Sample	Spike Duplicate	Cont. Cal. Standards	Other
231.2 Au	Each batch	Every 20 samples or new matrix	Semi-annual in duplicate	Each batch or 20 samples	Each sample set and every 20 samples	Each sample set and every 20 samples	Each batch or 20 samples	
236.2, 7381 Fe	Each sample set and every 20 samples	Every 20 samples or new matrix	Semi-annual in duplicate	Each batch or 20 samples	Each sample set and every 20 samples	Each sample set and every 20 samples	Each batch or 20 samples	
239.2, 7421 Pb	Each sample set and every 20 samples	Every 20 samples or new matrix	Semi-annual in duplicate	Each batch or 20 samples	Each sample set and every 20 samples	Each sample set and every 20 samples	Each batch or 20 samples	
242.1 Mg	Each sample set and every 20 samples	Every 20 samples or new matrix	Semi-annual in duplicate	Each batch or 20 samples	Each sample set and every 20 samples	Each sample set and every 20 samples	Each batch or 20 samples	
243.2, 7461 Mn	Each sample set and every 20 samples	Every 20 samples or new matrix	Semi-annual in duplicate	Each batch or 20 samples	Each sample set and every 20 samples	Each sample set and every 20 samples	Each batch or 20 samples	
245.1, 245.5, 7470 Hg	Each sample set and every 20 samples	Every 20 samples or new matrix	Semi-annual in duplicate	Each batch or 20 samples	Each sample set and every 20 samples	Each sample set and every 20 samples	Each batch or 20 samples	

† QC check sample failures are reported in QA reports to originating agency.

Table 11.1. (continued) Laboratory routine quality control check frequency.

EPA Method	Reagent Blanks	Matrix Spikes	QC Check Samples†	QC Check Standard	Duplicate Sample	Spike Duplicate	Cont. Cal. Standards	Other
246.2, 7481 Mo	Each sample set and every 20 samples	Every 20 samples or new matrix	Semi-annual in duplicate	Each batch or 20 samples	Each sample set and every 20 samples	Each sample set and every 20 samples	Each batch or 20 samples	
249.2 Ni	Each sample set and every 20 samples	Every 20 samples or new matrix	Semi-annual in duplicate	Each batch or 20 samples	Each sample set and every 20 samples	Each sample set and every 20 samples	Each batch or 20 samples	
252.1 Os	Each sample set and every 20 samples	Every 20 samples or new matrix	Semi-annual in duplicate	Each batch or 20 samples	Each sample set and every 20 samples	Each sample set and every 20 samples	Each batch or 20 samples	
252.2 Os	Each sample set and every 20 samples	Every 20 samples or new matrix	Semi-annual in duplicate	Each batch or 20 samples	Each sample set and every 20 samples	Each sample set and every 20 samples	Each batch or 20 samples	
270.2 7740 Se	Each sample set and every 20 samples	Every 20 samples or new matrix	Semi-annual in duplicate	Each batch or 20 samples	Each sample set and every 20 samples	Each sample set and every 20 samples	Each batch or 20 samples	
270.3, 7741 SeH_2	Each sample set and every 20 samples	Every 20 samples or new matrix	Semi-annual in duplicate	Each batch or 20 samples	Each sample set and every 20 samples	Each sample set and every 20 samples	Each batch or 20 samples	

† QC check sample failures are reported in QA reports to originating agency.

Table 11.1. (continued) Laboratory routine quality control check frequency.

EPA Method	Reagent Blanks	Matrix Spikes	QC Check Samples†	QC Check Standard	Duplicate Sample	Spike Duplicate	Cont. Cal. Standards	Other
272.2, 7761 Ag	Each sample set and every 20 samples	Every 20 samples or new matrix	Semi-annual in duplicate	Each batch or 20 samples	Each sample set and every 20 samples	Each sample set and every 20 samples	Each batch or 20 samples	
279.2, 7841 Tl	Each sample set and every 20 samples	Every 20 samples or new matrix	Semi-annual in duplicate	Each batch or 20 samples	Each sample set and every 20 samples	Each sample set and every 20 samples	Each batch or 20 samples	
282.1, 7870 Sn	Each sample set and every 20 samples	Every 20 samples or new matrix	Semi-annual in duplicate	Each batch or 20 samples	Each sample set and every 20 samples	Each sample set and every 20 samples	Each batch or 20 samples	
282.2, 7871 Sn	Each sample set and every 20 samples	Every 20 samples or new matrix	Semi-annual in duplicate	Each batch or 20 samples	Each sample set and every 20 samples	Each sample set and every 20 samples	Each batch or 20 samples	
283.1 Ti	Each sample set and every 20 samples	Every 20 samples or new matrix	Semi-annual in duplicate	Each batch or 20 samples	Each sample set and every 20 samples	Each sample set and every 20 samples	Each batch or 20 samples	
283.2 Ti	Each sample set and every 20 samples	Every 20 samples or new matrix	Semi-annual in duplicate	Each batch or 20 samples	Each sample set and every 20 samples	Each sample set and every 20 samples	Each batch or 20 samples	

† QC check sample failures are reported in QA reports to originating agency.

Table 11.1. (continued) Laboratory routine quality control check frequency.

EPA Method	Reagent Blanks	Matrix Spikes	QC Check Samples†	QC Check Standard	Duplicate Sample	Spike Duplicate	Cont. Cal. Standards	Other
286.2, 7911 V	Each sample set and every 20 samples	Every 20 samples or new matrix	Semi-annual in duplicate	Each batch or 20 samples	Each sample set and every 20 samples	Each sample set and every 20 samples	Each batch or 20 samples	
289.2, 7951 Zn	Each sample set and every 20 samples	Every 20 samples or new matrix	Semi-annual in duplicate	Each batch or 20 samples	Each sample set and every 20 samples	Each sample set and every 20 samples	Each batch or 20 samples	
305.1 Acidity	Each sample set	5% of samples	Semi-annual in duplicate	Each sample set	Every 20 samples	5% of samples	NA	Standardize titrant before each sample set
310.1 Alkalinity	Each sample set	5% of samples	Semi-annual in duplicate	Each sample set	Every 20 samples	5% of samples	NA	Standardize titrant before each sample set
325.2, 9251 Cl	Each sample set	Every 10 samples	Semi-annual in duplicate	Each sample set	Every 20 samples	Every 10 samples	NA	
325.3, 9252 Cl	Each sample set	Every 10 samples	Semi-annual in duplicate	Each sample set and every 15 samples	Every 10 samples	Each sample set	NA	Standardize titrant before each sample set
330.2 Cl_2	Each sample set	5% of samples	Semi-annual in duplicate	Each sample set	Each sample set and every 20 samples	5% of samples	NA	Standardize titrant before each sample set
335.1, 9012 CN	Each sample set	Each sample set and each new matrix	Semi-annual in duplicate	Every 15 samples	Every 10 samples	Every 10 samples	Every 15 samples	

† QC check sample failures are reported in QA reports to originating agency.

Table 11.1. (continued) Laboratory routine quality control check frequency.

EPA Method	Reagent Blanks	Matrix Spikes	QC Check Samples†	QC Check Standard	Duplicate Sample	Spike Duplicate	Cont. Cal. Standards	Other
335.2, 9012 CN	Each sample set	Each sample set and each new matrix	Semi-annual in duplicate	Every 15 samples	Every 10 samples	Every 10 samples	Every 15 samples	
340.1 F SPADNS	Each sample set	5% of samples	Semi-annual in duplicate	Every 15 samples	Every 10 samples	5% of samples	Every 10 samples	
340.2 F electrode	Each sample set	5% of samples	Semi-annual in duplicate	Every 15 samples	Every 10 samples	5% of samples	Every 10 samples	
350.1 NH_3	Each sample set	5% of samples	Semi-annual in duplicate	Every 15 samples	Every 10 samples	5% of samples	Every 20 samples	
351.2 auto N-Kjel	Each sample set	5% of samples	Semi-annual in duplicate	Every 15 samples	Every 10 samples	5% of samples	Every 20 samples	
351.3 N-Kjeldahl	Each sample set	5% of samples	Semi-annual in duplicate	Every 15 samples	Every 10 samples	5% of samples	Every 20 samples	Standardize titrant before each sample set
352.1, 9200 NO_3	Each sample set	Each sample set and each new matrix	Semi-annual in duplicate	Every 15 samples	Every 10 samples	Every 10 samples	Every 20 samples	
353.3 NO_3-NO_2	Each sample set	5% of samples	Semi-annual in duplicate	Every 15 samples	Every 10 samples	5% of samples	5% of samples	
354.1 NO_2	Each sample set	5% of samples	Semi-annual in duplicate	Every 15 samples	Every 10 samples	5% of samples	5% of samples	
365.1 P	Each sample set	5% of samples	Semi-annual in duplicate	Every 15 samples	Every 10 samples	5% of samples	Every 20 samples	
365.4 Total P	Each sample set	5% of samples	Semi-annual in duplicate	Every 15 samples	Every 10 samples	5% of samples	Every 20 samples	
370.1 Silica	Each sample set	5% of samples	Semi-annual in duplicate	Every 15 samples	Every 10 samples	5% of samples	Each sample set	

† QC check sample failures are reported in QA reports to originating agency.

Table 11.1. (continued) Laboratory routine quality control check frequency.

EPA Method	Reagent Blanks	Matrix Spikes	QC Check Samples†	QC Check Standard	Duplicate Sample	Spike Duplicate	Cont. Cal. Standards	Other
375.2, 9036 SO_4	Hourly	Each sample	Semi-annual in duplicate	Every 15 samples	Every 10 samples	Every 10 samples	5% of samples	
376.1, 9030, 9031 Sulfide	Each sample set or every 20 samples	Each sample set or every 20 samples	Semi-annual in duplicate	Each sample set or every 20 samples	Every 10 samples	Every 10 samples	Every 20 samples	
377.1 SO_3	Each batch	5% of samples	Semi-annual in duplicate	Each batch	Every 10 samples	5% of samples	5% of samples	
405.1 BOD	Unseeded dilution water each sample set	NA	Semi-annual in duplicate	Each batch GGA and KHP in duplicate	Every 10 samples	NA	5% of samples	DO meter calibrated against Winkler daily
410.1 COD	Each sample set	Each sample set	Semi-annual in duplicate	Every 15 samples	Every 10 samples	Each sample set	5% of samples	
413.1, 9070, 9071 O&G	100 mL freon residue each batch	NA	Semi-annual in duplicate	Every 15 samples	Every 10 samples	NA	5% of samples	
415.2 TOC	Each batch	5% of samples	Semi-annual in duplicate	Every 20 samples	Every sample	Each MS	5% of samples	
418.1 TPH	Each batch	Each new matrix and 5% of samples	Semi-annual in duplicate	Every 15 samples	Every 10 samples	Every 10 samples	5% of samples	
420.2, 9066 Phenolics	Hourly	Hourly and each new matrix	Semi-annual in duplicate	Every 15 samples	Every 10 samples	Every 10 samples	Every 20 samples	

† QC check sample failures are reported in QA reports to originating agency.

Table 11.1. (continued) Laboratory routine quality control check frequency.

EPA Method	Reagent Blanks	Matrix Spikes	QC Check Samples†	QC Check Standard	Duplicate Sample	Spike Duplicate	Cont. Cal. Standards	Other
425.1 MBAS	Each sample set	Each sample set	Semi-annual in duplicate	NA	Every 10 samples	Each sample set	5% of samples	
524.2 VOA	Each sample set/every 20 samples	Each sample set/every 20 samples	Semi-annual in duplicate	Each sample set	Each sample set	Each sample set/every 20 samples	Every 12 hours	BFB tune every 12 hrs, Surrogates & Int. Std. every sample
525 Semi-volatiles	Each sample set/every 20 samples	Each sample set/every 20 samples	Semi-annual in duplicate	Each sample set	Each sample set	Each sample set/every 20 samples	Every 12 hours	DFTPP tune every 12 hrs, Surrogates and Int. Std every sample
608, 8080 Cl-pesticides	Each sample set/every 20 samples	Each sample set/every 20 samples	Semi-annual in duplicate	Each sample set	Each sample set	Each sample set/every 20 samples	Every 12 hours	Surrogates in every sample
624, 8260 VOA	Each sample set/every 20 samples	Each sample set/every 20 samples	Semi-annual in duplicate	Each sample set	Each sample set	Each sample set/every 20 samples	Every 12 hours	BFB tune every 12 hrs, Surrogates & Int. Std. every sample
8270 BNA	Each sample set/every 20 samples	Each sample set/every 20 samples	Semi-annual in duplicate	Each sample set	Each sample set	Each sample set/every 20 samples	Every 12 hours	DFTPP tune every 12 hrs, Surrogates and Int. Std every sample
8150 Herbicides	Each sample set/every 20 samples	Each sample set/every 20 samples	Semi-annual in duplicate	Each sample set	Each sample set	Each sample set/every 20 samples	Every 12 hours	Surrogates in every sample
9045 soil pH	NA	NA	Semi-annual in duplicate	Every 15 samples	Every 10 samples	NA	NA	
9095 Paint filter	NA	NA	Semi-annual in duplicate	NA	Monthly	NA	NA	

† QC check sample failures are reported in QA reports to originating agency.

Table 11.1. (continued) Laboratory routine quality control check frequency.

EPA Method	Reagent Blanks	Matrix Spikes	QC Check Samples†	QC Check Standard	Duplicate Sample	Spike Duplicate	Cont. Cal. Standards	Other
9131 FC MPN	each batch of media, and each sample set	NA	Semi-annual in duplicate	Monthly positive control, each sample set negative control	10% of all positives, plus one a week	NA	NA	All positives are confirmed
9132 FC membrane filter	each batch of media, and first and last plus 10% of samples in a set	NA	Semi-annual in duplicate	Monthly positive control, each sample set negative control	10% of all positives, plus one a week	NA	NA	All positives are confirmed

† QC check sample failures are reported in QA reports to originating agency.

Table 11.2. Methods used to generate precision and accuracy targets.

Method	Purpose	Concentration Level	Method Reference
Matrix spike	Accuracy, MDL	Low level	130.2,180.1, all metals,325.2,9251, 325.3, 9252, 330.2, 335.1, 9012, 335.2, 340.2, 350.1,351.2, 351.3, 352.1, 9200, 353.3, 354.1, 365.1, 365.4, 370.1, 375.2, 9036, 376.1, 9030, 9031, 377.1, 410.1, 413.1, 9070, 9071, 415.2, 418.1, 420.2, 9066, 425.2, all organics
	Accuracy	Mid level	130.2,180.1, all metals,325.2,9251, 325.3, 9252, 330.2, 335.1, 9012, 335.2, 340.2, 350.1,351.2, 351.3, 352.1, 9200, 353.3, 354.1, 365.1, 365.4, 370.1, 375.2, 9036, 376.1, 9030, 9031, 377.1, 410.1, 413.1, 9070, 9071, 415.2, 418.1, 420.2, 9066, 425.2, all organics
Matrix spike duplicate	Accuracy and precision	Low level	130.2,180.1, all metals,325.2,9251, 325.3, 9252, 330.2, 335.1, 9012, 335.2, 340.2, 350.1,351.2, 351.3, 352.1, 9200, 353.3, 354.1, 365.1, 365.4, 370.1, 375.2, 9036, 376.1, 9030, 9031, 377.1, 410.1, 413.1, 9070, 9071, 415.2, 418.1, 420.2, 9066, 425.2, all organics

Table 11.2 (continued). Methods used to generate precision and accuracy targets.

Method	Purpose	Concentration Level	Method Reference
Matrix Spike Duplicate	Accuracy	Mid level	130.2,180.1, all metals,325.2,9251, 325.3, 9252, 330.2, 335.1, 9012, 335.2, 340.2, 350.1,351.2, 351.3, 352.1, 9200, 353.3, 354.1, 365.1, 365.4, 370.1, 375.2, 9036, 376.1, 9030, 9031, 377.1, 410.1, 413.1, 9070, 9071, 415.2, 418.1, 420.2, 9066, 425.2, all organics
Duplicate sample	Precision	NA	130.2,180.1, all metals,325.2,9251, 325.3, 9252, 330.2, 335.1, 9012, 335.2, 340.2, 350.1,351.2, 351.3, 352.1, 9200, 353.3, 354.1, 365.1, 365.4, 370.1, 375.2, 9036, 376.1, 9030, 9031, 377.1, 405.1, 410.1, 413.1, 9070, 9071, 415.2, 418.1, 420.2, 9066, 425.2, all organics
Surrogate spike	Accuracy	Mid level	524.2, 525, 624, 625, 8260, 8270, 8080, 8150
QC check standards	Accuracy	low & mid level	All methods
QC check samples in duplicates	Accuracy and precision	low & mid levels	All methods

DATA REDUCTION, VALIDATION AND REPORTING

Data Reduction

A. Responsibilities and specific duties of the individual analyst

Each analyst is responsible for collecting and recording the raw data for each analytical sample and quality control sample in a neat, legible fashion on the appropriate worksheet or notebook. The analyst performs and records necessary computations to transform the raw data into a useful analytical result, by procedures which are specified in the referenced EPA method. Examples of documentation records are contained in Appendix C and are represented by:

Laboratory and field notebooks,
Chromatograms and charts with proper sample identification,
Computer record files with proper sample identification, and
Work sheets used to calculate values.

B. Formulas used to calculate final values and applicable types of analysis

1. Linear regression calculations:

Linear regression is used for all computerized metals and GC organics analyses which do not use Internal Standards. In the cases of the metals and the organic 8080 and 8150 analyses the instrument response is directly computed in the linear regression:

Concentration = A + B(instrument response); where A and B are constants determined for each assay.

The concentration may be reported directly in terms of mass (mg or µg) per liter or per kilogram, or the initially derived concentration may be corrected for any dilution or volume reduction which occured during the sample preparation.

$$\text{Concentration}_{\text{Initial}} = \text{Concentration}_{\text{Final}} \times \text{DF}$$; where DF is the dilution factor

A variant on the linear regression calculation is used in all colorimetric and turbidimetric spectroscopic techniques. The best fit straight line is drawn through the linear plot of spectroscopic response *vs.* concentration. Concentrations of unknown samples are directly read from the plot. The determination of fluoride with the ion-specific electrode (method 340.2) is similar except the millivolt response is plotted *vs.* the concentration on semi-log paper with concentration on the log scale.

2. Response factor calculations:

In the case of organic GC/MS assays, an internal standard (IS) is used and the initial calibration is the calculation of response factors (RF) at five concentration levels for each target analyte:

$$\text{RF} = \frac{\text{Analyte instrument response x IS concentration}}{\text{Analyte concentration x IS instrument response}}$$

where the instrument responses are the areas of the characteristic ion for the internal standard and the analyte.

The five RF's are averaged and used in the calculation of analyte concentrations in unknowns:

$$\text{Concentration} = \frac{\text{Analyte instrument response x IS concentration}}{\text{RF x IS instrument response}}$$

Again, the final reported concentration may be corrected for dilution or volume reduction occuring during the sample preparation steps in the method.

3. Single point reference calculations:

These type calculations are performed during titration analyses. A general chemical equation for such a process is:

aA + bB -------> products ;

where A is the analyte and B is the titrant, with a and b the respective stoichiometric constants. A general solution for this type of process is:

$$\text{A mg/L} = \frac{a \times [t - y]\ \text{mL B} \times M\ \text{B} \times \text{Mwt A} \times 1000}{b \times \text{mL A}};$$

where a is the reaction coefficient of A,
b is the reaction coefficient of B,
t is the number of mL of B used in the titration,
y is the number of mL of B used in a blank titration,
M is the molarity of B,
mL A is the number of mL of A analyzed, and
Mwt A is the molecular weight of A

These formulas are most often shortened to the following:

A mg/L = C [t - y] mL B

where C is a constant which includes all of the missing factors and assumes that the concentration of the titrant B (molarity or more commonly normality) is always prepared in the same exact manner. The initial calculations of mg/L of A can be corrected for dilution or volume reduction occuring during the sample preparation as described above.

4. Bias correction:

Bias is the actual amount of analyte in the sample *vs.* how much is identified in the analysis. Correction for bias is based on the percent recovery of target analytes from spiked matrix samples:

$$\%R = \frac{X_s - X_u}{K} \times 100;$$

where %R is the percent recovery, X_s is the result from the spiked sample, X_u is the result from the unspiked sample and K is the amount of the spike. The corrected analytical result with bias is:

$$X_c = 100 \times \frac{X_u}{\%R};$$

where X_c is the corrected value.

Corrections for bias are not made under the following conditions:

1. The %R is over 80%.

2. The method is self-correcting for bias, such as isotopic dilution methods.
3. The analytical result without correction is in excess of regulatory limits.

C. Data entry into computer (LIMS)

The Laboratory Director and the data entry clerk are responsible for data entry.

Data Validation

A. Laboratory activities

The following activities are overseen by the QA Manager, Laboratory Director and Chief Chemist:

1. Completeness of Laboratory reports: Checks to insure that all requested analyses and samples have been processed; checks to insure that complete records exist for each analysis and associated QC samples such as raw data entries and calculations in lab notebooks, extraction logs, instrument/analytical logs, calibrations, and internal chain-of-custody; and checks to insure that procedures specified in the method and the QA manual have been followed.

2. Evaluation of data with respect to detection limits: Compares analytical results with detection limits in the QA manual and documents any detection limits which exceed regulatory limits or action levels.

3. Evaluation of data with respect to control limits: Compares the results of QC and calibration check samples to control criteria. Data not within control limits require corrective action and the reviewer checks that corrective action reports, and the results of sample re-analysis are available. The reviewer checks to insure that samples associated with out-of-control QC data are identified in a written record and assesses the utility of the sample results on the record.

4. Review of holding time data: Compares sample holding time to those required in Section 6 and notes all deviations in writing.

5. Review of perfomance evaluation results: Documents any recurring trends or problems revealed in PE samples and evaluates their effects on results reported from the laboratory.

6. Correlation of laboratory data: Reviews the agreement of results from related tests and documents the significance of any differences.

B. Field activities

The following activities are overseen by the Field Supervisor, QA Manager, and Chief Chemist:

1. Completeness of field reports: Checks to insure that complete field records exist for each field activity and that the procedures are in accordance with method specifications and the QA manual. The results of the completeness check are documented and environmental data affected by incomplete field records are identified.

2. Identification of valid samples: The reviewer interprets and evaluates the field records to detect problems affecting the representativeness of the samples. Any samples associated with incomplete or incorrect field operations are identified in writing.

3. Correlation of field test data: The reviewer compares field test results and measurements to

insure that they are compatible. Inconsistencies are noted in writing.

4. Identification of anomalous field data: Checks for anomalous field data and evaluates in writing the impact of anomalous field measurement results on associated samples.

5. Validation of field analyses: Checks to insure that field QC checks and samples meet acceptance criteria and documents corrective action taken for any samples analyzed while QC checks were out-of-control.

C. Sample Management

The Sample Custody Supervisor, Field Supervisor, QA Manager, Laboratory Director and Chief Chemist are responsible for the oversight and review of sample custody integrity. The responsibility is for checking the completeness of the chain-of-custody (external and internal) record, the correct volume of sample required for the requested analyses, correct preservation techniques, and adherence to specified holding times (Section 6).

D. Laboratory Quality control checks

The following acceptance criteria are used to determine if the sample set is in or out of control:

Matrix spike: Corrects for bias, must be within method QA objective for accuracy (Section 5)
Matrix spike duplicate: Must be within method QA objective for precision (Section 5)
Sample duplicates: Must be within method QA objective for precision (Section 5)
Quality Control check standards: Must be within method QA objective for retaining the calibration curve. In general 0-10% RSD for metals and wet chemical analyses and 0-30% for organic analyses.
Surrogates: Required surrogate recoveries must be within method QA objectives for accuracy (Section 5)
Internal standards: Response must be within 2 SD of day-to-day mean.
Performance evaluation (quality control check samples): Results must be within 2 SD of published mean results.
Control charts: Daily results must be evenly distributed around the mean within the warning limits. Samples outside the control limits are suspect and must be repeated.
Reagent blanks: Results for target analytes less than MDL.
Continuing calibration checks: Must be within method QA objective. In general 0-10% RSD for metals and wet chemical analyses and 0-30% RSD for organic analyses.

E. Field Quality Control checks

The following acceptance criteria are used to determine if the sample set is in or out of control:

Trip blanks: Target analytes must be below MDL.
Duplicate samples: Must be within method QA objective for precision (Section 5)
Instrument QC standards and checks: Must be within manufacturers' and method criteria
Equipment blanks: Target analytes must be below MDL.

F. Project data

The Chief Chemist, Laboratory Director and Field Supervisor are responsible for review of project data. Areas of review include:

Field and lab QC data

Completeness of supporting documentation (chain-of-custody, records)
Examination of data for anomalies.

Data Reporting

Each individual analyst is responsible for entry of data into the LIMS generated from their assigned work. The persons responsible for checking the analytical result data entry are the Laboratory Director, the QA Manager and the Chief Chemist. The data entered in the LIMS system is checked against the results on the laboratory worksheets, interpreted for reasonableness and finally initialled as checked before release to the client by the Laboratory Director, QA Manager, or Chief Chemist.

Data Storage

All chromatograms, loose laboratory worksheets, chain-of-custody records, and loose field result reports are attached to a Laboratory Results Worksheet as hardcopy. These, with a hardcopy of the Final Analytical Report and a summary of other records in bound notebooks, are maintained in a folder filed by laboratory sample number in the front office filing cabinets for a period of 5 years. Electronic data are kept on mirrored harddisks on-site with a harddisk backup off-site and tape backup for 5 years. The tapes are stored in the sample receiving trailer which is climate controlled. Mirrored harddisk back-up is instantaneous with data entry and editing. Tape and off-site harddisk back-up is performed daily at the close of office hours. Electronic data integrity of stored files is assessed weekly through recall and checking of random files on each tape and archived harddisk.

Indexing and accessing of archived data: The primary information source is the analytical hardcopy folder in the front office. These folders are filed by laboratory sample number. An additional hardcopy file is maintained for each client stored alphabetically in the front office and consists of copies of all final analytical reports for the client. The sample number can be accessed through the hardcopy of the analytical report in the client file or through the hardcopy of the daily sample log-in file. Electronic records are maintained in the LIMS on harddisk and tape. Access to particular records can be obtained through either the client's name or the laboratory sample number.

CORRECTIVE ACTION

The Section Leader is responsible for the initial checking of the results from QC measures, followed by the Laboratory Director, the QA Manager, and the Chief Chemist. Each is responsible for initiating/approving corrective action, while at the same time informing the other responsible persons of the action/approval. Results from QC Check samples will be reviewed by the Chief Chemist, the QA Manager, and the Laboratory Director.

Appropriate corrective action for each type of QC measure failure is outlined in Table 13.1. Sample analysis is always suspended until the QC measure failure is satisfactorily explained/resolved.

External sources which may initiate corrective action based on results from performance evaluation results, split samples, audits, *etc.*, include but are not limited to clients, EPA, and state environmental certification agencies. Measures suggested or mandated by the EPA or state environmental regulatory agencies as appropriate corrective actions will be followed.

Project/laboratory personnel are notified of QC measure failures and appropriate corrective measures taken in writing. This memorandum becomes part of the permanent project file.

Table 13.1 Criteria for acceptance levels for each QC measure by analyte technique and initial corrective actions

QC Activity	Acceptance Criteria	Corrective Action
Initial Calibration	AA, ICP: >0.995 linear correlation MS Semi-volatiles: 30% RSD for CCC, >0.05 RRF for SPCC MS Volatiles: 25% RSD for CCC, >0.30 RRF for SPCC (0.25 for $CHBr_3$) GC Organics: >0.99 linear correlation or %RSD < 20% Colorimetric: >0.95 linear correlation Electrometric: >0.95 log correlation	Repeat calibration
Initial Calibration Verification	AA, ICP: <10% RSD for each metal Colorimetric: <10% RSD Electrometric: <10% RSD	Repeat initial verification; if fails again repeat calibration
Continuing Calibration Verification	AA, ICP: <10% RSD for each metal MS Semi-Volatiles: %D<30 for CCC, >0.05 RRF for SPCC MS Volatiles: %D <25 for CCC, >0.30 RRF for SPCC (0.25 for $CHBr_3$) GC Organics: %D<15 for all compounds Titrations: <10% RSD Colorimetric: <10% RSD Electrometric: <10% RSD	Repeat continuing verification; if fails again run check standard; if fails again repeat calibration
QC Check Standard	AA, ICP: <10% RSD for each metal MS Organics: <30% RSD GC Organics: <30% RSD Titrations: <10% RSD Colorimetric: <10% RSD Electrometric: <10% RSD	Repeat check standard; if fails again check calibration and repeat if necessary.
Reagent Blanks	All methods: <MDL	Reanalyze blank; examine all reagents for contamination until source is found; reanalyze samples that were part of the batch containing the out-of-control blank; decontaminate instrument

Table 13.1 (continued) Criteria for acceptance levels for each QC measure by analyte technique and initial corrective actions

QC Activity	Acceptance Criteria	Corrective Action
Matrix Spike	AA, ICP: <25% deviation from expected MS Organics: varies with matrix and analyte GC Organics: varies with matrix and analyte Titrations: <10% deviation from expected Colorimetric: <10% deviation from expected Electrometric: <10% deviation from expected	Repeat matrix spike; check concentration of matrix spiking solution
Spike Duplicate	AA, ICP: <20% RSD MS Organics: precision varies with specific analyte and matrix (Section 5) GC Organics: Precision varies with specific analyte and Matrix (Section 5) Titrations: <10% RSD Colorimetric: <10% RSD Electrometric: <10% RSD	Repeat spike duplicate
Duplicate Sample	AA, ICP: <20% precision Titrations: <10% precision Colorimetric: <10% precision Electrometric: <10% precision	Repeat duplicate
Surrogate Spike	MS Organics: recovery varies with matrix and analyte (Section 5) GC Organics: recovery varies with matrix and analyte (Section 5)	Repeat sample preparation and/or analysis; check surrogate spiking solution concentration.
QC Check Sample	All methods: within 2 standard deviations of published result.	Repeat Check sample analysis; check calibration.

Table 13.1 (continued) Criteria for acceptance levels for each QC measure by analyte technique and initial corrective actions

QC Activity	Acceptance Criteria	Corrective Action
Field Duplicates	AA, ICP: <20% precision MS Organics: varies with matrix and analyte (Section 5) GC Organics: varies with matrix and analyte (Section 5) Titrations: <10% precision Colorimetric: <10% precision Electrometric: <10% precision	Repeat duplicate analysis and original sample analysis if necessary.
Equipment Blanks	All methods: <MDL	Repeat analysis; find cause of contamination
Trip Blanks	Volatile Organics: <MDL	Repeat analysis; find cause of contamination

PERFORMANCE AND SYSTEM AUDITS

ASI participates in semi-annual EPA performance evaluation check sample analyses. Also, ASI performs analyses of annual NPDES check samples which are provided by each client with an NPDES permit. In addition ASI performs analyses on split and check samples provided by clients to establish data reliability and client confidence.

The QA Manager on a quarterly basis will introduce blind check samples to the analytical through put of the laboratory. The results of these blind samples are combined with a system audit of the analytical procedure to produce an annual internal report of each method. This report is written and kept in the QA Manager's files for inspection.

Each year the QA Manager will conduct a system audit of each method used in the laboratory and field for analysis and production of data. This audit will be oriented toward insuring the adherence of the analyst to the written method and the requisite QC measures. Activities by the QA Manager will include inspection of the actual analytical process by the analyst and a determination of the training level of the analyst, inspection of the calculations, and inspection of the required documentation such as bench sheets, chromatograms, standard preparation logs, instrument logs, calibration and tuning files, *etc.* The results of this audit are written into the Quality Assurance Report which is issued on Monday of each week..

ASI welcomes and assists in external audits performed by EPA, state environmental regulatory agencies, third party certification groups and clients.

QUALITY ASSURANCE REPORTS

The QA Manager issues a Quality Assurance report each week addressed to the Chief Chemist and the Laboratory Director. The report covers a laboratory wide review of the control charts and any other facets of the laboratory operations which impinge upon quality assurance. These reports are maintained in a file in the QA Manager's office.

The QA Manager is responsible for preparing an annual Quality Assurance report for each area of activity in the laboratory, primarily for internal use. The report is addressed to the Laboratory Director, the Chief Chemist and the appropriate Section Leader. Included in the report are the results of performance samples, blind check samples, and inter-laboratory split samples, along with a summary of the annual system audit by the QA Manager. Also covered is performance during the last year on the quality control measures to determine accuracy, precision and method detection limits. QA/QC problems and the required corrective action taken during the last year are summarized. The report includes the name of the person conducting the audit, the date of the audit and a summary of the areas examined with the findings. These reports are kept on file by the QA Manager and are available for examination by external parties such as clients, EPA, and state environmental regulatory agencies. ASI will generate specific quality assurance reports *ab initio* on on receipt of a written request from an external party.

The QA Manager also prepares an annual report of the key QA activities undertaken during the year, for distribution to the Chief Chemist and Laboratory Director. Topics discussed include method revisions implemented, systems audits performed, changes to the QA program or organization, status of laboratory accreditation/certification, and a summary of significant QA problems encountered and resolved during the reporting period. In addition a summary of overall trends in QA and QC in the laboratory is included.

RESUMES

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Name: Robert G. Owens, Jr. SSN: 257-84-1695

Position: Chief Chemist Date Began: Sept 1, 1985

Education:

High School:Darlington HS

College: Presbyterian College

Year: 1975 Degree: BS Chemistry, BS Biology

College: Georgia State University

Year: current Degree: Ph. D. Biochemistry Candidate

Technical Schools

Year: 1989 Course: H-P GC-MS-RTE Advanced Training

Year: 1989 Course: Mass Spectra Interpretation

Year: 1984 Course: HPLC

Year: 1981 Course: Electrochemistry

Seminars Attended: GWPCA, Hewlett-Packard, East Tenn. Mass Spec Society, EPA Annual Technical Conference 1990, 1991, 1992

Work Experience

Last Position: Chemist Company: Law & Co.

Dates: Aug 1975 to Aug 1985

Position: Company:

Dates:

Position: Company:

Dates:

Current Job Skills: Wet Chemistry, Colorimetry, Titrations, BOD_5 AA, ICP, IR, Bomb Calorimetry, GC, GC-MS, Methods Development, Complex matrix parameter determination

Resumé continued of: Robert G. Owens, Jr.

Certifications:

Seminars Taught: OSHA 40 hr NSI elemental seminar, TCLP at Solid Waste Conference, Marietta, GA 1991

Publications: Laboratory visits: What to look for as a client. Conference Proceedings of the Industrial Pollution Contol Conference, Atlanta. GA, February 22-24, 1993.

Results of laboratory tests of the Accelerated One-Step™ Liquid-liquid Extractor. Proceedings of the Ninth Annual Waste Testing and Quality Assurance Symposium, EPA and ACS, Washington, D.C. July 12-16, 1993.

Other Information

Name: Denise Swords Geier SSN: 420-04-4603

Position: Laboratory Director Date Began: July 15, 1985

Education:

High School: Dale County HS, Midland City AL

College: Huntingdon College

Year: 1984 Degree: BA Chemistry

College: Georgia State University

Year: 1985-87 Degree: MS Chemistry Candidate

College:

Year: Degree:

Technical Schools

Year: 1989 Course: Perkin-Elmer Spectroscopy

Year: 1990 Course: Varian GC-MS Analysis

Year: 1988 Course: Microsoft Word

Year: 1989 Course: H-P Advanced RTE Training

Seminars Attended: H-P Environmental Teleconference 1988, 1990, 1992; H-P Environmental Analysis; H-P Chromatography; Hiring & Firing Seminar; MS Interpretation; H-P Basic GC-MS operator; Management Seminar; GWPCA Chemical Hygiene Plan; LAN Administrator, EPA Annual Technical Conference 1990, 1991, 1992

Work Experience

Last Position: Chemist Company: Law & Co.

Dates: May 1984 - July 1985

Position: Lab Technician Company: Deep South Laboratories

Dates: May 1983 - May 1984

Position: Company:

Dates:

Current Job Skills: Oversee daily operations of Laboratory, Review all incoming projects and schedule testing, review and approve all laboratory reports, hands-on operation and supervision of H-P GC-MS-RTE systems, meet client needs as Project Manager, Maintain and oversee stock on all laboratory supplies, work with section supervisors to insure proper flow of samples through the lab, serve as a Chemical Hygiene Officer, train new personnel in all areas of operation, coordinate and establish new training programs, work with computer operations to design and establish LIMS system

Resumé continued of: Denise Swords Geier

Certifications: DOS; Microsoft Word; LAN Administrator; H-P Advanced RTE System Manager; American Oil Chemist's Society

Seminars Taught:
Publications: Laboratory visits: What to look for as a client. Conference Proceedings of the Industrial Pollution Contol Conference, Atlanta. GA, February 22-24, 1993.
Results of laboratory tests of the Accelerated One-Step™ Liquid-liquid Extractor. Proceedings of the Ninth Annual Waste Testing and Quality Assurance Symposium, EPA and ACS, Washington, D.C. July 12-16, 1993.

Other Information

Name: Roy-Keith Smith SSN: 037-32-5524

Position: Analytical Methods Manager Date Began: 1 March, 1992

Quality Assurance Manager

Education

High School: East Greenwich HS, East Greenwich RI

College: Georgia Institute of Technology

Year: 1976 Degree: BS Chemistry

College: Colorado State University

Year: 1981 Degree: Ph. D. Chemistry

College: California Institute of Technology

Year: 1981-82 Degree: Reasearch Faculty in Chemistry

Technical Schools

Year: 1987 Course: Finnegan OWA 1020

Year: 1990 Course: GA Right to Know Hazardous Chemical Supervisor

Year: 1992 Course: H-P MS-DOS GC/MS, UNIX, andTarget analysis

Year: 1992 Course: all H-P GC and Cap. Column courses

Seminars Attended: EPA Annual Technical Conference and many others

Work Experience

Last Position: Assistant Professor of Environmental Chemistry Company: Southern College of Technology

Dates: Jan 1990 - Jun 1992

Position: Laboratory Manager Company: Southeast Laboratories

Dates: Oct 1989 - Dec 1989

Position: Senior Scientist Company: GA Dept Agriculture

Dates: Mar, 1985 to Oct 1989

Current Job Skills: Through knowledge of QA/QC and EPA, NIOSH and misc. analytical methods for analysis of pollutants in air, water, and solids by LC, GC, GC-MS, AA, Furnace AA, ICP, spectroscopic methods and wet chemistry.

Certifications: Licensed State of Georgia Water and Wastewater Laboratory Analyst

Seminars Taught: Many in the areas of environmental laboratory QA/QC, use of GC and GC-MS for insect species determination, pesticide residue methods for fruits, vegatables, honey beeswax and honey bees. Taught Environmental Analysis at Southern Tech.

Other Information: Listed in *Who's Who Environmental Registry*. Consultant for chemistry and GC courses to the Analytical Education Center, Hewlett-Packard, Inc.

Publications: 1. Highly stereoselective addition of organolithium reagents to chiral oxazolines. Asymmetric synthesis of 3-substituted alkanoic acids and 3-substituted lactones. Journal of Organic Chemistry (1979) 44(13): 2250-2256. With A.I.Meyers and C.E.Whitten.

2. Separation of diastereomers using a low cost preparative medium-pressure liquid chromatograph. Journal of Organic Chemistry (1979) 44(13):2247-2249. With A.I.Meyers, J.Slade, E.D.Mihelich, F.M.Hershenson and C.D.Liang.

3. A total asymmetric synthesis of (+)-ar-Turmerone. Tetrahedron Letters (1979) 20: 2749-2752. With A.I.Meyers.

4. Asymmetric synthesis using chiral 2-alkenyl oxazolines. Ph.D. dissertation, Colorado State University, 1981.

5. Intramolecular Diels-Alder reactions of 2-alkenyl-1,2-dihydropyridines. An approach to the synthesis of the cis-decahydroquinoline ring system. Tetrahedron Letters (1983) 24(27): 2711-2714. With D.L.Comins and A.H.Abdullah.

6. Identification of Africanization in honey bees based on extracted hydrocarbons assay. In Africanized Honey Bees and Bee Mites (G.R.Needham, R.E.Page Jr., M.Delfinado-Baker and C.E.Bowman, Editors) Ellis Horwood Ltd (Division of J.Wiley & Sons, New York, NY), (1988) pp 275-280.

7. Europeanization of Honey Bees in South Africa. American Bee Journal (1988) 128(10): 329-330.

8. Stock certification of European queens. American Bee Journal (1988) 128(10): 676-678. With O.R.Taylor Jr., J.F.Rossman, and H.F.York Jr.

9. Application of gas chromatographic/pattern recognition techniques to the problem of identifying Africanized honey bees. Microchemical journal (1989) 39: 308-316. With B.K.Lavine, A.J.I.Ward and O.R.Taylor Jr.

10. Confirmation of Daminozide residues (1989). Georgia Department of Agriculture. With J.B.McKinney and M.M.Wilcox.

11. The behavior and chemical disguise of the cuckoo ant *Leptothorax kutteri* in relation to its host *Leptothorax acevorum* . Journal of Chemical Ecology (1990) 16(5):1431-1444. With N.R.Franks, M.Blum and A.B.Allies.

12. Chemical residues in bees, honey, and beeswax. American Bee Journal (1990) 130(3): 188-192. With M.M.Wilcox.

13. A rapid acaricide detection method for honey analysis. In Proceedings of the Second Tracheal Mite Symposium, Weslaco, TX, October 1-2, 1989 (F.Eischen and W.Wilson, Editors) OneBetter Publishing (1990) in press.

14. Unsaturated extracted hydrocarbon caste differences between European queen and worker honey bees, *Apis mellifera* L. (Hymenoptera: Apidae). Journal Kansas Entomological Society (1990) 63(3):369-374. With O.R.Taylor Jr.

15. Chemotaxonomy of honey bees (*Apis mellifera* L.). Part 1: European and African workers. Bee Science (1990) 1(1):23-32.

16. The effect of mislabeled samples on the performance of the linear learning machine. Journal of Chemometrics (1990) 4:47-50. With B.K.Lavine, A.J.I. Ward, J.H.Han and O.R.Taylor Jr.

17. Taxonomy based on chemical constitution: differentiation of heavily Africanized honey bees from moderately Africanized honey bees. Submitted for publication (1989). With B.K.Lavine, A.J.I.Ward, J.H.Han and O.R.Taylor Jr.

18. Chemotaxonomy of honey bees (*Apis mellifera* L.). Part 2: Africanized workers. Bee Science (1991) 1(2):82-94.

19. Principles of chemical analysis of bee hydrocarbons. Bee Science (1990) 1(1): 15-17.

20. Chemotaxonomy of honey bees (*Apis mellifera* L.). Part 3: Identification of Africanization in honey bee queens (Hymenoptera: Apidae). Bee Science (1992) 2(2):93-105. With M. Spivak, O.R. Taylor, Jr , C. Bennett, and M.L. Smith.

21. Maturation of tergal gland alkenes in European honey bee queens, *Apis mellifera* L. J. Chem Ecol. (1993) 19(1):133-142. With M. Spivak, O.R. Taylor, Jr., C. Bennett, M.L. Smith and G. Hoffmann.

22. Computer modeling of hydrocarbon data toward detection of Africanization in honey bees. American Bee Journal (1987) 127(12). With B.K.Lavine.

23. Determination of Africanization in honey bee queens. American Bee Journal (1988) 128(12): 808-809. With O.R.Taylor Jr.

24. Cuticular olefin assay of African honey bees visiting cotton flowers. American Bee Journal (1989) 129(12): 818. With G.M.Loper.

25. A rapid acaricide detection method for honey analysis. American Bee Journal (1989) 129(12): 823.

26. European honey bee stock certification via olefin assay. American Bee Journal (1989) 129(12): 823-824.

27. Olefin assay for detection of Africanization in comb wax. American Bee Journal (1989) 129(12): 824. With O.R.Taylor Jr.

28. Chemical studies on drone honey bees. American Bee Journal (1990) 130(12): 813. With O.R. Taylor, Jr.

29. *Handbook of Environmental Analysis* 1993, Genium Publishing Schenectady, NY

Name: Elena L. Rodriguez SSN: 265-63-2589

Position:Project Manager Date Began: Feb 1, 93

Education:

High School: Bishop Kenny HS, Jacksonville, FL

College: Jacksonville University

Year: 1985 Degree: BS Biology

College: Jacksonville University

Year: 1990 Degree: MBA

College:

Year: Degree:

Technical Schools

Year: 1990 Course: EPA Drinking Water Laboratory Certification Course - Microbiology and Inorganic Parameters

Year: 1990 Course: EPA Drinking Water Laboratory Certification Course - Organic Parameters

Year: Course:

Year: Course:

Seminars Attended: 1993 - Hazardous Materials Management (Padgett-Thompson)

Work Experience

Last Position: Laboratory Certification Officer Company: Florida DHRS

Dates: May 1988 - Jan 1993

Position: Technician Company: Mayo Clinic

Dates: Aug 86 - Jan 88

Position: Company:

Dates:

Current Job Skills: Project Manager, data validation and review, microbiology auditing

Resumé continued of: Elena L. Rodriguez

Certifications: State of Georgia Licensed Water Laboratory Analyst, State of Florida HRS licensed Clinical Laboratory Technician

Seminars Taught: FL DHRS Workshop on EPA Microbiological Methods for Water and Wastewater 24 hrs (May 90, Sep 90, Mar 91, Aug 91, Apr 92, Aug 92)

Publications:

Other Information: Member FSEA, NAEP and PEMA

Name: Jeff E. Newman SSN: 257-98-3350

Position: Computer Operations Manager Date Began: July 1, 1990

Education:

High School: North ClaytonHS

College: Jacksonville State University

Year: 1982 Degree: BS Marketing

College:

Year: Degree:

College:

Year: Degree:

Technical Schools

Year: Course: ACIT LAN Administrator

Year: Course: Intermediate dBase Programing

Year: Course: Padget/Thompson: Hiring & Firing

Year: Course:

Seminars Attended:

Work Experience

Last Position: Office Manager, Programer, Mechanical Engineer Company: United Elevator Corp.

Dates: Feb 1983 - June 1990

Position: Company:

Dates:

Position: Company:

Dates:

Current Job Skills: Programing; Development of LIMS System; Network Manager

Resumé continued of: Jeff E. Newman

Certifications:

Seminars Taught::

Publications: "Current Trends and Development" *Elevator World* Feb, 1990

Other Information

Name: G. Wyn Jones SSN: 239-96-5649

Position: Project Coordinator Date Began: February 5, 1986

Education:

High School: Chapel Hill HS, Chapel Hill NC

College: University of North Carolina, Wilmington

Year: 1981 Degree: BS Marine Biology

College: Georgia State University

Year: 1984-85 Degree: BS Chemistry candidate

College:

Year: Degree:

Technical Schools

Year: 1988 Course: ASTM Groundwater Monitoring

Year: 1989 Course: Hazardous Waste Management 16 hr

Year: 1990 Course: Hazardous Waste Management 16 hr

Year: 1991 Course: OSHA Health and Safety 40 hr

Seminars Attended:

Work Experience

Last Position: Chemist Analyst Company: Law & Co.

Dates: October, 1981 - February, 1986

Position: Company:

Dates:

Position: Company:

Dates:

Current Job Skills: Project Manager, client contact, project development for solid waste management and groundwater monitoring programs, Projects include sampling and analysis plans for solid waste delistings, Part B applications, waste stream characterization and NPDES industrial monitoring programs. Train new personnel in all areas of field operations. Market development, Project bidding and sales.

Resumé continued of: G. Wyn Jones

Certifications:

Seminars Taught:

Publications:

Other Information

Name: Rachel B. Fried SSN: 083-48-6822

Position: Senior Microbiologist Date Began: April 30 1984

Education:

High School: Louis D. Brandeis, NYC

College: University of Vermont

Year: 1978 Degree: BS Food Science

College:

Year: Degree:

College:

Year: Degree:

Technical Schools

Year: Course:

Year: Course:

Year: Course:

Year: Course:

Seminars Attended:

Work Experience

Last Position: QC Technician Company: Flav-o-Rich Daries

Dates: 1982-1984

Position: Lab Technician Company: Applied Biology

Dates: 1980-1982

Position: Lab Technician Company: Vermont Whey Inc.

Dates: 1978-1980

Current Job Skills: Supervisor and Senior Microbiologist; QA/QC manager for microbiology; Microbiology consultant and program leading to State Certification; Oversee sample log-in, distribution, storage and tracking; proofread final reports, data review and data validation

Resumé continued of: Rachel B. Fried

Certifications: State of Georgia Certified Microbiologist, State of Georgia licensed Water Laboratory Analyst

Seminars Taught:

Publications:

Other Information

Name: Pamela M. (Owens) Varner SSN: 564-96-1931

Position: General Chemistry Section Supervisor Date Began: June 26, 1989

Education:

High School: Lake Braddock HS, Burke VA

College: Jacksonville University, Jacksonville FL

Year: 1989 Degree: BS Biology

College:

Year: Degree:

College:

Year: Degree:

Technical Schools

Year: 1989 Course: Skalar Auto-Analyzer

Year: 1990 Course: GWPCA QC training

Year: Course:

Year: Course:

Seminars Attended: 1991 - Basics of Hazardous Materials Management (Padgett Thompson)

Work Experience

Last Position: Company:

Dates:

Position: Company:

Dates:

Position: Company:

Dates:

Current Job Skills: General Chemistry Section Supervisor; Colorimetric analysis; Auto-Analyzer for inorganics and nutrients operation and maintenance; surfactant analysis; flash point determinations; titrations; QA-QC procedures as applied to inorganic and nutient analysis

Resumé continued of: Pamela M. Owens

Certifications: State of Georgia licensed Wastewater Laboratory Analyst

Seminars Taught:

Publications:

Other Information

Name: Timothy Allan Shaw SSN: 252-27-0055

Position: GC and semi-volatiles preparation supervisor Date Began: May 23, 1990

Education:

High School: Dooly County HS, GA

College: Valdosta State College

Year: 1990 Degree: BS Biology

College:

Year: Degree:

College:

Year: Degree:

Technical Schools

Year: Course:

Year: Course:

Year: Course:

Year: Course:

Seminars Attended: EPA Technical Conference 1992

Work Experience

Last Position: Laboratory Analyst Company: USECI

Dates: April 1990 - May 1990

Position: Company:

Dates:

Position: Company:

Dates:

Current Job Skills: Analysis of TPH, Specific Conductance, pH, BOD, Karl Fischer water, Oil & Grease, and BTU parameters; sample preparation for BNA, Pesticides, PCB and other GC organics; QC procedures for analysis, sample log-in; operation of GC and IRID

Resumé continued of: Timothy Allan Shaw

Certifications:

Seminars Taught:
Publications: Results of laboratory tests of the Accelerated One-Step™ Liquid-liquid Extractor. Proceedings of the Ninth Annual Waste Testing and Quality Assurance Symposium, EPA and ACS, Washington, D.C. July 12-16, 1993.

Other Information

Name: Bill Dyer SSN: 260-40-0421

Position: Microbiology Section Supervisor Date Began: 1981

Education:

High School: Lanier HS, Macon GA

College: Georgia State University

Year: 1974 Degree: BS Chemistry/Microbiology

College:

Year: Degree:

College:

Year: Degree:

Technical Schools

Year: Course:

Year: Course:

Year: Course:

Year: Course:

Seminars Attended:

Work Experience

Last Position: Laboratory Manager Company: Southeast Laboratories

Dates: 1974 - 1980

Position: Company:

Dates:

Position: Company:

Dates:

Current Job Skills: Project Manager; Organic analysis by GC and GC-MS, Supervisor of Microbiology Section, Microbiology of water, wastewater, and food products, QA/QC procedures in microbiology

Resumé continued of: Bill Dyer

Certifications: State of Georgia Treatment Plant Operator; State of Georgia Laboratory Analyst

Seminars Taught:

Publications:

Other Information

Name: Michael L. Rabeneck SSN: 258-04-9607

Position: Metals Section Supervisor Date Began: June 26, 1990

Education:

High School: Lakeside HS Atlanta, GA

College: North Georgia College

Year: 1988 Degree: BS Biology

College: Augusta College

Year: 1990 Degree: College Courses

College:

Year: Degree:

Technical Schools

Year: 1991 Course: OSHA Hazardous waste operator

Year: 1991 Course: ASTM

Year: Course:

Year: Course:

Seminars Attended:

Work Experience

Last Position: Professional Educator Company: Butler HS, Augusta GA

Dates: August 1989 - June 1990

Position: Field Technician Company: GA Dept Natural Resources

Dates: February 1989 - August 1989

Position: Company:

Dates:

Current Job Skills: Auto-analyzer for inorganics and nutrients operation and maintenance; colorimetric analysis, scheduling metals prep and analysis work, data review and validation, ICP, GFAA and CVAA operation and maintenance.

Resumé continued of: Michael L. Rabeneck

Certifications: OSHA Certified Hazardous waste operator & ASTM Certified

Seminars Taught:

Publications:

Other Information

Name: Lee Phillips SSN: 259-84-1477

Position: Field Services Supervisor Date Began: November 19, 1990

Education:

High School: Lakeside HS Atlanta GA

College: Georgia Southwestern College

Year: 1984-86 Degree: Geology Courses

College: University of Georgia

Year: 1989 Degree: BS Agriculture

College:

Year: Degree:

Technical Schools

Year: 1991 Course: OSHA Hazardous Waste Operation

Year: 1992 Course: EPA Stormwater Permit

Year: Course:

Year: Course:

Seminars Attended:

Work Experience

Last Position: Field Utilities Company: Byers Engineering

Dates: June 1990 - November 1990

Position: Electrician Apprentice Company: Pircle Electric Company

Dates: October 1989 - November 1990

Position: Company:

Dates:

Current Job Skills: Field Services Supervisor; team leader; NPDES Monitoring and field audits; Ground water monitoring, sample log-in, field analytical services, Project Coordinator; shipping & receiving; wet chemistry; purchasing equipment and supplies for field operations

Resumé continued of: Lee Phillips

Certifications: OSHA certified for hazardous waste operations

Seminars Taught: 1992 Stormwater Monitoring

Publications:

Other Information

Name: Julia E (Betsy) Martin SSN: 260-19-0775

Position: Sample Log-in Coordinator Date Began: 4 May 1992

Education:

High School: Parkview HS

College: West Georgia College

Year: 1991 Degree: BS Biology

College:

Year: Degree:

College:

Year: Degree:

Technical Schools

Year: Course:

Year: Course:

Year: Course:

Year: Course:

Seminars Attended:

Work Experience

Last Position: Company:

Dates:

Position: Company:

Dates:

Position: Company:

Dates:

Current Job Skills: Computer operation and data entry; classification and preservation of samples; determination of correct test method based on sample type; sample custody; chain-of-custody

Resumé continued of: Julia E. (Betsy) Martin

Certifications:

Seminars Taught:

Publications:

Other Information:

Name: John K. Phillips SSN: 036-40-2410

Position: GC-MS Volatiles Section Supervisor Date Began: April 15, 1991

Education:

High School: LaSalle Academy

College: Georgia Institute of Technology

Year: 1988 Degree: BS Chemistry

College:

Year: Degree:

College:

Year: Degree:

Technical Schools

Year: Course:

Year: Course:

Year: Course:

Year: Course:

Seminars Attended:

Work Experience

Last Position: GC & GC-MS Analyst Company: Ecotek Laboratory Services

Dates: 1989 - 1991

Position: Company:

Dates:

Position: Company:

Dates:

Current Job Skills: Analyze water/soil and other matrices for volatile organics using GC-MS per EPA protocols; maintenance and operation of two GC-MS systems; QA/QC procedures for GC-MS analyses

Resumé continued of: John K. Phillips

Certifications:

Seminars Taught:

Publications:

Other Information:

Name: Donna L. Phinney SSN: 130-44-9099

Position: Semi-volatiles GC-MS Date Began: October 1991

Education:

High School: Gates-Chili HS Rochester NY

College: University of Buffalo

Year: 1975 Degree: BS Pharmacy

College:

Year: Degree:

College:

Year: Degree:

Technical Schools

Year: 1992 Course: H-P RTE Operations

Year: Course:

Year: Course:

Year: Course:

Seminars Attended:

Work Experience

Last Position: Self-employed Company: A&D Pool Service

Dates: 1986-1989

Position: Company:

Dates:

Position: Company:

Dates:

Current Job Skills: Analytis of semi-volatiles by GC-MS

Resumé continued of: Donna L Phinney

Certifications:

Seminars Taught:
Publications: Results of laboratory tests of the Accelerated One-Step™ Liquid-liquid Extractor. Proceedings of the Ninth Annual Waste Testing and Quality Assurance Symposium, EPA and ACS, Washington, D.C. July 12-16, 1993.

Other Information:

Name: Danny Brookshire SSN: 253-33-0994

Position: Mobile Laboratory Manager Date Began: 9 Mar 92

Education:

High School: F. T. Willis HS

College: Kennesaw State College

Year: 1989 Degree: BS Chemistry & BS Biology

College:

Year: Degree:

College:

Year: Degree:

Technical Schools

Year: 1990 Course: OSHA Hazardous Materials Management

Year: 1991 Course: OSHA Hazardous Mat. Management Supervisor

Year: 1991 Course: Contamination Remediation Specialist Training

Year: Course:

Seminars Attended:

Work Experience

Last Position: Field Services Supervisor & Safety Coordinator Company: Groundwater Technology

Dates: June 1989 - March 1992

Position: Company:

Dates:

Position: Company:

Dates:

Current Job Skills: Safety Director; Field screening methods and technologies; mobile laboratory manager; Environmental compliance

Resumé continued of: Danny Brookshire

Certifications: First Aid CPP ; OSHA 29 CFR 1910.120 Hazardous Waste Operations

Seminars Taught: OSHA Hazardous Waste Operations

Publications:

Other Information:

Name: Dale L. Chappelow SSN: 329-40-7131

Position: GC Supervisor and Chief Operator Date Began: May 1993

Education:

High School:

College:

Year: Degree:

College:

Year: Degree:

College:

Year: Degree:

Technical Schools

Year: Course:

Year: Course:

Year: Course:

Year: Course:

Seminars Attended:

Work Experience

Last Position: Laboratroy Director Company: Kiber Analytical Services

Dates: 1991-1992

Position: Group Manager Company: Law Environmental

Dates: 1989-191

Position: Organics Supervisor Company: Core Laboratories

Dates: 1985-1989

Current Job Skills: Instrumental analysis of environmental samples by GC with specific and general detectors

Resumé continued of: Dale L. Chappelow

Certifications:

Seminars Taught:

Publications: Spironolactone: Diversity in metabolic pathways, Xenobiotica, 1977

Other Information:

Name: Rhonda Benjamin SSN: 435-61-3624

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College:

Year: Degree:

College:

Year: Degree:

Technical Schools

Year: Course:

Year: Course:

Year: Course:

Year: Course:

Seminars Attended:

Work Experience

Last Position: Company:

Dates:

Position: Company:

Dates:

Position: Company:

Dates:

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Resumé continued of: Rhonda Benjamin

Certifications:

Seminars Taught:

Publications:

Other Information:

APPENDIX A

Glossary

Analytical Set: The basic unit for analytical quality control. Also known as sample set or analytical batch. The analytical set is defined as samples which are analyzed (or sampled together) with the same method sequence, the same lots of reagents and with the same treatment common to all samples. The samples must have been analyzed (or collected) within the same specified time period or in continuous sequential time periods. Samples contained in a set are of a similar composition or matrix.

Audit: A systematic check to determine the quality of the operation of a function or activity.

Performance audit: Quantitative data are independently obtained for comparison with routinely obtained data in a measurement system. Examples of these type audits are EPA performance evaluation programs, commercial performance evaluation programs, split samples involving at least two laboratories, and blind spike samples.

Systems audit: These are qualitative in nature and consist of an on-site review and evaluation off a laboratory or field operations unit quality assurance system and physical facilities for sampling, calibration and measurements.

Calibration: Process by which the correlation between instrument response and actual value of a measured parameter is determined.

Calibration Curve: A curve which plots the concentration of known analyte standards against the instrument response to the analyte. Also known as the **standard curve**.

Calibration Standard: Solutions or dilutions of a substance or material with a verifiable accuracy which are used to evaluate the sample property of an unknown sample. In analytical terms, these standards are used to establish a calibration curve or standard instrument response factors.

Continuing Calibration Standard: Standards that are analyzed during an analytical set to verify the accuracy of the calibration curve.

Internal Standard: A compound having similar chemical properties to the compounds of interest but which is not normally found in the environment or does not interfere with the compounds of interest. A known and specified concentration of the standard is added to each sample prior to analysis. The concentrations of analytes of interest in the sample are based on the response of the internal standard relative to that of the calibration standards and compounds in the sample.

Confidence Level: The statistical probability associated with an interval of precision (or accuracy) values in a Quality Control chart. The values of confidence intervals are generally expressed as percent probability. It is a commonly accepted convention that the result being tested is significant if the calculated probability is greater than 90%, and is highly significant if the probability is greater than 99%.

Data Quality: The totality of features and characteristics of data that bears on its ability to satisfy a given purpose. The characteristics of major importance are accuracy, precision, completeness, representativeness, and comparability. These characteristics are defined as follows:

Accuracy: The degree of agreement of a measurement (X) with an accepted reference or true value (T). It is generally expressed as the difference between the two values (T-X), or as a percent difference of the true value $\frac{T-X}{T} \times 100$. Another method of expressing accuracy is the simple ratio $\frac{X}{T}$. Accuracy is an average measure of the bias in a system.

Precision: A measurement of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. Precision is best expressed

in terms of the standard deviation. Various measures of precision exist depending on the prescribed similar conditions.

Completeness: Data which is reported to the final consumer is the result of the application of all steps necessary for the determination of the physical or chemical parameter along with all proper quality control procedures. Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that is expected to be obtained under correct normal conditions. The highest ratio possible of sample results reported in control as compared to the total number of samples received by the laboratory.

Representativeness: Expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition.

Comparability: Expresses the confidence with which one data set can be compared to another.

Data Quality Objectives: A set of specifications that the environmental data must meet in order to be acceptable for its intended use in a program area. DQO's are commonly established for limits of detection and quality of data (accuracy, precision, representativeness, and comparability).

Detection Limits: The smallest concentration/amount of an analyte of interest that can be measured with a stated probability of significance. Detection limits must be further defined as:

Method Detection Limit (MDL): The smallest concentration of an analyte of interest that can be measured and reported with a 99% confidence that the concentration is greater than zero. MDL's are determined from the analysis of a sample in a given matrix containing the analyte at a specified level. Determination of MDL's must be done by procedures listed in Appendix B, 40 CFR, Part 136 and repeated in EPA SW-846.

Practical Quantification Limit (PQL): The smallest concentration of an analyte of interest that can be reported with a specific degree of confidence. PQL's are determined in the same manner as MDL's by using the procedures outlined in Section 1, SW-846

Instrument Detection Limit: The smallest amount of an analyte of interest that generates an instrument response (signal) under prescribed conditions such that the magnitude of the signal is larger than the absolute uncertainty (error) associated with it.

Environmental Sample: Any sample from a natural source or source that may reasonably be expected to contribute pollution or receive pollution from ground or surface waters of the state. This includes, but is not limited to, solid or liquid samples from: receiving waters; waters used to define natural background conditions; soils; sediments; industrial, domestic or municipal discharge effluents or sludges; chemical storage or handling facilities; waste disposal facilities or areas; industrial or agricultural chemical handling or application areas; surface water run-off; and facilities for handling or applying of chemicals for weed or insect control.

Parameter Group: Defined as a group of target analytes which are preserved in the same manner, prepared by similar protocols and analyzed using instruments of similar technology (also known as **analyte group**). Examples of parameter groups are:

Volatiles (EPA methods 601, 602, 624)
Pesticides (EPA methods 608, 614 and 622)
Trace Metals (all methods except mercury)
Nutrients (Total Kjeldahl Nitrogen, Nitrate ± Nitrite, Total Phosphorus)

Performance Evaluation Sample: A sample submitted for analysis whose composition and concentration are known to the submittor but unknown to the analyst. Also known as **Blind Sample**.

Quality Assurance(QA): A system of activities whose purpose is to provide the producer or user of environmental data the assurance that it meets defined standards of quality with a stated level of confidence.

Quality Assurance Plan: A written, orderly assembly of detailed and specific procedures which delineates how data of a known and accepted quality is generated.

Comprehensive Quality Assurance Plan: A quality assurance plan that outlines all the capabilities of the subject organization, the routinely used quality control measures, the routine QA targets for precision and accuracy, and all documentation, calibration and maintenance activities that are performed to produce data of a known and acceptable quality.

Quality Control (QC): A set of activities whose purpose is to document and control the quality of data generated from an analysis so that it meets the needs of the user. QA generally refers to the overall program of proving data quality in a laboratory, while QC generally refers to specific proceedures used for a particular assay.

Quality Control Measures: Specific proceedures used to insure data quality.

Blanks: An artificial sample of an analytical matrix designed to monitor the introduction of artifacts into the system.

Field Blank: Blanks of analyte-free water that are prepared on-site by filling appropriate sample containers with the water, adding appropriate preservatives, sealing the containers and completing the requisite documentation. These blanks are prepared during the middle to end of the sampling event by filling sample containers with water from the equipment decontamination water transport containers. They are treated, stored, transported, and analyzed in the exact same manner as the sample group with which they are prepared. These blanks may be submitted with all water parameter groups.

Equipment Blank: Blanks of analyte-free water that are prepared on-site by pouring equipment decontamination water through decontaminated field equipment. Appropriate sample containers for each analyte group are used, preservatives added if required and appropriate documentation completed. These blanks are stored, transported and analyzed with the intended parameter group. At least one equipment blank is required for each water and solid matrix analytical group, and is collected at the beginning of the sampling period. If field decontamination is performed on-site, additional equipment blanks are submitted for all liquid and solid analytical groups.

Trip Blank: These blanks are required for water samples for volatile organic compound (VOC) assay. Blanks of VOC-free water are prepared by the organization providing the sample containers. These are transported to the sample site with the empty VOC containers and returned to the analyzing laboratory with the filled VOC sample containers. Proper labeling and documentation is completed. A trip blank is submitted for each cooler which is used to transport VOC samples.

Method Blank: A blank of an appropriate analyte-free matrix that is processed (digested, extracted, etc.) and analyzed with a specified sample set.

Reagent Blank: A sample of analyte-free water which is analyzed with the sample set.

Spiked Samples: Samples fortified to a known and validated concentration of analyte. Percent recoveries are calculated for each compound in the spike.

Field Spike: An environmental sample fortified to a known and validated concentration in the field. These may be submitted as **Blind Spikes** (laboratory does not know the samples are spiked) or identified as field spikes.

Reagent Spike: Samples of an appropriate analyte-free matrix (deionized water, sand, soil, etc.) that are fortified to a known and validated concentration of analyte before sample preparation.

Sample Matrix Spike: Samples are selected from an analytical set and are fortified to a known and validated concentration prior to sample preparation. The concentration of each analyte spiked is 3-5 times the level expected in the sample.

Surrogate Spike: Compounds having similar chemical characteristics to analytes of interest but not normally found in environmental samples are added in known concentration to all samples prior to any sample preparation.
Replicate Sample: Samples that have been collected at the same time from the same source (**Field replicates**) or aliquots of the same sample that are prepared and analyzed at the same time (**Laboratory replicates**). **Duplicate samples** are one type of replicate sample. The analytical results from replicates are used to determine the precision of the system. If the concentration of analytes in the sample are below MDL, **Duplicate spike samples** may be used to determine precision. **Blind replicates** are replicates that have been collected (field replicate) or prepared (laboratory replicate) and submitted for analysis without the technician's knowledge.
Quality Control Checks: Standards or samples from an independent source that are analyzed at a specified frequency.
Quality Control Check Standards: Standard solutions from a source other than normal calibration standards that are certified and traceable. These standards are used to check the accuracy of a calibration curve.
Quality Control Check Sample: Also known as **Reference Materials**, these are samples obtained from an independent source for which the level(s) of analytes have been validated. These samples are prepared and analyzed with a sample set of similar matrix. If these samples have been obtained from the National Institute of Standards and Testing, they are referred to as **Standard Reference Materials**.
Split Samples: Replicates of the same sample that are given to two independent laboratories for analysis.

Sample Custody: All records and documentation required to trace a sample from point of origin through disposal after analysis. These records include, but are not limited to:

Field notebooks
Field sample identification (ID) tags
Laboratory transmittal forms
Laboratory sample receipt logs
Sample extraction/preparation logs or worksheets
Analytical (instrument) logs or worksheets
Analytical set calibration and quality control data
Instrument maintenance logs
Sample disposition logs
Final reports

Legal Chain of Custody: A special type of sample custody in which all events associated with a specific sample must be documented in writing. In addition to the records listed above chain of custody records include: 1) sample transmittal forms and/or tags with adequate spaces for the dated original signatures of individuals who handled the sample from time of collection through laboratory delivery; and 2) laboratory sample storage logs that identify date, time and persons who remove samples from storage. Secured, limited access sample storage areas are required for establishment of legal chain of custody.

Sample Matrix: The physical and chemical characteristics of an environmental or laboratory sample which define how a sample is processsed prior to determination of the specific analytes. The following sample matrices (major matrix groups) are used in this QA plan to specify data quality objectives:

Reagent water: Water which conforms to ASTM grade I, II, or III . Also refered to as **Laboratory water**.
Drinking water: Finished or raw source water designated as potable. Relevant sources may be surface or ground water.
Surface water: Fresh or saline waters from streams, canals, rivers, ponds, lakes, bays and estuaries (natural or manmade).

Ground water: All water found below ground in confined or unconfined aquifers.
Wastewater: Any influent or effluent water associated with domestic or industrial waste treatment facilities.
Chemical waste: Any sludge and/or liquid residual from domestic or industrial wastewater processing, and liquid or solid chemicals that are no longer used for their intended purpose.
Soil / sediment: Surface or subsurface soils and sediments, may be associated with fresh or saltwater origin.

APPENDIX B

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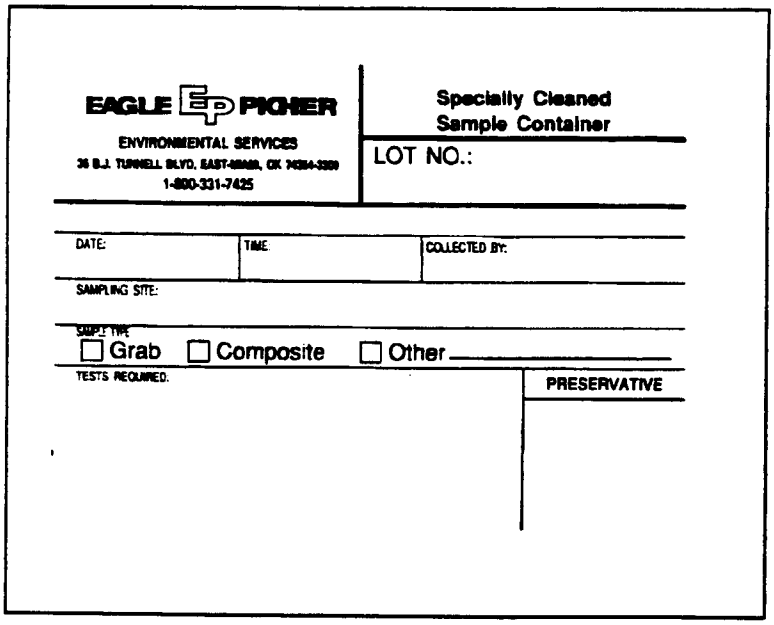
Figure C.1. Example of a Field Sample Label



Full Size

Figure C.2 Tag used for labeling of field sample.

PROJECT CODE	STATION NO.	MONTH/DATE/YEAR	TIME	DESIGNATE: COMP.	DESIGNATE: GRAB

TAG NO.	STATION LOCATION	SAMPLERS (SIGNATURES)
1002		

LAB SAMPLE NO.	REMARKS:	NUTRIENTS	WET CHEMISTRY	BACTERIOLOGY	VOLATILE ORGANICS	ORGANICS GC/MS	ORGANICS GC	OIL AND GREASE	CYANIDE	METALS	PHENOLS	COD, TOC, TOX	BOD, SOLIDS	ANALYSES	PRESERVATIVE Yes ☐ No ☐

ASI

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ENVIRONMENTAL MONITORING & LABORATORY ANALYSIS

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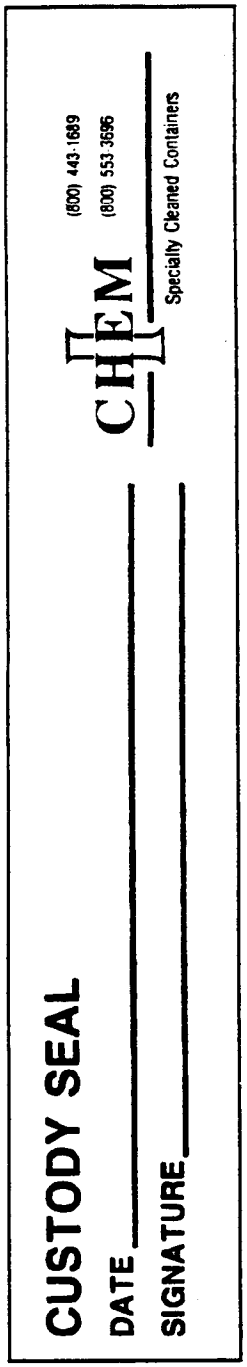
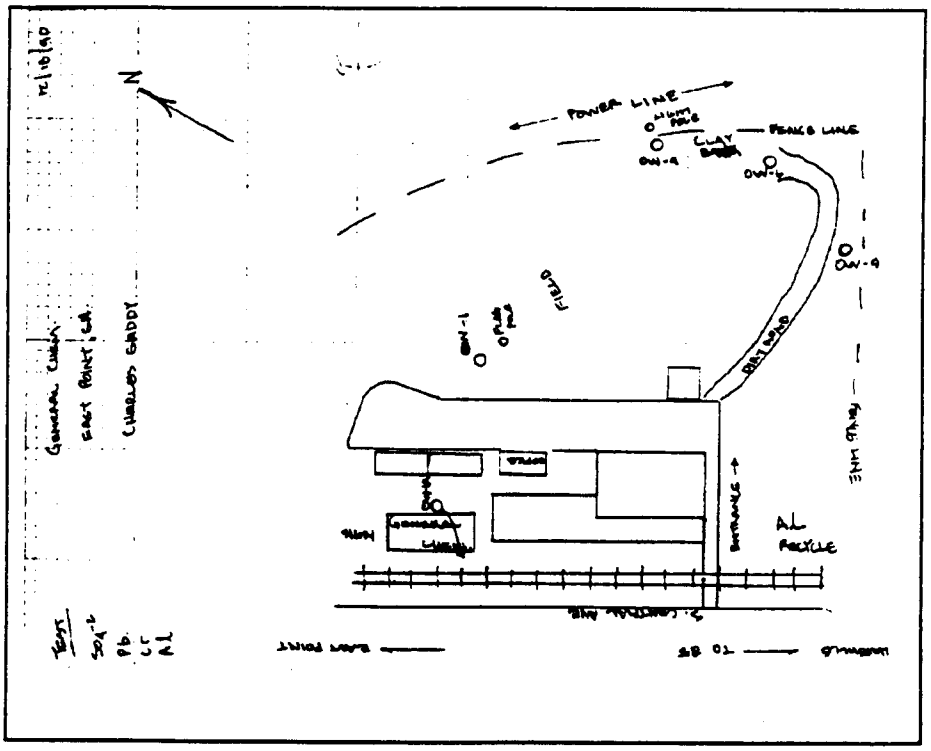
UNIT OF AMERICAN ANALYTICAL SERVICES, INC.

Figure C.3. Seal used for sample security.



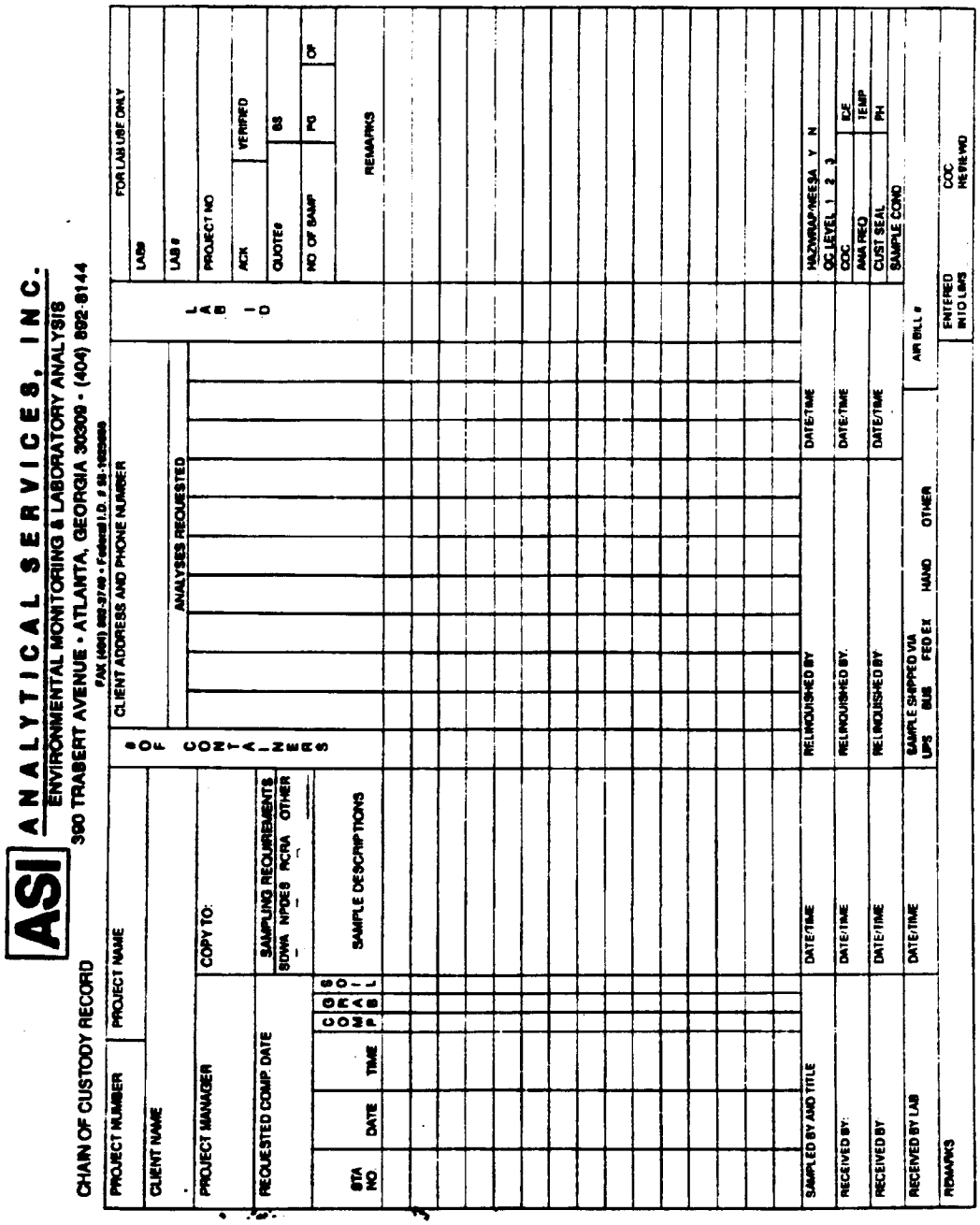
Full Size

Figure C.4. Page from a field logbook.



60% reduction of full size

Figure C.5. Chain-of-custody form.



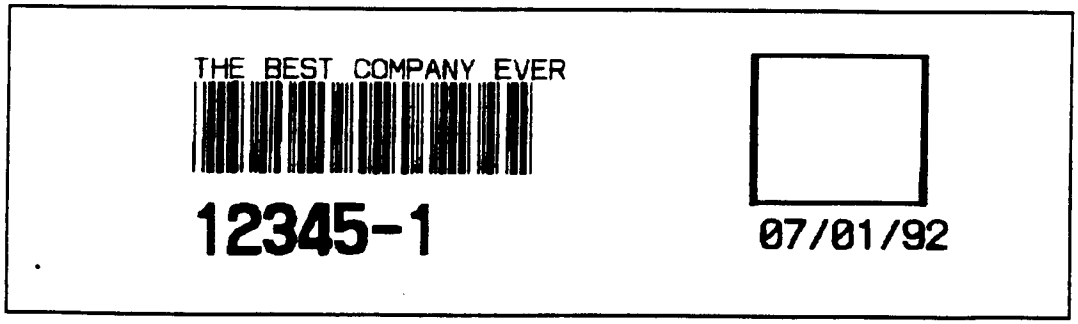
60 % reduction of normal size

Figure C.6. Example of a page from the laboratory sample sign-in log.

```
                    L O G B O O K      PAGE
                     printed 02/26/91

Sample #      Client / Tests                    Date: RECEIVED/COMPLETED
24775     JOHN C. DOE COMPANY SC LARGETOWN          02/22/91   02/26/91
     TESTS:BOD COD                                              # Samp: 4
     SAMPLE: WASTE WATER   02/22/91 I.D.:PROJECT# 12345, EFFLUANT 001
     PO:ANOTHER PO#        INVOICE: 0 / 45                      / /     / /

24776     THE BIG NEW PLANT FL SMALLTOWN            02/22/91   02/25/91
     TESTS:BTEX TPH                                             # Samp: 1
     SAMPLE: SOIL          02/20/91 I.D.:PROJ: TANK EXTRACTION, FROM SOUTH END OF TANK
     PO:                   INVOICE: 0 / 250                     / /     / /

24777     SMALL CLIENT CO. GA ATLANTA               02/22/91   02/22/91
     TESTS:METALS                                               # Samp: 1
     SAMPLE: GRAB LIQUID   02/15/91 I.D.:GR-041234/A
     PO:                   INVOICE: 0 / 1200                    / /     / /

24778     ANOTHER CLIENT GA SOME CITY               02/22/91     / /
     TESTS:TCLP                                                 # Samp: 1
     SAMPLE: WASTE WATER   02/19/91 I.D.:THIS IS THE AREA RESERVED FOR THE SAMPLE DESCRIPTION !!!!!!!
     PO:SOME PO#           INVOICE: 0 / 0                       / /     / /

24779     SAMPLE CLIENT CO. TX HOUSTON              02/22/91     / /
     TESTS:NH-3                                                 # Samp: 1
     SAMPLE: SOIL            / /   I.D.:TANK LEEK A-1
     PO:                   INVOICE: 0 / 0                       / /     / /

24780     JOHN C. DOE COMPANY SC LARGETOWN          02/25/91     / /
     TESTS:BOD COD TSS                                          # Samp: 2
     SAMPLE: WASTE WATER   02/21/91 I.D.:EFFLUANT BROWN STREEM
     PO:ANOTHER PO#        INVOICE: 0 / 0                       / /     / /

24781     THE BIG NEW PLANT FL SMALLTOWN            02/25/91     / /
     TESTS:BTEX TPH                                             # Samp: 1
     SAMPLE: SOIL          02/24/91 I.D.:PROJ: TANK EXTRACTION, FROM EAST SIDE OF TANK
     PO:                   INVOICE: 0 / 0                       / /     / /

24782     SAMPLE CLIENT CO. TX HOUSTON              02/25/91     / /
     TESTS:NH-3                                                 # Samp: 1
     SAMPLE: SOIL          02/25/91 I.D.:TANK REMOVAL B-2
     PO:                   INVOICE: 0 / 0                       / /     / /

24783     THE BIG NEW PLANT FL SMALLTOWN            02/25/91     / /
     TESTS:BTEX TPH                                             # Samp: 1
     SAMPLE: SOIL          02/24/91 I.D.:PROJ: TANK EXTRACTION, FROM EAST SIDE OF TANK (SECOND TIME)
     PO:                   INVOICE: 0 / 0                       / /     / /

24784     THE BIG NEW PLANT FL SMALLTOWN            02/25/91     / /
     TESTS:BTEX TPH                                             # Samp: 1
     SAMPLE: SOIL          02/18/91 I.D.:PROJ: TANK EXTRACTION, FROM EAST SIDE OF TANK (THIRD TIME)
     PO:                   INVOICE: 0 / 0                       / /     / /
```

60% reduction from full size

Figure C.7. Example of a Laboratory Sample Label



1.5 times full size

Figure C.8. Example of a sample preparation bench sheet.

SAMPLE PREP WORKSHEET

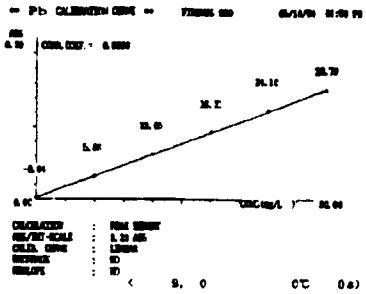
Client Name_____ Work Order No._____

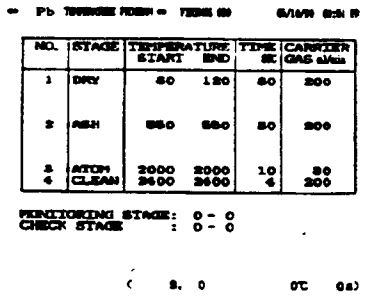
ASI Sample No.	Matrix	Analyte	Analyte Prep Date	Analyte Holding Time[1] (Days)

[1]Holding time is determined as number of days between the date received and the sample preparation date.

60% reduction from full size.

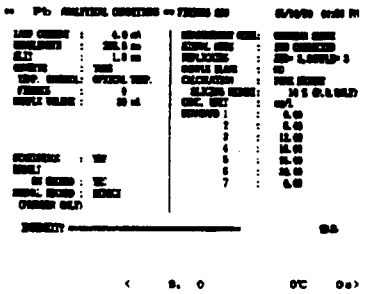
Figure C.9. Example of a sample analysis bench sheet.





NO.	STAGE	TEMPERATURE START	TEMPERATURE END	TIME SEC	CARRIER GAS
1	DRY	60	120	60	200
2	ASH	650	650	50	200
3	ATOM	2000	2000	10	50
4	CLEAN	2600	2600	4	200

MONITORING STAGE: 0 - 0
CHECK STAGE : 0 - 0



60% of full size

Figure C.9 continued.

== Pb RESULT TABLE == DATE : 7. 18. 90 3: 7 PM
REMARKS: 22210
ANALYST: BENDECK

S. NO.	PEAK HEIGHT CONC (ug/L)	ABS	REF1	REF2
STD 1	0. 00	0. 0026	0. 008	0. 004
STD 1	0. 00	0. 0021	0. 009	0. 003
STD 2	6. 00	0. 0223	0. 009	0. 006
STD 2	6. 00	0. 0245	0. 009	0. 006
STD 3	12. 00	0. 0432	0. 009	0. 008
STD 3	12. 00	0. 0436	0. 009	0. 009
STD 4	18. 00	0. 0642	0. 011	0. 011
STD 4	18. 00	0. 0643	0. 011	0. 010
STD 5	24. 00	0. 0852	0. 013	0. 013
STD 5	24. 00	0. 0845	0. 012	0. 012
STD 6	30. 00	0. 1069	0. 013	0. 013
STD 6	30. 00	0. 1038	0. 014	0. 014
CORR. COEF. =	1. 0000			
1	0. 20	0. 0032	0. 008	0. 004
1	-0. 01	0. 0024	0. 009	0. 006
MEAN =	0. 10			
SD =	0. 15			
RSD =	150. 0 %			
2	-0. 30	0. 0015	0. 010	0. 005
2	-0. 12	0. 0021	0. 009	0. 006
MEAN =	-0. 21			
SD =	0. 13			
RSD =	-61. 9 %			
3	5. 57	0. 0216	0. 009	0. 008
3	6. 46	0. 0247	0. 009	0. 006
MEAN =	6. 02			
SD =	0. 63			
RSD =	10. 5 %			
4	12. 12	0. 0441	0. 009	0. 008
4	12. 05	0. 0438	0. 010	0. 009
MEAN =	12. 09			
SD =	0. 05			
RSD =	0. 4 %			
5	18. 03	0. 0643	0. 009	0. 009
5	18. 46	0. 0658	0. 010	0. 010
MEAN =	18. 25			
SD =	0. 30			
RSD =	1. 6 %			
6	25. 43	0. 0897	0. 014	0. 014
6	24. 97	0. 0881	0. 012	0. 012
MEAN =	25. 20			
SD =	0. 33			
RSD =	1. 3 %			

60% of full size.

Figure C.9 continued.

American Analytical Services, Inc.

COLORIMETRIC ANALYSIS WORKSHEET

Date _____ Test _____

Time _____ Analyst _____

DATA

AAS No.	Client	Comments	Sample Size	Absorbance (λ = _____)	% Recovery of Spike	% Agreement of Duplicates	Results (mg/L)

60% of full size.

Figure C.10. Example of a Laboratory Results Worksheet

Priority: 3 Due :04/11/91 Sample # 24924

SMALL CLIENT CO.
123 SOUTH STREET
BLDG. 456
ATLANTA, GA 00923 Clnt# 23456789
Attn: John Doe

Date Recived: 04/05/91
P.O. #SOME PO#

Samples = 1 # Containers = 1

L O C A T I O N : W1

Sample # 24924

Description:
WEEKLY SAMPLE. WASTE WATER. WW-001. 04/05/91 Received:04/05/91

Tests	Results	Detection	By
Biochemical Oxygen Demand (BOD5)(mg/l)(EPA 405.1)	_____	5	____
Chemical Oxygen Demand (COD)(mg/l)(EPA 410.1)	_____	5	____
Total Solids (mg/l)(SM 209-B)	_____	5	____
Total Solids (mg/l)(EPA 160.3)	_____	5	____

30.00	_____	_____	_____	30.00
Courier	Sample	Chemistry	Micro.	Total

DATES : Completed - / / By _____ Typed - / / By _____ Mailed - / / By _____

INVOICE : No. _____ Amount = -------- By _____ Date - / /

Notes :

60% of full size.

Figure C.11. Example of a Customer's request for sample containers form.

ASI ANALYTICAL SERVICES, INC.

ENVIRONMENTAL MONITORING & LABORATORY ANALYSIS
390 TRABERT AVENUE • ATLANTA, GEORGIA 30309 • (404) 892-8144

REQUEST FOR CONTAINERS

Date: _____

Client: _____

Street Address: _____

Contact Name: _____

Project Name: _____

Method of Shipment: Regular UPS _____ Fed-X _____ Pick-up _____

Courier _____ Other _____

Materials Needed: Chain of Custody _____

Custody Seals _____

Coolers _____

Other _____

Sample Type	Number of Bottles	Test

Comments: _____

Requested By: _____

60% of full size.

Figure C.12. Example of a Field Sampling Information Sheet for billing purposes.

Purchase Order # _____ ASI Lab # _____

SAMPLING INFORMATION SHEET

Client Name _____

Client Address _____

Client Phone # _____

Contact Person _____

Purpose of Trip:

Equipment Used:

Misc. Expenses:

Mileage: Time in Field:

Chain of Custody attached: Yes ____ No _____

Sampling Date: _____

_____
Signature

60% of full size.

Figure C.13. Example of a page from the log of samples sent out for subcontract analysis.

Work order #	Date Rcvd.	Client	Sample	Company	Test for	Date sent	Sent to	Date Rc
[illegible]	6/6/90	T+R	Liquid	GIC	Pest	6/7/90	RH/Cour	[illegible]
21655	6/7/90	YKK	Liquid	GIC	Pest	6/7/90	RH/Cour	[illegible]
21658-2	6/9/90	JJ+G	water	GK	Pest	6/10/90	TS/Cour	6/[illegible]
21659-1	6/9	JJ+G	water	GIC	Pest	6/11/90	TS/Cour	6/29/[illegible]
21659-4	6/9	JJ+G	water	GIC	Pest	6/11/90	TS/Cour	[illegible]
21660-1	6/9	JJ+G	water	GK	Pest	6/11/90	TS/Cour	[illegible]
21660-11	6/9	JJ+G	water	GK	Pest	6/11/90	TS/Cour	[illegible]
21668-2	6/9	JJ+G	water	GK	Pest	6/11/90	TS/Cour	[illegible]
21668-4	6/9	JJ+G	water	GK	Pest	6/11/90	TS/Cour	[illegible]
21673-1	6/9	JJ+G	water	GK	Pest	6/11/90	TS/Cour	[illegible]
21673-4	6/9	JJ+G	water	GK	Pest	6/11/90	TS/Cour	[illegible]
21675-2	6/9	JJ+G	water	GK	Pest	6/11/90	TS/Cour	[illegible]
21675-10	6/9	JJ+G	water	GK	Pest	6/11/90	TS/Cour	[illegible]

60% reduction from full size

Figure C.14. Example of a sample Purchase Order/Request form for subcontract analysis.

ANALYTICAL SERVICES, INC.
390 Trabert Avenue N.W.
ATLANTA, GA 30309

(404) 892-8144

DATE
SHIP TO

TO

WHEN SHIP	SHIP VIA	F.O.B. POINT	TERMS

QTY. ORDERED	QTY. RECEIVED	DESCRIPTION	PRICE	AMOUNT

1. Please send _____ copies of your invoice.
2. Please show this Purchase Order Number on all packages and invoices.
3. Notify us immediately if you are unable to ship as specified.

Authorized by

REMARKS

3192

75% of full size.

Figure C.15. Example of Water Monitoring Report on Solid Waste Disposal Sites.

WATER MONITORING REPORT

SOLID WASTE DISPOSAL SITES

Site Name:_____

Type Sample: ___ Background ___Operational Other_____

Monitoring Results

	Analytical Results				
Monitoring Station #	pH	Specific Conductance (umhos)	Chlorides (mg/l)	Well Water Level (Ft.)	Physical Condition of Monitoring Station. (Describe)

Lab._____ **Project Mgr.**_____ **Phone#**_____

60% reduction from full size.

Figure C.16. Example of a Groundwater Monitoring Worksheet

GROUNDWATER MONITORING LOCATION:
DATE:

W #	W D	W L	(1)	(3)	Act.	pH	SC	Temp.

60% of full size.

Figure C.17. Computer generated work assignment example

B E N C H S H E E T For JEN Date:07/01/91

SAMPLE #	Result	D/Lim	Location	** C L I E N T **
			Total Phenols (as Phenol)(mg/l)(EPA 420.1)	
27051	_____	0.01	6 I2	SMALL CLIENT CO. ATLANTA GA
27122-1	_____	0.01	H1	CITY OF SOMEWHERE SOMEWHERE
27122-4	_____	0.01	H1	CITY OF SOMEWHERE SOMEWHERE
27155	_____	0.01	3 GC I3	NONAME COMPANY, INC. ATLANTA

Figure C.18. Report of Analytical Results example

ASI **ANALYTICAL SERVICES, INC.**

ENVIRONMENTAL MONITORING & LABORATORY ANALYSIS
390 TRABERT AVENUE ● ATLANTA, GEORGIA 30309 ● (404) 892-8144
FAX (404)892-2740 ● Federal I.D. #58-1625856

LABORATORY REPORT

April 8, 1991

P. O. No. 34923

Report No. 26603

Sample: Wastewater, Supernate, Treated with $mg(OH_2)$, 3/28/91,
Project: Project #30271.01, received 3/28/91

RESULTS

	Result	Detection Limit
Biochemical Oxygan Demand (BOD_5)(mg/l)(SM 507).....	300	5
*Soluble Biochemical Oxygen Demand (BOD_5)(mg/l)(SM 507)	240	5
Chemical Oxygen Demand (COD)(mg/l)(SM 508-C).....	980	5
Total Kieldahl Nitrogen (N)(mg/l)(SM 420).....	37.8	0.1
Ammonia Nitrogen (N)(mg/l)(SM 417-B).....	15.8	0.1
Total Phosphorus (P)(mg/l)(SM 424-F).....	11.1	0.02
Total Dissolved Solids (mg/l)(SM 209-B).....	5,400	5
Sulfate (SO_4)(mg/l)(SM 426).....	780	10

*Sample filtered through 0.45 micron filter prior to analysis

Respectfully submitted,

By: Denise A. Weir

A Unit of American Analytical Services, Inc.

75% reduction of normal sized form.

Figure C.19. Quality Control Report form

American Analytical Services, Inc.

QUALITY CONTROL REPORT

Test _____ Submitted By _____

Week Ending _____ Lab Manager _____

QA Coordinator _____

Report all duplicate analyses values as well as results on spikes.

AAS No.	Client	Comments	Value 1	Value 2	% Recovery of Spike	% Agreement of Duplicates	Analyst

60% reduction from full size.

Figure C.20. Quality Control Standard Computerized Results and Report (Metals)

Analysis Report QC Standard Thu 04-18-91 03:57:04 PM page 1

Method: TESTBK Sample Name: CCV Operator: mab
Run Time: 04/18/91 15:53:13
Comment:
Mode: CONC Corr. Factor: 1

Elem	Ag3280	Al3082	As1936	B_2496	Ba4934	Be3130	Ca3158
Units	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Avge	-.0192	5.176	4.701	.0104	Q6.231	Q4.272	4.896
SDev	.0014	.058	.001	.0001	.186	.018	.042
%RSD	-7.050	1.116	.0167	1.211	2.991	.4240	.8675
#1	-.0182	5.135	4.702	.0103	Q6.363	Q4.259	4.866
#2	-.0201	5.217	4.701	.0104	Q6.100	Q4.284	4.926
Errors	NOCHECK	QC Pass	QC Pass	NOCHECK	QC Fail	QC Fail	QC Pass
Value		4.900	5.000		4.900	4.900	5.000
Range		10.00	10.00		10.00	10.00	10.00

Elem	Cd2288	Co2286	Cr2677	Cu3247	Fe2599	K_7664	Mg2790
Units	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Avge	4.787	4.863	4.616	5.268	5.345	47.43	4.868
SDev	.064	.048	.035	.033	.038	.14	.048
%RSD	1.327	.9917	.7599	.6294	.7121	.3026	.9798
#1	4.742	4.829	4.592	5.225	5.319	47.33	4.815
#2	4.832	4.898	4.641	5.272	5.372	47.53	4.882
Errors	QC Pass	QC Pass	QC Pass	QC Pass	QC Pass	QC Pass	QC Pass
Value	4.900	4.900	4.900	5.400	5.000	50.00	4.900
Range	10.00	10.00	10.00	10.00	10.00	10.00	10.00

Elem	Mn2576	Mo2020	Na5889	Ni2316	P_2149	Pb2203	Sb2068
Units	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Avge	4.766	-.0005	5.022	5.202	.0225	4.926	-.0180
SDev	.032	.0017	.057	.036	.0375	.086	.0111
%RSD	.6667	-330.0	1.125	.6587	167.0	1.747	-61.28
#1	4.743	.0007	4.982	5.177	.0490	4.865	-.0259
#2	4.788	-.0017	5.062	5.226	-.0041	4.987	-.0102
Errors	QC Pass	NOCHECK	QC Pass	QC Pass	NOCHECK	QC Pass	NOCHECK
Value	4.800		5.000	5.000		5.100	
Range	10.00		10.00	10.00		10.00	

Elem	Se1960	Si2881	Ti1908	V_2924	Zn2138
Units	ppm	ppm	ppm	ppm	ppm
Avge	4.720	-2.205	-.1741	Q4.287	4.783
SDev	.004	.046	.0196	.030	.028
%RSD	.0769	-2.088	-11.25	.6959	.5856
#1	4.718 *	-2.173	-.1879	Q4.265	4.763
#2	4.723	-2.237	-.1602	Q4.308	4.803
Errors	QC Pass	NOCHECK	NOCHECK	QC Fail	QC Pass
Value	4.900			5.000	4.900
Range	10.00			10.00	10.00

Figure C.21. Run log for Semi-volatiles GC-MS

ASI SEMIVOLATILE SAMPLE LOG

ANALYST:
DATE:
INSTRUMENT:

QE BATCH(ES):
INITIAL CALIBRATION:

	ASI SAMPLE NO.	CLIENT	QE BATCH	ALS	MATRIX	EXT/FVOL	ul	STATUS	NOTES
1							1.0		
2							1.0		
3							1.0		
4							1.0		
5							1.0		
6							1.0		
7							1.0		
8							1.0		
9							1.0		
10							1.0		
11							1.0		
12							1.0		
13							1.0		
14							1.0		
15							1.0		

P= primary analysis R=reanalysis REXT=rextraction/reanalysis D=dilution

SVLOG.FRM
FOR MTOOL
10/10/91 WR

PAGE: _____

75% Full size.

Figure C.22. Quality Control forms for matrix spike recovery and precision.

SPIKE RECOVERY FORM-ASI

PARAMETER_____ MATRIX: __ AQUEOUS __ SOIL/SEDIMENT __ OTHER

	BATCH #	SAMPLE ID/DATE	LC1	LC2	TRUE VALUE	%REC1	%REC2	AVG. REC	RPD
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									

CONTROL LIMITS: RECOVERY_____ RPD_____

COMMENTS: _____

PAGE _____

75% full size.

Figure C.23. Pesticide lab control sample reporting form.

ASI PESTICIDE LAB CONTROL SAMPLES
AQUEOUS MATRIX

COMPOUND	%REC	%RPD
g-BHC	32-127	0-40
Heptachlor	34-111	0-40
Aldrin	42-122	0-40
Dieldrin	36-146	0-40
Endrin	30-147	0-40
p,p-DDT	25-160	0-40

COMPOUND	rec1	rec2	avg	%rpd	notes
g-BHC					
Heptachlor					
Aldrin					
Dieldrin					
Endrin					
p,p'-DDT					

file(lcs):_____

file(lcs dup):_____

date:_____

analyst:_____

75% full size.

Figure C.24. GC Surrogate Spike Recovery Form

ASI SURROGATE SPIKE RECOVERY
AQUEOUS SAMPLES

		recovery limits
S1	Dibutylchlorendate	10-150
S2	Tetrachloro-m-xylene	50-150
S3	Decachlorobiphenyl	50-150

SAMPLE	FILE	S1	S2	S3	NOTES

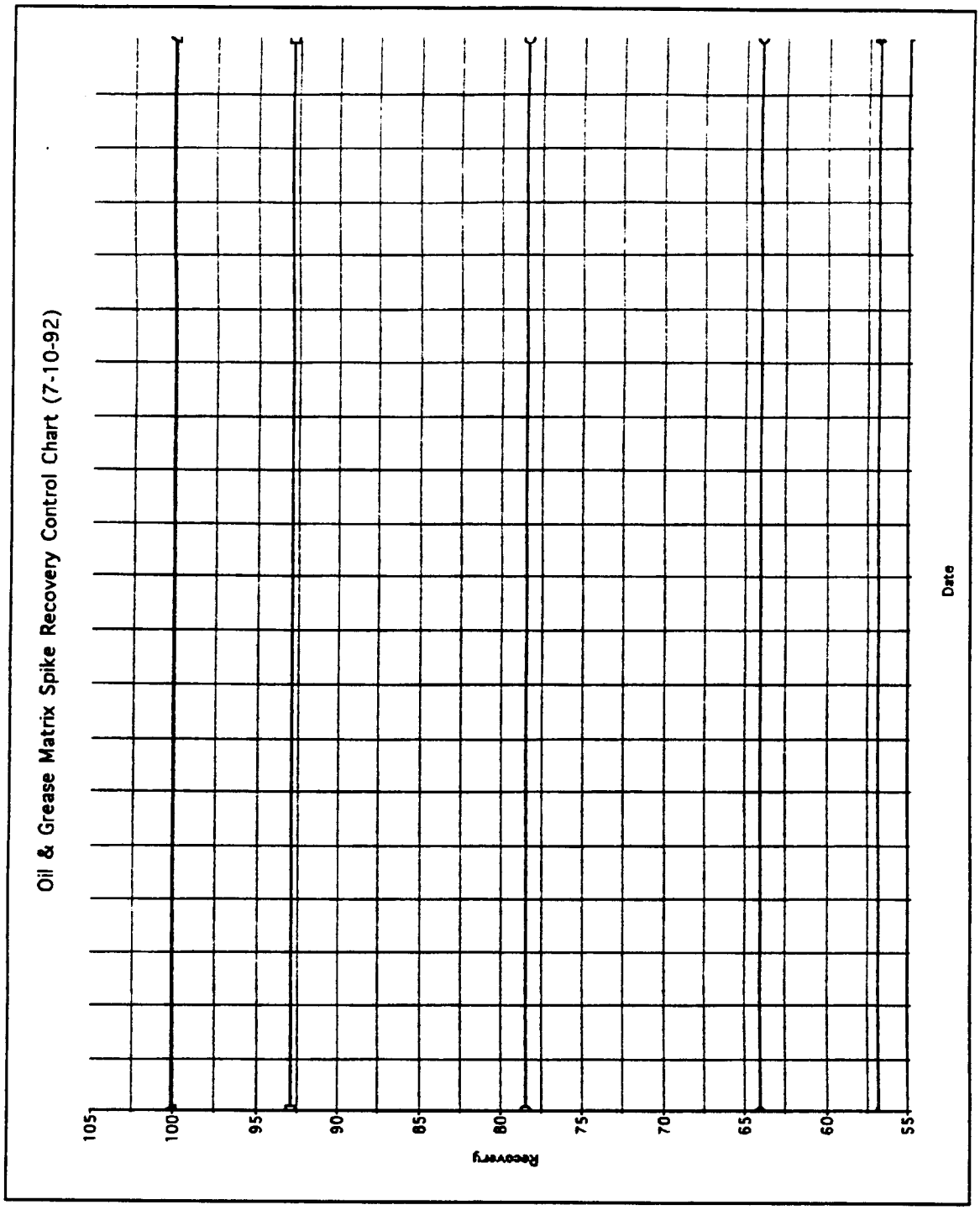
QE BATCH NUMBER: _____

ANALYST: _____ DATE: _____

PAGE 3 of 3

75% full size

Figure C.25. Control Chart example for Oil & Grease Recovery



75% full size

Table D.1. Sample Preservation, Holding Times, Containers and Volumes for water samples for testing of 129 Priority Pollutants under Georgia EPD Appendix IX Monitoring.

Parameter	* Container	Sample volume mL	Preservation	Max. Holding Time
Cyanide (all)	P, G	500	Cool, 4°C, NaOH to pH>12, 0.6g ascorbic acid	14 days
Metals				
Chromium, Hexavalent	P, G	200	Cool 4°C	24 hours
Mercury	P, G	100	HNO_3 to pH<2	28 days
All other metals	P, G	100	HNO_3 to pH<2	3 months
Organics				
Volatile Halocarbons	G, Teflon-lined septum	3 x 40	Cool 4°C, 0.008% $Na_2S_2O_3$	7 days
Volatile Aromatic Hydrocarbons	G, Teflon-lined septum	3 x 40	Cool 4°C, 0.008% $Na_2S_2O_3$ HCl to pH 2	7 days
Acrolein and Acrylonitrile	G, Teflon-lined septum	3 x 40	Cool 4°C, 0.008% $Na_2S_2O_3$ Adjust pH to 4-5	14 days
Phenols	G, Teflon-lined cap	1000	Cool 4°C, 0.008% $Na_2S_2O_3$	5 days until extraction, 30 days after extraction
Benzidines	G, Teflon-lined cap	1000	Cool 4°C, 0.008% $Na_2S_2O_3$	5 days until extraction, 30 days after extraction
Phthalate Esters	G, Teflon-lined cap	1000	Cool 4°C	5 days until extraction, 30 days after extraction
Nitrosamines	G, Teflon-lined cap	1000	Cool 4°C, 0.008% $Na_2S_2O_3$ store in dark	5 days until extraction, 30 days after extraction
PCB's	G, Teflon-lined cap	1000	Cool 4°C	5 days until extraction, 30 days after extraction
Nitroaromatics and Isophorone	G, Teflon-lined cap	1000	Cool 4°C, 0.008% $Na_2S_2O_3$ store in dark	5 days until extraction, 30 days after extraction
Polynuclear Aromatic Hydrocarbons	G, Teflon-lined cap	1000	Cool 4°C, 0.008% $Na_2S_2O_3$ store in dark	5 days until extraction, 30 days after extraction
Haloethers	G, Teflon-lined cap	1000	Cool 4°C, 0.008% $Na_2S_2O_3$	5 days until extraction, 30 days after extraction
Chlorinated Hydrocarbons	G, Teflon-lined cap	1000	Cool 4°C	5 days until extraction, 30 days after extraction
Total Organic Halogens	G, Teflon-lined cap	1000	Cool, 4°C, H_2SO_4 to pH<2	7 days
Pesticides	G, Teflon-lined cap	1000	Cool 4°C, pH 5-9	5 days until extraction, 14 days after extraction
Herbicides	G, Teflon-lined cap	1000	Cool 4°C, pH 5-9	5 days until extraction, 30 days after extraction

* Polyethylene (P) or Glass (G)

Table D.2. QA Objectives for the Analysis of 129 Priority Pollutants in Ground, Surface and Waste Water Samples (Georgia EPD Appendix IX Monitoring).

Component / Parameter	Analytical Methods EPA	SM[1]	EPA	Precision %RSD	Accuracy % Recovery	MDL ug/L
Cyanide, Total	335.2	412-B	9010	0-20	75-125	20
Metals						
Antimony	200.7		6010	0-20	75-125	50
Arsenic	206.2		7060	0-20	75-125	30
Beryllium	200.7		6010	0-20	75-125	10
Cadmium	200.7		6010	0-20	75-125	10
Chromium, Total	200.7		6010	0-20	75-125	10
Chromium, Hexavalent		312-B	7196	0-20	75-125	10
Copper	200.7		6010	0-20	75-125	20
Lead	200.7		6010	0-20	75-125	25
Mercury	245.1		7470	0-20	75-125	0.5
Nickel	200.7		6010	0-20	75-125	20
Selenium	270.2		7741	0-20	75-125	40
Silver	200.7		6010	0-20	75-125	10
Thallium	200.7		6010	0-20	75-125	50
Zinc	200.7		6010	0-20	75-125	20
Herbicides						
2,4-D	8150			0-30	40-140	1.2
2,4,5-TP	8150			0-50	40-140	0.17
Pesticides\PCB's						
4,4'-DDD	8080			0-40	31-141	0.2
4,4'-DDE	8080			0-40	30-145	0.2
4,4'-DDT	8080			0-40	25-160	0.2
α-BHC	8080			0-40	37-134	0.1
Aldrin	8080			0-40	42-122	0.1
Aroclor 1016	8080			0-40	50-114	0.5
Aroclor 1221	8080			0-40	15-178	0.5
Aroclor 1232	8080			0-40	10-215	0.5
Aroclor 1242	8080			0-40	39-150	0.5
Aroclor 1248	8080			0-40	38-158	0.5
Aroclor 1254	8080			0-40	29-131	0.5
Aroclor 1260	8080			0-40	8-127	0.5
β-BHC	8080			0-40	17-147	0.1
Chlordane	8080			0-40	45-119	0.1
δ-BHC	8080			0-40	19-140	0.1
Dieldrin	8080			0-40	36-146	0.1
Endosulfan I	8080			0-40	45-153	0.1
Endosulfan II	8080			0-40	D-202	0.1
Endosulfan Sulfate	8080			0-40	26-144	0.1
Endrin	8080			0-40	30-147	0.1
Endrin aldehyde	8080			0-40	10-150	0.2
γ-BHC (Lindane)	8080			0-40	32-127	0.1
Heptachlor	8080			0-40	34-111	0.1
Heptachlor epoxide	8080			0-40	37-142	0.1
Methoxychlor	8080			0-40	82-116	0.2
Toxaphene	8080			0-40	41-126	0.24

[1] Standard Methods, 16th Edition

Table D.2 (continued). QA Objectives for the Analysis of 129 Priority Pollutants in Ground, Surface and Waste Water Samples (Georgia EPD Appendix IX Monitoring).

Component / Parameter	Analytical Methods EPA	SM[1]	EPA	Precision %RSD	Accuracy % Recovery	MDL ug/L
Phenols						
2-Chlorophenol	8270			0-40	27-123	10
2-Methyl-4,6-dinitrophenol	8270			0-93	10-181	50
2-Nitrophenol	8270			0-40	29-182	50
4-Chloro-3-methylphenol	8270			0-42	23-97	10
4-Nitrophenol	8270			0-50	10-80	50
2,4-Dichlorophenol	8270			0-40	39-135	10
2,4-Dimethylphenol	8270			0-40	32-119	10
2,4-Dinitrophenol	8270			0-50	10-191	50
2,4,6-Trichlorophenol	8270			0-40	37-144	10
Pentachlorophenol	8270			0-50	9-103	20
Phenol	8270			0-42	12-89	10
Phthalates						
bis(2-Ethylhexyl)phthalate	8270			0-40	10-158	10
Butyl benzyl phthalate	8270			0-40	10-152	10
Diethylphthalate	8270			0-40	10-114	10
Dimethylphthalate	8270			0-40	10-112	10
Di-n-butylphthalate	8270			0-50	10-118	10
Di-n-octylphthalate	8270			0-50	10-146	10
Semi-volatile Organics						
2-Chloronaphthalene	8270			0-40	60-118	10
3,3'-Dichlorobenzidine	8270			0-100	10-262	10
4-Bromophenylphenyl ether	8270			0-40	53-127	10
4-Chlorophenylphenyl ether	8270			0-33	25-158	10
1,2-Dichlorobenzene	8270			0-40	32-129	10
1,2-Diphenylhydrazine	8270			0-50	10-150	10
1,3-Dichlorobenzene	8270			0-40	10-172	10
1,4-Dichlorobenzene	8270			0-28	36-97	10
2,4-Dinitrotoluene	8270			0-38	24-96	20
2,6-Dinitrotoluene	8270			0-40	50-158	20
1,2,4-Trichlorobenzene	8270			0-28	44-142	10
Acenaphthene	8270			0-31	46-118	10
Acenaphthylene	8270			0-40	33-145	10
Anthracene	8270			0-40	27-133	10
Benzidine	8270			0-100	10-200	80
Benzo(a)anthracene	8270			0-40	33-143	10
Benzo(a)pyrene	8270			0-40	17-163	10
Benzo(b)fluoranthene	8270			0-40	24-159	10
Benzo(ghi)perylene	8270			0-56	10-219	10
Benzo(k)fluoranthene	8270			0-42	11-162	10
bis(2-Chloroethoxy)methane	8270			0-43	33-184	10
bis(2-Chloroethyl)ether	8270			0-50	10-150	10
bis(2-Chloroisopropyl)ether	8270			0-46	36-166	10
Chrysene	8270			0-48	17-168	10
Dibenzo(a,h)anthracene	8270			0-70	10-227	10
Fluoranthene	8270			0-40	26-137	10
Fluorene	8270			0-40	59-121	10

[1] Standard Methods, 16th Edition

Table D.2 (continued). QA Objectives for the Analysis of 129 Priority Pollutants in Ground, Surface and Waste Water Samples (Georgia EPD Appendix IX Monitoring).

Component / Parameter	Analytical Methods EPA	SM[1]	EPA	Precision %RSD	Accuracy % Recovery	MDL ug/L
Hexachlorobenzene	8270			0-40	10-152	10
Hexachlorobutadiene	8270			0-40	24-116	10
Hexachlorocyclopentadiene	8270			0-50	10-150	10
Hexachloroethane	8270			0-40	40-113	10
Indeno(1,2,3-cd)pyrene	8270			0-45	10-171	10
Isophorone	8270			0-60	21-196	10
N-Nitrosodi-n-propylamine	8270			0-38	41-116	10
N-Nitrosodimethylamine	8270			0-50	10-150	10
N-Nitrosodiphenylamine	8270			0-50	10-150	10
Naphthalene	8270			0-40	21-133	10
Nitrobenzene	8270			0-40	35-180	10
Phenanthrene	8270			0-40	54-120	10
Pyrene	8270			0-31	26-127	10
1,2-Diphenylhydrazine	8270			0-50	40-160	10
Volatile Organics						
2-Chloroethylvinyl ether	624		8260	0-94	10-199	10
1,1-Dichloroethane	624		8260	0-43	10-169	2
1,1-Dichloroethene	624		8260	0-14	61-145	2
1,2-Dichloroethane	624		8260	0-40	56-146	2
1,2-Dichloropropane	624		8260	0-55	10-162	2
cis-1,3-Dichloropropene	624		8260	0-62	10-162	2
trans-1,3-Dichloropropene	624		8260	0-45	26-160	2
1,1,1-Trichloroethane	624		8260	0-40	55-150	1
1,1,2-Trichloroethane	624		8260	0-40	53-152	1
1,1,2,2-Tetrachloroethane	624		8260	0-40	54-142	2
Acrolein			8260	0-40	60-140	25
Acrylonitrile			8260	0-40	60-145	3
Benzene	624		8260	0-11	76-127	2
Bromodichloromethane	624		8260	0-40	35-155	10
Bromoform	624		8260	0-40	46-169	10
Bromomethane	624		8260	0-65	10-170	10
Carbon tetrachloride	624		8260	0-40	71-140	2
Chlorobenzene	624		8260	0-13	75-130	2
Chloroethane	624		8260	0-80	10-160	2
Chloroform	624		8260	0-40	60-140	2
Chloromethane	624		8260	0-60	10-140	2
Dibromochloromethane	624		8260	0-40	56-142	2
Dichloromethane	624		8260	0-40	41-177	2
Ethylbenzene	624		8260	0-40	38-152	2
Tetrachloroethene	624		8260	0-40	70-140	2
Toluene	624		8260	0-13	76-125	2
trans-1,2-Dichloroethene	624		8260	0-40	56-146	2
Trichloroethene	624		8260	0-14	71-120	1
Vinyl chloride	624		8260	0-87	10-181	2

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CHEMICAL WASTES

Sampling Liquid Hazardous Wastes (Drums)

Sampling from drums is very hazardous and ASI performs this duty with extreme reluctance. Necessary equipment in addition to the basic equipment above will include heavy chemical resistant gloves, Tyvek® suits, Coliwasa tubes, OVA (rented from a sampling equipment supplier as needed), spark-proof drum bung wrench, safety glasses, *etc.*

1. Prior to departure from ASI review the sampling requirements, calibrate field instruments and prepare necessary sampling equipment and containers, special safety equipment and other supplies.
2. On arrival at the sampling area, locate the specific drum(s) to be sampled. Wearing protective equipment, document the drum(s) location, list the label contents in the logbook and obtain pictures of location and label. Scan the drum(s) with the OVA. If positive retreat to a safe distance and contact client about hazards and further instructions. If OVA negative, record in the logbook a physical description of the drum(s) and an estimate of the volume.
3. Insure the safety of the field operators. Prepare Coliwasa tubes and obtain equipment blank QC samples. Open the drum and insert the Coliwasa tube. Withdraw a sample and note in logbook if stratified. Obtain QC and analytical samples in the order listed in Table 6.3. For VOC samples, fill the 40 mL VOC vial to almost overflowing, then cap with the septum cap. Check for the presence of headspace by inverting the vial and looking for bubbles. If bubbles are present, another sample is prepared. Prepare VOC samples in triplicate, label them, then place them together in a plastic bag. Seal the plastic bag with tape, tag it and store the samples in an ice-chest with ice. Initiate the chain-of-custody forms for the samples in addition to making appropriate notes in the field logbook. Prepare the rest of the samples by filling the containers to just under full with sample. Do not add any preservatives. Prepare a label for each sample and attach it to the container. Seal the lid to the container with a custody seal, then place the sample in a plastic bag which is sealed with tape and tagged. The bagged sample is cooled on ice in an ice-chest for transport to the laboratory.
4. Replace the bung on the drum. Record the QC and analytical samples obtained in the logbook, then check the list against the requested parameters. Record the initiation of chain-of-custody forms.
5. Store the samples and equipment in the vehicle and restore the site to its normal condition.

Table E.1. QA Objectives for the Analysis of Chemical Waste Samples.

Component / Parameter	Analytical Methods EPA	SM[1]	EPA	Precision %RSD	Accuracy % Recovery	MDL ug/Kg
Acidity	305.1			0-30	75-125	1000
Alkalinity	310.1			0-30	75-125	1000
Ammonia	350.2	417-C		0-30	75-125	100
		417-D		0-30	75-125	100
Ash	160.4			0-20	80-110	1000
Bicarbonate	310.1	403		0-30	75-125	500
BOD 5-day	405.1			0-30	75-125	5000
COD	410.1			0-30	75-125	5000
Chloride	325.2		9252	0-30	75-125	1000
	325.3	407-B	9252	0-30	75-125	1000
Conductivity	120.1	205	9050	0-30	75-125	1.0 µmhos/cm
Corrosivity (NACE Standard)	1110			0-30	75-125	0.01 mm/yr
Cyanide, Total	335.2	412-B	9010	0-20	75-125	20
Cyanide, amenable to chlorination	335.1		9010	0-30	75-125	20
Flashpoint (P-M)	1010			0-30	75-125	0°C
Flashpoint (Closed Cup)	1020			0-30	75-125	0°C
Hydrogen sulfide	376.1	427	9030	0-40	60-140	1000
Nitrate	352.1		9200	0-30	75-125	100
Paint Filter Test	9095			0-30	75-125	100000
Oil & Grease (Total)	413.1	503-A	9070	0-40	60-140	5000
Oil & Grease (Sludge)	413.2	503-B	9071	0-40	60-140	1000
pH	150.1	423	9040	0-20	80-120	N/A
Phenols, Total	420.1	510-C	9065	0-25	78-126	10
Solids, Total	1311			0-40	60-140	5000
Sulfate	375.2	426	9038	0-30	75-125	100
	375.4			0-30	75-125	1000
Sulfide, Total	376.2		9030	0-40	60-140	100
Metals						
Aluminum	200.7		6010	0-20	75-125	25
	202.2		7021	0-20	75-125	10
Antimony	200.7		6010	0-20	75-125	50
	204.2		7041	0-20	75-125	3
Arsenic	206.2		7060	0-20	75-125	10
	206.3		7061	0-20	60-140	2
Barium	200.7		6010	0-20	75-125	1
	208.2		7081	0-20	75-125	2
Beryllium	200.7		6010	0-20	75-125	1
	210.2		7091	0-20	75-125	0.2
Boron	200.7		6010	0-20	75-125	50
		3120B[2]		0-20	75-125	20
Cadmium	200.7		6010	0-20	75-125	2
	213.2		7131	0-20	75-125	0.1
Calcium	200.7		6010	0-20	75-125	20
Chromium, Total	200.7		6010	0-20	75-125	5
	218.2		7191	0-20	75-125	1
Chromium, Hexavalent		312-B	7196	0-20	75-125	20

[1] Standard Methods, 16th Edition
[2] Standard Methods, 17th Edition

Table E.1 (continued). QA Objectives for the Analysis of Chemical Waste Samples.

Component / Parameter	Analytical Methods EPA	SM[1]	EPA	Precision %RSD	Accuracy % Recovery	MDL ug/Kg
Cobalt	200.7		6010	0-20	75-125	3
	219.2		7201	0-20	75-125	1
Copper	200.7		6010	0-20	75-125	2
	220.2		7211	0-20	75-125	1
Gold	231.1			0-20	75-125	100
	231.2			0-20	75-125	1
Iron	200.7		6010	0-20	75-125	5
	236.2		7381	0-20	75-125	1
Lead	200.7		6010	0-20	75-125	25
	239.2		7421	0-20	75-125	5
Magnesium	200.7		6010	0-20	75-125	15
Manganese	200.7		6010	0-20	75-125	1
	243.2		7461	0-20	75-125	0.2
Mercury	245.1		7470	0-20	75-125	0.5
Molybdenum	200.7		6010	0-20	75-125	5
	246.2		7481	0-20	75-125	1
Nickel	200.7		6010	0-20	75-125	10
	249.2		7521	0-20	75-125	1
Osmium	252.1			0-20	75-125	300
	252.2			0-20	75-125	20
Potassium	200.7		6010	0-20	75-125	200
Selenium	270.2		7741	0-20	75-125	5
Silver	200.7		6010	0-20	75-125	3
	272.2		7761	0-20	75-125	0.2
Sodium	200.7		6010	0-20	75-125	10
Thallium	200.7		6010	0-20	75-125	100
	279.2		7841	0-20	75-125	10
Tin	282.1		7870	0-20	75-125	800
	282.2		7871	0-20	75-125	5
Titanium	283.1			0-20	75-125	400
	283.2			0-20	75-125	10
Vanadium	200.7		6010	0-20	75-125	2
	286.2		7911	0-20	75-125	4
Zinc	200.7		6010	0-20	75-125	4
	289.2		7951	0-20	75-125	0.05
Organic Internal Standards						
Acenaphthene -d10	8270			0-40	NA	NA
Chrysene-d12	8270			0-40	NA	NA
Perylene-d12	8270			0-40	NA	NA
Phenanthrene-d10	8270			0-40	NA	NA
1-Bromo-4-fluorobenzene	8260			0-40	NA	NA
1,2-Dichlorobenzene-d4	8260			0-40	NA	NA
Fluorobenzene	8260			0-40	NA	NA
Organic Surrogates						
2-Fluorophenol	8270			0-40	21-100	NA
Phenol-d6	8270			0-40	10-94	NA
2,4,6-Tribromophenol	8270			0-40	10-123	NA
2-Fluorobiphenyl	8270			0-40	43-116	NA
Nitrobenzene-d5	8270			0-40	35-114	NA

[1] Standard Methods, 16th Edition

Table E.1 (continued). QA Objectives for the Analysis of Chemical Waste Samples.

Component / Parameter	Analytical Methods EPA	SM[1]	EPA	Precision %RSD	Accuracy % Recovery	MDL ug/Kg
Terphenyl-d14	8270			0-40	33-141	NA
Bromofluorobenzene	8260			0-40	86-115	NA
1,2-Dichloroethane-d4	8260			0-40	76-114	NA
Toluene-d8	8260			0-40	88-110	NA
Decachlorobiphenyl	8080			0-40	10-150	NA
2,4,5,6-Tetrachloro-m-xylene	8270			0-40	60-150	NA
Bromochloromethane	8260			0-30	50-150	NA
2-Bromo-1-chloropropane	8260			0-40	50-150	NA
1,4-Dichlorobutane	8260			0-40	50-150	NA
Dibutychlorendate	8080			0-40	24-154	NA
Herbicides						
2,4-D	8150			0-40	40-140	1.2
2,4-DB	8150			0-40	40-140	0.91
2,4,5-T	8150			0-40	40-140	0.20
2,4,5-TP	8150			0-40	40-140	0.17
Dalapon	8150			0-80	10-160	5.8
Dicamba	8150			0-80	10-150	0.27
Dichloroprop	8150			0-80	10-150	0.65
Dinoseb	8150			0-80	10-150	0.07
MCPA	8150			0-80	10-150	249
MCPP	8150			0-80	10-150	192
Pesticides\PCB's						
4,4'-DDD	8080			0-40	31-141	0.011
4,4'-DDE	8080			0-40	30-145	0.004
4,4'-DDT	8080			0-40	25-160	0.012
α-BHC	8080			0-40	37-134	0.003
Aldrin	8080			0-40	42-122	0.004
Aroclor 1016	8080			0-40	50-114	0.5
Aroclor 1221	8080			0-40	15-178	0.5
Aroclor 1232	8080			0-40	10-215	0.5
Aroclor 1242	8080			0-40	39-150	0.065
Aroclor 1248	8080			0-40	38-158	0.5
Aroclor 1254	8080			0-40	29-131	0.5
Aroclor 1260	8080			0-40	8-127	0.5
β-BHC	8080			0-40	17-147	0.006
Chlordane	8080			0-40	45-119	0.014
δ-BHC	8080			0-40	19-140	0.009
Dieldrin	8080			0-40	36-146	0.002
Endosulfan	8080			0-50	D-202	0.07
Endosulfan I	8080			0-40	45-153	0.014
Endosulfan II	8080			0-40	D-202	0.004
Endosulfan Sulfate	8080			0-40	26-144	0.066
Endrin	8080			0-40	30-147	0.006
Endrin aldehyde	8080			0-40	10-150	0.023
Endrin ketone	8080			0-50	10-150	0.03
γ-BHC (Lindane)	8080			0-40	32-127	0.004
Heptachlor	8080			0-40	34-111	0.003
Heptachlor epoxide	8080			0-40	37-142	0.083
Isodrin	8080			0-50	10-150	0.02

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Table E.1 (continued). QA Objectives for the Analysis of Chemical Waste Samples.

Component / Parameter	Analytical Methods EPA	SM[1]	EPA	Precision %RSD	Accuracy % Recovery	MDL ug/Kg
Kepone	8080			0-50	10-150	0.05
Methoxychlor	8080			0-40	50-140	0.176
Toxaphene	8080			0-40	41-126	0.24
Phenols						
2-Chlorophenol	8270			0-40	27-123	10
2-Methyl-4,6-dinitrophenol	8270			0-93	10-181	50
2-Methylphenol	8270			0-50	10-150	10
2-Nitrophenol	8270			0-40	29-182	50
3-Methylphenol	8270			0-50	10-150	10
4-Chloro-3-methylphenol	8270			0-42	23-97	10
4-Methylphenol	8270			0-50	10-150	10
4-Nitrophenol	8270			0-50	10-80	50
2,4-Dichlorophenol	8270			0-40	39-135	10
2,4-Dimethylphenol	8270			0-40	32-119	10
2,4-Dinitrophenol	8270			0-50	10-191	50
2,6-Dichlorophenol	8270			0-50	10-150	10
2,4,5-Trichlorophenol	8270			0-50	10-150	10
2,4,6-Trichlorophenol	8270			0-40	37-144	10
2,3,4,6-Tetrachlorophenol	8270			0-50	10-150	10
Hexachlorophene	8270			0-50	10-150	100
Pentachlorophenol	8270			0-50	9-103	50
Phenol	8270			0-42	12-89	10
Phthalates						
bis(2-Ethylhexyl)phthalate	8270			0-40	10-158	10
Butyl benzyl phthalate	8270			0-40	10-152	10
Diethylphthalate	8270			0-40	10-114	10
Dimethylphthalate	8270			0-40	10-112	10
Di-n-butylphthalate	8270			0-50	10-118	10
Di-n-octylphthalate	8270			0-50	10-146	10
Semi-volatile Organics						
1-Naphthylamine	8270			0-50	10-150	10
2-Acetylaminofluorene	8270			0-50	25-150	10
2-Chloronaphthalene	8270			0-40	60-118	10
2-Methylnaphthalene	8270			0-50	10-150	10
2-Naphthylamine	8270			0-50	10-150	10
2-Nitroaniline	8270			0-50	10-150	50
3-Methylcholanthene	8270			0-50	10-150	10
3-Nitroaniline	8270			0-50	10-150	50
3,3'-Dichlorobenzidine	8270			0-100	10-262	10
3,3'-Dimethylbenzidine	8270			0-100	10-200	10
4-Aminobiphenyl	8270			0-50	10-150	10
4-Bromophenylphenyl ether	8270			0-40	53-127	10
4-Chloroaniline	8270			0-50	10-150	10
4-Chlorophenylphenyl ether	8270			0-33	25-158	10
4-Nitroaniline	8270			0-50	10-150	50
4-Nitroquinoline-1-oxide	8270			0-50	10-150	10
5-Nitro-o-toluidine	8270			0-50	10-150	10
1,2-Dichlorobenzene	8270			0-40	32-129	10

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Table E.1 (continued). QA Objectives for the Analysis of Chemical Waste Samples.

Component / Parameter	Analytical Methods EPA	SM[1]	EPA	Precision %RSD	Accuracy % Recovery	MDL ug/Kg
1,2-Diphenylhydrazine	8270			0-50	10-150	10
1,3-Dichlorobenzene	8270			0-40	10-172	10
1,3-Dinitrobenzene	8270			0-50	10-150	10
1,4-Dichlorobenzene	8270			0-28	36-97	10
1,4-Naphthoquinone	8270			0-50	10-150	10
2,4-Dinitrotoluene	8270			0-38	24-96	20
2,6-Dinitrotoluene	8270			0-40	50-158	20
1,2,4-Trichlorobenzene	8270			0-28	44-142	10
7,12-Dimethylbenzo(a)anthracene	8270			0-50	10-150	10
1,2,4,5-Tetrachlorobenzene	8270			0-50	10-150	10
Acenaphthene	8270			0-31	46-118	10
Acenaphthylene	8270			0-40	33-145	10
Acetophenone	8270			0-50	10-150	20
Aniline	8270			0-50	10-150	10
Anthracene	8270			0-40	27-133	10
Azobenzene	8270			0-50	10-150	10
Benzidine	8270			0-100	10-200	80
Benzo(a)anthracene	8270			0-40	33-143	10
Benzo(a)pyrene	8270			0-40	17-163	10
Benzo(b)fluoranthene	8270			0-40	24-159	10
Benzoic acid	8270			0-50	10-150	50
Benzo(ghi)perylene	8270			0-56	10-219	10
Benzo(k)fluoranthene	8270			0-42	11-162	10
Benzyl alcohol	8270			0-50	10-150	10
bis(2-Chloroethoxy)methane	8270			0-43	33-184	10
bis(2-Chloroethyl)ether	8270			0-50	10-150	10
bis(2-Chloroisopropyl)ether	8270			0-46	36-166	10
Chlorobenzilate	8270			0-50	10-150	50
Chrysene	8270			0-48	17-168	10
Diallate	8270			0-50	10-150	20
Dibenzo(a,h)anthracene	8270			0-70	10-227	10
Dibenzofuran	8270			0-50	10-150	10
Dimethylphenethylamine	8270			0-50	10-150	30
Diphenyl amine	8270			0-50	10-150	10
Ethyl methanesulfonate	8270			0-50	10-150	20
Fluoranthene	8270			0-40	26-137	10
Fluorene	8270			0-40	59-121	10
Hexachlorobenzene	8270			0-40	10-152	10
Hexachlorobutadiene	8270			0-40	24-116	10
Hexachlorocyclopentadiene	8270			0-50	10-150	20
Hexachloroethane	8270			0-40	40-113	10
Hexachloropropene	8270			0-50	10-150	30
Indeno(1,2,3-cd)pyrene	8270			0-45	10-171	10
Isophorone	8270			0-60	21-196	10
Isosafrole	8270			0-50	10-150	10
Methapyrilene	8270			0-50	10-150	10
Methyl methanesulfonate	8270			0-50	10-150	20
N-Nitrosodi-n-butylamine	8270			0-50	10-150	10
N-Nitrosodi-n-propylamine	8270			0-38	41-116	10
N-Nitrosodiethylamine	8270			0-50	10-150	10
N-Nitrosodimethylamine	8270			0-50	10-150	10

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Table E.1 (continued). QA Objectives for the Analysis of Chemical Waste Samples.

Component / Parameter	Analytical Methods EPA	SM[1]	EPA	Precision %RSD	Accuracy % Recovery	MDL ug/Kg
N-Nitrosodiphenylamine	8270			0-50	10-150	10
N-Nitrosomethylethylamine	8270			0-50	10-150	20
N-Nitrosomorpholine	8270			0-50	10-150	10
N-Nitrosopiperidine	8270			0-50	10-150	20
N-Nitrosopyrrolidine	8270			0-50	10-150	20
Naphthalene	8270			0-40	21-133	10
Nitrobenzene	8270			0-40	35-180	10
o-Toluidine	8270			0-50	10-150	20
p-Benzoquinone	8270			0-50	10-150	10
p-Dimethylaminoazobenzene	8270			0-50	10-150	10
Pentachlorobenzene	8270			0-50	10-150	10
Pentachloronitrobenzene	8270			0-50	10-150	10
Phenacetin	8270			0-50	10-150	100
Phenanthrene	8270			0-40	54-120	10
Phenylenediamine	8270			0-50	10-150	10
Pronamide	8270			0-50	10-150	10
Pyrene	8270			0-31	26-127	10
Safrole	8270			0-50	10-150	50
Volatile Organics						
2-Chloro-1,3-butadiene			8260	0-50	10-150	10
2-Chloroethylvinyl ether	624		8260	0-94	10-199	10
2-Hexanone			8260	0-40	49-151	2
2-Nitropropane			8260	0-50	10-150	100
2-Picoline			8260	0-50	10-150	10
3-Chloropropene			8260	0-50	10-140	10
4-Methyl-2-pentanone			8260	0-40	46-152	2
1,1-Dichloroethane	624		8260	0-43	10-169	2
1,1-Dichloroethene	624		8260	0-14	61-145	2
1,1-Dichloropropene			8260	0-50	10-150	10
1,2-Dibromo-3-chloropropane			8260	0-40	55-140	10
1,2-Dibromoethane			8260	0-65	10-170	5
1,2-Dichloroethane	624		8260	0-40	56-146	2
1,2-Dichloropropane	624		8260	0-55	10-162	2
1,3-Dichloropropane			8260	0-55	10-162	2
cis-1,3-Dichloropropene	624		8260	0-62	10-162	2
trans-1,3-Dichloropropene	624		8260	0-45	26-160	2
1,4-Dichloro-2-butene			8260	0-40	50-150	5
1,4-Dioxane			8260	0-50	10-150	100
2,2-Dichloropropane			8260	0-50	10-150	10
1,1,1-Trichloroethane	624		8260	0-40	55-150	1
1,1,2-Trichloroethane	624		8260	0-40	53-152	1
1,2,3-Trichloropropane			8260	0-40	60-140	3
1,1,1,2-Tetrachloroethane			8260	0-40	60-140	10
1,1,2,2-Tetrachloroethane	624		8260	0-40	54-142	2
Acetone			8260	0-40	47-143	25
Acetonitrile			8260	0-65	10-170	50
Acrolein			8260	0-40	60-140	25
Acrylonitrile			8260	0-40	60-145	3
Benzene	624		8260	0-11	76-127	2
Bromodichloromethane	624		8260	0-40	35-155	10

[1] Standard Methods, 16th Edition

Table E.1 (continued). QA Objectives for the Analysis of Chemical Waste Samples.

Component / Parameter	Analytical Methods EPA	SM[1]	EPA	Precision %RSD	Accuracy % Recovery	MDL ug/Kg
Bromoform	624		8260	0-40	46-169	10
Bromomethane	624		8260	0-65	10-170	10
Carbon disulfide			8260	0-40	53-148	10
Carbon tetrachloride	624		8260	0-40	71-140	2
Chlorobenzene	624		8260	0-13	75-130	2
Chloroethane	624		8260	0-80	10-160	2
Chloroform	624		8260	0-40	60-140	2
Chloromethane	624		8260	0-60	10-140	2
cis-1,2-Dichloroethene			8260	0-40	56-146	2
Dibromochloromethane	624		8260	0-40	56-142	2
Dibromomethane			8260	0-40	50-150	1
Dichlorodifluoromethane			8260	0-40	65-140	3
Dichloromethane	624		8260	0-40	41-177	2
Diethyl ether			8260	0-50	10-150	1000
Ethanol			8260	0-40	40-160	1000
Ethylbenzene	624		8260	0-40	38-152	2
Ethyl methacrylate			8260	0-40	45-140	1
Ethylene glycol monoethylether			8260	0-50	10-150	1000
Iodomethane			8260	0-40	35-150	2
Isobutyl alcohol			8260	0-60	10-170	1000
Isopropylbenzene			8260	0-50	10-150	10
Methacrylonitrile			8260	0-60	10-170	50
Methyl ethyl ketone			8260	0-40	46-153	10
Methyl isobutyl ketone			8260	0-40	46-152	2
Methyl methacrylate			8260	0-60	10-170	10
Pentachloroethane			8260	0-40	55-140	10
Propionitrile			8260	0-50	10-110	50
Pyridine			8260	0-50	10-150	10
Styrene			8260	0-42	34-176	2
Tetrachloroethene	624		8260	0-40	70-140	2
Toluene	624		8260	0-13	76-125	2
trans-1,2-Dichloroethene	624		8260	0-40	56-146	2
Trichloroethene	624		8260	0-14	71-120	1
Trichlorofluoromethane	624		8260	0-48	20-160	3
Vinyl acetate			8260	0-50	39-151	1
Vinyl chloride	624		8260	0-87	10-181	2
Xylene (o + m)			8260	0-40	50-150	3
Xylene (p)			8260	0-40	50-150	2

[1] Standard Methods, 16th Edition

Table E.2. Sample Preservation, Holding Times, Containers and Volumes for chemical waste samples.

Parameter	* Container	Sample volume mL	Preservation	Max. Holding Time
Bacterial Tests				
Coliform, Fecal and Total	Sterile P	250	Cool 4°C	30 hours from time of collection
Fecal streptococci	Sterile P	250	Cool 4°C	30 hours from time of collection
Inorganic Tests				
Acidity	P, G	100	Cool, 4°C	14 days
Alkalinity	P, G	100	Cool, 4°C	14 days
Ammonia	P, G	400	Cool, 4°C	28 days
BOD (5 day and ultimate)	P, G	1000	Cool, 4°C	48 hours
COD	P, G	50	Cool, 4°C	28 days
Chloride	P, G	50	None	28 days
Cyanide (all)	P, G	500	Cool, 4°C	14 days
Flashpoint	P, G	100	Cool, 4°C	14 days
Nitrogen (Kjeldahl & organic)	P, G	500	Cool, 4°C	28 days
Nitrate	P, G	100	Cool 4°C	48 hours
Nitrate-nitrite	P, G	100	Cool, 4°C	28 days
Nitrite	P, G	50	Cool 4°C	48 hours
Oil & Grease	G	1000	Cool, 4°C	28 days
Organic Carbon, Total	P, G	25	Cool, 4°C	28 days
Paint filter test	P, G	500	Cool 4°C	48 hours
pH	P, G	-	None	Analyze immediately
Phenols	G	500	Cool, 4°C	28 days
Residue (Total)	P, G	100	Cool 4°C	7 days
Residue (Filterable)	P, G	100	Cool 4°C	7 days
Residue (Nonfilterable, TSS)	P, G	100	Cool 4°C	7days
Residue (Settleable)	P, G	1000	Cool 4°C	48 hours
Residue (Volatile)	P, G	100	Cool 4°C	7 days
Specific conductance	P, G	100	Cool 4°C	28 days
Sulfate	P, G	100	Cool 4°C	28 days
Sulfide	P, G	500	Cool 4°C	7 days
Sulfite	P, G	200	Cool 4°C	Analyze immediately
Surfactants	P, G	500	Cool 4°C	48 hours
Temperature	P, G	-	None	Analyze on site
Turbidity	P, G	100	Cool 4°C	48 hours
Metals				
Chromium, Hexavalent	P, G	200	Cool 4°C	24 hours
Mercury	P, G	100	Cool 4°C	28 days
All other metals	P, G	100	Cool 4°C	6 months
Organics				
Volatile Halocarbons	G, Teflon-lined septum	3 x 40	Cool 4°C	14 days

Table E.2 (continued). Sample Preservation, Holding Times, Containers and Volumes for chemical waste samples.

Parameter	* Container	Sample volume mL	Preservation	Max. Holding Time
Volatile Aromatic Hydrocarbons	G, Teflon-lined septum	3 x 40	Cool 4°C	14 days
Acrolein and Acrylonitrile	G, Teflon-lined septum	3 x 40	Cool 4°C,	14 days
Phenols	G, Teflon-lined cap	1000	Cool 4°C	7 days until extraction, 40 days after extraction
Benzidines	G, Teflon-lined cap	1000	Cool 4°C	7 days until extraction, 40 days after extraction
Phthalate Esters	G, Teflon-lined cap	1000	Cool 4°C	7 days until extraction, 40 days after extraction
Nitrosamines	G, Teflon-lined cap	1000	Cool 4°C	7 days until extraction, 40 days after extraction
PCB's	G, Teflon-lined cap	1000	Cool 4°C	7 days until extraction, 40 days after extraction
Nitroaromatics and Isophorone	G, Teflon-lined cap	1000	Cool 4°C,store in dark	7 days until extraction, 40 days after extraction
Polynuclear Aromatic Hydrocarbons	G, Teflon-lined cap	1000	Cool 4°C, store in dark	7 days until extraction, 40 days after extraction
Haloethers	G, Teflon-lined cap	1000	Cool 4°C	7 days until extraction, 40 days after extraction
Chlorinated Hydrocarbons	G, Teflon-lined cap	1000	Cool 4°C	7 days until extraction, 40 days after extraction
TCDD	G, Teflon-lined cap	1000	Cool 4°C	7 days until extraction, 40 days after extraction
Total Organic Halogens	G, Teflon-lined cap	1000	Cool, 4°C	7 days
Pesticides	G, Teflon-lined cap	1000	Cool 4°C	7 days until extraction, 40 days after extraction
Herbicides	G, Teflon-lined cap	1000	Cool 4°C	7 days until extraction, 40 days after extraction

* Polyethylene (P) or Glass (G)

APPENDIX E

TARGET ANALYTES AND MDLs

Table 1. Target analytes and MDLs for method 8240 in groundwater.

Target Analyte	MDL ppb	Target Analyte	MDL ppb
Acetone	20	1,2-Dichloropropane	1
Benzene	1	*cis*-1,3-Dichloropropene	1
Bromodichloromethane	1	*trans*-1,3-Dichloropropene	1
Bromoform	1	Ethylbenzene	1
Bromomethane	2	2-Hexanone	10
2-Butanone	20	Methylene chloride	1
Carbon disulfide	20	4-Methyl-2-pentanone	10
Carbon tetrachloride	1	Styrene	1
Chlorobenzene	1	1,1,2,2-Tetrachloroethane	1
Chlorodibromomethane	1	Tetrachloroethene	1
Chloroethane	2	Toluene	1
2-Chloroethylvinyl ether	2	1,1,1-Trichloroethane	1
Chloroform	1	Trichloroethene	1
Chloromethane	2	Vinyl acetate	10
1,2-Dibromo-3-chloropropane	*	Vinyl chloride	0.4
1,2-Dibromoethane	*	Xylene	1
1,1-Dichloroethane	1	cis-1,2-Dichloroethene	1
1,2-Dichloroethane	1		
1,1-Dichloroethene	1		
trans-1,2-Dichloroethene	1		

* Performed by method 504 to achieve MDL of 0.01 ug/L for EDB and 0.04 for DBCP

Table 2. Target analytes and MDLs for method 8240 in surface water.

Target Analyte	MDL ppb	Target Analyte	MDL ppb
Acetone	20	1,2-Dichloropropane	1
Benzene	1	*cis*-1,3-Dichloropropene	1
Bromodichloromethane	1	*trans*-1,3-Dichloropropene	1
Bromoform	1	Ethylbenzene	1
Bromomethane	2	2-Hexanone	10
2-Butanone	20	Methylene chloride	1
Carbon disulfide	20	4-Methyl-2-pentanone	10
Carbon tetrachloride	1	Styrene	1
Chlorobenzene	1	1,1,2,2-Tetrachloroethane	1
Chlorodibromomethane	1	Tetrachloroethene	1
Chloroethane	2	Toluene	1
2-Chloroethylvinyl ether	2	1,1,1-Trichloroethane	1
Chloroform	1	Trichloroethene	1
Chloromethane	2	Vinyl acetate	10
1,2-Dibromo-3-chloropropane	*	Vinyl chloride	0.4
1,2-Dibromoethane	*	Xylene	1
1,1-Dichloroethane	1	cis-1,2-Dichloroethene	1
1,2-Dichloroethane	1		
1,1-Dichloroethene	1		
trans-1,2-Dichloroethene	1		

* Performed by method 504 to achieve MDL of 0.01 ug/L for EDB and 0.04 for DBCP

Table 3. Target analytes and MDLs for method 8240 in soils/sediments.

Target Analyte	MDL ppb	Target Analyte	MDL ppb
Acetone	20	1,2-Dichloropropane	1
Benzene	1	*cis*-1,3-Dichloropropene	1
Bromodichloromethane	1	*trans*-1,3-Dichloropropene	1
Bromoform	1	Ethylbenzene	1
Bromomethane	2	2-Hexanone	10
2-Butanone	20	Methylene chloride	1
Carbon disulfide	20	4-Methyl-2-pentanone	10
Carbon tetrachloride	1	Styrene	1
Chlorobenzene	1	1,1,2,2-Tetrachloroethane	1
Chlorodibromomethane	1	Tetrachloroethene	1
Chloroethane	2	Toluene	1
2-Chloroethylvinyl ether	2	1,1,1-Trichloroethane	1
Chloroform	1	Trichloroethene	1
Chloromethane	2	Vinyl acetate	10
1,2-Dibromo-3-chloropropane	*	Vinyl chloride	0.4
1,2-Dibromoethane	*	Xylene	1
1,1-Dichloroethane	1	cis-1,2-Dichloroethene	1
1,2-Dichloroethane	1		
1,1-Dichloroethene	1		
trans-1,2-Dichloroethene	1		

Table 4. Target analytes and MDL of method 8270 in groundwater.

Target Analyte	MDL ppb	Target Analyte	MDL ppb
Acenaphthene	0.2	Hexachlorobenzene	1
Acenaphthalene	0.2	Hexachlorobutadiene	10
Anthracene	10	Hexachlorocyclopentadiene	10
Benz(a)anthracene	0.2	Hexachloroethane	10
Benzo(b)fluoranthene	0.2	Indeno(1,2,3-cd)pyrene	10
Benzo(k)fluoranthene	0.2	Isophorone	10
Benzoic acid	50	2-Methylnaphthalene	10
Benzo(g,h,i)perylene	0.2	2-Methylphenol	10
Benzo(a)pyrene	0.2	3-Methylphenol	10
Benzyl alcohol	20	4-Methylphenol	10
Bis(2-chloroethoxy)methane	10	Naphthalene	10
Bis(2-chloroethyl)ether	10	2-Nitroaniline	50
Bis(2-chloroisopropyl)ether	10	3-Nitroaniline	50
4-Bromophenyl phenyl ether	10	4-Nitroaniline	20
Butyl benzyl phthalate	2	Nitrobenzene	10
4-Chloroaniline	20	2-Nitrophenol	10
4-Chloro-3-methylphenol	20	4-Nitrophenol	50
2-Chloronaphthalene	10	*N*-Nitrosodiphenylamine	10
2-Chlorophenol	10	*N*-Nitroso-di-*n*-propylamine	10
4-Chlorophenyl phenyl ether	10	Pentachlorophenol	1
Chrysene	10	Phenanthrene	10
Dibenz(a,h)anthracene	0.2	Phenol	10
Dibenzofuran	10	Pyrene	10
Di-*n*-butyl phthalate	2	1,2,4-Trichlorobenzene	10
1,2-Dichlorobenzene	10	2,4,5-Trichlorophenol	10
1,3-Dichlorobenzene	10	2,4,6-Trichlorophenol	10
1,4-Dichlorobenzene	10	2,4-Dinitrophenol	50
3,3'-Dichlorobenzidine	20	2,4-Dinitrotoluene	10
2,4-Dichlorophenol	10	2,6-Dinitrotoluene	10
Diethyl phthalate	2	Di-*n*-octyl phthalate	2
2,4-Dimethylphenol	10	Bis(2-ethylhexyl)phthalate	2
Dimethyl phthalate	2	Fluoranthene	0.2
4,6-Dinitro-2-methylphenol	50	Fluorene	0.2

Table 5. Target analytes and MDL of method 8270 in surface water.

Target Analyte	MDL ppb	Target Analyte	MDL ppb
Acenaphthene	0.2	Hexachlorobenzene	1
Acenaphthalene	0.2	Hexachlorobutadiene	10
Anthracene	10	Hexachlorocyclopentadiene	10
Benz(a)anthracene	0.2	Hexachloroethane	10
Benzo(b)fluoranthene	0.2	Indeno(1,2,3-cd)pyrene	10
Benzo(k)fluoranthene	0.2	Isophorone	10
Benzoic acid	50	2-Methylnaphthalene	10
Benzo(g,h,i)perylene	0.2	2-Methylphenol	10
Benzo(a)pyrene	0.2	3-Methylphenol	10
Benzyl alcohol	20	4-Methylphenol	10
Bis(2-chloroethoxy)methane	10	Naphthalene	10
Bis(2-chloroethyl)ether	10	2-Nitroaniline	50
Bis(2-chloroisopropyl)ether	10	3-Nitroaniline	50
4-Bromophenyl phenyl ether	10	4-Nitroaniline	20
Butyl benzyl phthalate	2	Nitrobenzene	10
4-Chloroaniline	20	2-Nitrophenol	10
4-Chloro-3-methylphenol	20	4-Nitrophenol	50
2-Chloronaphthalene	10	*N*-Nitrosodiphenylamine	10
2-Chlorophenol	10	*N*-Nitroso-di-*n*-propylamine	10
4-Chlorophenyl phenyl ether	10	Pentachlorophenol	1
Chrysene	10	Phenanthrene	10
Dibenz(a,h)anthracene	0.2	Phenol	10
Dibenzofuran	10	Pyrene	10
Di-*n*-butyl phthalate	2	1,2,4-Trichlorobenzene	10
1,2-Dichlorobenzene	10	2,4,5-Trichlorophenol	10
1,3-Dichlorobenzene	10	2,4,6-Trichlorophenol	10
1,4-Dichlorobenzene	10	2,4-Dinitrophenol	50
3,3'-Dichlorobenzidine	20	2,4-Dinitrotoluene	10
2,4-Dichlorophenol	10	2,6-Dinitrotoluene	10
Diethyl phthalate	2	Di-*n*-octyl phthalate	2
2,4-Dimethylphenol	10	Bis(2-ethylhexyl)phthalate	2
Dimethyl phthalate	2	Fluoranthene	0.2
4,6-Dinitro-2-methylphenol	50	Fluorene	0.2

Table 6. Target analytes and MDL of method 8270 in soil/sediment.

Target Analyte	MDL ppb	Target Analyte	MDL ppb
Acenaphthene	330	Hexachlorobenzene	330
Acenaphthalene	330	Hexachlorobutadiene	330
Anthracene	330	Hexachlorocyclopentadiene	330
Benz(a)anthracene	330	Hexachloroethane	330
Benzo(b)fluoranthene	330	Indeno(1,2,3-cd)pyrene	330
Benzo(k)fluoranthene	330	Isophorone	330
Benzoic acid	1650	2-Methylnaphthalene	330
Benzo(g,h,i)perylene	330	2-Methylphenol	330
Benzo(a)pyrene	330	3-Methylphenol	330
Benzyl alcohol	660	4-Methylphenol	330
Bis(2-chloroethoxy)methane	330	Naphthalene	330
Bis(2-chloroethyl)ether	330	2-Nitroaniline	1650
Bis(2-chloroisopropyl)ether	330	3-Nitroaniline	1650
4-Bromophenyl phenyl ether	330	4-Nitroaniline	660
Butyl benzyl phthalate	330	Nitrobenzene	330
4-Chloroaniline	660	2-Nitrophenol	330
4-Chloro-3-methylphenol	660	4-Nitrophenol	1650
2-Chloronaphthalene	330	*N*-Nitrosodiphenylamine	330
2-Chlorophenol	330	*N*-Nitroso-di-*n*-propylamine	330
4-Chlorophenyl phenyl ether	330	Pentachlorophenol	1650
Chrysene	330	Phenanthrene	330
Dibenz(a,h)anthracene	330	Phenol	330
Dibenzofuran	330	Pyrene	330
Di-*n*-butyl phthalate	330	1,2,4-Trichlorobenzene	330
1,2-Dichlorobenzene	330	2,4,5-Trichlorophenol	330
1,3-Dichlorobenzene	330	2,4,6-Trichlorophenol	330
1,4-Dichlorobenzene	330	2,4-Dinitrophenol	1650
3,3'-Dichlorobenzidine	660	2,4-Dinitrotoluene	330
2,4-Dichlorophenol	330	2,6-Dinitrotoluene	330
Diethyl phthalate	330	Di-*n*-octyl phthalate	330
2,4-Dimethylphenol	330	Bis(2-ethylhexyl)phthalate	330
Dimethyl phthalate	330	Fluoranthene	330
4,6-Dinitro-2-methylphenol	1650	Fluorene	330

Table 7. Metal Target analytes and PQLs

Metal	Soil/Sediment ppm	Groundwater MCL ppb	Surfacewater ppb
Antimony	5.0	2	50
Arsenic	3.0	10	30
Beryllium	1.0	1	10
Cadmium	1.0	1	10
Chromium	1.0	10	10
Copper	2.0	20	20
Lead	2.5	3	25
Manganese	4.0	40	40
Mercury	0.25	0.5	0.5
Nickel	2.0	20	20
Selenium	4.0	10	40
Silver	1.0	10	10
Thallium	5.0	0.5	50
Zinc	2.0	20	20

Table 8. Target analyte list and PQL[1] of explosive residues by method 8330 (modified) in aqueous samples.

Target analyte	PQL ppb	Target analyte	PQL ppb
2,4,6-TNT	0.64	4-Am-DNT	1.57
1,3,5-TNB	0.45	2-Am-DNT	0.16
NB	0.65	2-NT	0.41
2,4-DNT	0.10	3-NT	1.4
2,6-DNT	0.10	4-NT	0.62
4-Am-2-NT	-	2-Am-4-NT	-
3,4-DNT	-	1,3-DNB	0.15

[1] From Jenkins, *et. al.* CRREL Special Report 92-25.

Table 9. Target analyte list and PQL[2] of explosive residues by method 8330 (modified) in soil/sediment samples.

Target analyte	PQL ppm	Target analyte	PQL ppm
2,4,6-TNT	0.25	4-Am-DNT	-
1,3,5-TNB	0.25	2-Am-DNT	-
NB	0.26	2-NT	0.25
2,4-DNT	0.25	3-NT	0.25
2,6-DNT	0.26	4-NT	0.25
4-Am-2-NT	-	2-Am-4-NT	-
3,4-DNT	-	1,3-DNB	0.25

[2] From EPA method 8330.

Mr. Albert/5232/Mr. Burns

CEORH-ED-GS (200-1c) 6 October 1994

MEMORANDUM FOR Commander, U.S. Army Engineer District, Nashville
ATTN: CEORN-ER-M, Rick Connor, P.O. Box 1070
Nashville, Tennessee 37202-1070

SUBJECT: Plum Brook Ordnance Works, Sandusky, Ohio - Draft Monitoring Well Installation Plan

1. The subject plan has been reviewed and comments are attached.

2. An advanced copy of these comments has been faxed to Captain Michael Riebel, CEORN-ER-M. If you have any questions, please contact Frank Albert, CEORH-ED-GS, at (304) 529-5232.

FOR THE COMMANDER:

Encl
as

DWIGHT L. BURNS, P.E.
Chief, Engineering Division

CF:
CEORH-ED-G
CEORH-ED-GS
CEORH-ED-AE
CEORH-DL-M

PHELPS	ED-G
RIDDLE	ED-AE
CHRISTIAN	DP
BURNS	ED

COMMENTS - DRAFT MONITORING WELL INSTALLATION PLAN
PLUM BROOK ORDNANCE WORKS

Section 2.0 WELL LOCATIONS AND DEPTHS

The plan should include site maps showing proposed location of wells.

Section 2.1 and 2.2 MONITORING WELL INSTALLATION AT TNT AREAS/RED WATER PONDS

Suggest adding the word "Overburden" to the title to distinguish from section 2.3.

Section 3.0 DRILLING EQUIPMENT, para. 4

Suggest noting that the equipment will be inspected upon arrival at the work site and daily prior to use.

Section 4.0 DRILLING PROCEDURES

1. The plan should note compliance with EM 385-1-1.

2. Plan should note that the Contractor shall coordinate with NASA for the location of underground utilities prior to any drilling activities.

3. It should be noted that the drilling equipment will be decontaminated prior to leaving the site after drilling operations are complete.

4. It should be noted that PPE and personnel decontamination shall be in accordance with the project SSHP.

Section 4.1 INTRODUCTION

1. The plan needs to provide more detail on the handling of IDW or reference an IDW Plan, i.e.; define suitable containers, be more specific as to the information required on labels, time allowed before being transported to storage, storage time, disposal records required, etc.

2. Para. 2. Suggest making reference to (or include copy of) Figure 4-6 from the Sampling and Analysis Plan for the location of the IDW storage area.

Section 4.2 OVERBURDEN WELLS

1. The plan makes reference to soil samples being scanned with HNu/OVA for the presence of contamination but does not provide any direction on what to do if contamination is detected. Should reference proper plan for additional guidance.

COMMENTS - DRAFT MONITORING WELL INSTALLATION PLAN, cont'd
PLUM BROOK ORDNANCE WORKS

Section 4.2 OVERBURDEN WELLS, cont'd

2. The plan states that all drilling and sampling equipment will be steam cleaned prior to drilling and between each sample and boring. Should mention how the runoff from decon procedures will be handled. Will this be part of the IDW?

Section 4.3 BEDROCK WELLS

The last paragraph states that contaminated/suspected contaminated cores may require special handling, etc. The Contractor should be certain of the handling requirements and state proper disposal in this plan.

Section 5.0 WELL INSTALLATION

How is QA/QC being addressed for the well installations?

Section 5.2 WELL PROTECTION

Request that the Contractor use Master Lock Number 3216 for the wells and also provide keys (4 min) to CEORH.

Section 5.3 WELL CONSTRUCTION DIAGRAMS

Should note that the well coordinates will be surveyed and recorded to nearest 0.1 ft and referenced to State Plane coordinates or local grid. Should also note that well elevations shall be referenced to the 1929 NGVD or an existing local vertical datum. (per Section 4.15 SURVEYING of the SAP)

Section 6.2 WELL DEVELOPMENT METHOD

Should mention the disposition of the fluids/sediments from well development. Decon water shall be collected and stored in the designated storage area.

CEORH-DL-M 5 October 1994

COMMENTS: Draft Work Plan, Part II, Monitoring Well Installation Plan for Hazardous and Toxic Waste Investigation, Plum Brook Ordnance Works, Sandusty, Ohio, September 1994

1. Plan needs to include site map showing proposed location of wells.

2. The plan needs to provide more detail on the handling of IDW or reference an IDW Plan, i.e.; define suitable containers, be more specific as to the info required on labels, time allowed before being transported to storage, storage time, disposal records required, etc.

3. The plan makes reference to soil samples being scanned with HNu/OVA for the presence of contamination but does not provide any direction on what to do if contamination is detected. Should reference proper plan for additional guidance.

4. How is QA/QC being addressed for the well installations?

5. Plan should reinforce need to comply with EM 385-1-1.

6. Plan should reinforce Contractors need to check for underground utilities before drilling.

7. Should final decontamination of drilling equipment be addressed in this plan?

8. Section 4.2 states that all drilling and sampling equipment will be steam cleaned prior to drilling and between each sample and boring. How is runoff (decon procedures) going to be handled. Will this be part of the IDW?

9. Comment should be made that PPE and personnel decontamination will be in accordance with the SSHP.

10. Section 5.2 talks about the wells being locked. Request that the Contractor use Master Lock Number 3216. If not, also request that Contractor provide keys (4 min) to CEORH.

FINAL WORK PLAN
PART II
MONITORING WELL INSTALLATION PLAN

FOR

HAZARDOUS AND TOXIC WASTE INVESTIGATION
PLUM BROOK ORDNANCE WORKS
PLUM BROOK STATION/NASA
SANDUSKY, OHIO

Prepared for:

U.S. Army Corps of Engineers
Nashville District

Prepared by:

Dames & Moore, Inc.
Atlanta, Georgia

OCTOBER 1994

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1.0 INTRODUCTION AND BACKGROUND

Chemical contamination caused by Department of Defense (DoD) activities may exist at the former Plum Brook Ordnance Works (PBOW), located in Sandusky, Ohio. The Corps of Engineers, Nashville District (CEORN) has issued Dames & Moore Delivery Order 0020 of Contract DACA62-92-D-0015 to perform a Hazardous and Toxic Waste (HTW) Investigation of selected Areas of Concern (AOCs) at the PBOW. The site investigations to be performed address the possible chemical contamination at two of the AOCs and of the groundwater in the bedrock aquifer underlying the site.

1.1 SITE BACKGROUND

The PBOW is located 4.7 miles south of Sandusky, Ohio and 59.0 miles west of Cleveland, Ohio in Erie County, Ohio. The original site consisted of 9,071.06 acres of land which was acquired by DoD in 1941. An ammunition plant was constructed on this site and operated by Trojan Powder Company for DoD until 1945. After operations ceased, the magazine area was renamed Plum Brook Depot and was used for ammunition storage. This area was also referred to as Erie Ordnance Depot. The facility was placed on inactive status in June 1961. The National Aeronautics and Space Administration (NASA) acquired PBOW and Plum Brook Depot on March 15, 1963. On April 18, 1978, NASA declared 2,152.15 acres of land as excess. 46.023 acres of this excess were conveyed to the Perkins Board of Education on June 2, 1978, which currently uses the area as a bus transportation center. The Ohio National Guard currently uses 604 acres of the site for training.

NASA is currently using their site to conduct space research as a satellite operation of NASA, Lewis Research, Cleveland, Ohio. Most of the original structures from the PBOW were removed by NASA, and NASA has constructed numerous facilities on the site since its acquisition. Some of the original structures, power plants, and red water ponds have not been removed or remediated (COE, 1994).

Past disposal practices during the period of DoD control are unknown. Explosives manufacture and/or handling at the site resulted in the operation of holding ponds ("red

water ponds") for process waste water. This process waste water may have contained residues of the explosive manufacturing process and may have been acidic in nature. Out-of-specification explosives and munitions may have been burned or buried on the facility. Several suspected burial and other disposal sites have been identified; however, specific materials buried are unknown. Possible effects of the buried materials on groundwater and surface water at the site are also unknown. The HTW Investigation involves the investigation of the remaining DoD structures and the contiguous groundwater, sediment, and soil for possible contamination by hazardous substances known to be associated with the operation, maintenance, and deactivation of the PBOW (COE, 1994).

A number of environmental investigations have been conducted at the PBOW. In 1989, IT Corporation (IT) performed a limited investigation of areas of potential concern to the DoD. The field investigation activities included: collection of soil, surface water, sediment, and groundwater samples for geotechnical or chemical analysis; and conducting hydraulic conductivity tests. MK Ferguson performed a preliminary sitewide environmental investigation for NASA in 1993 (report dated 1994). Additional investigations have been performed by NASA (e.g., investigations of underground storage tanks) and other interested parties (the U.S. Army Reserve conducted a limited investigation of some red water ponds).

1.2 OBJECTIVES

The HTW Investigation of the PBOW includes three components: (1) Site Investigations (SIs) for AOC 1 (three TNT Areas); (2) a focused Remedial Investigation (RI) of AOC 2 (West Area Red Water Ponds and Pentolite Road Red Water Ponds); and (3) a sitewide groundwater investigation of the bedrock aquifer.

The objectives of the sitewide groundwater investigation are to evaluate the presence and nature of contamination in the bedrock aquifer underlying the site and to assess the direction of groundwater flow and the potential off-site migration of contamination.

- Possible contaminants in the groundwater in the bedrock include nitroaromatics (explosives), volatile organic compounds, base neutral/acid compounds, and metals. Previous investigations of the bedrock groundwater have been limited to sampling and analysis for radioactivity by NASA at the reactor area on the north side of the site. According to NASA personnel, evidence of radioactivity in the groundwater in the bedrock has not been detected.

- As part of the focused RI for the Red Water Ponds (AOC 2) and the SI of the TNT Areas (AOC 1), the presence and nature of contamination in the groundwater aquifer in the unconsolidated overburden materials will be assessed. The groundwater in the overburden will be evaluated for the presence of nitroaromatics (explosives) and metals.

- The regional direction of groundwater flow at the site is to the north toward Lake Erie which is the regional groundwater discharge point. Previous investigations have not evaluated the groundwater in the bedrock, but the regional direction of flow in the bedrock is assumed to be to the north. Previous investigations of groundwater flow in the overburden indicate that flow direction across the site in variable. Water level contouring has indicated localized flow directions to the north and northeast.

1.3 ORGANIZATION OF MONITORING WELL INSTALLATION PLAN

This Monitoring Well Installation Plan consists of seven sections, as follows:

Section 1 describes the site background and objectives of the installation of the groundwater monitoring wells.

Section 2 presents the general locations and target depths of the monitoring wells.

Section 3 describes drilling equipment that will be used to install the monitoring wells.

Section 4 outlines the drilling procedures that will be used to install the monitoring wells.

Section 5 describes the well installation procedures.

Section 6 describes the well development procedures.

Section 7 presents the project assignments and personnel qualifications.

Figures are presented after the page on which they are first mentioned.

2.0 WELL LOCATIONS AND DEPTHS

This section discusses the proposed locations for installation of groundwater monitoring wells for the HTW Investigation at the PBOW. The groundwater investigation is designed to assess the potential for contamination in both the unconsolidated overburden materials and the consolidated limestone and shale bedrock. In connection with the SIs for the TNT Areas (AOC 1) and the focused RI for the Red Water Pond Areas (AOC 2), 12 groundwater monitoring wells will be installed in the unconsolidated overburden materials overlying the bedrock at the site. In addition eight groundwater monitoring wells will be installed in the bedrock. The proposed locations and depths for these wells are described in the sections below and are illustrated on Figure 2-1. Underground utilities at all proposed monitoring well locations will be cleared by NASA.

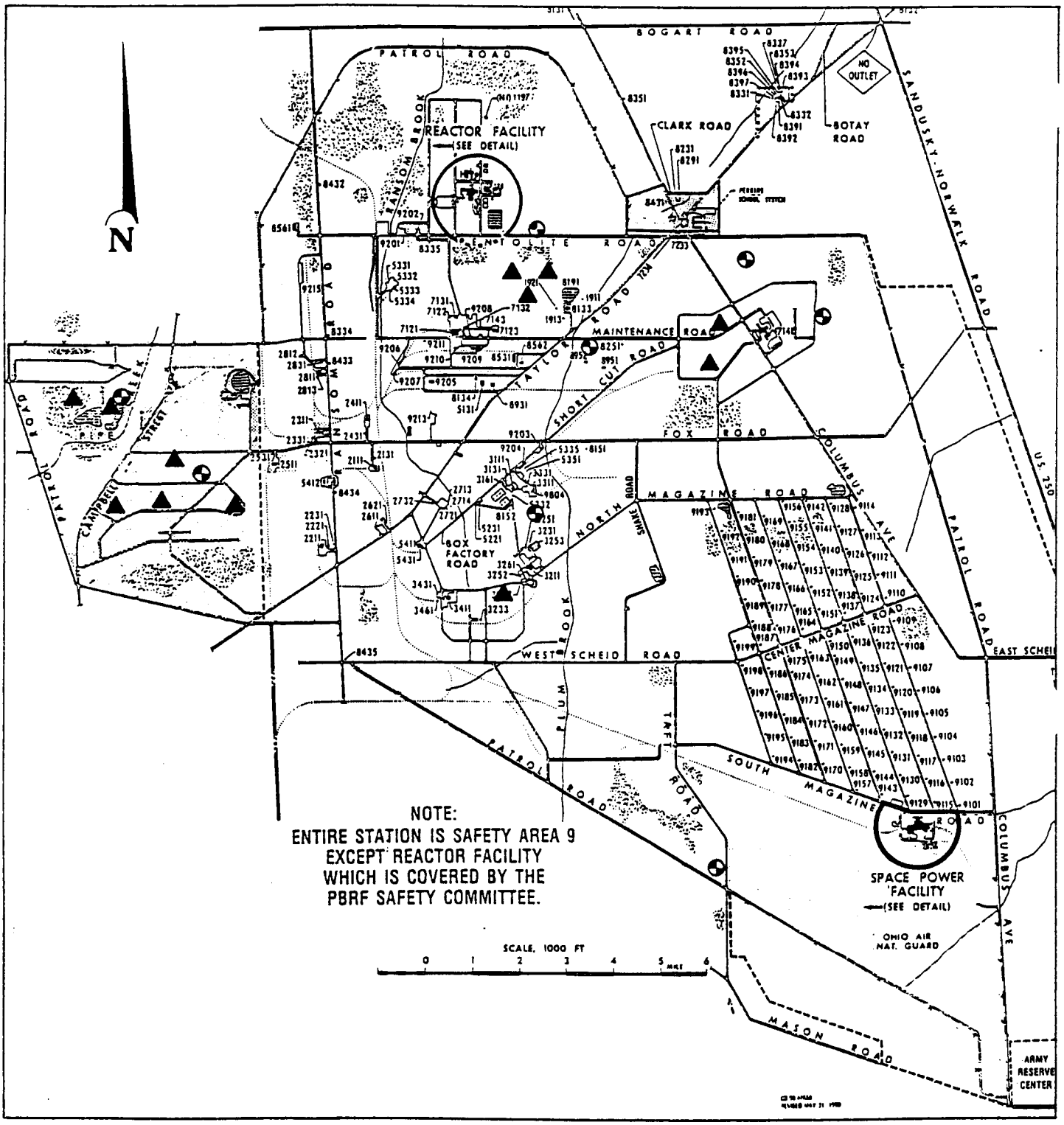
2.1 OVERBURDEN MONITORING WELL INSTALLATION AT TNT AREAS

Two overburden groundwater monitoring wells will be installed at TNT Area A. The wells are proposed for the west and northwest portions of the area near the Wash House for line 3 and the Wash House and Fortifier House for line 4.

One overburden groundwater monitoring well will be installed in TNT Area B. The proposed location for the well is on the east side of the area north of the Wash House for TNT manufacturing line 5.

Four overburden monitoring wells will be installed in TNT Area C. Three of the wells are proposed for areas near the Wash Houses. One well is proposed to be installed north of the Wash House for line 12, the second north of the Wash House for line 10, and the third north of the Wash House for line 9. A fourth well is proposed for the northern portion of TNT Area C near the Waste Water Settling Tanks along Fox Road.

The overburden wells will be installed to the top of bedrock. If bedrock is encountered at a depth of less than 6 feet below land surface, a monitoring well will not be installed. However, a well screen will be placed in the borehole and a groundwater



LEGEND:

- Proposed Bedrock Monitoring Well
- Proposed Overburden Monitoring Well

Figure 2-1

WELL LOCATION MAP

Plum Brook Ordnance Works

DAMES & MOORE

sample will be collected, if possible. The screened interval for the overburden wells will be from 1 foot above the water table to the bottom of the borehole (top of bedrock).

2.2 OVERBURDEN MONITORING WELL INSTALLATION AT THE RED WATER PONDS

Two additional overburden groundwater monitoring wells will be installed at the locations (coincident with the two 10-foot boring locations north and northwest of the West Pond).

Three overburden groundwater monitoring wells will be installed at the locations (coincident with three of the 10-foot boring locations). The three wells locations are in the central portion of the pond area and on the western and southern sides of the area. Due to the presence of the drainage ditch on the east side of the pond area, a well is not proposed in this area.

The overburden wells will be installed to the top of bedrock. If bedrock is encountered at a depth of less than 6 feet below land surface, a monitoring well will not be installed. However, a well screen will be placed in the borehole and a groundwater sample will be collected, if possible. The screened interval for the overburden wells will be from 1 foot above the water table to the bottom of the borehole (top of bedrock).

2.3 BEDROCK MONITORING WELLS

Bedrock monitoring wells will be installed to allow sampling of the first water producing zone of the bedrock aquifer but to a total depth not to exceed 80 feet. Bedrock monitoring wells will be installed in the following areas.

- North of TNT Area A
- East of TNT Area A
- North of TNT Area B

- North of TNT Area C
- North of the Pentolite Road Red Water Ponds
- North of the West Area Red Water Ponds
- Near the Intersection of Patrol Road and Taft Road
- In the Vicinity of Toluene Tanks 255 and 265

3.0 DRILLING EQUIPMENT

A D-50 or similar truck-mounted drill rig equipped with 4 ¼-inch inside diameter (ID) hollow stem augers will be used for drilling wells. Two-inch outside diameter (OD) stainless steel split spoon samplers attached to AW (1 ½) -inch diameter) drill rods will be used for sample collection in all wells. Drill rods attached to a 140-pound hammer will be used to drive the sampler.

A D-50 or similar truck-mounted rotary drill rig equipped with 4 ¼-inch ID augers will be used for overburden well drilling.

A D-120 or similar truck-mounted rotary drill rig equipped with 12-inch ID augers will be used for the bedrock well drilling. Additional equipment required for bedrock wells includes 10-inch Tricone roller bit and NQ size coring equipment.

Drilling and sampling equipment will arrive on site in operable condition and will be free of leaks in the hydraulic, lubrication, fuel, and other fluid systems that would be detrimental to the project effort. All equipment will arrive on site with switches (to include safety switches, gages, and other electrical, mechanical, hydraulic, and pneumatic systems) in safe operating condition. Drilling equipment will be inspected at the initiation of the project and daily during the project.

Fifty-five gallon steel drums or other suitable containers will be used to contain soil cuttings, drilling-core water, and well development water.

Suitable filter sand will be provided for the screen filter pack. Pellet/granular bentonite will be provided for the hydrologic well seal. Cement grout and concrete materials will be provided for well finishing.

4.0 DRILLING PROCEDURES

This section describes the procedures that will be used to drill the overburden and bedrock groundwater monitoring wells.

4.1 INTRODUCTION

The site monitoring wells (overburden and bedrock) will be installed in accordance with the requirements of the COE guidance document EM 1110-7-XX(FR) (Draft) and in accordance with the program described in the Scope of Work for Delivery Order 0020 dated April 8, 1994. In addition, the wells will be completed in general accordance with the procedures and details documented in Section 5 of this Monitoring Well Installation Plan. All well installation work will be performed in strict accordance with the relevant provisions of the Site-Specific Safety and Health Plan for this HTW Investigation which was prepared in accordance with COE Safety and Health Requirements Manual EM-385-1-1 dated October 1992. All field drilling personnel will meet Occupational Safety and Health Administration (OSHA) requirements.

All soil cuttings, drilling water, and well development water will be recovered and stored in suitable containers. The containers will be labeled to identify the project name, date, contents, and source. The containers will be transported to a designated storage area at the NASA facility for future disposal. Disposal options will be presented in the project Investigation Derived Waste Report which will be prepared after receipt of the results of the laboratory analyses as provided for in the project Scope of Work.

4.2 OVERBURDEN WELLS

Each overburden boring will be advanced from ground surface using hollow stem augering techniques and 4 ¼-inch ID augers. The overburden wells will extend to the top of rock as defined by auger refusal. Soil samples will be collected continuously using a 2-inch OD stainless steel split spoon sampler attached to drill rods. The drill

rods will be attached to a 140-pound free fall hammer which will be used to drive the split spoon sampler into the undisturbed soil in advance of the hollow stem augers. One soil sample will be collected from the screened interval for sieve analysis. During the soil sampling, soil samples will be scanned with a HNu/OVA for the presence of contamination. Action levels are listed in Table 5-2 of the Site-Specific Safety and Health Plan included in Part III of this Work Plan.

All drilling and sampling equipment will be steam cleaned prior to drilling; between each sample and boring; and at the conclusion of the field work prior to taking the equipment from the PBOW. The decontamination fluids will be contained at the central decontamination area illustrated on Figure 4-1 and stored in the drum storage area (also shown in Figure 4-1) at the end of the investigation.

4.3 BEDROCK WELLS

Bedrock monitoring wells will be installed to allow sampling of the first water producing zone of the bedrock aquifer, but to a total depth not to exceed 80 feet.

The bedrock monitoring wells will be advanced through the overburden to the top of rock using a 12-inch ID hollow stem augers, while continuously sampling with a split spoon sampler. After encountering the top of rock, the boring will be advanced approximately 10 feet until competent rock is encountered using a 10-inch diameter roller cone bit.

In order to ensure the integrity of the bedrock well, at least 20 feet of 4-inch diameter polyvinyl chloride (PVC) casing will be installed in each bedrock well to seal off the unconsolidated overburden materials and incompetent bedrock near the bedrock surface. This solid casing will extend into the bedrock approximately 10 feet (the depth at which competent rock is assumed to be present). Once the borehole has been cleaned of loose material, a 4-inch PVC riser casing will be installed into the borehole and grouted in place. The casing will be grouted to the surface.

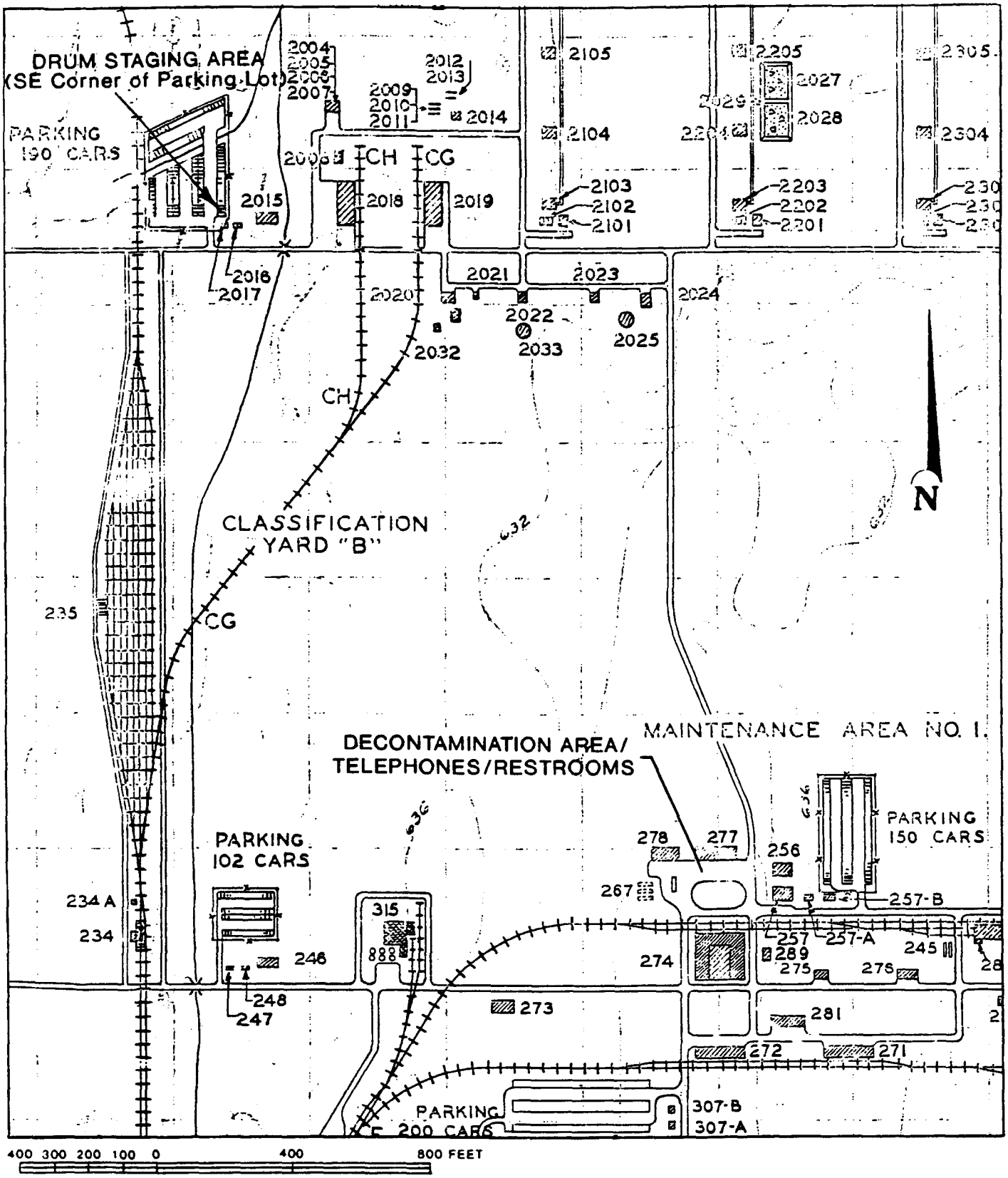


Figure 4-1

DECON AREA AND DRUM STORAGE AREA
Plum Brook Ordnance Works

The grout will be allowed to cure for a minimum of 48 hours before continuing coring operations on the well. When the grout has cured, NQ coring equipment will be placed through the 4-inch surface casing and coring will continue until the first water bearing zone is reached. The resulting cored well will be approximately 3 inches in diameter. No bedrock monitoring well will exceed 80 feet in depth.

In order to identify water bearing zones in the bedrock during coring, the on-site geologist will:

- monitor the water level in the boring at the end of each pull; and
- monitor the loss of drilling water during drilling.

The rock cores will be stored in covered core boxes in such a manner as to preserve their relative position by depth. Intervals of lost core will be noted in the core sequence. Boxes will be marked on the cover (both inside and outside) and on the ends to provide project names, boring number, cored interval, and box number in cases of multiple boxes. Any core box known or suspected to contain contaminated core will be appropriated marked on the box cover (inside and outside) and one both ends. The weight of each fully loaded box will not exceed 75 pounds. No geotechnical or contamination data will appear on or within the box that is not specified on the boring log.

The core within each complete box will be photographed after the core surface has been cleaned or peeled, as appropriate, and wetted. Photographs will be taken using color film with one box per frame. Each photo will be in sharp focus and contain both a legible scale in feet and tenths of feet and a photographic color chart for color comparison. The core will be oriented so that the top of the core is at the top of each photo. Each photo will be annotated on the back as to the project name, bore/well designation, box number, cored depth denoted in the photograph, and date photographed.

All rock cores, except those for analysis and reference, will be stored at the "Gray Barn" located along Campbell Street until the conclusion of the investigation. At the

conclusion of the investigation the cores will be provided to CEORN or disposed as investigation derived waste.

Bedrock cores known to be contaminated will be segregated and properly disposed in accordance with a plan for disposal of Investigation Derived Waste for this project. Recommendations for disposal of Investigation Derived Waste will be presented in the Investigation Derived Waste Report.

4.4 BOREHOLE LOGGING REQUIREMENTS

An HTRW Drilling Log (Figure 4-2) will be used for all wells installed. The logs will be prepared in the field, as the borings are drilled, by a qualified, experienced geologist or engineer. All log entries will be printed.

Borehole depth information will be from direct measurements accurate to 0.1 ft. precision.

All relevant information blanks in the log heading will be completed, including:

- Manufacturer's name and type of drilling equipment;
- Sizes and types of drilling and sampling equipment;
- Starting and completion dates of drilling;
- Borehole location and surface elevation (estimated from map if prior to survey). The borehole will be approximately located on a sketch map by measuring distances to prominent surface features.
- Overburden thickness and depth drilled into rock (if applicable); and
- Signature of the log preparer.

Each material type encountered will be described on the log form. Unconsolidated materials will be described as follows:

HTRW DRILLING LOG

1. COMPANY NAME	2. DRILLING SUBCONTRACTOR	HOLE NUMBER SHEET OF SHEETS
3. PROJECT	4. LOCATION	
5. NAME OF DRILLER	6. MANUFACTURER'S DESIGNATION OF DRILL	
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	8. HOLE LOCATION	
	9. SURFACE ELEVATION	
	10. DATE STARTED	11. DATE COMPLETED
12. OVERBURDEN THICKNESS	15. DEPTH GROUNDWATER ENCOUNTERED	
13. DEPTH DRILLED INTO ROCK	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY
22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR		

LOCATION SKETCH/COMMENTS SCALE:

PROJECT HOLE NO.

Figure 4-2
HTRW DRILLING LOG
Plum Brook Ordnance Works

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HTRW DRILLING LOG

HOLE NUMBER	
PROJECT	INSPECTOR
SHEET	OF SHEETS

ELEV. (3)	DEPTH (4)	DESCRIPTION OF MATERIALS (5)	FIELD SCREENING RESULTS (6)	GEOTECH SAMPLE OR CORE BOX NO. (7)	ANALYTICAL SAMPLE NO. (8)	REMARKS (9)

PROJECT

HOLE NO.

Figure 4-2 (cont'd)

- Depositional type (alluvium, till, loess, etc.) and formation (if named and if known);
- Description according to the Unified Soil Classification System;
- Estimated quantities of components, grain or fragment size, grain angularity, sorting;
- Consistency of cohesive materials or apparent density of noncohesive materials;
- Moisture content assessment (dry, moist, wet, saturated);
- Color, using a reference such as the Munsell Soil Color Chart;
- Texture and primary depositional features (e.g., bedding or stratification characteristics);
- Secondary structures and textures (e.g., fractures, fissures, root holes, cementation, precipitates in fissures or other openings);
- Other descriptive features (e.g., presence of organic material, soil horizons, odors, etc.).

Rock materials will be described in accordance with standard geologic nomenclature, including:

- Formation name (if known);
- Rock type, with an appropriate descriptive modifiers (e.g., fossiliferous limestone, garnetbiotite schist);
- Relative hardness;
- Density;
- Color; "Geological Society of America Rock Color Chart";
- Weathering;
- Texture;
- Primary structures (e.g., bedding, vesicularity);
- Secondary structures (e.g., fractures, joints, faults, foliation, lineation, brecciation, solution cavities, empty space coatings or filings); and
- Other descriptive features (e.g., fossils).

Depths to all stratigraphic lithologic changes will be identified by a solid horizontal line at the appropriate scale depth of the log which corresponds to measured borehole depths at which changes occur, measured and recorded to the nearest 0.1 foot. Gradational transitions, changes identified from cuttings or methods other than direct observation and measurement will be identified by a horizontal dashed line at the appropriate depth based upon the best judgement of the logger.

The length and depth of each sampled interval will be clearly identified. Logs will clearly identify the depth at which water is first encountered, the depth to water at the completion of drilling, and the stabilized depth to water. The absence of water in borings will also be indicated. Stabilized water level data will include time allowed for levels to stabilize.

Logs will show borehole and sample diameters and depths at which drilling or sampling methods or equipment change, and total depth of penetration and sampling. The bottom of the hole will be identified on the log by solid double lines from margin to margin with the notion "bottom of hole" or BOH.

Logs will show drilling fluids used, including, as appropriate:

- Sources of makeup water;
- Type of filter for compressed air;
- Drilling fluid losses, including depths at which they occur, rate of loss, and total volume of fluid lost;
- Significant color changes in the drilling fluid return, even when intact soil samples or rock core are being recovered.

Intervals of intact soil sampling attempts will be shown, including depths from which attempts were made and length of sample recovered from each attempt.

Bedrock coring information will be recorded in consecutively numbered runs and will include the following:

- Start and stop time of each core run;
- Depth to top and bottom of each core run;
- Length of core recovered from each run;
- Size and type of coring bit and barrel; and
- Measured depth to the bottom of the hole after core is removed from each run.

Other information relevant to a particular investigation will be indicated in the logs, including but not limited to odors, HNu/OVA measurements, and/or any observed evidence of contamination in samples, cuttings or drilling fluids.

4.5 SAMPLING OF WATER USED IN CORING

One sample of the water used during coring will be submitted for laboratory analysis of explosives residues, metals, base neutral/acid extractable compounds (BNAs), and volatile organic compounds (VOCs).

5.0 WELL INSTALLATION

An inventory will be prepared which lists the materials and equipment for drilling and installing a given well. The inventory will be checked prior to drilling each well to ensure that all needed materials and equipment are available and on-site.

The installation of each monitoring well will begin within 12 hours of boring completion. For the overburden wells, once installation has begun, no breaks in the installation process will be made until the well has been grouted, except in cases of unscheduled delay such as personal injury, equipment breakdown, or sudden inclement weather. For the bedrock wells, the 4-inch casing will be grouted and allowed to set a minimum of 48 hours prior to coring and completing construction of the bedrock well.

Temporary casing and hollow-stem augers may be withdrawn from the boring prior to well installation if the borehole walls will not slough during the time required for well installation.

If the borehole will not remain stable long enough to complete placement of all necessary well construction materials in their proper position, it will be necessary to install some or all of the well materials prior to removal of the casing or hollow-stem augers. The hollow-stem augers or casing will have an inside diameter sufficient to allow the installation of the prescribed diameter screen and casing plus annular space for a pipe through which to place the filter pack and grout.

Any materials, especially soils, blocking the bottom of the hollow-stem augers will be dislodged and removed prior to well insertion.

5.1 WELL CONSTRUCTION

Typical well construction details for the overburden and bedrock wells are shown on Figures 5-1 and 5-2, respectively. All overburden wells will be advanced to top of rock. If rock is encountered at a depth of less than 6 feet, a section of well screen will

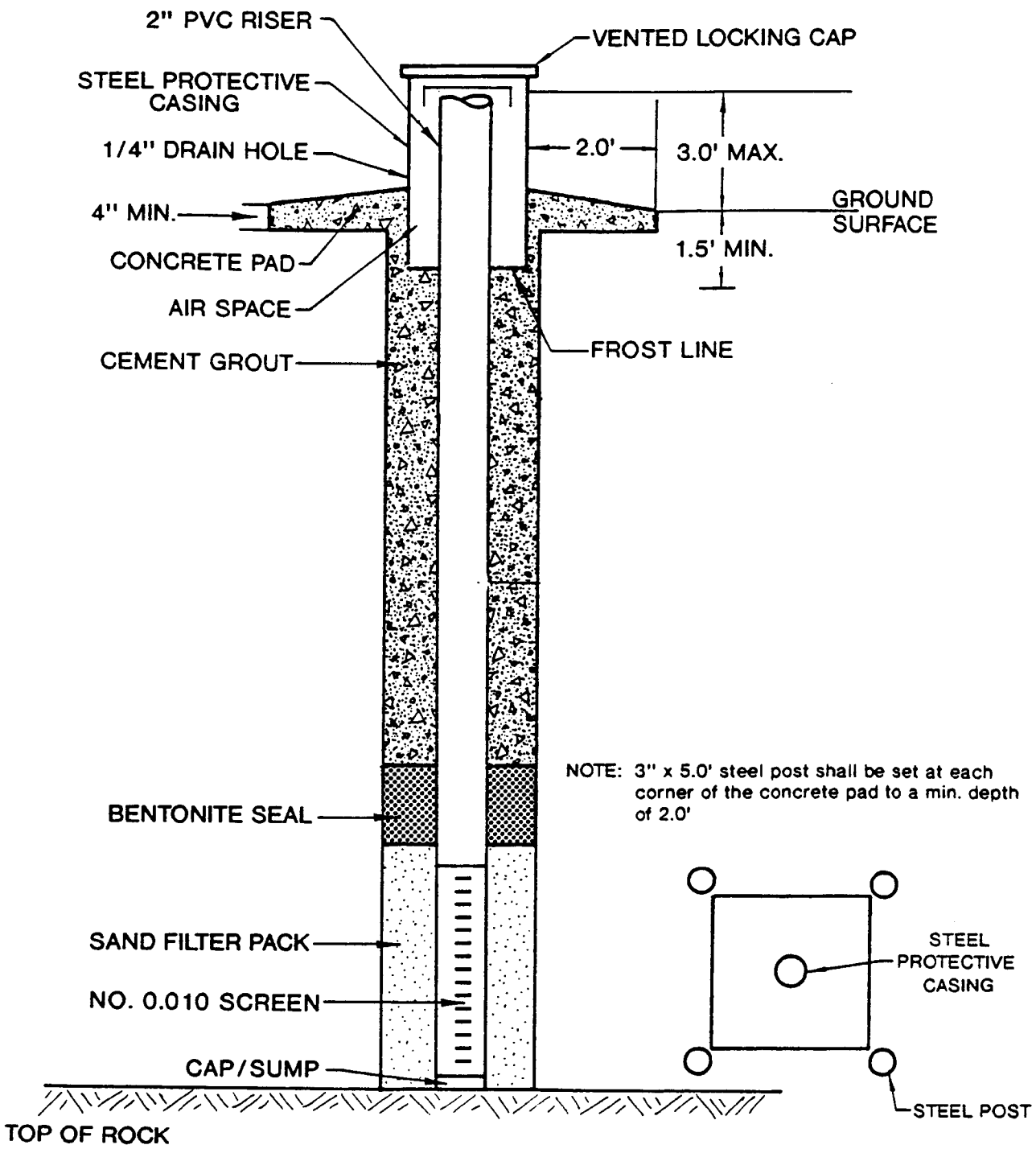

Figure 5-1
TYPICAL OVERBURDEN WELL
Plum Brook Ordnance Works

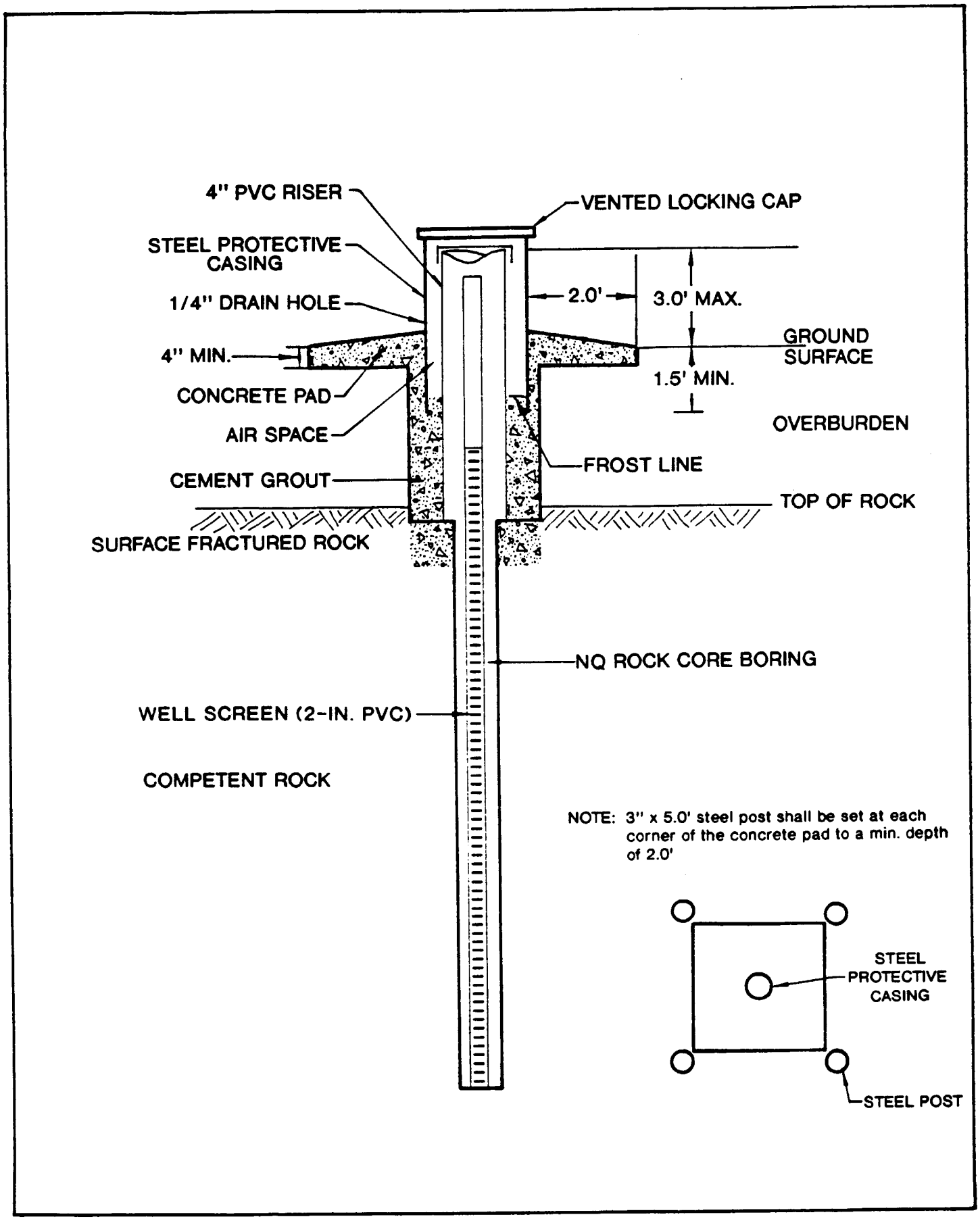

Figure 5-2
TYPICAL BEDROCK WELL
Plum Brook Ordnance Works

be placed in the boring and as soon as possible, and a sample obtained. No filter pack will be used for these installations. After sampling, the well screen will be removed from the boring. If rock is encountered at a depth of 6 feet or greater, then an appropriate screen length will be selected for a proper installation. A sand filter pack will be placed around the screen and, at a minimum, 0.5 foot of sand and bentonite will be used above the well screen. A minimum of 1.5 feet of grout will be placed above the bentonite seal. The screened area of all wells will be from top of rock to a minimum of 1 foot above the water table.

5.1.1 Boring Diameter

Each borehole for the overburden wells will be of sufficient diameter to permit at least 2 inches of annular space between the borehole wall and all sides of the centered riser and screen.

The bedrock wells will have a sufficient diameter (approximately 10 to 12 inches) to allow installation of a 4-inch casing into the top of rock. The borehole diameter below the surface casing will be approximately 3 inches.

5.1.2 Well Riser

The well riser will consist of new, threaded flush-joint PVC pipe with a minimum 2-inch ID for the overburden wells and 4-inch ID for the bedrock wells. In addition, a 2-inch ID riser and screen will be used in the bedrock wells for debris protection only. All well risers will, as a minimum, conform to the requirements of ASTM-D1785 Schedule 40 pipe. The top of each well will be level such that the differences in elevation between the highest and lowest points on the top of the well casing or riser are less than or equal to 0.02 foot. All well risers will be free of foreign matter (e.g., adhesive tape, labels, soil, grease, etc.) and will be washed prior to use. Prewashing is not necessary if the materials have been packaged by the manufacturer and have their packaging intact up to the time of installation. Pipe nomenclature stamped or stenciled directly

on the riser within and below the bentonite seal will be removed via sanding, unless removable in distilled water.

5.1.3 Well Screen

All well screens will be free of foreign matter (e.g., adhesive tape, labels, soil, grease, etc.) and washed prior to use. Prewashing is not necessary if the materials have been packaged by the manufacturer and have their packaging intact up to the time of installation. Pipe nomenclature stamped or stenciled directly on the screen will be removed via sanding, unless it can be removed using water.

The well screen will be sized to the depth of the well, but will not be less than 2 feet and will be constructed of the same material as the riser pipe. The screen will be non-contaminating, factory-constructed slotted or "continuous wrap" design. The screen slot size will be 0.010 inch so as to be compatible with the suspected aquifer material and gravel pack material.

Bottoms of well screens will be at the top of the bedrock in the overburden wells. All screen bottoms will be securely fitted with a threaded cap or plug of the same composition as the screen. This cap/plug will be within 0.5 foot of the open portion of the screen.

A 2-inch diameter PVC well screen will be installed in each bedrock well to prevent blockage of the wells by falling rock and heaving shale. Since the purpose of the well screen is to protect the well from falling debris, this screen will not use a sand pack, seal, or grouting. The debris protection screen used in the bedrock wells will be 0.020 inch slot size.

5.1.4 Screen Location

The screen will be placed in the most appropriate location in the borehole, depending upon the nature of the aquifer materials and water depth. One sieve analysis of the filter pack material and one sieve analysis of the aquifer material from each of the overburden wells will be performed. In all wells, the well screen will be placed to intersect the water table. When possible, the screen will extend 1 foot above the water table. The screened interval will extend to the bottom of the well.

5.1.5 Granular Filter Pack

A clean, inert, noncarbonated material will be selected to construct a uniform and continuous filter pack. The granular filter pack will consist of finely-graded 20/40 sand. The filter pack will be placed by tremie pipe from the bottom of the boring to a minimum of 0.5 feet above the top of the well screen. If possible, the sand pack will be extended 3 to 5 feet above the top of the well screen. The final depth to the top of the granular filter pack will be directly measured (via tape) and recorded.

5.1.6 Bentonite Seals

The bentonite seals will be composed of commercially available pellets. A minimum 0.5 foot thick layer of bentonite pellets will be placed into the annular space between the riser and borehole wall immediately above the filter pack. If possible, a seal 3 to 5 feet in thickness will be installed. The bentonite seal will be installed by slowly releasing the pellets through the well annulus coupled with frequent depth measurements. The final depth to the top of the bentonite seal will be directly measured (via tape) and recorded. The bentonite seal will be sufficiently hydrated with clean, non-chlorinated water to preclude transmission of grout from above into the filter pack or well screen.

5.1.7 Grouting

All prescribed portions of grout material will be combined in an above-ground rigid container (grout mixer) and mechanically blended to produce a thick, lump-free mixture throughout the mixing vessel.

The cement grout will consist of a mixture of portland cement (ASTM C 150) and water in the proportion of not more than 8 gallons of clean water per bag of cement (one cubic foot or 94 pounds). Additionally, 4 to 5 percent by weight of bentonite powder will be added to the cement grout to keep the grout from shrinking.

Grout will be placed around the monitor well as follows:

1. The grout will be placed from within a rigid grout pipe (tremie pipe) located just over the top of the bentonite seal.

2. Prior to exposing any portion of the borehole above the seal by removal of any drill casing (to include hollow-stem augers), the annulus between the drill casing and well casing will be filled with sufficient grout to allow for planned drill casing removal.

   - If all drill casing is to be removed in one operation, the grout will be pumped through the grout pipe until undiluted grout flows from the annulus at ground surface forming a continuous grout column from the seal to the ground surface. The drill casing will then be removed making certain that no portion of the borehole is exposed. When removing hollow-stem augers, this may necessitate reinsertion of the grout pipe and addition of more grout before the entire drill string is removed.

   - If drill casing is to be removed in increments with intermittent grout addition, the grout will be pumped through the grout pipe until it reaches a level which will permit at least 10 feet of grout to remain in the well drill casing annulus after removing the selected length of drill casing.

3. If the ungrouted portion of the hole is less than 15 feet deep and without fluids after casing removal and if the hole is stable, standing open, with no side sloughing, , the ungrouted portion may be filled by pouring grout from the surface without a pipe.

4. Once begun, the grouting process will be continuous until all the drill casing has been removed and all annular spaces are grouted to the ground surface.

5. After 24 hours, grout settlement will be checked. If needed, more grout will be added.

5.2 WELL PROTECTION

At all times during the progress of work, precautions will be used to prevent tampering with the well or entrance of foreign material into it. Upon completion of the well, a suitable protective steel casing will be installed to prevent material from entering the well. Standard commercially available protective casing of quality construction will be used. For security purposes, the protective casing that houses the riser pipe will have a lockable lid. Locks will be placed on each well. Keys to the locks will be provided to NASA which will control access to the wells.

All protective casing will be steam or hot water pressure cleaned prior to placement, devoid of any asphaltic, bituminous, encrusting, and/or coating materials (except the black paint or primer applied by the manufacturer).

The minimum elements of protection design will include:

- A 5-foot length of new protective steel casing with a lockable lid set from the top of the riser pipe to 2 feet into the grout (assumed frost line).
- The protective casing ID will be at least 4 inches greater than the nominal diameter of the well riser.
- The casing will contain a ¼-inch drain hole.
- All padlocks on the wells will be opened by the same key. Four keys will be provided to the CEORN on-site field representative.
- All protective casings will be painted orange with a paint brush. The well designation will be painted on both the outside and inside of each protective casing using white paint and a brush.
- A stamped tag will be attached to the protective casing indicating the well number, USACE Nashville District, and top of casing elevation.

A concrete well pad will be installed around the protective steel casing. The concrete will be a minimum of 4 inches below the ground surface, and will slope downward away from the casing. Four protective steel posts will be installed, one at each corner of the concrete pad. The hollow steel posts will be 3-inches in diameter, 5-feet in length, and set to a minimum depth of 2 feet into the ground and will be filled with concrete.

5.3 WELL CONSTRUCTION DIAGRAMS

A well construction diagram will be completed for each well installed in connection with this investigation. Well construction diagrams will be prepared by the geologist or engineer present during well installation. Well elevations will be surveyed to within 0.1 feet. Dames & Moore will verify all well depths during installation by measurement with a weighted tape. Construction diagrams will accurately depict well details including but not limited to the following:

- The bottom of the boring and boring diameter
- Screen location
- Joint locations
- Granular filter pack
- Seal
- Grout
- Cave in (if any) and other unusual drilling conditions
- Centralizers (if any)
- Protective casing detail
- Base of protective casing below ground surface
- Water level 24 hours after completion with date and time of measurement.

In addition, the following will be described on the diagram:

- Drilling method and fluid used.
- Total depth of well to nearest 0.01 foot.
- The actual quantity, composition, and manufacturer (if known) of the grout, bentonite seals, and granular filter pack used for each well.
- The screen slot size (in inches), slot configuration, total open area per foot of screen, outside diameter, nominal inside diameter, schedule/thickness, composition, and manufacturer.
- The material between the bottom of the boring and the bottom of the screen.
- The outside diameter, nominal inside diameter, schedule/thickness, composition, and manufacturer of the well casing.
- The joint design and composition.
- Centralizer design and composition (if applicable).
- Protective casing composition and nominal inside diameter.
- Special problems and their resolutions (if applicable).
- Dates and times for the start and completion of well installation.
- Ground elevation, riser elevation, and description of protective pad and cap including height the pad extends above the ground surface and depth it extends into the borehole.
- Any deviation from the planned installation methods, procedures, equipment or materials.

6.0 WELL DEVELOPMENT

6.1 INTRODUCTION

Well development will be performed to restore or locally improve the aquifer's hydraulic conductivity and to remove well drilling fluids, cuttings, mobile particulates, and entrapped gases from within and adjacent to the well. The resulting inflow should be physically and chemically representative of the aquifer.

The development of monitoring wells will be initiated not sooner than 48 hours, nor longer than 7 days after grouting is completed. Well development will be completed at least 14 days before well sampling. The intent of this hiatus is to provide time for the newly installed well and backfill materials to sufficiently equilibrate to their new environment and for that environment to re-stabilize after the disturbance of drilling.

Very shallow wells installed without a permanent well screen for the purpose of immediately collecting a grab sample of groundwater will not be developed.

Eight existing wells at the PBOW will be redeveloped in connection with this HTW Investigation. Seven of the wells are overburden wells located in the following areas: three (MK-MW22, MK-MW24, and MK-MW23) in TNT Area A; two (MK-MW17 and MK-MW16) in TNT Area B; one (MW-IT02) at the West Area Red Water Ponds; and one (MW-IT05) at the Pentolite Road Red Water Ponds. A ninth well, installed to an approximate depth of 40 feet at the NASA Reactor Area may also be redeveloped if permission is granted by NASA. The specific well to be redeveloped will be selected in the field with the concurrence of the CEORN on-site field representative.

6.2 WELL DEVELOPMENT METHOD

Well development will be accomplished by pumping and surging techniques. A surge block will be raised and lowered throughout the screened area of the well to draw fine material into the well. After this is done, the well will be pumped or bailed until the water is clear. This process will be repeated until no fines are pulled into the well

during the surging process. For new wells, development will continue for a maximum of 6 hours or until the well appears developed. If after this time the well has not been developed, the Dames & Moore personnel will contact the CEORN on-site field representative for further instructions. Development of existing wells will continue for a period of 1 hour. If after this time the well has not developed, Dames & Moore will contact the CEORN on-site field representative for further instructions.

All downhole development equipment will be thoroughly cleaned prior to use and between wells.

Development water will be containerized and the containers stored at the central drum storage area. The water will be disposed as Investigation Derived Waste.

6.3 DEVELOPMENT CRITERIA

Development will proceed until the following criteria are met:

1. The well water is clear to the unaided eye.
2. The sediment thickness remaining within the well is less than 1 percent of the screen length or less than 0.1 foot for screens equal to or less than 10 feet long.
3. In addition to minimally removing five times the standing water volume in the well (to include the well screen and casing plus saturated annulus, assuming 30 percent porosity), five times any water used in granular filter pack placement will be removed. For those wells where water was introduced into the borehole during drilling (to load the augers for control of heaving sands), five times the amount of water used to load the augers will also be removed.

Should recharge be so slow that the required volume cannot be removed in 48 consecutive hours, the water remains discolored, or excess sediment is present in the well after the five volume removal, the CEORN on-site field representative will be contacted for guidance.

Water will not be added to a well as part of the developmental process. The addition of air inside the screen or casing to develop the well will not be used. However, this does not preclude use of specific tools that use non-contracting air to operate piston pumps.

6.4 DEVELOPMENT WATER SAMPLE

For each well, a 1 pint sample of the last water to be removed during development will be placed in a clear glass jar and labeled with well number and date. These samples will not be preserved. Each sample will be individually agitated and immediately photographed close-up with a 35-mm camera and color print film, using a back-lit set-up to show water clarity. These photos, minimally 5 inch by 7 inch, individually identified with project name, well number, and photo date; will be provided to the COE after all wells are developed. The film negatives will also be provided to the COE.

6.5 WELL WASHING

Part of well development will include the washing of the well caps and the interior of the well casing above the water table using only water from that well. This washing will be conducted before and /or during development. Should any free phase contaminants are present (e.g., petroleum products), the need for washing will need to be evaluated by the COE.

6.6 WELL DEVELOPMENT RECORD

The following data will be recorded on a Well Development Record, a copy of which is presented as Figure 6-1. The following will be recorded on the form:

- Project name, location.
- Well designation, location.

WELL DEVELOPMENT RECORD

1. Project Name: _____

   Location: _____

2. Well Designation: _____

   Location: _____

3. Well Installation:
   Date(s) and Time(s): _____

4. Well Development:
   Date(s) and Time(s): _____

5. Static Water Level

   Before Development: _____ ft below top of casing
   24 Hours After Development: _____ ft below top of casing

6. Quantity of Water
   Added During Filter Placement: _____ gallons
   Added during drilling: _____ gallons

7. Quantity of Fluid in Well
   Prior to Development:

   a. Standing in Well: _____ gallons
      (_____ ft x.17 gal)
   b. Contained in Annulus
      (assuming 30% porosity): _____ gallons

8. Total amount of water to be purged from well: Add amounts from 6 and 7 and multiply by 5 _____ gals x 5 = _____ gals to be purged.

9. Field Measurements of pH, Conductivity, and Temperature:

   a. Before Development:

      pH: _____ conductivity: _____ temperature: _____

Figure 6-1
WELL DEVELOPMENT RECORD
Plum Brook Ordnance Works

b. During Development:

pH: _____ conductivity: _____ temperature: ____ °C/°F

pH: _____ conductivity: _____ temperature: ____ °C/°F

c. After Development:

pH: _____ conductivity: _____ temperature: ____ °C/°F

10. Depth from top of well casing to bottom of well: _____ ft

11. Screen length: _____ ft

12. Depth from top of well casing to top of sediment inside well

    a. Before development: _____ ft

    b. After development: _____ ft

13. Physical character of removed water

    a. Clarity _____

    b. Color _____

    c. Particulates _____

    d. Odor _____

14. Type and size/capacity of pump and/or bailor used:_____

15. Depth of well casing below ground surface (since flush-mount):_____ft

16. Typical pumping rate (if applicable): _____gpm

17. Estimated recharge rate: _____gpm

18. Quantity of water removed: _____ gal.

19. Quantity of sediment removed: ___ gal.

Figure 6-1 (cont'd)

WELL DEVELOPMENT RECORD
Plum Brook Ordnance Works

DAMES & MOORE

- Date(s) and time(s) of well installation.
- Date(s) and time(s) of well.
- Elevation of top of casing (if available).
- Depth from top of well casing to bottom of well.
- Static water level from top of well casing before and 24 hours after development.
- Quantity of mud/water:
  a. Lost during drilling.
  b. Removed prior to well insertion.
  c. Lost during thick fluid displacement.
  d. Added during drilling to load augers for greater head pressures to prevent surging sands.
  e. Added during granular filter placement.
- Quantity of fluid in well prior to development:
  a. Standing in well.
  b. Contained in saturated annulus (assumed 30 percent porosity).
- Field measurement of pH, conductivity, and temperature before, twice during, and after development using an appropriate device and method according to EPA 600/4-79-020: Methods for Chemical Analysis of Water and Wastes.
- Screen length.
- Depth from top of well casing to top of sediment inside well, before and after development (from actual measurements at time of development).
- Physical character of removed water, to include changes during development in clarity, color, particulates, and any noted odor.
- Type and size/capacity of pump and /or bailer used.
- Description of surge technique, if used.
- Depth of casing below ground surface (from actual measurement at time of development).

- Typical pumping rate, if used.
- Estimated recharge rate.
- Quantity of fluid/water removed and time for removal (both incremental and total values).
- Quantity of sediment removed.

7.0 PROJECT ASSIGNMENTS AND PERSONNEL QUALIFICATIONS

7.1 PROJECT ORGANIZATION

The Atlanta office of Dames & Moore will perform and coordinate the field activities described herein. The CEORN Project Manager is Captain Michael Riebel. Dames & Moore will also coordinate the field activities through and in conjunction with Captain Riebel with Ms. Amy Bower of the NASA Plum Brook Station. Ms. Deborah L. Raede will serve as the Project Manager for this project. In this capacity, she will oversee the project activities and review all plans and reports prepared for the project to ensure their concurrence with the project objectives.

7.2 FIELD PERSONNEL RESPONSIBILITIES

Qualified and experienced Dames & Moore geologists and engineers will be responsible for implementing the monitoring well drilling and installation procedures described in this Plan. The Dames & Moore field personnel will monitor activities by the drilling subcontractor and will be responsible for assuring that the work completed complies with the specifications approved for this project. The field personnel will complete the necessary field logs for the borings and monitoring wills and will complete well construction diagrams. They will also maintain a detailed field record of daily activities and events. Classification techniques, boring forms, and well construction diagrams will be completed in accordance with the COE guidance document EM 1110-7-XX (FR) (Draft).

7.3 QUALIFICATIONS OF PERSONNEL INSTALLING MONITORING WELLS

Qualified geologists or engineers will be present during the drilling, installation, and development of the groundwater monitoring wells installed as part of the HTW Investigation at the PBOW and will provide technical observation of all phases of the field work. The personnel will be qualified to log the boreholes and select well depths and screened intervals. Because a significant number of wells will be installed during

the course of this investigation, several project personnel have been identified to perform the field work. Qualified project personnel proposed for monitoring well installation activities include: Mr. Kendall J. Deatherage, Mr. Jeff Endres, Mr. Brent Jacobs, Mr. William Puff, Mr. Martin Shields, Mr. William Smith, Mr. Dale Voykin, Mr. Charles Way, and Ms. Patricia Westermann. Curriculum Vitae for these personnel are provided in the Appendix. If other personnel are to be utilized for monitoring well installation activities during the project, their qualifications will be provided for review prior to their participation in monitoring well installation activities.

Curriculum Vitae

K. JOE DEATHERAGE

TITLE	Engineer
EXPERTISE	Asbestos Inspection and Management Well Purging and Well Development Water and Soil Sampling
EXPERIENCE WITH FIRM	Performed limited asbestos sampling during Phase I site assessments of manufacturing facilities, apartment complexes, office buildings, banks, etc. Most sampling efforts have been performed during sites assessments conducted in Tennessee, Georgia, and Virginia. Incorporated sampling methods and analytical results into the summary reports for clients. Headed a soil sampling team in Umatilla, Oregon, and was in charge of well development and well purging. Also member of water sampling team there. Part of another well purging and water sampling team in Newport, Indiana. Assist with monitoring team for hazardous waste closure site in Oak Ridge, Tennessee. Performed site assessments and UST closure projects. Limited experience in soil gas surveys and unit weight testing of concrete.
ACADEMIC BACKGROUND	B.S. (1989), Civil Engineering, University of Tennessee
CITIZENSHIP	United States
COUNTRIES WORKED IN	United States
LANGUAGE PROFICIENCY	English
CERTIFICATIONS	Inspecting Buildings for Asbestos-Containing Materials Managing Asbestos in Buildings Virginia Asbestos License; Inspector License

* * *

Curriculum Vitae

JEFFREY M. ENDRES

TITLE Staff Engineer

EXPERTISE Geotechnical Engineering

EXPERIENCE WITH FIRM Experience with Dames & Moore as a full-time employee (since June 1990):

- Project Manager of the proposed 47-story Odyssey Tower for the Coca-Cola Company in Atlanta, Georgia. Tasks included: geotechnical engineering analyses related to shallow and deep foundation design and excavation and dewatering methods.

- Performed geotechnical oversight for the American Society of Civil Engineers deep foundation load testing research project in Atlanta, Georgia.

- Performed geotechnical drilling oversight for the Westinghouse Savannah River Company Sanitary Landfill Expansion Project in Aiken, South Carolina. Tasks included: technical supervision of hollow-stem and rotary wash drilling operations; classification of subsurface strata; completion of quality control data sheets; and reporting progress to the client.

- Field and office geotechnical engineer for numerous projects including: two proposed confidential manufacturing facilities in South Carolina; four proposed manufacturing facility additions for the Reynolds Metals Company in Sheffield, Alabama. Tasks included: geotechnical drilling oversight; classification of the subsurface soil and rock strata; laboratory testing of selected soil samples; and geotechnical engineering analyses related to shallow and deep foundation design, including bearing capacity and estimation of potential settlement.

- Project Manager of proposed confidential manufacturing facility in South Carolina. Tasks included: geotechnical drilling oversight; classification of the subsurface strata; laboratory testing of selected soil samples; geotechnical engineering analyses related to foundation design; and preparation of the technical report.

- Supervised fill placement and compaction operations for the SmithKline Beecham Bioscience Laboratory Addition Project, Atlanta, Georgia, and the Southern Mills, Inc., Storage Impoundment Project, Senoia, Georgia.

- Computer program experience related to slope stability and soil settlement calculations.

- Principal investigator for the Westinghouse Savannah River Company R-Area Seepage Basins Remedial Investigation Work Plan in Aiken, South Carolina. Tasks included the development of soil and surfacewater/sediment investigatory procedures.

Employed on a co-operative basis throughout senior year at the Georgia Institute of Technology (June 1989 through June 1990). This employment phase provided experience and training in many aspects of Dames & Moore's services.

- Supervised hollow-stem auger drilling activities and test pit excavations, classified soils, and performed field permeability testing for the proposed Mount Vernon Mills, Inc., spray irrigation field, Alto, Georgia.
- Supervised fill placement and compaction operations for the SmithKline Beecham Bioscience Laboratory Addition Project, Atlanta, Georgia. Procedures included in-place density testing using a sand cone and soil compaction testing.
- Performed geotechnical engineering analyses and laboratory testing of soil samples for various projects.

Employed as a full-time summer intern prior to senior year at the Georgia Institute of Technology (June 1989 to September 1989).

- Supervised on-site hollow-stem auger and rotary wash drilling activities and classified soil strata encountered for the proposed Memphis International Airport Expansion Project, Memphis, TN.
- Performed geotechnical engineering analyses and laboratory testing of soil samples for various projects.

ACADEMIC BACKGROUND

Bachelor of Civil Engineering, Georgia Institute of Technology, 1990.

SPECIAL TRAINING

40-hour OSHA Health and Safety Training in accordance with 29 CFR 1910.120, Hazardous Waste Site Worker Protection Standards.

PROFESSIONAL AFFILIATIONS

American Society of Civil Engineers.

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Curriculum Vitae

BRENT B. JACOBS

TITLE — Project Manager

EXPERTISE — Hazardous Waste Management, Alternative Technology, Site Investigations and Remediation, and UST investigations.

EXPERIENCE WITH FIRM — Joined Dames & Moore in January 1991

- Conducted an extensive six month audit for a major client at a large refinery in east Texas. Audit was performed on a 2½ year, 270 million dollar RCRA remediation project involving solidification of refinery wastes, impoundment and conveyance ditch closures, and Minimum Technology Requirement surface impoundment design and installation. Audited environmental remediation and construction activities and issued detailed audit reports including recommendations which improved the data management and operating facility record keeping for the project. Audit required knowledge of RCRA, TC Rule, Primary Sludge listing, EPA and TWC MTR requirements, EPA Construction and Analytical QA/QC guidance. Provided client with additional consulting services as requested.

- Performed environmental and geotechnical inspection services for a major client during closure of nine crude oil surface impoundments. Conducted treatability study to solidify 60,000 yards^3 of sludges removed from the impoundments. Designed and implemented a QA/QC sampling and testing program to ensure the solidification specifications were met.

- Provided on-site management for UST removals, remedial investigation, and bioremediation of 3,000 cubic yards of TPH-contaminated soils. Negotiated with ADPC&E officials for cleanup levels and implementation of preferred alternative technology. Designed and performed extensive soil sampling program to delineate extent of contamination at the facility. Prepared detailed closure report for all site activities.

- Implemented detailed surface soil sampling and QA/QC program for a chrome plating facility in north Texas. Supervised a sampling team which collected over 400 soil samples on 4 acres of property. Performed background soil sampling and statistical analysis of data to determine cleanup goals. Prepared detailed report for submittal to the Texas Water Commission.

- Supervised UST testing program on multiple sites for major client. Conducted numerous integrity tests (volumetric and tracer) on USTs to ascertain UST system integrity. Provided consultation to client for regulatory compliance of UST program.

- Supervised multiple UST removals for major client. Developed and implemented sampling plan and field screening program during UST removals. Prepared detailed closure reports for submittal to Texas Water Commission.

- Prepared proposals, work plans, cost estimates, and technical presentations for clients.

PAST EXPERIENCE

Roy F. Weston, Inc. (May 1987 to January 1991)
Technical Assistance Team for EPA Region IV, Atlanta, Georgia
Assistant Regional Manager

Assistant Regional Manager for U.S. Environmental Protection Agency (EPA) Technical Assistance Team Contract for Region IV. Provided technical consulting to Region IV Emergency Response and Removal Branch on CERCLA hazardous waste removal actions, remedial investigations, chemical and oil spill emergency responses.

- Manager of ten mutidisciplined personnel. Responsibilities included project assignments, technical report review, field activity coordination, adminstrative duties, and daily interaction with EPA officials. Also responsible for personnel field training and project QA/QC.

- Substantial and varied experience on CERCLA Removal Actions, including such Alternative Technologies as: Insitu-Vapor Extraction, Incineration, Solidification/ Fixation, Waste Stabilization and Ultimate Removal/Disposal.

- Utilization of geophysical (EM-31 and Magnetometer) and soil gas surveys to define extent of contamination and buried drums.

- Experienced in monitoring well installations and closures, multimedia sampling, air monitoring instrumentation, and field screening equipment.

- Provided on-site management for excavation and disposal of 200 buried drums at an abandoned solvent reclaiming facility, installation of a vapor extraction system consisting of 36 extraction and 16 air injection wells, installation of monitoring well network to delineate the extent of groundwater contamination.

- Supervised on-site incineration of 5,500 cubic yards of pesticide contaminated soil at a former crop dusting operation and treatment of 350,000 gallons of contaminated water. Designed and implemented extensive soil sampling program to provide confirmatory analytical data to confirm EPA cleanup levels. Prepared detailed closure report for EPA.

- Conducted on-site supervision during the sampling, segregation, stabilization, and identification of 290 drums of acids, oxidizers, and cyanide wastes at a former plating facility. Performed waste stream categorization of 42 plating vats and management of facility cleanup. Designed and implemented extensive soil sampling program which was instrumental in a successful criminal investigation.

- Conducted on-site supervision of successful solidification of 3,000 cubic yards of PCB-contaminated soils; UST removals; staging, sampling, decommissioning and disposal of 3,000 transformers and 20,000 gallons of PCB and waste oils at the Mowbray Engineering site in Greenville, Alabama.

Roy F. Weston, Inc. (Continued)

- Provided emergency response assessment and remediation oversight at a 17 car train derailment involving 20,000 gallons of toluene and 10,000 gallons of xylene. Remediation actions included extensive soil boring program and monitor well and piezometer networks to delineate extent of contamination, soil excavation and disposal (8,000 yd^3), water treatment (100,000 gallons), product recovery trenches and extraction well installations. Remediated four acres of pastureland utilizing a 500 well insitu vapor extraction system and air injection network.

GeoHydro Engineers, Inc.
Marietta, Georgia
Engineering Geologist, (May 1986 to May 1987)

- Performed geotechnical inspection on construction sites. Considerable experience in soil testing methods (sand cone, drive cylinder, nuclear density gauge), foundation inspections, concrete testing, pile installations, and soil boring programs. Performed inspection services for a wide variety of clients including U.S. Army Corp Engineers.

ACADEMIC BACKGROUND

B.S. Geology, Georgia Southern College, 1983
M.S. Geology, Eastern Kentucky University, May 1986

REGISTRATIONS

Professional Geologist, Tennessee TN0638
Georgia Level II Geotechnician #685-312 II

CONTINUING EDUCATION

Short Course: Application of Bioremediation, Hazardous Materials Research Institute, 1991.
Management By Responsibility, 1989
40 Hour Hazardous Waste Training (Level "B" and "C" certified)
8 Hour Supervisor and Refresher Training
Union Pacfic Railroad Safety Training
Southeast Texas Safety Association, August 1991

CITIZENSHIP

United States

PUBLICATIONS

"Hinson Chemical Superfund Removal Case Study: Buried Drum Removal and In-Situ Vapor Extraction," paper presented at proceedings of Hazardous Materials Control Research Institute Conference, February, 1991.

* * *

Curriculum Vitae

WILLIAM K. PUFF, P.G.

TITLE

Geologist

EXPERTISE

Supervision of environmental and geotechnical drilling operations. Oversight of hazardous waste landfill closure construction and remediation. Supervision of underground storage tank closures.

EXPERIENCE WITH FIRM

Project Manager: Groundwater assessment.
Supervised environmental drilling and rock coring operations.

Project Manager: Environmental Assessment. Supervised soil sampling utilizing a drilling rig fitted with small diameter hollow-stem augers. A split spoon soil sampler was used to obtain samples.

Project Manager for numerous underground storage tank closure.

Geologist providing support in the closure activities of numerous Department of Energy (DOE) Hazardous Waste Landfills.

- Responsible for closure certification reports of hazardous waste facilities.
- Monitoring soil testing operations for low permeability clay caps. Testing parameters included in-place density testing with companion moisture testing.
- Monitored installation of flexible geomembrane liner, drainage net, and geotextile fabric on impermeable clay caps.
- Managed and trained geotechnical assistants while working in the petroleum industry.
- Managed well drilling, logging, coring, and testing subcontractors while working in the petroleum industry.
- Extensive geological well log and geophysical seismic record interpretation.
- Prepared and submitted Environmental Assessment Plans to the Tennessee Department of Environment and Conservation.

ACADEMIC BACKGROUND

B.S., (1977), Earth Science - University of Eastern Connecticut

COUNTRIES WORKED IN

United States

LANGUAGE PROFICIENCY

English

PROFESSIONAL AFFILIATIONS	National Water Well Association
REGISTRATIONS	State of Tennessee Professional Geologist 40-hour Health and Safety Training per 29 CFR 1910.120

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Curriculum Vitae

MARTIN D. SHIELDS, P.E., CHMM

TITLE Project Engineer

EXPERTISE Civil, Environmental and Geotechnical Engineering; Site Remediation; Hazardous Waste Remediation Technologies; Hazardous Waste Cleanup, Transportation and Disposal; Regulatory Permitting; and Project Management

EXPERIENCE WITH FIRM Joined Dames & Moore in January, 1990

- Project Manager for the removal of three Underground Storage Tanks (UST) and engineering design of a free product intercept trench and product recovery system for the cleanup of a Leaking Underground Storage Tank (LUST) site at a compressor manufacturing facility in Hartselle, Alabama. Project responsibilities included: preparation of a Free Product Recovery Plan and UST Closure Report for the Alabama Department of Environmental Management (ADEM); site investigation work; field supervision of the removal operations for the USTs, excavation of petroleum-affected soils, confirmatory soil sampling, loading and disposal of excavated soils to an offsite hot-asphalt mix plant, installation of the free product intercept trench (165-foot long x 15 feet deep) which utilizes a high density polyethylene (HDPE) liner to intercept free product on the confined aquifer, and the installation of six product recovery wells. Provided and continue to provide assistance in soil and groundwater quality compliance efforts as directed by ADEM.

- Project Manager for the cleanup of a Leaking Underground Storage Tank (LUST) site for a major airline at O'Hare International Airport in Chicago, Illinois. Project responsibilities included: preparation of 45-Day Report and Corrective Action Plan (CAP) for the Illinois Environmental Protection Agency (IEPA); site investigation activities; design of an extensive soil vapor extraction system to remove hydrocarbon soil contamination; procurement and preparation of all federal, state and local permits required to construct and operate the remediation system; field supervision of a baseline soil boring program and groundwater sampling of three onsite monitoring wells. Provided and continue to provide assistance in soil and groundwater quality compliance efforts as directed by the IEPA.

- Project Manager of the cleanup of an Leaking Underground Storage Tank (LUST) site for a major airline at Raleigh-Durham Airport in Raleigh, North Carolina. Project responsibilities included: preparation of a Comprehensive Site Assessment and Corrective Action Plan (CSA/CAP) and Quarterly Operational Reports for the North Carolina Department of Environmental Management (NCDEM); site investigation activities; engineering design and field supervision of the installation of a dual-pass air stripper and associated piping leading from the pumping well, seven groundwater monitoring wells, a soil vapor extraction system, a free product intercept sump, a free product recovery system, a 1,000-gallon product recovery tank, a 24-hour groundwater pump test, 20 soil percolation tests and quarterly groundwater sampling of monitoring wells and air stripper. Provided and continue to provide assistance in water quality compliance efforts as directed by NCDEM.

- Performed a baseline inventory and assessment of wash rack systems for the 121st Army Reserve Command for ten Army facilities. Prepared a detailed engineering report of the findings and included recommendations for repairs and improvements.

- Provided project management and engineering support for an extensive groundwater pumping test program for the Westinghouse Savannah River Site in Aiken, South Carolina. Performed and analyzed the results of approximately 150 pump tests.

- Provide project management and engineering support for a RCRA Part B Permit Application and closure permits for a secondary lead smelting operation in Leeds, Alabama.

- Provided project management and seismic engineering analysis for three South Carolina Department of Health and Environmental Control Location Standards Reports for the Safety-Kleen Corporation facilities located in Florence, Lexington, and Greer, South Carolina.

- Developed an extensive water quality computer database for over three years of laboratory groundwater sampling data for 150 monitoring wells for two RCRA Part B Permit Applications for the Westinghouse Savannah River Site in Aiken, South Carolina. Additionally, developed a computer spreadsheet program to group and statistically analyze the water quality database.

- Supervised onsite pile driving of approximately 500 prestressed concrete piles and a 1000-ton pile load test for a 40-story condominium in Honolulu, Hawaii.

- Supervised fill and compaction operations which included field soil density tests for a multi-level concrete parking garage for the United Family Life Insurance Company Building, Atlanta, Georgia.

- Supervised on-site drilling activities which included both hollow stem and rock coring for the proposed Georgian Terrace Apartments in Atlanta, Georgia.

PAST EXPERIENCE

Field Engineer (4/88 - 8/88)
Ardaman & Associates, Sarasota, Florida

- Field duties included: pile driving monitoring, static load testing of driven piles, surveying, permeability testing, SPT testing, groundwater surveys, concrete testing, and site investigations. Office duties included: developing LOTUS 1-2-3 spreadsheets to analyze field data, writing reports, and laboratory testing of soils.

ACADEMIC BACKGROUND

B.S. in Civil Engineering, 1988, University of Florida
M.C.E. in Geotechnical Engineering, 1989, University of Florida

REGISTRATION

Registered Professional Engineer: Georgia (No. 20686)
Certified Hazardous Materials Manager (CHMM No. 4561)
40-hour Health & Safety Training per 29 CFR 1910.120
8-Hour Hazardous-Waste-Site Supervisor/Manager Training per 29 CFR 1910.120 (e)

PROFESSIONAL AFFILIATIONS	American Society of Civil Engineers Tau Beta Pi Engineering Society Professional Environmental Marketing Association (PEMA)

* * *

Curriculum Vitae

WILLIAM G. SMITH, P.G.

TITLE Senior Geologist

EXPERTISE Project Management
Geology, Hydrogeology
Geophysics, Marine Geology, and Subsurface Engineering Explorations

EXPERIENCE WITH FIRM Experience with firm as Project Manager and/or Principal Investigator for numerous hazardous waste, remediation, geologic, hydrologic, geotechnical, marine, and multi-discipline projects. Joined Dames & Moore in June, 1968.

Selected Projects

- Hazardous waste investigations at numerous sites located in the southeastern U.S.; provided project management, and was responsible for overall accuracy and quality of field and office studies. Investigations included site reconnaissance, field explorations to define geologic and hydrologic site conditions, development of soil, sediment, and water sampling plans, design and installation of monitoring well fields, soil and groundwater sampling and testing, evaluation of chemical testing results, bench test reviews, alternative remedial options evaluations, recommendations and reports.

- Project Manager and Principal Investigator for specifications, design, permitting, and installation of ultraviolet oxidation remediation system for groundwater contaminated with high levels (95 ppm) of TCE. Project has included installation of recovery well and performance of pump test using carbon filtration of pumped groundwater for permit discharge.

- Project Manager for large groundwater investigation at RCRA site in NW Georgia. Water contaminated from former PCB use at facility located on crystalline limestone. Some solvent contamination also occurs. Project includes extensive monitoring well field, quarterly sampling analyses, reporting, and evaluation of remediation options.

- Project Manager for RCRA site in Georgia impacted by metals from closed landfills. Project included detailed geologic and hydrogeologic investigations, installation of an extensive monitoring well field, quarterly groundwater sampling, stream sediment sampling, groundwater recovery wells, and water modeling.

- Project Manager for the remediation of trychlorethylene (TCE) contaminated site. Dames & Moore, Inc. designed and constructed a mobile vacuum extraction facility, installed extraction wells, piping, filters, and instrumentation. Site soils were remediated within nine (9) months, with over 2,000 lbs of TCE recovered.

- Removal of 8,000-gallon gasoline and 10,000-gallon diesel fuel USTs. As part of this project a determination of hydrocarbon contamination due to spillage of materials was conducted. A series of borings were installed to estimate the extent of contamination and the vertical and lateral movement of the

contaminant. A Corrective Action Plan was prepared. The contaminated soils were excavated and successfully processed by a portable on-site incinerator to levels below 10 ppm TPH.

- Project manager for installation of deep monitoring well field at large nuclear processing site. Obtained continuous core and tube samples for geologic correlation. Borings were geophysically logged for added correlation. Project included RCRA Part B applications.

- Managed removal of numerous large underground tanks in Georgia and Tennessee. Investigated sites in Georgia, Alabama, Tennessee and North and South Carolina varying from one to several acres in size using soil sampling, soil gas monitoring, surface water sampling, monitoring well installation, groundwater sampling, and chemical analyses. Several sites are presently in remediation stage.

- Investigation and remediation of large site (several acres) contaminated by underground storage tank petroleum and chlorinated hydrocarbon leakage. Reviewed previous reports by others. Installed soil borings and monitoring wells. Developed Corrective Action Plan. Installed deep pumping well to control spread of contaminants and enable free product recovery. Design of soil and groundwater treatment methods in progress.

- Provided project management and geologic evaluations for investigations and recovery of a large underground storage tank hydrocarbon spill in highly urbanized location. Over 3,000 gallons of liquid hydrocarbon recovered. Soil washing and enhanced natural bioremediation implemented. Final soil and groundwater remediation measures in preparation.

- Project manager for site contaminated with heavy fuel oil. Project has included area well and surface water supply survey for risk assessment, contaminated soil excavation and incineration, sampling, and is in groundwater evaluation stage.

- Project Manager for an Underground Storage Tank Compliance Program for a major international airline. These studies were conducted at airport terminals and maintenance facilities throughout the United States. The compliance audits covered the following regulations: air emissions, water discharges, Spill Prevention Control and Countermeasures (SPCC) Plans, hazardous waste, solid waste, underground storage tanks (UST), and emergency planning and community right-to-know. As part of the project a large underground tank farm was removed at an international airport and an enhanced biodegradation program was developed for a large quantity of contaminated soil (Jet fuel). The soils were remediated to hydrocarbon levels of less than 35 ppm, well below the 100 ppm remediation level for soil at this site.

- Site identification study for proposed nuclear waste repository in Triassic Basin rocks of Eastern United States. Performed as Project Manager and a Principal Investigator. Acquired available geologic and hydrologic data and interviewed principal information sources. Reviewed and evaluated total data base for each basin, established criteria, and identified and rated potential sites.

ACADEMIC BACKGROUND	BS, 1966, Geology and Physics, Emory University, Atlanta, Georgia.
PROFESSIONAL AFFILIATIONS	Association of Engineering Geologists; Marine Technology Society; Sigma Gamma Epsilon
REGISTRATION	Professional Geologist: Georgia (1977), Maine (1974), North Carolina (1985), South Carolina (1988), Tennessee (1988), Florida (1989), and Arkansas (1989)

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Curriculum Vitae

DALE P. VOYKIN, P.G.

TITLE Senior Hydrogeologist

EXPERTISE Groundwater Remediation, Remedial Investigations/Feasibility Studies, Tank Closure, Environmental Assessments, Groundwater Modeling, and Aqueous Geochemistry

EXPERIENCE

- Groundwater Remediation - Designed a monitoring program to identify the rate and extent of migration of an underground storage tank gasoline discharge at a facility located in a large metropolitan area in the southeast. Implemented and managed a remedial free product recovery operation that has been ongoing without incident or disruption of the facility's normal business routine (over 1,500 gallons recovered). Designed and implemented a soil washing program and enhanced natural bioremediation measures. Additional soil and groundwater remediation in preparation.

- Groundwater Remediation - Designed and installed a monitoring program to identify the rate and extent of a underground storage tank gasoline release at a facility near Atlanta, Georgia. Developed and implemented a state-approved remedial recovery program for a several acre site subject to investigation. Site Remediation in progress.

- Groundwater Assessment - Designed and implemented a monitoring program to assess the degree of contamination at a former roofing manufacturing operation in eastern Georgia, prior to purchase of the property by a confidential client.

- Groundwater Assessment - Designed and managed various programs to evaluate the extent of groundwater and soil contamination from former Underground Storage Tanks and, where applicable, to remediate any resulting groundwater and soil contamination at various properties purchased by PYA Monarch, Inc., in Georgia, South Carolina, Virginia, and Pennsylvania.

- Groundwater Assessment - Designed and presently manage a program for the determination of the extent of groundwater contamination at large multi-acre site, resulting from former PCB use at a General Electric facility in Rome, Georgia, where medium transformers were constructed. Presently in development of a site-wide remediation plan.

- Groundwater Assessment - Designed and implemented a groundwater monitoring program to aid in the exoneration of a confidential client involved with primary metal generation and fabrication in Alabama.

- Groundwater Assessment - Designed and managed a hydrogeologic assessment to determine the degree of contamination resulting from past operations at an explosives manufacturing facility (Piedmont Explosives) near Statesville, North Carolina, prior to its sale.

- Groundwater Assessment - Performed hydrogeologic evaluations to determine the degree and extent of groundwater contamination resulting from former wood treating operations and discharges from underground hydrocarbon storage tanks situated at property acquired by Georgia-Pacific Corporation near Atlanta.

- Groundwater Remediation - Implemented a monitoring program to assess the degree of contamination of a property in southern Georgia, formerly used for storage of fertilizer and K061 wastes. Designed a state-approved remediation program for Mutual of New York, who unknowingly accepted responsibility for the property through foreclosure.

- Groundwater Contamination - Managed a program for post-closure monitoring and aquifer characteristic delineation at a closed Superfund site formerly operated by Monsanto Industrial Chemical Company, Augusta, Georgia.

- Groundwater Contamination - Designed and implemented the hydrogeologic evaluation phase of an engineering study to determine the contamination potential of Georgia-Pacific Corporation's solid waste disposal practices at its Monticello, Mississippi, pulp and paper plant.

- Groundwater Development - Performed a fracture-trace analysis which resulted in the development of a much more productive industrial well in low-yield terrain (crystalline rock) at Photocircuits Atlanta, Inc., Peachtree City, Georgia.

- Groundwater Contamination - Managed and performed a Phase I Confirmation Study at one of five sites identified for further study by an earlier Initial Assessment Study (IAS) at the U.S Naval Weapons Industrial Reserve Plant in Bristol, Tennessee. This study evaluated the immediate threat to the environment by specific toxic or hazardous materials.

- Groundwater Development - Determined the subsurface hydrogeologic conditions within a 55 square mile reserve being developed in western Florida (Sarasota County), to supplement the existing public water supply, through the combined augmentation of both surface and groundwater sources.

- Groundwater Development - Determined the anticipated impact of a proposed subdivision on existing groundwater usage, Woodward Properties, Barrow County, Georgia.

- Groundwater Contamination - Performed a confidential analysis of the subsurface flow regime and impact on groundwater quality due to phosphate mining; towards the eventual development of an acceptable remediation plan, Nichols, Florida.

- Groundwater Contamination - Aided the development of the exposure assessment (groundwater pathway) for the Savannah River Plant, Aiken, South Carolina. Performed a detailed review of existing conditions for compliance with RCRA groundwater monitoring regulations; towards eventual certification.

- Groundwater Contamination - Provided expert testimony, as a rebuttal witness, at a hearing involving closure of a commercial hazardous waste facility (Sechan Industries vs. Commonwealth of Pennsylvania), Pittsburgh, Pennsylvania.

PAST EXPERIENCE

Pennsylvania Division of Hazardous Waste Management

- Coordinated, evaluated, and developed Pennsylvania's permit review program for groundwater monitoring at all hazardous waste land disposal (RCRA TSD) facilities.

- Supervised the RCRA enforcement efforts of nine Regional Hydrogeologists.
- Reviewed all detection monitoring results and directed the assessment and abatement efforts at 74 TSD facilities.
- Provided expert testimony at various TSD litigative closures (Commonwealth Court and Pennsylvania Environmental Hearing Board).
- Responsible for hydrogeologic input at all negotiated TSD Consent Orders and Agreements for RCRA compliance.
- Coordinated the statewide emergency remedial response at all spills of hazardous waste within the Commonwealth.

Pennsylvania Bureau of Water Quality Management

- Coordinated an Aquifer Designation Study which identified and classified Pennsylvania's 356 Groundwater Basins.
- Supervised a team of seven hydrogeologists in the development of technical standards, regulations, policy and procedure, permit requirements, and guidance documents for a proposed program to control underground injection of wastes.

Pennsylvania Bureau of Land Protection (Central Pennsylvania Regional Office)

- Responsible for the hydrogeologic review and field investigation of all permit applications concerning industrial waste impoundments, spray irrigation of treated wastewater, public water supply wells, salt storage locations, mine seals, mine refuse disposal, fly ash disposal, municipal waste disposal, demolition sites, sludge disposal, brine injection, and hazardous waste storage.
- Principal field investigator of all reported groundwater pollution problems. Directed the on-site emergency remedial response at all reported waste spills.
- Investigated and directed the groundwater clean-up efforts at more than 30 separate incidents of petroleum contamination due to leaking underground storage tanks or transmission pipeline breaks.

ACADEMIC BACKGROUND
B.S. (1970), Geology, Washington State University
Graduate Study (1971), Geology, Washington State University
Graduate Study (1982-1985), Hydrogeology, University of Pennsylvania at Millersville.

CITIZENSHIP
U.S.

COUNTRIES WORKED IN
Germany, Thailand

PROFESSIONAL AFFILIATIONS
International Association of Engineering Geologists
American Water Resources Association
American Institute of Professional Geologists
Association of Groundwater Scientists and Engineers
National Water Well Association, Technical Section

Water Pollution Control Association
Georgia Groundwater Association
Harrisburg Area Geological Society

PROFESSIONAL REGISTRATION
Certified Professional Geologist (AIPG) No. 6983
Licensed Professional Geologist, North Carolina, No.210
Registered Geologist, South Carolina, No. 637
Professional Geologist, Florida, No. 787
Professional Geologist, Arkansas, No. 1193

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Curriculum Vitae

CHARLES G. WAY, III

TITLE Staff Geologist

EXPERTISE Investigative Drilling, Geologic and Environmental Sampling of Soils and Water, Fill Control Supervision

EXPERIENCE WITH FIRM

Geotechnical Experience

- Principal Field Investigator for geotechnical investigation for Liquid Nitrogen Gas Tank Site in South Carolina.
- Principal Field Investigator for geotechnical investigation for runway and taxiway extensions at Memphis Airport, Tennessee.
- Principal Field Investigator for geotechnical investigation for runway and taxiway extensions at Henry County Airport, Georgia.
- Principal Field Investigator for geotechnical and hydrogeologic investigation for textile plant in Central, Georgia.
- Principal Field Investigator for geotechnical investigation for parking deck in Atlanta, Georgia.
- Field Investigator for geotechnical investigation for Kaolin Plant in Central, Georgia.
- Fill Control Supervisor and inspector for SmithKline Bioscience Laboratory building and parking lot expansion.
- Fill Control Supervisor and inspector for United Family Life Parking Deck and Western Kraft Box Company building and parking lot expansions.
- Principal Field Investigator for geotechnical investigation for General Electric building expansion.
- Principal Field Investigator for geotechnical investigation for wastewater treatment plant expansion.
- Principal Field Investigator for geotechnical and hydrogeologic investigation in Northwest, Alabama.
- Principal Field Investigator for geotechnical investigation in Ellijay, Georgia.
- Principal Field Investigator for geotechnical investigation at site in Southwest, Georgia.

Environmental, Hydrogeologic, and Geologic Experience

- Principal Field Investigator for geohydrologic studies at site in Southern Georgia. Duties included installation, developing and sampling of monitoring wells and report preparation.

- Principal Field Investigator for geohydrologic studies at site in Atlanta, Georgia. Duties included installation, developing and sampling of monitoring wells and report preparation.

- Principal Field Investigator for site in North Carolina. Duties include drilling supervision and sampling of soil near UST to check for leakage.

- Principal Field Investigator on several sites around Atlanta, Georgia. Duties include drilling supervision and sampling of soils to check for hydrocarbon contamination. Also prepared reports for the jobs.

- Principal Field Investigator at a petroleum tank farm in Alabama. Duties include installation, developing and sampling of monitoring wells. Also install vapor probes around various parts of site and extracted vapors for laboratory analysis.

- Principal Field Investigator for vapor probe installation at landfill site in Central, Georgia.

- Inspector for underground storage tank removal at site in Atlanta, Georgia.

- Field Investigator at an Old Tannery in Sako, Maine. Duties included environmental sampling of sludges, stains and soils.

- Principal Field Investor for geohydrologic studies at site in Upson County, Georgia. Duties include drilling and monitor well installation oversight.

- Principal Field Investigator for geohydrologic studies at site in Rome, Georgia. Duties include drilling and monitor well installation oversight and report preparation.

- Responsible for retrieving groundwater samples from monitoring wells on a quarterly basis at two sites in Georgia.

- Principal Field Investigator for geohydrologic studies at site in Greenville, S.C. Duties include drilling and monitor well installation oversight. Also responsible for retrieving groundwater samples from the monitoring wells.

- Principal Field Investigator for geohydrologic studies at site in Brunswick, GA. Duties include drilling and monitor well installation oversight. Also responsible for retrieving groundwater samples from the monitoring wells.

- While on temporary transfer to Phoenix, Arizona, responsible for monitoring well installation oversight, along with drilling oversight for several environmental job sites. Also responsible for writing reports for jobs and arranging job setup.

- Inspector for underground storage tank removal at site in Forest Park, Georgia.

- Principal Field Investigator for hydrocarbon contamination in Chattanooga, Tennessee.

PAST EXPERIENCE

- While working with drilling firm in Atlanta, Georgia, installed monitoring wells along with various other subsurface investigations for office buildings, malls and subdivisions.

ACADEMIC BACKGROUND

Bachelor of Science Degree in Geology from Georgia Southern University - Graduated August 1984

CERTIFICATES

40 hour Health and Safety trained
Site Safety Supervisor

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Curriculum Vitae

PATRICIA M. WESTERMANN

TITLE Project Geologist

EXPERTISE Geologic and Hazardous Waste Investigations, Environmental Assessment and Regulatory Compliance, Underground Storage Tank Regulations.

EXPERIENCE Ms. Westermann joined Dames & Moore in 1985. During the last two years, she has performed numerous projects for the U.S. Army Corps of Engineers, Nashville District and Missouri River Division. She also manages two ongoing remediation projects in the Atlanta, Georgia area and has worked extensively throughout the Southeast on hazardous waste investigation and real estate transaction projects. She is familiar with federal and state regulations, and routinely prepares Work Plans and Investigation Reports and manages projects involving site assessments and data validation.

Geologic and Hazardous Waste Investigations

- Project Manager for a hazardous, toxic, and radioactive waste (HTRW) site investigation for the Marmet Lock Replacement Project, Contamination Evaluation for the Nashville District of the U.S. Army Corps of Engineers. The evaluation included preparation of Sampling and Analysis, Chemical Data Acquisition, and Health and Safety Plans; field investigations including monitoring well installation and groundwater sampling, soil sampling, trench exploration, sediment sampling, and a geophysical survey; preparation of the Chemical Quality Summary Report; and preparation of an Investigation Report, including aerial photograph interpretation, data validation, groundwater and soil quality assessment, establishment of action levels, and preparation of a plan and costs for remedial action.

- Project Manager for a hazardous and toxic waste survey (HTW) for 38 properties located in Grundy, Virginia.

- Prepared the Sampling and Analysis Plan for additional data collection activities for the former American Car & Foundry/Winfield Risk Assessment Project located in Winfield, West Virginia. The field activities included soil, groundwater, sediment, surface water, and plant sampling. Health and Safety Officer during field activities.

- Project Manager for a HTW Construction Site Clearance for the Kingsbury Local Training Area located in LaPorte, Indiana. The investigation will include soil sampling, a geophysical survey, chemical evaluation, and Work Plan and Engineering Report preparation.

- Project manager for a bioremediation project at a gasoline-contaminated site located in Atlanta, Georgia.

- Supervised on-site drilling and conducted geology field work at various hazardous and non-hazardous sites. Work has been conducted in support of dam design, underground storage tank and various geotechnical and ground water monitoring projects.

- Assisted in preparation of the RCRA Part B Applications for waste management facilities at the Savannah River Plant. Prepared boring logs, various geologic maps and cross-sections, and selected sections of the text.

- Conducted a Phase II study which involved the collection of smear tab wipe samples to measure heavy metals contamination in four warehouses and soil samples to measure the vertical and horizontal extent of heavy metals contamination. Level "C" personal protective gear was worn during the warehouse sampling. Reviewed the analytical results and prepared the report of findings, interpretations, and recommendations. The report was submitted to the client and EPA Region IV.

- Prepared Project Management, Sampling and Analysis and Data Management Plans and the geology, facility background, and environmental setting sections of RFI Work Plans.

- Assisted in hydrogeologic monitoring (drawdown and water level studies) for a hazardous spill site in downtown Atlanta.

- Prepared data management plans for a secondary lead smelter hazardous waste site in Alabama. Plans were required under court order and were reviewed and approved by both ADEM and the EPA. Implemented the extensive data management system which includes soils, ground water, surface water, stream sediment, and downstream water system studies.

- Prepared surface and interpretive subsurface structural geology maps designed to depict both the aerial geology and the economic potential of the deposit for a commercial mining site.

- Managed and performed an environmental assessment and subsequent soils investigation at a manufacturing facility located in Athens, Georgia. Phase II included identification of a hazardous waste spill area, collection of soil samples from shallow, hand auger borings, sample analysis, interpretation of the results, contacts with the Georgia EPD, and recommendations to the client concerning regulatory requirements and remedial options.

- Managed and performed investigations to test for hazardous constituents in the subsurface soils at two adjacent parking lot sites (formerly a dry cleaning facility) located in downtown Atlanta, Georgia.

- Performed soil and sediment sampling at Gaston Copper Recycling Company facility located in Gaston, South Carolina as part of a comprehensive environmental assessment and regulatory audit of the site.

- Performed numerous pumping tests of monitoring wells at the Savannah River Site. Gained proficiency with transducers and "Hermit" dataloggers and rate test and pump test techniques.

Environmental Assessments and Regulatory Compliance

- Performed several environmental site assessments for property transfers, which included site reconnaissance and regulatory review. Sites include former cement

production facilities, one of which is on the State of Tennessee CERCLA list, and other industrial sites located throughout the Southeastern United States. Regulatory compliance reviews have been performed in Georgia, Tennessee, Virginia, North Carolina and Alabama.

- Conducted a regulatory compliance audit of an electroplating facility located in Greenwood, South Carolina. The audit consisted of site visits and employee interviews, review of state and local regulatory agency files, identification of applicable local and state regulations and evaluation of the compliance status of the site.

Underground Storage Tanks

- Responsible for obtaining, reviewing, and summarizing Underground Storage Tank State and Federal Regulations and for updating office personnel on new regulations.

- Performed testing of subsurface soils at former petroleum and hazardous waste underground storage tank sites in Georgia, Tennessee, South Carolina, and Pennsylvania. Included review of applicable regulations, laboratory analysis of samples, and evaluation of the environmental integrity of sites.

- Prepared a Corrective Action Plan and serves as the Project Manager for a project involving petroleum contamination from an underground storage tank system in Georgia.

ACADEMIC BACKGROUND

B.S., Geology, Emory University, 1985

ASTM Short Course: Ground Water and Vadose Zone Monitoring and Sampling Technology

Association of Engineering Geologists Technical Training Seminar; Underground Storage Tanks

Association of Engineering Geologists Short Course: Geology and Site Characterization of Hazardous Waste Sites.

Completed 40-hour, EPA-approved, Hazardous Waste Worker Training Seminar, University of Alabama

Completed 8-hour Supervisor's Training Seminar

Completed 40-hour, Quality Assurance Auditor Training Course

AFFILIATIONS

Association of Engineering Geologists
International Association of Engineering Geologists
Georgia Groundwater Association

* * *

WORK PLAN

PART III
SITE-SPECIFIC SAFETY AND HEALTH PLAN

FOR

HAZARDOUS AND TOXIC WASTE INVESTIGATION
PLUM BROOK ORDNANCE WORKS
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
SANDUSKY, OHIO

Plan Number: ATL-DP-156

Approved By: E. E. Fischer
Kenneth E. Fischer, CIH

Date: 10-17-94

Prepared for:

U.S. Army Corps of Engineers
Nashville District

Prepared by:

Dames & Moore, Inc.
Atlanta, Georgia
Job No. 24637-035-009

OCTOBER 1994

WORK PLAN

PART III
SITE-SPECIFIC SAFETY AND HEALTH PLAN

FOR

HAZARDOUS AND TOXIC WASTE INVESTIGATION
PLUM BROOK ORDNANCE WORKS
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HAZARDOUS AND TOXIC WASTE INVESTIGATION
PLUM BROOK ORDNANCE WORKS
PLUM BROOK STATION/NASA
SANDUSKY, OHIO

1.0 INTRODUCTION

1.1 PLAN OBJECTIVE

Dames & Moore, Inc. (Dames & Moore) is performing a Hazardous and Toxic (HTW) Investigation at the Plum Brook Ordnance Works (PBOW) in Sandusky, Ohio for the U.S. Army Corps of Engineers, Nashville District. The purpose of the HTW Investigation is to identify areas of contamination that may have impacted the soil, sediment, groundwater and surface water on the site. The health and safety of site personnel and the public is a primary concern during the field investigations at the PBOW site. Thus, a comprehensive, carefully managed, and thoroughly documented Site-Specific Safety and Health Plan (SSHP) is crucial for successful project completion. Dames & Moore's Health and Safety Program was developed by physicians and certified industrial hygienists (CIHs) to be protective of field personnel. All Dames& Moore SSHPs are reviewed by a divisional Health and Safety Director who is a CIH.

This plan is based on available background information and an on-site inspection. It addresses field implementation of the SSHP, specific responsibilities, training requirements, protective equipment, site operating procedures, emergency procedures and medical monitoring. Its flexibility allows unanticipated site-specific problems to be addressed while providing adequate and suitable worker protection.

The SSHP will be bound with other pertinent information and used by the Site Safety Officer and field team members as a field reference manual for safety, health, and emergency response procedures. The complete SSHP will be discussed with all site personnel and a copy will be provided to each Site Safety Officer, Site Supervisor, and

Drilling Supervisor to ensure sufficient awareness of potentially hazardous conditions and safety procedures on the site.

The SSHP addresses all phases of field operations at the site, including:

- Names of key personnel responsible for site safety and health
- Work practices
- Hazard identification and assessment
- Established work zones
- Level of personal protective equipment required in each zone
- Sampling procedures
- Entry and exit routes
- Decontamination procedures
- Accident/emergency response
- Medical surveillance
- Training
- Record keeping

1.2 SITE HISTORY

The PBOW is located 4.7 miles south of Sandusky, Ohio and 59 miles west of Cleveland, Ohio in Erie County. The original site consisted of 9071.06 acres of land which was acquired by the Department of Defense (DoD) in 1941. An ammunition plant was constructed on this site and operated by Trojan Powder Company for DoD until 1945. After operations ceased, the magazine area was renamed Plum Brook Depot and was used for ammunition storage. This area was also referred to as Erie Ordnance Depot. The facility was placed on inactive status in June 1961. The National Aeronautics and Space Administration (NASA) acquired the PBOW and Plum Brook Depot on March 15, 1963. On April 18, 1978, NASA declared 2152.15 acres of land as excess. 46.023 acres of this excess were conveyed to the Perkins Board of Education on June 2, 1978. The General Services Administration (GSA) retained the remaining acreage and currently has a use agreement with the Ohio National Guard for 604 acres of the site.

NASA is currently using their site to conduct space research as a satellite operation of NASA, Lewis Research Center in Cleveland, Ohio. Most of the original structures from the PBOW were removed by NASA, and NASA has constructed numerous facilities on the site since its acquisition. Past disposal practices during the period of DoD control are undocumented. Possible effects of past disposal practices on groundwater and surface water at the site are also unknown. Explosives manufacturing and/or handling at the site resulted in the operation of holding ponds which processed waste water. This process waste water may have contained residues of the explosive manufacturing process and may have been acidic in nature. Limited site investigations were conducted by IT Corporation and Morrison Knudsen Corporation in January 1991, and January 1994. Records of these investigations have been reviewed by Dames & Moore. A Hazard Ranking System analysis performed by Morrison Knudsen Corporation indicated a relative threat of actual or potential releases of hazardous substances well below the National Priority List (NPL) threshold.

1.3 FIELD INVESTIGATION ACTIVITIES COVERED UNDER THIS SSHP

The field investigation tasks to be performed at the PBOW that will be covered by this SSHP include:

- Visual site inspection;
- Surface and subsurface soil sampling (from hand-augured and machine drilled borings);
- Sediment sampling (from a 16 foot aluminum john boat and by wading);
- Surface water sampling (from the john boat and by wading); and
- Installation of deep and shallow groundwater monitoring wells and subsequent groundwater sampling.

Sampling of groundwater wells will also involve the sampling of existing wells including the wells in the reactor area. Historical sampling of these reactor area wells by NASA indicates that the groundwater is not radioactive. Dames & Moore will review the results of NASA's October 1994 sampling to confirm that the water is not radioactive prior to purging and sampling these wells.

1.4 HAZARD POTENTIAL

Potential hazards that may be incurred at the site include:

- Exposure to chemicals via inhalation or skin contact,
- Explosion and/or flammability of contaminants,
- Heat stress,
- Hypothermia/cold stress,
- Boating/water hazards, and
- Hazards associated with routine sampling investigations.

Intrusive activities such as soil and sediment sampling, and groundwater and surface water sampling, will increase the potential for exposure to hazardous materials via soil or water contact and inhalation due to volatilization of potential organics present in contaminated media.

Table 1-1 lists the tasks to be performed at this site and the associated risks or hazards associated with the work and Dames & Moore's presence on the site.

Numerous deer and wildlife live on the site. Precautions will be taken to avoid hitting wildlife and to remain safe while driving on-site. Dames & Moore has been informed that NASA may restrict access to certain areas of the site because of road work or NASA testing exercises in these areas. NASA will place road blocks restricting access to these areas. Dames & Moore and its subcontractors will honor all NASA road barricades and will not cross them under any circumstances. Alternate traffic routes will be selected and used.

1.5 CONSTITUENTS OF CONCERN

The primary constituents of concern are listed in Table 1-2. Table 1-3 provides the regulatory limits, immediately dangerous to life and health (IDLH) levels, upper explosive limit (UEL), lower explosive limit (LEL), ionization potential, and health hazards for these constituents. Concentrations of contaminants in the potentially

TABLE 1-1

ACTIVITY HAZARD ANALYSIS
PLUM BROOK ORDNANCE WORKS
HAZARDOUS AND TOXIC WASTE INVESTIGATION

Contract No. DACA62-92-D-0015 Delivery Order No. 0020	Project: Hazardous and Toxic Waste Investigation	Facility: Plum Brook Ordnance Works/ NASA, Lewis Research Center, Plum Brook Station
Date: 15 September 1994	Location: Sandusky, Ohio	Estimated Start Date: 3 October 1994

Item	Phase-of-Work	Safety Hazard	Precautionary Action to be Taken
1	General Non-Phase-Specific	General	1. Attend site safety briefing and updates as necessary. 2. Review contents of Site-Specific Safety and Health Plan and question any activities or instructions not understood. 3. Take precautions in operation of heavy equipment, DO NOT operate when taking medications.
		Use of motor vehicles	1. Always wear seat belts while vehicle is in operation. 2. Use headlights when it is raining and at least one half hour prior to sunrise and before sunset. 3. Obey all posted speed limits and honor any NASA road blocks or barricades. 4. Numerous deer and other wildlife live on the site and frequently cross roads and paths. Maintain employee awareness and drive slowly when in wooded areas or in areas with limited site distance (i.e. - winding roads). 5. DO NOT operate when taking medications.
		Cold objects	1. Wear appropriate work gloves and proper clothing.
		Hot surfaces or fluids	1. Wear appropriate work gloves and proper clothing. 2. Avoid direct contact with hot objects or fluids.

TABLE 1-1

ACTIVITY HAZARD ANALYSIS
(Continued)

Item	Phase-of-Work	Safety Hazard	Precautionary Action to be Taken
1 (cont.)	(cont.)	Frostbite and Hypothermia	1. Wear proper clothing; if clothing becomes wet or if employee perspires, change to dry clothes (review Section 5.2.2 and Table 5-3). 2. Maintain employee awareness. 3. Provide adequate shelter to allow refuge from inclement conditions.
		Heat stress	1. Provide adequate shelter for workers. 2. Make sure workers maintain normal body fluid levels. 3. Provide cooling devices. 4. Adjust work schedules. 5. Maintain employee awareness.
		Horsing Around	1. Maintain a professional attitude.
		Fire	1. Maintain a neat and organized site free of potentially hazardous objects. 2. Properly store flammable materials. 3. Be sure that an operable fire extinguisher is readily accessible and is suitable for the potential types of fire (i.e. ABC: wood & trash; liquid & grease; and, electrical).

TABLE 1-1

ACTIVITY HAZARD ANALYSIS
(Continued)

Item	Phase-of-Work	Safety Hazard	Precautionary Action to be Taken
1 (cont.)	(cont.)	Electrical Hazards	1. Locate and mark buried utilities before drilling. 2. If unavoidably close to buried or overhead power lines, have power turned off, with circuit breaker locked and tagged. 3. Properly ground all electrical equipment. 4. Avoid standing in water when operating electrical equipment. 5. If equipment must be connected by splicing wires, make sure all connections are properly taped. 6. Be familiar with specific operating instructions for each piece of equipment. 7. If temporary wiring is used, such as extensions lying on ground, use ground fault current interrupters (GFCIs).

TABLE 1-1

ACTIVITY HAZARD ANALYSIS
(Continued)

Item	Phase-of-Work	Safety Hazard	Precautionary Action to be Taken
1 (cont.)	(cont.)	Exposure to poisonous plants and animals	Plants: 1. Avoid body contact with unknown types of plants. 2. Use protective gloves when handling suspect plants. Should contact occur, be sure to wash area thoroughly and avoid contamination of other body parts. 2. Do not eat any vegetation, berries, or fruits found on-site. Animals or insects: 1. Watch footing to prevent stepping on snakes and ground dwelling insects (i.e., fire ants, ground hornets, etc.). 2. Use insect repellant whenever practical. 3. At the end of a work session check body and head for ticks. If a tick is encountered on your body, remove it and place it in a container. Keep the tick, as it may be analyzed later to determine if exposure to any tickborne diseases has occurred. 4. If allergic to insect stings, etc., carry antidote as stipulated by physician. 5. Maintain employee awareness.
		Encountering/Exposure to Contamination	1. Use proper personal protective equipment (gloves, safety glasses, etc.). See Tables 5-1 and 5-2. 2. Use monitoring equipment appropriate for the potential chemical contaminants (see Tables 1-2, 1-3, and 5-2). 3. Make careful observations and report possible contamination to other site workers. 4. Stop work and notify Site Safety Officer if action levels are reached. 5. No eating, drinking, chewing gum or tobacco, or smoking while working. 6. Wet dusty areas prior to sampling.

TABLE 1-1

ACTIVITY HAZARD ANALYSIS
(Continued)

Item	Phase-of-Work	Safety Hazard	Precautionary Action to be Taken
2	Drilling of Borings and Monitoring Well Installation (AOC 1, AOC 2, and Sitewide)	Hitting Existing Utilities	1. Find and mark existing utilities before drilling. 2. Instruct operator. 3. Use care while drilling. 4. Watch for overhead electrical lines.
		Head injuries from falling objects	1. Wear hardhats. 2. Be aware of overhead dangers.
		Foot injuries from dropped objects	1. Wear steel-toed shoes. 2. Secure loose objects.
		Crushed fingers or hands	1. Keep hands and fingers away from moving parts. 2. Use proper tool handling techniques. 3. Wear protective gloves.
		Backing over workmen	1. Backup alarms on equipment. 2. Have a spotter guide operator while backing. 3. Instruct workmen not to stand or walk behind equipment.
		Rotating Equipment	1. Do not wear loose clothing or jewelry when operating. 2. Inspect "kill switches" before using. 3. Make sure "kill switches" are easily accessible and within operator's reach. 4. Do not touch during rotation.
		Flying objects	1. Wear proper eye protection with side shields. 2. Wear other protective clothing as necessary. 3. Be aware.
		Noise	1. Wear proper ear protection.

TABLE 1-1

ACTIVITY HAZARD ANALYSIS
(Continued)

Item	Phase-of-Work	Safety Hazard	Precautionary Action to be Taken
2 (cont.)	(cont.)	Back injuries	1. Instruct workmen how to properly lift materials. 2. Instruct workmen to get help and/or to use lifting equipment.
		Falling and tripping	1. Keep work site neat and organized. 2. Thoroughly inspect areas prior to entrance. 3. Maintain employee alertness, especially around uneven ground (i.e. watch your step and constantly observe your surroundings).
		Drill rig toppling	1. Make sure rig is properly jacked and stabilized.
		Improper rig operation	1. Follow proper rig operating procedures.
		Cathead rope and operations	1. Inspect rope to make sure it is in good condition. 2. Keep rope in tangle free position. 3. Operate on level surfaces with good, firm footing. 4. Do not operate when wet; operate with extreme caution.
		Electrocution	1. Locate underground utilities (see above). 2. Inspect any wiring for exposed wire or faulty connections. 3. Make sure electrical equipment is properly grounded and perhaps employ ground fault current interrupters (GFCIs). 4. Do not drill during adverse weather conditions. 5. Locate overhead lines; do not position drill rig within 20 feet of overhead lines. 6. Avoid equipment in touch with electrical lines.
		Pedestrian Accidents	1. Rope off or fence drill site. 2. Mark drill site clearly.

TABLE 1-1

ACTIVITY HAZARD ANALYSIS
(Continued)

Item	Phase-of-Work	Safety Hazard	Precautionary Action to be Taken
3	Hand-Auger Borings/Surface Soil Sampling (AOC 1 and AOC 2)	Injuries from sharp objects	1. Use care when using sharp objects. 2. Maintain employee awareness by constantly observing your surroundings and looking for objects with the potential to cause injury.
		Falling and tripping	1. Keep work site neat and organized. 2. Thoroughly inspect areas prior to entrance. 3. Maintain employee alertness, especially around uneven ground (i.e. watch your step and constantly observe your surroundings).
4	Sediment and Surface Water Sampling (AOC 2)	Falling out of boat	1. Distribute weight equally. 2. Do not excessively lean over side of boat. 3. Keep bottom of boat clear of unnecessary objects. 4. Do not stand or walk in the boat (if "Jon boat" size). 5. Be alert for overhanging branches and overhead objects or lines. 6. Avoid sudden movements in boat. 7. Follow safe boating guidelines (see Appendix B).
		Drowning	1. Wear a life jacket at all times. 2. Do not work alone; have a second person available for rescue. 3. Pair strong swimmers with weak swimmers. 4. Personnel agree to pair up or stay together in water and work together to reach the shore.
		Sinking boat	1. Follow safe boat guidelines (see Appendix B). 2. Do not anchor boat in swift water. 3. Stay clear of all lines.

TABLE 1-1

ACTIVITY HAZARD ANALYSIS
(Continued)

Item	Phase-of-Work	Safety Hazard	Precautionary Action to be Taken
4 (cont.)	(cont.)	Falling and tripping during sampling/wearing hip waders	1. While in the shallows, carry only what you need; keep it simple. 2. Establish sure footing when moving to new position and before attempting to sample. 3. Maintain employee alertness, especially around uneven ground (i.e. watch your step and constantly observe your surroundings).
5	Groundwater Sampling (AOC 1, AOC 2, Sitewide)	Injuries from sharp objects	1. Use care when using sharp objects. 2. Maintain employee awareness.
		Electrocution/Electrical contact	1. Inspect any wiring for exposed wire or faulty connections. 2. Make sure electrical equipment is properly grounded and employ ground fault current interrupters (GFCIs). 3. Avoid equipment in touch with electrical lines. 4. Keep equipment and lines clear of standing water.
		Falling and tripping	1. Keep work site neat and organized. 2. Thoroughly inspect areas prior to entrance. 3. Maintain employee alertness, especially around uneven ground (i.e. watch your step and constantly observe your surroundings).

TABLE 1-2

CONSTITUENTS OF CONCERN
PLUM BROOK ORDNANCE WORKS

Compound

Volatile Organics

Acetone
Carbon Tetrachloride
Methylene Chloride
Toluene

Semivolatile Organics and Nitro-Aromatic Explosives

1,3-Dinitrobenzene (1,3-DNB)
2,4-Dinitrotoluene (2,4-DNT)
2,6-Dinitrotoluene (2,6-DNT)
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
Methyl-2,4,6-trinitro-phenylnitramine (Tetryl)
Nitrobenzene (NB)
Nitroglycerin (NG)
2-Nitrotoluene (2-NT)
3-Nitrotoluene (3-NT)
4-Nitrotoluene (4-NT)
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)
1,3,5-Trinitrobenzene (1,3,5-TNB)
2,4,6-Trinitrotoluene (2,4,6-TNT)

Metals and Inorganics

Arsenic (As)
Barium (Ba)
Cadmium (Cd)
Chromium (Cr)
Hydrogen Sulfide (H_2S)
Iron (Fe)
Lead (Pb)
Manganese (Mn)
Mercury (Hg)
Selenium (Se)
Silver (Ag)

( ) - Commonly used abbreviations.

TABLE 1-3

IMPORTANT PROPERTIES OF CONSTITUENTS OF CONCERN
AT THE PLUM BROOK ORDNANCE WORKS

Constituent	OSHA PEL (ppm)	ACGIH TLV (ppm)	IDLH (ppm)	UEL (%)	LEL (%)	Ionization Potential (eV)	Health Hazards
Volatile Organics							
Acetone	750 1000(ST)	750 1000(ST)	20,000	13	2.5	9.69	Irritation of eyes, nose, throat; headache; dizziness; and dermatitis
Carbon Tetrachloride	2 (ST)	5 10 (ST) (skin)	300	NA	NA	11.47	Central Nervous System depressant; nausea, vomiting; liver and kidney damage; skin irritation; [suspected human carcinogen]
Methylene Chloride	500 1000(C)	50	5000	22	14	11.32	Fatigue, weakness, sleepiness, light-headedness; limb numbness, tingling; nausea; irritation of eyes, skin; [suspected human carcinogen]
Toluene	100 150 (ST)	50 (skin)	2000	7.1	1.2	8.82	Fatigue, weakness; confusion, euphoria, dizziness, headache; dilated pupils, lacrimation; nervousness, muscle fatigue, insomnia; paresthesia; dermatitis
Semivolatile Organics and Nitro-Aromatic Explosives							
1,3-Dinitrobenzene (1,3 DNB)	0.15 (skin)	0.15 (skin)	29	NA	NA	10.43	Anoxia, cyanosis; visual disturbance; bad taste, burning mouth, dry throat; yellowing hair, eyes, skin; anemia; liver damage
2,4-Dinitrotoluene (2,4 DNT)[1]	0.2 (skin)	0.02 (skin)	27	NA	NA	NA	Anoxia, cyanosis; anemia, jaundice; carcinogen
2,6-Dinitrotoluene (2,6 DNT)[1]	0.2 (skin)	0.02 (skin)	27	NA	NA	NA	Anoxia, cyanosis; anemia, jaundice; carcinogen
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	NA	0.165 (skin)	NA	NA	NA	NA	NA

TABLE 1-3

IMPORTANT PROPERTIES OF CONSTITUENTS OF CONCERN
(Continued)

Constituent	OSHA PEL (ppm)	ACGIH TLV (ppm)	IDLH (ppm)	UEL (%)	LEL (%)	Ionization Potential (eV)	Health Hazards
Methyl-2,4,6-trinitro-phenylnitramine (Tetryl)	0.13 (skin)	0.13 (skin)	NE	NA	NA	NA	Sensitization dermatitis, itching, erythema, edema on nasal folds, cheeks, neck; keratitis; sneezing; anemia; fatigue; coughing, coryza; irritability; malaise, headache, lassitude, insomnia; nausea, vomiting
Nitrobenzene (NB)	1 (skin)	1 (skin)	200	NA	1.8[2]	9.92	Anoxia; irritation of eyes; dermatitis; anemia
Nitroglycerin (NG)	0.01 (skin)	0.05 (skin)	53	NA	NA	NA	Throbbing head; dizziness; nausea, vomiting, abdominal pain; hypotension; flush; palpitation; methemoglobin; delirium, depression of CNS; angina; skin irritation
2-Nitrotoluene (2 NT)	2 (skin)	2 (skin)	200	NA	NA	9.43	Anoxia, cyanosis; headache, weakness, dizziness; ataxia; dyspnea; tachycardia; nausea, vomiting
3-Nitrotoluene (3 NT)	2 (skin)	2 (skin)	200	NA	NA	9.48	Anoxia, cyanosis; headache, weakness, dizziness; ataxia; dyspnea; tachycardia; nausea, vomiting
4-Nitrotoluene (4 NT)	2 (skin)	2 (skin)	200	NA	NA	9.50	Anoxia, cyanosis; headache, weakness, dizziness; ataxia; dyspnea; tachycardia; nausea, vomiting
Octahydro-1,3,5,7-tetranitro -1,3,5,7-tetrazocine (HMX)	NA	NA	NA	NA	NA	NA	NA
1,3,5-Trinitrobenzene (1,3,5 TNB)	NA	NA	NA	NA	NA	NA	Eye, skin irritation; eye inflammation, swelling of adjoining tissues, blindness; sneezing; cyanosis; liver, kidney injury;

TABLE 1-3

IMPORTANT PROPERTIES OF CONSTITUENTS OF CONCERN
(Continued)

Constituent	OSHA PEL (ppm)	ACGIH TLV (ppm)	IDLH (ppm)	UEL (%)	LEL (%)	Ionization Potential (eV)	Health Hazards
2,4,6-Trinitrotoluene (2,4,6 TNT)	0.05 (skin)	0.05 (skin)	NE	NA	NA	10.59	Liver damage, jaundice; cyanosis; sneezing; coughing, sore throat; peripheral neuropathy, muscle pain; kidney damage; cataract; sensitization dermatitis; leukocytosis; anemia; cardiac irregularities
Metals and Inorganics							
Arsenic	0.01 mg/m^3	0.01 mg/m^3	100 mg/m^3	NA	NA	NA	Ulceration of nasal septum, dermatitis, GI disturbances, peripheral neuropathy, respiratory irritation, hyperpigmentation of skin; [human carcinogen]
Barium	0.5 mg/m^3	0.5 mg/m^3	1100 mg/m^3	NA	NA	NA	Upper respiratory irritation; gastroenteritis; muscle spasms; slow pulse, extrasystoles; hypokalemia; irritation of eyes, skin; skin burns
Cadmium	0.2 0.6 (C) mg/m^3	0.01 mg/m^3	50 mg/m^3	NA	NA	NA	Pulmonary edema, dyspnea, cough, chest tightness, substernal pain; headache; chills, muscle aches; nausea, vomiting, diarrhea; anosmia, emphysema, proteinuria, mild anemia; [suspected human carcinogen]
Chromium	1 mg/m^3	0.5 mg/m^3	NE	NA	NA	NA	Histologic fibrosis of the lungs

TABLE 1-3

IMPORTANT PROPERTIES OF CONSTITUENTS OF CONCERN
(Continued)

Constituent	OSHA PEL (ppm)	ACGIH TLV (ppm)	IDLH (ppm)	UEL (%)	LEL (%)	Ionization Potential (eV)	Health Hazards
Hydrogen Sulfide	10 15 (ST)	10 15 (ST)	300	44.0	4.0	10.46	Apnea coma, convulsions; irritation of eyes: conjunctivitis, pain, lacrimation, photophobia, corneal vesiculation; irritation of the respiratory system; dizziness; headache; fatigue, irritability; insomnia; gastrointestinal disturbances
Iron	10 mg/m^3	1 mg/m^3	NE	NA	NA	NA	Benign pneumoconiosis with X-ray shadows indistinguishable from fibrotic pneumoconiosis
Lead	0.05 mg/m^3	0.15 mg/m^3	700 mg/m^3	NA	NA	NA	Weakness, lassitude, insomnia; facial pallor; pal eye, anorexia, low-weight, malnutrition; constipation, abdominal pain, colic; anemia; gingival lead line; tremors; paralysis of wrists, ankles; encephalopathy; nephropathy; irritation of eyes; hypotension
Manganese	5 (C) mg/m^3	5 mg/m^3	NE	?	?	NA	Parkinson's; asthenia, insomnia, mental confusion; metal fume fever: dry throat, cough, tight chest, dyspnea, rales, flu-like fever; low-back pain; vomiting; malaise; fatigue
Mercury	0.05 mg/m^3 (skin)	0.01 mg/m^3 (skin)	28 mg/m^3	NA	NA	?	Cough, chest pain, dyspnea, bronchitis pneumonitis; tremor, insomnia; irritability, indecision; headache, fatigue, weak; stomatitis, salivation; GI disturbance, anorexia, low-weight; proteinuria; irritation of eyes and skin

TABLE 1-3

IMPORTANT PROPERTIES OF CONSTITUENTS OF CONCERN
(Continued)

Constituent	OSHA PEL (ppm)	ACGIH TLV (ppm)	IDLH (ppm)	UEL (%)	LEL (%)	Ionization Potential (eV)	Health Hazards
Selenium	0.2 mg/m^3	0.2 mg/m^3	?	?	?	NA	Irritation of eyes, nose, throat; vision disturbance; headache; chills, fever; dyspnea, bronchitis; metallic taste, garlic breath, GI disturbance; dermatitis; skin, eye burns
Silver	0.01 mg/m^3	0.1 mg/m^3	NE	NA	NA	NA	Blue-gray eyes, nasal septum, throat, skin; irritation of skin, ulceration; GI disturbance

(1) = Denoted by NIOSH as an occupational carcinogen
(2) = LEL determined at 200 °F
IDLH = Immediately dangerous to life or health
NA = Not available
NE = No evidence found for existence of an IDLH
? = Unknown
C = Ceiling value, not to be exceeded during any part of the workday.
ST = Short-term exposure limit, 15-minute TWA exposure not to be exceeded at any time during a workday.
(skin) = Potential exists for dermal absorption

REFERENCES:

ACGIH, Threshold Limit Values, 1993-1994.
NIOSH, Pocket Guide to Chemical Hazards, 1990.
OSHA, Permissible Exposure Limits (1989), 29 CFR 1910.1000.

impacted media are unknown. Potentially affected media are referenced in the Sampling and Analysis Plan (SAP).

A review of the Preliminary Assessment performed by SAIC indicated the potential for the presence of asbestos within TNT area soils. Standard practices performed during drilling and hand-auguring to mitigate dust and particulate generation will adequately address potential exposures.

2.0 PROJECT ORGANIZATION

2.1 KEY INDIVIDUALS

Key participants for this project include the Project Principal, Project Manager, Health and Safety Officer, Site Safety Officers, Site Supervisors, and Drilling Supervisor. Table 2-1 lists the key participants and their responsibilities at this site. Responsibilities relevant to safety and health are provided in Section 2.2 and Section 5.3. Qualifications of key individuals are included in Section 2.0 of the SAP.

2.2 RESPONSIBILITIES

The Project Principal, Project Manager, Health and Safety Officer, Site Safety Officers (SSO), Site Supervisors, and Drilling Supervisors are responsible for formulating and enforcing health and safety requirements. Those responsibilities are outlined in detail in the OSHA standards (29 CFR 1910.120); the U.S. Army Corps of Engineers (USACE) Safety and Health Requirements Manual (EM 385-1-1, revised October 1992); USACE, ER 385-1-92, Appendix B, Safety and Occupational Health Document Requirements for Hazardous, Toxic, and Radioactive Waste (HTRW) Activities; and the National Institute of Occupational Safety and Health/Occupational Safety and Health Administration/United States Coast Guard/Environmental Protection Agency (NIOSH/ OSHA/USCG/EPA) "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities," (October 1985). These responsibilities include assuring the items listed below:

- All site team members have received the OSHA required 40-hour health, safety, and emergency response training and receive annual 8-hour refresher courses. In addition, all Dames & Moore team members are certified in first aid and CPR by the American Red Cross or an equivalent agency.
- All Supervisors on-site have received the OSHA required 8-hour supervisory course in addition to the above courses.
- All team members have completed the required medical examination and have met the qualification criteria for site work.

TABLE 2-1

PROJECT ORGANIZATION
PLUM BROOK ORDNANCE WORKS
SANDUSKY, OHIO

Project Principal/ Project Manager Charles T. Allen	Health & Safety Officer Kenneth E. Fischer, CIH	Site Supervisor Deborah L. Raede Eric M. Samuels Patricia M. Westermann	Drilling Supervisor Charles G. Way	Field Investigators*	Site Safety Officer Eric M. Samuels Steven J. Susten Charles G. Way Patricia M. Westermann
• Provides technical quality control, oversight, and direction for all aspects of the planning, site investigation and data evaluation • Serves as senior reviewer of technical reports on the site investigation • Point of contact for contractual issues	• Oversees the Site-Specific Safety and Health Plan • Conducts or oversees personnel training • Administers company hazard assessment and medical surveillance program • Coordinates with the SSO and Field Investigators for site safety • Available for consultation during actual investigation	• Responsible for overall management of the site investigations • Coordinates between office and field personnel • Manages administrative requirements • Supervises schedules, technical approach, and implementation • Supervises report preparation	• Responsible for set-up and operation of the on-site decontamination area • Coordinates with the drilling contractor regarding installation and development of all proposed monitoring wells • Supervise collection of groundwater samples	• Conducts field investigation activities • Responsible for implementation of the Work Plans during field investigations • Reports directly to the Site Supervisor/SSO • Works with the SSO regarding site safety	• Directly responsible for the implementation of the Site-Specific Safety and Health Plan in the field

* Potential filed investigators include the persons listed in Table 3-2 of this SSHP.

- All site workers have received appropriate site-specific training which will include a briefing on the SSHP.

- All equipment, including safety equipment, is suitable and adequate for its purpose.

- A site safety briefing with all site personnel is held daily prior to commencement of field work and as needed during field work, and that a written record is maintained which notes date, time, attendance, the subjects discussed, and who conducted the meeting (see Appendix A for Site Safety Briefing Form and other forms).

- Material Safety Data Sheets (MSDSs) for chemicals used during the field activities (Appendix B) are reviewed by site personnel.

- Site standard operating procedures are followed at all times.

The SSO will have direct responsibility for administering the SSHP relative to all site activities and is answerable to the CIH overseeing the project. The Project Principal has overall responsibility for the project.

Visitors entering designated work areas will be subject to all applicable health and safety requirements during field operations at the site. Each of the visitors will be under the direct supervision of the SSO and Site Supervisor and will report to the SSO and Site Supervisor. Individuals not complying with the SSHP may be refused access to or dismissed from the site area by the SSO and Site Supervisor or their representative.

Dames & Moore will subcontract with a qualified drilling company for monitoring well installations. Drilling subcontractor personnel are subject to the same requirements and responsibilities as the Dames & Moore personnel working on this project.

A detailed discussion of drilling safety is provided in Appendix C to this SSHP.

3.0 PERSONNEL HAZARD TRAINING

3.1 COMPREHENSIVE TRAINING

A thorough understanding of the types of hazards most likely to be encountered at hazardous waste sites and the personal protection measures needed to protect on-site personnel are the first requirements of a complete SSHP. As a result, Dames & Moore requires that each project team member participate in a 40-hour comprehensive training course, or be certified equivalent in compliance with OSHA 29 CFR 1910.120. Annual refresher training and supervisory training are also an integral part of overall hazardous waste awareness.

During sediment and surface water sampling, field personnel will require the use of a boat. Because of the inherent dangers of boat use, additional safety considerations will be addressed by the SSO. All Dames & Moore personnel who will be on boats will have successfully completed a U.S. Coast Guard approved Boating Skills and Seamanship course or its equivalent and will follow the appropriate boating safety precautions. Boating safety hazards and precautionary measures are outlined in Table 1-1. For a more extensive discussion of boating safety and appropriate precautionary measures suggested by the U.S. Coast Guard, Section HS 290 of the Dames & Moore Health and Safety Manual will be consulted during field work (see Appendix D). An outline and/or a copy of a boating safety course, manual, such as the United States Power Squadrons Safety Manual, will also be available on-site and may be reviewed if site conditions warrant additional precautions.

Table 3-1 provides an outline of a typical comprehensive 40-hour training course. The course includes a hands-on training session to familiarize the participants with safety equipment and field situations, including use of the types of air monitoring equipment to be used at hazardous waste sites. A complete discussion of the above Health & Safety Training Program can be found in Section HS110 of the Dames & Moore Firmwide Health and Safety Manual. Table 3-2 presents a list of possible Dames & Moore field personnel, the training courses they have attended, and the dates that the courses were completed. In addition to the OSHA 29 CFR 1910.120 40-hour and 8-hour refresher courses, 8-hour supervisor courses (where applicable), First Aid

TABLE 3-1

OUTLINE FOR HEALTH AND SAFETY TRAINING FOR HAZARDOUS WASTE OPERATIONS A 40-HOUR COURSE

I. Review of OSHA 29 CFR 1910.120

II. Chemical Hazards

- A. Physical Hazards
- B. Health Hazards

III. Compatibility of Chemicals

IV. Toxicology

- A. Acute Exposure
- B. Chronic Exposure
- C. Carcinogens

V. Medical Surveillance

VI. First Aid

VII. Radiation, Heat and Cold Stress and Noise

VIII. Site Control

IX. Safe Work Practices

- A. OSHA Standards
- B. Common Injuries
- C. Common Work-Site Hazards
- D. Drum Handling
- E. Drilling Safety
- F. Lock Out/Tag Out (as related to drilling safety)

X. Air Monitoring

XI. Protective Clothing

XII. Respiratory Protection

XIII. Confined Spaces

XIV. Decontamination

XV. Contingency Plan

TABLE 3-1

OUTLINE FOR HEALTH AND SAFETY TRAINING
(Continued)

XVI. Workshop

- A. SCBAs
- B. Protective Clothing
- C. Respirators
- D. Air Monitoring
- E. Decontamination

TABLE 3-2

DAMES & MOORE HEALTH AND SAFETY TRAINING LOG

Employee Name	Type of Training	Duration	Date of Completion
Charles Allen	OSHA 29 CFR 1910.120	8-hour Refresher	February 7, 1994
	OSHA 29 CFR 1910.120	40-hour	---
	Standard First Aid	Good for 3 years	February 8, 1993
	Adult CPR	Good for 1 year	September 30, 1994
Ted Berry	OSHA 29 CFR 1910.120	40-hour	July 27, 1987
	OSHA 29 CFR 1910.120	8-hour Refresher	January 14, 1994
Michael Breiner	OSHA 29 CFR 1910.120	40-hour	September 4, 1992
	OSHA 29 CFR 1910.120	8-hour Refresher	December 17, 1993
	Standard First Aid	Good for 3 years	September 4, 1992
	Adult CPR	Good for 1 year	September 4, 1992
Lynn Borowski	OSHA 29 CFR 1910.120	8-hour Refresher	July 19, 1994
	OSHA 29 CFR 1910.120	40-hour	August 30, 1991
	OSHA 29 CFR 1910.120	8-hour Supervisor's	February 5, 1992
	Standard First Aid	Good for 3 years	September 30, 1994
	Adult CPR	Good for 1 year	September 30, 1994
Joe Deatherage	OSHA 29 CFR 1910.120	40-hour	July 20 1990
	OSHA 29 CFR 1910.120	8-hour Refresher	October 28, 1993
	Standard First Aid	Good for 3 years	September 1994
	Adult CPR	Good for 1 year	June 10, 1993

TABLE 3-2

DAMES & MOORE TRAINING LOG

Employee Name	Type of Training	Duration	Date of Completion
Jeff Endres	OSHA 29 CFR 1910.120	8-hour Refresher	July 19, 1994
	OSHA 29 CFR 1910.120	40-hour	September 24, 1990
	OSHA 29 CFR 1910.120	8-hour Supervisor's	May 27, 1993
	Standard First Aid	Good for 3 years	January 31, 1992
	Adult CPR	Good for 1 year	September 30, 1994
Allison Meyrowitz	OSHA 29 CFR 1910.120	40-hour	January 20, 1994
	Standard First Aid	Good for 3 years	January 20, 1994
	Adult CPR	Good for 1 year	December 16, 1993
Steve Mills	OSHA 29 CFR 1910.120	8-hour Refresher	December 17, 1993
	OSHA 29 CFR 1910.120	40-hour	September 4, 1992
	Standard First Aid	Good for 3 years	August 1992
	Adult CPR	Good for 1 year	September 30, 1994
Deborah Raede	OSHA 29 CFR 1910.120	8-hour Refresher	February 7, 1994
	OSHA 29 CFR 1910.120	40-hour	May 26, 1987
	OSHA 29 CFR 1910.120	8-hour Supervisor's	December 12, 1989
	Standard First Aid	Good for 3 years	February 8, 1993
	Adult CPR	Good for 1 year	September 30, 1994
Rick Samuels	OSHA 29 CFR 1910.120	8-hour Refresher	December 17, 1993
	OSHA 29 CFR 1910.120	40-hour	July 21, 1989
	OSHA 29 CFR 1910.120	8-hour Supervisor's	September 21, 1990
	Standard First Aid	Good for 3 years	February 8, 1993
	Adult CPR	Good for 1 year	September 30, 1994

TABLE 3-2

DAMES & MOORE TRAINING LOG

Employee Name	Type of Training	Duration	Date of Completion
Martin Shields	OSHA 29 CFR 1910.120	8-hour Refresher	December 10, 1993
	OSHA 29 CFR 1910.120	40-hour	September 28, 1990
	OSHA 29 CFR 1910.120	8-hour Supervisor's	December 10, 1993
	Standard First Aid	Good for 3 years	February 8, 1993
	Adult CPR	Good for 1 year	September 30, 1994
Bill Smith	OSHA 29 CFR 1910.120	8-hour Refresher	July 19, 1994
	OSHA 29 CFR 1910.120	40-hour	March 30, 1987
	OSHA 29 CFR 1910.120	8-hour Supervisor's	September 21, 1990
	Standard First Aid	Good for 3 years	September 30, 1994
	Adult CPR	Good for 1 year	September 30, 1994
William Starkel	OSHA 29 CFR 1910.120	8-hour Refresher	February 7, 1994
	OSHA 29 CFR 1910.120	40-hour	September 4, 1992
	Standard First Aid	Good for 3 years	September 30, 1994
	Adult CPR	Good for 1 year	September 30, 1994
Steve Susten	OSHA 29 CFR 1910.120	8-hour Refresher	December 17, 1993
	OSHA 29 CFR 1910.120	40-hour	January 10, 1992
	Standard First Aid	Good for 3 years	February 8, 1993
	Adult CPR	Good for 1 year	December 16, 1993
Chris Taylor	OSHA 29 CFR 1910.120	8-hour Refresher	July 19, 1994
	OSHA 29 CFR 1910.120	40-hour	June 12, 1992
	Standard First Aid	Good for 3 years	September 27, 1993
	Adult CPR	Good for 1 year	September 30, 1994

TABLE 3-2

DAMES & MOORE TRAINING LOG

Employee Name	Type of Training	Duration	Date of Completion
Dale Voykin	OSHA 29 CFR 1910.120	8-hour Refresher	May 27, 1993
	OSHA 29 CFR 1910.120	40-hour	March 1, 1991
	OSHA 29 CFR 1910.120	8-hour Supervisor's	May 27, 1990
	Standard First Aid	Good for 3 years	February 8, 1993
	Adult CPR	Good for 1 year	September 30, 1994
Charles Way	OSHA 29 CFR 1910.120	8-hour Refresher	September 23, 1994
	OSHA 29 CFR 1910.120	40-hour	April 29, 1988
	OSHA 29 CFR 1910.120	8-hour Supervisor's	December 12, 1989
	Standard First Aid	Good for 3 years	February 8, 1993
	Adult CPR	Good for 1 year	February 8, 1993
Patricia Westermann	OSHA 29 CFR 1910.120	8-hour Refresher	July 19, 1994
	OSHA 29 CFR 1910.120	40-hour	May 12, 1989
	OSHA 29 CFR 1910.120	8-hour Supervisor's	December 12, 1989
	Standard First Aid	Good for 3 years	February 8, 1993
	Adult CPR	Good for 1 year	September 30, 1994

TABLE 3-3

BELASCO DRILLING SERVICES, INC. HEALTH AND SAFETY TRAINING LOG

Employee Name	Type of Training	Duration	Date of Completion
Darryl M. Bailey	OSHA Basic OSHA Refresher Physical	40-hour 8-hour ---	March 18, 1993 March 12, 1994 October 27, 1993
Michael E. Zanella	OSHA Basic OSHA Refresher Physical	40-hour 8-hour ---	October 26, 1991 March 12, 1994 January 10, 1996 (expires)
Allen W. Dudley	OSHA Basic OSHA Refresher Physical	40-hour 8-hour ---	December 1, 1989 March 12, 1994 February 8, 1996 (expires)
William H. Patterson	OSHA Basic Physical	40-hour ---	March 24, 1994 February 9, 1996 (expires)

(includes training requirements of 29 CFR 1910.1030), and Adult CPR, and Boating Safety (where applicable) have been included. Table 3-3 provides a list of Drilling Subcontractor field personnel and their dates of OSHA-required training classes.

3.2 PRE-INVESTIGATION HEALTH AND SAFETY BRIEFING

Prior to the start of the field activities, the SSO and Site Supervisor will meet with all field investigation workers. The purpose of this meeting is to discuss in detail the hazards specific to the site and the tasks to be performed; and to specify the proper level of protection, required monitoring, decontamination procedures, and disposal methods for each work area. As part of this meeting, the procedures to be followed at the site, as described in the Work Plans prepared for this project, will be outlined. It is the responsibility of the Project Manager to ensure that workers are thoroughly familiar with each sampling and investigation procedure and the overall chain-of-command at the site.

Additional drilling safety will be discussed with the relevant site personnel prior to the commencement of well installation operations.

4.0 MEDICAL SURVEILLANCE

Each individual will undergo and pass a comprehensive physical examination prior to engaging in the field work at the PBOW site. Dames & Moore employees participate in the program described below, under the direction of Occupational Medicine Associates, Inc. (OMA), Atlanta, Georgia. OMA performs medical examinations and consultations as required by OSHA 29 CFR 1910.120, Hazardous Waste Operations and Emergency Response. Dames & Moore's Medical Surveillance Program is overseen by Dr. Gary Krieger who is certified by the American Board of Preventative Medicine.

The tests included in the Dames & Moore medical examination are described in Table 4-1. Other tests are added if warranted by special needs or exposure history. For a complete discussion of Dames & Moore's Medical Surveillance Program, refer to Section HS120 of the Dames & Moore Firmwide Health and Safety Manual.

4.1 INITIAL EXAMINATION

The initial examination is intended to determine each employee's complete medical history as well as the compatibility of his medical status with the job description. For example, minimum physical requirements must be met as follows:

- Vision - Binocular vision is required, and must be correctable to 20/40 (Snellen) in one eye and 20/20 in the other. Normal depth perception and basic color distinction are required. Vision must be correctable with the use of glasses only.
- Hearing - The Pressure/Volume needed to hear pure tones should not exceed 30 dBA.
- Smell - Normal.
- Speech - No conditions causing indistinct speech.
- Other - No disease or condition which would interfere with the full performance of duties (i.e., sprained ankle, asthma, diabetes, etc.).

TABLE 4-1

DAMES & MOORE, INC.
STANDARD BIOMEDICAL MONITORING

Test	Initial Examination	Annual Examination
Full physical	X	X
EKG	X	(X)
Chest x-ray	X	(X)
Hematology evaluation (including complete blood count, differential and platelet count)	X	X
Hemoglobin and hematocrit	X	X
Urinalysis	X	X
Vision screen	X	X
Executive profile (SMA-22, CBC, thyroid profile)	X	X
Pulmonary function	X	X
Audiometry	X	X
Proctoscopic exam	(X)	(X)

(X) - Included at the discretion of the occupational medicine physician.

An electrocardiogram and spirometry are performed. The electrocardiogram is recorded as optional for annual re-examination. Employees over 35 years of age and employees with cardiac risk factors (overweight, smoking) are required to have annual EKGs.

Chest x-rays have, for the most part, been eliminated from the annual physical examination except for the initial baseline exam. During each annual physical examination, the physician gives the patient a complete examination of the chest. This chest exam, coupled with pulmonary function studies, gives the medical staff sufficient information relative to any potential pulmonary problems. If chest x-rays are indicated from the results of later examinations or from hazardous operations, they are then performed. This decision is made at the discretion of the examining physician.

In addition, an extensive battery of hematological and serum chemistry determinations are performed. Hematological tests include a full blood count with differential and platelet count.

The standard serum-enzyme chemistry is also performed for the following parameters:

Alanine aminotransferase (ALT, SGPT)
Aspartate aminotransferase (AST, SGOT)
Albumin
Alkaline phosphatase
Bilirubin (total)
Blood Urea Nitrogen (BUN)
BUN/Creatinine ratio
Calcium
CO_2 (Content)
Cholesterol
Chloride
Creatinine
Globulin
Glucose
Lactate dehydrogenase (LDH)
Phosphorus (Inorganic)
Potassium
Protein
Sodium
Triglycerides
Uric acid

A routine urine analysis is performed, including observation of color, specific gravity, and microscopic examination of formed elements and pathologically significant elements not normally present such as glucose, protein, blood, ketones, and bile acids. The majority of these parameters are indicative of kidney dysfunction.

Audiometry (hearing examination) is also included in the examination cycle.

4.2 ANNUAL EXAMINATION

Annual examinations are the same as the initial examination. A number of the recommended biomedical tests for the establishment of baseline and sensitivity parameters can sometimes be dispensed with at this time. All personnel included in the initial exam program are given annual exams.

4.3 SPECIAL PARAMETERS

If indicated by the medical history and/or initial laboratory results, the examining physician will order additional tests. Other parameters can be added to the parameters mentioned to account for prior and expected exposure conditions; for example, exposure to heavy metals. No special tests have been deemed necessary for this site.

Summary reports of the examinations are provided and reviewed with each employee. Complete records are kept at the OMA clinic office located in Atlanta, Georgia and at the Dames & Moore office located in Denver, Colorado.

5.0 FIELD IMPLEMENTATION

5.1 PERSONAL PROTECTIVE EQUIPMENT (PPE)

No single combination of protective clothing and equipment can protect field personnel from all hazards. The use of personal protective equipment (PPE) can create significant worker hazards, such as heat stress, physical and psychological stress, and impaired vision, mobility, and communication. Nonetheless, field personnel must be prepared to upgrade their PPE if an unexpected hazardous situation is encountered. Careful pre-entry planning, anticipation of worst-case conditions, and caution during field operations are imperative to an effective PPE program. A complete discussion of the Dames & Moore PPE Program can be found in Section HS170 of the Dames & Moore Firmwide Health and Safety Manual.

Three levels of personal protection (Levels B through D) are described in this SSHP. Table 5-1 lists the required PPE for each of these levels. Equipment selections for each level are based on recommendations given by (1) OSHA Standards 29 CFR 1910.120 and CFR 1926; (2) the U.S. Army Corps of Engineers Safety and Health Requirements Manual, EM 385-1-1; (3) NIOSH/OSHA/USCG/EPA "Occupational Safety and Health Guidance for Hazardous Waste Operations" handbook; (4) "CHRIS Hazardous Chemical Data", U.S. Dept. of Transportation/USCG; and (5) NIOSH Pocket Guide to Chemical Hazards.

Based on a review of the proposed activities and the potential for exposure to contaminants, field activity will be initiated in Level D PPE. Level D PPE will include the equipment listed on Table 5-1. If Level B or Level C conditions are encountered, site work will be terminated, the Project Principal will be notified, and the contract will be modified to allow upgrades necessary to operate at these levels.

In the event that respiratory protection is required, all field personnel have been quantitatively or qualitatively fit-tested for their individual respirators as outlined in 29 CFR 1910.1025. Each individual will conduct a negative and positive pressure check prior to each use. Should air purifying respirators be required, atmospheric concentrations of chemicals must not exceed the maximum use concentration for the

TABLE 5-1

PERSONAL PROTECTIVE EQUIPMENT FOR LEVELS OF PROTECTION

ITEM	LEVEL OF PROTECTION		
	B	C	D
Hard Hat	X	X	
Face Shield/Safety Glasses		X	X
Chemical Resistant Work Boots	X	X	
Disposable Rubber Boots or Boot Covers	X	X	X
Chemical Resistant Inner Gloves	X	X	X
Chemical Resistant Outer Gloves	X	X	X
Tyvek Suit			O
Work Clothes (full torso, arm, and leg coverage)			X
Chemical Resistant Coveralls		X	
Chemical Resistant Suit	X		
Fully-Encapsulating Suit			
Air-Purifying Respirator		X	
SCBA/Air-Line Respirator	X		
2-Way Radio			
Cooling System			
Earplugs	O	O	O

X = Required
O = Optional

Chemical Resistant Coverall Material: Saranex-Coated Tyvek
Chemical Resistant Outer Glove Material: Nitrile
Air-Purifying Respirator Cartridge Type: Organic Vapor/Dust and Mist/HEPA Filter

filter cartridges. Air purifying respirators shall not be used for IDLH conditions. The atmosphere must contain at least 19.5 percent oxygen and not greater than 23 percent oxygen. Because certain chemicals of concern occur in particulate form, combination organic vapor/dust and mist/HEPA filter respirator cartridges will be used. A complete discussion of Dames & Moore's Respiratory Protection Program can be found in Section HS150 of the Dames & Moore Firmwide Health and Safety Manual.

OSHA recently revised its PPE Standard (29CFR 1910.132) to require a workplace hazard assessment. The signatures in the front of this SSHP constitute approval and certification that a workplace hazard assessment has been performed.

5.2 MONITORING

5.2.1 Environmental Monitoring

The methods and equipment that will be used to monitor the ambient air within the working zone for airborne concentrations of hazardous substances are discussed in this SSHP. A complete discussion of the Dames & Moore Exposure Monitoring Program can be found in Section HS180 of the Dames & Moore Firmwide Health and Safety Manual. The SSO shall ensure that all project personnel have received the necessary training on the operation, including calibration checks and maintenance, of air monitoring equipment.

Table 5-2 lists the monitoring equipment, and action guidelines to be used when measuring the breathing air zone of workers during site activities. The monitoring equipment includes photoionization detectors (PID), a particulate monitor, and combustible gas indicators (CGI). The calibration for the photoionization meters will be checked each day using isobutylene calibration gas. The CGI will also be calibrated daily, but with three different calibration gases: a methane mixture, a hydrogen sulfide/nitrogen mixture, and a carbon monoxide mixture. A daily instrument calibration checksheet is provided in Appendix A. An air monitoring data sheet is also provided for in Appendix A for the purpose of documenting air concentrations. An 11.7 eV lamp will be used in the PID. The CGI has four gas sensors which will detect

TABLE 5-2

HAZARD MONITORING METHODS, ACTION LEVELS, AND PROTECTIVE MEASURES

Hazard	Monitoring Method	Action Level	Monitoring Schedule	Protective Measures
Organic vapors	PID	Up to 3 ppm above background in the breathing zone	Continuously during on-site field activities	Level D
		3- 10	Continuously during on-site field activities	Level C
		>10	Periodically (every 30 minutes) during on-site field activities	Level B or Evacuate Area
Oxygen deficient atmosphere	O_2 meter (CGI)	20.8%	Continue operations	Level D
		< 20.8%, but > 19.5%	Continuous monitoring	
		≤ 19.5%	Do not enter. Ventilate and determine if supplied air is required. Consider that any low CGI readings are suspect or false.	
		> 23.5%	Fire explosion hazard. Withdraw from area immediately.	
Explosion	Explosimeter (CGI)	< 5% LEL	Continue investigation	
		5-10% LEL	Continue monitoring with caution as high levels are encountered.	
		> 10% LEL	Explosion hazard. Withdraw from area immediately.	

TABLE 5-2

HAZARD MONITORING METHODS, ACTION LEVELS, AND PROTECTIVE MEASURES

Hazard	Monitoring Method	Action Level	Monitoring Schedule	Protective Measures
Toxic dust	Particulate monitor (Miniram)	Up to 5 mg/m^3 (respirable fraction) above background in the breathing zone	Periodically (every 30 minutes) during invasive field activities	Level D
		5 mg/m^3 (respirable fraction)	Periodically (every 30 minutes) during invasive field activities	Level C
		> 5 mg/m^3 (respirable fraction)	Periodically (every 30 minutes) during invasive field activities	Level B or EVACUATE AREA

ppm - parts per million
mg/m^3 - milligrams per cubic meter
LEL - Lower Explosive Limit

Note: It takes 14 min. @ 5 ppm to exceed the 8 hour time-weighted average for dinitrobenzene.
The maximum use concentration for an organic vapor cartridge for dinitrobenzene is 7.25 ppm for 8 hours.
The Actions Levels above are based on typical site activities where exposures are not constant.

oxygen, hydrogen sulfide, carbon monoxide, and the lower explosive limit. Action levels for the PID are based on the lowest time-weighted average (TWA) of the suspected contaminants. Monitoring will be conducted on a periodic basis during all sampling activities.

There is a potential for skin and/or inhalation exposure to dusts that may be contaminated with nitrated aromatics. Therefore, prior to performing field activities in dry, dusty areas, workers shall wet down the area of activity with water in order to decrease potential dust inhalation. A Miriram particulate monitor will also be employed to measure respirable dust that may be produced during drilling operations.

5.2.2 Personnel Monitoring

The SSO will provide project personnel with the necessary training and monitoring designed to prevent personnel injury due to cold and heat stress, as dictated by weather conditions. This monitoring shall commence when the ambient environmental temperature falls below 40°F or rises above 70°F. In addition, field personnel will be provided rest breaks. The break areas will be situated so that personnel may remove the chemical-protective clothing, rest in a protected area, and drink warm or cold fluids (as the weather dictates).

5.2.2.1 Cold Stress Monitoring - To guard against cold injury appropriate clothing will be worn, rest periods will be allowed, and workers' conditions will be monitored in accordance with the current American Conference of Governmental Industrial Hygienists Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices (ACGIH TLV and BEI) Booklet and the work/warm-up schedule provided in Table 5-3.

The work rate should not be so high as to cause heavy sweating that will result in wet clothing. If heavy work must be done, rest periods must be taken periodically and workers must be offered the opportunity for changing into dry clothing. Dry PPE will

TABLE 5-3

THRESHOLD LIMIT VALUES
WORK/WARM-UP SCHEDULE FOR FOUR-HOUR SHIFT DURING COLD WEATHER*

Air Temperature - Sunny Sky		No Noticeable Wind		5 mph Wind		10 mph Wind		15 mph Wind		20 mph Wind	
°C (approx.)	°F(approx.)	Max Work Period	No. of Breaks	Max Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks
-26° to -28°	-15° to -19°	(Norm. breaks)	1	(Norm. breaks)	1	75 min.	2	55 min.	3	40 min.	4
-29° to -31°	-20° to -24°	(Norm. breaks)	1	75 min.	2	55 min.	3	40 min.	4	30 min	5
-32° to -34°	-25° to -29°	75 min.	2	55 min.	3	40 min.	4	30 min.	5	Non-emergency work should cease ↓	
-35° to -37°	-30° to -34°	55 min.	3	40 min.	4	30 min.	5	Non-emergency work should cease ↓			
-38° to -39°	-35° to -39°	40 min.	4	30 min	5	Non-emergency work should cease ↓					
-40° to -42°	-40° to -44°	30 min.	5	Non-emergency work should cease ↓							
-43° & below	-45° & below	Non-emergency work should cease									

NOTES:

1. Schedule applies to moderate to heavy work activity with warm-up breaks of ten (10) minutes in a warm location. For Light-to-Moderate Work (limited physical movement), apply the schedule one step lower. For example, at -35°C (-30°F) with no noticeable wind (Step 4), a worker at a job with little physical movement should have a maximum work period of 40 minutes with 4 breaks in a 4-hour period (Step 5).

2. The following is suggested as a guide for estimating wind velocity if accurate information is not available:
   5 mph: light flag moves; 10 mph: light flag fully extended; 15 mph: raises newspaper sheet; 20 mph: blowing and drifting snow.

3. If only the wind chill cooling rate is available, a rough rule of thumb for applying it rather than the temperature and wind velocity factors given above would be: 1) special warm-up breaks should be initiated at a wind chill cooling rate of about 1750 W/m^2; 2) all non-emergency work should have ceased at or before a wind chill of 2250 W/m^2. In general, the warm-up schedule provided above slightly under-compensates for the wind at the warmer temperatures, assuming acclimatization and clothing appropriate for winter work. On the other hand, the chart slightly over-compensates for the actual temperatures in the colder ranges, since windily conditions rarely prevail at extremely low temperatures.

4. TLVs apply only for workers in dry clothing.

*Adapted from Occupational Health & Safety Division, Saskatchewan Department of Labour.

be available to all workers. Dry personal clothing will be provided by the individual workers. Decontamination procedures as described in Section 5.5 will be followed when changing from wet clothing into dry clothing. The work shall be arranged in such a way that sitting still or standing still for prolonged periods is minimized.

5.2.2.2 Heat Stress Monitoring - To guard against heat injury, appropriate clothing will be worn, rest periods will be allowed, water or Gatorade will be provided for body fluid replacement, and workers' conditions will be monitored in accordance with the current ACGIH TLV and BEI Booklet and the work/cool-down schedule provided in Table 5-4.

Signs of heat stress include heat rash, heat cramps (muscle spasms), and heat exhaustion (pale, cool, moist skin, heavy sweating, dizziness, nausea, and fainting). Extreme heat stress can result in heat stroke, as temperature regulation fails and the body temperature rises to critical levels. Symptoms of heat stroke include red, hot, usually dry skin; lack of or reduced perspiration; nausea; dizziness and confusion; strong, rapid pulse; and coma.

If symptoms of heat stress are exhibited by the workers, the pulse rate and body temperature will be monitored during all tasks (as deemed necessary or appropriate by the SSO). The action guidelines are as follows:

> Pulse rate: Determine normal resting pulse rate. Monitor pulse rate as soon as possible at beginning of rest period. If the rate is 40 beats per minute (BPM) above the normal rate, shorten the next work period by one-third (1/3) without changing the rest period. If the pulse rate is greater than 40 BPM at beginning of next rest period, shorten the following work cycle again by 1/3. Repeat.
>
> Body Temperature: Determine body temperature at the end of the work cycle and before drinking. If the temperature is greater than 99.6°F (37.6°C), shorten the next work cycle by 1/3 without changing the rest cycle. Repeat. DO NOT permit a worker to wear semipermeable or impermeable clothing when his/her body temperature exceeds 100.6°F (38.1°C).

TABLE 5-4

ACGIH PERMISSIBLE HEAT EXPOSURE THRESHOLD LIMIT VALUES
(Values are given in °F and (°C) WBGT)

Work/Rest Regime	Work Load		
	Light	Moderate	Heavy
Continuous Work	86°F (30.0°C)	80°F (26.7°C)	77°F (25.0°C)
75% Work/25% Rest (each hour)	87°F (30.6°C)	82°F (28.0°C)	78°F (25.9°C)
50% Work/50% Rest (each hour)	89°F (31.4°C)	85°F (29.4°C)	82°F (27.9°C)
25% Work/75% Rest (each hour)	90°F (32.2°C)	88°F (31.1°C)	86°F (30.0°C)

* For unacclimated workers the permissible exposure TLV should be reduced by 2.5°C

Reference: 1992-1993 Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices, American Conference of Governmental Industrial Hygienists

5.3 SITE OPERATING PROCEDURES

The SSO operating procedures include safety plan responsibilities and site safety procedures to be followed prior to site entrance, while on-site, and upon exiting the site. The SSO has overall responsibility for on-site safety and health, and is answerable to the CIH overseeing the project.

5.3.1 Safety Plan Responsibilities

The SSO will be on-site and will ensure that each member of the field team is aware of all components of the safety plan. If the SSO has to leave the site, he may designate an alternate. The alternate should have received the OSHA 8-hour supervisory course and be certified in first aid and CPR by the American Red Cross or an equivalent agency. The SSO:

1) Instructs all workers on safety procedures at the work site;

2) Supervises decontamination, inspection, maintenance and storage of the safety equipment;

3) Controls entry and exit for the site (site security);

4) Observes work parties for signs of stress or illness and removes affected individuals from work;

5) Monitors on-site conditions (weather, ambient air concentrations);

6) Enforces the buddy system;

7) Knows emergency procedures, evacuation routes and emergency telephone numbers;

8) Insures that a map to the hospital is posted and that local hospital and emergency response personnel are alerted to specific hazards associated with the field operations;

9) Coordinates emergency medical care;

10) Characterizes the site and alerts field personnel to the presence of low-lying areas, barriers, confined spaces and ditches, trenches or hollows with potential to present dangerous conditions;

11) Notifies fire department/emergency response personnel in the event of an accident or emergency; and

12) Notifies the U.S. Army Corps of Engineers in the event of an accident or emergency and completes and submits the appropriate documentation.

5.3.2 Site Safety Procedures

The following items are requirements to protect the health and safety of field workers and will be discussed in the safety briefing prior to initiating work on the site. Table 1-1, which provides an activity hazard analysis that outlines precautionary actions to be taken at the site, will be reviewed during the briefing. Appendix A provides the Site Safety Briefing Forms that will be filled out by the SSO and signed by all persons who received the site safety briefing.

5.3.2.1 General Safety Operating Procedures

- A buddy system will be used. Hand signals will be established to maintain communication.
- During site operations, workers will consider themselves as a safety backup to their partner/buddy. Off-site personnel provide emergency assistance. All personnel will be aware of dangerous situations that may develop.
- Visual contact will be maintained between buddies on-site at all times.
- Eating, drinking, chewing gum or tobacco, smoking, or any practice that increases the probability of hand-to-mouth transfer and ingestion of hazardous material is prohibited except in designated areas.
- Prescription drugs may be used at the site, provided their use is reviewed and approved by the medical consultant. Prescription drugs will not be taken by personnel where the potential for contact with toxic substances exist. Alcoholic beverage intake is prohibited during the work day. Illegal drug intake is also prohibited.
- Any facial hair which interferes with the face to face-piece seal of the respirator will not be permitted on personnel required to wear such equipment. Contact lenses will not be allowed to be worn in conjunction with the use of respiratory protection. Arrangements shall be made prior to site mobilization to obtain spectacle kits for those who need them.

- Each staff member will be qualitatively fit-tested for respirators using positive and negative pressure checks and qualitative fit tests prior to the onset of field activities. During the qualitative fit test, the wearer will be exposed to a test agent such as an irritant smoke or isoamyl acetate vapor using procedures outlined in 29 CFR 1910.1025. If the wearer cannot detect penetration of the test agent, the respirator is considered a good fit (NIOSH, 1987).

  A positive and negative pressure fit check will be performed prior to site activity when a respirator is to be worn. All respiratory protection will be NIOSH approved as required by OSHA under 29 CFR 1910.134.

- Work areas for various operational activities (equipment testing, decontamination) will be established and implemented at the site.

- Procedures for leaving any contaminated area will be planned and reviewed prior to going on-site.

- Work areas, decontamination areas, and assembly points will be established based on prevailing site conditions and are subject to change if site conditions change.

- No personnel will be admitted to the work areas without proper safety equipment and training. Authorized visitors will be briefed on the Site-Specific Safety and Health Plan and emergency procedures before entering work areas.

- All personnel must comply with established safety procedures. Any staff member who does not comply with safety policy, as established by the Site Safety Officer or the Project Principal, will be immediately dismissed from the site.

- Any medical emergency supersedes routine safety and decontamination requirements.

5.3.2.2 Before Beginning Work Day

- All field personnel shall review site information and work procedures for:

  - Expected hazards
  - Special conditions such as natural disasters or multiple personnel injuries
  - Sampling procedures
  - Location of telephones and emergency equipment
  - Emergency medical information including hospital location
  - Level(s) of personnel protection required

- Check safety gear and equipment. The following equipment will be used at the site, or will be available for issue, depending on site-specific conditions. The safety gear and equipment will be available on-site in a support vehicle or building.

  - Disposable rubber boots
  - Standard Tyvek coveralls
  - Coated (Saranex) Tyvek coveralls (hooded)
  - Hard-hats
  - Goggles or Safety Glasses
  - Latex gloves
  - Nitrile gloves
  - Full-face, air-purifying respirator with combination organic vapors/dusts and mists/HEPA cartridges
  - Ziplock baggies (quart and gallon size) to store clean spare equipment
  - Field procedures and safety references
  - Eye Wash Kit
  - First Aid Kit(s)
  - Ear Plugs
  - Fire Extinguisher

- Backup equipment and spares will be maintained, including:

  - Disposable paper towels
  - Respirator swabs
  - Disinfectant spray for boots and gloves
  - Extra Tyvek suits and gloves
  - Duct tape
  - Trash barrel for return transportation of contamination gear and equipment
  - Wash and rinse tubs for decontamination
  - Extra respirator cartridges
  - Scrub brushes
  - Emergency spill clean-up kit with sorbent material
  - Plastic trash bags and drop cloths

5.3.2.3 Before Entering Site

- No eating/drinking/smoking is allowed except in the designated areas away from the work site. Use good sanitary practices and wash hands and face thoroughly before eating/drinking/smoking. An eating/drinking/smoking area will be set up in a clean area.

- Place sample containers in field sample carrier (backpacks or carrier). Do not place containers or equipment on potentially contaminated surfaces.

- Check location of emergency eye wash supply and telephones.

- Check alternate safety gear.
- Check respirator (even if it is not going to be worn immediately).
- Check gear for rips/tears/malfunctions before, during, and after use.
- Set up buddy system prior to proceeding.
- Preliminary site survey.

  - Characterize physical conditions of site

- Use caution - go slowly.

5.3.2.4 Leaving Work Site (Exclusion Zone)

- The buddy system will be adhered to at all times when leaving the work site (Exclusion Zone).
- Inform buddy of intent to leave work zone.
- Secure equipment as necessary before leaving work site.
- Wait for replacement if buddy is not leaving work site. Do <u>not</u> leave your buddy alone at work site.
- Proceed directly to Contamination Reduction Zone and follow decontamination procedures.

5.3.2.5 Sampling

- No eating/drinking/smoking while sampling.
- Use standard, specified sampling techniques (see Work Plans or discuss with Site & Drilling Supervisors).
- Follow Boating Safety Procedures when collecting surface water samples from a boat.
- Use appropriate care in collecting samples. Use the appropriate equipment to collect samples; do not touch potentially contaminated surfaces or materials without wearing protective gloves. If the sampling site is not

accessible with available gear, do not take a sample. The SSO will evaluate alternate sampling locations.

- Using disposable paper towels and clean water, promptly wipe or wash off splashes, dirt, and site residue from sample collection materials. Decontamination procedures as discussed in Section 5.5 will be followed.

- If gear or equipment damage develops, immediately repair or replace.

- If a field worker develops any physical discomfort, such as lightheadedness, the worker must stop work, notify their buddy, return to the designated Support Zone and report to the SSO. Specific symptoms of discomfort or exposure are presented in Table 1-3.

5.4 SITE CONTROL

Delineation of work zones, communications procedures, and site illumination requirements are discussed below.

For safety purposes, a hazardous waste site is generally divided into three specific zones on the basis of contamination potential: Zone 1 - Exclusion Zone; Zone 2 - Contamination Reduction Zone; and Zone 3 - Support Zone.

The Exclusion Zone is the area of greatest suspected environmental contamination and presents the greatest potential for worker exposure. These areas will be marked by flagging. Personnel entering the area must wear the mandated level of protection. In certain instances, different levels of protection will be required depending on the tasks to be performed within that zone. The Support Zone serves as a clean control area. The Contamination Reduction Zone serves as a transition area between the Exclusion Zone and the Support Zone. Decontamination facilities are located in the Contamination Reduction Zone. All areas will be defined and marked as appropriate.

At the PBOW Site, the establishment of these three specific zones is based on the location of suspected contamination, and the proposed areas of sampling and sample preparation. Several Exclusion Zones will be established, each corresponding to the areas of investigation. The Exclusion Zones will be established by the SSO prior to the sampling activities.

The Support Zone will be considered any area outside the Exclusion Zones. The Contamination Reduction Zone will be established between the Exclusion and Support Zones and will serve as the decontamination area. Sampling and auguring personnel will be instructed about activities and protective equipment requirements for each zone by the SSO. For this project, Contamination Reduction Zones will be established prior to the sampling activities. The support zone will be established at the entrance to the Contamination Reduction Zone. Figure 5-1 shows the location of the exclusion zones for this project.

5.5 DECONTAMINATION PROCEDURES

Procedures for the removal of contaminants from personnel and equipment are discussed in the following sections.

5.5.1 Personnel Decontamination

All personnel must complete appropriate decontamination procedures in a manner that is responsive to actual site conditions prior to leaving the site. A decontamination area will be set up at an appropriate site location. Following a detergent-water washing, equipment will be rinsed at least once prior to use of the appropriate decon solution. Clean water will be used for the final rinse. The choice of decontamination solution is dependent upon the type of soluble contaminants which must be removed from reusable protective equipment.

Gloves and other PPE shall be inspected frequently for integrity and following manufacturers' recommendations for breakthrough times.

Used PPE and decontamination and rinse solutions will be disposed of in properly labeled 55-gallon drums and secured on-site for later disposal.

Each individual shall conduct proper personal hygiene, which includes washing any exposed skin prior to eating, smoking, or leaving the site.

A proposed schematics for maximum Levels C and D decontamination is provided in Figure 5-2. The SSO may adjust the decontamination requirements according to site conditions encountered.

5.5.2 Equipment Decontamination

- Respirators

  - Workers will be issued their own respirator and will be responsible for cleaning and decontamination of that respirator. Remove filters and cartridges, and carefully wipe clean as much as possible.

  If prefilters (outside filters in snap-on rings) are dirty, replace them with fresh ones. If respirator has surface dirt, clean external and internal surfaces with decontamination solution (MSA cleaner/sanitizer or soap) and water. Wipe internal surfaces with respirator wipes. Use packaged wipes for daily nominal disinfection. Further daily disinfection of respirators will be at the discretion of the individual user.

  [Note: Personnel with respiratory tract infections, however minor they may appear, shall disinfect their respirators at least weekly and, if possible, daily.]

5.6 COMMUNICATIONS

Emergency telephone numbers for ambulance, physician, hospital, fire and police are provided in Section 6.1 of this SSHP.

All field personnel will be briefed concerning the people and equipment which will be summoned during an emergency. A map to the nearest hospital with proper emergency room facilities is provided in this SSHP. All field personnel will be briefed concerning their responsibilities during an emergency situation requiring hospitalization.

An internal hand signals communication system and voice communication will be used by field personnel in the event of noisy working conditions on the site. Prearranged hand signals or other emergency communications signals are as follows:

- Hand gripping throat: out of air, can't breathe.
- Gripping partner's wrist or placing both hands around waist: leave the area immediately, no debate.
- Hands on top of head: need assistance.
- Thumbs up: okay, I'm alright, I understand.
- Thumbs down: no, negative.

Each field team will be provided a two-way radio in order to maintain voice communication with NASA security personnel. The radios will remain on during all field activities and will be used to notify other field personnel and NASA representatives of emergency situations.

5.7 ILLUMINATION

No artificial illumination will be required, as work is scheduled to be performed during daylight hours.

6.0 EMERGENCY PROCEDURES/CONTINGENCY PLAN

This section describes the contingencies and emergency planning procedures to be implemented at the site. The list of appropriate emergency contacts is given in Section 6.4.

6.1 PRE-EMERGENCY PLANNING

An emergency evacuation route(s) will be chosen immediately upon arrival at the site. During the initial site briefing, all workers will be trained in provisions of the Emergency Response Plan, communication systems, and evacuation routes. The plan will be reviewed and revised, if necessary, on a regular basis by the Dames & Moore SSO to ensure that the plan is adequate and consistent with prevailing site conditions. The briefing may be repeated periodically upon discretion of the Dames & Moore SSO.

6.2 PERSONNEL ROLES AND LINES OF RESPONSIBILITY

The Dames & Moore SSO has primary responsibility for responding to and correcting emergency situations. This includes taking appropriate measures to ensure the safety of site personnel and the public, such as evacuation of personnel from the site area. The SSO shall also ensure that corrective measures have been implemented, appropriate authorities have been notified, and follow-up reports have been completed, if necessary. The SSO may temporally call upon other qualified personnel to act on the SSO's behalf.

6.3 EMERGENCY RECOGNITION

Listings of on-site chemical and physical hazards are identified in Tables 1-1 and 1-2. Personnel shall be familiar with techniques of hazard recognition from pre-assignment training and site-specific briefings. The Dames & Moore SSO shall ensure that the proper PPE and monitoring equipment are available to personnel.

In an emergency, personnel shall proceed to the closest exit and mobilize to the safe distance area associated with the evacuation route. Personnel shall remain at that area until further instructions are provided by the SSO.

6.4 EMERGENCY TELEPHONE NUMBERS

Contact	Person or Agency	Telephone No.
Security	Police Richard Burroughs	On-site radio, 419/627-0824
Fire	Capt. Steve Miller	On-site radio, 419/626-1334
Ambulance	Erie County EMA, Bill Walker	On-site radio, 419/627-7617
Hospital	Providence Hospital 1912 Hayes Ave Sandusky, Ohio Dr. Tom Neosgoda	419/621-7000
OSHA	OSHA - Cleveland, Ohio	419/259-7542
Poison Control	Poison Control Centers Local	800/642-3625 800/589-3897 419/381-3897
Emergency Response	National Response Center Toxic Chemical & Oil Spills	800/424-8802
COE Contact/Nashville	Captain Michael Riebel, U.S. Army	615/736-7122
	Doug Webb U.S. Army Engineer District, Nashville	615/736-7140
NASA Site Contact	Amy Bower, NASA Plum Brook Station	419/621-3233
Project Principal	Charles T. Allen	404/262-2915
Project Manager	Deborah L. Raede	404/262-2915
Regional H&S Officer	Kenneth E. Fischer, CIH	301/652-2215
Firmwide H&S Director	Dr. Gary Krieger	303/294-9100
Site Safety Officers	Eric M. Samuels Steven J. Susten Charles G. Way Patricia M. Westermann	404/262-2915

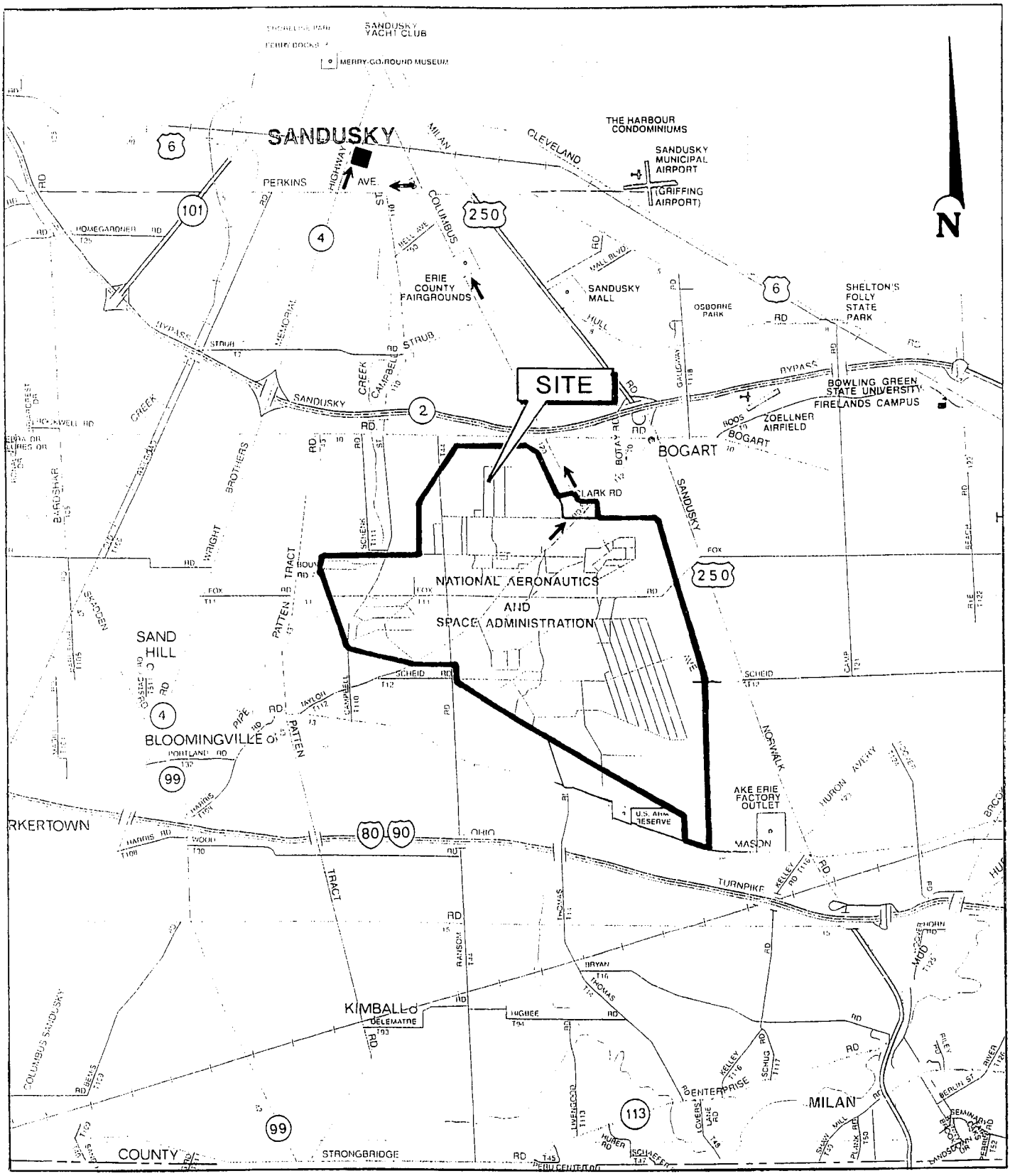

Figure 6-1
HOSPITAL ROUTE
Plum Brook Ordnance Works
Sandusky, Ohio

DAMES & MOORE

Prior to commencement of field work, Dames & Moore shall contact local fire/police/rescue authorities and appropriate personnel at Providence Hospital in order to notify them of upcoming site activities. Site activities, potential emergency situations, and response capabilities will be discussed at this time.

6.5 HOSPITAL

Figure 6-1 provides a map showing the location of the nearest hospital, Providence Hospital. Directions to the hospital are as follows:

Exit the PBOW on Taylor Road (through the Guard Station). Turn left (north) onto Columbus Avenue just as you leave NASA property. Continue north on Columbus Avenue for approximately 4.5 miles to Perkins Avenue. Turn left (west) on Perkins Ave. and proceed for approximately 1.0 mile to Wright Brothers Memorial Highway (State Highway 4). Turn right (north) on Highway 4 heading into Sandusky. Providence Hospital will be on the right, approximately 1/3 mile north of Perkins Avenue and 1/8 mile south of the train tracks, at 1912 Hayes Avenue.

6.6 ACCIDENT/INJURIES

6.6.1 Procedures

Depending upon the severity of the injury, first-aid treatment may be given at the site by trained personnel. Additional assistance from emergency medical technicians may be required at the site, or the victim may have to be transported to a hospital.

Any person who becomes ill or injured in the Exclusion Zones shall be decontaminated to the maximum extent possible. If the injury or illness is minor, full decontamination shall be completed and first aid administered prior to support. If the patient's condition is serious, at least partial decontamination shall be completed (e.g., complete disrobing the victim and redressing in clean coveralls or wrapping in a blanket). First aid shall

be administered while awaiting ambulance or paramedics. All injuries and illnesses shall be reported immediately to the Project Manager.

Personnel who are transported to a clinic or hospital for treatment shall take with them information on the chemical(s) they have been exposed to at the site. This information is included in Tables 1-2 and 1-3.

Any vehicle used to transport contaminated personnel will be treated and cleaned, as necessary.

The SSO shall immediately notify the COE Contact of any accident/incident. Accident reporting and record keeping will fulfill the requirements set forth in the U.S. Army Corps of Engineer's "Safety and Health Requirements Manual," EM 385-1-1. Copies of the forms to be completed in the event of an accident at the site are provided in Appendix A.

It will be the responsibility of the SSO to thoroughly investigate the details of any accident or injury. Based on findings, corrective action will be recommended relative to field procedures to prevent recurrence. The recommended corrective action will be discussed with and approved by the COE Contact.

6.6.2 Exposure to Bloodborne Pathogens

For purposes of this SSHP, personnel fall into the category of classification B in Dames & Moore's Bloodborne Pathogens Program, which are jobs where required tasks normally do not but could involve exposure to blood, body fluids, or tissues, for example, in the event first aid or CPR is required. If exposure to blood, body fluids, or tissues occurs, Universal Precautions such as the following will minimize the chance of contracting disease.

- Wash hands with soap and water as soon as possible after contact with blood, body fluids, or human tissue from an injured worker. When handwashing facilities are not readily available, antiseptic hand cleansers in

conjunction with clean cloth/paper towels shall be used and hands shall be washed with soap and water as soon afterwards as possible.

- Wear gloves when anticipating contact with blood, body fluid, tissues, mucous membranes, or contaminated surfaces, or if breaks in the skin are present.

- Wear appropriate protective equipment at all times including a mask and eye protection if aerosolization or splattering is likely to occur when attending to an injured worker or when conducting normal work routines.

- Insure that mouthpieces and appropriate personal protective equipment are readily available in first aid kits.

- Report immediately to the SSO all sticks or cuts, mucosal splashes, or contamination of open wounds with blood or body fluids.

- Dispose of all spills which contain or may contain biological contaminants in accordance with policies for hazardous waste disposal. Until clean up is complete, an accident area shall be roped off to other workers.

The following procedures and work practice controls shall also be used to eliminate or minimize employee exposure. Where occupational exposure remains after instituting these controls, personal protective equipment shall also be used.

- Ingestion of bloodborne pathogens - Eating, drinking, smoking, applying cosmetics, and handling contact lenses are prohibited in work areas where there is a reasonable likelihood of occupational exposure. Food and drink shall not be kept in refrigerators, freezers, shelves, cabinets, or on countertops or benchtops where blood or other potentially infectious materials are present.

- If handling potentially infectious body parts following dismemberment in an accident, specimens of blood or other potentially infectious materials shall be placed in a container which prevents leakage during collection, handling, processing, storage, transport, or shipping. The container shall be labelled or color coded according to labeling requirements and closed prior to storage, transportation, or shipping. If outside contamination of the primary container occurs, the primary container shall be placed within a secondary container that is puncture resistant in addition to the above characteristics.

- Equipment which may become contaminated with blood or other potentially infectious materials (such as drill rigs or equipment used in first aid responses) shall be examined prior to servicing or shipping and decontaminated as necessary, unless the SSO determines that decontamination of such equipment is not feasible. A readily observable biohazard label shall be attached to the equipment stating which portions

remain contaminated. The SSO shall insure that this information is conveyed to all affected employees, the servicing representative and/or manufacturer as appropriate, prior to handling servicing, or shipping so that appropriate precautions may be taken.

- Personal protective equipment - appropriate personal protective equipment will be provided, such as gloves and mouthpieces in the first aid kits.

- All emergency first aid kits will contain red biohazard bags to contain waste created in first aid/emergency situations.

  - Gloves will be worn at all times
  - Containers will not be overfilled
  - Containers will be tightly closed or sealed prior to transportation
  - Pools of blood, body fluid, tissue, or spills from biohazard waste containers shall be cleaned up with Sodium Hypochlorite or Chlorox bleach, 1 part to 10 parts water.

Employees who have had an exposure incident will be referred for a confidential post exposure evaluation and follow up. This will be made available within a reasonable time and location, and performed by or under the supervision of a licensed physician or licensed healthcare professional.

When an exposure incident is reported, the Project Manager will complete the Bloodborne Pathogens Incident Evaluation Form and will immediately refer the employee for a confidential medical evaluation and follow up. This referral must be made within 24 hours.

The procedure for decontaminating equipment exposed to bloodborne pathogens is provided below.

1. Clean spills from around equipment immediately.

2. Employees engaged in cleaning equipment shall use personal protective equipment that will insure that there is no contact of potentially contaminated material with skin or personal clothing.

3. Clean large equipment with a germicidal detergent or bleach (1 part to 10 parts water), avoiding splatter or dripping. If dripping is reasonably anticipated, use a drop cloth under the equipment being cleaned.

4. Wipe contamination from small reusable equipment. Label the equipment with warning labels indicating which parts are contaminated before sending it to an appropriate location for reprocessing.

5. All cleaning materials and personal protective equipment shall be disposed of as infectious waste or properly prepared for transport to a laundry as potentially infectious laundry.

6. Wash hands after removal of personal protective equipment.

6.7 FIRE

The potential for fire is significant at many hazardous waste sites. During subsurface operations, oxygen monitors and photoionization detectors will be used to monitor levels of potentially combustible gases and volatile organics. Fire extinguishers will be located within 100 feet of the field crew. The local fire department will also be alerted to the nature and location of any field investigation activities.

In the event of fire or explosion, all field personnel will evacuate the area and the local fire department will be notified immediately. The SSO or a designated alternate will advise the fire commander of the location, nature, and identification of the hazardous materials on-site.

6.8 SPILLS OR LEAKS

Containers shall be inspected and their integrity assured prior to being moved. Operations on-site will be organized so as to minimize the amount of container movement. Where spills, leaks, or ruptures may occur, adequate quantities of spill containment equipment (absorbent pillows, etc.) will be stationed in the immediate area. The spill containment program must be sufficient to contain and isolate the entire volume of hazardous substances being transferred. Drums or containers that cannot be moved without failure shall be emptied into a sound container. Fire extinguishing equipment shall be on hand and ready to use if needed to control incipient fires.

In the event of a spill or leak, site personnel will

- inform the SSO immediately;
- locate the source of the spillage and stop the flow if it can be done safely; and
- begin containment and recovery of the spilled materials.

6.9 EMERGENCY EQUIPMENT

Fire Extinguishers

Because of the possibility of fire and explosion at hazardous waste sites, portable fire extinguishers will be readily available (within 100 feet) to field personnel. Foam, dry chemical or CO_2 type extinguishers will be inspected for proper charge, pressure and physical integrity before field operations begin. All personnel will be trained in the use of the fire extinguishers.

First Aid Kits

An industrial first aid kit (physician-approved) with sufficient supplies will be readily available within the support area. Smaller kits will be kept in the clean areas and with field crews. The contents of the first aid kits will be checked by the SSO before being sent out to the job site and rechecked at least once weekly while work is in progress to insure that expended items are replaced.

Eye Wash

A portable eye wash and sufficient potable water for copious flushing will be readily available throughout the investigation. The eye wash unit will be stationed in the Support Zone.

Additional Equipment

Ice will be available for the first aid treatment of sprains and similar moderate injuries.

In addition, an adequate supply of plastic trash bags and liners will be available to aid effective disposal of contaminated disposable work items and protect reusable equipment from recontamination after cleaning.

6.10 SITE EVACUATION

Three stages of evacuation have been determined:

- Withdrawal from immediate work area
- Evacuation of site
- Evacuation of nearby area facilities

The SSO is responsible for determining if circumstances exist for contamination of the surrounding area, and will always assume worst-case conditions until proven otherwise.

If vapor concentrations exceed the work site action levels described in Table 5-2, PID readings will be taken at the edge of the exclusion zone to be protective of workers nearby. If these action levels are encountered, readings will be taken at the edge of occupied nearby buildings. If action levels are encountered at these buildings, the appropriate COE contact will be notified that evacuation is recommended. If these concentrations exist at the site boundary, in addition to COE, the fire and police departments must be notified; A list of their addresses and telephone numbers will be carried by the SSO.

6.11 SAFETY OF THIRD PARTIES

Site work area access will be controlled and only verified team members and previously approved personnel will be allowed to enter work areas or areas where potentially hazardous materials or conditions may be encountered. Work zones will be staked and flagged to deter access by third parties. No unauthorized personnel will be allowed in the designated work zones.

6.12 RECORD KEEPING

Safety inspection reports, accident/incident reports, site safety training and site monitoring results will be recorded on the A&E Daily Quality Control Report each working day. All accidents will be reported to the Contracting Officer within two working days (ENG Form 3394). Accidents and injuries will also be reported per OSHA requirements. Appendix A provides the appropriate forms and report sheets required to document site activities.

6.13 HAZARD COMMUNICATION

Provisions of the Hazard Communication Standard (29 CFR 1910.1200) will be followed including maintaining Material Safety Data Sheets for chemicals carried onto the site. These Material Safety Data Sheets are provided in Appendix B.

7.0 REFERENCES

American Conference of Governmental Industrial Hygienists (ACGIH), 1992. Threshold Limit Values and Biological Exposure Indices for 1993-94. ACGIH, Cincinnati, Ohio.

NIOSH, 1987. NIOSH Guide to Industrial Respiratory Protection, U.S. Dept. of Health and Human Services.

NIOSH, 1990. NIOSH Pocket Guide to Chemical Hazards, U.S. Dept. of Health and Human Services.

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

Sittig, M., 1979. Hazardous and Toxic Effects of Industrial Chemicals. Noyes Data Corporation, Park Ridge, New Jersey.

U.S. Army Corps of Engineers, October 1982. Safety and Health Requirements Manual (EM 385-1-1).

U.S. Department of Transportation, 1985. Chemical Hazard Response Information System (CHRIS), U.S. Coast Guard.

U.S. Environmental Protection Agency, 1986. Superfund Public Health Evaluation Manual. EPA/540/1-86/060.

APPENDIX A

FORMS

APPENDIX A
FORMS

The following forms will be provided to the SSO during final preparations for departure to the job site:

- Federal Safety Poster
- Daily Instrument Calibration Checksheet
- Air Monitoring Data Sheet
- Plan Acceptance Form
- Plan Feedback Form
- Accident/Exposure Report Form
- Accident Report Form (ENG Form 3394)
- Exposure to Bloodborne Pathogen Incident Report Form
- Site Safety Briefing Form.
- Daily QC Report Form

The Plan Acceptance Form will be filled out by all employees working on the site. The Plan Feedback Form will be filled out by the SSO and any other onsite employee who wishes to fill one out. The Accident Report Form will be filled out by the Project Manager if an accident occurs. The Site Safety Briefing Form will be filled out by the SSO and signed by all persons who received the site safety briefing.

ALL COMPLETED FORMS SHOULD BE RETURNED TO THE OFFICE OSC FOR RETENTION IN PROJECT FILES.

JOB SAFETY & HEALTH PROTECTION

The Occupational Safety and Health Act of 1970 provides job safety and health protection for workers by promoting safe and healthful working conditions throughout the Nation. Provisions of the Act include the following:

Employers

All employers must furnish to employees employment and a place of employment free from recognized hazards that are causing or are likely to cause death or serious harm to employees. Employers must comply with occupational safety and health standards issued under the Act.

Employees

Employees must comply with all occupational safety and health standards, rules, regulations and orders issued under the Act that apply to their own actions and conduct on the job.

The Occupational Safety and Health Administration (OSHA) of the U.S. Department of Labor has the primary responsibility for administering the Act. OSHA issues occupational safety and health standards, and its Compliance Safety and Health Officers conduct jobsite inspections to help ensure compliance with the Act.

Inspection

The Act requires that a representative of the employer and a representative authorized by the employees be given an opportunity to accompany the OSHA inspector for the purpose of aiding the inspection.

Where there is no authorized employee representative, the OSHA Compliance Officer must consult with a reasonable number of employees concerning safety and health conditions in the workplace.

Complaint

Employees or their representatives have the right to file a complaint with the nearest OSHA office requesting an inspection if they believe unsafe or unhealthful conditions exist in their workplace. OSHA will withhold, on request, names of employees complaining.

The Act provides that employees may not be discharged or discriminated against in any way for filing safety and health complaints or for otherwise exercising their rights under the Act.

Employees who believe they have been discriminated against may file a complaint with their nearest OSHA office within 30 days of the alleged discriminatory action.

Citation

If upon inspection OSHA believes an employer has violated the Act, a citation alleging such violations will be issued to the employer. Each citation will specify a time period within which the alleged violation must be corrected.

The OSHA citation must be prominently displayed at or near the place of alleged violation for three days, or until it is corrected, whichever is later, to warn employees of dangers that may exist there.

Proposed Penalty

The Act provides for mandatory civil penalties against employers of up to $7,000 for each serious violation and for optional penalties of up to $7,000 for each nonserious violation. Penalties of up to $7,000 per day may be proposed for failure to correct violations within the proposed time period and for each day the violation continues beyond the prescribed abatement date. Also, any employer who willfully or repeatedly violates the Act may be assessed penalties of up to $70,000 for each such violation. A minimum penalty of $5,000 may be imposed for each willful violation. A violation of posting requirements can bring a penalty of up to $7,000.

There are also provisions for criminal penalties. Any willful violation resulting in the death of any employee, upon conviction, is punishable by a fine of up to $250,000 (or $500,000 if the employer is a corporation), or by imprisonment for up to six months, or both. A second conviction of an employer doubles the possible term of imprisonment. Falsifying records, reports, or applications is punishable by a fine of $10,000 or up to six months in jail or both.

Voluntary Activity

While providing penalties for violations, the Act also encourages efforts by labor and management, before an OSHA inspection, to reduce workplace hazards voluntarily and to develop and improve safety and health programs in all workplaces and industries. OSHA's Voluntary Protection Programs recognize outstanding efforts of this nature.

OSHA has published Safety and Health Program Management Guidelines to assist employers in establishing or perfecting programs to prevent or control employee exposure to workplace hazards. There are many public and private organizations that can provide information and assistance in this effort, if requested. Also, your local OSHA office can provide considerable help and advice on solving safety and health problems or can refer you to other sources for help such as training.

Consultation

Free assistance in identifying and correcting hazards and in improving safety and health management is available to employers, without citation or penalty, through OSHA-supported programs in each State. These programs are usually administered by the State Labor or Health department or a State university.

Posting Instructions

Employers in States operating OSHA approved State Plans should obtain and post the State's equivalent poster.

Under provisions of Title 29, Code of Federal Regulations, Part 1903.2(a)(1) employers must post this notice (or facsimile) in a conspicuous place where notices to employees are customarily posted.

More Information

Additional information and copies of the Act, specific OSHA safety and health standards, and other applicable regulations may be obtained from your employer or from the nearest OSHA Regional Office in the following locations:

Atlanta, GA	(404) 347-3573
Boston, MA	(617) 565-7164
Chicago, IL	(312) 353-2220
Dallas, TX	(214) 767-4731
Denver, CO	(303) 844-3061
Kansas City, MO	(816) 426-5861
New York, NY	(212) 337-2378
Philadelphia, PA	(215) 596-1201
San Francisco, CA	(415) 744-6670
Seattle, WA	(206) 553-5930

To report suspected fire hazards, imminent danger safety and health hazards in the workplace, or other job safety and health emergencies, such as toxic waste in the workplace, call OSHA's 24-hour hotline: 1-800-321-OSHA

Washington, DC
1992 (Reprinted)
OSHA 2203

Robert B. Reich, Secretary of Labor

U.S. Department of Labor

Occupational Safety and Health Administration

This information will be made available to sensory impaired individuals upon request. Voice phone: (202) 219-8615. TDD message referral phone: 1-800-326-2577

DAMES & MOORE

DAILY INSTRUMENT CALIBRATION CHECK SHEET

Project Name:

Project Number:

Instrument(s):

Serial #(s):

Date	Pure Air (Y/N)	Calibration Gas (ppm)	Battery Check (Good/Bad)	Calibrated by	Remarks

Proper calibration of instruments shall be conducted immediately prior to site activities. Using felt tip pens/markers or similar items is not considered proper calibration and is not acceptable.

DAMES & MOORE

AIR MONITORING DATA SHEET

Project:

Address:

Job Number:

Date:

Wind Direction:

Field Activities:

Equipment Used:

Calibration Date:

Estimated Wind Speed:

Sample Number	Time	Duration (minutes)	Sample Location	Reading (ppm)	Comments

DAMES & MOORE

PROJECT HEALTH & SAFETY PLAN

PLAN ACCEPTANCE FORM

INSTRUCTIONS: This form is to be completed by each person to work on the subject project work site and returned to the Office Safety Coordinator prior to site activities.

Project Number: _____

Client/Project: _____

Date: _____

I represent that I have read and understand the contents of the above Plan and agree to perform my work in accordance with it.

Signed	Signed
Print Name	Print Name
Company	Company
Date	Date
Signed	Signed
Print Name	Print Name
Company	Company
Date	Date

DAMES & MOORE

PLAN FEEDBACK FORM

Job Name: _____

Job Number: _____

Date: _____

Problems with plan requirements:

_____

_____

_____

_____

_____

_____

Unexpected situations encountered:

_____

_____

_____

_____

_____

_____

Recommedations for future revisions:

_____

_____

_____

_____

_____

_____

DAMES & MOORE

Accident/Exposure Report

EMPLOYEE NAME _____ DATE OF BIRTH _____

HOME ADDRESS _____ PHONE NO. _____

SEX: MALE ____ FEMALE ____ JOB TITLE _____ SOCIAL SECURITY NO. _____

OFFICE NO. _____ OFFICE LOCATION _____ DATE OF HIRE _____

HOURS USUALLY WORKED: HOURS PER DAY _____ HOURS PER WEEK _____ TOTAL HOURS WEEKLY _____

WHERE DID ACCIDENT OR EXPOSURE OCCUR? (INCLUDE ADDRESS) _____

COUNTY _____ ON EMPLOYER'S PREMISES? YES ____ NO ____

WHAT WAS EMPLOYEE DOING WHEN INJURED? (BE SPECIFIC) _____

HOW DID THE ACCIDENT OR EXPOSURE OCCUR? (DESCRIBE FULLY) _____

WHAT STEPS COULD BE TAKEN TO PREVENT SUCH AN OCCURRENCE? _____

OBJECT OR SUBSTANCE THAT DIRECTLY INJURED EMPLOYEE _____

DESCRIBE THE INJURY OR ILLNESS _____ PART OF BODY AFFECTED _____

NAME AND ADDRESS OF PHYSICIAN _____

IF HOSPITALIZED, NAME AND ADDRESS OF HOSPITAL _____

DATE OF INJURY/ILLNESS _____ TIME OF DAY _____ LOSS OF ONE OR MORE DAY OF WORK? YES/NO _____

IF YES-DATE LAST WORKED _____

HAS EMPLOYEE RETURNED TO WORK? _____ IF YES-DATE RETURNED _____ DID EMPLOYEE DIE? _____ IF YES-DATE _____

COMPLETED BY (PRINT) _____ SIGNATURE _____

TITLE _____ DATE _____

An accident/exposure report must be completed by the supervisor or site safety officer immediately upon learning of the incident. The completed report must be immediately transmitted to the office administrative manager.

HS 210A

(For Safety Staff only)	REPORT NO	EROC CODE	UNITED STATES ARMY CORPS OF ENGINEERS ACCIDENT INVESTIGATION REPORT (For Use of this Form See Attached Instructions and USACE Suppl to AR 385-40)	REQUIREMENT CONTROL SYMBOL: CEEC-S-8(R2)

1 ACCIDENT CLASSIFICATION

PERSONNEL CLASSIFICATION	INJURY/ILLNESS/FATAL	PROPERTY DAMAGE	MOTOR VEHICLE INVOLVED	DIVING
GOVERNMENT ☐ CIVILIAN ☐ MILITARY	☐	☐ FIRE INVOLVED ☐ OTHER	☐	☐
☐ CONTRACTOR	☐	☐ FIRE INVOLVED ☐ OTHER	☐	☐
☐ PUBLIC	☐ FATAL ☐ OTHER		☐	

2 PERSONAL DATA

a NAME (Last,First,MI)	b AGE	c SEX ☐ MALE ☐ FEMALE	d SOCIAL SECURITY NUMBER	e GRADE
			___ ___ ___ - ___ ___ - ___ ___ ___ ___	

f JOB SERIES/TITLE	g DUTY STATUS AT TIME OF ACCIDENT	h EMPLOYMENT STATUS AT TIME OF ACCIDENT
	☐ ON DUTY ☐ TDY ☐ OFF DUTY	☐ ARMY ACTIVE ☐ ARMY RESERVE ☐ VOLUNTEER ☐ PERMANENT ☐ FOREIGN NATIONAL ☐ SEASONAL ☐ TEMPORARY ☐ STUDENT ☐ OTHER (Specify)

3 GENERAL INFORMATION

a DATE OF ACCIDENT (month/day/year)	b TIME OF ACCIDENT (Military time))	c EXACT LOCATION OF ACCIDENT	d CONTRACTOR'S NAME
/ /			(1) PRIME

e CONTRACT NUMBER	f TYPE OF CONTRACT	g HAZARDOUS/TOXIC WASTE ACTIVITY	(2) SUBCONTRACTOR
☐ CIVIL WORKS ☐ MILITARY ☐ OTHER (Specify)	☐ CONSTRUCTION ☐ SERVICE ☐ A/E ☐ DREDGE ☐ OTHER (Specify)	☐ SUPERFUND ☐ DERP ☐ IRP ☐ OTHER (Specify)	

4 CONSTRUCTION ACTIVITIES ONLY (Fill in line and corresponding code number in box from list - see instructions)

a CONSTRUCTION ACTIVITY	(CODE)	b TYPE OF CONSTRUCTION EQUIPMENT	(CODE)

INJURY / ILLNESS INFORMATION (Include name on line and corresponding code number in box for items e, f & g - see instructions)

a. SEVERITY OF ILLNESS / INJURY	(CODE)	b. ESTIMATED DAYS LOST	c. ESTIMATED DAYS HOSPITALIZED	d. ESTIMATED DAYS RESTRICTED DUTY

e. BODY PART AFFECTED	(CODE)	g TYPE AND SOURCE OF INJURY/ILLNESS	(CODE)
PRIMARY		TYPE	
SECONDARY		SOURCE	
f. NATURE OF ILLNESS / INJURY			

6 PUBLIC FATALITY (Fill in line and corresponding code number in box - see instructions)

a ACTIVITY AT TIME OF ACCIDENT	(CODE)	b PERSONAL FLOATATION DEVICE USED?
		☐ YES ☐ NO ☐ N/A

7 MOTOR VEHICLE ACCIDENT

a TYPE OF VEHICLE	b TYPE OF COLLISION	c. SEAT BELTS	USED	NOT USED	NOT AVAILABLE
☐ PICKUP/VAN ☐ AUTOMOBILE ☐ TRUCK ☐ OTHER (Specify)	☐ SIDE SWIPE ☐ HEAD ON ☐ REAR END ☐ BROADSIDE ☐ ROLL OVER ☐ BACKING ☐ OTHER (Specify)	(1) FRONT SEAT			
		(2) REAR SEAT			

8 PROPERTY/MATERIAL INVOLVED

a. NAME OF ITEM	b OWNERSHIP	c $ AMOUNT OF DAMAGE
(1)		
(2)		
(3)		

9 VESSEL / FLOATING PLANT ACCIDENT (Fill in line and corresponding code number in box from list - see instructions)

a TYPE OF VESSEL/FLOATING PLANT	(CODE)	b TYPE OF COLLISON/MISHAP	(CODE)

1 ACCIDENT DESCRIPTION (Use additional paper, if necessary)

11 **CAUSAL FACTOR(S)** *(Read Instruction Before Completing)*

a *(Explain YES answers in item 13)*	YES	NO
DESIGN Was design of facility,workplace or equipment a factor?	☐	☐
INSPECTION/MAINTENANCE Were inspection & maintenance procedures a factor?	☐	☐
PERSON'S PHYSICAL CONDITION In your opinion, was the physical condition of the person a factor?	☐	☐
OPERATING PROCEDURES Were operating procedures a factor?	☐	☐
JOB PRACTICES Were any job safety/health practices not followed when the accident occurred?	☐	☐
HUMAN FACTORS Did any human factors such as, size or strength of person, etc.,contribute to accident?	☐	☐
ENVIRONMENTAL FACTORS Did heat, cold, dust, sun, glare, etc , contribute to the accident?	☐	☐

a *(CONTINUED)*	YES	NO
CHEMICAL AND PHYSICAL AGENT FACTORS Did exposure to chemical agents, such as dust fumes,mists,vapors or physical agents, such as, noise,radiation,etc ,contribute to accident?	☐	☐
OFFICE FACTORS Did office setting such as, lifting office furniture,carrying,stooping,etc ,contribute to the accident?	☐	☐
SUPPORT FACTORS Were inappropriate tools/resources provided to properly perform the activity/task?	☐	☐
PERSONAL PROTECTIVE EQUIPMENT Did the improper selection, use or maintenance of personal protective equipment contribute to the accident?	☐	☐
DRUGS/ALCOHOL In your opinion,was drugs or alcohol a factor to the accident?	☐	☐

b. WAS A WRITTEN JOB/ACTIVITY HAZARD ANALYSIS COMPLETED FOR TASK BEING PERFORMED AT TIME OF ACCIDENT?

☐ YES *(If yes, attach a copy)* ☐ NO

12 **TRAINING**

a WAS PERSON TRAINED TO PERFORM ACTIVITY/TASK?	b. TYPE OF TRAINING	c DATE OF MOST RECENT FORMAL TRAINING
☐ YES ☐ NO	☐ CLASSROOM ☐ ON JOB	/ / *(Month) (Day) (Year)*

13 **FULLY EXPLAIN WHAT ALLOWED OR CAUSED THE ACCIDENT; INCLUDE DIRECT AND INDIRECT CAUSES** *(See instruction for definition of direct and indirect causes) (Use additional paper if necessary)*

a DIRECT CAUSE

b INDIRECT CAUSE(S)

14 **ACTION(S) TAKEN, ANTICIPATED OR RECOMMENDED TO ELIMINATE CAUSE(S)**

DESCRIBE FULLY.

15 **DATES FOR ACTIONS IDENTIFIED IN BLOCK 14.**

a BEGINNING *(Month/Day/Year)* / /	b ANTICIPATED COMPLETION *(Month/Day/Year)* / /

c SIGNATURE AND TITLE OF SUPERVISOR COMPLETING REPORT	d DATE *(Mo/Da/Yr)*	e ORGANIZATION IDENTIFIER *(Div. Br. Sect)*	f. OFFICE SYMBOL
CORPS _____	___ / ___ / ___		
CONTRACTOR _____	___ / ___ / ___		

16 **MANAGEMENT REVIEW** *(1st)*.

a ☐ CONCUR b ☐ NON CONCUR c. COMMENTS

SIGNATURE	TITLE	DATE

17 **MANAGEMENT REVIEW** *(2nd - Chief Operations, Construction, Engineering, etc.)*

a ☐ CONCUR b ☐ NON CONCUR c. COMMENTS

SIGNATURE	TITLE	DATE

18 **SAFETY AND OCCUPATIONAL HEALTH OFFICE REVIEW**

a ☐ CONCUR b ☐ NON CONCUR c ADDITIONAL ACTIONS/COMMENTS

SIGNATURE	TITLE	DATE

19 **COMMAND APPROVAL**

COMMENTS

COMMANDER SIGNATURE	DATE

GENERAL. Complete a separate report for each person who was *injured, caused,* or *contributed* to the accident (excluding uninjured personnel and witnesses). Use of this form for reporting USACE employee first-aid type injuries not submitted to the Office of Workers' Compensation Programs (OWCP) shall be at the descretion of the FOA Commander. Please type or print legibly. Appropriate items shall be marked with an "X" in box(es). If additional space is needed, provide the information on a separate sheet and attach to the completed form. Ensure that these instructions are forwarded with the completed report to the designated management reviewers indicated in sections 16. and 17.

INSTRUCTIONS FOR SECTION 1 — ACCIDENT CLASSIFICATION. *(Mark All Boxes That Are Applicable.)*

a. GOVERNMENT. Mark "CIVILIAN" box if accident involved government civilian employee; mark "MILITARY" box if accident involved U.S. military personnel.

(1) INJURY/ILLNESS/FATALITY — Mark if accident resulted in any government civilian employee injury, illness, or fatality that requires the submission of OWCP Forms CA-1 (injury), CA-2 (illness), or CA-6 (fatality) to OWCP; mark if accident resulted in military personnel lost-time or fatal injury or illness.

(2) PROPERTY DAMAGE — Mark the appropriate box if accident resulted in any damage of $1000 or more to government property (including motor vehicles).

(3) VEHICLE INVOLVED — Mark if accident involved a motor vehicle, *regardless* of whether "INJURY/ILLNESS/FATALITY" or "PROPERTY DAMAGE" are marked.

(4) DIVING ACTIVITY — Mark if the accident involved an in-house USACE diving activity.

b. CONTRACTOR.

(1) INJURY/ILLNESS/FATALITY — Mark if accident resulted in any contractor lost-time injury/illness or fatality.

(2) PROPERTY DAMAGE — Mark the appropriate box if accident resulted in any damage of $1000 or more to contractor property (including motor vehicles).

(3) VEHICLE INVOLVED — Mark if accident involved a motor vehicle, *regardless* of whether "INJURY/ILLNESS/FATALITY" or "PROPERTY DAMAGE" are marked.

(4) DIVING ACTIVITY — Mark if the accident involved a USACE Contractor diving activity.

c. PUBLIC.

(1) INJURY/ILLNESS/FATALITY — Mark if accident resulted in public fatality or permanent total disability. (The "OTHER" box will be marked when requested by the FOA to report an unusual non-fatal public accident that could result in claims against the government or as otherwise directed by the FOA Commander).

(2) VOID SPACE — Make no entry.

(3) VEHICLE INVOLVED — Mark if accident resulted in a fatality to a member of the public and involved a motor vehicle, *regardless* of whether "INJURY/ILLNESS/FATALITY" is marked.

(4) VOID SPACE — Make no entry.

INSTRUCTIONS FOR SECTION 2 — PERSONAL DATA

a. NAME — (MANDATORY FOR GOVERNMENT ACCIDENTS. OPTIONAL AT THE DISCRETION OF THE FOA COMMANDER FOR CONTRACTOR AND PUBLIC ACCIDENTS). Enter last name, first name, middle initial of person involved.

b. AGE — Enter age.

SEX — Mark appropriate box.

c. SOCIAL SECURITY NUMBER — (FOR GOVERNMENT PERSONNEL ONLY) Enter the social security number (or other personal identification number if no social security number issued).

e. GRADE — (FOR GOVERNMENT PERSONNEL ONLY) Enter pay grade. Example: O-6; E-7; WG-8; WS-12; GS-11; etc.

f. JOB SERIES/TITLE — For *government civilian employees* enter the pay plan, full series number, and job title, e.g. GS-0810/Civil Engineer. For *military personnel* enter the primary military occupational specialty (PMOS), e.g., 15A30 or 11G50. For *contractor employees* enter the job title assigned to the injured person, e.g. carpenter, laborer, surveyor, etc.,

g. DUTY STATUS — Mark the appropriate box.

(1) ON DUTY — Person was at duty station during duty hours or person was away from duty station during duty hours but on official business at time of the accident.

(2) TDY - Person was on official business, away from the duty station and with travel orders at time of accident. Line-of-duty investigation required.

(3) OFF DUTY - Person was not on official business at time of accident

h. EMPLOYMENT STATUS — (FOR GOVERNMENT PERSONNEL ONLY) Mark the most appropriate box. If "OTHER" is marked, specify the employment status of the person.

INSTRUCTION FOR SECTION 3 — GENERAL INFORMATION

a. DATE OF ACCIDENT — Enter the month, day, and year of accident.

b. TIME OF ACCIDENT — Enter the local time of accident in military time. Example: 1430 hrs (not 2:30 p.m.).

c. EXACT LOCATION OF ACCIDENT — Enter facts needed to locate the accident scene. (installation/project name, building number, street, direction and distance from closest landmark, etc.,).

d. CONTRACTOR NAME

(1) PRIME — Enter the exact name (title of firm) of the prime contractor.

(2) SUBCONTRACTOR — Enter the name of any subcontractor involved in the accident.

e. CONTRACT NUMBER — Mark the appropriate box to identify if contract is civil works, military, or other: if "OTHER" is marked, specify contract appropriation on line provided. Enter complete contract number of prime contract, e.g., DACW 09-85-C-0100.

f. TYPE OF CONTRACT — Mark appropriate box. A/E means architect/engineer. If "OTHER" is marked, specify type of contract on line provided.

g. HAZARDOUS/TOXIC WASTE ACTIVITY (HTW) — Mark the box to identify the HTW activity being performed at the time of the accident. For Superfund, DERP, and Installation Restoration Program (IRP) HTW activities include accidents that occurred during inventory, predesign, design, and construction. For the purpose of accident reporting, DERP Formerly Used DoD Site (FUDS) activities and IRP activities will be treated separately. For Civil Works O&M HTW activities mark the "OTHER" box.

INSTRUCTIONS FOR SECTION 4 — CONSTRUCTION ACTIVITIES

a. CONSTRUCTION ACTIVITY — Select the *most appropriate* construction activity being performed at time of accident from the list below. Enter the activity name and place the corresponding code number identified in the box.

CONSTRUCTION ACTIVITY LIST

1. MOBILIZATION
2. SITE PREPARATION
3. EXCAVATION/TRENCHING
4. GRADING (EARTHWORK)
5. PIPING/UTILITIES
6. FOUNDATION
7. FORMING
8. CONCRETE PLACEMENT
9. STEEL ERECTION
10. ROOFING
11. FRAMING
12. MASONRY
13. CARPENTRY
14. ELECTRICAL
15. SCAFFOLDING/ACCESS
16. MECHANICAL
17. PAINTING
18. EQUIPMENT/MAINTENANCE
19. TUNNELING
20. WAREHOUSING/STORAGE
21. PAVING
22. FENCING
23. SIGNING
24. LANDSCAPING/IRRIGATION
25. INSULATION
26. DEMOLITION

b. TYPE OF CONSTRUCTION EQUIPMENT—Select the equipment involved in the accident from the list below. Enter the name and place the corresponding code number identified in the box. If equipment is not included below, use code 24, "OTHER", and write in specific type of equipment.

CONSTRUCTION EQUIPMENT

1. GRADER
2. DRAGLINE
3. CRANE (ON VESSEL/BARGE)
4. CRANE (TRACKED)
5. CRANE (RUBBER TIRE)
6. CRANE (VEHICLE MOUNTED)
7. CRANE (TOWER)
8. SHOVEL
9. SCRAPER
10. PUMP TRUCK (CONCRETE)
11. TRUCK (CONCRETE/TRANSIT MIXER)
12. DUMP TRUCK (HIGHWAY)
13. DUMP TRUCK (OFF HIGHWAY)
14. TRUCK (OTHER)
15. FORKLIFT
16. BACKHOE
17. FRONT-END LOADER
18. PILE DRIVER
19. TRACTOR (UTILITY)
20. MANLIFT
21. DOZER
22. DRILL RIG
23. COMPACTOR/VIBRATORY ROLLER
24. OTHER

INSTRUCTIONS FOR SECTION 5—INJURY/ILLNESS INFORMATION

a. SEVERITY OF INJURY / ILLNESS - Reference para 2-10 of USACE Suppl 1 to AR 385-40 and enter code and description from list below.

NOI NO INJURY
FAT FATALITY
PTL PERMANENT TOTAL DISABILITY
PPR PERMANENT PARTIAL DISABILITY
LWD LOST WORKDAY CASE INVOLVING DAYS AWAY FROM WORK
NLW RECORDABLE CASE WITHOUT LOST WORKDAYS
RFA RECORDABLE FIRST AID CASE
NRI NON-RECORDABLE INJURY

b. ESTIMATED DAYS LOST—Enter the estimated number of workdays the person will lose from work.

c. ESTIMATED DAYS HOSPITALIZED—Enter the estimated number of workdays the person will be hospitalized.

d. ESTIMATED DAYS RESTRICTED DUTY—Enter the estimated number of workdays the person, as a result of the accident, will not be able to perform all of their regular duties.

e. BODY PART AFFECTED—Select the most appropriate primary and when applicable, secondary body part affected from the list below. Enter body part name on line and place the corresponding code letters identifying that body part in the box.

GENERAL BODY AREA	CODE	BODY PART NAME
ARM/WRIST	AB	ARM AND WRIST
	AS	ARM OR WRIST
TRUNK, EXTERNAL MUSCULATURE	B1	SINGLE BREAST
	B2	BOTH BREASTS
	B3	SINGLE TESTICLE
	B4	BOTH TESTICLES
	BA	ABDOMEN
	BC	CHEST
	BL	LOWER BACK
	BP	PENIS
	BS	SIDE
	BU	UPPER BACK
	BW	WAIST
	BZ	TRUNK OTHER
HEAD, INTERNAL	C1	SINGLE EAR INTERNAL
	C2	BOTH EARS INTERNAL
	C3	SINGLE EYE INTERNAL
	C4	BOTH EYES INTERNAL
	CB	BRAIN
	CC	CRANIAL BONES
	CD	TEETH
	CJ	JAW
	CL	THROAT, LARYNX
	CM	MOUTH
	CN	NOSE
	CR	THROAT, OTHER
	CT	TONGUE
	CZ	HEAD OTHER INTERNAL
ELBOW	EB	BOTH ELBOWS
	ES	SINGLE ELBOW
FINGER	F1	FIRST FINGER
	F2	BOTH FIRST FINGERS
	F3	SECOND FINGER
	F4	BOTH SECOND FINGERS
	F5	THIRD FINGER
	F6	BOTH THIRD FINGERS
	F7	FOURTH FINGER
	F8	BOTH FOURTH FINGERS
TOE	G1	GREAT TOE
	G2	BOTH GREAT TOES
	G3	TOE OTHER
	G4	TOES OTHER
HEAD, EXTERNAL	H1	EYE EXTERNAL
	H2	BOTH EYES EXTERNAL
	H3	EAR EXTERNAL
	H4	BOTH EARS EXTERNAL
	HC	CHIN
	HF	FACE
	HK	NECK/THROAT
	HM	MOUTH/LIPS
	HN	NOSE
	HS	SCALP
KNEE	KB	BOTH KNEES
	KS	KNEE
LEG, HIP, ANKLE, BUTTOCK	LB	BOTH LEGS/HIPS/ ANKLES/BUTTOCKS
	LS	SINGLE LEG/HIP ANKLE/BUTTOCK
HAND	MB	BOTH HANDS
	MS	SINGLE HAND
FOOT	PB	BOTH FEET
	PS	SINGLE FOOT
TRUNK, BONES	R1	SINGLE COLLAR BONE
	R2	BOTH COLLAR BONES
	R3	SHOULDER BLADE
	R4	BOTH SHOULDER BLADES
	RB	RIB
	RS	STERNUM (BREAST BONE)
	RV	VERTEBRAE (SPINE; DISC)
	RZ	TRUNK BONES OTHER
SHOULDER	SB	BOTH SHOULDERS
	SS	SINGLE SHOULDER
THUMB	TB	BOTH THUMBS
	TS	SINGLE THUMB
TRUNK, INTERNAL ORGANS	V1	LUNG, SINGLE
	V2	LUNGS, BOTH
	V3	KIDNEY, SINGLE
	V4	KIDNEYS, BOTH
	VH	HEART
	VL	LIVER
	VR	REPRODUCTIVE ORGANS
	VS	STOMACH
	VV	INTESTINES
	VZ	TRUNK, INTERNAL; OTHER

f. NATURE OF INJURY/ILLNESS - Select the most appropriate nature of injury / illness from the list below. This nature of injury / illness shall correspond to the primary body part selected in 5e, above. Enter the nature of injury / illness name on the line and place the corresponding CODE letters in the box provided.

CODE	SOURCE OF INJURY NAME
0200	ENVIRONMENTAL CONDITION
0210	TEMPERATURE EXTREME (INDOOR)
0220	WEATHER (ICE, RAIN, HEAT, ETC.)
0230	FIRE, FLAME, SMOKE (NOT TOBACCO)
0240	NOISE
0250	RADIATION
0260	LIGHT
0270	VENTILATION
0271	TOBACCO SMOKE
0280	STRESS (EMOTIONAL)
0290	CONFINED SPACE
0300	MACHINE OR TOOL
0310	HAND TOOL (POWERED: SAW, GRINDER, ETC.)
0320	HAND TOOL (NONPOWERED)
0330	MECHANICAL POWER TRANSMISSION APPARATUS
0340	GUARD, SHIELD (FIXED, MOVEABLE, INTERLOCK)
0350	VIDEO DISPLAY TERMINAL
0360	PUMP, COMPRESSOR, AIR PRESSURE TOOL
0370	HEATING EQUIPMENT
0380	WELDING EQUIPMENT
0400	VEHICLE
0411	AS DRIVER OF PRIVATELY OWNED/RENTAL VEHICLE
0412	AS PASSENGER OF PRIVATELY OWNED/RENTAL VEHICLE
0421	DRIVER OF GOVERNMENT VEHICLE
0422	PASSENGER OF GOVERNMENT VEHICLE
0430	COMMON CARRIER (AIRLINE, BUS, ETC.)
0440	AIRCRAFT (NOT COMMERCIAL)
0450	BOAT, SHIP, BARGE
0500	MATERIAL HANDLING EQUIPMENT
0510	EARTHMOVER (TRACTOR, BACKHOE, ETC.)
0520	CONVEYOR (FOR MATERIAL AND EQUIPMENT)
0530	ELEVATOR, ESCALATOR, PERSONNEL HOIST
0540	HOIST, SLING CHAIN, JACK
0550	CRANE
0551	FORKLIFT
0560	HANDTRUCK, DOLLY
0600	DUST, VAPOR, ETC.
0610	DUST (SILICA, COAL, ETC.)
0620	FIBERS
0621	ASBESTOS
0630	GASES
0631	CARBON MONOXIDE
0640	MIST, STEAM, VAPOR, FUME
0641	WELDING FUMES
0650	PARTICLES (UNIDENTIFIED)
0700	CHEMICAL, PLASTIC, ETC.
0711	DRY CHEMICAL—CORROSIVE
0712	DRY CHEMICAL—TOXIC
0713	DRY CHEMICAL—EXPLOSIVE
0714	DRY CHEMICAL—FLAMMABLE
0721	LIQUID CHEMICAL—CORROSIVE
0722	LIQUID CHEMICAL—TOXIC
0723	LIQUID CHEMICAL—EXPLOSIVE
0724	LIQUID CHEMICAL—FLAMMABLE
0730	PLASTIC
0740	WATER
0750	MEDICINE
0800	INANIMATE OBJECT
0810	BOX, BARREL, ETC.
0820	PAPER
0830	METAL ITEM, MINERAL
0831	NEEDLE
0840	GLASS
0850	SCRAP, TRASH
0860	WOOD
0870	FOOD
0880	CLOTHING, APPAREL, SHOES
0900	ANIMATE OBJECT
0911	DOG
0912	OTHER ANIMAL
0920	PLANT
0930	INSECT
0940	HUMAN (VIOLENCE)
0950	HUMAN (COMMUNICABLE DISEASE)
0960	BACTERIA, VIRUS (NOT HUMAN CONTACT)

CODE	SOURCE OF INJURY NAME
1000	PERSONAL PROTECTIVE EQUIPMENT
1010	PROTECTIVE CLOTHING, SHOES, GLASSES, GOGGLES
1020	RESPIRATOR, MASK
1021	DIVING EQUIPMENT
1030	SAFETY BELT, HARNESS
1040	PARACHUTE

INSTRUCTIONS FOR SECTION 6 — PUBLIC FATALITY

a. ACTIVITY AT TIME OF ACCIDENT—Select the activity being performed at the time of the accident from the list below. Enter the activity name on the line and the corresponding number in the box. If the activity performed is not identified on the list, select from the *most* appropriate primary activity area (water related, non-water related or other activity), the code number for "Other", and write in the activity being performed at the time of the accident.

WATER RELATED RECREATION

1. Sailing
2. Boating—powered
3. Boating—unpowered
4. Water skiing
5. Fishing from boat
6. Fishing from bank dock or pier
7. Fishing while wading
8. Swimming/supervised area
9. Swimming/designated area
10. Swimming/other area
11. Underwater activities (skin diving, scuba, etc.)
12. Wading
13. Attempted rescue
14. Hunting from boat
15. Other

NON-WATER RELATED RECREATION

16. Hiking and walking
17. Climbing (general)
18. Camping/picnicking authorized area
19. Camping/picnicking unauthorized area
20. Guided tours
21. Hunting
22. Playground equipment
23. Sports/summer (baseball, football, etc.)
24. Sports/winter (skiing, sledding, snowmobiling etc.)
25. Cycling (bicycle, motorcycle, scooter)
26. Gliding
27. Parachuting
28. Other non-water related

OTHER ACTIVITIES

29. Unlawful acts (fights, riots, vandalism, etc.)
30. Food preparation/serving
31. Food consumption
32. Housekeeping
33. Sleeping
34. Pedestrian struck by vehicle
35. Pedestrian other acts
36. Suicide
37. "Other" activities

b. PERSONAL FLOTATION DEVICE USED—If fatality was water-related was the victim wearing a person flotation device? Mark the appropriate box.

INSTRUCTIONS FOR SECTION 7—MOTOR VEHICLE ACCIDENT

a. TYPE OF VEHICLE—Mark appropriate box for each vehicle involved. If more than one vehicle of the same type is involved, mark both halves of the appropriate box. USACE vehicle(s) involved shall be marked in left half of appropriate box.

b. TYPE OF COLLISION—Mark appropriate box.

c. SEAT BELT—Mark appropriate box.

INSTRUCTIONS FOR SECTION 8—PROPERTY/ MATERIAL INVOLVED

a. NAME OF ITEM—Describe all property involved in accident. Property/material involved means material which is damaged or whose use or misuse contributed to the accident. Include the name, type, model; also include the National Stock Number (NSN) whenever applicable.

b. OWNERSHIP—Enter ownership for each item listed. (Enter one of the following: *USACE; OTHER GOVERNMENT; CONTRACTOR; PRIVATE)*

c. $ AMOUNT OF DAMAGE—Enter the total estimated dollar amount of damage (parts and labor), if any.

* The injury or condition selected below must be caused by a specific incident or event which occurred during a single work day or shift.

GENERAL NATURE CATEGORY	CODE	NATURE OF INJURY NAME
*TRAUMATIC INJURY OR DISABILITY	TA	AMPUTATION
	TB	BACK STRAIN.
	TC	CONTUSION. BRUISE. ABRASION
	TD	DISLOCATION
	TF	FRACTURE
	TH	HERNIA
	TK	CONCUSSION
	TL	LACERATION. CUT
	TP	PUNCTURE
	TS	STRAIN. MULTIPLE
	TU	BURN. SCALD. SUNBURN
	TI	TRAUMATIC SKIN DISEASES/ CONDITIONS INCLUDING DERMATITIS
	TR	TRAUMATIC RESPIRATORY DISEASE
	TQ	TRAUMATIC FOOD POISONING
	TW	TRAUMATIC TUBERCULOSIS
	TX	TRAUMATIC VIROLOGICAL/ INFECTIVE/PARASITIC DISEASE
	T1	TRAUMATIC CEREBRAL VASCULAR CONDITION/STROKE
	T2	TRAUMATIC HEARING LOSS
	T3	TRAUMATIC HEART CONDITION
	T4	TRAUMATIC MENTAL DISORDER. STRESS. NERVOUS CONDITION
	T8	TRAUMATIC INJURY — OTHER (EXCEPT DISEASE. ILLNESS)

**A nontraumatic physiological harm or loss of capacity produced by systemic infection; continued or repeated stress or strain; exposure to toxins, poisons, fumes, etc.; or other continued and repeated exposures to conditions of the work environment over a long period of time. For practical purposes, an occupational illness/disease or disability is any reported condition which doses not meet the definition of traumatic injury or disability as described above.

GENERAL NATURE CATEGORY	CODE	NATURE OF INJURY NAME
**NON-TRAUMATIC ILLNESS/DISEASE OR DISABILITY		
RESPIRATORY DISEASE	RA	ASBESTOSIS
	RB	BRONCHITIS
	RE	EMPHYSEMA
	RP	PNEUMOCONIOSIS
	RS	SILICOSIS
	R9	RESPIRATORY DISEASE. OTHER
VIROLOGICAL. INFECTIVE & PARASITIC DISEASES	VB	BRUCELLOSIS
	VC	COCCIDIOMYCOSIS
	VF	FOOD POISONING
	VH	HEPATITIS
	VM	MALARIA
	VS	STAPHYLOCOCCUS
	VT	TUBERCULOSIS
	V9	VIROLOGICAL/INFECTIVE/ PARASITIC—OTHER
DISABILITY. OCCUPATIONAL	DA	ARTHRITIS. BURSITIS
	DB	BACK STRAIN. BACK SPRAIN
	DC	CEREBRAL VASCULAR CONDITION: STROKE
	DD	ENDEMIC DISEASE (OTHER THAN CODE TYPES R&S)
	DE	EFFECT OF ENVIRONMENTAL CONDITION
	DH	HEARING LOSS
	DK	HEART CONDITION
	DM	MENTAL DISORDER. EMOTIONAL STRESS NERVOUS CONDITION
	DR	RADIATION
	DS	STRAIN. MULTIPLE
	DU	ULCER
	DV	OTHER VASCULAR CONDITIONS
	D9	DISABILITY. OTHER
SKIN DISEASE OR CONDITION	SB	BIOLOGICAL
	SC	CHEMICAL
	S9	DERMATITIS. UNCLASSIFIED

g. TYPE AND SOURCE OF INJURY/ILLNESS (CAUSE) - Type a Codes are used to describe what caused the incident. The Type Code stands for an ACTION and the Source Code for an OBJECT or SUBSTANCE. Together, they form a brief description of how the incident occurred. Where there are two different sources, code the initiating source of the incident (see example 1, below). Examples

(1) An employee tripped on carpet and struck his head on a desk.
TYPE: 210 (fell on same level) SOURCE: 0110 (walking/working surface)

NOTE This example would NOT be coded 120 (struck against) and 0140 (furniture)

(2) A Park Ranger contracted dermatitis from contact with poison ivy/ oak.
TYPE: 510 (contact) SOURCE: 0920 (plant)

(3) A lock and dam mechanic punctured his finger with a metal sliver while grinding a turbine blade.
TYPE: 410 (punctured by) SOURCE: 0830 (metal)

(4) An employee was driving a government vehicle when it was struck by another vehicle..
TYPE: 800 (traveling in) SOURCE: 0421 (government-owned vehicle, as driver)

NOTE The Type Code 800. "Traveling In" is different from the other type codes in that its function is not to identify factors contributing to the injury or fatality, but rather to collect data on the type of vehicle the employee was operating or traveling in at the time of the incident.

Select the most appropriate TYPE and SOURCE identifier from the list below and enter the name on the line and the corresponding code in the appropriate box.

CODE	TYPE OF INJURY NAME
	STRUCK
0110	STRUCK BY
0111	STRUCK BY FALLING OBJECT
0120	STRUCK AGAINST
	FELL. SLIPPED. TRIPPED
0210	FELL ON SAME LEVEL
0220	FELL ON DIFFERENT LEVEL
0230	SLIPPED. TRIPPED (NO FALL)
	CAUGHT
0310	CAUGHT ON
0320	CAUGHT IN
0330	CAUGHT BETWEEN
	PUNCTURED. LACERATED
0410	PUNCTURED BY
0420	CUT BY
0430	STUNG BY
0440	BITTEN BY
	CONTACTED
0510	CONTACTED WITH (INJURED PERSON MOVING)
0520	CONTACTED BY (OBJECT WAS MOVING)
	EXERTED
0610	LIFTED. STRAINED BY (SINGLE ACTION)
0620	STRESSED BY (REPEATED ACTION)
	EXPOSED
0710	INHALED
0720	INGESTED
0730	ABSORBED
0740	EXPOSED TO
0800	TRAVELING IN

CODE	SOURCE OF INJURY NAME
0100	BUILDING OR WORKING AREA
0110	WALKING/WORKING SURFACE (FLOOR. STREET. SIDEWALKS. ETC)
0120	STAIRS. STEPS
0130	LADDER
0140	FURNITURE. FURNISHINGS. OFFICE EQUIPMENT
0150	BOILER. PRESSURE VESSEL
0160	EQUIPMENT LAYOUT (ERGONOMIC)
0170	WINDOWS. DOORS
0180	ELECTRICITY

INSTRUCTIONS FOR SECTION 9—VESSEL/ FLOATING PLANT ACCIDENT

a. TYPE OF VESSEL/FLOATING PLANT—Select the most appropriate vessel/floating plant from list below. Enter name and place corresponding number in box. If item is not listed below, enter item number for "OTHER" and write in specific type of vessel/ floating plant.

VESSEL/FLOATING PLANTS

1. ROW BOAT
2. SAIL BOAT
3. MOTOR BOAT
4. BARGE
5. DREDGE/HOPPER
6. DREDGE/SIDE CASTING
7. DREDGE/DIPPER
8. DREDGE/CLAMSHELL, BUCKET
9. DREDGE/PIPE LINE
10. DREDGE/DUST PAN
11. TUG BOAT
12. OTHER

b. COLLISION/MISHAP—Select from the list below the object(s) that contributed to the accident or were damaged in the accident.

COLLISION/MISHAP

1. COLLISION W/OTHER VESSEL
2. UPPER GUIDE WALL
3. UPPER LOCK GATES
4. LOCK WALL
5. LOWER LOCK GATES
6. LOWER GUIDE WALL
7. HAULAGE UNIT
8. BREAKING TOW
9. TOW BREAKING UP
10. SWEPT DOWN ON DAM
11. BUOY/DOLPHIN/CELL
12. WHARF OR DOCK
13. OTHER

INSTRUCTIONS FOR SECTION 10—ACCIDENT DESCRIPTION

DESCRIBE ACCIDENT—Fully describe the accident. Give the sequence of events that describe what happened leading up to and including the accident. Fully identify personnel and equipment involved and their role(s) in the accident. Ensure that relationships between personnel and equipment are clearly specified. Continue on blank sheets if necessary and attach to this report.

INSTRUCTIONS FOR SECTION 11—CAUSAL FACTORS

a. Review thoroughly. Answer each question by marking the appropriate block. If any answer is yes, explain in item 13 below. Consider, as a minimum, the following:

(1) DESIGN—Did inadequacies associated with the building or work site play a role? Would an improved design or layout of the equipment or facilities reduce the likelihood of similar accidents? Were the tools or other equipment designed and intended for the task at hand?

(2) INSPECTION/MAINTENANCE—Did inadequately or improperly maintained equipment, tools, workplace, etc. create or worsen any hazards that contributed to the accident? Would better equipment, facility, work site or work activity inspections have helped avoid the accident?

(3) PERSON'S PHYSICAL CONDITION—Do you feel that the accident would probably not have occurred if the employee was in "good" physical condition? If the person involved in the accident had been in better physical condition, would the accident have been less severe or avoided altogether? Was over exertion a factor?

(4) OPERATING PROCEDURES—Did a lack of or inadequacy within established operating procedures contribute to the accident? Did any aspect of the procedures introduce any hazard to, or increase the risk associated with the work process? Would establishment or improvement of operating procedures reduce the likelihood of similar accidents?

(5) JOB PRACTICES—Were any of the provisions of the Safety and Health Requirements Manual (EM 385-1-1) violated? Was the task being accomplished in a manner which was not in compliance with an established job hazard analysis or activity hazard analysis? Did any established job practice (including EM 385-1-1) fail to adequately address the task or work process? Would better job practices improve the safety of the task?

(6) HUMAN FACTORS—Was the person under undue stress (either internal or external to the job)? Did the task tend toward overloading the capabilities of the person; i.e., did the job require tracking and reacting to many external inputs such as displays, alarms, or signals? Did the arrangement of the workplace tend to interfere with efficient task performance? Did the task require reach, strength, endurance, agility, etc., at or beyond the capabilities of the employee? Was the work environment ill-adapted to the person? Did the person need more training, experience, or practice in doing the task? Was the person inadequately rested to perform safely?

(7) ENVIRONMENTAL FACTORS—Did any factors such as moisture, humidity, rain, snow, sleet, hail, ice, fog, cold, heat, sun, temperature changes, wind, tides, floods, currents, dust, mud, glare, pressure changes, lightning, etc., play a part in the accident?

(8) CHEMICAL AND PHYSICAL AGENT FACTORS—Did exposure to chemical agents (either single shift exposure or long-term exposure) such as dusts, fibers (asbestos, etc.), silica, gases (carbon monoxide, chlorine, etc.,), mists, steam, vapors, fumes, smoke, other particulates, liquid or dry chemicals that are corrosive, toxic, explosive or flammable, by-products of combustion or physical agents such as noise, ionizing radiation, non-ionizing radiation (UV radiation created during welding, etc.) contribute to the accident/incident?

(9) OFFICE FACTORS—Did the fact that the accident occurred in an office setting or to an office worker have a bearing on its cause? For example, office workers tend to have less experience and training in performing tasks such as lifting office furniture. Did physical hazards within the office environment contribute to the hazard?

(10) SUPPORT FACTORS—Was the person using an improper tool for the job? Was inadequate time available or utilized to safely accomplish the task? Were less than adequate personnel resources (in terms of employee skills, number of workers, and adequate supervision) available to get the job done properly? Was funding available, utilized, and adequate to provide proper tools, equipment, personnel, site preparation, etc?

(11) PERSONAL PROTECTIVE EQUIPMENT—Did the person fail to use appropriate personal protective equipment (gloves, eye protection, hard-toed shoes, respirator, etc.) for the task or environment? Did protective equipment provided or worn fail to provide adequate protection from the hazard(s)? Did lack of or inadequate maintenance of protective gear contribute to the accident?

(12) DRUGS/ALCOHOL—Is there any reason to believe the person's mental or physical capabilities, judgement, etc., were impaired or altered by the use of drugs or alcohol? Consider the effects of prescription medicine and over the counter medications as well as illicit drug use. Consider the effect of drug or alcohol induced "hangovers".

b. WRITTEN JOB/ACTIVITY HAZARD ANALYSIS—Was a written Job/Activity Hazard Analysis completed for the task being performed at the time of the accident? Mark the appropriate box. *If one was performed, attach a copy of the analysis to the report.*

INSTRUCTIONS FOR SECTION 12—TRAINING

a. WAS PERSON TRAINED TO PERFORM ACTIVITY/TASK?—For the purpose of this section "trained" means the person has been provided the necessary information (either formal and/or on-the-job (OJT) training) to competently perform the activity/task in a safe and healthful manner.

b. TYPE OF TRAINING—Mark the appropriate box that best indicates the type of training; (classroom or on-the-job) that the injured person received before the accident happened.

c. DATE OF MOST RECENT TRAINING—Enter the month, day, and year of the last *formal* training completed that covered the activity-task being performed at the time of the accident.

INSTRUCTIONS FOR SECTION 13—CAUSES

a. DIRECT CAUSES—The direct cause is that single factor which most directly lead to the accident. See examples below.

b. INDIRECT CAUSES—Indirect causes are those factors which contributed to but did not directly initiate the occurrence of the accident.

Examples for section 13:

a. Employee was dismantling scaffold and fell 12 feet from unguarded opening.
Direct cause: failure to provide fall protection at elevation.
Indirect causes: failure to enforce USACE safety requirements; improper training/motivation of employee (possibility that employee was not knowledgeable of USACE fall protection requirements or was lax in his attitude towards safety); failure to ensure provision of positive fall protection whenever elevated; failure to address fall protection during scaffold dismantling in phase hazard analysis.

b. Private citizen had stopped his vehicle at intersection for red light when vehicle was struck in rear by USACE vehicle. (note USACE vehicle was in proper/safe working condition).
Direct cause: failure of USACE driver to maintain control of and stop USACE vehicle within safe distance.
Indirect cause: Failure of employee to pay attention to driving (defensive driving).

INSTRUCTIONS FOR SECTION 14—ACTION TO ELIMINATE CAUSE(S)

DESCRIPTION—Fully describe all the actions taken, anticipated, and recommended to eliminate the cause(s) and prevent reoccurrence of similar accidents/illnesses. Continue on blank sheets of paper if necessary to fully explain and attach to the completed report form.

INSTRUCTIONS FOR SECTION 15—DATES FOR ACTION

a. BEGIN DATE—Enter the date when the corrective action(s) identified in Section 14 will begin.

b. COMPLETE DATE—Enter the date when the corrective action(s) identified in Section 14 will be completed.

c. TITLE AND SIGNATURE—Enter the title and signature of supervisor completing the accident report. For a GOVERNMENT employee accident/illness the immediate supervisor will complete and sign the report. For PUBLIC accidents the USACE Project Manager/Area Engineer responsible for the USACE property where the accident happened shall complete and sign the report. For CONTRACTOR accidents the Contractor's project manager shall complete and sign the report and provide to the USACE supervisor responsible for oversight of that contractor activity. This USACE Supervisor shall also sign the report. Upon entering the information required in 15.d, 15.e and 15.f below, the responsible USACE supervisor shall forward the report for management review as indicated in Section 16.

d. DATE SIGNED—Enter the month, day, and year that the report was signed by the responsible supervisor.

e. ORGANIZATION NAME—For GOVERNMENT employee accidents enter the USACE organization name (Division, Branch, Section, etc.) of the injured employee. For PUBLIC accidents enter the USACE organization name for the person identified in block 15.c. For CONTRACTOR accidents enter the USACE organization name for the USACE office responsible for providing contract administration oversight.

f. OFFICE SYMBOL—Enter the latest complete USACE Office Symbol for the USACE organization identified in block 15.e.

INSTRUCTIONS FOR SECTION 16—MANAGEMENT REVIEW (1st)

1ST REVIEW—Each USACE FOA shall determine who will prov 1st management review. The responsible USACE supervisor in section 15.c shall forward the completed report to the USACE office designated as the 1st Reviewer by the FOA. Upon receipt, the Chief of the Office shall review the completed report, mark the appropriate box, provide substantive comments, sign, date, and forward to the FOA Staff Chief (2nd review) for review and comment.

INSTRUCTIONS FOR SECTION 17—MANAGEMENT REVIEW (2nd)

2ND REVIEW—The FOA Staff Chief (i.e., FOA Chief of Construction, Operations, Engineering, Planning, etc.) shall mark the appropriate box, review the completed report, provide substantive comments, sign, date, and return to the FOA Safety and Occupational Health Office.

INSTRUCTIONS FOR SECTION 18—SAFETY AND OCCUPATIONAL HEALTH REVIEW

3RD REVIEW—The FOA Safety and Occupational Health Office shall review the completed report, mark the appropriate box, ensure that any inadequacies, discrepancies, etc, are rectified by the responsible supervisor and management reviewers, provide substantive comments, sign, date and forward to the FOA Commander for review, comment, and signature.

INSTRUCTION FOR SECTION 19—COMMAND APPROVAL

4TH REVIEW—The FOA Commander shall (to include the person designated Acting Commander in his absence) review the completed report, comment if required, sign, date, and forward the report to the FOA Safety and Occupational Health Office. Signature authority not be delegated.

DAMES & MOORE

EXPOSURE TO BLOODBORNE PATHOGENS INCIDENT REPORT

Employee Name: _____

Office/Location: _____

Date: _____/_____/_____ **Time:** _____ **a.m./p.m.**

Circumstances: Supervisor's Assessment of the Following Control Measures Used at the Time of the Exposure (see definitions below):

Route of Exposure: _____

_____

_____

Engineering: _____

_____

_____

Work Practice: _____

_____

_____

Personal Protective Equipment: _____

_____

_____

Reason for Failures of the Control Measures or Failure to Comply with Recommended Protective Measures: _____

_____

_____

Measures Taken to Minimize Reoccurrence of Incident: _____

_____

_____

Supervisor's Signature: _____

Definitions:

Exposure Incident: a specific eye, mouth, other mucous membrane, non-intact skin, or parenteral contact with blood or other potentially infectious materials that results from the performance of an employee's duties.

Engineering Controls: controls (e.g., sharps, disposal containers, self-sheathing needles) that isolate or remove the bloodborne pathogens hazard from the workplace.

Work Practice Controls: controls that reduce the likelihood of exposure by altering the manner in which a task is performed (e.g., prohibiting recapping of needles a two-handed technique).

Personal Protective Equipment is specialized clothing or equipment worn by an employee for protection against a hazard. General work clothes not intended to function as protection against a hazard are not considered to be personal protective equipment.

DAMES & MOORE

SITE SAFETY BRIEFINGS

Job Name: Job Number:

Date: Start Time: Completion Time:

Site Location:

Work Description:

SAFETY ISSUES

Tasks (this shift):

Protective Clothing/Equipment:

Chemical Hazards:

Physical Hazards:

Control Methods:

Special Equipment/Techniques:

Nearest Phone:

Hospital Name/Address:

Special Topics (incidents, actions taken, etc.):

Print Name	Sign Name

Meeting Conducted By:

A-E DAILY QUALITY CONTROL REPORT

DATE _____

DAY	S	M	T	W	TH	F	S

COE PROJECT MANAGER _____

PROJECT _____

JOB NO. _____

CONTRACT NO. _____

WEATHER	BRIGHT SUN	CLEAR	OVERCAST	RAIN	SNOW
TEMP	TO 32	32-50	50-70	70-85	85-UP
WIND	STILL	MODER	HIGH	REPORT NO.	
HUMIDITY	DRY	MODER	HUMID		

SUBCONTRACTORS ON-SITE:

EQUIPMENT ON-SITE:

WORK PERFORMED (INCLUDING SAMPLING):

ER 1110-1-263
1 OCT 90

PROJECT _____ REPORT NO. _____

JOB NO. _____ DATE _____

QUALITY CONTROL ACTIVITIES (INCLUDING FIELD CALIBRATIONS):

HEALTH AND SAFETY LEVELS AND ACTIVITIES:

PROBLEMS ENCOUNTERED/CORRECTIVE ACTION TAKEN:

SPECIAL NOTES:

TOMORROW'S EXPECTATIONS:

BY _____ TITLE _____

COE

APPENDIX B

MATERIAL SAFETY DATA SHEETS

HEXANES
HEXANES
HEXANES

MATERIAL SAFETY DATA SHEET

FISHER SCIENTIFIC
CHEMICAL DIVISION
1 REAGENT LANE
FAIR LAWN NJ 07410
(201) 796-7100

EMERGENCY NUMBER: (201) 796-7100
CHEMTREC ASSISTANCE: (800) 424-9300

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SUBSTANCE IDENTIFICATION

SUBSTANCE: **HEXANES**

TRADE NAMES/SYNONYMS:
N-HEXANE; NCI-C60571; HEXYLHYDRIDE; NORMAL HEXANE; SKELLYSOLVE B; STCC 4908183; UN 1208; H291; N3; H302; H303; H292; H300; H334; H302SK; N3S; C6H14;

CHEMICAL FAMILY:
HYDROCARBON, ALIPHATIC

MOLECULAR FORMULA: C6-H14

MOLECULAR WEIGHT: 86.20

CERCLA RATINGS (SCALE 0-3): HEALTH=U FIRE=3 REACTIVITY=0 PERSISTENCE=1
NFPA RATINGS (SCALE 0-4): HEALTH=1 FIRE=3 REACTIVITY=0

COMPONENTS AND CONTAMINANTS

COMPONENT: N-HEXANE PERCENT: VARIES
CAS# 110-54-3

COMPONENT: 2-METHYLPENTANE PERCENT: VARIES
CAS# 107-83-5

COMPONENT: 3-METHYLPENTANE PERCENT: VARIES
CAS# 96-14-0

COMPONENT: 2,3-DIMETHYLBUTANE PERCENT: VARIES
CAS# 79-29-8

COMPONENT: METHYLCYCLOPENTANE PERCENT: VARIES
CAS# 96-37-7

COMPONENT: 2,2-DIMETHYLPENTANE PERCENT: VARIES
CAS# 590-35-2

[illegible]-DIMETHYLPENTANE
CAS# 108-08-7

OTHER CON. .NANTS: NONE

EXPOSURE LIMITS:
N-HEXANE:
50 PPM (180 MG/M3) OSHA TWA
50 PPM (180 MG/M3) ACGIH TWA
50 PPM (180 MG/M3) NIOSH RECOMMENDED TWA
50 PPM (180 MG/M3) DFG MAK TWA;
100 PPM (360 MG/M3) DFG MAK 30 MINUTE PEAK, AVERAGE VALUE, 4 TIMES/SHIFT

MEASUREMENT METHOD: CHARCOAL TUBE; CARBON DISULFIDE; GAS CHROMATOGRAPHY WITH FLAME IONIZATION DETECTION; (NIOSH VOL. III # 1500, HYDROCARBONS).

HEXANE, ALL ISOMERS OTHER THAN N-HEXANE:
500 PPM (1800 MG/M3) OSHA TWA; 1000 PPM (3600 MG/M3) OSHA STEL
500 PPM (1800 MG/M3) ACGIH TWA; 1000 PPM (3600 MG/M3) ACGIH STEL

MEASUREMENT METHOD: CHARCOAL TUBE; CARBON DISULFIDE; GAS CHROMATOGRAPHY WITH FLAME IONIZATION DETECTION; (NIOSH VOL. III # 1500, HYDROCARBONS).

ALKANES (C5-C8):
350 MG/M3 NIOSH RECOMMENDED 10 HOUR TWA;
1800 MG/M3 NIOSH RECOMMENDED 15 MINUTE CEILING

PHYSICAL DATA

DESCRIPTION: COLORLESS LIQUID, FAINT ODOR, VERY VOLATILE

BOILING POINT: 136 F (58 C) MELTING POINT: -139 F (-95 C)

SPECIFIC GRAVITY: 0.7 VAPOR PRESSURE: 124 MMHG @ 20 C

SOLUBILITY IN WATER: INSOLUBLE VAPOR DENSITY: 3.0

SOLVENT SOLUBILITY: ALCOHOL, CHLOROFORM, ETHER

FIRE AND EXPLOSION DATA

FIRE AND EXPLOSION HAZARD:
DANGEROUS FIRE HAZARD WHEN EXPOSED TO HEAT OR FLAME.

VAPORS ARE HEAVIER THAN AIR AND MAY TRAVEL A CONSIDERABLE DISTANCE TO A SOURCE OF IGNITION AND FLASH BACK.

VAPOR-AIR MIXTURES ARE EXPLOSIVE ABOVE FLASH POINT.

DUE TO LOW ELECTROCONDUCTIVITY OF THE SUBSTANCE, FLOW OR AGITATION MAY GENERATE ELECTROSTATIC CHARGES RESULTING IN SPARKS WITH POSSIBLE IGNITION.

FLASH POINT: -7 F (-22 C) (CC) UPPER EXPLOSIVE LIMIT: 7.5%

LOWER EXPLOSIVE LIMIT: 1.1% AUTOIGNITION TEMP.: 437 F (223 C)

FLAMMABILITY CLASS(OSHA): IB

FIREFIGHTI... MEDIA:
DRY CHEMICAL, CARBON DIOXIDE, WATER SPRAY OR REGULAR FOAM
(1990 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.5).

FOR LARGER FIRES, USE WATER SPRAY, FOG OR REGULAR FOAM
(1990 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.5).

FIREFIGHTING:
MOVE CONTAINER FROM FIRE AREA IF YOU CAN DO IT WITHOUT RISK. APPLY COOLING WATER TO SIDES OF CONTAINERS THAT ARE EXPOSED TO FLAMES UNTIL WELL AFTER FIRE IS OUT. STAY AWAY FROM ENDS OF TANKS. FOR MASSIVE FIRE IN CARGO AREA, USE UNMANNED HOSE HOLDER OR MONITOR NOZZLES; IF THIS IS IMPOSSIBLE, WITHDRAW FROM AREA AND LET FIRE BURN. WITHDRAW IMMEDIATELY IN CASE OF RISING SOUND FROM VENTING SAFETY DEVICE OR ANY DISCOLORATION OF TANK DUE TO FIRE. ISOLATE FOR 1/2 MILE IN ALL DIRECTIONS IF TANK, RAIL CAR OR TANK TRUCK IS INVOLVED IN FIRE (1990 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.5, GUIDE PAGE 27).

EXTINGUISH ONLY IF FLOW CAN BE STOPPED; USE WATER IN FLOODING AMOUNTS AS FOG. SOLID STREAMS MAY NOT BE EFFECTIVE. COOL CONTAINERS WITH FLOODING QUANTITIES OF WATER. APPLY FROM AS FAR A DISTANCE AS POSSIBLE. AVOID BREATHING TOXIC VAPORS; KEEP UPWIND. EVACUATE TO A RADIUS OF 1500 FEET FOR UNCONTROLLABLE FIRES. CONSIDER EVACUATION OF DOWNWIND AREA IF MATERIAL IS LEAKING.

WATER MAY BE INEFFECTIVE (NFPA 325M, FIRE HAZARD PROPERTIES OF FLAMMABLE LIQUIDS, GASES, AND VOLATILE SOLIDS, 1991)

TRANSPORTATION DATA

DEPARTMENT OF TRANSPORTATION HAZARD CLASSIFICATION 49 CFR 172.101:
FLAMMABLE LIQUID

DEPARTMENT OF TRANSPORTATION LABELING REQUIREMENTS 49 CFR 172.101 AND SUBPART E:
FLAMMABLE LIQUID

DEPARTMENT OF TRANSPORTATION PACKAGING REQUIREMENTS: 49 CFR 173.119
EXCEPTIONS: 49 CFR 173.118

FINAL RULE ON HAZARDOUS MATERIALS REGULATIONS (HMR, 49 CFR PARTS 171-180), DOCKET NUMBERS HM-181, HM-181A, HM-181B, HM-181C, HM-181D AND HM-204. EFFECTIVE DATE OCTOBER 1, 1991. HOWEVER, COMPLIANCE WITH THE REGULATIONS IS AUTHORIZED ON AND AFTER JANUARY 1, 1991. (55 FR 52402, 12/21/90)

EXCEPT FOR EXPLOSIVES, INHALATION HAZARDS, AND INFECTIOUS SUBSTANCES, THE EFFECTIVE DATE FOR HAZARD COMMUNICATION REQUIREMENTS IS EXTENDED TO OCTOBER 1, 1993. (56 FR 47158, 10/18/91)

U.S. DEPARTMENT OF TRANSPORTATION SHIPPING NAME-ID NUMBER, 49 CFR 172.101:
HEXANES-UN 1208

U.S. DEPARTMENT OF TRANSPORTATION HAZARD CLASS OR DIVISION, 49 CFR 172.101:
3 - FLAMMABLE LIQUID

U.S. DEPARTMENT OF TRANSPORTATION PACKING GROUP, 49 CFR 172.101:
PG II

U.S. DEPARTMENT OF TRANSPORTATION LABELING REQUIREMENTS, 49 CFR 172.101

AND SUB E:
FLAMMABLE LIQUID

U.S. DEPARTMENT OF TRANSPORTATION PACKAGING REQUIREMENTS:
EXCEPTIONS: 49 CFR 173.150
NON-BULK PACKAGING: 49 CFR 173.202
BULK PACKAGING: 49 CFR 173.242

U.S. DEPARTMENT OF TRANSPORTATION QUANTITY LIMITATIONS 49 CFR 172.101:
PASSENGER AIRCRAFT OR RAILCAR: 5 L
CARGO AIRCRAFT ONLY: 60 L

TOXICITY

N-HEXANE:
IRRITATION DATA: 10 MG EYE-RABBIT MILD.
TOXICITY DATA: 190 PPM/8 WEEKS INHALATION-HUMAN TCLO; 120 GM/M3 INHALATION-MOUSE LCLO; 28,710 MG/KG ORAL-RAT LD50; 831 MG/KG INTRAVENOUS-MOUSE LDLO; 132 MG/KG INTRAVENOUS-RABBIT LDLO; 9100 MG/KG INTRAPERITONEAL-RAT LDLO; MUTAGENIC DATA (RTECS); REPRODUCTIVE EFFECTS DATA (RTECS).
CARCINOGEN STATUS: NONE.
LOCAL EFFECTS: IRRITANT- SKIN, EYE.
ACUTE TOXICITY LEVEL: RELATIVELY NON-TOXIC BY INGESTION.
TARGET EFFECTS: CENTRAL NERVOUS SYSTEM DEPRESSANT; NEUROTOXIN.
AT INCREASED RISK FROM EXPOSURE: PERSONS WITH SKIN, PULMONARY, LIVER, OR KIDNEY DISORDERS.
ADDITIONAL DATA: ALCOHOL MAY ENHANCE THE TOXIC EFFECT. A LOW ORDER OF MYOCARDIAL SENSITIZATION TO EPINEPHRINE MAY OCCUR. ACETONE AND METHYL ETHYL KETONE MAY ENHANCE THE TOXIC EFFECTS.

2-METHYLPENTANE:
CARCINOGEN STATUS: NONE.
LOCAL EFFECTS: IRRITANT- INHALATION, SKIN, EYES.
ACUTE TOXICITY LEVEL: NO DATA AVAILABLE.
TARGET EFFECTS: CENTRAL NERVOUS SYSTEM DEPRESSANT.
ADDITIONAL DATA: STIMULANTS SUCH AS EPINEPHRINE MAY INDUCE VENTRICULAR FIBRILLATION.

3-METHYLPENTANE:
CARCINOGEN STATUS: NONE.
LOCAL EFFECTS: IRRITANT- SKIN, EYE, MUCOUS MEMBRANES.
ACUTE TOXICITY LEVEL: NO DATA AVAILABLE.
TARGET EFFECTS: CENTRAL NERVOUS SYSTEM DEPRESSANT.
ADDITIONAL DATA: CONSUMPTION OF ALCOHOL MAY POTENTIATE THE TOXIC EFFECTS. USE OF STIMULANTS SUCH AS EPINEPHRINE MAY INDUCE VENTRICULAR FIBRILLATION.

2,3-DIMETHYLBUTANE:
CARCINOGEN STATUS: NONE.
LOCAL EFFECTS: IRRITANT- INHALATION, SKIN, EYE.
ACUTE TOXICITY LEVEL: NO DATA AVAILABLE.
TARGET EFFECTS: CENTRAL NERVOUS SYSTEM DEPRESSANT.
ADDITIONAL DATA: ALCOHOL MAY ENHANCE THE TOXIC EFFECTS. STIMULANTS SUCH AS EPINEPHRINE MAY INDUCE VENTRICULAR FIBRILLATION.

METHYLCYCLOPENTANE:
TOXICITY DATA: 95,000 MG/M3 INHALATION-MOUSE LCLO.

CARCINOGEN STATUS: NONE.
LOCAL EFFECTS: IRRITANT- INHALATION, SKIN, EYE.
ACUTE TOXICITY LEVEL: INSUFFICIENT DATA.
TARGET EFFECTS: CENTRAL NERVOUS SYSTEM DEPRESSANT.
ADDITIONAL DATA: ALCOHOL MAY ENHANCE THE TOXIC EFFECTS. USE OF STIMULANTS SUCH AS EPINEPHRINE MAY INDUCE VENTRICULAR FIBRILLATION.

2,2-DIMETHYLPENTANE:
CARCINOGEN STATUS: NONE.
ACUTE TOXICITY LEVEL: NO DATA AVAILABLE.
TARGET EFFECTS: POISONING MAY AFFECT THE CENTRAL NERVOUS SYSTEM.*

* MAY BE BASED ON GENERAL ALIPHATIC HYDROCARBON INFORMATION.

2,4-DIMETHYLPENTANE:
CARCINOGEN STATUS: NONE.
ACUTE TOXICITY LEVEL: NO DATA AVAILABLE.
TARGET EFFECTS: NO DATA AVAILABLE.

HEALTH EFFECTS AND FIRST AID

INHALATION:
N-HEXANE:
IRRITANT/NARCOTIC/NEUROTOXIN.
5000 PPM IMMEDIATELY DANGEROUS TO LIFE OR HEALTH.
ACUTE EXPOSURE- 880 PPM FOR 15 MINUTES HAS CAUSED UPPER RESPIRATORY TRACT IRRITATION. EXPOSURE TO 1000-5000 PPM MAY PRODUCE HEADACHE, NAUSEA, AND DIZZINESS. OTHER EFFECTS MAY INCLUDE GIDDINESS, COUGHING, NUMBNESS IN THE EXTREMITIES, DIFFICULTY WALKING, DEFECTS OF MEMORY, EXCITEMENT FOLLOWED BY DEPRESSION, AND UNCONSCIOUSNESS. ANESTHESIA OF SHORT DURATION WITHOUT SEQUELA IS POSSIBLE. PULMONARY EDEMA, CARDIAC ARRHYTHMIAS, BRAIN DAMAGE, CARDIAC ARREST AND DEATH MAY RESULT. HIGH CONCENTRATIONS MAY PRODUCE ASPHYXIA. CONVULSIONS HAVE BEEN PRODUCED IN ANIMALS.
CHRONIC EXPOSURE- RESULTS IN AXONAL NEUROPATHY. NEUROPATHY IS OF AN INSIDIOUS BILATERAL, SYMMETRICAL, SENSORIMOTOR, PERIPHERAL NATURE. 100 PPM DAILY MAY PRODUCE CHANGES IN MUSCLE STRENGTH. PROLONGED EXPOSURE MAY CAUSE EFFECTS AS IN ACUTE EXPOSURE AS WELL AS MEMORY LOSS, PROGRESSIVE WEAKNESS, ACHING MUSCLES, SENSORY LOSS IN FEET AND HANDS, CALF CRAMPS, FACIAL NUMBNESS, IMPOTENCE, BLURRED VISION, COLOR VISION ABNORMALITIES, AND PARALYSIS OF MUSCLES USUALLY OF LOWER LIMBS. EXAMINATION REVEALS HYPOACTIVE DEEP KNEE REFLEXES, BILATERAL FOOTDROP, REDUCTION IN NERVE AND SENSITIVE CONDUCTION VELOCITIES, MODIFICATION OF DISTAL LATENCY, DIMINISHING OF SENSORY POTENTIAL, AND NEUROGENIC ATROPHY OF SKELETAL MUSCLE. REPRODUCTIVE EFFECTS HAVE BEEN REPORTED IN ANIMALS.

HEXANES (OTHER THAN N-HEXANE):
IRRITANT/NARCOTIC.
ACUTE EXPOSURE- MAY CAUSE IRRITATION TO THE MUCOUS MEMBRANES. LIQUID ALIPHATICS, C5-C9, HAVE ANESTHETIC AND CENTRAL NERVOUS SYSTEM DEPRESSANT ACTIONS. SYMPTOMS MAY INCLUDE, BUT ARE NOT LIMITED TO, DIZZINESS, DROWSINESS, INCOORDINATION, CONVULSIONS, COLLAPSE OR COMA. SOME ISOHEXANE ISOMERS HAVE BEEN DOCUMENTED TO SENSITIZE THE MYOCARDIUM TO EPINEPHRINE.
CHRONIC EXPOSURE- REPEATED OR PROLONGED EXPOSURE TO ALIPHATIC HYDROCARBONS MAY RESULT IN EFFECTS AS DESCRIBED IN ACUTE EXPOSURE.

FIRST AID- REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, PERFORM ARTIFICIAL RESPIRATION. KEEP PERSON WARM AND AT REST.

TREAT SY OMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATE.

SKIN CONTACT:
N-HEXANE:
IRRITANT.
ACUTE EXPOSURE- VAPOR MAY CAUSE IRRITATION WITH REDNESS. 2 ML/KG/4 HOURS ON RABBIT SKIN RESULTED IN ATAXIA AND RESTLESSNESS. AT 5 ML/KG/4 HOURS SOME DEATHS OCCURRED.
CHRONIC EXPOSURE- REPEATED OR PROLONGED CONTACT MAY CAUSE DERMATITIS DUE TO DEFATTING. BLISTER FORMATION, ITCHING, ERYTHEMA, PIGMENTATION AND PAIN HAVE BEEN REPORTED. SKIN EXPOSURES MAY ENHANCE NEUROTOXIC EFFECTS FROM INHALATION EXPOSURE.

HEXANES (OTHER THAN N-HEXANE):
IRRITANT.
ACUTE EXPOSURE- MAY CAUSE IRRITATION AND BE ABSORBED THROUGH THE SKIN.
CHRONIC EXPOSURE- THE C5 AND HIGHER LIQUID ALIPHATIC HYDROCARBONS ARE FAT SOLVENTS, AND REPEATED OR PROLONGED CONTACT MAY RESULT IN DEFATTING DERMATITIS.

FIRST AID- REMOVE CONTAMINATED CLOTHING AND SHOES IMMEDIATELY. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

EYE CONTACT:
N-HEXANE:
IRRITANT.
ACUTE EXPOSURE- CONTACT MAY CAUSE IRRITATION WITH REDNESS AND PAIN. VAPORS AT 880 PPM FOR 15 MINUTES CAUSED IRRITATION.
CHRONIC EXPOSURE- REPEATED OR PROLONGED CONTACT WITH IRRITANTS MAY CAUSE CONJUNCTIVITIS.

HEXANES (OTHER THAN N-HEXANE):
IRRITANT.
ACUTE EXPOSURE- MAY CAUSE IRRITATION. MOST LIQUID HYDROCARBONS CAUSE LITTLE OR NO INJURY ON DIRECT EXTERNAL CONTACT WITH THE EYE.
CHRONIC EXPOSURE- REPEATED OR PROLONGED CONTACT WITH IRRITANTS MAY CAUSE CONJUNCTIVITIS.

FIRST AID- WASH EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER OR NORMAL SALINE, OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

INGESTION:
N-HEXANE:
NARCOTIC.
ACUTE EXPOSURE- MAY CAUSE CENTRAL NERVOUS SYSTEM EFFECTS, HEADACHE, NAUSEA, VOMITING, VERTIGO, BRONCHIAL AND GENERAL INTESTINAL IRRITATION WITH ABDOMINAL SWELLING AND PAIN. THE FATAL HUMAN DOSE MAY BE ABOUT 50 GRAMS. MAY VAPORIZE WHEN ASPIRATED INTO THE TRACHEOBRONCHIAL TREE WITH A RESULTANT RAPID DILUTION OF ALVEOLAR AIR AND MARKED FALL IN ITS OXYGEN CONTENT, WITH CONSEQUENT BRAIN DAMAGE OR CARDIAC ARREST.
CHRONIC EXPOSURE- REPRODUCTIVE EFFECTS HAVE BEEN REPORTED IN ANIMALS.

HEXANES (OTHER THAN N-HEXANE):
NARCOTIC.

ACUTE EXPOSURE- MAY CAUSE GASTROINTESTINAL DISTURBANCES. IF SUFFICIENT AMOUNTS OF ALIPHATIC HYDROCARBONS ARE INGESTED AND RETAINED, CENTRAL NERVOUS SYSTEM DEPRESSION MAY OCCUR. SYMPTOMS MAY INCLUDE, BUT ARE NOT LIMITED TO, NAUSEA, VOMITING, DIZZINESS, DROWSINESS, INCOORDINATION, CONVULSIONS, AND COMA. IN ANIMAL STUDIES, ASPIRATION OF 0.2 ML OF C6-C8 ALIPHATICS, CAUSED ALMOST IMMEDIATE DEATH DUE TO RESPIRATORY PARALYSIS, ASPHYXIA AND CARDIAC ARREST.

CHRONIC EXPOSURE- NO DATA AVAILABLE.

FIRST AID- EXTREME CARE MUST BE USED TO PREVENT ASPIRATION. USE GASTRIC LAVAGE WITH ACTIVATED CHARCOAL AND A CUFFED ENDOTRACHEAL TUBE WITHIN 15 MINUTES. IN THE ABSENCE OF DEPRESSION OR CONVULSIONS OR IMPAIRED GAG REFLEX, IPECAC EMESIS CAN BE DONE. WHEN VOMITING BEGINS, KEEP HEAD LOWER THAN HIPS TO PREVENT ASPIRATION. AFTER VOMITING STOPS, GIVE 30-60 MILLILITERS OF FLEET'S PHOSPHO-SODA DILUTED 1:4 IN WATER. MAINTAIN AIRWAY, BLOOD PRESSURE AND RESPIRATION. (DREISBACH, HANDBOOK OF POISONING, 11TH ED.) TREATMENT MUST BE ADMINISTERED BY QUALIFIED MEDICAL PERSONNEL. GET MEDICAL ATTENTION.

ANTIDOTE:
NO SPECIFIC ANTIDOTE. TREAT SYMPTOMATICALLY AND SUPPORTIVELY.

REACTIVITY

REACTIVITY:
STABLE UNDER NORMAL TEMPERATURES AND PRESSURES.

INCOMPATIBILITIES:
N-HEXANE:
- CALCIUM HYPOCHLORITE: FIRE AND EXPLOSION HAZARD.
- CHLORINE (LIQUID): FIRE AND EXPLOSION HAZARD.
- DINITROGEN TETRAOXIDE: POSSIBLE EXPLOSION HAZARD.
- OXIDIZERS (STRONG): FIRE AND EXPLOSION HAZARD.
- OXYGEN (CONCENTRATED): FIRE AND EXPLOSION HAZARD.
- PLASTICS, RUBBER, AND COATINGS: MAY BE ATTACKED.
- SODIUM HYPOCHLORITE: FIRE AND EXPLOSION HAZARD.

DECOMPOSITION:
THERMAL DECOMPOSITION PRODUCTS MAY INCLUDE TOXIC OXIDES OF CARBON.

POLYMERIZATION:
HAZARDOUS POLYMERIZATION HAS NOT BEEN REPORTED TO OCCUR UNDER NORMAL TEMPERATURES AND PRESSURES.

STORAGE AND DISPOSAL

OBSERVE ALL FEDERAL, STATE AND LOCAL REGULATIONS WHEN STORING OR DISPOSING OF THIS SUBSTANCE. FOR ASSISTANCE, CONTACT THE DISTRICT DIRECTOR OF THE ENVIRONMENTAL PROTECTION AGENCY.

STORAGE

STORE IN ACCORDANCE WITH 29 CFR 1910.106.

BONDING AND GROUNDING: SUBSTANCES WITH LOW ELECTROCONDUCTIVITY, WHICH

MAY BE IGNI BY ELECTROSTATIC SPARKS, SHOULD BE STORED IN CONTAINERS WHICH MEET THE BONDING AND GROUNDING GUIDELINES SPECIFIED IN NFPA 77-1983, RECOMMENDED PRACTICE ON STATIC ELECTRICITY.

STORE AWAY FROM INCOMPATIBLE SUBSTANCES.

DISPOSAL

DISPOSAL MUST BE IN ACCORDANCE WITH STANDARDS APPLICABLE TO GENERATORS OF HAZARDOUS WASTE, 40 CFR 262. EPA HAZARDOUS WASTE NUMBER D001.
100 POUND CERCLA SECTION 103 REPORTABLE QUANTITY.

****

CONDITIONS TO AVOID

AVOID CONTACT WITH HEAT, SPARKS, FLAMES, OR OTHER SOURCES OF IGNITION. VAPORS MAY BE EXPLOSIVE. AVOID OVERHEATING OF CONTAINERS; CONTAINERS MAY VIOLENTLY RUPTURE IN HEAT OF FIRE. AVOID CONTAMINATION OF WATER SOURCES.

****

SPILL AND LEAK PROCEDURES

OCCUPATIONAL SPILL:
SHUT OFF IGNITION SOURCES. STOP LEAK IF YOU CAN DO IT WITHOUT RISK. USE WATER SPRAY TO REDUCE VAPORS. FOR SMALL SPILLS, TAKE UP WITH SAND OR OTHER ABSORBENT MATERIAL AND PLACE INTO CONTAINERS FOR LATER DISPOSAL. FOR LARGER SPILLS, DIKE FAR AHEAD OF SPILL FOR LATER DISPOSAL. NO SMOKING, FLAMES OR FLARES IN HAZARD AREA. KEEP UNNECESSARY PEOPLE AWAY; ISOLATE HAZARD AREA AND RESTRICT ENTRY.

PROTECTIVE EQUIPMENT

VENTILATION:
PROVIDE LOCAL EXHAUST OR GENERAL DILUTION VENTILATION TO MEET PUBLISHED EXPOSURE LIMITS. VENTILATION EQUIPMENT MUST BE EXPLOSION-PROOF.

RESPIRATOR:
THE FOLLOWING RESPIRATORS ARE RECOMMENDED BASED ON INFORMATION FOUND IN THE PHYSICAL DATA, TOXICITY AND HEALTH EFFECTS SECTIONS. THEY ARE RANKED IN ORDER FROM MINIMUM TO MAXIMUM RESPIRATORY PROTECTION.
THE SPECIFIC RESPIRATOR SELECTED MUST BE BASED ON CONTAMINATION LEVELS FOUND IN THE WORK PLACE, MUST BE BASED ON THE SPECIFIC OPERATION, MUST NOT EXCEED THE WORKING LIMITS OF THE RESPIRATOR AND MUST BE JOINTLY APPROVED BY THE NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH AND THE MINE SAFETY AND HEALTH ADMINISTRATION (NIOSH-MSHA).

ANY TYPE 'C' SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE OR WITH A FULL FACEPIECE, HELMET OR HOOD OPERATED IN CONTINUOUS-FLOW MODE.

ANY SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

FOR FIREFIGHTING AND OTHER IMMEDIATELY DANGEROUS TO LIFE OR HEALTH CONDITIONS:

ANY SELF-CONTAINED BREATHING APPARATUS THAT HAS A FULL FACEPIECE AND IS OPERATED IN A PRESSURE-DEMAND OR OTHER POSITIVE-PRESSURE MODE.

ANY SUPPLIED-AIR RESPIRATOR THAT HAS A FULL FACEPIECE AND IS OPERATED IN A PRESSURE-DEMAND OR OTHER POSITIVE-PRESSURE MODE IN COMBINATION WITH AN AUXILIARY SELF-CONTAINED BREATHING APPARATUS OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE-PRESSURE MODE.

CLOTHING:
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE (IMPERVIOUS) CLOTHING AND EQUIPMENT TO PREVENT REPEATED OR PROLONGED SKIN CONTACT WITH THIS SUBSTANCE.

GLOVES:
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE GLOVES TO PREVENT CONTACT WITH THIS SUBSTANCE.

EYE PROTECTION:
EMPLOYEE MUST WEAR SPLASH-PROOF OR DUST-RESISTANT SAFETY GOGGLES TO PREVENT EYE CONTACT WITH THIS SUBSTANCE.

EMERGENCY EYE WASH: WHERE THERE IS ANY POSSIBILITY THAT AN EMPLOYEE'S EYES MAY BE EXPOSED TO THIS SUBSTANCE, THE EMPLOYER SHOULD PROVIDE AN EYE WASH FOUNTAIN WITHIN THE IMMEDIATE WORK AREA FOR EMERGENCY USE.

AUTHORIZED - FISHER SCIENTIFIC, INC.
CREATION DATE: 05/23/85 REVISION DATE: 11/08/91

-ADDITIONAL INFORMATION-

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Material Safety Data Sheet

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No. 674

ISOBUTYLENE

Issued: November 1988

SECTION 1. MATERIAL IDENTIFICATION

Material Name: ISOBUTYLENE

Description (Origin/Uses): Obtained from refinery steams by absorption on 65% sulfuric acid (H_2SO_4) at 59°F (15°C). Used primarily to produce diisobutylene, trimers, butyl rubber, and other polymers; also used to produce antioxidants for foods, plastics, and packaging food supplements.

Other Designations: Isobutene; 2-Methylpropene; *gamma*-Butylene; $CH_2=C(CH_3)_2$; CAS No. 0115-11-7

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

NFPA: 4 / 1 / 0 / -

HMIS			
H	1	R	1
F	4	I	1
R	0	S	1
PPG*		K	4

*See sect. 8

SECTION 2. INGREDIENTS AND HAZARDS

	%	EXPOSURE LIMITS
Isobutylene, CAS No. 0115-11-57	Ca 100	**OSHA PEL** None Established **ACGIH TLV, 1988-89** None Established **NIOSH REL** None Established **Toxicity Data*** Rat, Inhalation, LC_{50}: 620 g/m³ (4 Hrs) Mouse, Inhalation, LC_{50}: 415 g/m³ (2 Hrs)

*Monitor NIOSH, *RTECS* (UD0890000), for additional data.

SECTION 3. PHYSICAL DATA

Boiling Point: -19.6°F (-6.9°C)
Melting Point: -220°F (-140°C)
Vapor Density (Air = 1): 1.9
Specific Gravity (H_2O = 1): Ca 0.6
Molecular Weight: 56 Grams/Mole
Solubility in Water (%): Insoluble*
% Volatile by Volume: 100

Appearance and Odor: A colorless, extremely flammable gas; odor not listed.

*Isobutylene is very soluble in alcohol, ether, and sulfuric acid.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point*	Autoignition Temperature: 869°F (465°C)	LEL: 1.8% v/v	UEL: 9.6% v/v

Extinguishing Media: Isobutylene gas is an extremely flammable gas that has a substantial explosive air-gas range. For isobutylene fires, the recommended fire-fighting technique is to stop the flow of gas instead of extinguishing the fire. If the flames are extinguished and the isobutylene gas continues to escape or leak, an explosive air-gas mixture can form quickly and ignite without warning. A resulting explosion could cause greater damage than that which would be caused by allowing the fire to burn itself out. If the fire must be extinguished to allow safe access to shutoff valves, recommended extinguishing agents include CO_2 and dry chemical. **Unusual Fire or Explosion Hazards:** In many cases, the preferred strategy is to allow the flames to continue to burn and to cool the surroundings with water spray to prevent ignition of nearby combustibles. Isobutylene gas is heavier than air and can collect in low-lying, confined spaces. Potentially explosive air-gas mixtures are especially likely to build up in such an area, so enter it with extreme caution whether or not it is presently involved in a fire. Possible sources of ignition must not be brought into any area suspected of containing substantial concentrations of isobutylene gas. **Special Fire-fighting Procedures:** Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

* Sax (Genium ref. 6) reports a flash point of -105°F (-76°C) for isobutylene.

SECTION 5. REACTIVITY DATA

Stability/Polymerization: Isobutylene is stable in closed, pressurized containers during routine operations at room temperature. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Isobutylene can react dangerously with strong oxidizing materials. **Conditions to Avoid:** Prevent exposing isobutylene to any source of ignition such as an open flame, sparks, lighted tobacco products, or steam lines. **Hazardous Products of Decomposition:** Isobutylene fires can produce toxic gases such as carbon monoxide (CO) or lower-molecular-weight hydrocarbons. **Comments:** The extreme flammability of isobutylene means that any reactions involving this material, including nonhazardous ones, must be performed carefully in order to prevent fires and/or explosions.

SECTION 6. HEALTH HAZARD INFORMATION

Carcinogenicity: Isobutylene is not listed as a carcinogen by the NTP, IARC, or OSHA.
Summary of Risks: Isobutylene is a simple asphyxiant. As such it will not cause significant physiological responses, but it can displace the minimum required atmospheric oxygen level. Significant displacement by isobutylene results in an oxygen-deficient atmosphere with no adequate warning properties. Asphyxiation fatalities can occur especially in confined, low-lying, poorly ventilated spaces because isobuty-

SECTION 6. HEALTH HAZARD INFORMATION, cont.

lene gas is almost twice as dense as air itself (see sect. 3). Medical Conditions Aggravated by Long-Term Exposure: None reported. Target Organs: None reported. Primary Entry: Inhalation. Acute Effects: Initial symptoms of the effects of simple asphyxiant gases are rapid respiration and air hunger, diminished mental alertness, and impaired muscular coordination. Continuing lack of oxygen causes faulty judgment, depression of all sensations, rapid fatigue, and emotional instability. As the asphyxia continues, nausea; vomiting; prostration; loss of consciousness; and, finally, convulsions; deep coma; and death can occur. Chronic Effects: None reported. FIRST AID: Inhalation. Would-be rescuers need to be concerned about their own safety when entering confined, poorly ventilated, oxygen-deficient areas. Self-contained breathing equipment must be readily available for rescuers. Station standby workers outside the immediate area so that they can summon additional help if it is needed. Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have qualified medical personnel administer oxygen as required. Comments: The extreme flammability of isobutylene gas warrants special attention even during rescue operations. Rescue personnel must not smoke. All emergency lamps and floodlights that must be lowered into enclosed areas for rescue operations must be explosion proof. Obtain this equipment before any emergency occurs and make it accessible to emergency-response personnel. Get medical help (in plant, paramedic, community) for all exposures. Seek prompt medical assistance for further treatment, observation, and support after first aid.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: *Treat any isobutylene gas leak as an emergency.* If the leaking gas has not yet ignited, use water spray to direct flammable gas-air mixtures away from sources of ignition. Extinguish all sources of ignition as quickly as possible; however, if the leaking gas is burning, do not attempt to extinguish the flames until the source of the isobutylene gas is located and sealed. Otherwise, flammable isobutylene gas-air mixtures can explode without warning and cause widespread damage that might not have occurred if the original fire had been allowed to burn itself out. If it is necessary to extinguish isobutylene flames in order to gain access to a shutoff valve, use dry chemical or carbon dioxide as extinguishing agents. Waste Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

OSHA Designations

Air Contaminant (29 CFR 1910.1000 Subpart Z): Not Listed

EPA Designations (40 CFR 302.4): Not Listed

SECTION 8. SPECIAL PROTECTION INFORMATION

Respirator: Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (leaks or cleaning reactor vessels and storage tanks), wear an SCBA. Warning: Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres, which lack warning properties; to work in them safely requires that an SCBA be worn. Ventilation: Install and operate general and local maximum, explosion-proof ventilation systems powerful enough to maintain airborne levels of this material below the lower explosive limit cited in section 4. Local exhaust ventilation is preferred because it prevents dispersion of the contaminant into the general work area by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations. Safety Stations: Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas. Contaminated Equipment: Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do *not* wear contact lenses in any work area. Comments: Practice good personal hygiene; always wash thoroughly after using this material and before eating, drinking, smoking, using the toilet, or applying cosmetics. Keep it off your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Do not inhale isobutylene vapor.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store isobutylene in closed, pressurized containers in a cool, dry, well-ventilated area away from sources of ignition, combustible materials, and strong oxidizers. Protect containers from physical damage. Engineering Controls: Make sure all engineering systems (production, transportation) are of maximum explosion-proof design. Electrically ground and bond all containers, pipelines, etc., used in shipping, transferring, reacting, production, and sampling operations to prevent static sparks. Comments: Isobutylene is an extremely explosive and flammable gas. It must not be exposed to any possible source of ignition in work or storage areas.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Liquefied Petroleum Gas
DOT Hazard Class: Flammable Gas
ID No. UN1055
DOT Label: Flammable Gas
DOT Packaging Requirements: 49 CFR 173.304, .314, .315
DOT Packaging Exceptions: 49 CFR 173.306

IMO Shipping Name: Isobutylene
IMO Hazard Class: 2.1
IMO Label: Flammable Gas

References: 1, 6, 84-94, 116, 117, 120, 122.

Judgments as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corp extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for applications to purchaser's intended purposes or for consequences of its use.

Prepared by PJ Igoe, BS

Industrial Hygiene Review: DJ Wilson, CIH

Medical Review: W Silverman, MD

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Material Safety Data Sheet

Required under USDL Safety and Health Regulations for Shipyard Employment (29 CFR 1915)

U.S. Department of Labor

Occupational Safety and Health Administration

OMB No 1218-0074
Expiration Date 05/31/86

PREPARED 1/10/86

Section I

Manufacturer's Name: ALCONOX, INC.

Emergency Telephone Number: (212) 473-1300

Address (Number Street City State and ZIP Code): 215 PARK AVENUE SOUTH

NEW YORK, N.Y. 10003

Chemical Name and Synonyms: N.A.

Trade Name and Synonyms: LIQUI-NOX

Chemical Family: ANIONIC DETERGENT

Formula: N.A.

Section II - Hazardous Ingredients

Paints, Preservatives, and Solvents	%	TLV (Units)	Alloys and Metallic Coatings	%	TLV (Units)
Pigments: NONE			Base Metal: NONE		
Catalyst: NONE			Alloys: NONE		
Vehicle: NONE			Metallic Coatings: NONE		
Solvents: ETHYLENE GLYCOL MONO-BUTYL ETHER	4	25	Filler Metal Plus Coating or Core Flux: NONE		
Additives: NONE			Others: NONE		
Others: NONE					

Hazardous Mixtures of Other Liquids, Solids or Gases

	%	TLV (Units)
NONE		

Section III - Physical Data

Boiling Point (°F)	210	Specific Gravity (H_2O=1)	1.065
Vapor Pressure (mm Hg)	NO DATA	Percent Volatile by Volume (%)	34
Vapor Density (AIR=1)	NO DATA	Evaporation Rate (_____=1)	SLOWER THAN ETHER

Solubility in Water: COMPLETE

Appearance and Odor: YELLOW LIQUID - PRACTICALLY ODORLESS

Section IV - Fire and Explosion Hazard Data

Flash Point (Method Used)	Flammable Limits	Lel	Uel
NONE (CLOSED CUP)	NA	NA	NA

Extinguishing Media: WATER, CO_2, DRY CHEMICAL, FOAM, SAND/EARTH

Special Fire Fighting Procedures: FOR FIRES INVOLVING THIS MATERIAL, DO NOT ENTER WITHOUT PROTECTIVE EQUIPMENT AND SELF CONTAINED BREATHING APPARATUS

Unusual Fire and Explosion Hazards: NONE

Section V - Health Hazard Data

Threshold Limit Value: NO DATA AVAILABLE

Effects of Overexposure: CONTACT WITH EYES AND MUCOUS MEMBRANES MAY BE IRRITATING

Emergency First Aid Procedures: EYES-FLUSH WITH PLENTY OF WATER FOR 15 MINUTES. SKIN-FLUSH WITH PLENTY OF WATER. INGESTION - INDUCE VOMITING AND CONSULT A PHYSICIAN.

Section VI - Reactivity Data

Stability	Unstable		Conditions to Avoid: NONE
	Stable X		

Incompatability (Materials to Avoid): STRONG OXIDIZING AGENTS

Hazardous Decomposition Products: CO, CO_2, SO_2, MAY BE RELEASED ON BURNING

Hazardous Polymerization	May Occur		Conditions to Avoid: NONE
	Will Not Occur X		

Section VII - Spill or Leak Procedures

Steps to be Taken in Case Material is Released or Spilled: MATERIAL FOAMS PROFUSELY. RECOVER AS MUCH AS POSSIBLE WITH ABSORBENT MATERIAL AND RINSE REMAINDER TO SEWER. MATERIAL IS COMPLETELY BIODEGRADABLE.

Waste Disposal Method: SMALL QUANTITIES MAY BE DISPOSED OF IN SEWER. LARGE QUANTITIES SHOULD BE SOAKED UP WITH ABSORBENT MATERIAL AND DISPOSED OF ACCORDING TO LOCAL REQUIREMENTS FOR NON-HAZARDOUS DETERGENT.

Section VIII - Special Protection Information

Respiratory Protection (Specify Type): NOT NECESSARY

Ventilation	Local Exhaust	NORMAL	Special	N.A.
	Mechanical (General)	N.A.	Other	N.A.

Protective Gloves	REQUIRED	Eye Protection	REQUIRED

Other Protective Equipment:

Section IX - Special Precautions

Precautions to be Taken in Handling and Storing: NONE REQUIRED - VISCOSITY OF MATERIAL INCREASES AT VERY LOW TEMPERATURES.

Other Precautions: NO SPECIAL REQUIREMENTS OTHER THAN THE GOOD INDUSTRIAL HYGIENE AND SAFETY PRACTICES EMPLOYED WITH ANY INDUSTRIAL CHEMICAL.

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METHANOL
METHANOL
METHANOL

MATERIAL SAFETY DATA SHEET

FISHER SCIENTIFIC
CHEMICAL DIVISION
1 REAGENT LANE
FAIR LAWN NJ 07410
(201) 796-7100

EMERGENCY NUMBER: (201) 796-7100
CHEMTREC ASSISTANCE: (800) 424-9300

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SUBSTANCE IDENTIFICATION

CAS-NUMBER 67-56-1

SUBSTANCE: **METHANOL**

TRADE NAMES/SYNONYMS:
METHYL ALCOHOL, WOOD ALCOHOL; METHYL HYDROXIDE; CARBINOL; MONOHYDROXYMETHANE; WOOD SPIRIT; WOOD NAPHTHA; METHYLOL; COLONIAL SPIRIT, COLUMBIAN SPIRIT, PYROXYLIC SPIRIT; COULOMATIC (R) CONDITIONER SOLUTION; STANDARD WATER IN METHANOL; SICC 4509230; UN 1230; RCRA U154; A454; A452, A936, A408; A947; A935; BP1105; A412; A411, A433P; SW2.; SC95; A452SR; A408SR; A516; A412P; A434; A412SR; A451SR; A453; CH40; ACC10280

CHEMICAL FAMILY:
HYDROXYL, ALIPHATIC

MOLECULAR FORMULA: C-H3-O-H

MOLECULAR WEIGHT: 32.04

CERCLA RATINGS (SCALE 0-3): HEALTH=3 FIRE=3 REACTIVITY=0 PERSISTENCE=0
NFPA RATINGS (SCALE 0-4): HEALTH=1 FIRE=3 REACTIVITY=0

COMPONENTS AND CONTAMINANTS

COMPONENT: METHYL ALCOHOL (METHANOL) PERCENT: 100
CAS# 67-56-1

OTHER CONTAMINANTS: NONE

EXPOSURE LIMITS:
METHYL ALCOHOL (METHANOL):
200 PPM (260 MG/M3) OSHA TWA (SKIN); 250 PPM (325 MG/M3) OSHA STEL
200 PPM (260 MG/M3) ACGIH TWA (SKIN); 250 PPM (310 MG/M3) ACGIH STEL
200 PPM NIOSH RECOMMENDED 10 HOUR TWA;
800 PPM NIOSH RECOMMENDED 15 MINUTE CEILING

5000 POUNDS CERCLA SECTION 103 REPORTABLE QUANTITY
SUBJECT TO SARA SECTION 313 ANNUAL TOXIC CHEMICAL RELEASE REPORTING

PHYSICAL DATA

DESCRIPTION: CLEAR, COLORLESS LIQUID WITH A CHARACTERISTIC ALCOHOLIC ODOR.

BOILING POINT: 149 F (65 C) MELTING POINT: -137 F (-94 C)

SPECIFIC GRAVITY: 0.7914 VAPOR PRESSURE: 97.25 MMHG @ 20 C

EVAPORATION RATE: (BUTYL ACETATE=1) 4.6 SOLUBILITY IN WATER: VERY SOLUBLE

ODOR THRESHOLD: 100 PPM VAPOR DENSITY: 1.11

SOLVENT SOLUBILITY: ETHER, BENZENE, ALCOHOL, ACETONE, CHLOROFORM, ETHANOL.

VISCOSITY: 0.59 CPS @ 20 C

FIRE AND EXPLOSION DATA

FIRE AND EXPLOSION HAZARD:
DANGEROUS FIRE HAZARD WHEN EXPOSED TO HEAT, FLAME, OR OXIDIZERS.

VAPORS ARE HEAVIER THAN AIR AND MAY TRAVEL A CONSIDERABLE DISTANCE TO A SOURCE OF IGNITION AND FLASH BACK.

VAPOR-AIR MIXTURES ARE EXPLOSIVE.

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FLASH POINT: 62 F (11 C) (CC) UPPER EXPLOSIVE LIMIT: 36.0%

LOWER EXPLOSIVE LIMIT: 6.0% AUTOIGNITION TEMP.: 725 F (385 C)

FLAMMABILITY CLASS(OSHA): IB

FIREFIGHTING MEDIA.
DRY CHEMICAL, CARBON DIOXIDE, WATER SPRAY OR ALCOHOL-RESISTANT FOAM (1990 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.5).

FOR LARGER FIRES, USE WATER SPRAY, FOG OR ALCOHOL-RESISTANT FOAM (1990 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.5).

FIREFIGHTING:
MOVE CONTAINER FROM FIRE AREA IF YOU CAN DO IT WITHOUT RISK. DIKE FIRE CONTROL WATER FOR LATER DISPOSAL; DO NOT SCATTER THE MATERIAL. APPLY COOLING WATER TO SIDES OF CONTAINERS THAT ARE EXPOSED TO FLAMES UNTIL WELL AFTER FIRE IS OUT. STAY AWAY FROM ENDS OF TANKS. WITHDRAW IMMEDIATELY IN CASE OF RISING SOUND FROM VENTING SAFETY DEVICE OR ANY DISCOLORATION OF TANK DUE TO FIRE. ISOLATE FOR 1/2 MILE IN ALL DIRECTIONS IF TANK, RAIL CAR OR TANK TRUCK IS INVOLVED IN FIRE (1990 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.5, GUIDE PAGE 28).

EXTINGUISH ONLY IF FLOW CAN BE STOPPED; USE WATER IN FLOODING AMOUNTS AS FOG, SOLID STREAMS MAY NOT BE EFFECTIVE. COOL CONTAINERS WITH FLOODING QUANTITIES OF WATER. APPLY FROM AS FAR A DISTANCE AS POSSIBLE. AVOID BREATHING TOXIC VAPORS, KEEP UPWIND.

TRANSPORTATION DATA

DEPARTMENT OF TRANSPORTATION HAZARD CLASSIFICATION 49 CFR 172.101:
FLAMMABLE LIQUID

DEPARTMENT OF TRANSPORTATION LABELING REQUIREMENTS 49 CFR 172.101 AND SUBPART E:
FLAMMABLE LIQUID

DEPARTMENT OF TRANSPORTATION PACKAGING REQUIREMENTS: 49 CFR 173.118
EXCEPTIONS: 49 CFR 173.118

TOXICITY

METHYL ALCOHOL (METHANOL):
IRRITATION DATA: 20 MG/24 HOURS SKIN-RABBIT MODERATE; 40 MG EYE-RABBIT MODERATE; 100 MG/24 HOURS EYE-RABBIT MODERATE.
TOXICITY DATA: 86,000 MG/M3 INHALATION-HUMAN TCLO; 300 PPM INHALATION HUMAN TCLO; 64,000 PPM/4 HOURS INHALATION-RAT LC50; 1000 PPM INHALATION MONKEY LCLO; 50 GM/M3/2 HOURS INHALATION-MOUSE LCLO; 44,000 MG/M3/6 HOURS INHALATION-CAT LCLO; 15,800 MG/KG SKIN-RABBIT LD50; 393 MG/KG SKIN MONKEY LDLO; 428 MG/KG ORAL-HUMAN LDLO; 143 MG/KG ORAL-HUMAN LDLO; 6422 MG/KG ORAL-MAN LDLO; 3429 MG/KG ORAL-MAN TDLO; 4 GM/KG ORAL-WOMAN TDLO; 7 GM/KG ORAL-MONKEY LD50; 5628 MG/KG ORAL-RAT LD50; 7300 MG/KG ORAL MOUSE LD50; 14,200 MG/KG ORAL-RABBIT LD50; 7500 MG/KG ORAL-DOG LDLO; 5800 MG/KG SUBCUTANEOUS-MOUSE LD50; 2131 MG/KG INTRAVENOUS RAT LD50; 4710 MG/KG INTRAVENOUS-MOUSE LD50; 8907 MG/KG INTRAVENOUS-RABBIT LD50; 7529 MG/KG INTRAPERITONEAL-RAT LD50; 10,765 MG/KG INTRAPERITONEAL-MOUSE LD50; 1826 MG/KG INTRAPERITONEAL-RABBIT LD50; 59 GM/KG PARENTERAL-FROG LDLO; 868 MG/KG UNREPORTED-MAN LDLO; MUTAGENIC DATA (RTECS); REPRODUCTIVE EFFECTS DATA (RTECS).
CARCINOGEN STATUS: NONE.
LOCAL EFFECTS: IRRITANT- SKIN, EYE.
ACUTE TOXICITY LEVEL: SLIGHTLY TOXIC BY INHALATION, DERMAL ABSORPTION, INGESTION.
TARGET EFFECTS: CENTRAL NERVOUS SYSTEM DEPRESSANT; NEUROTOXIN.
AT INCREASED RISK FROM EXPOSURE: PERSONS WITH KIDNEY, EYE OR SKIN DISORDERS.

HEALTH EFFECTS AND FIRST AID

INHALATION:
METHYL ALCOHOL (METHANOL):
NARCOTIC/NEUROTOXIN. 25,000 PPM IMMEDIATELY DANGEROUS TO LIFE OR HEALTH
ACUTE EXPOSURE- MAY CAUSE IRRITATION OF THE MUCOUS MEMBRANES, COUGHING, OPPRESSION IN THE CHEST, TRACHEITIS, BRONCHITIS, TINNITUS, UNSTEADY GAIT, TWITCHING, COLIC, CONSTIPATION, NYSTAGMUS, AND BLEPHAROSPASM. SYMPTOMS FROM OCCUPATIONAL EXPOSURE INCLUDE PARESTHESIAS, NUMBNESS AND SHOOTING PAINS IN THE HANDS AND FOREARMS. METABOLIC ACIDOSIS, AND EFFECTS ON THE EYES AND CENTRAL NERVOUS SYSTEM MAY OCCUR AS DETAILED IN ACUTE INGESTION.
CHRONIC EXPOSURE- REPEATED OR PROLONGED EXPOSURE MAY CAUSE EFFECTS AS IN ACUTE INGESTION. REPEATED EXPOSURE TO 200-375 PPM CAUSED RECURRENT HEADACHES IN WORKERS. EXPOSURE FOR 4 YEARS TO 1200-8000 PPM RESULTED IN MARKED DIMINUTION OF VISION AND ENLARGEMENT OF THE LIVER IN A WORKMAN. REPRODUCTIVE EFFECTS HAVE BEEN REPORTED IN ANIMALS.

FIRST AID. REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, PERFORM ARTIFICIAL RESPIRATION. KEEP PERSON WARM AND AT REST. TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY.

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SKIN CONTACT:
METHYL ALCOHOL (METHANOL):
IRRITANT/NARCOTIC/NEUROTOXIN.
ACUTE EXPOSURE - CONTACT WITH LIQUID MAY CAUSE IRRITATION. SKIN ABSORPTION MAY OCCUR AND CAUSE METABOLIC ACIDOSIS AND EFFECTS ON THE EYES AND CENTRAL NERVOUS SYSTEM AS DETAILED IN ACUTE INGESTION.
CHRONIC EXPOSURE - REPEATED OR PROLONGED CONTACT WITH THE LIQUID MAY CAUSE INFLAMING OF THE SKIN RESULTING IN ERYTHEMA, SCALING, AND ECZEMATOID DERMATITIS. CHRONIC ABSORPTION MAY RESULT METABOLIC ACIDOSIS AND EFFECTS AS DETAILED IN ACUTE INGESTION.

FIRST AID- REMOVE CONTAMINATED CLOTHING AND SHOES IMMEDIATELY. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

EYE CONTACT:
METHYL ALCOHOL (METHANOL):
IRRITANT.
ACUTE EXPOSURE - VAPORS MAY CAUSE IRRITATION. HIGH CONCENTRATIONS HAVE BEEN REPORTED TO CAUSE VIOLENT INFLAMMATION OF THE CONJUNCTIVA AND EPITHELIAL DEFECTS ON THE CORNEA. MILD IRRITATION MAY OCCUR WITH DILUTE SOLUTIONS; THE UNDILUTED LIQUID HAS PRODUCED MODERATE CORNEAL OPACITY AND CONJUNCTIVAL REDNESS IN RABBITS. APPLICATION OF A DROP OF METHANOL IN RABBIT EYES CAUSED A MILD REVERSIBLE REACTION, GRADED 3 ON A SCALE OF 1-10 AFTER 24 HOURS.
CHRONIC EXPOSURE - REPEATED OR PROLONGED CONTACT MAY CAUSE CONJUNCTIVITIS.

FIRST AID- WASH EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER OR NORMAL SALINE, OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

INGESTION:
METHYL ALCOHOL (METHANOL):
NARCOTIC/NEUROTOXIN.
ACUTE EXPOSURE - MAY CAUSE MILD AND TRANSIENT INEBRIATION AND SUBSEQUENT DROWSINESS FOLLOWED BY AN ASYMPTOMATIC PERIOD LASTING 8 48 HOURS FOLLOWING THE DELAY, COUGHING, DYSPNEA, HEADACHE, DULLNESS, WEARINESS, VERTIGO OR DIZZINESS, NAUSEA, VOMITING, OCCASIONAL DIARRHEA, ANOREXIA, VIOLENT PAIN IN THE BACK, ABDOMEN, AND EXTREMITIES, RESTLESSNESS, APATHY OR DELIRIUM, AND RARELY, EXCITEMENT AND MANIA MAY OCCUR. RAPID, SHALLOW RESPIRATION DUE TO METABOLIC ACIDOSIS, COLD AND CLAMMY SKIN, HYPOTENSION, CYANOSIS, OPISTHOTONOS, CONVULSIONS, MILD TACHYCARDIA, CARDIAC DEPRESSION, PERIPHERAL NEURITIS, CEREBRAL AND PULMONARY EDEMA, UNCONSCIOUSNESS, AND COMA ARE POSSIBLE. EFFECTS ON THE EYE MAY INCLUDE OPTIC NEURITIS, BLURRED OR DIMMED VISION, DILATED, UNRESPONSIVE PUPILS, PTOSIS, EYE PAIN, CONCENTRIC CONSTRICTION OF VISUAL FIELDS, DIPLOPIA, CHANGE IN COLOR PERCEPTION, PHOTOPHOBIA, AND OPTIC NERVE ATROPHY. PARTIAL BLINDNESS OR POSSIBLY DELAYED TRANSIENT OR PERMANENT BLINDNESS MAY OCCUR. BILATERAL SENSORINEURAL DEAFNESS HAS BEEN REPORTED IN A SINGLE CASE. LIVER, KIDNEY, HEART, STOMACH, INTESTINAL AND PANCREATIC DAMAGE MAY ALSO OCCUR. DEATH MAY BE DUE TO RESPIRATORY FAILURE OR RARELY FROM CIRCULATORY COLLAPSE. AS LITTLE AS 15 ML HAS CAUSED BLINDNESS, THE USUAL FATAL DOSE IS 60-240 ML. PROLONGED ASTHENIA AND IRREVERSIBLE EFFECTS ON THE NERVOUS SYSTEM INCLUDING DIFFICULTY IN SPEECH, MOTOR DYSFUNCTION WITH RIGIDITY, SPASTICITY, AND HYPORINESIS HAVE BEEN REPORTED.
CHRONIC EXPOSURE - REPEATED INGESTION MAY CAUSE VISUAL IMPAIRMENT AND BLINDNESS AND OTHER SYSTEMIC EFFECTS AS DETAILED IN ACUTE INGESTION. REPRODUCTIVE EFFECTS HAVE BEEN REPORTED IN ANIMALS.

FIRST AID- IF INGESTION OF METHANOL IS DISCOVERED WITHIN 2 HOURS, GIVE SYRUP OF IPECAC. LAVAGE THOROUGHLY WITH 2-4 L OF TAP WATER WITH SODIUM BICARBONATE (20 G/L) ADDED. GET MEDICAL ATTENTION IMMEDIATELY. LAVAGE SHOULD BE PERFORMED BY QUALIFIED MEDICAL PERSONNEL (DREISBACH, HANDBOOK OF POISONING, 12TH ED.).

ANTIDOTE:
THE FOLLOWING ANTIDOTE(S) HAVE BEEN RECOMMENDED. HOWEVER, THE DECISION AS TO WHETHER THE SEVERITY OF POISONING REQUIRES ADMINISTRATION OF ANY ANTIDOTE AND ACTUAL DOSE REQUIRED SHOULD BE MADE BY QUALIFIED MEDICAL PERSONNEL.

METHANOL POISONING:
GIVE ETHANOL, 50% (100 PROOF), 1.5 ML/KG ORALLY INITIALLY, DILUTED TO NOT MORE THAN 5% SOLUTION, FOLLOWED BY 0.5-1.0 ML/KG EVERY 2 HOURS ORALLY OR INTRAVENOUSLY FOR 4 DAYS IN ORDER TO REDUCE METABOLISM OF METHANOL AND TO ALLOW TIME FOR ITS EXCRETION. BLOOD ETHANOL LEVEL SHOULD BE IN THE RANGE OF 1.1.5 MG/ML (DREISBACH, HANDBOOK OF POISONING, 12TH ED.). ANTIDOTE SHOULD BE ADMINISTERED BY QUALIFIED MEDICAL PERSONNEL.

ORAL OR INTRAVENOUS ADMINISTRATION OF 4 METHYLPYRAZOLE INHIBITS ALCOHOL DEHYDROGENASE AND HAS BEEN USED EFFECTIVELY AS AN ANTIDOTE FOR METHANOL OR ETHYLENE GLYCOL POISONING (ELLENHORN AND BARCELOUX, MEDICAL TOXICOLOGY).

REACTIVITY

REACTIVITY:
STABLE UNDER NORMAL TEMPERATURES AND PRESSURES.

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WATER, DRY CHEMICAL OR SODA ASH
(1990 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.5).

FOR LARGER FIRES, FLOOD AREA WITH WATER FROM A DISTANCE
(1990 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.5).

FIREFIGHTING:
MOVE CONTAINER FROM FIRE AREA IF YOU CAN DO IT WITHOUT RISK. APPLY COOLING WATER TO SIDES OF CONTAINERS THAT ARE EXPOSED TO FLAMES UNTIL WELL AFTER FIRE IS OUT. STAY AWAY FROM ENDS OF TANKS. FOR MASSIVE FIRE IN CARGO AREA, USE UNMANNED HOSE HOLDER OR MONITOR NOZZLES; IF THIS IS IMPOSSIBLE, WITHDRAW FROM AREA AND LET FIRE BURN (1990 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.5, GUIDE PAGE 44).

USE FLOODING AMOUNTS OF WATER AS FOG. COOL CONTAINERS WITH FLOODING AMOUNTS OF WATER. APPLY FROM AS FAR A DISTANCE AS POSSIBLE. AVOID BREATHING CORROSIVE VAPORS, KEEP UPWIND. CONSIDER EVACUATION OF DOWNWIND AREA IF MATERIAL IS LEAKING.

TRANSPORTATION DATA

DEPARTMENT OF TRANSPORTATION HAZARD CLASSIFICATION 49 CFR 172.101:
OXIDIZER

DEPARTMENT OF TRANSPORTATION LABELLING REQUIREMENTS 49 CFR 172.101 AND SUBPART E:
OXIDIZER AND CORROSIVE

DEPARTMENT OF TRANSPORTATION PACKAGING REQUIREMENTS: 49 CFR 173.268
EXCEPTIONS: NONE

TOXICITY

NITRIC ACID:
TOXICITY DATA:
ANHYDROUS: 110 MG/KG UNREPORTED-MAN LDLO; 430 MG/KG ORAL-HUMAN LDLO.
REPRODUCTIVE EFFECTS DATA (RTECS).
MONOHYDRATE: NO DATA AVAILABLE.
TRIHYDRATE: NO DATA AVAILABLE.
CARCINOGEN STATUS: NONE.
LOCAL EFFECTS: CORROSIVE- INHALATION, SKIN, EYES, INGESTION.
ACUTE TOXICITY LEVEL: INSUFFICIENT DATA.
TARGET EFFECTS: NO DATA AVAILABLE.
AT INCREASED RISK FROM EXPOSURE: PERSONS WITH IMPAIRED PULMONARY FUNCTION, PRE-EXISTING EYE AND SKIN DISORDERS.

HEALTH EFFECTS AND FIRST AID

INHALATION:
NITRIC ACID:
CORROSIVE. 100 PPM IMMEDIATELY DANGEROUS TO LIFE OR HEALTH.
ACUTE EXPOSURE- INHALATION OF ACIDIC SUBSTANCES MAY CAUSE SEVERE RESPIRATORY IRRITATION WITH COUGHING, CHOKING, AND POSSIBLY YELLOWISH BURNS OF THE MUCOUS MEMBRANES. OTHER INITIAL SYMPTOMS MAY INCLUDE DIZZINESS, HEADACHE, NAUSEA, AND WEAKNESS. PULMONARY EDEMA MAY BE IMMEDIATE IN THE MOST SEVERE EXPOSURES, BUT MORE LIKELY WILL OCCUR AFTER A LATENT PERIOD OF 5-72 HOURS. THE SYMPTOMS MAY INCLUDE TIGHTNESS IN THE CHEST, DYSPNEA, DIZZINESS, FROTHY SPUTUM, AND CYANOSIS. PHYSICAL FINDINGS MAY INCLUDE HYPOTENSION, WEAK, RAPID PULSE, MOIST RALES, AND HEMOCONCENTRATION. IN NON FATAL CASES, COMPLETE RECOVERY MAY OCCUR WITHIN A FEW DAYS OR WEEKS OR, CONVALESCENCE MAY BE PROLONGED WITH FREQUENT RELAPSES AND CONTINUED DYSPNEA AND OTHER SIGNS AND SYMPTOMS OF PULMONARY INSUFFICIENCY. IN SEVERE EXPOSURES, DEATH DUE TO ANOXIA MAY OCCUR WITHIN A FEW HOURS AFTER ONSET OF THE SYMPTOMS OF PULMONARY EDEMA OR FOLLOWING A RELAPSE.
CHRONIC EXPOSURE- DEPENDING ON THE CONCENTRATION AND DURATION OF EXPOSURE, REPEATED OR PROLONGED EXPOSURE TO AN ACIDIC SUBSTANCE MAY CAUSE EROSION OF THE TEETH, INFLAMMATORY AND ULCERATIVE CHANGES IN THE MOUTH, AND POSSIBLY JAW NECROSIS. BRONCHIAL IRRITATION WITH COUGH AND FREQUENT ATTACKS OF BRONCHIAL PNEUMONIA MAY OCCUR. GASTROINTESTINAL DISTURBANCES ARE ALSO POSSIBLE.

FIRST AID- REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, GIVE ARTIFICIAL RESPIRATION. MAINTAIN AIRWAY AND BLOOD PRESSURE AND ADMINISTER OXYGEN IF AVAILABLE. KEEP AFFECTED PERSON WARM AND AT REST. TREAT SYMPTOMATICALLY AND SUPPORTIVELY. ADMINISTRATION OF OXYGEN SHOULD BE PERFORMED BY QUALIFIED PERSONNEL. GET MEDICAL ATTENTION IMMEDIATELY.

SKIN CONTACT:
NITRIC ACID:
CORROSIVE
ACUTE EXPOSURE- DIRECT CONTACT WITH LIQUID OR VAPOR MAY CAUSE SEVERE PAIN, BURNS AND POSSIBLY YELLOWISH STAINS. BURNS MAY BE DEEP WITH SHARP EDGES AND HEAL SLOWLY WITH SCAR TISSUE FORMATION. DILUTE SOLUTIONS OF NITRIC ACID MAY PRODUCE MILD IRRITATION AND HARDEN THE EPIDERMIS WITHOUT DESTROYING IT.

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INCOMPATIBILITIES:
METHYL ALCOHOL (METHANOL):
ACETYL BROMIDE: VIOLENT REACTION WITH FORMATION OF HYDROGEN BROMIDE.
ALKYLALUMINUM SOLUTIONS: VIOLENT REACTION.
ALUMINUM: CORRODES.
BARIUM PERCHLORATE: DISTILLATION YIELDS HIGHLY EXPLOSIVE ALKYL PERCHLORATE.
BERYLLIUM HYDRIDE: VIOLENT REACTION, EVEN AT -196 C.
BROMINE: VIGOROUSLY EXOTHERMIC REACTION.
CALCIUM CARBIDE: VIOLENT REACTION
CHLORINE: POSSIBLE IGNITION AND EXPLOSION HAZARD.
CHLOROFORM AND SODIUM HYDROXIDE: EXPLOSIVE REACTION.
CHROMIUM TRIOXIDE (CHROMIC ANHYDRIDE): POSSIBLE IGNITION.
CYANURIC CHLORIDE: VIOLENT REACTION
DICHLOROMETHANE: POSSIBLE IGNITION AND EXPLOSION.
DIETHYL ZINC: POSSIBLE IGNITION AND EXPLOSION.
HYDROGEN PEROXIDE + WATER: EXPLOSION HAZARD.
IODINE + ETHANOL + MERCURIC OXIDE: EXPLOSION HAZARD.
LEAD: CORRODES.
LEAD PERCHLORATE: EXPLOSION HAZARD.
MAGNESIUM: VIOLENT REACTION.
MAGNESIUM (POWDERED): MIXTURES ARE CAPABLE OF DETONATION.
METALS: INCOMPATIBLE.
NICKEL: POSSIBLE IGNITION IN THE PRESENCE OF NICKEL CATALYST.
NITRIC ACID (CONCENTRATED): MIXTURES OF GREATER THAN 25% ACID MAY DECOMPOSE VIOLENTLY.
OXIDIZERS (STRONG): FIRE AND EXPLOSION HAZARD.
PERCHLORIC ACID: EXPLOSION HAZARD.
PHOSPHOROUS TRIOXIDE: POSSIBLE VIOLENT REACTION AND IGNITION.
PLASTICS, RUBBER, COATINGS: MAY BE ATTACKED.
POTASSIUM: POSSIBLE DANGEROUS REACTION
POTASSIUM HYDROXIDE + CHLOROFORM: EXOTHERMIC REACTION.
POTASSIUM TERT-BUTOXIDE: FIRE AND EXPLOSION HAZARD.
SODIUM + CHLOROFORM: POSSIBLE EXPLOSION.
SODIUM HYPOCHLORITE: EXPLOSION HAZARD
SODIUM METHOXIDE + CHLOROFORM: VIOLENT REACTION.
SULFURIC ACID: FIRE AND EXPLOSION HAZARD.
ZINC: EXPLOSION HAZARD.

DECOMPOSITION:
THERMAL DECOMPOSITION PRODUCTS MAY INCLUDE TOXIC OXIDES OF CARBON.

POLYMERIZATION:
HAZARDOUS POLYMERIZATION HAS NOT BEEN REPORTED TO OCCUR UNDER NORMAL TEMPERATURES AND PRESSURES.

STORAGE AND DISPOSAL

OBSERVE ALL FEDERAL, STATE AND LOCAL REGULATIONS WHEN STORING OR DISPOSING OF THIS SUBSTANCE. FOR ASSISTANCE, CONTACT THE DISTRICT DIRECTOR OF THE ENVIRONMENTAL PROTECTION AGENCY.

STORAGE

STORE IN ACCORDANCE WITH 29 CFR 1910.106.

STORE AWAY FROM INCOMPATIBLE SUBSTANCES.

DISPOSAL

DISPOSAL MUST BE IN ACCORDANCE WITH STANDARDS APPLICABLE TO GENERATORS OF HAZARDOUS WASTE, 40 CFR 262. EPA HAZARDOUS WASTE NUMBER U154.

****

CONDITIONS TO AVOID

AVOID CONTACT WITH HEAT, SPARKS, FLAMES OR OTHER IGNITION SOURCES. VAPORS MAY BE EXPLOSIVE. MATERIAL IS POISONOUS; AVOID INHALATION OF VAPORS OR CONTACT WITH SKIN. DO NOT ALLOW MATERIAL TO CONTAMINATE WATER SOURCES.

****

SPILL AND LEAK PROCEDURES

SOIL SPILL:
DIG HOLDING AREA SUCH AS LAGOON, POND OR PIT FOR CONTAINMENT.

DIRE FLOW OF SPILLED MATERIAL USING SOIL OR SANDBAGS OR FOAMED BARRIERS SUCH AS POLYURETHANE OR CONCRETE.

AIR SPILL:
APPLY WATER SPRAY TO KNOCK DOWN VAPORS.

WATER SPILL:
ALLOW SPILLED MATERIAL TO AERATE.

LIMIT SPILL MOTION AND DISPERSION WITH NATURAL BARRIERS OR OIL SPILL CONTROL

BOOMS.

USE SUCTION HOSES TO REMOVE TRAPPED SPILL MATERIAL.

OCCUPATIONAL SPILL:
SHUT OFF IGNITION SOURCES. DO NOT TOUCH SPILLED MATERIAL. STOP LEAK IF YOU CAN DO IT WITHOUT RISK. USE WATER SPRAY TO REDUCE VAPORS. FOR SMALL SPILLS, TAKE UP WITH SAND OR OTHER ABSORBENT MATERIAL AND PLACE INTO CONTAINERS FOR LATER DISPOSAL. FOR LARGER SPILLS, DIKE FAR AHEAD OF SPILL FOR LATER DISPOSAL. NO SMOKING, FLAMES OR FLARES IN HAZARD AREA! KEEP UNNECESSARY PEOPLE AWAY; ISOLATE HAZARD AREA AND DENY ENTRY.

REPORTABLE QUANTITY (RQ): 5000 POUNDS
THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA) SECTION 304 REQUIRES THAT A RELEASE EQUAL TO OR GREATER THAN THE REPORTABLE QUANTITY FOR THIS SUBSTANCE BE IMMEDIATELY REPORTED TO THE LOCAL EMERGENCY PLANNING COMMITTEE AND THE STATE EMERGENCY RESPONSE COMMISSION (40 CFR 355.40). IF THE RELEASE OF THIS SUBSTANCE IS REPORTABLE UNDER CERCLA SECTION 103, THE NATIONAL RESPONSE CENTER MUST BE NOTIFIED IMMEDIATELY AT (800) 424-8802 OR (202) 426-2675 IN THE METROPOLITAN WASHINGTON, D.C. AREA (40 CFR 302.6).

PROTECTIVE EQUIPMENT

VENTILATION:
PROVIDE GENERAL DILUTION VENTILATION TO MEET PUBLISHED EXPOSURE LIMITS. VENTILATION EQUIPMENT MUST BE EXPLOSION-PROOF.

RESPIRATOR:
THE FOLLOWING RESPIRATORS AND MAXIMUM USE CONCENTRATIONS ARE RECOMMENDATIONS BY THE U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES, NIOSH POCKET GUIDE TO CHEMICAL HAZARDS, NIOSH CRITERIA DOCUMENTS OR BY THE U.S. DEPARTMENT OF LABOR, 29 CFR 1910 SUBPART Z.
THE SPECIFIC RESPIRATOR SELECTED MUST BE BASED ON CONTAMINATION LEVELS FOUND IN THE WORK PLACE, MUST NOT EXCEED THE WORKING LIMITS OF THE RESPIRATOR AND BE JOINTLY APPROVED BY THE NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH AND THE MINE SAFETY AND HEALTH ADMINISTRATION (NIOSH-MSHA).

METHYL ALCOHOL (METHANOL):

2000 PPM- ANY SUPPLIED-AIR RESPIRATOR.
ANY SELF-CONTAINED BREATHING APPARATUS.

5000 PPM- ANY SUPPLIED-AIR RESPIRATOR OPERATED IN A CONTINUOUS FLOW MODE.

10,000 PPM- ANY SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACEPIECE.
ANY SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE.
ANY SUPPLIED-AIR RESPIRATOR WITH A TIGHT-FITTING FACEPIECE OPERATED IN A CONTINUOUS FLOW MODE.

25,000 PPM- ANY SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE AND OPERATED IN A PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

ESCAPE- ANY APPROPRIATE ESCAPE-TYPE SELF-CONTAINED BREATHING APPARATUS.

FOR FIREFIGHTING AND OTHER IMMEDIATELY DANGEROUS TO LIFE OR HEALTH CONDITIONS:

ANY SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

ANY SUPPLIED-AIR RESPIRATOR WITH FULL FACEPIECE AND OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE IN COMBINATION WITH AN AUXILIARY SELF-CONTAINED BREATHING APPARATUS OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

CLOTHING:
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE (IMPERVIOUS) CLOTHING AND EQUIPMENT TO PREVENT REPEATED OR PROLONGED SKIN CONTACT WITH THIS SUBSTANCE.

GLOVES:
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE GLOVES TO PREVENT CONTACT WITH THIS SUBSTANCE.

EYE PROTECTION:
EMPLOYEE MUST WEAR SPLASH-PROOF OR DUST-RESISTANT SAFETY GOGGLES TO PREVENT EYE CONTACT WITH THIS SUBSTANCE.

EMERGENCY EYE WASH: WHERE THERE IS ANY POSSIBILITY THAT AN EMPLOYEE'S EYES MAY BE EXPOSED TO THIS SUBSTANCE, THE EMPLOYER SHOULD PROVIDE AN EYE WASH FOUNTAIN WITHIN THE IMMEDIATE WORK AREA FOR EMERGENCY USE.

-ADDITIONAL INFORMATION-
THIS INFORMATION IS BELIEVED TO BE ACCURATE AND REPRESENTS THE BEST INFORMATION CURRENTLY AVAILABLE TO US. HOWEVER, WE MAKE NO WARRANTY OF

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NITRIC ACID
NITRIC ACID
NITRIC ACID

MATERIAL SAFETY DATA SHEET

FISHER SCIENTIFIC
CHEMICAL DIVISION
1 REAGENT LANE
FAIR LAWN NJ 07410
(201) 796-7100

EMERGENCY NUMBER: (201) 796-7100
CHEMTREC ASSISTANCE: (800) 424-9300

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SUBSTANCE IDENTIFICATION

CAS-NUMBER 7697-37-2

SUBSTANCE: **NITRIC ACID**

TRADE NAMES/SYNONYMS:
AQUA FORTIS; WINA; RFNA; HYDROGEN NITRATE; AZOTIC ACID; NITRYL HYDROXIDE; NITAL; SICC 4918520; UN 2031;
A200; A200C; A200S; A202; A206C; A509; A467; A200S1; A198C; A483, HNO3, ACC16550

CHEMICAL FAMILY:
INORGANIC ACID

MOLECULAR FORMULA: H-N-O3

MOLECULAR WEIGHT: 63.01

CERCLA RATINGS (SCALE 0-3): HEALTH=3 FIRE=0 REACTIVITY=1 PERSISTENCE=0
NFPA RATINGS (SCALE 0-4): HEALTH=3 FIRE=0 REACTIVITY=0

COMPONENTS AND CONTAMINANTS

COMPONENT: NITRIC ACID PERCENT: 70

COMPONENT: WATER PERCENT: 30

OTHER CONTAMINANTS: NONE

EXPOSURE LIMITS:
NITRIC ACID:
2 PPM (5 MG/M3) OSHA TWA; 4 PPM (10 MG/M3) OSHA STEL
2 PPM (5 MG/M3) ACGIH TWA; 4 PPM (10 MG/M3) ACGIH STEL
2 PPM NIOSH RECOMMENDED 10 HOUR TWA

1000 POUNDS SARA SECTION 302 THRESHOLD PLANNING QUANTITY
1000 POUNDS SARA SECTION 304 REPORTABLE QUANTITY
1000 POUNDS CERCLA SECTION 103 REPORTABLE QUANTITY
SUBJECT TO SARA SECTION 313 ANNUAL TOXIC CHEMICAL RELEASE REPORTING

PHYSICAL DATA

DESCRIPTION: COLORLESS TO PALE YELLOW LIQUID WITH A SUFFOCATING ODOR.

BOILING POINT: 181 F (83 C) MELTING POINT: -44 F (-42 C)

SPECIFIC GRAVITY: 1.5027 @ 25 C VAPOR PRESSURE: 47.9 MMHG @ 20 C

EVAPORATION RATE: NOT AVAILABLE SOLUBILITY IN WATER: VERY SOLUBLE

VAPOR DENSITY: 3.2

SOLVENT SOLUBILITY: SOLUBLE IN ETHER.

FIRE AND EXPLOSION DATA

FIRE AND EXPLOSION HAZARD:
NEGLIGIBLE FIRE HAZARD WHEN EXPOSED TO HEAT OR FLAME.

OXIDIZER: OXIDIZERS DECOMPOSE, ESPECIALLY WHEN HEATED, TO YIELD OXYGEN OR OTHER GASES WHICH WILL INCREASE THE BURNING RATE OF COMBUSTIBLE MATTER. CONTACT WITH EASILY OXIDIZABLE, ORGANIC, OR OTHER COMBUSTIBLE MATERIALS MAY RESULT IN IGNITION, VIOLENT COMBUSTION OR EXPLOSION.

FIREFIGHTING MEDIA:

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CHRONIC EXPOSURE - EFFECTS DEPEND ON THE CONCENTRATION AND DURATION OF EXPOSURE. REPEATED OR PROLONGED CONTACT WITH ACIDIC SUBSTANCES MAY RESULT IN DERMATITIS OR EFFECTS SIMILAR TO ACUTE EXPOSURE.

FIRST AID- REMOVE CONTAMINATED CLOTHING AND SHOES IMMEDIATELY. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (AT LEAST 15-20 MINUTES). IN CASE OF CHEMICAL BURNS, COVER AREA WITH STERILE, DRY DRESSING. BANDAGE SECURELY, BUT NOT TOO TIGHTLY. GET MEDICAL ATTENTION IMMEDIATELY.

EYE CONTACT:
NITRIC ACID:
CORROSIVE.
ACUTE EXPOSURE - DIRECT CONTACT WITH ACIDIC SUBSTANCES MAY CAUSE PAIN AND LACRIMATION, PHOTOPHOBIA, AND BURNS, POSSIBLY SEVERE. THE DEGREE OF INJURY DEPENDS ON THE CONCENTRATION AND DURATION OF CONTACT. IN MILD BURNS, THE EPITHELIUM REGENERATES RAPIDLY AND THE EYE RECOVERS COMPLETELY. IN SEVERE CASES, THE EXTENT OF INJURY MAY NOT BE FULLY APPARENT FOR SEVERAL WEEKS. ULTIMATELY, THE WHOLE CORNEA MAY BECOME DEEPLY VASCULARIZED AND OPAQUE RESULTING IN BLINDNESS. IN THE WORST CASES, THE EYE MAY BE TOTALLY DESTROYED. CONCENTRATED NITRIC ACID MAY IMPART A YELLOW COLOR TO THE EYE UPON CONTACT.
CHRONIC EXPOSURE - EFFECTS DEPEND ON THE CONCENTRATION AND DURATION OF EXPOSURE. REPEATED OR PROLONGED EXPOSURE TO ACIDIC SUBSTANCES MAY CAUSE CONJUNCTIVITES OR EFFECTS AS IN ACUTE EXPOSURE.

FIRST AID- WASH EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER, OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (AT LEAST 15-20 MINUTES). CONTINUE IRRIGATING WITH NORMAL SALINE UNTIL THE PH HAS RETURNED TO NORMAL (30-60 MINUTES). COVER WITH STERILE BANDAGES. GET MEDICAL ATTENTION IMMEDIATELY.

INGESTION:
NITRIC ACID:
CORROSIVE.
ACUTE EXPOSURE - ACIDIC SUBSTANCES MAY CAUSE CIRCUMORAL BURNS WITH YELLOW DISCOLORATION AND CORROSION OF THE MUCOUS MEMBRANES OF THE MOUTH, THROAT AND ESOPHAGUS. THERE MAY BE IMMEDIATE PAIN AND DIFFICULTY OR INABILITY TO SWALLOW OR SPEAK. EPIGLOTTAL EDEMA MAY RESULT IN RESPIRATORY DISTRESS AND POSSIBLY ASPHYXIA. MARKED THIRST, EPIGASTRIC PAIN, NAUSEA, VOMITING AND DIARRHEA MAY OCCUR. DEPENDING ON THE DEGREE OF ESOPHAGEAL AND GASTRIC CORROSION, THE VOMITUS MAY CONTAIN FRESH OR DARK PRECIPITATED BLOOD AND LARGE SHREDS OF MUCOSA. SHOCK WITH MARKED HYPOTENSION, WEAK, RAPID PULSE, SHALLOW RESPIRATION, AND CLAMMY SKIN MAY OCCUR. CIRCULATORY COLLAPSE MAY ENSUE AND IF UNCORRECTED, LEAD TO RENAL FAILURE. IN SEVERE CASES, GASTRIC, AND TO A LESSER DEGREE, ESOPHAGEAL PERFORATION AND SUBSEQUENT PERITONITIS MAY OCCUR AND BE ACCOMPANIED BY FEVER AND ABDOMINAL RIGIDITY. ESOPHAGEAL, GASTRIC AND PYLORIC STRICTURE MAY OCCUR WITHIN A FEW WEEKS, BUT MAY BE DELAYED FOR MONTHS OR EVEN YEARS. DEATH MAY RESULT WITHIN A SHORT TIME FROM ASPHYXIA, CIRCULATORY COLLAPSE OR ASPIRATION OF EVEN MINUTE AMOUNTS LATER DEATH MAY BE DUE TO PERITONITIS, SEVERE NEPHRITIS OR PNEUMONIA. COMA AND CONVULSIONS SOMETIMES OCCUR TERMINALLY.
CHRONIC EXPOSURE - DEPENDING ON THE CONCENTRATION, REPEATED INGESTION OF ACIDIC SUBSTANCES MAY RESULT IN INFLAMMATORY AND ULCERATIVE CHANGES IN THE MUCOUS MEMBRANES OF THE MOUTH AND OTHER EFFECTS AS IN ACUTE INGESTION. REPRODUCTIVE EFFECTS HAVE BEEN REPORTED IN ANIMALS.

FIRST AID- DO NOT USE GASTRIC LAVAGE OR EMESIS. DILUTE THE ACID IMMEDIATELY BY DRINKING LARGE QUANTITIES OF WATER OR MILK. IF VOMITING PERSISTS, ADMINISTER FLUIDS REPEATEDLY. INGESTED ACID MUST BE DILUTED APPROXIMATELY TEN FOLD TO REMAIN IT HARMLESS TO TISSUES. MAINTAIN AIRWAY AND TREAT SHOCK (LUNGSBACH, HANDBOOK OF POISONING, 12TH ED.). GET MEDICAL ATTENTION IMMEDIATELY. IF VOMITING OCCURS, KEEP HEAD BELOW HIPS TO HELP PREVENT ASPIRATION.

ANTIDOTE:
NO SPECIFIC ANTIDOTE. TREAT SYMPTOMATICALLY AND SUPPORTIVELY.

REACTIVITY

REACTIVITY:
REACTS EXOTHERMICALLY WITH WATER.

INCOMPATIBILITIES:

NITRIC ACID:
ACETIC ACID: MAY REACT EXPLOSIVELY.
ACETIC ANHYDRIDE. EXPLOSIVE REACTION BY FRICTION OR IMPACT.
ACETONE. MAY REACT EXPLOSIVELY.
ACETONITRILE. EXPLOSIVE MIXTURE.
4 ALLYLOXY-3 METHOXYBENZALDEHYDE: EXOTHERMIC REACTION.
ACROLEIN: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
ACRYLONITRILE. EXPLOSIVE REACTION AT 90 C.
ACRYLONITRILE-METHACRYLATE COPOLYMER. INCOMPATIBLE.
ALCOHOLS: POSSIBLE VIOLENT REACTION OR EXPLOSION; FORMATION OF EXPLOSIVE COMPOUND IN THE PRESENCE OF HEAVY METALS.
ALKANETHIOLS. EXOTHERMIC REACTION WITH POSSIBLE IGNITION.
2 ALKOXY 1,3 DIOXIA-2 PHOSPHOLANE. IGNITION REACTION.
ALLYL ALCOHOL: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
ALLYL CHLORIDE: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.

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AMINES (ALIPHATIC OR AROMATIC): POSSIBLE IGNITION REACTION.
2-AMINOETHANOL: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
2-AMINOPYRIMIDINE: EXPLOSIVE REACTION.
AMMONIA (GAS): BURNS IN AN ATMOSPHERE OF NITRIC ACID VAPOR.
AMMONIUM HYDROXIDE: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
AMMONIUM NITRATE: FORMS EXPLOSIVE MIXTURE.
ANILINE: IGNITES ON CONTACT.
ANTIMONY NITRATE: FORMS EXPLOSIVE SOLUTION.
ANION EXCHANGE RESINS: POSSIBLE VIOLENT EXOTHERMIC REACTION.
ANTIMONY: VIOLENT REACTION.
ARSINE: EXPLOSIVE REACTION.
ARSINE-BORON TRIBROMIDE: VIOLENT OXIDATION.
BASES: REACTS.
BENZENE: EXPLOSIVE REACTION.
BENZIDINE: SPONTANEOUS IGNITION.
BENZONITRILE: POSSIBLE EXPLOSION.
BENZOTHIOPHENE DERIVATIVES: FORMATION OF POSSIBLY EXPLOSIVE COMPOUNDS.
N-BENZYL-N-ETHYLANILINE: VIGOROUS DECOMPOSITION.
1,4-BISMETHOXYMETHYL-2,3,5,6-TETRAMETHYLBENZENE: GAS EVOLUTION.
BISMUTH: INTENSE EXOTHERMIC REACTION OR EXPLOSION.
1,3-BISTRIFLUOROMETHYLBENZENE: POSSIBLE EXPLOSION.
BORON: VIOLENT REACTION WITH INCANDESCENCE.
BORON DECAHYDRIDE: EXPLOSIVE REACTION.
BORON PHOSPHIDE: IGNITION REACTION.
BROMINE PENTAFLUORIDE: IGNITION REACTION.
N-BUTYL MERCAPTAN: IGNITION REACTION.
N-BUTYRALDEHYDE: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
CADMIUM PHOSPHIDE: EXPLOSIVE REACTION.
CALCIUM HYPOPHOSPHITE: IGNITION REACTION.
CARBON (PULVERIZED): VIOLENT REACTION.
CELLULOSE: FORMS EASILY COMBUSTIBLE ESTER.
CHLORATES: REACTS.
CHLORINE: INCOMPATIBLE.
CHLORINE TRIFLUORIDE: VIOLENT REACTION.
CHLOROBENZENE: POSSIBLE EXPLOSION.
4-CHLORO-2-NITROANILINE: FORMS EXPLOSIVE COMPOUND.
CHLOROSULFONIC ACID: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
COAL: EXPLOSIVE MIXTURE.
COATINGS: MAY BE ATTACKED.
CRESOL: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
CROTONALDEHYDE: VIOLENT DECOMPOSITION WITH IGNITION.
CUMENE: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
CUPRIC NITRIDE: EXPLOSIVE REACTION.
CUPROUS NITRIDE: VIOLENT REACTION.
CYANATES: POSSIBLE EXPLOSIVE REACTION.
CYCLOHEXANONE: VIOLENT REACTION.
CYCLOHEXYLAMINE: FORMS EXPLOSIVE COMPOUND.
CYCLOPENTADIENE: EXPLOSIVE REACTION.
1,2-DIAMINOETHANE(BISTRIMETHYLGLOL): EXPLOSIVE REACTION.
DIBORANE: SPONTANEOUS IGNITION.
DI-2-BUTOXYETHYL ETHER: VIOLENT DECOMPOSITION REACTION.
2,6-DI-T-BUTYL PHENOL: FORMATION OF EXPLOSIVE COMPOUND.
DICHLOROETHANE: FORMS SHOCK AND HEAT SENSITIVE MIXTURE.
DICHLOROFUROXANE: FORMS EXPLOSIVE COMPOUND.
DICHLOROMETHANE: FORMS EXPLOSIVE SOLUTION.
DICYCLOPENTADIENE: SPONTANEOUS IGNITION.
DIENES: IGNITION REACTION.
DIETHYLAMINO ETHANOL: POSSIBLE EXPLOSION.
DIETHYL ETHER: POSSIBLE EXPLOSION.
3,6-DIHYDRO-1,2,2H-OXAZIN: EXPLOSIVE INTERACTION.
DIISOPROPYL ETHER: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
DIMETHYLAMINOMETHYLFERROCENE: VIOLENT DECOMPOSITION IF HEATED.
DIMETHYL ETHER: FORMS EXPLOSIVE COMPOUND.
DIMETHYL HYDRAZINE: IGNITES ON CONTACT.
DIMETHYL SULFOXIDE + 1,4-DIOXANE: EXPLOSION.
DIMETHYL SULFOXIDE + <14% WATER: EXPLOSIVE REACTION.
DINITROBENZENE: EXPLOSION HAZARD.
DINITROTOLUENE: EXPLOSIVE REACTION.
DIOXANE + PERCHLORIC ACID: POSSIBLE EXPLOSION.
DIPHENYL DISULFIDE: EXPLOSIVE OXIDATION.
DIPHENYL MERCURY + CARBON DISULFIDE: VIOLENT REACTION.
DIPHENYL TIN: IGNITION REACTION.
DISODIUM PHENYL ORTHOPHOSPHATE: VIOLENT EXPLOSION.
DIVINYL ETHER: POSSIBLE IGNITION REACTION.
EPICHLOROHYDRIN: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
ETHANESULFONAMIDE: EXPLOSIVE REACTION.
ETHOXY-ETHYLENE DITHIOPHOSPHATE: IGNITION ON CONTACT.
N-ETHYL ANILINE: IGNITION REACTION.
ETHYLENE DIAMINE: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
ETHYLENE GLYCOL: FORMS SHOCK AND HEAT SENSITIVE MIXTURE.
ETHYLENEIMINE: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
5-ETHYL-2-METHYL PYRIDINE: EXPLOSIVE REACTION.
ETHYL PHOSPHINE: IGNITION REACTION.
5-ETHYL-2-PICOLINE: FORMS EXPLOSIVE COMPOUNDS.
FERROUS OXIDE (POWDERED): INTENSE EXOTHERMIC REACTION.
FLUORINE: POSSIBLE EXPLOSIVE REACTION.
FORMIC ACID: EXOTHERMIC REACTION WITH RELEASE OF TOXIC GASES.
2-FORMYLAMINO-4-PHENYL-1,3-PROPANEDIOL: POSSIBLE EXPLOSION.
FUEL OIL (HEATED): EXPLOSION.
FULMINATES: REACTS.

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FURFURYLIDENE KETONES: IGNITES ON CONTACT.
GERMANIUM: VIOLENT REACTION.
GLYCEROL: POSSIBLE EXPLOSION.
GLYOXAL: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
HEXALITHIUM DISILICIDE: EXPLOSIVE REACTION.
HEXAMETHYLBENZENE: POSSIBLE EXPLOSION
2,2,4,4,6,6 HEXAMETHYLTRITHIANE: EXPLOSIVE OXIDATION.
HEXENAL: EXPLODES ON HEATING.
HYDRAZINE: VIOLENT REACTION
HYDRAZOIC ACID: ENERGETIC REACTION.
HYDROGEN IODIDE: IGNITION REACTION.
HYDROGEN PEROXIDE: FORMS UNSTABLE MIXTURE.
HYDROGEN PEROXIDE AND KETONES: FORMS EXPLOSIVE PRODUCTS
HYDROGEN PEROXIDE AND MERCURIC OXIDE: FORMS EXPLOSIVE COMPOUNDS.
HYDROGEN PEROXIDE AND THIOUREA: FORMS EXPLOSIVE COMPOUNDS.
HYDROGEN SELENIDE: IGNITION REACTION.
HYDROGEN SULFIDE: INCANDESCENT REACTION.
HYDROGEN TELLURIDE: IGNITION AND POSSIBLE EXPLOSIVE REACTION.
INDANE AND SULFURIC ACID: EXPLOSIVE REACTION.
ISOPRENE: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
KETONES (CYCLIC): VIOLENT REACTION
LACTIC ACID + HYDROFLUORIC ACID: EXPLOSIVE REACTION.
LITHIUM: IGNITION REACTION
LITHIUM SILICIDE: INCANDESCENT REACTION.
MAGNESIUM: EXPLOSIVE REACTION.
MAGNESIUM + 2-NITROANILINE: MAY IGNITE ON CONTACT.
MAGNESIUM PHOSPHIDE: INCANDESCENT REACTION.
MAGNESIUM SILICIDE: VIOLENT REACTION.
MAGNESIUM-TITANIUM ALLOY: FORMS SHOCK AND HEAT SENSITIVE MIXTURE.
MANGANESE (POWDERED): INCANDESCENCE AND POSSIBLE EXPLOSION.
MESITYL OXIDE: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
MESITYLENE: POSSIBLE EXPLOSIVE REACTION.
METALS: VIOLENT REACTION WITH EXPLOSION OR IGNITION.
METAL ACETYLIDES: VIOLENT OR EXPLOSIVE REACTION.
METAL CARBIDES: VIOLENT OR EXPLOSIVE REACTION.
METAL CYANIDES: EXPLOSIVE REACTIONS.
METAL FERRICYANIDE OR FERROCYANIDE: VIOLENT REACTION.
METAL SALICYLATES: FORMS EXPLOSIVE COMPOUNDS.
METAL THIOCYANATES: POSSIBLE EXPLOSION.
2-METHYLBENZIMIDAZOLE + SULFURIC ACID: POSSIBLE EXPLOSIVE REACTION
4-METHYLCYCLOHEXANONE: EXPLOSIVE REACTION.
2-METHYL-5-ETHYLPYRIDINE: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
METHYL THIOPHENE: IGNITION REACTION.
MOLYBDENUM PHOSPHIDE: VIOLENT REACTION.
NICKEL TETRAPHOSPHIDE: IGNITION REACTION.
NITRO AROMATIC HYDROCARBONS: FORMS HIGHLY EXPLOSIVE PRODUCTS.
NITROBENZENE: EXPLOSIVE REACTION, ESPECIALLY IN THE PRESENCE OF WATER.
NITROMETHANE: EXPLOSIVE REACTION
NITRONAPHTHALENE: EXPLOSION HAZARD.
NON METAL OXIDES: EXPLOSIVE REACTION.
OLEUM: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
ORGANIC MATERIALS: FIRE AND EXPLOSION HAZARD.
ORGANIC SUBSTANCES AND PERCHLORATES: POSSIBLE EXPLOSION
ORGANIC SUBSTANCES AND SULFURIC ACID: POSSIBLE EXPLOSION.
PHENYL ACETYLENE + 1,1-DIMETHYLHYDRAZINE: VIOLENT REACTION.
PHENYL ORTHOPHOSPHORIC ACID DISODIUM SALT: FORMS EXPLOSIVE PRODUCTS.
PHOSPHINE + OXYGEN: SPONTANEOUS IGNITION.
PHOSPHONIUM IODIDE: IGNITION REACTION.
PHOSPHORUS (VAPOR): IGNITES WHEN HEATED.
PHOSPHORUS HALIDES: IGNITION REACTION
PHOSPHORUS TETRAIODIDE: VIGOROUS REACTION.
PHOSPHORUS TRICHLORIDE: EXPLOSIVE REACTION
PHTHALIC ACID AND SULFURIC ACID: POSSIBLE EXPLOSIVE REACTION
PHTHALIC ANHYDRIDE: EXOTHERMIC REACTION AND FORMS EXPLOSIVE PRODUCTS.
PICRATES: REACTS.
PLASTICS: MAY BE ATTACKED.
POLYALKENES: INTENSE REACTION..
POLYDIMETHOXYSILANES: EXPLOSIVE REACTION.
POLYETHYLENE OXIDE) DERIVATIVES: POSSIBLE EXPLOSION.
POLYPROPYLENE: TEMPERATURE AND PRESSURE INCREASE IN A CLOSED CONTAINER.
POLYSTYRENE): IGNITION
POLYURETHANE (FOAM): VIGOROUS REACTION.
POTASSIUM HYPOPHOSPHITE: EXPLOSIVE REACTION.
POTASSIUM PHOSPHINATE: EXPLODES ON EVAPORATION.

β PROPIOLACTONE: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
PROPIOPHENONE + SULFURIC ACID: EXOTHERMIC REACTION ABOVE -5 C.
PROPYLENE GLYCOL + HYDROFLUORIC ACID + SILVER NITRATE: EXPLOSIVE MIXTURE.
PROPYLENE OXIDE: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
PYRIDINE: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
PYROCATECHOL: IGNITES ON CONTACT
REDUCING AGENTS: POSSIBLE EXPLOSIVE OR IGNITION REACTION.
RESORCINOL: POSSIBLE EXPLOSION
RUBBER: VIGOROUS REACTION, POSSIBLE EXPLOSION.
SELENIUM: VIGOROUS REACTION
SELENIUM MONOXIDE: IGNITION OR INCANDESCENT REACTION.
SELENIUM TODOPHOSPHIDE: EXPLOSIVE REACTION.
SILICON: VIOLENT REACTION
SILICONE OIL: POSSIBLE EXPLOSION.
SILVER BUTEN-3-YNIDE: EXPLOSION.

SODIUM: SPONTANEOUS IGNITION.
SODIUM AZIDE: EXOTHERMIC REACTION.
SODIUM HYDROXIDE: TEMPERATURE AND PRESSURE INCREASE IN A CLOSED CONTAINER.
STIBINE: EXPLOSIVE REACTION.
SUCROSE (SOLID): VIGOROUS REACTION.
SULFAMIC ACID: VIOLENT REACTION WITH EVOLUTION OF TOXIC NITROUS OXIDE.
SULFIDES: REACTS.
SULFUR DIOXIDE: EXPLOSIVE REACTION.
SULFUR HALIDES: VIOLENT REACTION.
SULFURIC ACID + GLYCERIDES: EXPLOSIVE REACTION.
SULFURIC ACID + TERPENTHALIC ACID: VIOLENT REACTION.
SURFACTANTS + PHOSPHORIC ACID: EXPLOSION HAZARD.
TEMPENES: SPONTANEOUS IGNITION.
TETRABORANE: EXPLOSIVE REACTION.
TETRABORANE DECAHYDRIDE: EXPLOSIVE REACTION.
TETRAPHOSPHORUS DIIODOTRISELENIDE: EXPLOSIVE REACTION.
TETRAPHOSPHORUS IODIDE: IGNITES ON CONTACT.
TETRAPHOSPHORUS TETRABRIDE TRISULFIDE: VIOLENT REACTION.
THIOALDEHYDES: VIOLENT REACTION.
THIOKETONES: VIOLENT REACTION.
THIOPHENES: EXPLOSIVE REACTION.
TITANIUM: FORMS SHOCK-SENSITIVE COMPOUND.
TITANIUM ALLOYS: POSSIBLE EXPLOSIVE REACTION.
TITANIUM-MAGNESIUM ALLOY: POSSIBLE EXPLOSION ON IMPACT.
TOLUENE: VIOLENT REACTION.
TOLUIDENE: IGNITION REACTION.
1,3,5-TRIACETYLHEXAHYDRO-1,3,5-TRIAZINE + TRIFLUOROACETIC ANHYDRIDE:
EXPLOSIVE REACTION
TRIAZINE: VIOLENTLY EXPLOSIVE REACTION.
TRICADMIUM DIPHOSPHIDE: EXPLOSIVE REACTION
TRIETHYLGALLIUM MONOETHYL ETHER COMPLEX: IGNITION REACTION.
TRIMETHYLTRIBORANE: INTENSE REACTION.
TRISILOXOMERCURIPHOSPHINE: VIOLENT DECOMPOSITION.
TRITHIOACETONE: EXPLOSIVE REACTION.
TURPENTINE: EXPLOSIVE MIXTURE.
UNSYMMETRICAL DIMETHYL HYDRAZINE: SPONTANEOUS IGNITION.
URANIUM: EXPLOSIVE REACTION.
URANIUM ALLOY: VIOLENT REACTION.
URANIUM DISULFIDE: VIOLENT REACTION.
URANIUM-NEODYMIUM ALLOYS: EXPLOSIVE REACTION
VINYL ACETATE: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
VINYLIDENE CHLORIDE: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
WOOD: POSSIBLE IGNITION.
P-XYLENE: INTENSE REACTION IN PRESENCE OF SULFURIC ACID.
ZINC: INCANDESCENT REACTION.
ZINC ETHOXIDE: POSSIBLE EXPLOSION.
ZIRCONIUM-URANIUM ALLOYS: EXPLOSIVE REACTION.

DECOMPOSITION:
THERMAL DECOMPOSITION PRODUCTS MAY INCLUDE TOXIC OXIDES OF NITROGEN.

POLYMERIZATION:
HAZARDOUS POLYMERIZATION HAS NOT BEEN REPORTED TO OCCUR UNDER NORMAL TEMPERATURES AND PRESSURES.

STORAGE AND DISPOSAL

OBSERVE ALL FEDERAL, STATE AND LOCAL REGULATIONS WHEN STORING OR DISPOSING OF THIS SUBSTANCE. FOR ASSISTANCE, CONTACT THE DISTRICT DIRECTOR OF THE ENVIRONMENTAL PROTECTION AGENCY.

STORAGE

PROTECT AGAINST PHYSICAL DAMAGE. SEPARATE FROM METALLIC POWDERS, CARBIDES, HYDROGEN SULFIDE, TURPENTINE, ORGANIC ACIDS, AND ALL COMBUSTIBLE, ORGANIC OR OTHER READILY OXIDIZABLE MATERIALS. PROVIDE GOOD VENTILATION AND AVOID DIRECT SUNLIGHT (NFPA 49, HAZARDOUS CHEMICALS DATA, 1975).

STORE AWAY FROM INCOMPATIBLE SUBSTANCES.

THRESHOLD PLANNING QUANTITY (TPQ):
THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA) SECTION 302 REQUIRES THAT EACH FACILITY WHERE ANY EXTREMELY HAZARDOUS SUBSTANCE IS PRESENT IN A QUANTITY EQUAL TO OR GREATER THAN THE TPQ ESTABLISHED FOR THAT SUBSTANCE NOTIFY THE STATE EMERGENCY RESPONSE COMMISSION FOR THE STATE IN WHICH IT IS LOCATED. SECTION 303 OF SARA REQUIRES THESE FACILITIES TO PARTICIPATE IN LOCAL EMERGENCY RESPONSE PLANNING (40 CFR 355.30).

DISPOSAL

DISPOSAL MUST BE IN ACCORDANCE WITH STANDARDS APPLICABLE TO GENERATORS OF HAZARDOUS WASTE, 40 CFR 262. EPA HAZARDOUS WASTE NUMBER D002.
100 POUND CERCLA SECTION 103 REPORTABLE QUANTITY.

****

CONDITIONS TO AVOID

DATE: 04/19/91 ACCT: 197095-01
INDEX: 0191107036A CAT NO: A2060212 PO NBR: 02492 014-5355

MAY IGNITE OTHER COMBUSTIBLE MATERIALS (WOOD, PAPER, OIL, ETC.). REACTS VIOLENTLY WITH WATER AND FUELS. FLAMMABLE. POISONOUS GASES MAY ACCUMULATE IN TANKS AND HOPPER CARS. RUNOFF TO SEWER MAY CREATE FIRE OR EXPLOSION HAZARD.

CONSULT NFPA PUBLICATION 43A, STORAGE OF LIQUID AND SOLID OXIDIZING MATERIALS, FOR STORAGE REQUIREMENTS.

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SPILL AND LEAK PROCEDURES

SOIL SPILL:
DIG A HOLDING AREA SUCH AS A PIT, POND OR LAGOON TO CONTAIN SPILL AND DIKE SURFACE FLOW USING BARRIER OF SOIL, SANDBAGS, FOAMED POLYURETHANE OR FOAMED CONCRETE. ABSORB LIQUID MASS WITH FLY ASH OR CEMENT POWDER.

NEUTRALIZE SPILL WITH SLAKED LIME, SODIUM BICARBONATE OR CRUSHED LIMESTONE.

AIR SPILL:
APPLY WATER SPRAY TO KNOCK DOWN AND REDUCE VAPORS. KNOCK-DOWN WATER IS CORROSIVE AND TOXIC AND SHOULD BE DIKED FOR CONTAINMENT AND LATER DISPOSAL.

WATER SPILL:
ADD SUITABLE AGENT TO NEUTRALIZE SPILLED MATERIAL TO PH-7.

OCCUPATIONAL SPILL:
KEEP COMBUSTIBLES (WOOD, PAPER, OIL, ETC.) AWAY FROM SPILLED MATERIAL. DO NOT TOUCH SPILLED MATERIAL. STOP LEAK IF YOU CAN DO IT WITHOUT RISK. USE WATER SPRAY TO REDUCE VAPORS. DO NOT GET WATER INSIDE CONTAINER. FOR SMALL SPILLS, FLUSH AREA WITH FLOODING AMOUNTS OF WATER. FOR LARGER SPILLS, DIKE FAR AHEAD OF SPILL FOR LATER DISPOSAL. KEEP UNNECESSARY PEOPLE AWAY. ISOLATE HAZARD AREA AND DENY ENTRY. VENTILATE CLOSED SPACES BEFORE ENTERING.

REPORTABLE QUANTITY (RQ): 1000 POUNDS
THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA) SECTION 304 REQUIRES THAT A RELEASE EQUAL TO OR GREATER THAN THE REPORTABLE QUANTITY FOR THIS SUBSTANCE BE IMMEDIATELY REPORTED TO THE LOCAL EMERGENCY PLANNING COMMITTEE AND THE STATE EMERGENCY RESPONSE COMMISSION (40 CFR 355.40). IF THE RELEASE OF THIS SUBSTANCE IS REPORTABLE UNDER CERCLA SECTION 103, THE NATIONAL RESPONSE CENTER MUST BE NOTIFIED IMMEDIATELY AT (800) 424-8802 OR (202) 426-2675 IN THE METROPOLITAN WASHINGTON, D.C. AREA (40 CFR 302.6).

PROTECTIVE EQUIPMENT

VENTILATION:
PROVIDE LOCAL EXHAUST VENTILATION SYSTEM TO MEET PUBLISHED EXPOSURE LIMITS.

RESPIRATOR:
THE FOLLOWING RESPIRATORS AND MAXIMUM USE CONCENTRATIONS ARE RECOMMENDATIONS BY THE U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES, NIOSH POCKET GUIDE TO CHEMICAL HAZARDS; NIOSH CRITERIA DOCUMENTS OR BY THE U.S. DEPARTMENT OF LABOR, 29 CFR 1910 SUBPART Z.
THE SPECIFIC RESPIRATOR SELECTED MUST BE BASED ON CONTAMINATION LEVELS FOUND IN THE WORK PLACE, MUST NOT EXCEED THE WORKING LIMITS OF THE RESPIRATOR AND BE JOINTLY APPROVED BY THE NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH AND THE MINE SAFETY AND HEALTH ADMINISTRATION (NIOSH MSHA).

NITRIC ACID:

125 MG/M3- ANY SUPPLIED-AIR RESPIRATOR OPERATED IN A CONTINUOUS-FLOW MODE.

250 MG/M3- ANY SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACEPIECE.
ANY SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE
ANY AIR-PURIFYING FULL FACEPIECE RESPIRATOR (GAS MASK) WITH A CHIN-STYLE OR FRONT- OR BACK-MOUNTED CANISTER PROVIDING PROTECTION AGAINST NITRIC ACID
ANY CHEMICAL CARTRIDGE RESPIRATOR WITH A FULL FACEPIECE AND CARTRIDGE(S) PROVIDING PROTECTION AGAINST NITRIC ACID.

ESCAPE- ANY AIR-PURIFYING FULL FACEPIECE RESPIRATOR (GAS MASK) WITH A CHIN-STYLE OR FRONT-OR BACK-MOUNTED CANISTER PROVIDING PROTECTION AGAINST NITRIC ACID.
ANY APPROPRIATE ESCAPE-TYPE SELF-CONTAINED BREATHING APPARATUS.

NOTE: ONLY NON-OXIDIZABLE SORBENTS ARE ALLOWED (NOT CHARCOAL).

FOR FIREFIGHTING AND OTHER IMMEDIATELY DANGEROUS TO LIFE OR HEALTH CONDITIONS:

ANY SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

ANY SUPPLIED-AIR RESPIRATOR WITH FULL FACEPIECE AND OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE, IN COMBINATION WITH AN AUXILIARY SELF-CONTAINED BREATHING APPARATUS OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

CLOTHING:
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE (IMPERVIOUS) CLOTHING AND EQUIPMENT TO PREVENT ANY POSSIBILITY OF SKIN CONTACT WITH THIS SUBSTANCE.

EXPANDED VERMICULITE - MAGNESIUM ALUMINOSILICATE MINERAL

MATERIAL SAFETY DATA SHEET

DATE PREPARED: 8-15-92

IDENTITY: EXFOLIATED VERMICULITE ORE, MICAFIL, POOL BASE, POOL PROTECTION

CHEMICAL NAME AND FAMILY: EXPANDED VERMICULITE - MAGNESIUM ALUMINOSILICATE MINERAL

FORMULA: $(Mg, Ca, K)\ (Al, Fe, Mg)\ (Si, Al)_4\ O_{10}\ (OH)_2\ H_2O$

CAS: 1318-00-9

SECTION I

KOOS, INC., 4500 13TH COURT, KENOSHA WI 53140
414/654-5301 Emergency No. 800-558-5667

SECTION II HAZARDOUS INGREDIENTS/IDENTITY INFORMATION

Hazardous Components OSHA PEL ACGIH TLV Other Limits Recommended - Does Not Contain Hazardous Components

SECTION III PHYSICAL/CHEMICAL CHARACTERISTICS

Boiling Point N/A
Specific Gravity Exfoliated 0.04 -0.15
Vapor Pressure NONE
Melting Point N/A
Vapor Density NONE
Evaporation Rate N/A
Solubility in water Negligible
Appearance and Odor Free flowing particles, light brown to gray in color - No Odor

SECTION IV FIRE AND EXPLOSION HAZARD DATA

Flash Point NONE
Flammable Limits NONE
LEL & UEL N/A
Extinguishing Media: N/A
Special Fire Fighting Procedures NONE
Unusual Fire and Explosion Hazards NONE

SECTION V REACTIVITY DATA

Stability VERY STABLE
Conditions to Avoid NONE
Incompatibility NONE
Hazardous Decomposition or Byproducts N/A
Hazardous Polymerization Will Not Occur
Conditions to Avoid NONE

SECTION VI HEALTH HAZARD DATA

Routes of entry
Inhalation: Slight
Skin: Negligible
Ingestion: Unlikely
Eye: Unlikely

Health Hazards
Inhalation: May cause coughing. Wear dust mask if particles are airborne.
Skin: Minor irritation
Ingestion: NONE
Eye: Minor temporary irritation

Carcinogenicity:
NTP - Not listed
LARC Monographs - Not listed
OSHA Regulated - No

Signs and Symptoms of Exposure:
Inhalation: Sneezing and coughing
Skin and eye: Minor irritation
Ingestion: Minor distress

Medical Conditions Generally Aggravated by Exposure:
Breathing difficulties can be exaggerated by inhalation of dust.

Emergency and First Aid Procedures: If inhaled get fresh air. If dust in eyes, flush with water to remove or see physician if major irritation. Wash off with soap and water. If ingested drink plenty of fluids.

SECTION VII PRECAUTIONS FOR SAFE HANDLING AND USE

Steps to be taken in case material is released or spilled:
Avoid creating dust. Reuse all material not contaminated.

Waste Disposal Method: Not considered a hazardous material. Dispose according to local, state and federal regulations.

Precautions to be taken in handling or storing: No special conditions necessary for handling or storage. Avoid mechanical damage.

SECTION VIII CONTROL MEASURES

Respiratory Protection: Dust mask as needed
Ventilation: Not required, use if available
Protected Clothing or Equipment:
Gloves: Optional
Eye Protection: Goggles, if needed
Respiratory: Dust mask, if needed
Other: No special clothes

Work/Hygienic Practices: Good hygienic practices

2-PROPANOL
2-PROPANOL
2-PROPANOL

MATERIAL SAFETY DATA SHEET

FISHER SCIENTIFIC
CHEMICAL DIVISION
1 REAGENT LANE
FAIR LAWN NJ 07410
(201) 796-7100

EMERGENCY NUMBER: (201) 796-7100
CHEMTREC ASSISTANCE: (800) 424-9300

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SUBSTANCE IDENTIFICATION

CAS-NUMBER 67-63-0

SUBSTANCE: **2-PROPANOL**

TRADE NAMES/SYNONYMS:
ISOPROPANOL; LUTOSOL; PETROHOL; DIMETHYLCARBINOL; IPA; AVANTIN; PROPAN-2-OL; ALCOSOLVE 2; AVANTINE; ISOPROPYL ALCOHOL; ALCOJEL; ISOHOL; N-PROPAN-2-OL; SEC-PROPYL ALCOHOL; PRO; STCC 4909205; UN 1219; A415; A416; A417; A426; A419; A432; A451; A519; A520; A451SK; A416SK; A426P; C3H8O;

CHEMICAL FAMILY:
HYDROXYL, ALIPHATIC

MOLECULAR FORMULA: C3-H8-O

MOLECULAR WEIGHT: 60.11

CERCLA RATINGS (SCALE 0-3): HEALTH=3 FIRE=3 REACTIVITY=0 PERSISTENCE=0
NFPA RATINGS (SCALE 0-4): HEALTH=1 FIRE=3 REACTIVITY=0

COMPONENTS AND CONTAMINANTS

COMPONENT: 2-PROPANOL PERCENT: 100
CAS# 67-63-0

OTHER CONTAMINANTS: NONE

EXPOSURE LIMITS:
ISOPROPYL ALCOHOL (ISOPROPANOL; 2-PROPANOL):
400 PPM (983 MG/M3) OSHA TWA; 500 PPM (1230 MG/M3) OSHA STEL
400 PPM (983 MG/M3) ACGIH TWA; 500 PPM (1230 MG/M3) ACGIH STEL
400 PPM (983 MG/M3) NIOSH RECOMMENDED TWA;
500 PPM (1230 MG/M3) NIOSH RECOMMENDED STEL
400 PPM (983 MG/M3) DFG MAK TWA;
800 PPM (1966 MG/M3) DFG MAK 30 MINUTE PEAK, AVERAGE VALUE, 4 TIMES/SHIFT

MEASUREMENT METHOD: CHARCOAL TUBE; 2-BUTANOL/CARBON DISULFIDE; GAS CHROMATOGRAPHY WITH FLAME IONIZATION DETECTION; (NIOSH VOL. III # 1400

SUBJECT TO SARA SECTION 313 ANNUAL TOXIC CHEMICAL RELEASE REPORTING

PHYSICAL DATA

DESCRIPTION: TRANSPARENT, COLORLESS, MOBILE LIQUID WITH A CHARACTERISTIC MILD ALCOHOLIC ODOR AND A SLIGHTLY BITTER TASTE. BOILING POINT: 180 F (82 C)

MELTING POINT: -129 F (-89 C) SPECIFIC GRAVITY: 0.785 VOLATILITY: 100%

VAPOR PRESSURE: 40 MMHG @ 23.8 C EVAPORATION RATE: (BUTYL ACETATE=1) 2.88

SOLUBILITY IN WATER: SOLUBLE ODOR THRESHOLD: 50 PPM VAPOR DENSITY: 2.1

SOLVENT SOLUBILITY: SOLUBLE IN ETHANOL, ETHER, CHLOROFORM, ACETONE, BENZENE; INSOLUBLE IN SALT SOLUTIONS.

VISCOSITY: 2.1 CP @ 25 C

FIRE AND EXPLOSION DATA

FIRE AND EXPLOSION HAZARD:
DANGEROUS FIRE HAZARD WHEN EXPOSED TO HEAT OR FLAME.

VAPORS ARE HEAVIER THAN AIR AND MAY TRAVEL A CONSIDERABLE DISTANCE TO A SOURCE OF IGNITION AND FLASH BACK.

VAPOR-AIR MIXTURES ARE EXPLOSIVE ABOVE FLASH POINT.

FLASH POINT: 53 F (12 C) (CC) UPPER EXPLOSIVE LIMIT: 12.7% @ 93 C

LOWER EXPLOSIVE LIMIT: 2.0% AUTOIGNITION TEMP.: 750 F (399 C)

FLAMMABILITY CLASS(OSHA): IB

FIREFIGHTING MEDIA:
DRY CHEMICAL, CARBON DIOXIDE, WATER SPRAY OR ALCOHOL-RESISTANT FOAM (1990 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.5).

FOR LARGER FIRES, USE WATER SPRAY, FOG OR ALCOHOL-RESISTANT FOAM (1990 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.5).

ALCOHOL FOAM
(NFPA 325M, FIRE HAZARD PROPERTIES OF FLAMMABLE LIQUIDS, GASES, AND VOLATILE SOLIDS, 1991).

FIREFIGHTING:
MOVE CONTAINER FROM FIRE AREA IF YOU CAN DO IT WITHOUT RISK. APPLY COOLING WATER TO SIDES OF CONTAINERS THAT ARE EXPOSED TO FLAMES UNTIL WELL AFTER FIRE IS OUT. STAY AWAY FROM ENDS OF TANKS. FOR MASSIVE FIRE IN CARGO AREA, USE UNMANNED HOSE HOLDER OR MONITOR NOZZLES; IF THIS IS IMPOSSIBLE, WITHDRAW FROM AREA AND LET FIRE BURN. WITHDRAW IMMEDIATELY IN CASE OF RISING SOUND FROM VENTING SAFETY DEVICE OR ANY DISCOLORATION OF TANK DUE TO FIRE. ISOLATE FOR 1/2 MILE IN ALL DIRECTIONS IF TANK, RAIL CAR OR TANK TRUCK IS INVOLVED IN FIRE (1990 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.5, GUIDE PAGE 26).

EXTINGUISH ONLY IF FLOW CAN BE STOPPED; USE WATER IN FLOODING AMOUNTS AS FOG, SOLID STREAMS MAY NOT BE EFFECTIVE. COOL CONTAINERS WITH FLOODING QUANTITIES OF WATER, APPLY FROM AS FAR A DISTANCE AS POSSIBLE. AVOID BREATHING TOXIC VAPORS, KEEP UPWIND.

WATER MAY BE INEFFECTIVE (NFPA 325M, FIRE HAZARD PROPERTIES OF FLAMMABLE LIQUIDS, GASES, AND VOLATILE SOLIDS, 1991)

TRANSPORTATION DATA

DEPARTMENT OF TRANSPORTATION HAZARD CLASSIFICATION 49 CFR 172.101:
FLAMMABLE LIQUID

DEPARTMENT OF TRANSPORTATION LABELING REQUIREMENTS 49 CFR 172.101 AND SUBPART E:
FLAMMABLE LIQUID

DEPARTMENT OF TRANSPORTATION PACKAGING REQUIREMENTS: 49 CFR 173.119
EXCEPTIONS: 49 CFR 173.118

TOXICITY

ISOPROPYL ALCOHOL (ISOPROPANOL; 2-PROPANOL):
IRRITATION DATA: 500 MG SKIN-RABBIT MILD; 16 MG EYE-RABBIT; 10 MG EYE-RABBIT MODERATE; 100 MG/24 HOURS EYE-RABBIT MODERATE.
TOXICITY DATA: 12,800 PPM/3 HOURS INHALATION-MOUSE LCLO; 16,000 PPM/4 HOURS INHALATION-RAT LCLO; 12,800 MG/KG SKIN-RABBIT LD50; 5272 MG/KG ORAL-MAN LDLO; 14,432 MG/KG ORAL-MAN TDLO; 3570 MG/KG ORAL-HUMAN LDLO; 223 MG/KG ORAL-HUMAN TDLO; 5045 MG/KG ORAL-RAT LD50; 3600 MG/KG ORAL-MOUSE LD50; 6410 MG/KG ORAL-RABBIT LD50; 1537 MG/KG ORAL-DOG LDLO; 6 MG/KG SUBCUTANEOUS-MAMMAL LDLO; 6 GM/KG SUBCUTANEOUS-MOUSE LDLO; 1088 MG/KG INTRAVENOUS-RAT LD50; 1509 MG/KG INTRAVENOUS-MOUSE LD50; 1184 MG/KG INTRAVENOUS-RABBIT LD50; 1963 MG/KG INTRAVENOUS-CAT LDLO; 1024 MG/KG INTRAVENOUS-DOG LDLO; 2735 MG/KG INTRAPERITONEAL-RAT LD50; 4477 MG/KG INTRAPERITONEAL-MOUSE LD50; 667 MG/KG INTRAPERITONEAL-RABBIT LD50; 2560 MG/KG INTRAPERITONEAL-GUINEA PIG LD50; 3444 MG/KG INTRAPERITONEAL-HAMSTER LD50; 20 GM/KG PARENTERAL-FROG LDLO; 2770 MG/KG UNREPORTED-MAN LDLO; MUTAGENIC DATA (RTECS); REPRODUCTIVE EFFECTS DATA (RTECS).
CARCINOGEN STATUS: HUMAN INADEQUATE EVIDENCE, ANIMAL INADEQUATE EVIDENCE (IARC GROUP-3). STRONG ACID MANUFACTURING PROCESS: HUMAN SUFFICIENT EVIDENCE (IARC GROUP-1). WORKERS INVOLVED IN THE MANUFACTURE OF ISOPROPYL ALCOHOL BY THE STRONG-ACID PROCESS, INVOLVING THE FORMATION OF ISOPROPYL OILS, SHOWED AN INCREASE IN PARANASAL AND LARYNGEAL CANCER.
LOCAL EFFECTS: IRRITANT- INHALATION, EYE.
ACUTE TOXICITY LEVEL: SLIGHTLY TOXIC BY INGESTION, DERMAL ABSORPTION.
TARGET EFFECTS: CENTRAL NERVOUS SYSTEM DEPRESSANT.
AT INCREASED RISK FROM EXPOSURE: PERSONS WITH PRE-EXISTING SKIN DISORDERS; IMPAIRED LIVER, RENAL AND/OR PULMONARY FUNCTION.
ADDITIONAL DATA: POTENTIATES THE EFFECT OF CARBON TETRACHLORIDE AND OTHER HEPATOTOXIC CHLORINATED ALIPHATIC HYDROCARBONS.

HEALTH EFFECTS AND FIRST AID

INHALATION:
ISOPROPYL ALCOHOL (ISOPROPANOL; 2-PROPANOL):
IRRITANT/NARCOTIC. 12,000 PPM IMMEDIATELY DANGEROUS TO LIFE OR HEALTH.
ACUTE EXPOSURE- HUMAN SUBJECTS EXPOSED TO 400 PPM FOR 3-5 MINUTES HAD MILD IRRITATION OF THE NOSE AND THROAT. AT 800 PPM THE IRRITATION WAS NOT SEVERE BUT UNCOMFORTABLE. HIGHER CONCENTRATIONS MAY CAUSE EFFECTS AS DETAILED IN ACUTE INGESTION. THE LENGTH OF TIME REQUIRED TO PRODUCE DEEP NARCOSIS IN ANIMALS WAS INVERSELY PROPORTIONAL TO THE CONCENTRATION: THE ONSET OF DEEP NARCOSIS RANGED FROM 460 MINUTES AT 3250 PPM TO 100 MINUTES AT 24,500 PPM.
CHRONIC EXPOSURE- MICE SUBJECTED TO 10900 PPM ISOPROPYL ALCOHOL IN AIR FOR ABOUT 4 HOURS/DAY UNTIL THEY HAD ACCUMULATED 123 HOURS OF EXPOSURE WERE NARCOTIZED BUT SURVIVED. REVERSIBLE FATTY CHANGES WERE OBSERVED IN THE LIVER. MALE MICE EXPOSED TO EITHER 1000 OR 5000 PPM OF ISOPROPYL ALCOHOL VAPOR FOR 6 HOURS A DAY FOR 9 EXPOSURES EXHIBITED HYALINE DROPLET NEPHROPATHY. REPRODUCTIVE EFFECTS HAVE BEEN REPORTED IN ANIMALS. THERE HAS BEEN AN INCREASED INCIDENCE OF CANCER OF THE PARANASAL SINUSES, AND POSSIBLY OF THE LARYNX, IN THE MANUFACTURE OF ISOPROPYL ALCOHOL BY THE STRONG ACID PROCESS, INVOLVING THE FORMATION OF ISOPROPYL OILS. IT IS NOT CLEAR WHICH SUBSTANCES ARE RESPONSIBLE.

FIRST AID- REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, PERFORM ARTIFICIAL RESPIRATION. KEEP PERSON WARM AND AT REST. TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY.

SKIN CONTACT:
ISOPROPYL ALCOHOL (ISOPROPANOL; 2-PROPANOL):
NARCOTIC.
ACUTE EXPOSURE- CONTACT WITH THE SKIN MAY CAUSE SLIGHT IRRITATION. CONTACT DERMATITIS HAS BEEN REPORTED IN A FEW SENSITIVE INDIVIDUALS. SUBSTANCE MAY BE DERMALLY ABSORBED RESULTING IN SYSTEMIC TOXICITY AS DETAILED IN ACUTE INGESTION. TOXIC EFFECTS MAY BECOME MORE MARKED IF ABSORPTION AND INHALATION OCCUR CONCURRENTLY.
CHRONIC EXPOSURE- REPEATED OR PROLONGED EXPOSURE MAY CAUSE DERMATITIS DUE TO THE DEFATTING ACTION ON THE SKIN. REPEATED AND PROLONGED EXPOSURE TO THE SKIN OF RABBITS CAUSED SLIGHT ERYTHEMA, DRYING, AND SUPERFICIAL DESQUAMATION.

FIRST AID- REMOVE CONTAMINATED CLOTHING AND SHOES IMMEDIATELY. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

EYE CONTACT:
ISOPROPYL ALCOHOL (ISOPROPANOL; 2-PROPANOL):
IRRITANT.
ACUTE EXPOSURE- 400-800 PPM MAY CAUSE IRRITATION. IN RABBIT EYES, A DROP CAUSED MILD TRANSITORY INJURY AND A 50% AQUEOUS SOLUTION AFTER 3 MINUTES CAUSED MODERATE IRRITATION. CONTACT WITH A 70% SOLUTION CAUSED CONJUNCTIVITIS, IRITIS, AND CORNEAL OPACITY.
CHRONIC EXPOSURE- PROLONGED OR REPEATED EXPOSURE TO VAPORS MAY CAUSE CONJUNCTIVITIS.

FIRST AID- WASH EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER OR NORMAL SALINE,

OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

INGESTION:
ISOPROPYL ALCOHOL (ISOPROPANOL; 2-PROPANOL):
NARCOTIC.
ACUTE EXPOSURE- INGESTION MAY CAUSE ABDOMINAL PAIN, HEMATEMESIS, NAUSEA, VOMITING, AND HEMORRHAGE. CENTRAL NERVOUS SYSTEM DEPRESSION MAY OCCUR WITH HEADACHE, DIZZINESS, FLUSHING, INCOORDINATION, STUPOR, CONFUSION, HYPOTENSION, AREFLEXIA, AND REFRACTORY NARCOSIS. OLIGURIA FOLLOWED BY DIURESIS AND COMA MAY ALSO OCCUR. OTHER SYMPTOMS MAY INCLUDE HYPOGLYCEMIA, TENDERNESS AND EDEMA OF MUSCLES, AND ARRHYTHMIAS. VOMITING WITH ASPIRATION MAY CAUSE ASPIRATION PNEUMONIA. DEPRESSED RESPIRATION AND DEATH DUE TO RESPIRATORY PARALYSIS MAY OCCUR IN A FEW HOURS AFTER EXPOSURE. SEVERE AND PROLONGED SHOCK MAY LEAD TO SERIOUS OR FATAL RENAL DAMAGE AFTER SEVERAL DAYS. PATHOLOGIC FINDINGS HAVE INCLUDED EXTENSIVE HEMORRHAGIC TRACHEOBRONCHITIS, BRONCHOPNEUMONIA AND HEMORRHAGIC PULMONARY EDEMA.
CHRONIC EXPOSURE- NO ADVERSE EFFECTS RESULTED IN HUMANS FOLLOWING DAILY INGESTION OF 2.6 AND 6.4 MG/KG FOR 6 WEEKS. RATS THAT INGESTED 0.5 TO 10.0% ISOPROPYL ALCOHOL IN DRINKING WATER FOR 27 WEEKS SHOWED DECREASED BODY WEIGHT. PROLONGED ORAL ADMINISTRATION IN RABBITS PRODUCED ANESTHESIA AND DEATH. REPRODUCTIVE EFFECTS HAVE BEEN REPORTED IN ANIMALS.

FIRST AID- IN RESPIRATORY DEPRESSION, GIVE OXYGEN BY ARTIFICIAL RESPIRATION. GIVE ACTIVATED CHARCOAL. GASTRIC LAVAGE WITH PROTECTED AIRWAY IS USEFUL EVEN IF DELAYED. DO NOT ATTEMPT EMESIS IF RESPIRATION IS DEPRESSED. MAINTAIN BLOOD PRESSURE. TREATMENT SHOULD BE ADMINISTERED BY QUALIFIED MEDICAL PERSONNEL (DREISBACH, HANDBOOK OF POISONING, 12TH ED.). GET MEDICAL ATTENTION.

ANTIDOTE:
NO SPECIFIC ANTIDOTE. TREAT SYMPTOMATICALLY AND SUPPORTIVELY.

REACTIVITY

REACTIVITY:
ISOPROPYL ALCOHOL (ISOPROPANOL; 2-PROPANOL):
STABLE UNDER NORMAL TEMPERATURES AND PRESSURES. MAY SLOWLY PEROXIDISE ON EXPOSURE TO AIR UNDER NORMAL STORAGE CONDITIONS. AN EXPLOSION HAZARD MAY EXIST IF THE SUBSTANCE IS DISTILLED OR ALLOWED TO EVAPORATE TO DRYNESS.

INCOMPATIBILITIES:
ISOPROPYL ALCOHOL (ISOPROPANOL; 2-PROPANOL):
ACIDS: INCOMPATIBLE.
ACIDS ANHYDRIDES: INCOMPATIBLE.
ALUMINUM: DISSOLUTION IS EXOTHERMIC.
BARIUM PERCHLORATE: FORMATION OF EXPLOSIVE COMPOUND.
2-BUTANONE (METHYL ETHYL KETONE): ACCELERATES THE PEROXIDATION OF THE ALCOHOL.
CHROMIUM TRIOXIDE (GRANULAR): IGNITION.
COATINGS: MAY BE ATTACKED.
DIOXYGENYL TETRAFLUOROBORATE: IGNITION AT AMBIENT TEMPERATURES.
HALOGENS: INCOMPATIBLE.
HYDROGEN + PALLADIUM (PARTICLES): IGNITION ON EXPOSURE TO AIR.
HYDROGEN PEROXIDE: FORMATION OF EXPLOSIVE COMPOUND.
KETONES: MARKEDLY INCREASES THE POSSIBILITY OF PEROXIDATION.

NITROFORM (TRINITROMETHANE): DISSOLVES LIBERATING HEAT AND POSSIBLY EXPLODING.
OLEUM: TEMPERATURE AND PRESSURE INCREASE IN CLOSED CONTAINER.
OXIDIZERS (STRONG): FIRE AND EXPLOSION HAZARD.
OXYGEN (GAS): AUTOXIDATION, ON EXPOSURE TO LIGHT, RESULTS IN FORMATION OF KETONES AND POTENTIALLY EXPLOSIVE HYDROGEN PEROXIDE.
PHOSGENE: IN THE PRESENCE OF IRON SALTS, MAY EXPLODE.
PLASTICS: MAY BE ATTACKED.
POTASSIUM TERT-BUTOXIDE: IGNITION.
RUBBER: MAY BE ATTACKED.
SODIUM DICHROMATE + SULFURIC ACID: EXOTHERMIC REACTION WITH POSSIBLE INCANDESCENCE.
SEE ALSO ALCOHOLS.

DECOMPOSITION:
THERMAL DECOMPOSITION PRODUCTS MAY INCLUDE TOXIC OXIDES OF CARBON.

POLYMERIZATION:
HAZARDOUS POLYMERIZATION HAS NOT BEEN REPORTED TO OCCUR UNDER NORMAL TEMPERATURES AND PRESSURES.

STORAGE AND DISPOSAL

OBSERVE ALL FEDERAL, STATE AND LOCAL REGULATIONS WHEN STORING OR DISPOSING OF THIS SUBSTANCE. FOR ASSISTANCE, CONTACT THE DISTRICT DIRECTOR OF THE ENVIRONMENTAL PROTECTION AGENCY.

STORAGE

PRESERVE IN TIGHT CONTAINERS, REMOTE FROM HEAT. (U.S. PHARMACOPEIA, NATIONAL FORMULARY, 1985).

STORE IN ACCORDANCE WITH 29 CFR 1910.106.

BONDING AND GROUNDING: SUBSTANCES WITH LOW ELECTROCONDUCTIVITY, WHICH MAY BE IGNITED BY ELECTROSTATIC SPARKS, SHOULD BE STORED IN CONTAINERS WHICH MEET THE BONDING AND GROUNDING GUIDELINES SPECIFIED IN NFPA 77-1983, RECOMMENDED PRACTICE ON STATIC ELECTRICITY.

STORE AWAY FROM INCOMPATIBLE SUBSTANCES.

DISPOSAL

DISPOSAL MUST BE IN ACCORDANCE WITH STANDARDS APPLICABLE TO GENERATORS OF HAZARDOUS WASTE, 40 CFR 262. EPA HAZARDOUS WASTE NUMBER D001.
100 POUND CERCLA SECTION 103 REPORTABLE QUANTITY.

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CONDITIONS TO AVOID

AVOID CONTACT WITH HEAT, SPARKS, FLAMES, OR OTHER SOURCES OF IGNITION. VAPORS MAY BE EXPLOSIVE AND POISONOUS; DO NOT ALLOW UNNECESSARY PERSONNEL IN AREA. DO NOT OVERHEAT CONTAINERS; CONTAINERS MAY VIOLENTLY RUPTURE AND TRAVEL A CONSIDERABLE DISTANCE IN HEAT OF FIRE.

SPILL AND LEAK PROCEDURES

OCCUPATIONAL SPILL:
SHUT OFF IGNITION SOURCES. STOP LEAK IF YOU CAN DO IT WITHOUT RISK. USE WATER SPRAY TO REDUCE VAPORS. FOR SMALL SPILLS, TAKE UP WITH SAND OR OTHER ABSORBENT MATERIAL AND PLACE INTO CONTAINERS FOR LATER DISPOSAL. FOR LARGER SPILLS, DIKE FAR AHEAD OF SPILL FOR LATER DISPOSAL. NO SMOKING, FLAMES OR FLARES IN HAZARD AREA. KEEP UNNECESSARY PEOPLE AWAY; ISOLATE HAZARD AREA AND DENY ENTRY.

PROTECTIVE EQUIPMENT

VENTILATION:
PROVIDE GENERAL DILUTION VENTILATION TO MEET PUBLISHED EXPOSURE LIMITS. VENTILATION EQUIPMENT MUST BE EXPLOSION-PROOF.

RESPIRATOR:
THE FOLLOWING RESPIRATORS AND MAXIMUM USE CONCENTRATIONS ARE RECOMMENDATIONS BY THE U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES, NIOSH POCKET GUIDE TO CHEMICAL HAZARDS; NIOSH CRITERIA DOCUMENTS OR BY THE U.S. DEPARTMENT OF LABOR, 29 CFR 1910 SUBPART Z.
THE SPECIFIC RESPIRATOR SELECTED MUST BE BASED ON CONTAMINATION LEVELS FOUND IN THE WORK PLACE, MUST NOT EXCEED THE WORKING LIMITS OF THE RESPIRATOR AND BE JOINTLY APPROVED BY THE NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH AND THE MINE SAFETY AND HEALTH ADMINISTRATION (NIOSH-MSHA).

ISOPROPYL ALCOHOL:

1000 PPM- ANY POWERED, AIR-PURIFYING RESPIRATOR WITH ORGANIC VAPOR CARTRIDGE(S).
ANY CHEMICAL CARTRIDGE RESPIRATOR WITH A FULL FACEPIECE AND ORGANIC VAPOR CARTRIDGE(S).

10,000 PPM- ANY SUPPLIED-AIR RESPIRATOR OPERATED IN A CONTINUOUS FLOW MODE.

12,000 PPM- ANY AIR-PURIFYING, FULL-FACEPIECE RESPIRATOR (GAS MASK) WITH A CHIN-STYLE, FRONT- OR BACK-MOUNTED ORGANIC VAPOR CANISTER.
ANY SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACEPIECE.
ANY SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE.

ESCAPE- ANY AIR-PURIFYING, FULL-FACEPIECE RESPIRATOR (GAS MASK) WITH A CHIN-STYLE, FRONT- OR BACK-MOUNTED ORGANIC VAPOR CANISTER.
ANY APPROPRIATE ESCAPE-TYPE, SELF-CONTAINED BREATHING APPARATUS.

FOR FIREFIGHTING AND OTHER IMMEDIATELY DANGEROUS TO LIFE OR HEALTH CONDITIONS:

ANY SELF-CONTAINED BREATHING APPARATUS THAT HAS A FULL FACEPIECE AND IS OPERATED IN A PRESSURE-DEMAND OR OTHER POSITIVE-PRESSURE MODE.

ANY SUPPLIED-AIR RESPIRATOR THAT HAS A FULL FACEPIECE AND IS OPERATED IN A PRESSURE-DEMAND OR OTHER POSITIVE-PRESSURE MODE IN COMBINATION WITH AN AUXILIARY SELF-CONTAINED BREATHING APPARATUS OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE-PRESSURE MODE.

CLOTHING:
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE (IMPERVIOUS) CLOTHING AND EQUIPMENT TO PREVENT REPEATED OR PROLONGED SKIN CONTACT WITH THIS SUBSTANCE.

GLOVES:
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE GLOVES TO PREVENT CONTACT WITH THIS SUBSTANCE.

EYE PROTECTION:
EMPLOYEE MUST WEAR SPLASH-PROOF OR DUST-RESISTANT SAFETY GOGGLES TO PREVENT EYE CONTACT WITH THIS SUBSTANCE.

EMERGENCY EYE WASH: WHERE THERE IS ANY POSSIBILITY THAT AN EMPLOYEE'S EYES MAY BE EXPOSED TO THIS SUBSTANCE, THE EMPLOYER SHOULD PROVIDE AN EYE WASH FOUNTAIN WITHIN THE IMMEDIATE WORK AREA FOR EMERGENCY USE.

AUTHORIZED - FISHER SCIENTIFIC, INC.
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-ADDITIONAL INFORMATION-

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APPENDIX C

DRILLING SAFETY

DRILLING SAFETY

1.1 Basic Requirements

Employees will not proceed with work on, or in the proximity of, hazardous equipment until they have been properly trained and have received a safety briefing. If drilling is at a hazardous substance site, the site-specific safety plan must be reviewed onsite and discussed in the safety briefing.

Potential hazards (e.g., overhead or underground power, oil, or gas lines in the immediate vicinity of the drilling location) must be removed, avoided by relocating the drill site, or adequately barricaded to eliminate the hazard. For this project, NASA personnel will clear all sampling locations for underground and overhead utilities. Sampling sites will be relocated to avoid underground utilities. When approaching and setting up at drilling locations, overhead utilities will be identified and avoided.

The use of unsafe or defective equipment is not permitted. The Dames & Moore site supervisor and/or drilling inspector will regularly inspect all equipment. If equipment is found to be defective, it must be immediately removed from use and either repaired or replaced.

Employees will be familiar with the location of first-aid kits and fire extinguishers. Telephone numbers for emergency assistance must be prominently posted and kept current.

1.2 General Requirements at Drilling Operations

1.2.1 Housekeeping. Good housekeeping conditions shall be observed in and around the work area. Suitable storage places shall be provided for all materials and supplies. Pipe, drill rods, etc., must be securely stacked on solid, level sills.

Work surfaces, platforms, stairways, walkways, scaffolding, and access ways will be kept free of obstructions. All debris will be collected and stored in piles or containers

for removal and disposal.

1.2.2 Flammable Liquids. All highly flammable liquids shall be stored and handled only in approved containers. Portable containers must be the approved red safety containers equipped with flame arresters and self-closing lids.

Approved hand pumps will be used to dispense gasoline from barrels. Gasoline must not be used for degreasing or to start fires. Also, gasoline containers shall be clearly labeled, and storage areas shall be posted with "No Smoking" signs. Fire extinguishers shall be installed in all areas that contain flammable liquids.

1.2.3 Public Safety. Work areas will be regulated so that the public will be protected from injury or accident. Adequate danger signs, barriers, etc., will be placed to effectively warn the public of hazards as well as to restrict access to dangerous areas.

1.3 Off-Road Movement of Drill Rigs

The following rules apply to the off-road movement of drill rigs:

- Before moving a drill rig, an inspection shall be made of the route of travel for depressions, slumps, gullies, ruts, and similar obstacles.

- The brakes of a drill rig carrier shall always be checked before traveling, particularly on rough, uneven, or hilly ground.

- All passengers shall be discharged before a drill rig is moved on rough or hilly terrain.

- The front axle of 4 x 4 or 6 x 6 vehicles or carriers shall be engaged when traveling off-road on hilly terrain.

- Caution shall be used when traveling on a hillside. The hillside capability of drill rigs shall be evaluated conservatively, because the addition of drilling tools may raise the center of mass. When possible, travel shall be made directly uphill or downhill.

- Obstacles such as small logs, small erosion channels, or ditches shall be crossed squarely, not at an angle.

- When lateral or overhead clearance is close, someone on the ground shall act as a guide.

- After the drill rig has been moved to a new drilling site, all brakes or locks shall be set. Wheels shall be blocked on steep grades.

- The mast (derrick) of the drill rig shall not be in the raised or partially raised position during off-road travel.

- Loads on the drill rig and supporting trucks shall be tied down during transport.

1.4 Drilling Equipment

1.4.1 Skid-Mounted Units. Labels clearly indicating the function and direction of control levers shall be posted on the lower unit controls of all drills.

An emergency safety power shutoff device shall be installed within reach of the operator on all units. The device shall be clearly labeled or otherwise made readily identifiable and checked daily to ensure that it is operable. The power unit shall be operated only by authorized and qualified personnel.

Equipment will be shut down during manual lubrication and while repairs or adjustments are being made. Equipment such as internal combustion engines will not be refueled while running. Where practical, the gasoline tank shall be positioned or shielded to

avoid accidental spillage of fuel on the engine or exhaust manifold during refueling operations. Hazardous gears and moving parts also shall be shielded to prevent accidental contact.

A dry chemical or carbon dioxide fire extinguisher, rated 5 pounds or larger, shall be carried on the unit and removed to a position within 25 feet of the work site during drilling operations. Extinguishers will be inspected prior to the commencement of field work and at 1 month intervals thereafter until field work is completed.

Engine exhaust systems shall be equipped with spark arresters when operated in areas where sparks constitute a fire hazard.

1.4.2 Overhead and Underground Utilities. Special precaution must be taken when using a drill rig on a site within the vicinity of electrical power lines and other utilities. Electricity can shock, burn, and cause death. When overhead electrical power lines exist at or near a drilling site, all wires shall be considered dangerous.

A check shall be made for sagging power lines before a site is entered. Power lines shall not be lifted to gain entrance. The appropriate utility company shall be contacted and a request shall be made that it lift or raise and cut off power to the lines.

The area around the drill rig shall be inspected before the drill rig mast (derrick) is raised at a site in the vicinity of power lines. The minimum distance from any point on the drill rig to the nearest power line shall be determined when the mast is raised or is being raised. The mast shall not be raised and the drill rig shall not be operated if this distance is less than 20 feet, because hoist lines and overhead power lines can be moved toward each other by the wind.

NASA personnel will clear all sampling locations for underground and overhead utilities. Sampling sites will be relocated to avoid underground utilities. When approaching and setting up at drilling locations, overhead utilities will be identified and avoided.

If a sign warning of underground utilities is located on a site boundary, it shall not be assumed that underground utilities are located on or near the boundary or property line under the sign; they may be a considerable distance from the sign. The utility company shall be contacted to check it out.

The owners of utility lines or the nearest underground utility location service shall always be contacted before drilling is started. However, remember that some services provide information on utilities going to, but not within, a site. Metal detectors or other locating equipment may be necessary to determine the presence of shallow (surface) utilities onsite. The utility personnel shall mark or flag the location of the underground lines and determine what specific precautions must be taken to ensure safety.

1.4.3 Site Selection and Working Platforms. In preparing a work site located on adverse topography, precautions must be taken against cave-ins, slides, and loose boulders. The drill platform shall be stabilized by outriggers or adequate timbering.

Prior to drilling, adequate site clearing and leveling shall be performed to accommodate the drill rig and supplies and to provide a safe working area. Drilling shall not commence when tree limbs, unstable ground, or site obstructions result in unsafe tool-handling conditions.

Suitable storage locations shall be provided that allow for the convenient handling of tools, materials, and supplies without danger that they could fall and injure anyone. Storing or transporting tools, materials, or supplies within or on the drilling mast (derrick) shall be avoided. Pipes, drill rods, bits, casings, augers, and similar drilling tools shall be securely stacked in an orderly manner on racks or sills.

Penetration hammers or other types of driving hammers shall be placed at a safe location on the ground or secured when unattended on a platform. Work areas, platforms, walkways, scaffolding, and other access ways shall be kept free of obstructions and substances such as ice, grease, or oil that could create a hazardous surface. All controls, control linkages, and warning and operation lights and lenses also shall be kept free of ice, grease, or oil.

In the vicinity of power transmission or distribution lines, drills shall be adequately grounded and set with at least a 15-foot clearance between any part of the drill or mast and the power lines.

Toilet facilities will be convenient to drill crews, or transportation will be readily available to nearby toilet facilities. Toilets will be either the chemical type or constructed over ground pits, which will be backfilled when abandoned. They shall be fly tight and maintained in a sanitary condition.

Mud pits and drainage excavations shall be safely sloped and located to provide minimum interference with work. Where necessary, suitable barricades, catwalks, etc., shall be provided to reduce the possibility of personal injury. Ladders will be positioned in pits or excavations that are 5 or more feet deep. Such excavations shall be periodically inspected to ensure safe operation and adequate maintenance.

Truck-mounted drills will be equipped with a "safety line" or with clearly marked and conspicuously located emergency switches. The safety line emergency stop consists of a taut wire that runs around the back of the machine and connects to a special switch that turns off the power unit when the line is contacted. When emergency switches are used in lieu of a safety line, there shall be a minimum of two switches--one located within easy reach of the operator, and one located within easy reach of workers at ground level near the drill or auger head.

Trucks shall not be moved backward unless the driver has personally inspected the area behind the truck. In restricted or congested areas, or areas where workmen are located, the assistance of a "spotter" is mandatory. Also, trucks will be equipped with serviceable automatic backup alarms.

Before the mast is raised, personnel will be cleared from the immediate area--with the exception of the operator and a helper, when necessary. A check shall be made to ensure safe clearance from energized power lines or equipment. Unsecured equipment must be removed from the mast, and cables, mud lines, and catline ropes must be adequately secured to the mast before raising. After it is raised, the mast must be secured to the rig in an upright position with steel pins.

Drill equipment will not be moved until a thorough inspection has been made to ensure that the mast, drill rods, tools, and other equipment are secured. A check will also be made of the steering mechanism, brakes, lights, load limits, and proper flagging and lighting of load extensions. Applicable traffic laws will be observed when moving drill equipment over public roads.

1.5 Surface Drilling Operations

Before the mast of a drill rig is raised and drilling is commenced, the drill rig must first be leveled and stabilized with leveling jacks and/or solid cribbing. The drill rig shall be re-leveled if it settles after the initial setup. The mast shall only be lowered when the leveling jacks are down, and the leveling jack pads shall not be raised until the mast is completely lowered. Before drilling operations start, the mast shall be secured or locked, if required by the drill's manufacturer.

Before the power unit is started, all gears shall be disengaged, the cable drum brake shall be set, and no rope shall be in contact with the cathead.

Before the mast is raised, a check shall be made for overhead obstructions. Everyone (with the exception of the operator) shall be cleared from the areas immediately to the rear and sides of the mast and informed that the mast is being raised. The drill rig shall not be driven from hole to hole with the mast in the raised position.

The drill rig shall only be operated from the position of the controls. The operator shall shut down the drill engine before leaving the vicinity of the drill. "Horsing around" in the vicinity of the drill rig and tool and supply storage areas is strictly prohibited, even when the drill rig is shut down. Caution shall be taken when mounting/dismounting the platform.

Drill operations shall be terminated during an electrical storm.

The consumption of alcoholic beverages, depressants, stimulants, or any other chemical substance while on the job is strictly prohibited. All unattended boreholes must be

adequately covered or protected to prevent people or animals from stepping or falling into the hole. When the drilling project has been completed, all open boreholes shall be adequately covered, protected, or backfilled, according to local or state regulations.

A safety chain and cable arrangement shall be used to prevent water swivel and mud line whip. All water swivels and hoisting plugs shall be checked for possible frozen bearings and shall be properly lubricated before use. A frozen bearing could cause mud line whip, which could injure the operator.

Only drill operators shall brake or set the chucks to prevent engagement of the transmission prior to removal of the chuck wrench. Also, the chuck jaws shall be periodically checked and replaced as necessary.

A string of drill rods shall not be braked by the chuck jaws during lowering into the hole. A catline or hoisting cable and plug shall be used for braking prior to tightening of the chuck. Failure to follow this procedure could result in steel slivers on the rods, possible hand injuries, and loss of the rods into the hole. Following braking, drill rods shall be allowed to drain completely before removal from the working area.

Drill rods will not be lowered into the hole with a pipe wrench. Serious back and hand injuries may result if the rods are lowered by this method.

When using drilling fluids, a rubber or other suitable wiper shall be used to remove the material from the drill rods when removing them from the drill hole. When drilling with air, the exhaust and cuttings shall be directed away from workers with devices such as diverter heads, the use of which shall be stipulated on drilling agreements where appropriate.

Care must be exercised by the operator to avoid a sudden hoist release of the drill rod while the rod is being carried from the hole. The hoisting capacity and weight of the drill rod must be known to prevent collapse of the mast during drill string removal from the hole. The operating capacity of the mast and hoist also must be known and must not be exceeded.

When tool joints are broken on the ground or on a drilling platform, fingers shall be positioned so they will not be caught between the wrench handle and the ground or the platform if the wrench slips or the joint suddenly lets go. Pipe wrench jaws shall be checked periodically and replaced as they become worn.

1.6 Use of Augers

The use of mismatched auger sections shall be avoided. Different brands and different weights shall not be used in the same auger flight.

Because some pins lose their temper after very little use, causing the spring or clip section to fail, only tight-fitting pins designed for the auger shall be used.

A daily inspection--to include a thorough check of the hydraulic hoses, connections, and valves--will be made before equipment is used. Deficiencies shall be corrected or safe condition verified before the equipment is started.

A durable sign containing the following wording shall be installed on all equipment in full view of the operator:

- All personnel must be clear before starting this machine
- Stop the auger to clean it
- Stop engine when repairing, lubricating, or refueling
- Do not wear loose-fitting clothing or gauntlet-type gloves.

The following general procedures shall be used when advancing a boring with continuous flight or hollow stem augers:

- An auger boring shall be started with the drill rig level, the clutch or hydraulic rotation control disengaged, the transmission in low gear, and the engine running at low revolutions per minute (rpm).

- A system of responsibility shall be established for the series of activities required for auger drilling, such as connecting or disconnecting auger sections and inserting or removing the auger fork. The operator must be sure that the tool handler is well away from the auger column and that the auger fork has been removed before rotation is started.

- Only the manufacturer's recommended method of securing the auger to the power coupling shall be used. The coupling or the auger shall not be touched with the hands, a wrench, or any other tool during rotation.

- Tool hoists shall be used to handle auger sections whenever possible. Hands or fingers shall never be placed under the bottom of an auger section when the auger is being hoisted over the top of the auger section in the ground or other hard surface, such as the drill rig platform. Feet shall never be allowed to get under the auger section that is being hoisted.

- Workers shall stay clear of the auger and other rotating components of the drill rig. Workers shall never reach behind or around a rotating auger for any reason.

- Hands or feet shall never be used to remove cuttings from the auger.

- Augers shall be cleaned only when the drill rig is in neutral and the augers have stopped rotating. A special paddle shall be designed for cleaning auger flights; if available, pressurized water is recommended for jet cleaning.

1.7 Use of Hand Tools and Portable Power Tools

Hand tools shall be kept in good repair and used only for their designed purposes. Proper protective eye wear shall be worn when using hand tools and portable power tools. Unguarded sharp-edged or pointed tools will not be carried in employees'

pockets.

The use of tools with mushroomed heads, split or defective handles, worn parts, or other defects will not be permitted. Tools that have become unsafe will be reconditioned before reissue or discarded.

Throwing or dropping of tools from one level to another will not be permitted; rather, containers and hand lines shall be used for transporting tools from one level to another.

Non-sparking tools will be used in atmospheres where sources of ignition may cause fire or explosion.

Electric-powered shop and hand tools will be of the double-insulated, shock-proof type or be effectively grounded. Power tools shall be operated only by designated employees who are familiar with their use.

Portable grinding tools will not be used without properly installed safety guards. Guards and tool rests shall be maintained in proper adjustment. Grinding wheels shall not be operated at speeds in excess of the manufacturer's safe ratings. Cracked or defective wheels will not be used.

Portable circular saws shall be equipped with guards that automatically enclose the cutting edges. Cracked or defective blades will not be used. Also, power saws will not be left running when unattended.

Portable pneumatic tools shall be inspected periodically to ensure good mechanical condition. Pneumatic impact tools will be operated with safety clips or retainers installed to prevent the tools from accidentally being discharged from the chuck. Air hoses shall not be disconnected from equipment until the pressure has been shut off and exhausted from the line. Safety lashing will be provided at all hose and tool connections on air lines over 0.5 inch in diameter. Leaking or defective hoses shall be replaced.

When not in use, tools will not be left on scaffolds, ladders, or overhead working spaces. Containers shall be provided to hold tools and prevent them from falling.

1.8 Use of Ropes, Chains, and Accessories

The use of ropes and chains will be governed by the instructions on usage and safety limits as recommended by the manufacturer. Ropes and chains shall be inspected before use, and their loading shall not exceed the manufacturer's safety limits.

Hooks used in hoisting personnel or in hoisting loads over or in the immediate vicinity of workers shall be made of forged steel and equipped with safety keepers. When shackles are used under these conditions, they shall be of the locking type or the pin shall be secured to prohibit turning.

Load-lifting accessories, such as sheaves, shackles, hooks, headache balls, etc., shall be obtained from a reputable manufacturer. The use of job-fabricated lifting accessories is expressly prohibited. Load-lifting accessories that show excessive wear or have been bent, twisted, or otherwise damaged will be removed from service.

1.8.1 Slings. When in use, slings shall be inspected daily for signs of overloading, excessive wear, or damage. Defective slings shall be removed from service and repaired or replaced before reuse.

Proper storage shall be provided for slings to prevent any damage that would impair their strength. They shall be protected from sharp, rough, or square corners to prevent cutting or breaking of fibers, strands, or chain links.

1.8.2 Wire Rope. The safe performance of wire rope or cables can be ensured by rigid periodic inspection and by proper use and care.

The maximum allowable load for wire hoisting rope must not exceed the safe working load prescribed by the manufacturer or the ultimate strength of the rope divided by the safety factor. Commercial end-fastenings, clips, and zinc sockets must be properly applied to develop maximum strength. Wire rope shall be removed from hoisting or load-carrying service when kinked or when any one of the following conditions is observed:

- The existence of 12 randomly distributed broken wires in one rope lay, or four broken wires in a single strand in one rope lay.
- Evidence of corrosion or heat damage.
- One broken wire, rust, or corrosion adjacent to a socket or end-fitting (this requires removal from service or re-socketing).
- Distortion, stretching, elongation, or abnormal reduction in diameter.

Wire rope found to be defective for hoisting or load-carrying shall be plainly marked as being unfit for such use.

Running lines of hoisting equipment located within 8 feet of the ground or working level will be guarded; or access to the operating area can be restricted.

Rope clips attached with U-bolts shall have the U-bolts on the dead end of the rope. When a wedge-socket fastening is used, the dead or short end of the cable shall be clipped to the live cable with a U-bolt or another approved fastener.

1.8.3 Fiber and Synthetic-Fiber Rope. In selecting fiber and synthetic-fiber ropes for load-carrying purposes, only the best quality rope shall be used, with size and application in accordance with the manufacturer's recommendations. These ropes shall be inspected frequently to ensure safe performance.

Proper care must be given to ropes to maintain good condition and high strength capacity. Fiber ropes shall not be allowed to freeze after becoming wet, but shall be cleaned carefully and dried in loose coils. Ropes shall not be stored close to cement, lime, acids, or alkalies. Ropes that have been exposed to these materials shall be removed from service.

1.8.4 Chains. Extreme care is necessary in the use and maintenance of all load-carrying chains. They shall be inspected by a competent person after each installation and regularly thereafter. Chains must not be subjected to a load greater than their rated safe loading, which is determined from capacity tables issued by the chain manufacturer.

Splicing broken chains by inserting a bolt between two links with the heads of the bolt and the nut sustaining the load, or by passing one link through another and inserting a bolt or a nail to hold it, is prohibited.

1.8.5 Hoists. If a ball-bearing type hoisting swivel is used to hoist drill rods, swivel bearings shall be inspected and lubricated on a daily basis to ensure that the swivel freely rotates under load. If a rod-slipping device is used to hoist drill rods, the drill rods shall not be drilled or rotated through the slipping device. No more than 1 foot (0.3 meter) of the drill rod column shall be hoisted above the top of the mast (derrick). A rod column with loose tool joints shall not be hoisted while the rod column is being supported by a slipping device. If drill rods slip back into the bore-hole, an attempt shall not be made to break the fall of the rods with your hands.

Most sheaves on drill rigs are stationary, with a single-part line. The manufacturer of the drill rig shall be consulted before the number of line parts is increased. Wire ropes must be properly matched with each sheave.

Tool handling hoists shall only be used for vertical lifting of tools (except when angle hole drilling). Tool handling hoists shall not be used to pull on objects away from the drill rig; however, drills may be moved by using the main hoist as the wire rope is

spooled through proper sheaves, according to the manufacturer's recommendations.

When tools or similar loads cannot be raised with a hoist, the hoist line shall be disconnected and the tools connected directly to the feed mechanism of the drill. Hydraulic leveling jacks shall not be used for added pull to the hoist line or the feed mechanism of the drill.

When attempting to pull out a mired vehicle or drill rig carrier, only a winch on the front or rear of the vehicle or drill rig carrier shall be used and workers shall stay as far away as possible from the wire rope. Tool hoists shall not be used to pull out a mired vehicle or a drill rig carrier. The following rules also apply:

- The shock loading of a wire rope can be minimized by smooth and steady application of loads.
- Wire rope shall be protected from sharp corners or edges.
- Clutches and brakes of hoists shall be periodically inspected and tested.
- Gloves shall always be worn when handling wire ropes.
- Following the installation of a new wire rope, a light load shall be lifted first to allow the wire rope to adjust.
- A load shall never be hoisted over someone's head, body, or feet, or left suspended in the air when the hoist is unattended.
- Hands shall be kept away from hoists, wire rope, hoisting hooks, sheaves, and pinch point when the slack is being taken up, and when the load is being hoisted. Hands shall not be used to guide wire ropes on hoist drums.

Construction Schedule

As indicated in the attached application form (ADEM-110), initial construction of the thermal oxidizer system is expected to be completed by July 1995 (assuming that a permit will be received from ADEM by the end of December 1994). This initial construction will not include tie-ins for gas streams affected by the Cluster Rule. When the Cluster Rule is promulgated, additional gas stream connections will be added to the thermal oxidizer system as required. The system is being sized to handle these additional gas streams, as previously mentioned.

APPENDIX D

BOATING SAFETY FROM DAMES & MOORE, INC. HEALTH AND SAFETY MANUAL

DAMES & MOORE Firmwide **Health and Safety** Program and Procedure Manual	Procedure No.: HS 290 Date: July 1, 1990 Supercedes: Approved: Gary R. Krieger MD GARY R. KRIEGER, MD
Subject: BOATING SAFETY	

General Operating Requirements

The following general operating requirements pertain to all Dames & Moore boating operations, regardless of size or extent. A copy of this Procedure must be available on every vessel used by Dames & Moore personnel.

The boat operator is responsible for the safety of all persons and equipment on board and the operator must provide a safety briefing for all occupants of the boat prior to leaving the doc, pad, etc. Boat operators must complete emergency first-aid training.

Boats are not to be boarded by unauthorized or non-essential persons (e.g., family, dependents, or friends).

For extensive boating operations, the employee in charge should have taken the U.S. Coast Guard Boating Skills and Seamanship course or its equivalent.

Personal gear should include shoes or boots with anti-skid soles and footwear suitable for any sampling or other work done outside the boat. Water repellent clothing and sufficient warm clothing should be taken along on the boat, and a change of dry clothing is often needed.

Boat operators shall initiate operations on the ocean, estuaries, large lakes and large rivers only after acquiring a current and reliable weather forecast. Common sense must prevail. When in doubt, the safer course of action is required.

Auxiliary fuel should be stored in safety cans and secured to prevent spillage, away from sources of heat and sparks.

Boats must be equipped with non-slip floorboards. Employees must wear non-skid, soft-soled footwear while on board.

Excess equipment is to be minimized and that which remains on board should be stowed in such a way that walkways are kept clear and fire hazards are avoided.

The load-carrying capacity of the boat should not be exceeded. If rough weather is expected, the boat should be loaded more lightly to let it ride higher and make it less likely to be swamped by waves. If samples are to be collected, their estimated weight should be included in the total weightload.

To load capacity can be found on a plate mounted in the boat, and a certificate of compliance for an outboard motorboat shows the manufacturer's rating of maximum horsepower of an engine that can be safely used on the boat. A combination capacity plate will also list the maximum number of persons and the weight of persons that can be carried safely, as well as the maximum total weight (of persons, motor, and gear) which can be carried safely by the boat.

Subject: BOATING SAFETY: REQUIRED EQUIPMENT

Every motorboat shall have a fire extinguisher approved for fighting electrical fires or burning liquids (e.g., gasoline fires). A 2.5 pound dry chemical extinguisher will satisfy the requirement, but a 6 pound dry chemical extinguisher will offer a greater chance of putting out a liquid fuel fire. The fire extinguisher should be located convenient to the fueling area to put out spill fires.

All boats operated in estuaries or open seas should be equipped with two-way radios adequate to communicate with at least one shore station. Boats with marine radios will monitor a distress frequency when not transmitting.

Boats from 16 to 26 feet long must carry an audible signal, such as a whistle or horn, that can be heard for at least a half mile. A police whistle will meet this requirement. Boats from 26 to 40 feet long must carry a bell for use in fog, and a whistle or horn that can be heard for at least a mile. The whistle or horn can be operated by hand or power. Boats over 40 feet long must have a power-operated whistle or horn. The signaling devices should be used in fog, or in any other weather condition that obscures normal visibility. (See "Fog Signals" in HS 290.3).

Boats with enclosed spaces where spilled fuel or fuel vapors can accumulate must have powered ventilation to clear away the fuel vapors. This requirement does not normally apply to open boats.

All passengers must wear life jackets, although divers are permitted to wear wet suits in lieu of life jackets. Boats must also carry at least one towable flotation device.

Although floatation devices Types I, II, III, IV, and V are approved, only Types I and V are designed to save an unconscious person from drowning because they will turn an unconscious person from a face-down position in the water. The Type I device provides maximum flotation, and thus maximum protection in rough water. The Type V device is designed for work activities. Float coats or exposure suits, approved by the Coast Guard, are recommended for cold water operation. Wet suits can also be used, preferably with an additional flotation device.

First aid kits must be on board all boats during operation.

Visual distress signaling devices are required in boats 16 feet or longer, and are strongly recommended for any boat that may need a distress signal in any foreseeable circumstance.

- Non-pyrotechnic devices include a special flag (for daytime use) and a special electric signal that flashes SOS signals four to six times a minute, for night use. These devices do not set spilled fuel afire if they are accidentally activated.

- Pyrotechnic devices, common on larger boats, include hand-held orange smoke signals, floating orange smoke distress signals that last 5 to 15 minutes, hand-held red flares, and pistol-launched parachute red flares. Rocket propelled flares are also available for night use. Pyrotechnic devices should be replaced 42 months after the date of the manufacture.

Specified lights are required on any boat that is out on the water after dark. Boats at anchor must show an anchor light: a white light, visible in all directions for a least one mile. Vessels under way must show at least three lights:

- A white light visible for two miles, in all directions; two white lights are required in international waters, and many boats will show two (or more) white lights regularly.

- A green light, visible from ahead through an arc of 112.5° on the starboard (right) side of your boat. That 112.5° arc marks the zone in which your boat must yield the right of way to other vessels; any vessel that can see your green light has the right of way over your boat.

- A red light, visible from ahead through an arc of 112.5° on the port (left) side of your boat. Boats that can see your red light should yield the right of way to you.

Recommended additional equipment includes: a recent chart (or charts) of the area in which you will be boating, a compass, paddles of oars, a boat hook, and a bailing bucket or bilge pump. It is also prudent to carry an anchor (and anchor rope), food and water, a flashlight, tools and spare parts.

DAMES & MOORE Firmwide **Health and Safety** Program and Procedure Manual	Procedure No.: HS 290.2 Date: July 1, 1990 Supercedes: Approved: Gary R. Krieger MD GARY R. KRIEGER, MD
Subject: BOATING SAFETY: PREPARATION AND FUELING	

Preparation for Boating

The weather forecast should be obtained prior to each trip, charts should be reviewed and routes planned; and gear should be loaded so that it will not roll or slide when the boat rocks or tosses.

If the weather forecast is somewhat unfavorable, the boat should be loaded lightly so that it will float high in the water. If a storm is predicted, the trip should be postponed.

If the course takes the boat out of sight of land, at least one person aboard should know how to navigate. At least two people should know how to read charts and locate sandbars, shallows, rocks, rapids, etc.

The Coast Guard recommends that a "Float Plan" be filed with someone who can request a search if the boat does not return as expected. The float plan should give a detailed description of the boat and its planned course, to aid in a search. It should list the people aboard, the type and frequencies of the emergency radio, and the names and phone numbers of the Coast Guard or other personnel who should be notified if the vessel fails to return as expected.

Before a boat is taken out for a trip, it should be inspected to assure that everything works, that lights and motor are likely to continue working, and that tools and spare parts are adequate and accessible.

Safety Rules for Fueling

Complete fueling prior to the onset of darkness, except in emergencies or at well-lighted marinas.

Whenever a boat is moored at a fueling dock, do not smoke, strike matches or throw switches. All engines, motors, fans and devices that can produce sparks must be stopped. Lights on the boat and heating devices must be turned off and all other sources of ignition kept away from fuel vapors.

Before initiating fueling operations, the boat must be securely moored. Conditions of fuel-tank vents, connections, and flame screens must be checked.

During fueling, the nozzle must be kept in contact with the fill opening to prevent static sparks.

After fueling, fill openings are to be closed immediately. Spilled fuel must be cleaned up; all hatches, windows, doors, and covers are to be opened for 5 minutes to ensure adequate ventilation. The operator must ascertain that no gasoline odor is present in the boat prior to initiating starting procedures.

If the boat is equipped with exhaust blowers, they should be operated for at least 5 minutes before starting an engine.

Exhaust blowers are not substitutes for seaworthy fuel systems. Leaks in tanks and fuel lines must be corrected immediately upon discovery.

Use the special ventilation equipment required for inboard engines.

Portable fuel tanks should be filled outside the boat (i.e., on the dock or at another location) never in the boat, to prevent fuel spillage in the boat.

Sailboats have the right-of-way over power boats. Always yield to large ships.

Navigational charts will show the location of storm warning display stations, and your radio will carry weather bulletins.

- A small craft warning means winds may reach 38 mph (33 knots), a condition dangerous for boats generally used by Dames & Moore. A triangular red pennant, displayed at a storm warning display station, signals a small craft warning. Two triangular red flags signal a gale warning, with winds from 39 to 54 mph (34 to 47 knots); a single square red flag with a black center signals a storm warning, with winds of 55 to 73 mph (48 to 63 knots); and two square red flags with black centers signal a hurricane or tropical cyclone, with winds in excess of 74 mph (63 knots).

The person in command of the boat is expected to know the rules for operation and navigation, local regulations, and rules of the road. The rules of the road cover three topics: lights, signals used to identify course and position in fog, and action to avoid collision with other vessels. Lights are covered in HS 290.1, "Required Equipment."

Fog signals are required if visibility is obscured -- day or night, by mist, fog, rain or snow -- in order to avoid collisions. Power vessel must sound one prolonged blast on the whistle, at least every minute. A vessel anchored outside a designated anchorage must ring its bell, or sound its horn or whistle, rapidly for five seconds, at least once each minute. Towing vessels underway must sound a series of three blasts (one long and two short blasts) in succession, once each minute.

The vessel that has the right-of-way is called the "Stand-On vessel" (formerly, the "privileged vessel"). The Stand-On vessel has a right to maintain its course and speed. It is also a duty to maintain course and speed so that the other vessel can base its action on known conditions; however, if a collision should become imminent, the Stand-On vessel no longer has the right-of-way or any other privilege.

The vessel that does not have the right-of-way is the "Give-Way vessel" (formerly, the "burdened vessel"). When the Give-Way vessel approaches another closely enough to create a possibility of collision, the Give-Way vessel must slow, turn or take other positive action to keep out of the way.

- In a meeting situation, two vessels are approaching head-on or nearly so, and neither has the right-of-way. Both must alter course to starboard right so that they will pass to port (left side to left side). A vessel will signal its intent to alter course to the starboard with a "course indication signal" of one or two short blasts of a whistle or horn. The other vessel will return the same signal to indicate understanding and agreement, or will signal four short blasts (danger signal) to indicate its lack of understanding or agreement. (In International Waters, no response is required, and the danger signal is five short blasts.)

- In a crossing situation, when two vessels approach at an angle, the vessel on the right (starboard) has the right-of-way. Your vessel must give way to any vessel that approaches from the 112.5° arc in which your vessel shows its green light at night. The Give-Way vessel must slow or alter course to avoid a collisions. The Stand-On vessel should maintain course and speed.

- In an overtaking situation, the overtaking vessel is burdened; it must give way until the overtaken vessel has been passed safely. If the overtaking vessel wishes to alter course and pass to the starboard of the overtaken vessel, the overtaking (Give-Way) vessel should give one short signal of whistle or horn. The signal to pass on the port side is two short blasts of whistle or horn. The overtaken (Stand-On) vessel must signal agreement (one or two short blasts) or disagreement (four short blasts).

If you see only the (rear) white light of another vessel at night, you are overtaking that vessel and must follow the rules for overtaking. In a narrow channel, your boat should keep to the right side of the channel. When you near a bend, signal to any vessel that may be out of sight by giving a long (four to six seconds) warning blast on a whistle or horn. A small vessel must yield the right-of-way to large, deep draft ships that may not be able to maneuver or stop quickly.

In general, right-of-way must be given to sailing vessels, fishing vessels, working vessels and very large vessels.

Navigation aids, on navigable waters of the United States, consist of markers, buoys, and lights. The mark channels and constructions, provide direction, and show exact position.

The basic system uses red, triangular buoys or markers, with even numbers, to mark the right side of the channel when the vessel is moving upstream, against the current, returning from the sea ("red light returning"). The other side of the channel (on your starboard side going downstream) is marked with black, rectangular buoys or markers, with odd numbers. In the Great Lakes region, going west, or to the source of the lakes, corresponds to going upstream from the sea. On the Intracoastal Waterway and in coastal waters, "upstream" is marked from New Jersey going south to Florida and west to Texas. On the Pacific Coast, "upstream" is from California to Alaska.

On the Intracoastal Waterway, buoys and markers are marked with a yellow band, strip, square or triangle. The yellow band or square identifies the buoy as being on the Intracoastal Waterway.

Regulatory markers may provide information or give a warning (e.g., a boat speed restriction).

Lightships or Texas Towers provide warning and guidance in waters that are too deep for other navigation aids. A Texas Tower is a large navigational buoy that has primary and standby generators to operate a high intensity light, a radio beacon, and a fog signal. It also monitors meteorological conditions, air and water temperature, wind speed and direction, and other data. Texas Towers are replacing lighthouses at major harbor entrances.

DAMES & MOORE **Firmwide** **Health and Safety** **Program and Procedure Manual**	Procedure No.: HS 290.4 Date: July 1, 1990 Supercedes: Approved: Gary R. Krieger MD GARY R. KRIEGER, MD
Subject: BOATING SAFETY: EMERGENCY PROCEDURES	

In case of emergency, a radio, whistle, horn or visual signals may be used to summon help. On the radio, send "Mayday" on VHF channel 16 or 2182 kilohertz. Give the boat identification and call letters, the locations, the nature of distress, the number of persons aboard and condition of any that are injured, the estimated seaworthiness of the boat (how long you may stay afloat), descriptive details of the boat and any other information that may help rescuers.

If you have no radio, show visual distress signals. If you have only pyrotechnic distress signals, save them until there is someone who can see them.

Many boats have flotation chambers and will not sink. In such cases, it may be better to stay with the boat. If the boat can be righted, get into it: this may be warmer than staying in the water. If the water is cold, it is important to conserve body heat. Get out of the water if possible; if not, curl up. If several people are in the water, they should huddle close together. Do not swim for shore unless it is quite close or there is no chance of rescue. A boat is easier for rescuers to find than a swimmer.

If you hear or see a distress signal from another vessel, give what aid you can. Use a radio to notify the Coast Guard on VHF channel 16, or notify any listener on CB channel 9.