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POTENTIAL SOURCE OF CONTAMINATION SITE INVESTIGATION SOLID WASTE MANAGEMENT UNITS RCRA FACILITY WORK PLAN NSB KINGS BAY GA
10/1/1991
ABB ENVIRONMENTAL

POTENTIAL SOURCE OF CONTAMINATION (PSC) SITE INVESTIGATION/SOLID WASTE MANAGEMENT UNIT (SI/SWMU) RCRA FACILITY INVESTIGATION (RFI) WORKPLAN

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

CONTRACT TASK ORDER NO. 030
NAVY CLEAN - DISTRICT I
CONTRACT NO. N62467-89-D-0317

OCTOBER 1991

ABB Environmental Services, Inc.

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NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

POTENTIAL SOURCE OF CONTAMINATION (PSC) SITE INVESTIGATION/SOLID WASTE MANAGEMENT UNIT (SI/SWMU) RCRA FACILITY INVESTIGATION (RFI) WORKPLAN

CTO: 30

Contract No. N62467-89-D-0317

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OCTOBER 1991

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RECORD OF CHANGE

POTENTIAL SOURCE CONTAMINATION (PSC) SITE INVESTIGATION/
SOLID WASTE MANAGEMENT UNIT (SI/SWMU)
NSB KINGS BAY
KINGS BAY, GEORGIA

CHANGE NO.	DATE	PAGE	SUMMARY OF CHANGE

EXECUTIVE SUMMARY

This Workplan presents the planning documents for undertaking a combined Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) and a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Site Investigation (SI) at the Naval Submarine Base (NSB) Kings Bay, Georgia.

The RFI/SI will collect data sufficient to determine the nature and extent of any releases of contaminants and the potential pathways of contaminant migration via land, surface water, and groundwater.

The RFI/SI planning documents consist of the following plans.

1. Workplan

2. Sampling and Analysis Plan
   Field Sampling Plan
   Quality Assurance Project Plans

3. Health and Safety Plan

Together the three plans present the scope of the RFI/SI with associated methodology and rationale; quality assurance and health and safety procedures; data storage, handling, and presentation formats; and the project management approach.

The RFI/SI conducted at NSB Kings Bay will be consistent with the requirements of the Hazardous and Solid Waste Amendments (HSWA) permit. The four sites that have been identified in the HSWA Permit as warranting conformational sampling and requiring further investigation during the RFI/SI include:

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

Site 12, will not be investigated as a part of this scope. The Navy has conducted a historical review of the site and these data will be incorporated and addressed in the final report.

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NSB Kings Bay, Georgia

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GLOSSARY OF ACRONYMS AND ABBREVIATIONS

ABB-ES	ABB Environmental Services
AOC	Area of Contamination
ARAR	Applicable or Relevant and Appropriate Requirement
ASCII	American Standard Code of International Interchange
BLS	below land surface
CAS	Chemical Abstract Service
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-term Action Navy
COC	chain of custody
CRP	community relations plan
CTO	Contract Task Order
DO	dissolved oxygen
DOD	Department of Defense
DOE	Department of Energy
DPDO	Defense Property Disposal Office
DQO	data quality objectives
ECD	electron capture detector
EM	electromagnetic
FFA	Federal Facility Agreement
FID	flame ionization detector
FS	feasibility study
FSP	field sampling plan
ft/day	feet per day
ft^2/day	square feet per day
GC	Gas Chromatograph
GC/MS	gas chromatography/mass spectroscopy
GDNR	Georgia Department of Natural Resources
GEPD	Georgia Environmental Protection Division
gpm	gallons per minute
HASP	Health and Safety Plan
IAS	Initial Assessment Study
IDW	investigation derived waste
IRP	Installation Restoration Program
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
$\mu g/\ell$	micrograms per liter
mg/kg	milligram per kilogram

GLOSSARY OF ACRONYMS AND ABBREVIATIONS (Continued)

mg/ℓ	milligram per liter
MSL	Mean Sea Level
NACIP	Naval Assessment and Control of Installation Pollutants
NBS	National Bureau of Standards
NCP	National Contingency Plan
ND	none detect
NEESA	Naval Energy and Environmental Support Activity
NPL	National Priority List
OD	outer diameter
OVA	organic vapor analyzer
PARCC	Precision, Accuracy, Representativeness, Completeness, and Comparability
PCB	polychlorinated biphenyls
PCE	tetrachloroethene
PID	photoionization detector
ppb	parts per billion
ppm	parts per million
PVC	polyvinyl chloride
QA	Quality Assurance
QAPP	Quality Assurance Program Plan
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SMP	Site Management Plan
SOP	standard operating procedures
SOUTHNAVFAC-ENGCOM	Southern Division, Naval Facilities Engineering Command
SVOC	Semivolatile Organic Compound
TOC	total organic carbon
TPH	Total Petroleum Hydrocarbon
USCS	Unified Soil Classification System
USEPA	U.S. Environmental Protection Agency
VOA	Volatile Organic Aromatics
VOC	Volatile Organic Compound
WWTP	wastewater treatment plant

1.0 INTRODUCTION

1.1 PURPOSE AND REGULATORY SETTING. In accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, amended by the 1986 Superfund Amendments and Reauthorization Act (SARA), and as directed in Executive Order 12580 of January 1987, the Department of Defense (DOD) is authorized to conduct an Installation Restoration (IR) program for evaluating and remediating problems related to releases and disposal of toxic and hazardous materials at DOD facilities. The IR Program is consistent with CERCLA and SARA. The nomenclature for the Remedial Investigation/Feasibility Study (RI/FS) process is as follows:

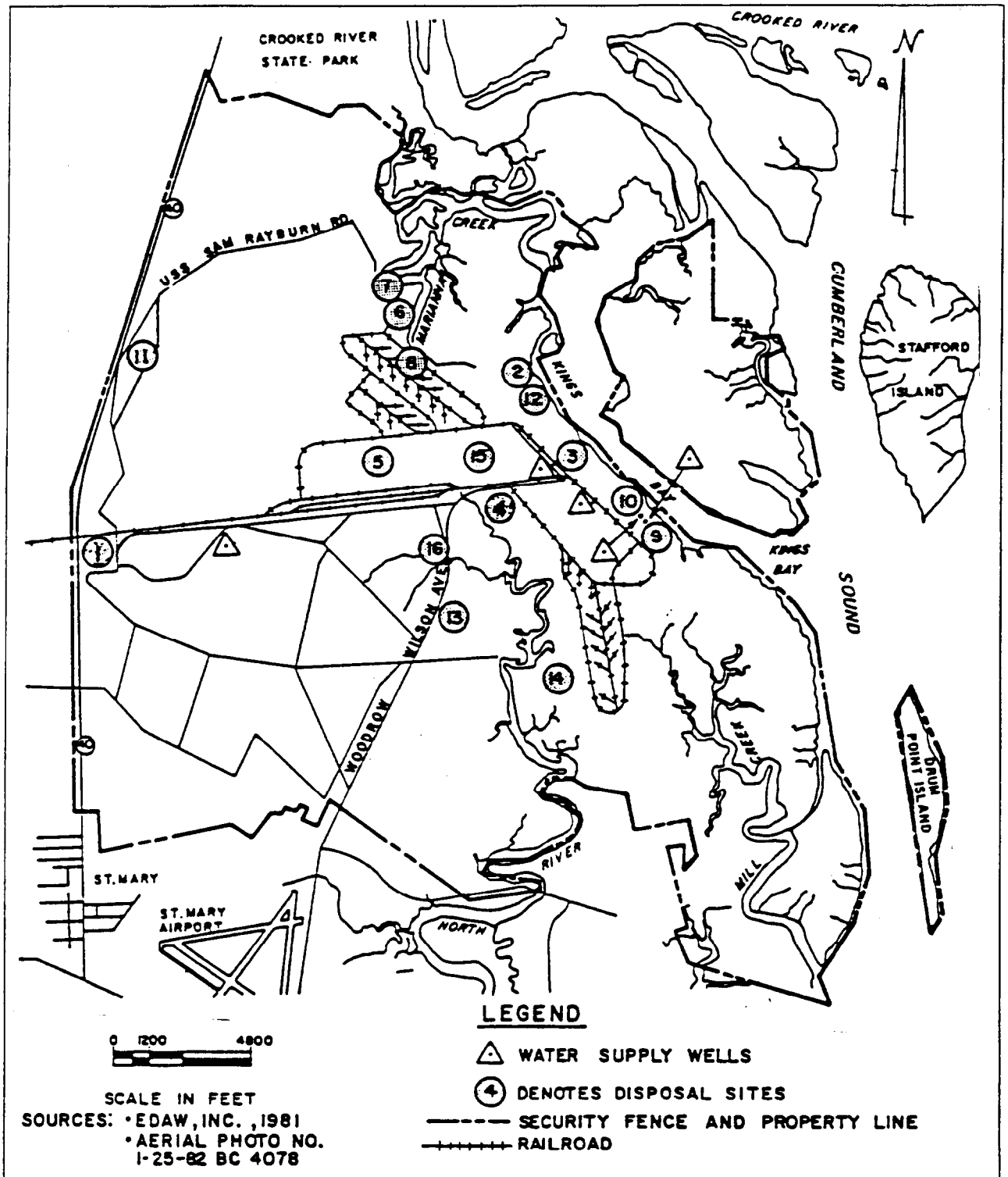
- Preliminary Assessment and Site Inspection,
- Remedial Investigation,
- Feasibility Study, and
- Planning and Implementation of Remedial Design.

In addition to these programs, military installations are subject to regulations promulgated by the 1976 Resource Conservation and Recovery Act (RCRA) and the 1986 Hazardous and Solid Wastes Act. Southern Division Naval Facility Engineering Command (SOUTHNAVFACENGCOM) has the responsibility for enforcement of the IR Program in the southeastern United States.

As a component of the IR Program, an Initial Assessment Study (IAS) was conducted in 1985 at the NSB Kings Bay, Georgia. The IAS identified a total of 16 waste disposal and spill sites (Figure 1-1). None of the 16 sites require further action under the IR program; however, four of the sites require further action under the Hazardous Waste Facility Permit. In February 1988, a RCRA and Hazardous and Solid Waste Amendments (HSWA) permit was issued to NSB Kings Bay by the Georgia Environmental Protection Division. As a result, ABB Environmental Services Inc. (ABB-ES) was contracted under the Comprehensive Long-Term Environmental Action Navy (CLEAN) contract (contract number N62467-89-D-0317, Contract Task Order Number 30 [CTO No. 30]) to prepare this RCRA Facility Investigation (RFI) Workplan and associated planning documents for three of the four sites at NSB Kings Bay. The NSB Kings Bay Public Works Department (PWD) is responsible for reviewing the historical data and disposal records at one of the sites, Site 12. These data will be incorporated and addressed in the final report prepared by ABB-ES.

This workplan will incorporate the information gathering requirements of both the RCRA RFI and the CERCLA SI procedures. This investigation will be called a RFI/SI to indicate its compliance with both programs. The objective of the RFI/SI is to collect sufficient data to determine whether contamination exists at NSB Kings Bay and, if it does exist, what type of contamination is present.

1.2 OVERVIEW OF PLANNING DOCUMENTS The workplan provides a record of site history, describes regional environmental factors, details previous investigative results, describes RFI/SI tasks, describes site-specific investigative methodology, and describes project organization and schedule. The format and scope of these documents are in compliance with the 1988 RI/FS guidance under Superfund and the Navy IR Program Manual of 1988.



SOURCES: • EDAW, INC., 1981
• AERIAL PHOTO NO. 1-25-82 BC 4078

FIGURE 1-1
LOCATION OF DISPOSAL SITES AND POTENTIAL CONTAMINATION

RFI/SI WORKPLAN

NSB KINGS BAY

The Sampling Analysis Plan (SAP) (Appendix A) focuses on the field investigation, analytical methods, and quality assurance/quality control (QA/QC) procedures. The SAP provides a project description, describes site management and field methods, details the technical approach, sampling plans for each site, and describes QA/QC requirements for sample collection, sample analysis, data assessment, corrective action, and reporting.

Appendix B, the Health and Safety Plan (HASP), outlines health and safety procedures for field tasks. The HASP includes material safety data sheets for chemicals that may be encountered at the site and provides emergency information and telephone numbers.

2.0 FACILITY BACKGROUND

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

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

2.2 SITE HISTORY. In the early 1950's, the U.S. Army began operations at NSB Kings Bay, developing the property as a military ocean terminal. Kings Bay Army Terminal, as it was called, was constructed to meet Department of the Army requirements for east coast port facilities capable of shipping ammunition and other explosives in the event of a national emergency. From its inception until June 30, 1965, the terminal was known as the Kings Bay Army Terminal. On April 1, 1965 as a result of a major reorganization, the terminal was placed under the jurisdiction of the newly organized Military Traffic Management and Terminal Service, and on July 1, 1965 became officially known as the U.S. Army Military Ocean Terminal, Kings Bay (MOTKI). MOTKI was a terminal, not a storage depot, designed to store ammunition or explosives for about 3 months. MOTKI had no assigned military personnel and was operated by 19 U.S. Government Civil Service employees, whose mission was to plan programs, perform utility repairs, and provide fire prevention and protection functions for the terminal.

In 1978, the Department of the Navy selected MOTKI as the East Coast basing site for its Fleet Ballistic Missile (FBM) submarine support facility. On July 1, 1978, the site was established in a developmental status and was named the Naval Submarine Support Base. The site became the Naval Submarine Base, Kings Bay in 1979. In 1979, the Navy moved Squadron 16 from Spain to Kings Bay. Although secondary to its primary mission, the terminal has in the past performed valuable service to the United State Government and to the local populace. For example, during the Cuban missile crisis a U.S. Army Transportation Battalion (Boat) consisting of approximately 1,100 military personnel and 70 small craft vessels were temporarily stationed at Kings Bay, and during Hurricane Dora in 1964 the terminal was utilized as a shelter area for nearly 100 local residents.

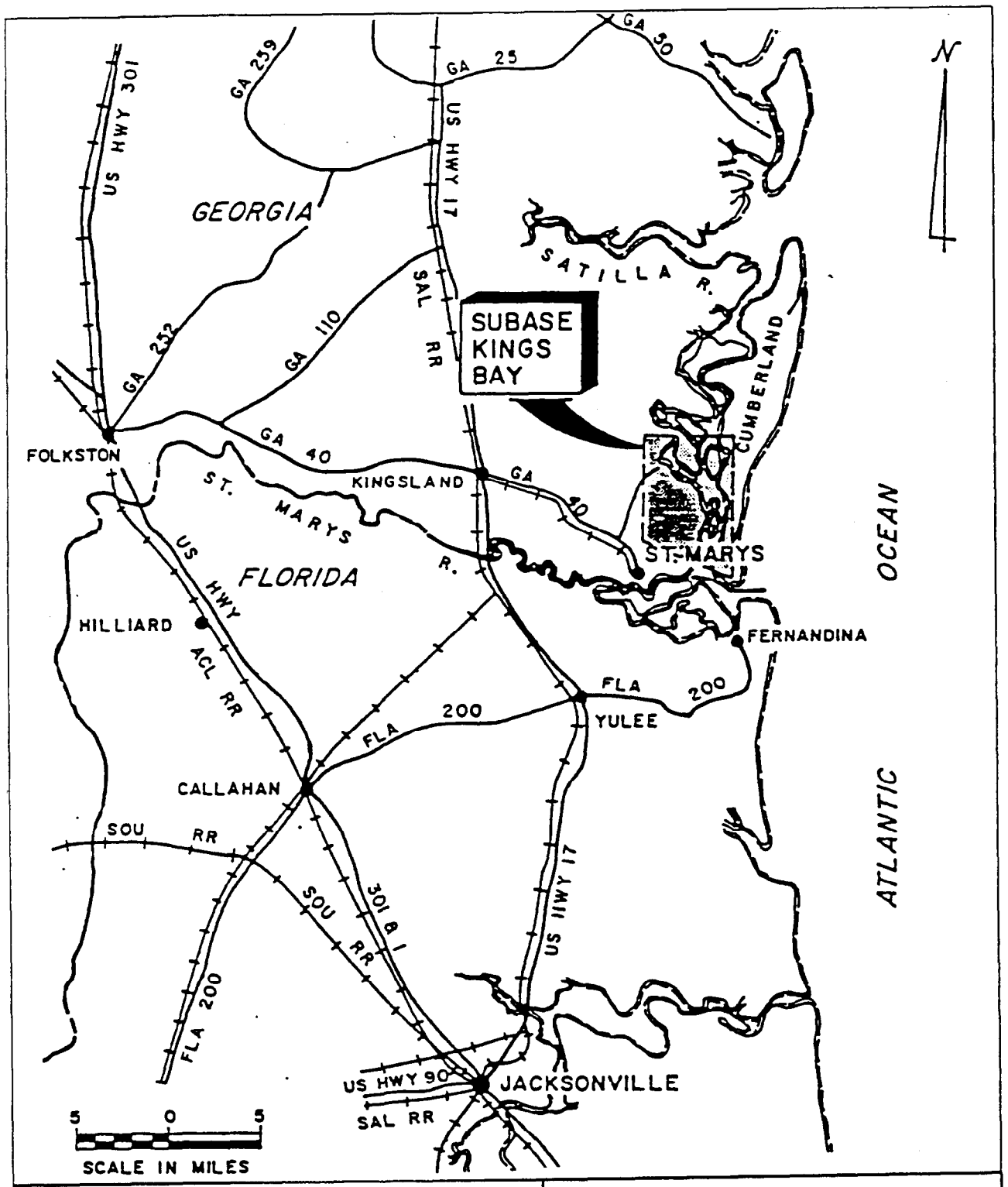


FIGURE 2-1
VICINITY MAP

RFI/SI WORKPLAN

NSB KINGS BAY

From its inception in the early 1950's until the Navy took possession in 1978, the base was used on a periodic basis for training by the U.S. Army Reserves. Reservist would train for 2 to 8 week periods throughout the year. It is believed that solid waste generated by the U.S. Army Reserve units was disposed of on site in trench and fill landfills.

2.3 ENVIRONMENTAL DESCRIPTION.

2.3.1 Climatology The NSB Kings Bay, Georgia, experiences sub-tropical climate, with hot wet summers and cool, dry winters. The mean annual temperature is approximately 68 °F. Temperatures rarely rise above 100 °F because of the moderating effect of the ocean. Most of the precipitation occurs in the form of rain from summertime showers or thundershowers. Snowfall is not very common but has been recorded during three of the past five winters. The mean annual precipitation at Kings Bay is estimated to be 54 inches (Environmental Science and Engineering Inc., 1975). Relative humidity varies widely throughout the year from an annual average of 87 percent in the morning to 55 percent during the afternoon. The relative humidity is generally highest during hot summer months (June through September), and lowest during the spring (March through May). Dense fog occurs quite frequently at Kings Bay.

Prevailing annual winds at the activity are westerly, with strong northerly components in winter and southerly components in summer. Highest prevailing wind speeds (9 to 10 miles per hour) are experienced in late winter and early spring, with lightest winds occurring during the summer. The seasonal and annual wind pattern is influenced by the land and water temperatures along the coast. Thunderstorms do occur, but more frequently in summer with an average occurrence of 64 days per year. Tropical cyclones and hurricanes have usually occurred in the months of August and September. Tornadoes are very common, but generally occur during the months of March through May (Environmental Science and Engineering, Inc., 1975).

2.3.2 Topography The area around the NSB Kings Bay is generally flat and marshy and traversed by slow, meandering streams. The highest area is about 60 feet above mean sea level (msl), located 10 miles southwest of the NSB Kings Bay (Environmental Science and Engineering, Inc., 1980).

The elevations on the NSB Kings Bay range from zero msl along the Bay and in streams to slightly above 30 feet msl in the extreme western sections along the State Road 40 spur. Generally, elevations decrease from west to east along the base with an average of about 15 feet msl. The area is virtually flat; however, steep slopes can be observed along deeper drainways.

2.3.3 Regional Geology The Kings Bay region is located in the Georgia Coastal Plain section of the continental shelf that was once beneath the sea. It emerged from the sea because of land uplift and a general decline of the sea. The present features in the region were etched during the Ice age. The growth of the ice caps caused enough accumulation of water to lower the level of the sea. Once the water melted the sea level rose again. The alternating retreating and advancing of the sea over the area accounted for the existing landform mainly through carving the ancient shore lines (Environmental Science and Engineering, Inc., 1975). The shoreline complexes that were deposited have not been accurately dated, but it is somewhere around Pleistocene and Holocene in age.

Seven different shorelines have been discovered around the Kings Bay. They are the Wicomico, Penholoway, Talbot, Pamlico, Princess Anne, Silver Bluff, and Holocene. The oldest is the highest on the landscape. Conversely the youngest is the lowest on the landscape. The description of the shoreline complexes are restricted to Pamlico, Princess Anne, and Silver Bluff, which occur in the vicinity of the NSB Kings Bay.

The Pamlico shoreline complex generally ranges from 15 to 35 feet above sea level consisting chiefly of clayey and sandy materials.

The Princess Anne shoreline complex is 10 to 15 feet above sea level. NSB Kings Bay falls into this classification of complexes. It is on low upland ridges just west of the salt marsh. The complex is not as well defined and developed as the others, which indicates that the sea was at this level for a relatively short time.

The Silver Bluff shoreline complex is 6 to 10 feet above sea level consisting of intercoastal flats, salt marshes, and the off-shore barrier island. The Silver Bluff shoreline is represented by Cumberland Island. Parts of the barrier islands have been formed in recent times. Most recent deposits, however, are on the floodplain of the major streams.

2.3.4 Surface Water Hydrology and Quality

2.3.4.1 Surface Water Hydrology NSB Kings Bay is dominated by the presence of large and small rivers draining into the Atlantic Ocean. The surface waters include the St. Marys River, the Satilla River, and the Crooked River. Most of the surface runoff at NSB Kings Bay is stored in the upland swamps and marshes and is diverted off base through long shallow ditches and meandering, low velocity, natural intermittent streams. Surface runoff at the site is slow because of flat slopes associated with high water table and dense ground cover vegetation. (Environmental Science and Engineering, Inc., 1975). The NSB Kings Bay drainage network covers approximately 11,000 acres within the boundaries of the activity located west of Kings Bay. Approximately 30 percent of this area is salt marsh, and the remainder is upland. The major drainage outlet on the activity is the North River draining 49 percent of the area to the south. To the north, the Crooked River drains 5 percent, and Marianna Creek drains 17 percent of the activity. The remaining 29 percent of the activity generally drains eastward into Cumberland Sound and Kings Bay.

The elevation of the 100 year floodplain in the region is slightly more than 10 feet above msl. Mainly because of the flatness of the region, about 1/2 of the facility would be inundated by a 100-year flood (Environmental Science and Engineering, Inc., 1975). Generally, the 100-year flood would inundate the low marsh areas on the site bordering Marianna Creek, and the North River.

2.3.4.2 Surface Water Quality The surface water in streams and creeks in the vicinity of the base are used mainly for noncontact recreation including boating, fishing and navigation. Sources of surface water contamination may include runoff from pine plantations, small agricultural areas, poorly operating septic tanks, leachate from sanitary landfills, and runoff from impervious areas such as highways and parking lots. The North River is classified for industrial use (IAS, 1985).

Water quality in the North River, Marianna Creek, and Mill Creek watersheds were characterized as generally highly colored, clear, with dissolved oxygen concentrations ranging from 9.2 to 13.2 mg/l. Conductivities were higher than in fresh waters in the vicinity, probably due to salt spray and tidal influence. Some of the Marianna Creek water quality monitoring stations were located within the estuarine complex as shown by the conductances ranging from 247 to 22,200 μmhos/cm. Heavy metal concentrations were low with the exception of mercury. Mercury-based fungicide use was cited as a possible cause for the elevated mercury levels of 3.0 to 9.4 μg/ℓ (Environmental Science and Engineering, 1980).

2.3.5 Groundwater Hydrology and Quality

2.3.5.1 Groundwater Hydrology Groundwater at NSB Kings Bay occurs in three different aquifers: the surficial or water table aquifer, the secondary artesian aquifer, and the primary artesian aquifer. The water table aquifer is primarily used for irrigation by adjacent communities. The secondary artesian aquifer is not used widely because of extreme variability in water yield. The primary artesian aquifer is used for public water supply by NSB Kings Bay and surrounding towns and urban areas.

The water table aquifer at the base is mainly composed of sands and limestone, with aquifer thickness ranging from 40 to 90 feet. On the western part of the activity, the aquifer is composed of loose to dense fine sands throughout its thickness. However, on the eastern parts of the facility near Kings Bay, the sands are only about 40 to 60 feet thick and overlie limestone 60 feet in thickness (Environmental Science and Engineering, Inc., 1975). There are 22 known water table aquifer wells at the activity, ranging in depth from 47 to 81 feet. These wells have been unused since 1978 when the property was transferred to the U.S. Navy.

The secondary artesian aquifer, which is located approximately 40 to 90 feet below the ground surface, is generally composed of isolated limestone lenses between the water table aquifer and the principal artesian aquifer. The limestone lenses are highly variable both in thickness and extent. The aquifer thickness ranges from approximately 380 feet to 530 feet. The yields are extremely variable, and hence the aquifer cannot be considered as a principal source of water. The yield is generally better than the overlying water table aquifer, but not as good as the underlying principal artesian aquifer (Environmental Science and Engineering, Inc., 1975). There are no major production wells on the NSB Kings Bay tapping the secondary artesian aquifer.

The principal artesian aquifer consists of limestone located approximately 470 to 570 feet below the ground surface. Drinking water for the activity and adjacent communities is pumped from this aquifer, which is the deepest and most productive in the vicinity of the base (Environmental Science and Engineering, Inc., 1981). The principal artesian aquifer is divided into two water bearing zones with different types of limestone, separated by a dense, 100 to 150 feet thick confining layer.

The major production wells at NSB Kings Bay tap the principal artesian aquifer. Wells tapping this aquifer are under pressure, and water levels within a tightly cased well will rise to an altitude of between 20 and 30 feet above sea level. Most wells tapping this aquifer yield in excess of 1,000 gallons per minute.

Well depths vary from 600 to 894 feet, with four of the five production wells greater than 800 feet in depth (Environmental Science and Engineering, Inc. 1980). Location of these wells are presented in Figure 1-1.

2.3.5.2 **Groundwater Quality** At NSB Kings Bay, ground water quality has been monitored periodically. The studies conducted by Environmental Science and Engineering, Inc. (1975), indicate that the water from the water table aquifer in the Kings Bay area is typically low in minerals and pH. Occasionally, high concentrations of chlorides near salt water bodies and high concentrations of iron at some places were observed. Further studies (Environmental Science and Engineering, Inc., 1980) concluded that the water from the water table aquifer is acidic in composition (pH range 4.0 to 6.6) with high levels of organic carbon. Occasionally, chlorides were high near salt water bodies. Mercury exceeded the Federal Primary Drinking Water Limits (USEPA, 1976).

Water in the secondary artesian aquifer has fewer minerals than the underlying principal artesian aquifer, but more than the upper water table aquifer (Environmental Science and Engineering, Inc., 1975).

Public water supplies for NSB Kings Bay and adjacent communities are drawn from the principal artesian aquifer, and the water is of such quality that only chlorination and aeration are required. Aeration removes high concentrations of iron and hydrogen sulfate. The treated waters typically are not softened even though hardness levels exceed 300 mg/l of calcium carbonate. Dissolved solids concentrations sometimes exceed the U.S. Public Health Service limit of 500 mg/l. The water in the principal artesian aquifer is categorized as very hard and alkaline with moderate amounts of dissolved solids (Environmental Science and Engineering, Inc., 1975).

Contamination of fresh groundwater with brackish surface water has also been noticed in Coastal areas around Kings Bay.

2.3.6 Water Supply The water supply system on the base consists of two water treatment plants. The Waterfront Water Treatment Facility (WWTF) serves the Waterfront Development Area and the Base Water Treatment Facility (BWTF) serves all other areas. Each system has associated distribution lines. A service line connecting the two water plants was constructed to meet the base fire flow requirements. The two plants act separately except during a fire. Water for these plants is supplied by five wells yielding in excess of 1,000 gallons per minute each. Well depths vary from 600 to 894 feet with four of the five production wells greater than 800 feet in depth.

In Camden County, water treatment facilities for St. Marys, Woodbine, and Kingsland are adequate for present demands. However, the water distribution systems of both St. Marys and Woodbine require extensions and replacement of inadequate sized lines. Kingsland's distribution system is adequate. Private wells supply water for most of the individual homes and businesses in rural areas.

2.4 WASTE GENERATION. Most of the shops and operations have existed subsequent to the Navy's acquisition of the Naval Submarine Base property on July 1, 1978. Waste types that have been generated from the shops and operations prior to and after the Navy's acquisition are summarized in Table 2-1.

Table 2-1
Summary of Waste Generation

RFI/SI Workplan
NSB Kings Bay
Kings Bay, Georgia

Shop/Operation	Waste Generated	Years of Generation
Vehicle Maintenance Shop	waste oil, batteries, paint waste	1981-1985
Steam and Compressed Air Shop	muriatic acid, tri-sodium, phosphate	1980-1985
USS Simon Lake	waste oils, paint waste, acids	1979-
Dry Dock (ARDM)	waste paints, grease, acids	1979-
Auto Hobby Shop	waste oil, batteries, waste solvents	1981-1985
U.S. Army Reserve	office waste, kitchen waste	1973-1979
Photo Laboratory	developer, activator, acotic acid	1983-1985
Dental Clinic	amalgam	1982-
Port Services	waste oil, solvents	1979
Auto Hobby Shop	waste oil solvents	1981-
Carpentry, Paint, and Plumbing Shop	waste paints, solvents	1980-

2.5 WASTE PROCESSING. Waste processing operations at NSB Kings Bay include: sewage treatment, solid waste disposal, hazardous waste disposal, oil and solvent recycling, and ordnance disposal.

2.5.1 Wastewater Conveyance and Treatment Plant The sewage and wastewater treatment system at NSB Kings Bay consists of two independent facilities. The Waterfront Sewage Treatment Plant (WSTP) services the Waterfront Development Area and the Base Sewage Treatment Plant (BSTP) services all other base development areas.

The WSTP, located south of the T-Shed, was constructed in 1978. The 0.4 million gallon per day (mgd) facility includes the following unit processes: aerated pretreatment (equalization), influent pumping, activated sludge, secondary clarification, chlorine contact, aerobic digestion, and sludge dewatering via drying beds. The treatment plant is designed to treat bilge wastewater and sanitary sewage pumped from naval ships in port through lift stations located at the wharf and ARDM area. Daily flows vary considerably with fluctuations in ship loads; however, for the period July 1982 to June 1983, daily flow averaged 0.26 mgd (SOUTHNAVFACENGCOM, 1983).

Effluent from the facility is discharged into Kings Bay under authorization of the National Pollutant Discharge Elimination System (NPDES) permit Number GA 0027707. When the Camden County landfill at NSB Kings Bay (Site 11) was operational (1974 to October 1981), sludge and grit from the treatment plants were disposed here. Since late 1981, dried sludge from the sludge drying beds has been periodically removed by a private contractor and disposed of off-station. The estimated quantity of sludge removed is 15 cubic yards per month based on the removal of three beds every two months.

The BSTP is a 0.3 mgd land application treatment system constructed in 1979. The plant, located north of the "Industry Support" area, is an aerated lagoon treatment plant with prescreening and grit removal. After chlorination, the wastewater effluent is land applied to forest areas using a spray irrigation system. Sludge is removed from the lagoons manually on an as needed basis. From 1979 to late 1981, sludge was disposed on-site at Site 11. Since late 1981, the sludge and grit were disposed off-station. The aerated lagoons were designed for 15 years of operation without sludge removal.

2.5.2 Solid Waste Disposal The Army Reserve generated general trash such as office wastes, wooden pallets, concrete blocks, metal ammo boxes and kitchen wastes. These disposal areas are Sites 5, 6, 7, 8, and 12. Sites 14, 15 and 16 were also used by the Reserves for disposal of drums, empty paint and solvent cans and the wastes mentioned above. All of these sites were active prior to the Navy acquiring the base in 1978. From 1974 to 1981 most of NSB Kings Bay disposal of solid wastes occurred at Site 11, Camden County Landfill. Since Site 11 closed in 1981, solid wastes from the base have been disposed of off-station by a waste disposal contractor. Since 1981, inert construction material, trees, stumps, roots and brush have been disposed within one of the dredge spoil areas and burned daily to reduce volume. There are approximately 25 acres of dredge spoil areas at the activity. No hazardous waste material have been reported to be disposed in these areas. An average of 28 tons per day of solid wastes has been generated at the base during the Navy's tenure (1969-1985).

2.5.3 Oil and Solvent Recycling During the Army's occupation of the base, oil and solvents were not recycled. From 1979 until 1981, waste oil was recycled through Navy facilities in Charleston, South Carolina. This practice occurred until 1981, at which time the recycling was handled through a private waste recycler. Approximately 5,000 gallons of waste oil is collected per month for recycling. Waste solvents generated at NSB Kings Bay have always been recycled through Defense Property Disposal Office (DPDO) at the Naval Air Station, Jacksonville.

2.5.4 Ordnance To date no ordnance processing operations have occurred at NSB Kings Bay.

2.6 HAZARDOUS WASTE SITES DESCRIPTIONS. This section describes each of the disposal sites or potentially contaminated areas identified in the IAS at the NSB Kings Bay, Georgia. The sites described were identified through several sources including NSB Kings Bay records, correspondence, maps, interviews with activity personnel, examination of aerial photographs, and field examination. For all sites, efforts were made to confirm data through multiple sources. The 16 sites included:

Site 1, PCB Transformer Storage Area No. 1
Site 2, Fire Fighting Pit
Site 3, PCB Transformer Storage Area No. 2
Site 4, PCB Transformer Storage Area No. 3
Site 5, Army Reserve Disposal Area, Towhee Trail
Site 6, Army Reserve Disposal Area No. 1
Site 7, Army Reserve Disposal Area No. 2
Site 8, Army Reserve Disposal Area No. 3
Site 9, Blue Star Shipping Disposal Area, Parking lot
Site 10, Blue Star Shipping Disposal Area, T-Shed
Site 11, Old Camden County Landfill
Site 12, Army Reserve Disposal Area, Future Dry Dock
Site 13, OLD DPDO Yard
Site 14, Army Reserve Disposal Area, Kamehameha Avenue
Site 15, Army Reserve Disposal Area near Water Treatment Plant, Stimson Drive
Site 16, Army Reserve Disposal Area near Old Sewage Lagoon 3990

The four sites that have been identified in the HSWA Permit as warranting confirmational sampling and requiring further investigation during the RFI/SI include:

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

ABB-ES will conduct a RFI/SI for sites 5, 11, and 16. No field work is scheduled for Site 12. The Navy will be responsible for conducting a historical review of the data for Site 12. Data complied on Site 12 will be incorporated and addressed in the final report prepared by ABB-ES.

2.6.1 Site 5, Army Reserve Disposal Area, Towhee Trail This disposal site was used by the Army Reserve from approximately 1969 to 1974. The site covers an area of approximately 8.5 acres located on both sides of Towhee Trail where the road makes a sharp turn to the northwest (see Figure 2-2). The area on the west side of the road was reportedly about 7 acres in size while that on the east side was about 1.5 acres. The areas were both excavated to a depth of five feet before wastes were disposed in them. Wastes disposed in the site included tree stumps, wooden pallets, metal ammo boxes (some empty and some filled with concrete) aluminum sheeting, concrete blocks and some kitchen waste and a large pile of dredge spoil. Gravel from abandoned railroad tracks covers most of the western area to a depth of about two feet. Burning took place twice a year at the end of reserve training on the western side of the road. A total of approximately 30 to 40 gallons of diesel fuel and waste oil were used to ignite the wastes. Therefore, over the 5 years that the site was in use a total of 300 to 400 gallons of waste oil and fuel were burned. Quantities of wastes disposed are approximated at 69,000 cubic yards based on the reported dimensions of the site.

2.6.2 Site 11, Old Camden County Landfill Located in the far western area of the activity (see Figure 2-3), this 35 acres landfill was operated by Camden County from 1974 to October 1981 (Knowlton, 1981). Reportedly, hazardous wastes were not accepted at the landfill. Discussions with landfill personnel indicated that domestic wastes were accepted from the following sources:

Source	Percentage of Total Waste
Camden County	60%
NSB Kings Bay	20 to 30%
Blue Star Shipping Co.	5 to 10%
Gilman Paper Co.	5 to 10%

Wastes, including general household and office wastes, scrap paper, wood, and sludge and grit from the base sewage treatment plants, were brought to the site by truck. On the average, about 12 truck loads per day of wastes were disposed of at the site. It was reported that for a three month period in 1974 or 1975, the Gilman Paper Co. sent about seven truck loads of scrap paper (seven or eight bales per truck) to the landfill. The landfill was a trench and fill operation with trenches oriented in an east-west direction across the landfill (approximately 800 feet long by 20 feet wide by 12 feet deep). Excavation was into the water table which is four to eight feet below the surface in this area. Burning of wastes took place once per week during 1974, but did not occur after 1974. Each day the wastes, including ashes in 1974, were compacted and covered with at least six inches of soil. Upon closure, a final soil cover of two feet was placed on the landfill. Estimated waste quantity is 500,000 cubic yards.

2.6.3 Site 16, Army Reserve Disposal Area Near Sewage Lagoon 3990 Site 16 located west of Woodrow Wilson Avenue and south of old sewage lagoon 3990 (see Figure 2-4), was used every 6 months by the Army Reserve from 1958 to 1964. The site covered an area of one acre and was excavated to a depth of three to five feet. Wastes disposed of included food, wood, trash, scrap metal, tree limbs and empty paint and solvent cans (about one or two 1-gallon cans per month). The waste quantity is estimated at approximately 4,000 cubic yards. Reportedly,

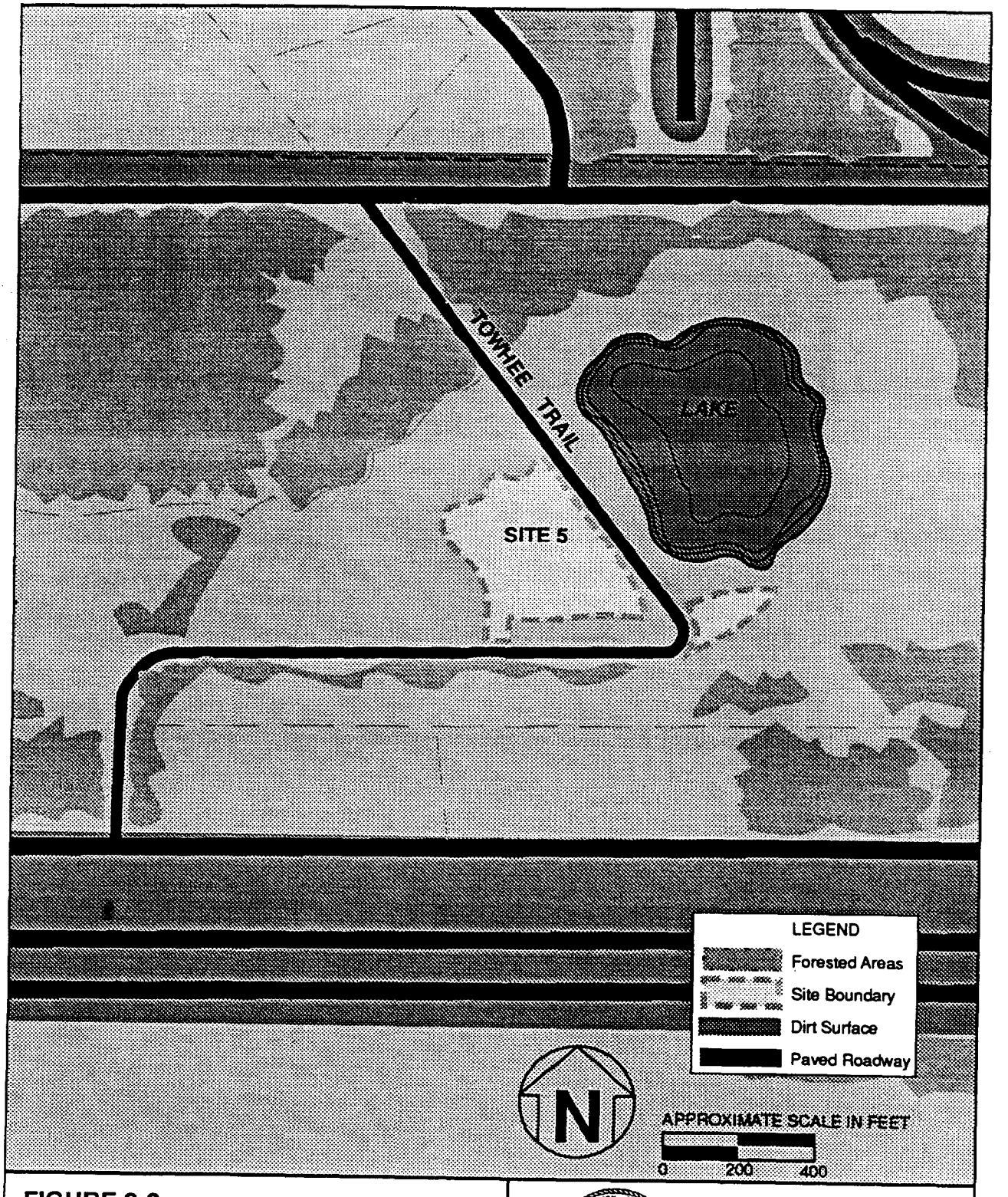


FIGURE 2-2
LOCATION OF SITE 5
ARMY RESERVE DISPOSAL AREA
TOWHEE TRAIL

RFI/SI WORKPLAN

NSB KINGS BAY

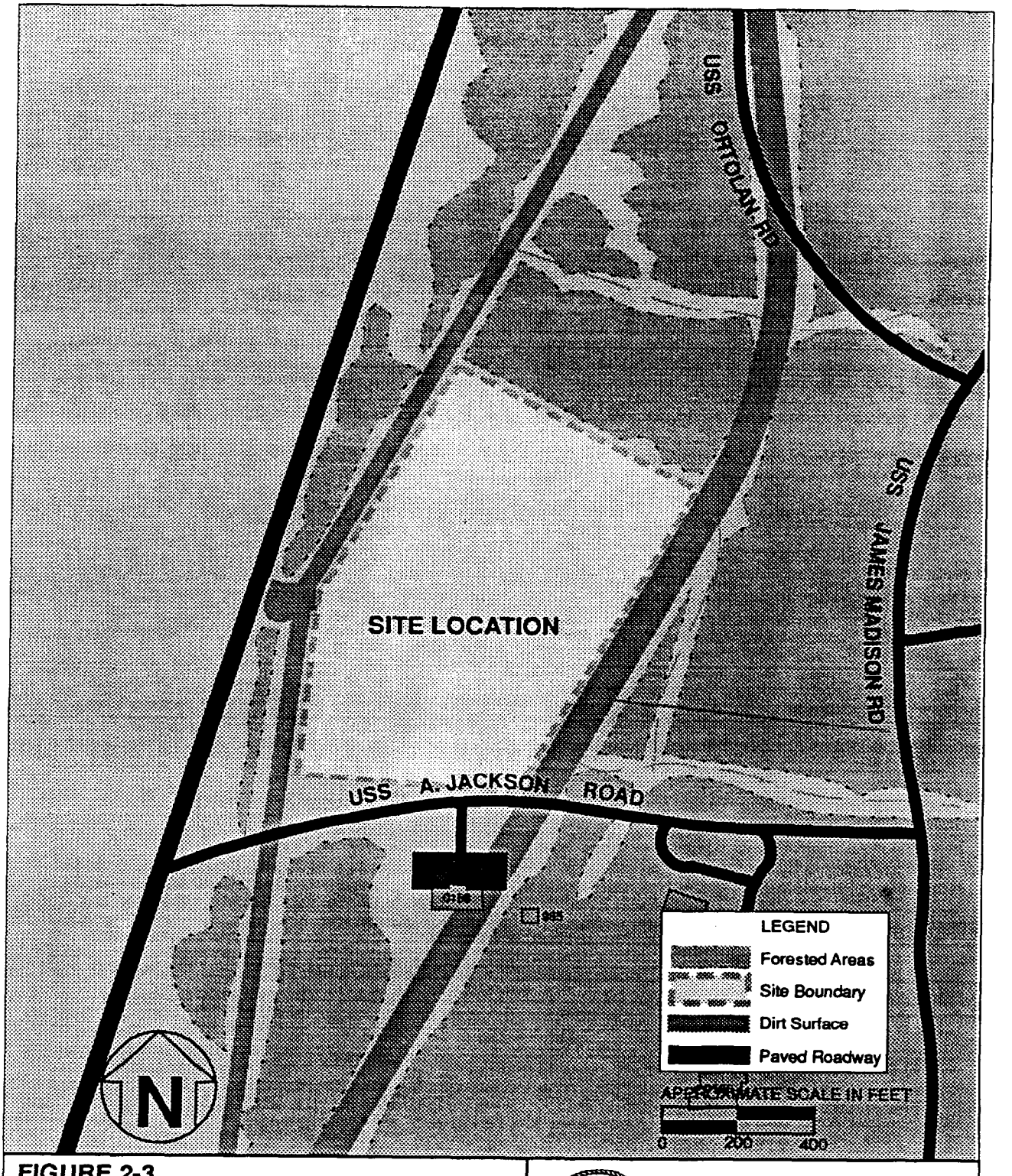


FIGURE 2-3
LOCATION OF SITE 11
OLD CAMDEN COUNTY LANDFILL

RFI/SI WORKPLAN

NSB KINGS BAY

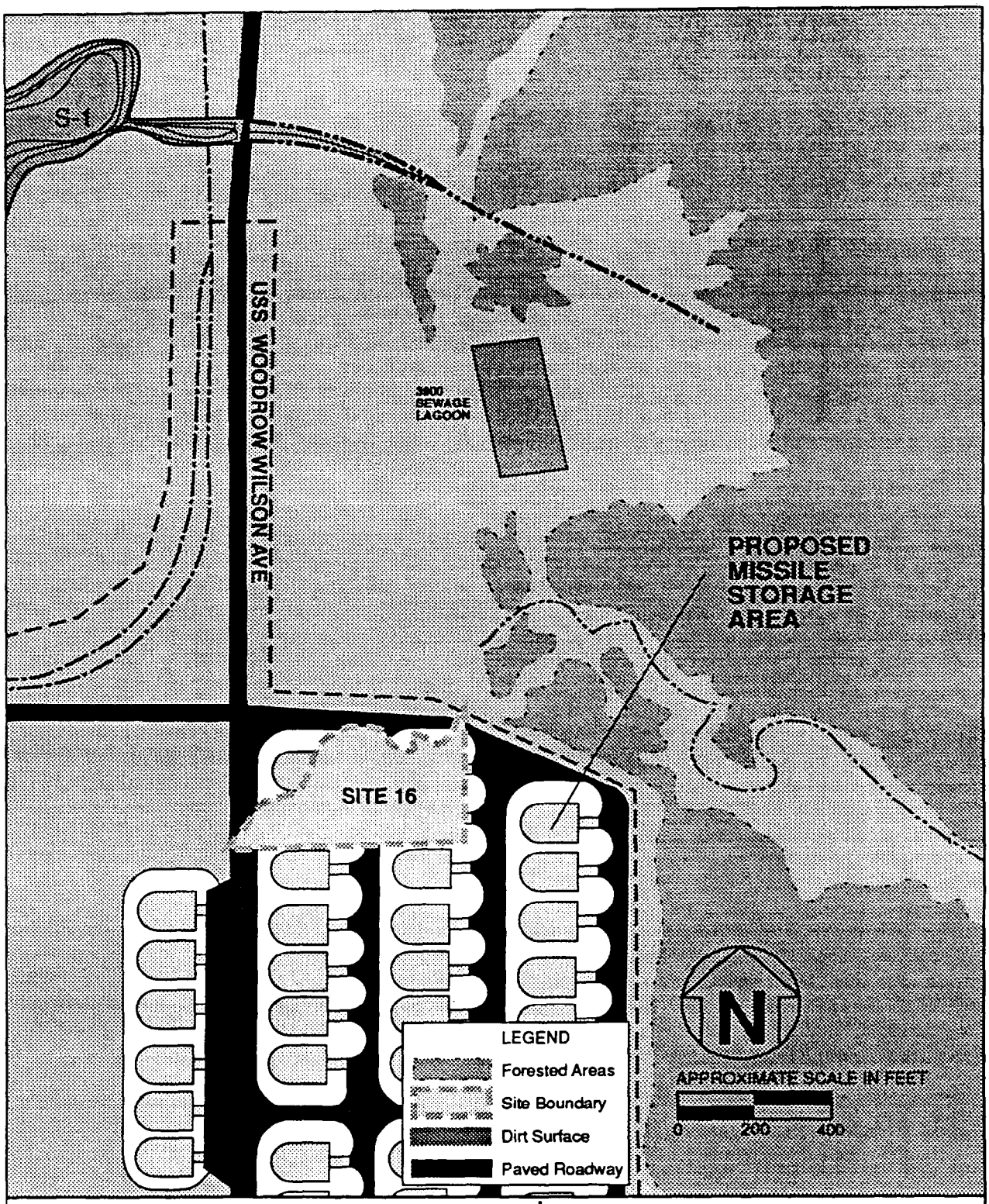


FIGURE 2-4
LOCATION OF SITE 16
ARMY RESERVE DISPOSAL AREA

RFI/SI WORKPLAN

NSB KINGS BAY

burning of wastes took place at this location. It is unknown how often burning took place or if any fuel was used to ignite the wastes. The site was covered with soil upon closure by the Army.

2.7 MIGRATION POTENTIAL. NSB Kings Bay is located on an arm of Cumberland Sound called Kings Bay. It is connected to the sea by a 12-mile access channel which passes through the St. Marys Inlet. Potential migration pathways for pollutants from past waste disposal and spill sites are through surface runoff to the intermittent creeks and rivers by storm drainage ditches, or by infiltration from the surface into the ground water. Surface runoff at NSB Kings Bay is slow because of the flat slopes and the amount and intensity of rainfall. The water table aquifer is isolated from the underlying artesian aquifers by confining layers of relatively impermeable clays and limestones. The presence of permeable sands in the area is conducive to rainfall percolation directly into the water table aquifer, which is a potential source of ground water contamination. The water eventually migrates through the water table aquifer and discharges into streams, rivers, and springs including the North River, Crooked River, and Marianna Creek. These streams and rivers eventually flow to Kings Bay and Cumberland Sound. The fresh water bodies described above are used principally for noncontact recreation including boating, fishing, and navigation.

2.7.1 Potential Contaminant Receptors Potential contaminant receptors include humans and endangered, threatened and rare plants and animals. Because the water table aquifer is hydraulically isolated from any domestic supply aquifers, direct contact (exposure by consumption or contact) with humans could only be through surface water. Most of the surface waters are used only for recreational boating and navigation. Therefore, the potential for human consumption is minimal. Indirect contact through the food chain is more likely since Cumberland Sound is a recreational and commercial fishery. Contaminants may migrate to Cumberland Sound by way of surface runoff or through subsurface flow in the water table aquifer and thereby enter the food chain. Humans consuming fish taken from the Sound could be exposed to levels of contaminants actually higher than levels in the water due to food-chain amplification. Several endangered species have been listed as possibly occurring in the general area by the U.S. Fish and Wildlife Service and the Georgia Department of Natural Resources (see Table 2-2) (Environmental Science and Engineering, Inc. 1980).

Table 2-3 shows all endangered, threatened, and unusual flora and fauna occurring or possibly occurring in the vicinity of NSB Kings Bay. Unusual species in the State of Georgia have been designated to include any resident species which exhibits special or unique features and therefore deserves special consideration in its continued survival in the state (Georgia Department of Natural Resources, Game and Fish Division, 1976).

Table 2-2
Endangered, Threatened, and Rare Species

RFI/SI Workplan
NSB Kings Bay
Kings Bay, Georgia

Common Name	Genus/Species	Habitat Requirements	Comments
Shortnose Sturgeon	Acipenser brevirostrum	Coastal marine waters and estuaries	Endangered south of South Carolina.
American Alligator	Alligator mississippiensis	Canals and wetland area	Species of concern.
Eastern Indigo Snake	Drymarchon corias cooperi	Coastal hammocks and forests	Threatened.
Atlantic Loggerhead Turtle	Caretta C. caretta	Nests on north Florida beaches	–
Arctic Peregrine Falcon	Falco peregrinus tundrius	Adequate prey and trees	Migrant and winter resident.
Bald Eagle	Haliaeetus leucocephalus	–	Endangered/threatened; none on NAVSTA Mayport; nest reported 3 miles west.
Wood Stork	Mycteria americana	Wetlands and shrub swamp	Endangered; suitable habitat on base.
Least Tern	Sterna antillarum	Open, sandy beaches	Will nest in landfills, parking lots, construction sites, roof tops.
Southeastern Kestrel	Falco sparverius paulus	Open, pine forests, clearings, open areas along rivers, coasts, urban areas	Likely to be found on base n forested areas with dead trees.
West Indian Manatee	Trichechus manatus latirostris	St. Johns River and offshore	Use of river heaviest in fall and spring.

Table 2-3
Endangered, Threatened, and Unusual Flora Occurring or Possibly Occurring in the Vicinity of Kings Bay

RFI/SI Workplan
NSB Kings Bay
Kings Bay, Georgia

Common Name	Scientific Name	GDNR	USFWS
Flora			
Buckthorn	*Bumelia thornei*	E	
Indian-plantain	*Cacalia diversifolia*	T	
Spider-lily	*Hymenocallis coronaria*	E	
Loosestrife	*Lythrum curtissii*	E	
Cow-bane	*Oxypolis canbyi*	T	
Panic grass	*Panicum hirstii*	E	
Trumpet leaf	*Sarracenia flava*	T	
White trumpet	*Sarracenia leucophylla*	T	
Hooded pitcher plant	*Sarracenia minor*	T	
Parrot pitcher plant	*Sarracenia psittacina*	T	
Amphibians			
Georgia blind cave salamander	*Haiedotriton wallacei*	U	
Reptiles			
American alligator	*Alligator mississippiensis*		E
Eastern indigo snake	*Drymarchon corais*	T	T
Birds			
Ivory-billed woodpecker	*Campephilus principalis*	E	E
American perigrine falcon	*Falco perigrinus anatum*	E	T
Artic perigrine falcon	*Falco peregrinus tundrius*	E	T
Bald eagle	*Haliaesetus leucocephalus*	E	E
Wood stork	*Mycteria americana*		E
Red-cockaded woodpecker	*Picoides borealis*	E	E
Bachman's warbler	*Vermivora bachmanni*	E	E

Source: Initial Assessment Study, Envirodyne Engineers (1985).

Notes: GDNR = Georgia Department of Natural Resources.
USFWS = United States Fish and Wildlife Service.
E = Endangered.
T = Threatened.
U = Unusual.

3.0 GENERAL DESCRIPTION OF TASKS

The RFI/SI process will focus on source identification and delineation, waste characterization, and confirmation of groundwater contamination. In this process, data are assessed and sites are evaluated to determine: (1) if a release of contaminants has occurred, and (2) if present, what type of contamination exists.

3.1 DATA QUALITY OBJECTIVES (DQO) The intended use of data and the required data quality objectives (DQOs) are best defined during the planning stages to ensure that collection, decontamination, containerization, shipping, and analytical methods are consistent with the degree of confidence required of the resultant data. The following sections provide a brief description of DQO levels and identifies the levels associated with each RFI/SI field task.

3.1.1 Data Quality Objectives (DQO), General Description DQOs refer to standards for analytical precision, accuracy, reproducibility, completeness, and comparability. Five DQO levels have been defined: Level I, Field Screening; Level II, Field Analysis; Level III, Laboratory Analysis; Level IV, Contract Laboratory Program-Routine Analytical Services (CLP-RAS); and Level V, Non-Conventional Parameter Analysis (USEPA, 1991c).

Task specific DQOs for this study range from Level I, primarily for initial screening activities, Level II for field measurements, to Level III for characterization and confirmation sampling.

3.2 PRELIMINARY ACTIVITIES.

3.2.1 Subcontractor Coordination Upon receipt of notice to proceed, the contractor will contact all appropriate subcontractors to finalize any remaining contractual matters and plan the mobilization and related activities associated with field work for each site. Coordination activities include: scheduling, staffing, and procurement of all personnel, materials, equipment, and supplies required to complete the proposed work. Such subcontractors may include drillers, land surveyors, and analytical laboratories.

3.2.2 Permitting, Authorization, and Site Access In conjunction with subcontractor scheduling, the contractor will ensure that the necessary authorization and approval is secured for all personnel scheduled for field activities. The Environmental Coordinator, Mr. James More, at the NSB Kings Bay will be contacted to arrange authorization of the appropriate contractor identification badges for contractor and subcontractor personnel. Such badges will permit authorized personnel to enter specified areas on the NSB Kings Bay facility during daylight hours for the purpose of completing approved field work. In addition, the contractor will ensure that all necessary permits have been obtained prior to mobilization for field work.

3.2.3 Utility Identification and Location Prior to mobilization for field work, the contractor will coordinate with, Mr. James More, NSB Kings Bay PWD, to identify and locate all underground utilities and other underground structures, as well as overhead utilities at each site that may obstruct field activities. Upon mobilization to the field, the contractor will work with base personnel to

mark each utility for future reference. This will be done to minimize the risk of jeopardizing the health and safety of field personnel or the integrity of the utility. Identification and location of utilities may include referring to blueprints and using electronic equipment in the field for physical location of utility lines. NSB Kings Bay will assume final responsibility for the location and identification of utilities or other subsurface structures.

3.3 GENERAL DESCRIPTION OF FIELD INVESTIGATIVE TASKS. The purpose of the RFI/SI field program is to characterize the waste and containment systems and determine if a release of contaminants to the environment has occurred.

The investigative methods that will be used to collect data are briefly discussed in this section. A more detailed discussion of each method, including decontamination and waste disposal procedures, is presented in Part A of the SAP (Field Sampling and Analysis Plan). Details concerning site-specific investigation and sampling activities are discussed in Section 4.0 of this Workplan. Quality assurance and quality control procedures are detailed in Part B of the SAP (Quality Assurance Project Plan).

3.4 DATA ASSESSMENT. Data collected from investigation activities include field observation data, geophysical survey data, and laboratory analytical data. The ultimate data uses include site characterization, the assessment of potential risk to human health and the environment, and the development of effective remedial measures, where necessary.

Field observation and geophysical surveys provide real-time qualitative data and level I quantitative data. This information is useful for site characterization and for determining strategic sampling locations. Laboratory analytical data provides qualitative and quantitative confirmation data concerning the type, quantity, and distribution of contaminants.

Analytical data will conform to level III data validation requirements. The analyzing laboratory must be approved by NEESA and be capable of performing level IV work if requested. Also, the laboratory data must be validated and assessed to determine the validity of the data and to ensure that DQOs are met. Sample results are validated through evaluation of field QA/QC procedures (field blanks, matrix spikes and matrix spike recoveries) and laboratory internal standards and controls. Data validation reviews the QA/QC data to assure that analytical results fall within acceptable accuracy and precision confidence limits, and to eliminate, correct, or flag matrix and other interference effects. Validated data are summarized and organized into formats that facilitate data evaluation.

The project sampling location data base will use the State Plane Coordinates. For presentation to USEPA, sampling locations and laboratory analytical data will be organized and reported in accordance with USEPA Locational Data Policy and Region IV Environmental Monitoring and Data Reporting Requirements (Appendix C). These requirements were developed to provide a national standardized reporting system for locating and tracking environmental data.

3.4.1 Data Evaluation Chemical and physical data collected during the RFI/SI will be used to characterize the site and to evaluate the potential levels of risk posed to human health and the environment. Physical data (groundwater elevations and flow, soil composition, hydraulic conductivity, etc.) and chemical

data will be integrated to form a conceptual overview of the site. Chemical data will be compared to Applicable Relevant and Appropriate Requirements (ARARs) and contaminants of concern will be identified. Table 3-1 lists State of Georgia ARARs for toxic priority pollutants.

If contamination is reported above ARARs the contractor will recommend additional contamination investigation designed to delineate the source and groundwater contamination. Groundwater, solute transport, geochemical, and/or ecosystem fate and transport modeling may be performed after initial data evaluation.

Ultimately, the data collected will be evaluated to support "no further action" or remedial action decisions. Remedial action evaluations may require additional investigations beyond the scope of this initial investigation.

TABLE 3-1

STATE OF GEORGIA ARARs FOR TOXIC PRIORITY POLLUTANTS

1.	Antimony	4308	µg/l
2.	Arsenic	0.14	µg/l
3.	Beryllium	0.117	µg/l
4.	Thallium	48	µg/l
5.	Acrolein	780	µg/l
6.	Acrylonitrile	0.665	µg/l
7.	Benzene	71.28	µg/l
8.	Bromoform (Tribromomethane)	470.8	µg/l
9.	Carbon Tetrachloride	4.42	µg/l
10.	Chlorobenzene	20	µg/l
11.	Chlorodibromomethane	470.8	µg/l
12.	2-Chloroethylvinyl Ether	17.6	µg/l
13.	Chloroform (Trichloromethane)	470.8	µg/l
14.	Dichlorobromomethane	470.8	µg/l
15.	1,2-Dichloroethane	95.6	µg/l
16.	1,1-Dichloroethylene	3.2	µg/l
17.	1,3-Dichloropropylene (Cis)	31.3	µg/l
18.	1,3-Dichloropropylene (Trans)	31.3	µg/l
19.	Ethylbenzene	28718	µg/l
20.	Methyl Bromide (Bromomethane)	470.8	µg/l
21.	Methyl Chloride (Chloromethane)	470.8	µg/l
22.	Methylene Chloride	1578	µg/l
23.	1,1,2,2-Tetrachloroethane	10.8	µg/l
24.	Tetrachloroethylene	8.85	µg/l
25.	Toluene	301941	µg/l
26.	1,2-Trans-Dichloroethylene	136319	µg/l
27.	1,1,2-Trichloroethane	41.99	µg/l
28.	Trichloroethylene	80.7	µg/l
29.	Vinyl Chloride	525	µg/l
30.	2-Chlorophenol	0.1	µg/l
31.	2,4-Dichlorophenol	0.3	µg/l
32.	2,4-Dimethylphenol	400	µg/l
33.	2-Methyl-4,6-Dinitrophenol	765	µg/l
34.	2,4-Dinitrophenol	14264	µg/l
35.	3-Methyl-4-Chlorophenol	3000	µg/l
36.	2,4,6-Trichlorophenol	3.6	µg/l
37.	Acenaphthene	20	µg/l
38.	Acenaphthylene	.0311	µg/l
39.	Anthracene	.0311	µg/l
40.	Benzidine	.000535	µg/l
41.	Benzo(a)Anthracene	.0311	µg/l
42.	Benzo(a)Pyrene	.0311	µg/l
43.	3,4-Benzofluoranthene	.0311	µg/l
44.	Benzo (ghi)Perylene	.0311	µg/l
45.	Benzo(k)Fluoranthene	.0311	µg/l
46.	Bis(2-Chloroethyl)Ether	1.42	µg/l
47.	Bis(2-Chloroisopropyl)Ether	4360	µg/l
48.	Bis(2-Ethylhexyl)Phthalate	5.92	µg/l
49.	Chrysene	.0311	µg/l
50.	Dibenzo(a,h)Anthracene	.0311	µg/l
51.	1,2-Dichlorobenzene	2600	µg/l
52.	1,3-Dichlorobenzene	2600	µg/l
53.	1,4-Dichlorobenzene	2600	µg/l
54.	3,3'-Dichlorobenzidine	0.02	µg/l
55.	Dimethyl Phthalate	2900000	µg/l
56.	Di-n-Butyl Phthalate	12100	µg/l
57.	2,4-Dinitrotoluene	9.1	µg/l
58.	1,2-Diphenylhydrazine	0.54	µg/l
59.	Fluoranthene	54	µg/l
60.	Fluorene	0.031	µg/l
61.	Hexachlorobenzene	0.00074	µg/l
62.	Hexachlorobutadiene	49.7	µg/l
63.	Hexachlorocyclopentadiene	1.0	µg/l
64.	Hexachloroethane	8.85	µg/l
65.	Indeno(1,2,3-cd)Pyrene	0311	µg/l
66.	Isophorone	520000	µg/l
67.	Nitrobenzene	30	µg/l
68.	N-Nitrosodimethylamine	8.12	µg/l
69.	N-Nitrosodi-n-Propylamine	8.55	µg/l
70.	N-Nitrosodiphenylamine	16.2	µg/l
71.	Phenanthrene	.0311	µg/l
72.	Pyrene	.0311	µg/l
73.	1,2,4-Trichlorobenzene	15385	µg/l
74	Aldrin	0.000136	µg/l
75.	a-BHC-Alpha	.0131	µg/l
76.	b-BHC-Beta	.046	µg/l
77.	Lindane [Hexachlorocyclohexane (g-BHC-Gamma)]	.0625	µg/l
78.	Chlordane	0.000588	µg/l
79.	4,4'-DDT	0.00059	µg/l
80.	Dieldrin	0.000144	µg/l
81.	Heptachlor	0.000214	µg/l
82.	Heptachlor Epoxide	0.000214	µg/l
83.	PCB-1242	0.00045	µg/l
84.	PCB-1254	0.00045	µg/l
85.	PCB-1221	0.00045	µg/l
86.	PCB-1232	0.00045	µg/l
87.	PCB-1248	0.00045	µg/l
88.	PCB-1260	0.00045	µg/l
89.	PCB-1016	0.00045	µg/l

REFERENCE: The Environmental Reporter, 30 August 1991. "Georgia Water Quality Control Regulations and Standards".

4.0 TECHNICAL APPROACH

The RFI/SI activities for NSB Kings Bay will consist of project management, project support, field investigations, data analysis and evaluation, and report preparation. The field investigation serves as the mechanism for data collection. The proposed field activities are based on several considerations including: (1) the physical characteristics and geographic location of the site, (2) site history, and (3) site reconnaissance. This study contains the following tasks.

4.1 TASK 1, PROJECT MANAGEMENT. Project management at NSB Kings Bay will include, but is not limited to, the following.

- The Task Order Manager will prepare monthly technical and financial reports for approximately 24 months. These monthly reports will summarize activities of the previous month, identify problem areas and project work for the next period.
- The Task Order Manager will be the primary point of contact for the Navy Engineer-in-Charge (EIC) and will notify the EIC of any problems, delays, or changes in the schedule of work.
- The Task Order Manager will respond to any questions or issues raised by the regulators, local residents, or base personal.
- The Task Order Manager will participate in and provide minutes for meetings with the EIC or Federal and State regulators.

4.2 TASK 2, PRELIMINARY FIELD ACTIVITIES. Preliminary field activities include organization, coordination, and initial setup for field activities.

4.2.1 Procurement of Subcontractors and Mobilization Before initiation of field activities, various mobilization tasks must be completed to ensure an efficient field sampling program. Immediately following receipt of notice to proceed, a technical and performance specification will be prepared to assist in the procurement of drilling, surveyor, and laboratory subcontractors. All subcontractor specifications will be written to follow the Sampling and Analysis Plan (Appendix A).

A schedule for initiating and completing the drilling and sampling activities will be developed.

4.2.2 Geophysical Survey. A geophysical survey of the sites will be performed before the beginning of drilling activities. A magnetometer survey will be performed at sites 5 and 16. A terrain electromagnetic conductivity (EM-31) survey will be performed at site 11. If the magnetometer survey identifies the disposal pits at Sites 5 and 16, an EM-31 survey will be performed at those sites, also.

4.3 TASK 3, FIELD INVESTIGATIONS, SOIL BORINGS, AND MONITORING WELL INSTALLATION. This section identifies the field tasks to be performed at the sites. Some tasks are common to all sites and others are site specific. Activities unique to a site will be discussed in the site-specific section.

4.3.1 Investigative Activities Common To All Sites Investigative activities common to all three sites at NSB Kings Bay include: aquifer characterization, sample location surveying, decontamination, and disposal of investigation derived waste.

For health and safety reasons, invasive sampling techniques (i.e., drilling and auguring) will not be performed within the boundaries of the Site 11 (Camden Landfill). Sampling locations beyond the boundary of the disposal areas can generally provide sufficient characterization and delineation data. Hand auguring will be performed at Sites 5 and 16. Reportedly, these two sites contained mostly tree debris. Augering will be stopped if material other than tree debris is found.

4.3.1.1 Aquifer Characterization A minimum of four rising head slug tests will be conducted at each site to obtain an estimate of the horizontal hydraulic conductivity of each water bearing zone. These tests can provide estimates for calculating groundwater transport parameters, potentially identify highly transmissive zones, and can provide preliminary data for groundwater transport modeling. A technical memorandum for conducting a slug test is presented in the SAP (Appendix A).

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

The inner casing (riser) for the monitoring wells will be surveyed for both horizontal and vertical control to a degree of accuracy of 0.1 and 0.01 foot, respectively.

Sampling locations and other control points will be plotted on site-specific base maps. In addition, the survey data will be organized and reported using State Plane Coordinates and USEPA Locational Data Policy and Region IV Environmental Monitoring and Data Reporting Requirements (Appendix C). These documents require the identification of sampling locations in terms of latitude and longitude coordinates according to the Federal Interagency Coordinating Committee for Digital Cartography (FICCDC) recommendations.

4.3.2 Field Investigation Activities For Site 5 Seven monitoring wells will be installed at Site 5 to determine the composition and magnitude of any groundwater contamination. The regional groundwater flow direction is toward the east. Local hydrologic features include two streams; east and northwest of the site. Piezometers cannot be used to determine the historical groundwater flow direction because a borrow pit was recently constructed which changed the local hydrology on a limited scale. Unless other information becomes available to help define a plume, monitoring wells will be installed on each side of the cleared area containing the landfill. Figure 4-1 shows the approximate location of the monitoring wells. The field geologist in conjunction with the Navy and

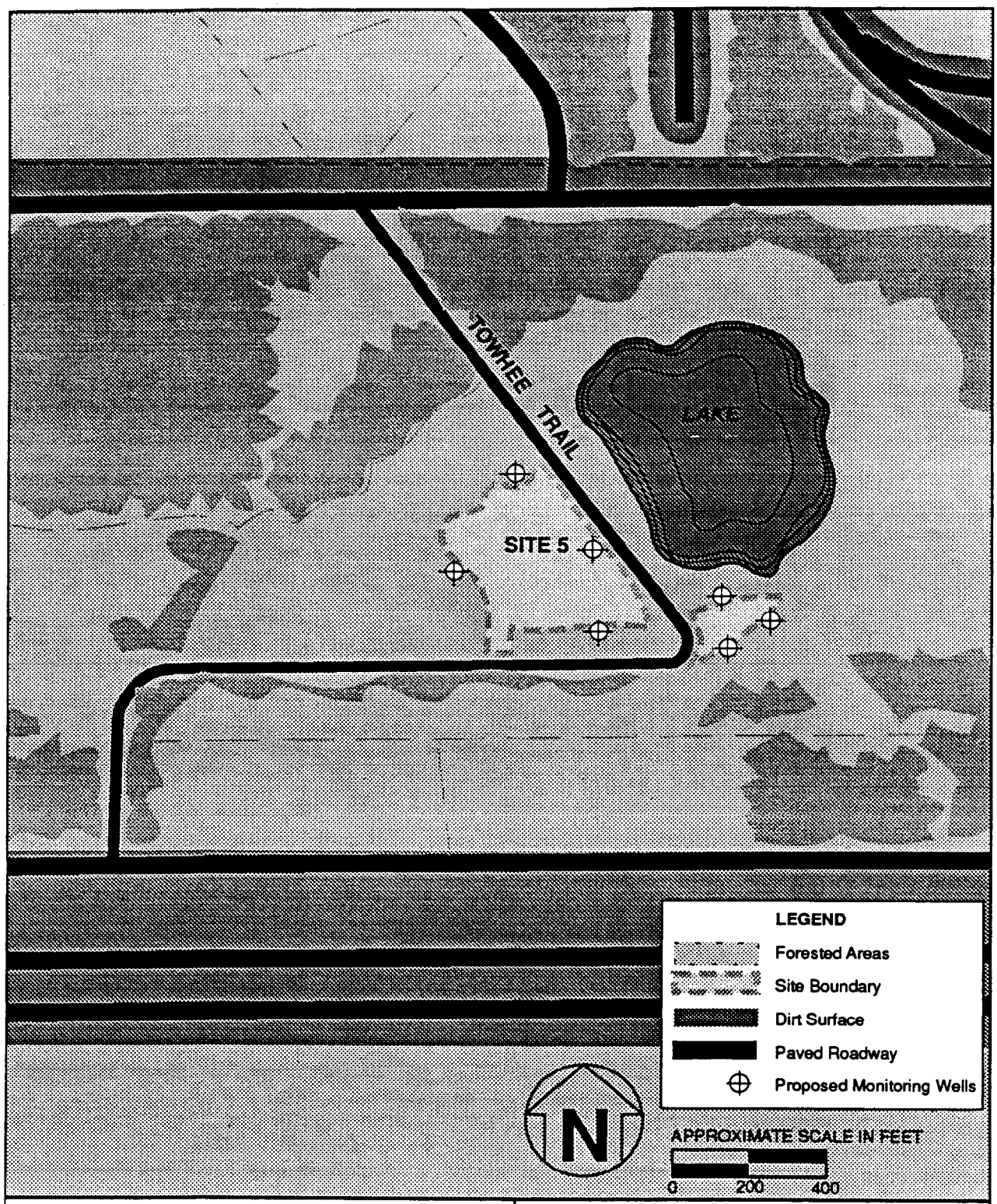


FIGURE 4-1
SITE 5
ARMY RESERVE DISPOSAL AREA
TOWHEE TRAIL LOCATION OF
PROPOSED MONITORING WELLS

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regulatory agencies will choose the exact location in the field based on the information available at that time.

During the construction of selected monitoring wells, continuous split-spoon sampling will be conducted to obtain lithologic information. Soil collected from the split spoon will be screened onsite with an organic vapor analyzer (OVA) for the presence of organic vapors. Also, a subsurface soil sample will collected at the water table interface during the construction of each monitoring well.

Drill cuttings generated during the installation of the monitoring wells, present a minimum risk to the environment. A pit located inside the designed site area shall be used as a disposal area for the drill cuttings. The field geologist will designate an undisturbed area of the site for the pit. The pit will be covered at the end of each day.

Decontamination fluids will be collected and drummed. The contractor shall transport the drums to the base's industrial wastes water treatment facility for disposal.

Other liquid wastes, such as well development and purge water, will be screened by an OVA or PID before disposing of them onsite. Water with OVA or PID readings above background will be drummed and transported to the base's industrial waste water treatment facility for disposal. Water discharged onsite will be contained until it either evaporates or percolates into the ground. No surface runoff into surrounding surface water body will be permitted.

A magnetometer will be used to locate and delineate fill areas of fill-cells containing ferric materials. The survey team will grid the site into 20 by 20 foot sections. The first row will be parallel to the east-west road located to the south of the site. The team will record magnetometer at each grid intersection or node. The survey team will return to each node with abnormally high values and intensely assess the area around the node. The magnetometer values will be plotted as contour lines onto a site map.

A terrain conductivity survey (EM-31) will be performed around each fill-cell identified during the magnetometer survey. If no fill-cells are identified, then the conductivity survey will be performed around the entire site. The survey will consist of two parallel transect lines 10 feet apart. The first transect will follow the fill-cell's suspected parameter. The survey team will record the terrain conductivity measurements at 10 feet intervals along the transect lines. A site map with the conductivity values plotted as contour lines will be created for the technical memorandum.

Seven shallow soil samples will be collected to characterize the waste material. The exact location of each sample will be determined by the field geologist. The geologist will attempt to take the sample from the fill cells identified during the magnetometer survey. Samples will be collected using hand-auguring techniques. The auguring will proceed until a visual change in the soil appears and the samples will be collected from this altered zone.

4.3.3 Field Investigation For Site 11 Twelve monitoring wells will be installed around the entire site to determine the composition and magnitude of any groundwater contamination (Figure 4-2). The exact location of the monitoring wells will be determined by the field geologist and Mr. James More, NSB Kings Bay Environmental Coordinator (EC). Criteria that will be used to locate the wells are as follows:

- close to the boundary of known disposal area,
- background well at Site 11 outside the influence of the localized radial flow network,
- place wells in areas of suspected groundwater contamination detected by non-invasive investigation techniques.
- one background wells will be installed upgradient of the site,
- a minimum of two wells will be installed upgradient of the site,
- a minimum of four wells will be installed downgradient of the site,
- at least one well will be installed on each side of the landfill, and
- a minimum of one well will be installed every 400 feet across the suspected path of the plume.

In between each monitoring well located every 400 feet across the plume a Terraprobe will be used to further delineate lithologic information.

During the construction of selected monitoring wells, continuous split-spoon sampling will be conducted to obtain lithologic information. Soil collected from the split spoon will be screened onsite with an OVA for the presence of organic vapors. Also, a subsurface soil sample will be collected at the water table interface during the construction of each monitoring well.

All wells are to be installed along the perimeter of the site. No wells shall be installed directly into fill material. Therefore, drill cuttings generated during the installation of these monitoring wells, present a minimum risk to the environment. A pit located inside the designated site area shall be used as a disposal area for the drill cuttings. The field geologist will locate the pit in an disturbed area of the site. The pit will be covered at the end of each day.

Decontamination fluids will be collected and drummed. The contractor shall transport the drums to the base's industrial wastewater treatment facility for disposal.

Other liquid wastes, such as well development and purge water, will be screened by an OVA or PID before disposing of them onsite. Water with OVA or PID readings above background will be drummed and transported to the base's industrial waste water treatment facility for disposal. Water discharged onsite will be contained until it either evaporates or percolates into the ground. No surface runoff into surrounding surface water body will be permitted.

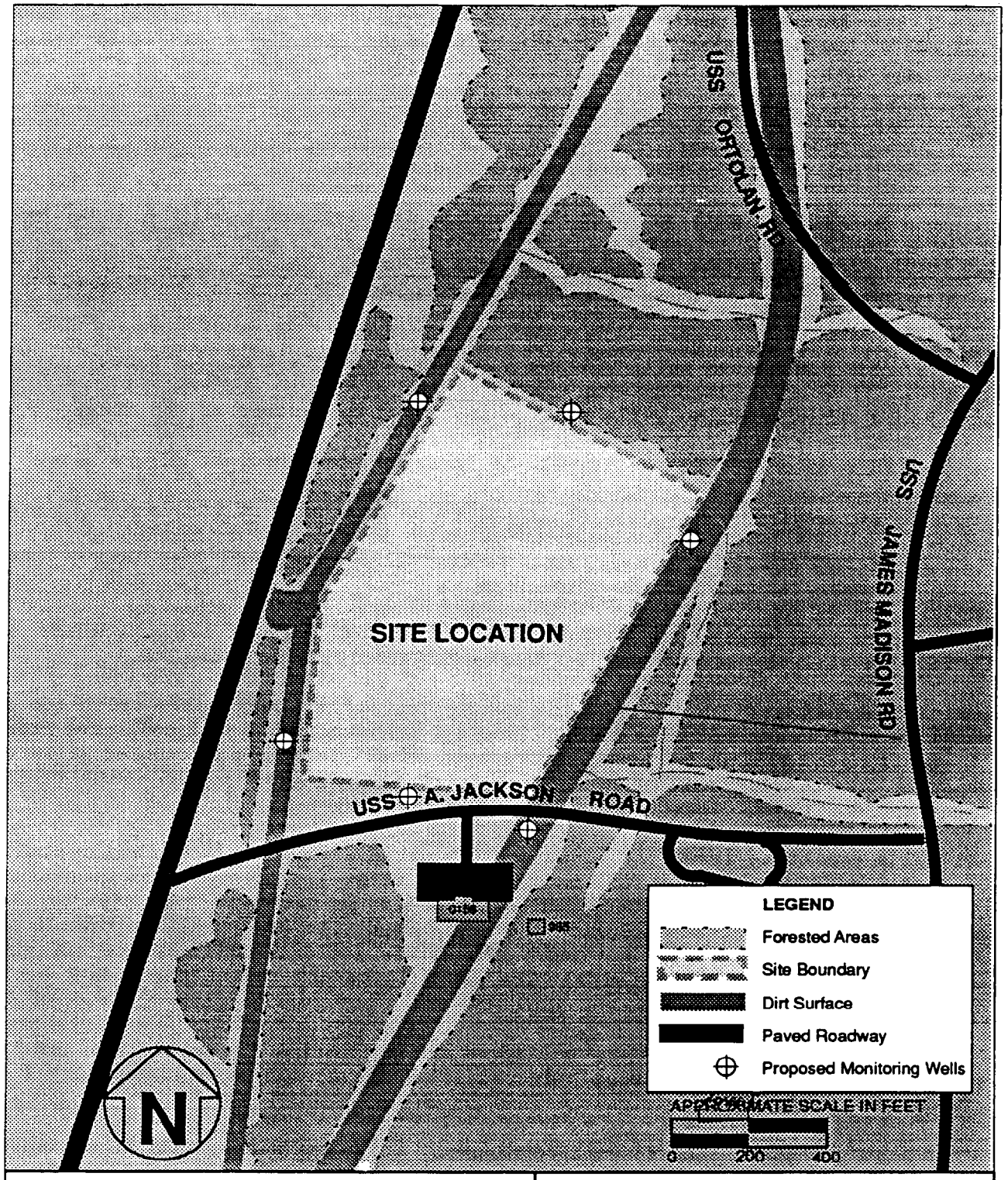

FIGURE 4-2
SITE 11
OLD CAMDEN COUNTY LANDFILL
LOCATION OF PROPOSED MONITORING WELLS

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A terrain conductivity survey (EM-31) will be performed around Site 11. The survey will consist of two transects around the perimeter of the landfill. The first transect line will parallel the perimeter fence at approximately 15 feet further out. This displacement should avoid interference from the metallic fence. The second transect will be another 10 feet out and parallel to the first. The survey team will collect conductivity measurement every 10 feet along the transect. The survey team may delineate anomalies by performing additional transects as needed. A site map with the conductivity values plotted as contour lines will be prepared in the technical memorandum.

4.3.4 Field Activities For Site 16 Four monitoring wells will be installed at Site 16 to determine the composition and magnitude of any groundwater contamination. The regional groundwater flow direction is toward the east. Local hydrological features include a stream to the north that drains into an estuarine environment adjacent to the site. Figure 4-3 presents the approximate location of each monitoring well. The exact location will be determined by the field geologist and EC. The well locations will include one upgradient and three downgradient wells.

During the construction of selected monitoring wells, continuous split-spoon sampling will be conducted to obtain lithologic information. Soil collected from the split spoon will be screened onsite with an OVA for the presence of organic vapors. A subsurface soil sample will collected during the construction of each monitoring well, for a total of four subsurface samples.

Drilling cuttings, generated during the installation of these monitoring wells, present a minimum risk to the environment. However, storage of the drill cuttings may interfere with current construction activities. Drill cutting materials will be drummed and properly labeled as hazardous material. The drums will be transported by the contractor to the base hazardous waste storage area. The Navy will then be responsible for disposal of the drums. Decontamination fluids will be collected and drummed. The contractor shall transport the drums to the base's industrial wastewater facility for disposal.

Other liquid wastes, such as well development and purge water, will be screened by an OVA or PID before disposing of them onsite. Water with OVA or PID readings above background will be drummed and transported to the base's industrial waste water treatment facility for disposal. Water discharged onsite will be contained until it either evaporates or percolates into the ground. No surface runoff into surrounding surface water body will be permitted.

A magnetometer survey will be performed at Site 16 to locate fill-cells containing metallic objects. The survey consist of griding the site into 20 by 20 foot sections. The grid will be oriented parallel and perpendicular to the existing east-west fence. The survey team will record magnetometer measurement at each grid intersection or node. Current construction activities may interfere with the magnetometer survey in some areas. The survey team will return to each node with abnormally high values (unless the value is the result of interference from construction activities) and intensely assess the area around that node. The magnetometer values will be plotted as contours line onto a site map.

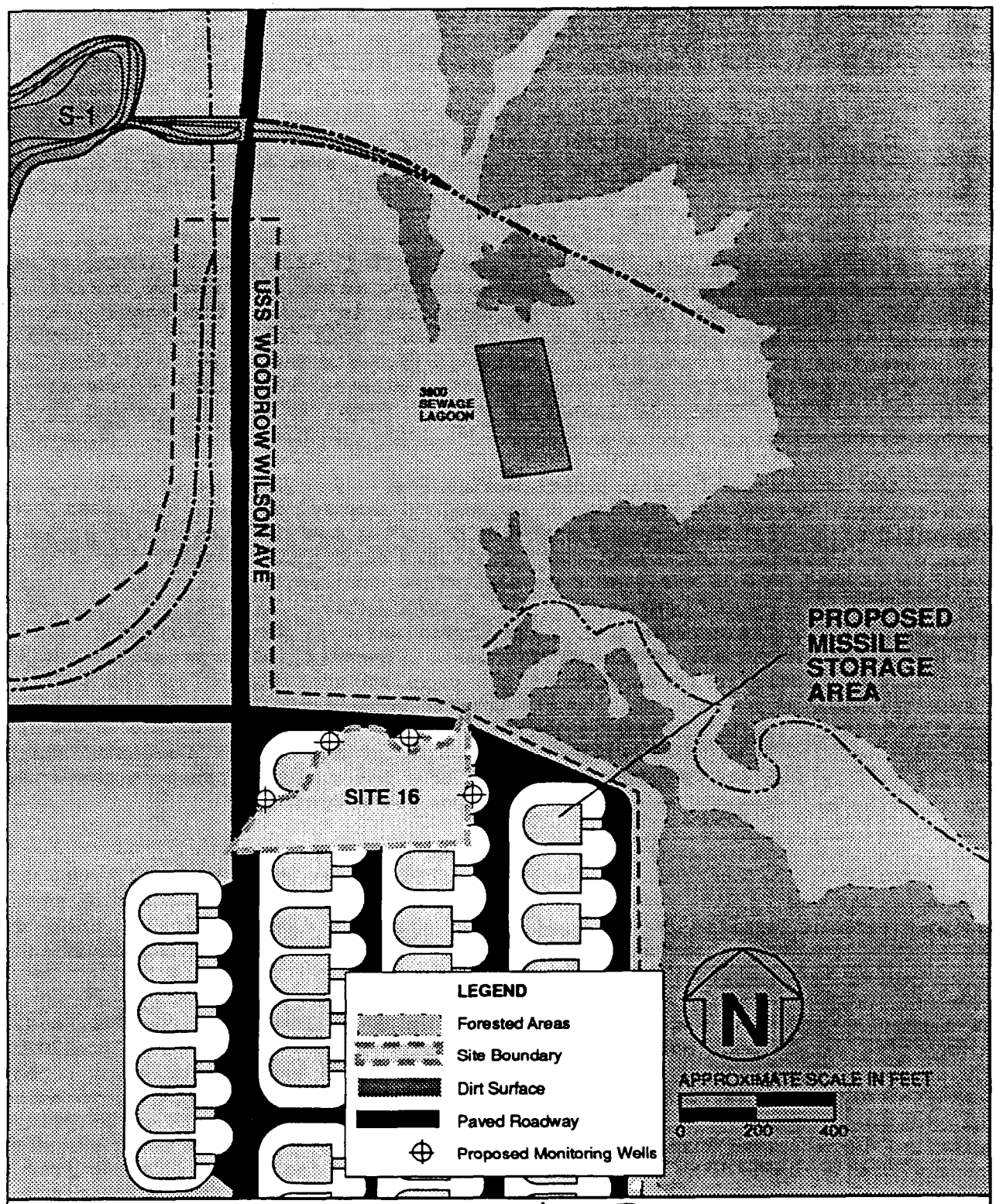

FIGURE 4-3
SITE 16
ARMY RESERVE DISPOSAL AREA
LOCATION OF PROPOSED
MONITORING WELLS

RFI/SI WORKPLAN

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If fill-cells are identified, then a terrain conductivity survey will be preformed. The survey will consist of two parallel transect lines 10 feet apart. The first transect shall follow the fill-cells's suspected perimeter. The survey team will record the terrain conductivity measurements at 10 feet intervals along the transect lines. A site map with the conductivity values plotted as contour lines will be created for the technical memorandum.

If the pits are located during the magnetometer survey or by other identification methods, four soil samples will be collected using hand-auguring techniques. The auguring will proceed until a visual change in the soil appears. The samples will be collected from this altered zone.

4.4 TASK 4, SAMPLING. Surface and subsurface soil samples will be collected as part of the drilling activities. The number of soil and monitoring well locations may vary depending on the above criteria. The exact number of samples has not been established, however, to facilitate the project costing and schedule required to perform each activity, the following values will be used.

Site	Surface Soils	Subsurface Soils	Monitoring Wells
Site 5	7	7	7
Site 11	0	12	12
Site 16	0	4	4
Total	7	23	23

Groundwater samples will be collected every 2 months for 1 year (six sets of samples). Field measurements (i.e., pH, temperature, and specific conductance) will be collected during each sampling event. Sample collection shall comply with the Navy CLEAN SOP.

4.5 TASK 5, CHEMICAL ANALYSIS. The chemical analysis task shall include contract laboratory oversight, analysis of six sets of samples, and the production of a technical memoranda for each sampling event. Laboratory oversight includes coordination with the laboratory, data acquisition and filing, completion of a sample identification matrix, and compilation of laboratory data for data entry. Laboratory coordination includes laboratory procurement, preparation of laboratory requests, and the day-to-day correspondence with the laboratory.

The laboratory shall be NEESA approved. Both NEESA and the contractor will make periodical inspections and audits of the laboratory facilities, in accordance with Chapter 4.0. of the SAP.

Soil and groundwater samples will be analyzed for Appendix IX parameters and be in conformance with level III DQOs. A table listing the Appendix IX parameters is located in Appendix A, Sampling and Analysis Plan. ABB-ES will recommend to the Navy that they remove from the parameter list any parameters not found during the first two rounds of analysis. Georgia Environmental Protection Division

(GEPD), and the Navy must approve the removal of a parameter before it will be deleted from the analysis list.

All sample collection shall conform to the Navy Clean SOP. The SOP procedures for chain-of-custody shall be followed during collecting, shipping, and laboratory analysis of each sample.

4.6 TASK 6, DATA VALIDATION. The data validation task evaluates the quality of data for use in the data evaluation task. This validation is in addition to the standard laboratory QA/QC review. The process includes the following activities:

- auditing the measurement system calibration and verifying the calibration,
- auditing quality control activities,
- reviewing data for technical credibility versus the sample site setting,
- auditing field sample data records and chain-of-custody,
- checking intermediate calculations, and
- documenting the process.

Level III data validation packages will be generated for this RFI/SI. A summary of the QA/QC sample analysis is presented in Table 4-1.

4.7 TASK 7, DATA EVALUATION AND INTERPRETATION. Data evaluation is the process of organizing validated data into a working format and then reviewing and using the data to meet the project DQOs. This task involves reviewing the data in terms of comparability and completeness as required by the DQOs. The DQOs for this site are defined as:

- documenting if a contaminant release to the environment has occurred,
- characterizing the waste, and
- characterizing the containment system.

The data evaluation task includes data compilation, data reduction, and database management. Field and laboratory data will be organized by site and sample matrix. Pertinent data will be organization and entered into a computer database. Data reduction will result in the production of various tables, figures, and drawings describing and summarizing the pertinent site features.

4.8 TASK 8, HAZARD RANKING SYSTEM II (HRS II). The HRS II task includes data acquisition, and evaluation. Data required to complete the HRS II scoring that will be obtained for each site during the RFI/SI include: the use or existence of containment structures, source waste characterization and whether an observed release can be established. The existing data will be evaluated and any new data acquired during the study will also be evaluated. Any data gaps that still exist will be identified and recommendations will be made to acquire these data. Table 4-2 lists the HRS II data requirements and the current status of the data.

Table 4-1
Summary of QA/QC Samples Per Matrix

Summary of Sampling Activities
Analysis

	A	B	C	D	Totals
Site 5 Surface Soils					
Number of Soil Samples	7	7	7	7	28
Number of Trip Blanks		1			1
Number of Rinsates*	1	1	1	1	4
Number of Field Blanks	2	2	2	2	8
Number of Field Duplicates	1	1	1	1	4
Number of Additional Samples**	2	2	2	1	7
Site 5 Soil Borings					
Number of Soil Samples	7	7	7	7	28
Number of Trip Blanks		1			1
Number of Rinsates*	1	1	1	1	4
Number of Field Blanks	2	2	2	2	8
Number of Field Duplicates	1	1	1	1	4
Number of Additional Samples**	2	2	2	1	7
Site 5 Groundwater					
Number of Groundwater Samples	7	7	7	7	28
Number of Trip Blanks		1			1
Number of Rinsates*	1	1	1	1	4
Number of Field Blanks	2	2	2	2	8
Number of Field Duplicates	1	1	1	1	4
Number of Additional Samples**	2	2	2	1	7
Site 16 Surface Soils - 0 to 4 samples					
Number of Soil Samples	4	4	4	4	16
Number of Trip Blanks		1			1
Number of Rinsates*	1	1	1	1	4
Number of Field Blanks	2	2	2	2	8
Number of Field Duplicates	1	1	1	1	4
Number of Additional Samples**	2	2	2	1	7
Site 16 Soil Borings 4 samples					
Number of Soil Samples	4	4	4	4	16
Number of Trip Blanks		1			1
Number of Rinsates*	1	1	1	1	4
Number of Field Blanks	2	2	2	2	8
Number of Field Duplicates	1	1	1	1	4
Number of Additional Samples**	2	2	2	1	7

Table 4-1 (Continued)
Summary of QA/QC Samples Per Matrix

	Summary of Sampling Activities Analysis				
	Site 5 Surface Soils				
	A	B	C	D	Totals
	Site 16 Groundwater 4 samples				
Number of Groundwater Samples	4	4	4	4	16
Number of Trip Blanks		1			1
Number of Rinsates*	1	1	1	1	4
Number of Field Blanks	2	2	2	2	8
Number of Field Duplicates	1	1	1	1	4
Number of Additional Samples**	2	2	2	1	7
	Site 11 Soil Borings Surface - 10 to 18 samples				
Number of Soil Samples	18	18	18	18	72
Number of Trip Blanks		1			1
Number of Rinsates*	1	1	1	1	4
Number of Field Blanks	2	2	2	2	8
Number of Field Duplicates	2	2	2	2	8
Number of Additional Samples**	2	2	2	1	7
	Site 11 Groundwater - 10 to 19 samples				
Number of Groundwater Samples	19	19	19	19	76
Number of Trip Blanks		1			1
Number of Rinsates*	1	1	1	1	4
Number of Field Blanks	2	2	2	2	8
Number of Field Duplicates	2	2	2	2	8
Number of Additional Samples**	2	2	2	1	7

Notes: A = semivolatiles
B = volatiles
C = pesticides/PCB
D = Metals

* = One rinsate is needed for each equipment used to obtain sample for each type of matrix per day.
** = Additional samples include matrix spikes (duplicates).

Table 4-2
FACILITY BACKGROUND INFORMATION CHECKLIST

Installation Name	A
Installation Location (city, county, state, latitude and longitude)	A
Service Branch	A
EPA Identification Number	B
Installation Commanding Officer	B
Installation Environmental Officer or Coordinator	A
Installation Environmental Command or Agency Contact	A
Installation Major Command or Headquarters Contact	B
History/Years of Operation	A
Nature of Operations (training, manufacturing, storage, etc.)	A
Primary and Secondary Missions of the Installation	A
Physiographic Division and Province	C
Previous Investigations	A
Topographic Setting	A
Geographic Features	A
Enviromental Setting	
geology	A
geohydrology	
surface water bodies	C
wetlands/sensitive enviroments	C
Demographic Setting	C
Permits (CERCLA, RCRA, NPDES, Other)	B
Notice of Violations	B
Viable Migration Pathways	B
Disposal History	A
Current Conditions (sources and locations)	B
Identify the 1/4, 1/2, 1, 2, 3, and 4-mile radii from each source	C
Hazardous Substances Associated with Each Source	B
Waste Quantities for Each Source	A
Containment Structures Present at Each Source Area	B
Hazardous Waste Types Generated by Installation Operations	B
Hazardous Substances Present on Installation	B

Table 4-2 (Continued)
CHECKLIST FOR THE PATHWAY EVALUATION OF SOURCE AREAS, HAZARDOUS SUBSTANCES, AND SCORING

Evaluate all of the following pathways to determine the overall HRS II site score.

• groundwater migration	C
• surface water migration	C
• soil exposure	C
• air migration	C
Identify all source areas at the installation.	A
Identify all hazardous substances associated with each source.	B
Evaluate the likelihood to release factor category.	C
Determine if an observed release can be identified.	B
If no observed release can be established, evaluate the potential to release.	C
Score the likelihood to release factor category for each pathway.	C
Evaluate the waste characteristics applicable to each pathway (toxicity, mobility, persistence, bioaccumulation,radioactivity, hazardous constituent quantity.)	C
Evaluate the hazardous waste quantity for each source.	C
Score the waste characteristics factor category for each pathway.	C
Evaluate the targets for each pathway.	C
Score the targets factor category for each pathway.	C
Calculate each pathway score.	C
Calculate the HRS II site score.	C

Table 4-2 (Continued)
GROUNDWATER PATHWAY SCORE CHECKLIST

General Information

Collect and evaluate the following data:

engineering data (describe the use or existence of containment structures),	B
chemical data (include analytical chemical data for groundwater within the target distance limit),	B
climatological data (include monthly average precipitation, temperature and evapotranspiration for the installation),	C
demographic data (determine the total number of people served by groundwater within the 4-mile target distance), and	C
hydrogeological data (include stratigraphic unit names, unit compositions, unit thickness, hydraulic conductivities, discontinuities, presence of karst units, aquifer thickness and depth, confining layers, and groundwater flow direction.	C

Likelihood of Release

Can an observed release be established? (If yes, demonstrate its existence through direct observation or chemical analysis.)	B
Evaluate the potential to release based on containment, note precipitation, depth to aquifer, and travel time.	C

Waste Characteristics

Determine the toxicity and mobility factors for each hazardous substance.	C
Calculate the hazardous waste quantity for each source based on hazardous constituent quantity, hazardous wastestream quantity, volume, or area.	C

Targets Evaluation

Identify the nearest potable water well to each source area and level of contamination, if any, in the groundwater from each well.	C
Identify and document all private wells and municipal water system wells serving the target population.	C
Determine the population served by groundwater that is subject to Level I concentrations, Level II concentrations, and potential contamination.	C
For the potential contamination category, estimate the population served by groundwater in the following seven distance zones: 0 to 1/4, 1/4 to 1/2, 1/2 to 1, 1 to 2, 2 to 3, 3 to 4, and greater than 4 miles.	C

Table 4-2 (Continued)
GROUNDWATER PATHWAY SCORE CHECKLIST

General Information

Determine if groundwater is used for the following:

• irrigation (5-acre minimum),	C
• watering of commercial livestock,	C
• commercial food preparation,	C
• commercial agriculture, or	C
• supply for a major or designated water recreation area.	C
Determine if any State or local Wellhead Protection Areas have been designated within the target limit distance.	C
Validate Total Pathway Score	C

Table 4-2 (Continued)
SURFACE WATER PATHWAY SCORE CHECKLIST

General Information

Collect and evaluate the following data:

engineering data (describe the use or existence of containment structures),	B
chemical data (include analytical chemical data for groundwater and surface water within the target distance),	B/C
climatological data (include monthly average precipitation, temperature, and evapotranspiration for the installation or surrounding area),	C
demographic data (estimate the total number of people served by surface water from intakes along the 15-mile target distance),	C
hydrogeological data (include the same information presented in the groundwater pathway checklist), and	C
surface water data (include surface water uses, intakes for 15 downstream miles from the source area, distance to surface water bodies from the source, drainage area, surface soil group, flood containment, flood frequency, designated surface water recreational areas, sensitive environments, and fisheries along the 15-mile surface water target distance.	C

Likelihood of Release

Can an observed release be established? (If yes, demonstrate its existence through direct observation or chemical analysis.)	B
Evaluate the potential to release by overland flow factor based on containment, runoff, and distance to surface water.	C
Evaluate the potential to release by flood based on containment and flood frequency.	C
Evaluate the potential to release by groundwater to surface water migration based on containment, net precipitation, depth to aquifer, and travel time.	C

Waste Characteristics

Determine the toxicity, persistence, bioaccumulation, and ecosystem toxicity for each hazardous substance being evaluated.	C
Calculate the hazardous waste quantity for each source (if calculated, can use same quantity from groundwater pathway).	C

Table 4-2 (Continued)
SURFACE WATER PATHWAY SCORE CHECKLIST

General Information

Targets Evaluation	C
Identify the nearest potable intake along the hazardous substance migration path.	C
Determine the population served by surface water that is subject to Level I concentrations, Level II concentrations, and potential contamination within the 15-mile target distance.	C
Determine if fisheries are located within the 15-mile target distance and if Level I or II concentrations are present.	C
Determine the annual production of human food chain organisms within the target fisheries.	C
Determine if surface water is used for any of the following:	
• irrigation,	C
• watering of commercial livestock,	C
• commercial food preparation, or	C
• supply for a major or designated water recreation area.	C
Determine if sensitive environments are located along the hazardous substance migration path and whether they are subjected to Level I or Level II concentrations.	C

Table 4-2 (Continued)
SOIL EXPOSURE PATHWAY CHECKLIST

General Information

Collect and evaluate the following data.

chemical data (include analytical chemical data for surface soil samples from the source area), and	B
demographic data (determine the number of people residing or working within the source area boundary and the number of people who live or attend school within a 1-mile travel distance of an area of observed contamination.	C

Likelihood of Exposure

Determine if an observed release of contamination is within:

the property boundary of a residence, school, or day care center and within 200 feet of the respective residence, school, or day care center,	C
a workplace property boundary and within 200 feet of a workplace area,	C
the boundaries of a resource, or	C
the boundaries of a terrestrial sensitive environment.	C
Describe the attractiveness and accessibility off each source area.	C
Calculate the areas of observed contamination at each site.	C

Waste Characteristics

Determine the toxicity for each hazardous substance being evaluated.	C
Calculate the hazardous waste quantity for each source (use the same quantity from groundwater pathway, if calculated).	C

Targets

Identify if persons living or attending school or day care on a property within 200 feet of an area of observed contamination who are subject to Level I or II concentrations.	C
Determine the total number of people living on the property of observed contamination and if they are exposed to Level I or II concentrations.	C
Determine the number of people working on or within 200 feet of the observed contamination.	C

Table 4-2 (Continued)
SOIL EXPOSURE PATHWAY CHECKLIST

General Information

Determine if any of the following resources are present on an area of observed contamination:	
• commercial agriculture,	C
• commercial silviculture,	C
• commercial livestock production, or	C
• commercial livestock grazing.	C
Determine if terrestrial sensitive environments are located on an area of observed contamination.	C
Estimate the number of people within the 0 to 1/4, 1/4 to 1/2, and 1/2 to 1 mile travel distance categories.	C
Determine the shortest travel distance from the site to any residence or school.	C

4.9 TASK 9, DRAFT AND FINAL RFI/SI REPORTS. The Technical Memoranda for each sampling event will be consolidated and then summarized into the RFI/SI report. The RFI/SI will contain site conclusions and recommendations for future activities, if warranted. A draft RFI/SI Report will be submitted to the Navy for its review. Navy recommendations and modifications from their review of the draft RFI/SI Report will be incorporated into the final RFI/SI report.

4.10 TASK 10, MEETINGS. The Task Order Manager and lead technical personnel will attend the following meetings:

- a kickoff meeting,
- a project management meeting at the beginning of the field work,
- a management meeting to discuss the initial assessment of data,
- a management meeting at the RFI/SI Report 90 percent complete stage, and
- a management meeting following receipt of Navy comments on the RFI/SI Report.

5.0 PROJECT MANAGEMENT

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

5.1 ORGANIZATION.

Southern Division Naval Facilities Engineering Command. SOUTHNAVFACENGCOM is responsible for establish policy and guidance for the CLEAN program. SOUTHNAV-FACENGCOM awards contracts, approves funding, and has primary control of report release and interagency communication.

NSB Kings Bay Environmental Coordinator. The base environmental coordinator (EC), Mr. James More, will coordinate and monitor RFI/SI activities at NSB Kings Bay. The EC will provide local support and be the primary point of contact with the local, state and federal regulatory agencies.

Southern Division Engineer-in-Charge (EIC). The SOUTHNAVFACENGCOM, Engineer-in-Charge (EIC), Mr. Joel Murphy, is responsible for the technical and financial management of the RFI activities at NSB Kings Bay. The EIC will prepare the project statement of work; monitor project scope, schedule and budget; and provide technical review and approval of all deliverables. Also the EIC will authorize changes in the scope of work determined during Project Managers Meetings.

Task Order Manager. The ABB-ES Task Order Manager (TOM) for the NSB Kings Bay RFI/SI is responsible for evaluating the appropriateness and adequacy of the technical and engineering services provided. The TOM is also responsible for financial and schedule management and for ensuring that the project fulfills the contracted scope of work. The TOM will be responsible for implementing changes in the scope of work determined during Project Managers meetings. The TOM is also responsible for the daily conduct of work, including integration of input from supporting disciplines and subcontracts, and is the primary ABB-ES project contact, with the EIC.

RFI/SI Technical Leader. The Technical Leader (TL) will be responsible for field studies and the development of the final report. The TL will also be responsible for the quality and completeness of data gathered during the field program, including overall management and coordination of field work, and supervision and scheduling of work.

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

Quality Assurance Manager. The Quality Assurance Manager, Mr. John McVoy, will be responsible for ensuring that field and laboratory activities support DQOs and conform with the project workplan. Mr. McVoy will perform periodic field and laboratory audits to monitor conformance with requirements.

5.2 PROJECT SCHEDULE AND DELIVERABLES. Accurate schedule planning, tracking, and reporting are important for expeditious completion of the RFI/SI at NSB Kings Bay. For the purpose of this workplan, the schedule is presented in Figure 5-1. The schedule reports will be updated to reflect actual progress during the project and will be forwarded to the SOUTHNAVFACENGCOM EIC, NSB Kings Bay, and USEPA (if required). Upon notice to proceed, the duration and schedules will be revised to reflect current dates. The schedule assumes ready access to the sites and close cooperation between ABB-ES and NSB Kings Bay.

Schedule Name: CTO #30 King's Bay
Responsible : Jim Wallace
As-of Date : 10/7/91 Schedule File : KB-WKP

Task Name	Start Date	Durat	End Date
DRAFT FINAL WORK PLAN 90%	8/28/91	36	10/3/91
PREPARE DRAFT PLAN	10/3/91	8	10/11/91
MAILING	10/11/91	5	10/16/91
REGULATORY AGENCY REVIEW	10/7/91	14	10/21/91
RESPONSE TO REGULATORY COMMENT	10/21/91	14	11/4/91
PROJ. MGR MEETING #2	11/4/91	1	11/5/91
PROJECT MGR MEETING #2 MINUTES	11/5/91	7	11/12/91
PARPARE FINAL WORKPLAN	11/12/91	7	11/19/91
SOW FROM NAVFAC	11/19/91	14	12/3/91
DEVELOP POA	12/3/91	21	12/24/91
NOTICE TO PROCEED	12/24/91	0	12/24/91
SUBCONTRACTING	12/24/91	21	1/14/92
RFI/SI FIELD WORK	1/14/92	68	3/22/92
SETUP AND GEOPHYSIS	1/14/92	7	1/21/92
SURFACE SOIL SAMPLING	1/21/92	3	1/24/92
MONITORING WELL INSTALLATION	1/24/92	30	2/23/92
MONITORING WELL DEVELOPMENT	2/23/92	7	3/1/92
AQUIFER TESTING	3/1/92	7	3/8/92
GROUNDWATER SAMPLING	3/8/92	7	3/15/92
LOCATION SURVEY	3/15/92	7	3/22/92
DATA ASSESSMENT	3/22/92	180.0	9/18/92
LAB ANALYSIS	3/22/92	60	5/21/92
DATA VALIDATION	4/21/92	60	6/20/92
DATA EVALUATION	6/20/92	60	8/19/92
TECHNICAL MEMORANDUM	8/19/92	30	9/18/92
SECOND GROUNDWATER SAMPLING	5/7/92	97	8/12/92
GROUNDWATER SAMPLING	5/7/92	7	5/14/92
LAB ANALYSIS	5/14/92	30	6/13/92
DATA VALIDATION	6/13/92	30	7/13/92
TECHNICAL MEMORANDUM	7/13/92	30	8/12/92
THIRD GROUNDWATER SAMPLING	7/6/92	97	10/11/92
GROUNDWATER SAMPLING	7/6/92	7	7/13/92
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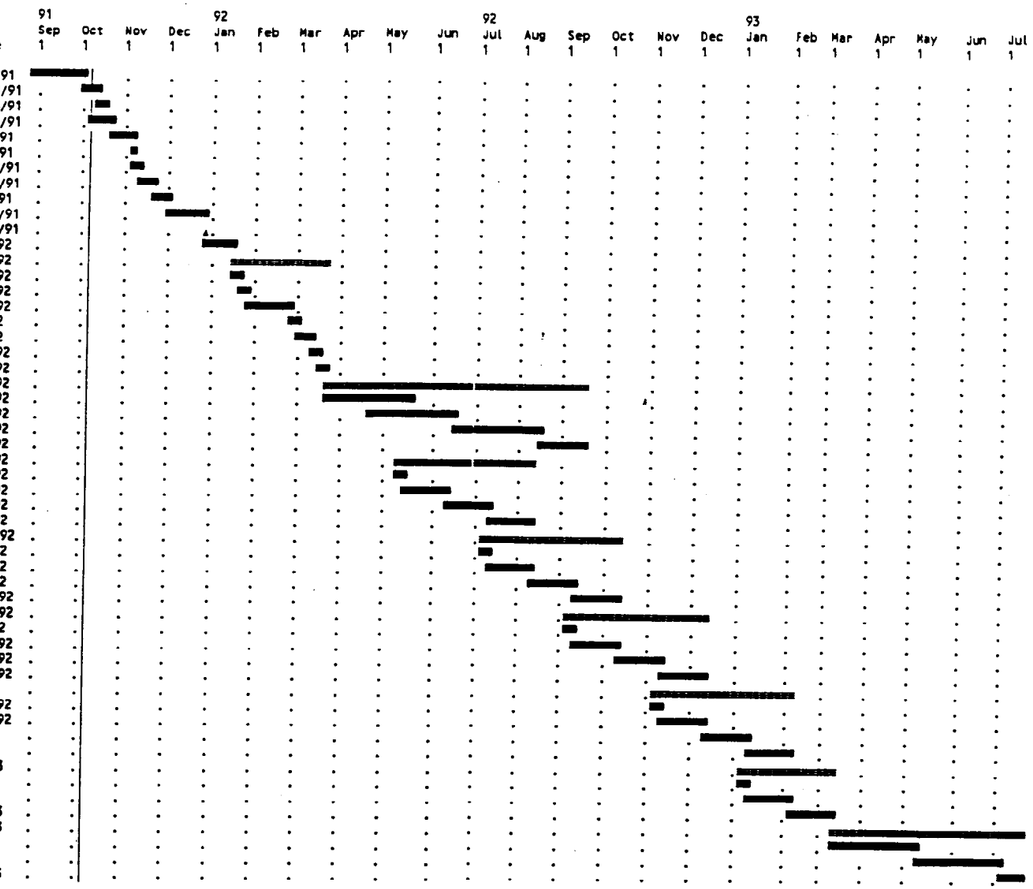
DATA VALIDATION	8/12/92	30	9/11/92
TECHNICAL MEMORANDUM	9/11/92	30	10/11/92
4TH GROUNDWATER SAMPLING	9/4/92	97	12/10/92
GROUNDWATER SAMPLING	9/4/92	7	9/11/92
LAB ANALYSIS	9/11/92	30	10/11/92
DATA VALIDATION	10/11/92	30	11/10/92
TECHNICAL MEMORANDUM	11/10/92	30	12/10/92
5TH GROUNDWATER SAMPLING	11/3/92	97	2/8/93
GROUNDWATER SAMPLING	11/3/92	7	11/10/92
LAB ANALYSIS	11/10/92	30	12/10/92
DATA VALIDATION	12/10/92	30	1/9/93
TECHNICAL MEMORANDUM	1/9/93	30	2/8/93
6TH GROUNDWATER SAMPLING	1/2/93	67	3/10/93
GROUNDWATER SAMPLING	1/2/93	7	1/9/93
LAB ANALYSIS	1/9/93	30	2/8/93
DATA VALIDATION	2/8/93	30	3/10/93
RFI/SI REPORT	3/10/93	134.0	7/22/93
DRAFT RFI/SI	3/10/93	60	5/9/93
DRAFT FINAL RFI/SI REPORT	5/9/93	60	7/8/93
FINAL RFI/SI REPORT	7/8/93	14	7/22/93



Detail Task — Summary Task — ***** Baseline
(Progress) — (Progress) — ►►► Conflict
(Slack) — (Slack) — Resource delay
Progress shows Percent Achieved on Baseline — ▲ Milestone
---------- Scale: 5 days per character ----------

TIME LINE Gantt Chart Report, Strip 1

TIME LINE Gantt Chart Report, Strip 2

FIGURE 5-1
PROJECT SCHEDULE AND DELIVERABLES

RFI/SI WORKPLAN

NSB KINGS BAY

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APPENDIX A

SAMPLING AND ANALYSIS PLAN

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1.0 PROJECT DESCRIPTION

1.1 INTRODUCTION. This Sampling and Analysis Plan (SAP) consists of two primary parts:

- Project Description (Section 1.0) and Field Sampling and Analysis Plan (Sections 2.0 and 3.0) and
- Quality Assurance Project Plan (Section 4.0).

The SAP is Appendix A of the RFI/SI Workplan. The SAP focuses on the field investigation, analytical methods and quality assurance/quality control (QA/QC) procedures. The SAP provides a project description, describes site management and field methods, details the technical approach and sampling plans for each site, and describes quality assurance and quality control requirements for sample collection, sample analysis, data assessment, corrective action, and reporting.

The Field Sampling Plan (FSP) and the Quality Assurance Project Plan (QAPP) have been incorporated into one document (the SAP, Appendix A) to provide one comprehensive document that can be used by on-site field teams. This also avoids triplication of many sections which are common to the Workplan, the FSP and the QAPP (i.e., project purpose and description; site history; sampling methods, locations, and procedures; data quality objectives; laboratory analytical methods; data assessment and evaluation; and project organization and schedule). These common sections are currently summarized in the Workplan.

2.0 FIELD SAMPLING PLAN

The Field Sampling Plan (FSP) consists of three elements: site management, remedial investigation data collection, and site-specific explorations. Site management (Section 2.1) comprises support activities to the data collection activities. These activities include mobilization, site access considerations, documentation and field monitoring instrumentation. In addition, methods to be used for decontamination, and control and disposal of investigation-derived wastes are included in this section.

Section 2.2, Data Collection, includes descriptions of the methods employed to gather information required to meet the RFI/SI objectives. Among these methods are exploratory geophysics programs; shallow subsurface explorations; monitoring well installations; aquifer characterization; groundwater, soil sampling and analysis; and topographic and elevation surveys.

Section 3.0 Site-specific technical approach provides a site description, a summary of previous investigations and investigation rationale, and details proposed investigative methods, sampling, and analysis for each site.

2.1 SITE MANAGEMENT.

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

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

2.1.2 Site Access and Control NSB Kings Bay is an active base with controlled site access. Several areas on base are high-security areas requiring Controlled Area badges. Where necessary, security police will be notified about on-base locations field activities. A base escort may be required while conducting field explorations in the restricted areas. Badges will be obtained through the base security. All sites are accessible from paved or dirt roads maintained by the base.

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

2.1.3.1 **Field Logbooks** Bound, weather-proof field notebooks will be maintained by the field team. Team members shall record all information related to sampling time, weather conditions, unusual events (e.g., well tampering), field measurements, etc. Field logbooks will document the details of each activity during the field investigation. Field team personnel will be responsible for data entry in field logbooks. These logbooks will document investigative and sampling activities for each site including equipment and sampling decontamination activities, sample collection, visual observations, sample handling and

shipping. Data entry into logs, forms, and notebooks will be written in ink and initialed by the author. Entry errors in the logbook or field notebooks will be crossed out with a single line and initialed.

2.1.3.2 **Field Change Logbook** A separate logbook will be maintained during the field investigation program to document deviations from the Project Workplan and SAP. The Field Operations Leader (FOL) will be responsible for completing the logbook.

2.1.3.3 **Plans** A copy of the RFI/SI Workplan (including the SAP and HASP) will be kept onsite. Appropriate plans including standard operating procedures (SOPs) and the SAP (FSP and QAPP) will also be provided to each field team.

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

- photoionization detector (PID)
- organic vapor analyzer (OVA)
- explosimeter
- radiation meter
- pH-temperature-specific conductance meter
- electronic water level meter
- metal detector
- two-way radios or cellular telephones

Instruments will be calibrated and inspected daily before field activities begin, as suggested by the manufacturers. Calibration information will be recorded in the field logbooks. Malfunctioning instruments will be repaired or replaced. Monitoring equipment will be protected (as much as possible) from contamination during field exploration activities without hindering operation of the unit. Equipment maintenance will be performed according to manufacturer specifications before field use, or by cycling units out of the field. As appropriate, routine periodic maintenance may be performed as a function of field calibration.

2.1.5 Equipment Decontamination Procedures In order to assure that analytical results reflect the actual concentration present at sampling locations, chemical sampling and field analysis equipment must be properly decontaminated prior to the field effort, during the sampling program (i.e., between sample points) and at the conclusion of the sampling program. This will minimize the potential for cross-contamination between sample points, and the transfer of contamination offsite. Field decontamination procedures conducted during a field event will be documented in the field logbook.

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

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

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

Solvent - shall be pesticide-grade solvent (i.e., isopropanol, acetone, hexane, etc.).

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

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

Organic-free water - tap water that has been treated with activated carbon and deionizing units. It should contain no pesticides, herbicides, extractable organic compounds, and less than 50 $\mu g/\ell$ of purgeable organic compounds as measured by a low level GC/MS scan. This organic-free water will be used for blank preparation and for final rinse in decontamination (where applicable). The contractor may use commercial sources of organic-free water. Each lot will be analyzed to demonstrate reliability and purity of water resource. Equipment blanks provide further documentation as to the purity of the water source.

Solvent - pesticide-grade isopropanol.

2.1.5.1 In-House Cleaning Procedures Prior to transport to the field, sampling equipment will be decontaminated using the procedures described below. To the extent feasible, enough sampling equipment will be made available to conduct a sampling episode without field decontamination. All decontamination procedures conducted in-house are documented in an equipment room logbook.

The following subsections describe cleaning procedures for sampling, pumping, and measurement equipment that will be conducted "in-house" prior to bringing the equipment to the field.

Teflon™ or Glass Sampling Equipment (Trace Organics and/or Metal Analyses) In-house decontamination procedures for Teflon™ or glass sampling equipment used to collect samples for trace organic and/or metal analysis are listed below.

1. Wash and scrub equipment thoroughly with laboratory detergent and hot water.

2. Rinse thoroughly with hot tap water.

3. Rinse with at least a 10 percent nitric acid solution.

4. Rinse thoroughly with tap water.

5. Rinse twice with solvent (pesticide-grade isopropanol).

6. Air dry for at least 24 hours.

7. Wrap equipment in aluminum foil. Roll the edges into a "tab" to allow easy removal. Seal the foil-wrapped equipment in plastic and date.

8. After use in the field, rinse the equipment thoroughly with tap water as soon as possible, if full field decontamination procedures are not used.

Stainless-Steel or Metal Sampling Equipment (Trace Organic and/or Metal Analyses). In-house decontamination procedures for stainless-steel or metal sampling equipment used to collect samples for trace organic and/or metal analysis are listed below.

1. Wash and scrub equipment thoroughly with laboratory detergent and hot water.

2. Rinse thoroughly with hot tap water.

3. Rinse with deionized water.

4. Rinse twice with solvent (pesticide-grade isopropanol).

5. Air dry for at least 24 hours.

6. Wrap equipment in aluminum foil. Roll the edges into a "tab" to allow easy removal. Seal the foil-wrapped equipment in plastic and date.

7. After use in the field, rinse the equipment thoroughly with tap water as soon as possible, if full field decontamination procedures are not used.

Submersible Pumps and Hoses. In-house decontamination procedures for submersible pumps and hoses used for purging monitoring wells are listed below.

1. Wash and scrub equipment thoroughly with laboratory detergent and hot water.

2. Rinse thoroughly with hot tap water, pump tap water through the system.

3. Rinse with deionized water, pump deionized water through the system.

4. Place equipment in polyethylene bag for storage and transport.

Sampling and/or Filtering Tubing. In-house decontamination procedures for Teflon™, PVC, stainless-steel and glass tubing used for groundwater sampling and/or filtering are listed below. In-line disposable filter cartridges should be rinsed with tap water and disposed.

Teflon™ Sampling Tubing. Use only new Teflon™ tubing and pre-clean as follows:

1. Pre-cut tubing to appropriate length.

2. Rinse outside of tubing with solvent.

3. Flush interior of tubing with solvent.

4. Dry overnight in drying oven at 105 degrees celsius.

5. Wrap tubing and cap ends with aluminum foil and seal in plastic to prevent contamination during storage and transport.

Polyvinyl Chloride (PVC) Sampling Tubing. Use only new PVC tubing and only when not sampling for organics. This tubing is not pre-cleaned, but should be stored and transported in its original container or wrapped in polyethylene to prevent contamination. Tubing should be flushed in the field with the sample before sample collection to remove any manufacturing residues.

Stainless-Steel Sampling Tubing. Pre-clean tubing as follows:

1. Wash and scrub equipment thoroughly with laboratory detergent and hot water.

2. Rinse thoroughly with hot tap water.

3. Rinse with deionized water.

4. Rinse twice with solvent (pesticide-grade isopropanol).

5. Air dry.

6. Wrap tubing and cap ends with aluminum foil and seal in plastic to prevent contamination during storage and transport.

Glass Sampling Tubing. Use only new glass tubing, pre-cleaned as follows:

1. Rinse with solvent.

2. Air dry for at least 24 hours.

3. Wrap tubing and cap ends with aluminum foil and seal in plastic to prevent contamination during storage and transport.

Well Sounders and Groundwater Measurement Tapes. In-house decontamination procedures for Teflon™, PVC, stainless steel and glass tubing used for groundwater sampling are listed below.

1. Wash with laboratory detergent and tap water.

2. Rinse with tap water.

3. Rinse with deionized water.

4. Wrap equipment in aluminum foil. Roll the edges into a "tab" to allow easy removal. Seal the foil-wrapped equipment in plastic and date.

Ice Chests and Shipping Containers. In-house decontamination procedures for ice chests and shipping containers are listed below. Noticeably contaminated containers should be thoroughly cleaned and disposed.

1. Wash inside and out with laboratory detergent and tap water.

2. Rinse with tap water.

3. Air dry.

Field Parameter Measurement Probes. Field parameter measurement probes, (e.g., pH or specific ion electrodes, geophysical probes, or thermometers) which come in direct contact with the sample, will be decontaminated using the procedures listed below, unless manufacturer's instructions indicate otherwise. Probes which make no direct contact (e.g., OVA equipment) will be wiped with clean paper-towels.

1. Rinse with tap water.

2. Rinse with deionized water.

3. Solvent rinse, if obvious contamination remains after rinsing and if solvent will not damage probe.

4. Rinse with deionized water.

Organic-Free Water Containers. New containers that will be used to store and transport organic-free water will be cleaned as follows:

1. Wash containers thoroughly with hot tap water and laboratory detergent, using a bottle brush to remove particulate matter and surface film.

2. Rinse containers thoroughly with hot tap water.

3. Rinse containers with at least 10 percent nitric acid.

4. Rinse containers thoroughly with tap water.

5. Rinse containers thoroughly with deionized water.

6. Rinse twice with solvent and allow to air dry for at least 24 hours.

7. Cap with aluminum foil or Teflon™ film.

8. After using, rinse with tap water in the field, seal with aluminum foil to keep the interior of the container wet, and return to the laboratory.

Used containers shall be capped with aluminum foil immediately after being used in the field. The exterior of the containers will be washed with laboratory detergent and rinsed with deionized water if necessary. The interior of the container shall be rinsed twice with solvent. The interior of the container will be thoroughly rinsed with organic-free or Milli-Q™ water. The container will be filled with organic-free or Milli-Q™ water and capped with aluminum foil for storage.

2.1.5.2 Field Decontamination Procedures When practical sufficient equipment will be transported to the field so that the entire study can be conducted without the need for field cleaning. However, when this is not possible, the following USEPA Region IV field decontamination procedures will be followed.

Sampling Equipment for Classic Water Quality Parameters. Sampling equipment for classic water quality parameters (dissolved oxygen [DO], biological oxygen demand [BOD], total organic carbon [TOC], etc.) including, but not limited to, Kemmerers, buckets, DO dunkers and dredges, will be cleaned in the field prior to use and between sampling locations as follows:

1. Rinse and scrub with sampling water or tap water.

2. Rinse with deionized water.

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

1. Wash and scrub equipment thoroughly with laboratory detergent and tap water.

2. Rinse thoroughly with tap water.

3. Rinse thoroughly with deionized water.

4. Rinse twice with solvent (pesticide-grade isopropanol).

5. Rinse with organic-free water and allow to air dry as long as possible.

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

2.1.5.3 Large Equipment Decontamination Large equipment (eg. drill rigs, backhoes, augers, drill pipe, casing, and screen) will be cleaned prior to use and between sample locations in accordance with SOPs as outlined below.

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

1. Steam clean and wire brush to remove soil and rust.

2. Inspect to assure that seals and gaskets are intact and that there are no residual oils, grease or hydraulic fluids that could drip into the sample location.

3. If necessary, use Teflon™ string to tighten drill stem.

4. Steam clean the drill rig prior to drilling each borehole.

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

1. Wash and scrub with tap water and laboratory-grade detergent.

2. Steam clean and/or high pressure wash, if necessary to remove soils. The steam cleaner or high pressure washer should be capable of generating a pressure of at least 2500 pounds per square inch (PSI) and producing hot water and/or steam (200 degrees Fahrenheit and above).

3. Rinse thoroughly with tap water.

4. Rinse thoroughly with deionized water.

5. Rinse twice with solvent (pesticide-grade isopropanol). Note: do <u>not</u> rinse PVC materials with solvent.

6. Rinse thoroughly with organic-free water and allow to air dry. Do not rinse again with deionized or distilled water.

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

8. Where appropriate, wrap with aluminum foil to prevent contamination during storage. Augers, drill stems, casings and other large items can be wrapped in clean plastic if necessary.

9. If caked mud, rust, and/or paint is present that can not be removed by steam or high pressure wash, the downhole equipment will be sandblasted prior to step number 1 above, and prior to arrival onsite.

10. Printing and/or writing on well casing, screens, tremie tubing, etc. will be removed with emery cloth or sand paper prior to arrival onsite. Where possible, materials without printing or writing will be ordered.

2.1.5.4 Decontamination Staging Area and Fluid Disposal Cleaning and decontamination of all equipment will occur at a designated area onsite which is downgradient and downwind (prevailing wind direction) of the clean equipment drying and storage area. The cleaning and decontamination area will contain an excavated pit, lined with heavy duty plastic sheeting, for containment of washwater and waste. The pit will be designed such that washwater will drain into the pit. Large portable equipment (drill rods, auger flights, well casing and screen, etc.) will be cleaned on saw horses or other supports constructed above the plastic sheeting.

Wastewater and sediment collected in the pit will be pumped into 55-gallon drums and screened with an OVA or PID. Based on the OVA or PID readings for each drum of wastewater, the FOL and NSB Kings Bay Public Works engineer will determine the appropriate method of disposal (onsite wastewater treatment plant or RCRA hazardous waste storage facility).

If it is necessary to place the drums in the RCRA hazardous waste storage facility, the drums will be properly labelled, sealed, and staged for storage.

2.1.6 Control and Disposal of Investigation-Derived Waste The following Waste Management Plan has been prepared to address the disposal of contaminated and uncontaminated investigation-derived wastes (IDW). These wastes can include drill cuttings or other soils and sediments, purge and development water, decontamination fluids, protective clothing and other disposable items (including disposable equipment and/or parts).

Investigation-derived purge and development water, decontamination water and soil cuttings may be disposed onsite within the area of contamination (AOC), if the following conditions are met: exposure to discharged waste or vapors will not present a known health risk, the water quality in the surficial aquifer will not be degraded, and the wastewater will not be discharged in a manner that would affect surface water bodies. This premise will be used to screen IDW prior to selecting a disposal option.

Wastewater from well development, purging, and decontamination operations, and soil cuttings from drilling operations will be visually examined and screened with an OVA or PID. If concentrations above background readings are detected, or if visual evidence of contamination is noted, the wastes will be drummed and stored at the NSB Kings Bay hazardous waste storage facility in clearly labelled and dated 55-gallon drums. If concentrations are at or below background readings, the wastes will be disposed onsite or into the wastewater treatment plant.

Decontamination fluids collected in waste pits and solvents collected at the decontamination area will be treated as described in the previous section (Section 2.1.5.4).

Personal protective equipment (PPE) and other disposable items will be drummed and transported to the hazardous waste storage facility.

Drummed materials will be left by field personnel at the NSB Kings Bay hazardous waste storage facility and will become the property of the NSB Kings Bay. ABB-ES will maintain a log of the drums and their contents and will clearly identify the containers, on weather-resistant labels, with the drum contents, site and sample location number, date filled, and corresponding log entry number. NSB Kings Bay will take responsibility for the drums and their contents.

2.1.6.1 Site 5 Seven wells will be installed along the perimeter of the site. None of the wells will be installed directly into fill material. Drill cuttings, generated during the installation of these monitoring wells, present a minimum risk to the environment. A pit located inside the designated site area shall be used as a disposal area for the drill cuttings. The field geologist will designate an undisturbed area of the site for the pit. The pit will be covered at the end of each day.

Decontamination fluids will be collected and drummed. The contractor shall transport the drums to the base's industrial wastewater treatment facility for disposal.

Other liquid wastes, such as well development and purge water, will be screened by an OVA or PID before disposing of them onsite. Water with OVA or PID readings above background will be drummed and transported and the base's industrial waste

water treatment facility for disposal. Water discharged onsite will be contained until it either evaporates or percolates into the ground. No surface runoff into surrounding surface water body will be permitted.

2.1.6.2 **Site 11** All wells are to be installed along the perimeter of the site. No wells shall be installed directly into fill material. Therefore, drill cuttings, generated during the installation of these monitoring wells, present a minimum risk to the environment. A pit located inside the designated site area shall be used as a disposal area for the drill cuttings. The field geologist will locate the pit in an undisturbed area of the site. The pit will be covered at the end of each day.

Decontamination fluids will be collected and drummed. The contractor shall transport the drums to the base's industrial wastewater treatment facility for disposal.

Other liquid wastes, such as well development and purge water, will be screened by an OVA or PID before disposing of them onsite. Water with OVA or PID readings above background will be drummed and transported to the base's industrial waste water treatment facility for disposal. Water discharged onsite will be contained until it either evaporates or percolates into the ground. No surface runoff into surrounding surface water body will be permitted.

2.1.6.3 **Site 16** Four wells are to be installed along the perimeter of the site. None of the wells will be installed directly into fill material. Drill cuttings, generated during the installation of these monitoring wells, present a minimum risk to the environment. However, storage of the drill cuttings may interfere with current construction activities. Drilling cutting materials will be drummed and labeled as hazardous material. The drums will be transported by the contractor to the base hazardous waste storage area. The Navy will then be responsible for disposal of the drums.

Decontamination fluids will be collected and drummed. The contractor shall transport the drums to the base's industrial wastewater treatment facility for disposal.

Other liquid wastes, such as well development and purge water, will be screened by an OVA or PID before disposing of them onsite. Water with OVA or PID readings above background will be drummed and transported to the base's industrial wastewater treatment facility for disposal. Water discharged onsite will be contained until it either evaporates or percolates into the ground. No surface runoff into surrounding surface water body will be permitted.

2.2 DATA COLLECTION

This section provides a description of each investigative technique to be used during the NSB Kings Bay RFI/SI.

2.2.1 Exploratory Geophysics Program

Geophysical investigations at NSB Kings Bay may include magnetometer and terrain conductivity surveys. In addition, a metal detector may be used before drilling at selected sites to screen for possible underground utility lines, or other obstructions that could interfere with the completion of subsurface explorations and to prevent damage to underground equipment.

2.2.1.1 **Magnetometer Survey** Magnetometers measure small variations in the earth's magnetic field due to changes in soil composition and stratigraphy. A magnetometer survey can be used to screen for the presence of buried ferrous materials (such as 55-gallon containers and abandoned tanks) and to define the edge of landfills where there is sufficient ferrous debris to show a contrast with natural terrain. Metal detectors can be used for smaller scale surveys to locate buried metal or utilities.

The magnetometer survey will use a Fisher™ TW-6 or equivalent. Prior to conducting the survey, field personnel will perform the following tasks.

1. Field personnel will identify and mark on a site map all potential cultural influences such as fences, powerlines, or underground utilities.

2. Stake the area with survey flags in a square grid approximately 10 feet on centers. The grid will be oriented in a north-south, east-west alignment. The grid row and columns will be labeled using a local cartesian coordinate system.

3. The coordinate system will be referenced to a permanent reference near the site (such as a building corner or similar structure) so that it may be re-established in the future. Simple field measurements using a flexible tape is sufficient for grid layout and benchmark reference. The benchmark reference will be recorded in the field log book.

4. Field personnel will calibrate the magnetometer in accordance with manufacturer's instructions. The magnetometer will be calibrated at the beginning of each survey day and at intermediate intervals as recommended by the manufacturer.

5. Photographs will be taken during the survey as a visual record of the grid geometry.

The field personnel will conduct the survey in phases. Phase I will consist of an initial survey of the general area following the flagged grid lines to identify any obvious anomalies. The survey will be conducted along the grid lines in both the north-south and east-west directions. Anomaly locations will be tagged and the locations recorded in the field log book using the cartesian coordinate system. Potential cultural influences will be noted.

Phase II will refine the dimensions of any anomalies discovered during the first phase. Field personnel will take measurements between staked grid rows and columns to delineate the anomalies. Magnetometer readings will be recorded with grid location data so that contours of magnetometer responses can be prepared.

Phase III will be composed of a "hunt and seek" strategy where judgmental readings will be taken in intermediate areas of the grid where no anomalies were discovered during Phase I. New anomalies will be tagged and their locations recorded as in Phase I.

Phase IV will refine the dimensions of any anomalies discovered during Phase III. Field personnel will take measurements between staked grid rows and columns to

delineate the anomalies. Magnetometer readings will be recorded with grid location data so that contours of magnetometer responses can be prepared.

2.2.1.2 Electromagnetic Survey Terrain conductivity refers to the ability of the earth to conduct electricity. Terrain conductivity can be measured using electromagnetic ground conductivity meters. As some types of leachate can alter the electrical properties of soil pore waters and groundwater, this technique can be useful in tracing ionic fractions of leachate plumes. In addition (by measuring the in-phase response) the instruments can detect buried metallic objects and can profile some changes in soil composition. These features can provide data for determining the limits of waste disposal areas or landfills. Both the magnetometry and terrain conductivity instruments are sensitive to metal objects; therefore, on-site fences, pipes, and power lines may cause interference.

The electromagnetic (EM) method provides a means of measuring the electrical conductivity of subsurface soil, rock, and groundwater. Electrical conductivity is a function of the type of soil and rock, its porosity, its permeability, and the fluids which fill the pore space. In most cases the conductivity (specific conductance) of the pore fluids will dominate the measurement. Accordingly, the EM method is applicable both to assessment of natural geohydrologic conditions and to mapping of many types of contaminant plumes. Additionally, trench boundaries, buried wastes and drums, as well as metallic utility lines can be located with EM techniques.

Natural variations in subsurface conductivity may be caused by changes in soil moisture content, groundwater specific conductance, depth of soil cover over rock, and thickness of soil and rock layers. Changes in basic soil or rock types, and structural features such as fractures or voids may also produce changes in conductivity. Localized deposits of natural organic, clay, sand, gravel, or saltrick zones will also affect subsurface and conductivity.

Many contaminants will produce an increase in free ion concentration when introduced into the soil or ground water systems This increase over background conductivity enables detection and mapping of contaminated soil and ground water at Hazardous Waste Sites (HWS), landfills, and impoundments. Large amounts of organic fluids such as diesel fuel can displace the normal soil moisture, causing a decrease in conductivity which may also be mapped, although this is not commonly done. The mapping of a plume will usually define the local flow direction of contaminants. Contaminant migration rates can be established by comparing measurements taken at different times.

The absolute values of conductivity for geologic materials (and contaminants) are not necessarily diagnostic in themselves, but the variations in conductivity, laterally and with depth, are significant. It is these variations which enable the investigator to rapidly find anomalous conditions.

Since the EM method does not require ground contact, measurements may be made quite rapidly. Lateral variations in conductivity can be detected and mapped by a field technique called profiling. Profiling measurements may be made to depths ranging from 0.75 to 60 meters. The data is recorded using strip chart and magnetic tape recorders. This continuous measurement allows increased rates of data acquisition and improved resolution for mapping small geohydrologic

features. Further, recorded data enhanced by computer processing has proved invaluable in the evaluation of complex hazardous waste sites. The excellent lateral resolution obtained from EM profiling data has been used to advantage in efforts to outline closely-spaced burial pits, to reveal the migration of contaminants into the surrounding soil, and to delineate fracture patterns.

Vertical variations in conductivity can also be detected by the EM method. A station measurement technique called sounding is employed for this purpose. Data can be acquired from depths by combining results from a variety of EM instruments, each requiring different field application techniques. Other EM systems are capable of sounding to depth of one-thousand feet or more, but have not yet been used at HWS and are not adaptable to continuous measurements

Profiling is the most cost-effective use of the EM method. Continuous profiling can be used in many applications to increase resolution, data density, and permit total site coverage at critical sites.

At HWS, applications of EM can provide:

- Assessment of natural geohydrologic conditions;
- Locating and mapping of burial trenches and pits containing drums and/or bulk wastes;
- Determination of flow direction in both unsaturated and saturated zones;
- Rate of plume movement by comparing measurements taken at different times; and
- Locating and mapping of utility pipes and cables which may affect other geophysical measurements, or whose trench may provide a permeable pathway for contaminant flow.

Although there is available a wide variety of EM equipment, most of it is intended for geophysical exploration of mineral deposits. These units have not been used at HWS and do not provide a simple conductivity reading. This text discusses only those instruments which are designed and calibrated to read directly in units of conductivity.

Conductance is measured with electronic instrumentation consisting of a transmitter coil and receiver coil. The transmitter coil radiates an electromagnetic field which induces eddy currents in the earth below the instrument. Each of these eddy current loops, in turn, generates a secondary electromagnetic field which is proportional to the magnitude of the current flowing within that loop. A part of the secondary magnetic field from each loop is intercepted by the receiver coil and produces an output voltage which (within limits) is linearly related to subsurface conductivity. This reading is a bulk measurement of conductivity, e.g., the cumulative response to subsurface conditions ranging all the way from the surface to the effective depth of the instrument.

The sampling depth of EM equipment is related to the instrument's coil spacing. Instruments with coil spacings of one, four, ten, twenty, and forty meters are

commercially available. The nominal sampling depth of an EM system is taken to be approximately 1.5 times the coil spacing.

The EM sounding method can rarely identify more than two or three layers with reasonable confidence. The greater the contrast in the conductivity values of each layer, the better the results. Often, the more detailed resistivity sounding method is used to complement EM profiling data.

The results of sounding analysis are usually presented as a vertical section, in which the conductivity layers are identified as a function of depth. The analyst may be able to correlate these layers to geohydrologic units believed to exist at the site.

Although the EM technique can be used for profiling or sounding, profiling is the most effective use of the EM method. Profiling makes possible the rapid mapping of subsurface conductivity changes, and the location, delineation, and assessment of spatial variables resulting from changes in the natural setting or from many contaminants.

EM is a very effective reconnaissance tool. The use of qualitative non-recorded data can provide initial interpretation in the field. If site conditions are complex, the use of a high-density survey grid, continuously-recording instruments, and computer processing may be necessary, in order to properly evaluate subsurface conditions. When continuously-recording instruments are used, total site coverage is feasible. More quantitative information can be obtained by using conductivity data from different depth ranges. At present, three different systems must be used to acquire data from 0.75 to 60 meters. Very often, however, data from two standard depths, e.g. six and fifteen meters, is adequate to furnish depth information.

Capabilities

- The EM profile method permits rapid data acquisition, resulting in high-density and high resolution surveys.
- Profiling data may be acquired from various discrete depths, ranging from 0.75 meters to 60 meters.
- Continuously-recording instruments (to 15 meter depth) can increase survey speed, density, and resolution permitting total site coverage, if required.
- EM reads directly in conductivity units (mm/m) permitting use of raw data in the field, and correlation to specific conductance of ground water samples.
- EM can map local and general changes in the natural geohydrologic setting.
- EM can detect and measure the boundaries of a conductivity plume.
- Direction of plume flow can be determined from an EM conductivity map.
- EM measurements taken at different times can provide the means to compute movement rates of conservative contaminants.

- EM can detect and map burial pits and trenches of both bulk and drummed wastes.

- EM can detect and map the location of buried metallic utility lines.

Limitations

- EM has less sounding (vertical) resolution than the resistivity method due to its limited number of depth intervals.

- The acquisition of data from depths of 0.75 to 60 meters requires the use of three different EM systems.

- Continuous data can be obtained only to depths up to approximately fifteen meters.

- An EM measurement is influenced by the shallower materials more than the deeper ones; this must be considered when evaluating the data.

- EM measurements become non-linear in zones of very high conductivity.

- The EM method is susceptible to noise from a number of sources, including natural atmospheric noise, powerlines, radio transmitters, buried metallic trash, pipes, cables, nearby fences, vehicles, and buildings.

2.2.2 Soil Borings Soil borings will be drilled using hollow-stem auger and split-spoon sampling techniques in areas where confirmatory soil sampling is needed and where exploration depths exceed 5 feet. If conditions are encountered where the hollow-stem auger method cannot be used (i.e., hard bedrock or caving sands), other investigative techniques, such as solid-stem auger, water or mud rotary, and air rotary, may be used. The borings will be sampled either continuously or at 5-foot intervals, depending on site-specific data needs. Air quality in the breathing zone will be monitored using a PID or OVA during borehole advancement.

Samples will be collected and logged by ABB-ES field personnel using the Unified Soil Classification System (USCS). Soil borings will be used to obtain characterization and confirmation samples for laboratory analysis. Soil samples will be collected in accordance with Level III DQOs. In general, samples collected for laboratory analysis will be selected based on previous field screening results, field monitoring results (i.e., elevated PID or GC readings), visual examination, and/or at pre-designated depth intervals. Most soil boring locations will correspond with monitoring well installations. Soil borings not used for monitoring well installation will be grouted to ground surface.

2.2.3 Surface Soil Sampling Hand augers (for sample depths from 0 to 5 feet) and/or stainless-steel tulip bulb planters (for sample depths from 0 to 6 inches) will be used to collect shallow soil samples for laboratory analysis. Augers will be decontaminated prior to use and between each sampling location. Bulb planters will be decontaminated before sampling and discarded after use. The soil samples will be logged by field personnel using the USCS. Detailed sampling procedures are included in Section 4.2 of Part B - QAPP.

2.2.4 Monitoring Well Installation Groundwater monitoring wells will be installed to provide groundwater samples in accordance with Level III DQOs (for Appendix IX analytical parameters), to monitor groundwater elevations, and to perform in-situ aquifer hydraulic conductivity tests. The monitoring well depths and screened intervals will depend on site-specific data objectives. Well screens will be placed at depths designed to intercept the water table.

Figure 2-1 presents a typical shallow monitoring well installation detail. Monitoring wells will be constructed of 2-inch-inside-diameter (ID), Schedule 40, flush-threaded, PVC screen and riser. Ten-foot well screens with 0.01 inch slotted will be used to construct all wells. Monitoring wells will be constructed and installed in accordance with Southern Division Naval Facilities Engineering Command (SOUTHNAVFACENGCOM) Guidelines For Groundwater Monitoring Well Installation (Appendix D). The annulus or annular space around all well screens will be backfilled with a clean silica sand, compatible with the screen slot size, from a minimum of 2 feet below the bottom of the well screen to 3 feet above the top of the screen, if possible. A 1 to 2 foot bentonite pellet seal will be installed above the sandpack. A cement-bentonite grout will be tremie grouted from the bentonite seal to within 2 feet of the ground surface. The well will be developed prior to sampling (after a minimum of 24 hours grout set time) to remove fines, improve the hydraulic connection with natural soils, and to obtain a representative sample.

Monitoring wells will be developed using an air-activated (pneumatic) surge pump, gasoline-powered diaphragm pump, or both. No air or water will be injected into the wells during development. Wells will generally be purged of at least five well volumes, until the water is clear and free of silts, and/or until field measurements of pH, temperature, and conductivity have stabilized.

Monitoring wells will either be flush-mounted with protective steel casing at ground surface or will have aboveground protective casings to protect the well riser. Aboveground wells in high traffic areas will be surrounded by four protective steel posts. Protective steel casings will be equipped with locking covers. A cement seal and cement pad will be placed from the top of the grout to the ground surface around each protective casing to secure the casing, prevent surface runoff from entering the borehole, and to direct runoff away from the casing. The aboveground portions of both the well riser and protective casing will be vented. The protective casing will have two weep holes near ground level to allow water to drain from inside the casing. Wells will be permanently and properly identified as specified in SDIV guidance.

2.2.5 Groundwater Sampling Where possible, sampling of monitoring wells will proceed from the upgradient (background) wells to the downgradient (or potentially contaminated) wells. Wells with free product will not be sampled for trace chemical analyses unless necessitated by special circumstances or client request. The sampling locations will be recorded in the field logbook and indicated on a site map.

Prior to collecting groundwater samples monitoring wells will be purged of five well volumes or until dry. Prior to sampling, field measurements of pH, temperature, and conductivity will be recorded. Groundwater samples will be collected for laboratory analysis using stainless-steel or Teflon™ bailers and clean nylon or monofilament line. Samples from deep monitoring wells may require the use of a sampling pump. Detailed sampling procedures are included in Section 4.2 of Part B, QAPP.

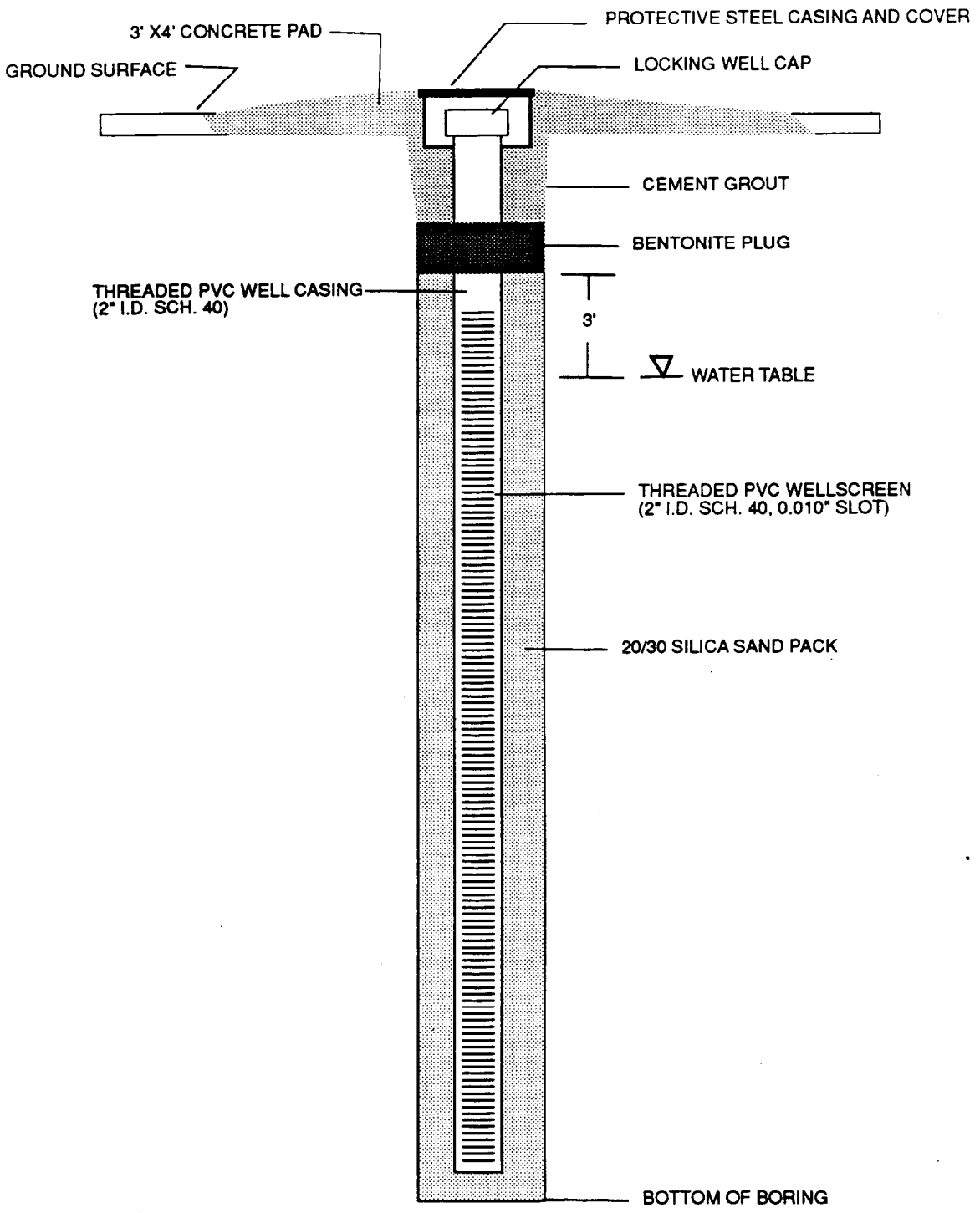

FIGURE 2-1
TYPICAL SHALLOW MONITORING WELL INSTALLATION DETAIL (SURFICIAL AQUIFER)

RFI/SI SAMPLING AND ANALYSIS PLAN

NSB KINGS BAY

2.2.6 Aquifer Characterization Hydraulic conductivity testing (slug tests) will be performed on selected monitoring wells representative of each sampling interval. Hydraulic conductivity measurements can be useful for calculating estimated groundwater flow parameters, for evaluating the heterogeneity of the aquifer, for identifying high permeability zones, and for determining the viability of various remedial options.

Slug tests will be performed in accordance with Technical Memorandum 1, Attachment 1 to the SAP. In general, the test consists of the introduction and withdrawal of either a slug of water or of a weight (such as a tube filled with sand), and the measurement of the change in water level, or fluid pressure, in the well over time. The data will be analyzed using a method developed by H. Bouwer and R.C. Rice (Bouwer and Rice, 1976) for calculating the hydraulic conductivity of an aquifer from partially penetrating wells in an unconfined aquifer.

Slug tests can be categorized into falling head and rising head tests. Falling head tests are typically performed either by introducing a solid 'slug' below the water level and measuring the rate of water level decrease per time until equilibrium conditions are reached (i.e., the rate of recovery). Rising head tests are performed by withdrawing a solid 'slug' and measuring the rate of recovery. The change in water level with time is measured with an electronic transducer and data logger over specified time intervals. Rising head tests will be performed on wells that are screened across the water table. Rising and/or falling head tests will be performed on wells that are screened below the water table.

2.2.7 Topographic and Water Elevation Survey The existing topographic maps of the NSB Kings Bay will be used as a base map for additional survey data collection. This base map is available in digitized and hard copy formats.

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

Sampling locations and other control points will be plotted on site specific base maps and will be available in both digitized and hard formats. In addition, the survey data will be organized and reported in both State Plane Coordinates and in accordance with USEPA Locational Data Policy and Region IV Environmental Monitoring and Data Reporting Requirements (Appendix C). These documents require the identification of sampling locations in terms of latitude/longitude coordinates in both State Plain Coordinates and accordance with the Federal Interagency Coordinating Committee for Digital Cartography (FICCDC) recommendations.

3.0 TECHNICAL APPROACH

The RFI/SI technical approach developed for each site is based on several considerations including: (1) the physical characteristics and geographic location of the site, (2) the history and previous use of the site, (3) results and conclusions of previous investigations, and (4) site reconnaissance. One previous investigation has been conducted: an Initial Assessment Study by C.C. Johnson and Associates, Inc., completed in September, 1985

This section provides a summary of the proposed technical approach for RFI/SI activities for each of the three sites to be investigated. Each subsection provides: a summary of previous investigative results, a rationale for proposed remedial investigative activities, and description of proposed RFI/SI survey and sampling activities for each of the three sites. The final subsections describe activities that are common to all sites and a summary of the number of survey and sampling points for all sites.

The approach for all sites includes three basic steps (1) survey techniques to define the lateral and vertical extent of the disposal areas, this information provides guidance for defining the source area and selecting subsequent sampling locations; (2) screening techniques with on-site analyses, these data can be used to direct and refine confirmation sampling locations; and (3) sampling and analysis in conformance with Level III DQOs. These data provide defensible confirmation of the presence or absence, magnitude, and quantification limits of contaminants.

For health and safety reasons, invasive sampling techniques (drilling) performed within the boundaries of the disposal areas will be limited. Invasive sampling within disposal areas will be performed only where necessary to characterize the source area and only after disposal trenches have been located. Sampling locations adjacent to and beyond the boundary of the disposal areas can generally provide sufficient characterization and delineation data.

All existing monitoring wells at the NSB Kings Bay are constructed of standard Schedule 40 PVC casing and well screen. This material (PVC) is not expected to significantly interact with contaminants detected or suspected at this facility. For these reasons, and to avoid excessive cost, proposed monitoring wells will be constructed of standard Schedule 40 PVC casing and well screen. All monitoring well sampling for laboratory analysis will be conducted in conformance with Level III DQOs to minimize and trace potential sampling interferences. SOUTHNAVFACENGCOM seven point rationale for using PVC is Attachment 2 to the SAP.

3.1 SITE 5, ARMY RESERVE DISPOSAL AREA, TOWHEE TRAIL.

3.1.1 Site 5 Description and Background The Army Reserve used this site from 1969 to 1974. They excavated pits to a depth of 5 feet, then filled the pits with waste. Waste materials disposed at this site included tree debris, metal ammunition boxes, aluminum sheeting, railroad bed material, diesel fuel, and waste oil (used to ignite fires). The Army disposed an estimated total of 69,000 cubic yards of fill material.

In recent years the Navy has used the adjacent property for a borrow pit. The pit is now filled with water, and may significantly influence the local hydrogeology. Because of the pit's influence, current groundwater flow direction may not be consistent with past flow directions.

3.1.2 Rationale for Technical Approach The objectives of the RFI/SI program at Site 5 are to define the location and orientation of the disposal pits, determine the composition and magnitude of soil contamination, and determine the composition and magnitude of groundwater contamination.

The following proposed actions are designed to meet these objectives in an expeditious and cost-effective manner. The following proposed actions are an iterative progression of steps designed to identify site areas and determine if contaminants have migrated in the environment. These steps begin with geophysical surveys and continue through more invasive procedures such as monitoring well installation.

The following investigative objectives and methods are proposed for Site 5.

Objective: To determine the location and orientation of the disposal pits.

Methods: Magnetometer survey
Electromagnetic (EM) terrain conductivity survey

Objective: To determine the composition, magnitude, and extent of soil contamination.

Method: Subsurface soil sampling

Objective: To determine the composition and magnitude of groundwater contamination.

Method: Monitoring well installation and sampling

3.1.3 Investigation The following provides a description of investigative methods and sampling and analysis plans for Site 5.

3.1.3.1 Geophysical Surveys A magnetometer survey will be used to attempt to locate and delineate the burial pits. If the pits are located, an EM survey will be used to identify any contaminant plume that may be emanating from the pit. The following are the proposed geophysical surveys proposed for Site 5.

- A magnetometer survey will be conducted to locate metal objects. If the metal objects located are the result of past disposal practices, then the debris-filled pits can be delineated.
- If the fill cells are located by the magnetometer, an EM survey will be performed around the edges of the suspected landfill to identify any metal plumes emanating from the cells.

A magnetometer will be used to locate and delineate fill areas or fill-cells containing ferric materials. The survey team will grid the site into 20 by 20 foot sections. The first row will be parallel to the east-west road located to

the south of the site. The team will record magnetometer measurement at each grid intersection or node. The survey team will return to each node with abnormally high values and intensely assess the area around the node. The magnetometer values will be plotted as contours line into a site map.

A terrain conductivity survey (EM-31) will be performed around each fill-cell identified during the magnetometer survey. If no fill-cells are identified, then the conductivity survey will be performed around the entire site. The survey will consist of two parallel transect lines 10 feet apart. The first transect will follow the fill-cell's suspected perimeter. The survey team will record the terrain conductivity measurements at 10 feet intervals along the transect liens. A site map with the conductivity values plotted as contour lines will be created for the technical memorandum.

3.1.3.2 **Monitoring Wells** A total of seven monitoring wells will be installed and sampled to determine the composition and magnitude of any groundwater contamination. The regional groundwater flow direction is toward the east. Local hydrological features include two streams; east and northwest of the site. Piezometers cannot be used to determined the historical groundwater flow direction because recent construction of a borrow pit has changed the local hydrology. Unless the EM or other information becomes available to help define a plume, monitoring wells will be installed on each side of the cleared areas containing the landfills. Figure 3-1 shows the approximate location of monitoring wells. The exact locations of the monitoring wells will be determined by the field geologist and EC.

During the construction of selected monitoring wells, continuous split-spoon sampling will be conducted to obtain lithologic information. Soil collected from the split spoon will be screened onsite with an organic vapor analyzer (OVA) for the presence of organic vapors.

All wells will be constructed of schedule 40 polyvinyl chloride (PVC) with 10 feet of 0.01-inch machine-slotted standard PVC well screen. The screened interval will intercept the water table with approximately 3 feet of screen above the water table. Wells will be constructed and installed in conformance with SOUTHNAVFACENGCOM guidelines (Appendix D).

Seven wells will be installed along the perimeter of the site. None of the wells will be installed directly into fill material. Drill cuttings generated during the installation of these monitoring wells present a minimum risk to the environment. A pit located inside the designated site area shall be used as a disposal area for the drill cuttings. The field geologist will designate an undisturbed area of the site for the pit. The pit will be covered at the end of each day.

Decontamination fluids will be collected and drummed. The contractor shall transport the drums to the base's industrial wastewater treatment facility for disposal.

Other liquid wastes, such as well development and purge water, will be screened by an OVA or PID before disposing of them onsite. Water with OVA or PID readings above background will be drummed and transported to the base's industrial waste

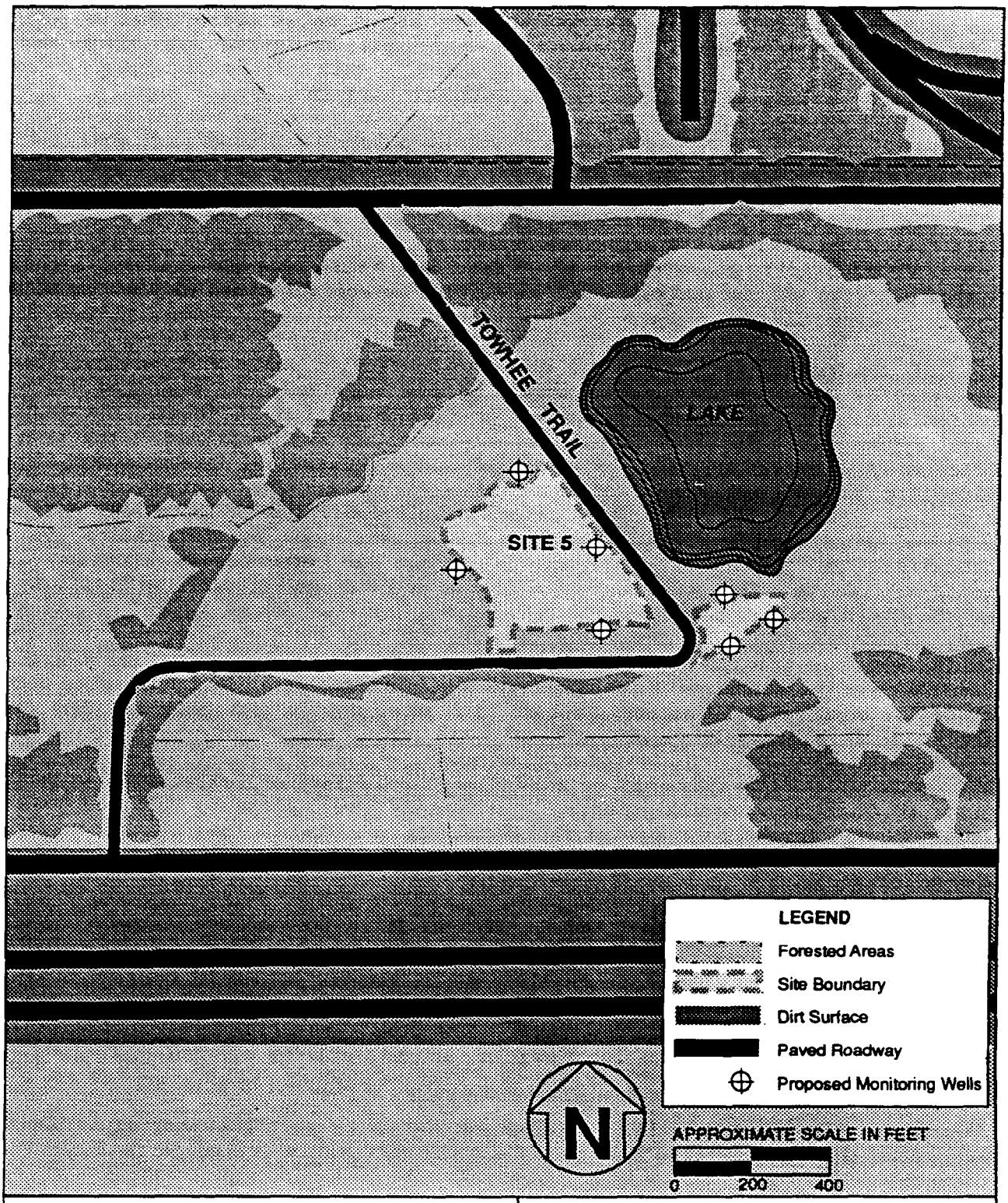

FIGURE 3-1
SITE 5
ARMY RESERVE DISPOSAL AREA
TOWHEE TRAIL LOCATION OF
PROPOSED MONITORING WELLS

RFI/SI SAMPLING AND ANALYSIS PLAN

NSB KINGS BAY

water treatment facility for disposal. Water discharged onsite will be contained until it either evaporates or percolates into the ground. No surface runoff into surrounding surface water body will be permitted.

Groundwater samples will be collected from all seven monitoring wells and analyzed for Appendix IX parameters in conformance with Level III DQOs.

Seven shallow soil samples will be collected to characterizes the waste material. The exact location of each sample will be determined by the field geologist. The geologist will attempt to take the sample from the fill cells identified during the magnetometer survey.

Samples will be collected using hand-auguring techniques. The auguring will proceed until visual changes in the soil appear. The samples will be collected from these altered zones.

A subsurface soil sample will collected at the water table interface during the construction of each monitoring well. Samples will be analyzed for Appendix IX parameters in conformance with level III DQOs.

3.2 SITE 11, CAMDEN LANDFILL

3.2.1 Site 11 Description and History Most of the 35-acre site was used in the landfill's trench and fill operation. Trenches were excavated into the water table, which is 4 to 8 feet below the surface. At the end of each day, the wastes were compacted and covered with at least 6 inches of soil. Upon closure, a final soil cover of 2 feet was placed on the landfill. Estimated waste quantity is 500,000 cubic yards. Twenty to thirty percent of the material came from the NSB Kings Bay (NEESA report 13-086).

3.2.2 Rationale for Technical Approach The objectives of the RFI/SI program at Site 11 are to determine the composition and magnitude of groundwater contamination.

The following proposed actions are designed to meet these objectives in an expeditious and cost-effective manner. The following proposed actions are an iterative progression of steps designed to identify site areas and determine if contaminants have migrated in the environment. These steps begin with geophysical surveys and continue through more invasive procedures such as monitoring well installation.

The following investigative objectives and methods are proposed for Site 11.

Objective: To determine if a contamination plume has migrated away from the site.

Method: EM terrain conductivity survey

Objective: To determine the composition, magnitude, and direction of groundwater contamination.

Method: Monitoring well installation and sampling

3.2.3 Investigation The following provides a description of investigative methods and sampling and analysis plans for Site 11.

3.2.3.1 **Geophysical Survey** Most old landfills have iron or manganese plumes migrating in the prevailing groundwater flow direction. If an organic contamination plume exists, it will usually be associated with the metal plume. An EM survey will be performed around the edges of the suspected landfill to locate contamination plumes that may be migrating away from the site.

A terrain conductivity survey (EM-31) will be performed around Site 11. The survey will consist of two transects around the perimeter of the landfill. The first transect line will parallel the perimeter fence at approximately 15 feet further out. This displacement should avoid interference from the metallic fence. The second transect will be another 10 feet out and parallel to the first. The survey team will collect conductivity measurement every 10 feet along the transect. The survey team may delineate anomalies by performing additional transects as needed. A site map with the conductivity values plotted as contour lines will be prepared in the technical memorandum.

3.2.3.2 **Monitoring Wells** Monitoring wells will be installed around the site and sampled to determine the composition and magnitude of the contamination problem. The exact number and locations of monitoring wells will be determined by the field geologist and EC. Criteria that will be used to locate the wells are as follows:

- close to the boundary of known disposal area,
- background well at Site 11 outside the influence of the localized radial flow network,
- place wells in areas of suspected groundwater contamination detected by non-invasive investigation techniques,
- one background well will be installed upgradient of the site,
- a minimum of two wells will be installed upgradient of the site,
- a minimum of four wells will be installed downgradient of the site,
- at least one well will be installed on each side of the landfill, and
- a minimum of one well will be installed every 400 feet across the suspected path of the plume.

In between each monitoring well located every 400 feet across the plume a Terraprobe will be used to further delineate lithologic information.

Figure 3-2 indicates the proposed location of monitoring wells at Site 11. During the construction of selected monitoring wells, continuous split-spoon sampling will be conducted to obtain lithologic information. Soil collected from the split spoon will be screened onsite with an OVA for the presence of organic vapors.

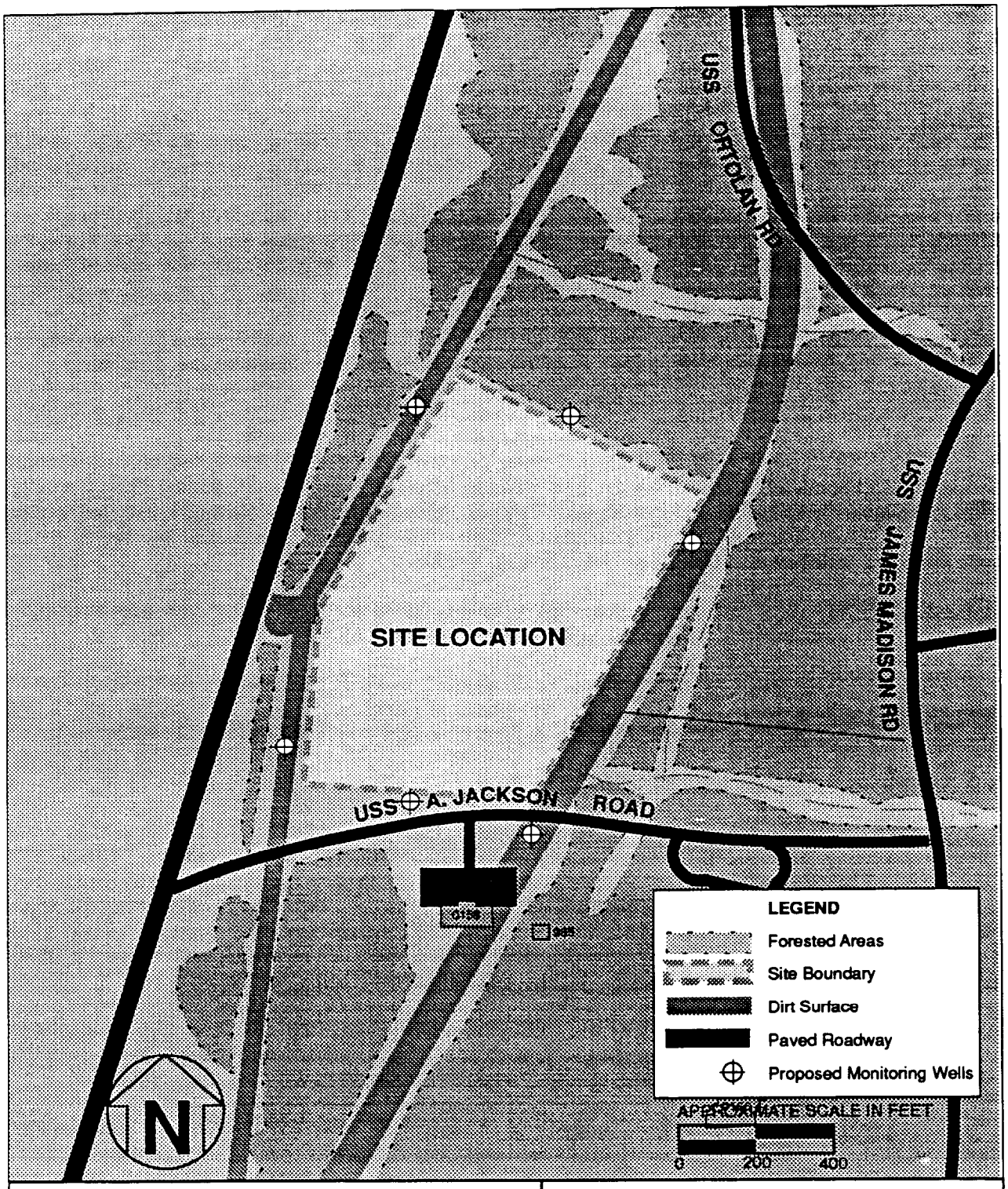

FIGURE 3-2
SITE 11
OLD CAMDEN COUNTY LANDFILL
LOCATION OF PROPOSED MONITORING WELLS

RFI/SI SAMPLING AND ANALYSIS PLAN

NSB KINGS BAY

All wells will be constructed of schedule 40 PVC with 10 feet of 0.01-inch, machine-slotted standard PVC well screen. The screened interval will intercept the water table with approximately 3 feet of screen above the water table. Wells will be constructed and installed in conformance with SOUTHNAVFACENGCOM guidelines (Appendix D).

All wells are to be installed along the perimeter of the site. No wells shall be installed directly into fill material. Therefore, drill cuttings, generated during the installation of these monitoring wells, present a minimum risk to the environment. A pit located inside the designated site area shall be used as adisposal area for the drill cuttings. The field geologist will locate the pit in an undisturbed area of the site. The pit will be covered at the end of each day.

Decontamination fluids will be collected and drummed. The contractor shall transport the drums to the base's industrial wastewater treatment facility for disposal.

Other liquid wastes, such as well development and purge water, will be screened by an OVA or PID before disposing of them onsite. Water with OVA or PID readings above background will be drummed and transported to the base's industrial waste water treatment facility for disposal. Water discharged onsite will be contained until it either evaporates or percolates into the ground. No surface runoff into surrounding surface water body will be permitted.

Groundwater samples will be collected from all monitoring wells and analyzed for Appendix IX parameters in conformance with level III DQOs.

3.2.3.3 **Soil samples** A subsurface soil sample will collected at the water table interface during the construction of each monitoring well. Samples will be analyzed for Appendix IX parameters in conformance with level III DQOs.

3.3 SITE 16, ARMY RESERVES DISPOSAL AREA.

3.3.1 Site 16 Description and Background The disposal pit is a small area (approximately 50 by 100 feet) located within a 5-acre cleared area. The exact location of the pit within the field has not been determined. The Army Reserves disposed of their waste by excavating a pit 3 to 5 feet deep, filling it with material, and finally covering the area. Fill material disposed at the site included tree debris, scrap metal, and empty paint and solvent cans. This location received approximately 4,000 cubic yards total material.

As part of a Base expansion project, the Navy has recently covered the whole area with approximately 5 feet of fill material. This additional surface covering will greatly impede the locating of the old fill cells.

3.3.2 Rationale for Technical Approach The objectives of the RFI/SI program at Site 16 are to define the location and orientation of the disposal pits, determine the composition and magnitude of soil contamination, and determine the composition and magnitude of groundwater contamination.

The following investigative objectives and methods are proposed for Site 16.

Objective: To determine the location and orientation of the disposal pits.

Method: Magnetometer survey

Objective: To determine the composition, magnitude, and extent of soil contamination.

Method: Subsurface soil sampling

Objective: To determine the composition and magnitude of groundwater contamination.

Method: Monitoring well installation and sampling

3.3.3 Investigation The following provides a description of investigative methods and sampling and analysis plans for Site 16.

3.3.3.1 **Geophysical Survey** A magnetometer survey will be used to locate metal objects. If the metal objects located are the result of past disposal practices, then the debris-filled pits can be delineated.

A magnetometer survey will be performed at Site 16 to locate fill-cells containing metallic objects. The survey consist of griding the site into 20 by 20 foot sections. The grid will be oriented parallel and perpendicular to the existing east-west fence. The survey team will record magnetometer measurement at each grid intersection or node. Current construction activities may interfere with the magnetometer survey in some areas. The survey team will return to each node with abnormally high values (unless the value is the result of interference from construction activities) and intensely assess the area around that node. The magnetometer values will be plotted as contours lines onto a site map.

If fill-cells are identified, then a terrain conductivity survey will be performed. The survey will consist of two parallel transect lines 10 feet apart. The first transect shall follow the fill-cells's suspected perimeter. The survey team will record the terrain conductivity measurements at 10 feet intervals along the transect lines. A site map with the conductivity values plotted as contour lines will be created for the technical memorandum.

3.3.3.2 **Monitoring wells** Four monitoring wells will be installed and sampled to determine the composition and magnitude of the contamination problem, if contamination exists. The regional groundwater flow direction is toward the east. Local hydrological features include a stream to the north that drains into an estuarine environment east of the site. Figure 3-3 shows the approximate locations of the monitoring wells. The exact location will be determined by the field geologist and EC. The well locations will include one upgradient and three downgradient wells.

During the construction of selected monitoring wells, continuous split-spoon sampling will be conducted to obtain lithologic information. Soil collected from the split spoon will be screened onsite with an OVA for the presence of organic vapors.

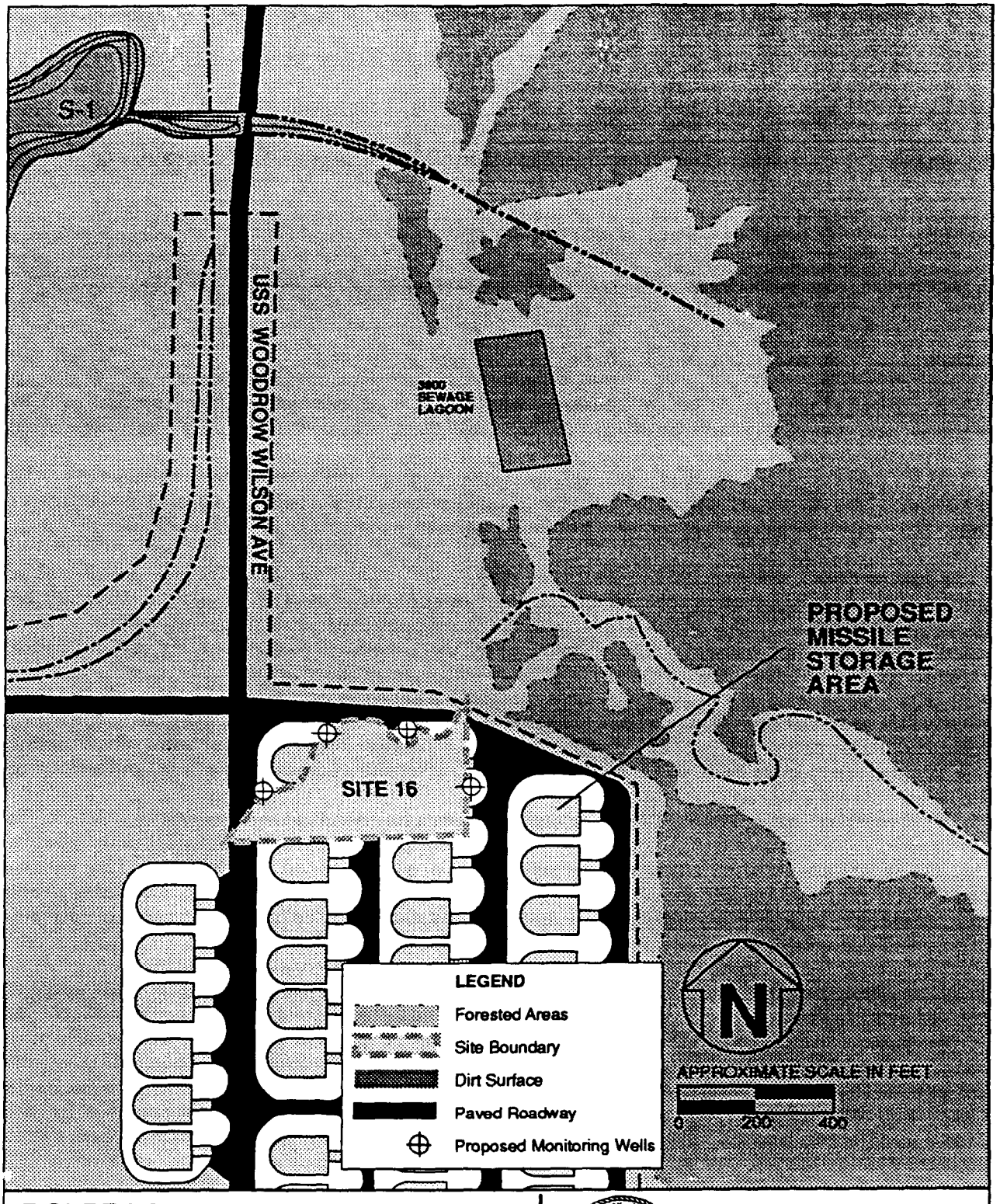

FIGURE 3-3
SITE 16
ARMY RESERVE DISPOSAL AREA
LOCATION OF PROPOSED
MONITORING WELLS

RFI/SI SAMPLING AND ANALYSIS PLAN

NSB KINGS BAY

All wells will be constructed of schedule 40 PVC with 10 feet of 0.01-inch, machine-slotted standard PVC well screen. The screened interval will intercept the water table with approximately 3 feet of screen above the water table. Wells will be constructed and installed in conformance with SOUTHNAVFACENGCOM guidelines (Appendix D).

The four wells are to be installed along the perimeter of the site. None of the wells will be installed directly into fill material. Drill cuttings, generated during the installation of these monitoring wells, present a minimum risk to the environment. However, storage of the drill cuttings may interfere with currentconstruction activities. Drill cutting materials will be drummed and properly labeled as hazardous material. The drums will be transported by the contractor to the base hazardous wastes storage area. The Navy will then be responsible for disposal of the drums.

Decontamination fluids will be collected and drummed. The contractor shall transport the drums to the base's industrial wastewater treatment facility for disposal.

Other liquid wastes, such as well development and purge water, will be screened by an OVA or PID before disposing of them onsite. Water with OVA or PID readings above background will be drummed and transported to the base's industrial waste water treatment facility for disposal. Water discharged onsite will be contained until it either evaporates or percolates into the ground. No surface runoff into surrounding surface water body will be permitted.

Groundwater samples will be collected from all four monitoring wells and analyzed for Appendix IX parameters in conformance with level III DQOs.

3.3.3.3 **Soil samples** Four soil samples will be collected only if the pits can be located through the use of the magnetometer or other investigative method. Samples will be collected using hand-auguring techniques. The auguring will proceed until the visual changes in the soil appear. The samples will be collected from these altered zones.

A subsurface soil sample will collected at the water table interface during the construction of each monitoring well. Samples will be analyzed for Appendix IX parameters in conformance with level III DQOs.

3.4 INVESTIGATION ACTIVITIES COMMON TO ALL SITES. Investigation activities common to all three sites include: aquifer characterization, sample location survey, and decontamination.

3.4.1 Aquifer Characterization Slug tests will be conducted at each site to obtain an estimate of the horizontal hydraulic conductivity of each water bearing zone. This testing can provide estimates for calculating groundwater transport parameters, can potentially identify high hydraulic conductivity zones, and can provide preliminary data for evaluating the feasibility of selected remedial actions.

3.4.2 Survey of Sampling Locations An elevation and location survey will be performed by a licensed surveyor to locate all sampling locations including monitoring wells and any other necessary control points. Sampling locations will be marked upon collection with a wooden stake and flagging tape.

The inner casing (riser) for the monitoring wells will be surveyed for both horizontal and vertical control to a degree of accuracy of 0.1 and 0.01 foot, respectively. Other exploration locations will be marked in the field and will be surveyed for horizontal and vertical control to a degree of accuracy of 0.1 foot.

Sampling locations and other control points will be plotted on site specific base maps and will be available in both digitized and hard copy formats. In addition, the survey data will be organized and reported in both State Plane Coordinates and in accordance with USEPA Locational Data Policy and Region IV Environmental Monitoring and Data Reporting Requirements (Appendix C). These documents require the identification of sampling locations in terms of latitude/longitude coordinates in accordance with the Federal Interagency Coordinating Committee for Digital Cartography (FICCDC) recommendations.

3.4.3 Decontamination In-house cleaning procedures, field cleaning procedures and containment and disposal of wastewater and solvents will be performed as detailed in Section 2.1.5. This section includes cleaning procedures for: sampling equipment, submersible pumps and hoses, sampling and/or filtering tubing, well sounders and measurement tapes, ice chests and shipping containers, field parameter measurement probes, organic-free water containers and large equipment. In addition, Section 2.1.6 includes a detailed description of the decontamination staging area and fluid disposal practices.

3.5 SUMMARY OF SAMPLING INVESTIGATIONS. The estimated number of sampling points can be divided into two location categories: upgradient/background locations and downgradient/source locations. The types of samples collected can be divided into investigation samples and QA/QC samples. The number and types of samples proposed for screening and for laboratory analysis at each of the three sites are summarized in Table 3-1.

3.6 SUMMARY OF MONITORING WELL INSTALLATIONS. Table 3-2 provides a summary of estimated quantities for monitoring well installations. Well depths are estimated at 15 feet. Top of screens will be 3 feet above the water table.

Table 3-1
Summary of QA/QC Samples Per Matrix

Summary of Sampling Activities
Analysis

	A	B	C	D	Totals
Site 5 Surface Soils					
Number of Soil Samples	7	7	7	7	28
Number of Trip Blanks		1			1
Number of Rinsates*	1	1	1	1	4
Number of Field Blanks	2	2	2	2	8
Number of Field Duplicates	1	1	1	1	4
Number of Additional Samples**	2	2	2	1	7
Site 5 Soil Borings					
Number of Soil Samples	7	7	7	7	28
Number of Trip Blanks		1			1
Number of Rinsates*	1	1	1	1	4
Number of Field Blanks	2	2	2	2	8
Number of Field Duplicates	1	1	1	1	4
Number of Additional Samples**	2	2	2	1	7
Site 5 Groundwater					
Number of Groundwater Samples	7	7	7	7	28
Number of Trip Blanks		1			1
Number of Rinsates*	1	1	1	1	4
Number of Field Blanks	2	2	2	2	8
Number of Field Duplicates	1	1	1	1	4
Number of Additional Samples**	2	2	2	1	7
Site 16 Surface Soils - 0 to 4 samples					
Number of Soil Samples	4	4	4	4	16
Number of Trip Blanks		1			1
Number of Rinsates*	1	1	1	1	4
Number of Field Blanks	2	2	2	2	8
Number of Field Duplicates	1	1	1	1	4
Number of Additional Samples**	2	2	2	1	7
Site 16 Soil Borings 4 samples					
Number of Soil Samples	4	4	4	4	16
Number of Trip Blanks		1			1
Number of Rinsates*	1	1	1	1	4
Number of Field Blanks	2	2	2	2	8
Number of Field Duplicates	1	1	1	1	4
Number of Additional Samples**	2	2	2	1	7

Table 3-1 (Continued)
Summary of QA/QC Samples Per Matrix

	Summary of Sampling Activities Analysis				
	Site 5 Surface Soils				
	A	B	C	D	Totals
	Site 16 Groundwater 4 samples				
Number of Groundwater Samples	4	4	4	4	16
Number of Trip Blanks		1			1
Number of Rinsates*	1	1	1	1	4
Number of Field Blanks	2	2	2	2	8
Number of Field Duplicates	1	1	1	1	4
Number of Additional Samples**	2	2	2	1	7
	Site 11 Soil Borings Surface - 10 to 18 samples				
Number of Soil Samples	18	18	18	18	72
Number of Trip Blanks		1			1
Number of Rinsates*	1	1	1	1	4
Number of Field Blanks	2	2	2	2	8
Number of Field Duplicates	2	2	2	2	8
Number of Additional Samples**	2	2	2	1	7
	Site 11 Groundwater - 10 to 19 samples				
Number of Groundwater Samples	19	19	19	19	76
Number of Trip Blanks		1			1
Number of Rinsates*	1	1	1	1	4
Number of Field Blanks	2	2	2	2	8
Number of Field Duplicates	2	2	2	2	8
Number of Additional Samples**	2	2	2	1	7

Notes: A = semivolatiles
B = volatiles
C = pesticides/PCB
D = Metals

* = One rinsate is needed for each equipment used to obtain sample for each type of matrix per day.
** = Additional samples include matrix spikes (duplicates).

Table 3-2
Summary of Estimated Quantities for Monitoring Well Installations

RFI/SI Sampling and Analysis
NSB Kings Bay
Kings Bay, Georgia

Site Number	Monitoring Well Number	Estimated Depth (feet)	Well Materials	
			2"PVC Screen (feet)	2" PVC Riser[1] (feet)
5	KBA-5-1	15	10	8
	KBA-5-2	15	10	8
	KBA-5-3	15	10	8
	KBA-5-4	15	10	8
	KBA-5-5	15	10	8
	KBA-5-6	15	10	8
	KBA-5-7	15	10	8
11	KBA-11-1	15	10	8
	KBA-11-2	15	10	8
	KBA-11-3	15	10	8
	KBA-11-4	15	10	8
	KBA-11-5	15	10	8
	KBA-11-6	15	10	8
	KBA-11-7	15	10	8
	KBA-11-8	15	10	8
	KBA-11-9	15	10	8
	KBA-11-10	15	10	8
	KBA-11-11	15	10	8
	KBA-11-12	15	10	8
16	KBA-16-1	15	10	8
	KBA-16-2	15	10	8
	KBA-16-3	15	10	8
	KBA-16-4	15	10	8
TOTAL		345	230	184

[1]Riser includes 3 feet above ground surface.

4.0 QUALITY ASSURANCE PROJECT PLAN

4.1 DATA QUALITY OBJECTIVES (DQO). The intended use of data and the required data quality objectives (DQOs) are best defined during the planning stages to ensure that collection, decontamination, containerization, shipping, and analytical methods are consistent with the degree of confidence required of the resultant data. The following sections provide a brief description of DQO levels and identifies the levels associated with each RFI/SI field task.

4.1.1 Data Quality Objectives (DQO), General Description DQOs refer to standards for analytical precision, accuracy, reproducibility, completeness, and comparability. Five DQO levels have been defined: Level I, Field Screening; Level II, Field Analysis; Level III, Laboratory Analysis; Level IV, Contract Laboratory Program-Routine Analytical Services (CLP-RAS); and Level V, Non-Conventional Parameter Analysis (USEPA, 1991c).

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

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

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

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

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

The use of potable water is limited only by the parameters being analyzed for and the minimum quantitation limits of the analytical method; water containing up to 1/2 the minimum quantitation limit of the parameters of concern may be used. A

minimum of 5 percent of samples collected for DQO Level II analysis should be split for DQO Level IV analysis. These samples must be representative of all samples analyzed in the field (USEPA, 1991c).

Level III, Laboratory Analysis. Laboratory analytical data is generated using USEPA-approved methods. Level III DQOs are appropriate for data collected for most activities including site characterization (i.e., qualitative and quantitative identification of contaminants and contaminant source(s) and extent of migration) and treatability studies. This level corresponds to NEESA Level C.

Level III field methods, decontamination procedures, sampling equipment, and construction materials are as specified in the USEPA Standard Operating Procedures and Quality Assurance Manual (USEPA Standard Operating Procedures [SOPs] [USEPA, 1991c]). Cleaning of down-hole drilling or excavation equipment must conform to the same requirements as Level IV with the exclusion of the deionized water rinse, the double rinse with pesticide grade isopropanol, and the rinse with organic-free water. All other cleaning and decontamination guidance must be followed.

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

Level III QA/QC sampling blank requirements include:

- a minimum of one equipment rinsate blank per day for each week sampling equipment is field cleaned,
- if samples are preserved, a preservative blank must be collected and analyzed at the beginning and end of the study, and
- a blank of the rinse water must be collected and analyzed prior to beginning the study and at the end of each week that sampling equipment is field cleaned.

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

Level IV, Contract Laboratory Program (CLP). Level IV DQOs are the most stringent and are defined as data collected in accordance with USEPA Standard Operating Procedures (USEPA, 1991c) and analyzed in accordance with the USEPA Contract Laboratory Program (USEPA, 1991a; 1991b). Data collected for characterization and confirmation, during remedial action, for compliance monitoring, or for enforcement often require Level IV for DQOs. This level corresponds to NEESA Level D.

Level V, Non-Conventional Parameter Analysis. Level V is used whenever the DQO must identify or quantify a parameter for which no USEPA-approved method exist. The level V DQOs associated with these types of analysis must, by definition, be defined on an individual basis. The DQOs identified will be dependent on the

specific collection method, decontamination procedures, and analysis to be used. This level corresponds with NEESA Level E.

4.1.2 Task Specific Data Quality Objectives (DQOs) Tasks for the RFI/SI at NSB Kings Bay will involve data collection with DQOs ranging from Level I through Level III. The following discusses the primary RFI/SI tasks for the NSB Kings Bay and the associated DQO level.

- **Geophysical Survey, Level I:** Magnetometer and terrain conductivity (EM-31) surveys will be used to define the perimeter of disposal areas. Data generated as a result of the surveys will indicate the presence or absence of metallic objects and the relative subsurface conductivity. Data requirements are primarily semi-qualitative.

- **Soil Sample Screening, Level I:** Split-spoon samples from discrete depths in soil borings will be screened in the field with an organic vapor analyzer (OVA), providing Level I data concerning the presence or absence of volatile compounds.

- **Air Quality Monitoring, Level I:** For health and safety purposes, air quality will be monitored in the breathing zone by OVA and/or by PID, providing Level I data concerning the presence or absence of volatile compounds.

- **Field Parameter Analysis, Level II:** Field measurements of groundwater temperature, pH, and specific conductance will be performed to screen samples for laboratory analysis and to determine aquifer stabilization during well purging. These measurements are both quantitative and qualitative and the data generated shall conform with both Level I and II DQOs.

- **Characterization and Confirmation Sampling, Level III:** Groundwater, and soil samples collected during monitoring wells construction, and hand augur soil samples will be collected and analyzed in conformance with Level III DQOs for Appendix IX parameters.

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

4.1.3 Precision, Accuracy, Representativeness, Completeness, and Comparability (PARCC) Definition Parameters used within the data validation process to evaluate data quality include measurement of precision, accuracy, representativeness, completeness and comparability (PARCC). The achievable limits for these parameters vary with the DQO Level of the data. The limits used for laboratory analytical data will be those set by the USEPA analytical method and must conform to Level III DQOs. These parameters are defined here and methods of calculation are discussed in Section 4.10.

Precision and Accuracy. Precision, the ability to replicate a value, and accuracy, the ability to obtain a true value, are addressed for all generated data. Precision and accuracy requirements vary depending on intended data uses and are selected in accordance with project requirements. DQOs for precision and

accuracy are established for each major parameter to be measured at the site based on knowledge of the capabilities of available measurement systems and the analytical detections limits required.

Representativeness. Representativeness expresses the degree to which sample data depict an existing environmental condition. Representativeness is accomplished through proper selection of sampling locations and sampling techniques and collection of a sufficient number of samples.

The rational for the number of samples and each sampling locations is discussed in the Workplan. If contamination above ARARs are found during this investigation, then additional studies will be recommended. Sampling and analytical protocols were chosen so that measurements of samples will be as representative of the media and conditions being measured as possible.

Sample collection, handling, and documentation will be performed in accordance with SOPS in this SAP. Use of the SOPs will ensure that collection and handling techniques do not alter the sample and will provide an adequate tracking mechanism from the time of collection through laboratory analysis.

Completeness. The characteristic of completeness is a measure of the amount of valid data obtained compared to the amount of data originally intended to be obtained.

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

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

Comparability. The characteristic of comparability reflects the confidence with which one data set can be compared with other measurements and the expression of results consistent with other organizations reporting similar data. This will be accomplished through the use of standard techniques for sample collection and analysis and the reporting of results in appropriate units. Comparability of analytical procedures also implies using analytical methodologies that produce results comparable in terms of precision, accuracy, and effective range of calibration.

4.2 SAMPLING PROCEDURES AND QUALITY CONTROL SAMPLES. Details of investigation and sampling plans (including the rationale, types, location and number of samples) for each site are included in Section 3.0 "Site-Specific Technical

Approach". Methodology and collection techniques for screening samples are presented in Section 2.0. This section focuses on samples collected for laboratory analysis in conformance with Level III DQOs, including collection methods, collection devices, requirements for containers, preservation and holding times, sample identification, sample handling, packaging, and shipping, sample records, and a definition of QC samples to be collected. Overall, the following types of samples will be collected for laboratory analysis: soil and groundwater.

4.2.1 Soil Sample Collection Procedures Soil samples collected for laboratory analysis will include split-spoon samples collected during monitoring well installation and soil borings collected with hand-augur.

4.2.1.1 Soil Boring Samples A split-spoon sampler will be used to collect soil samples at the water-table interphase. This sampler consists of a split-steel tube or sample barrel threaded at both ends. A sharpened drive shoe secures the bottom of the barrel and an adaptor secures the top. The adaptor contains a check valve and is threaded to connect directly to the drill rods. The split-spoon is driven into undisturbed soil below the casing or hollow-stem auger. After the sampler has been driven, it is withdrawn from the borehole and the sampler is opened by removing both drive shoe and adaptor.

Equipment required to collect split-spoon samples includes the items listed below:

- Field logbook,
- Sample tags/labels and appropriate forms/documentation,
- Glass or stainless-steel mixing bowls,
- Stainless-steel spoons/spatulas,
- Appropriate sampling containers,
- Split-spoons and hand augers
- Decontamination equipment and supplies,
- Personnel protective equipment, as necessary, and
- appropriate equipment (OVA or PID) for downhole, breathing zone and sample screening.

Sample Collection. Sample collection and documentation procedures include the following steps.

1. Scan the soil with an OVA or PID, record the results in the field logbook.

2. Visually examine the sample and record its characteristics (e.g., texture, color, consistency, moisture content, layering and other pertinent data) using the Unified Soil Classification System (USCS).

3. Remove the portion(s) of the sample selected for chemical analysis and place it into appropriate containers using a clean spatula. Soil intended for VOC analysis should be placed in 40-mℓ containers and capped as quickly as possible. Soil intended for other types of analyses should be placed in glass or stainless-steel mixing bowl and thoroughly mixed using a stainless-steel spoon. Once the sample has been thoroughly mixed, sample material should then be placed in the

appropriate sample containers. VOC containers should be placed on ice immediately.

4. Discard any excessively disturbed or loose material found in the top portion of the sampler which may not be representative of the interval sampled. This material will be discarded with other boring spoils at each boring location.

5. Properly label all containers and prepare chain-of-custody documents. Record sample location, description, sample numbers, and other pertinent information in the field logbook.

6. Decontaminate the sampling device in accordance with specified procedures.

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

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

2. Carefully remove and discard any portions of the sample that may have become contaminated by contacting the casing, auger, or drilling fluids (e.g., bentonite, drilling mud, or native intervals mixed with potable water).

3. Conserve sample volume, because under certain soil conditions it may be difficult or impossible to achieve good sample recovery with split-spoons.

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

- Samples are collected immediately after the boring is advanced to the desired sampling elevation.

- The down-hole sampling tools are decontaminated prior to the collection of each sample.

- The drilling technique and procedures to be utilized, particularly the use of drilling fluids, are carefully evaluated for each site.

4.2.1.2 Surface Soil and Sediment Samples Equipment and materials involved in the collection of surface soil samples include:

- field logbook;

- sample tags/labels and the appropriate forms/documentation;

- appropriate sample containers;

- plastic zip-top bags and sealing tape;
- decontamination equipment and supplies;
- protective clothing and gear;
- appropriate equipment (OVA or PID) for breathing zone and sample screening;
- stainless-steel and/or Teflon™-lined pans, trays, or bowls; and
- stainless-steel and/or Teflon™-lined scoops, shovels, trowels, spoons, or spatulas.

The following describes steps for sample collection.

1. Put on the personnel protective clothing and equipment, as necessary.
2. Place plastic sheeting on a flat, level surface near the sampling area, if possible. Place decontamination equipment and supplies, sampling equipment, sampling containers, and insulated cooler on separate plastic sheeting. Cover all equipment and supplies with plastic sheeting when not in use.
3. Record relevant information in the field logbook. Document sample location, soil description, sample number, and other pertinent information.
4. Use a hand-augur to remove the surface soils until the designed depth has been reached. A sample is then collected inside the hand-augur. The sample is transferred into a stainless steel or Teflon™-lined container.
5. Use a clean stainless-steel or Teflon™-lined scoop, trowel, or shovel to obtain a minimum of three sample volumes or the volume needed to fill the specified sample container.
6. Fill and cap VOC vials as quickly as possible, mix remainder of sample directly in a clean stainless-steel or Teflon™-lined tray or bowl. Fill and cap each sample container. Place VOC containers on ice immediately.
7. Label each sample container with the appropriate information. Fill out chain of custody forms and package samples.

<u>4.2.2 Groundwater Sample Collection Procedures</u> Groundwater samples for laboratory analyses will be collected from new permanent monitoring wells. The purging and sampling techniques outlined below help ensure the collection of a representative sample.

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

Purging equipment includes:

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

Two common procedures used to purge a monitoring well are presented below. These procedures include the indicator parameter method of well purging and the volumetric method of well purging. The actual method used in the field will be site investigation-specific. However, the purging of standing well water is considered complete when one of the following is achieved:

(1) five well volumes have been purged; or

(2) the well has been pumped dry.

<u>Volumetric Method of Well Purging</u>

1. Put on personnel protective clothing and equipment as specified in the site-specific health and safety plan (HASP).

2. Open well cover and check condition of the wellhead.

3. Determine volume of water in well by measuring distance from the bottom of the well to the static water level (height of standing water), then measure the inside diameter of well or casing. Water level measurements should be measured from the same point each time it is measured with minimum measurements made in 1/10th of a foot. Note: more stringent measurements may be required for specific project programs (i.e., 1/100th of a foot).

4. Calculate well volume by using the follow formula (or its equivalent):

$v = 5.09d^2h$ where, h = height of standing water column
d = inside diameter of well in feet
v = volume of water in gallons

5. Prepare pump and tubing, or bailer and lower it into casing.

6. Remove number of well volumes specified in project plans, measuring the length of time taken to purge a measured amount of water, calculating the flow rate, and allowing the well to purge for the necessary length of time.

7. If well goes dry during pumping or bailing, one is assured of removing all water which had prolonged contact with the well casing or air.

8. Record pertinent data in field logbook.

9. Remove pump assembly or bailer from the well and decontaminate as required.

10. Dispose of produced water as required by project workplan.

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

In order to prevent backflow of purged water into wells, submersible pumps must be equipped with a check valve, and centrifugal pumps must have a foot valve. When sampling for organics or metals, certain precautions must be taken to minimize the risk of contaminating the groundwater sample with the pump. In general, any parts of the pump and tubing that contact the groundwater must be constructed of Teflon™ and stainless steel. Submersible pumps may be used in this situation when no other pumping device is available, since lines cannot be practically constructed of inert materials.

4.2.2.2 Sampling Procedures for Monitoring Wells Where possible, sampling of monitoring wells will proceed from the upgradient (background) wells to the downgradient (or potentially contaminated) wells. Wells with free product will not be sampled for trace chemical analyses unless necessitated by special circumstances or client request. The sampling locations will be recorded in the field logbook and indicated on a site map. Groundwater sampling equipment includes:

- bailers constructed of appropriate material (i.e. Teflon™, stainless-steel, polypropylene),
- clean (nylon or monofilament) line of sufficient length to lower bailer (new lanyard must be used for each well),
- a pump (type dictated by physical conditions),
- appropriate sample containers with labels and preservatives, as required,
- coolers with wet ice,
- water-level meter and/or other water-level measuring device,

- temperature, conductivity, pH,
- plastic sheeting,
- decontamination supplies, as required, and
- personnel protective clothing and equipment, if required by the site-specific Health and Safety Plan.

Groundwater sampling procedures include the following steps.

1. Put on protective clothing and equipment as necessary.
2. Prepare the site for sample collection by covering the ground surface around the well head with plastic sheeting.
3. Open well and note condition of casing and cap. Check for vapors using vapor analyzing equipment.
4. Determine static water level and depth to well bottom using water-level meter or tape. Record this information in field logbook.
5. Determine purge volume and purge the well.
6. Arrange sample containers in order of use. Volatile organic analysis (VOC) samples, if required will be sampled first, followed in order by semi-volatiles (SVOA) and other samples.
7. Lower bailer or pump intake (as appropriate for parameters of concern) into well. Bailer should enter the water slowly to prevent aeration, particularly when VOC and SVOA samples are being collected. Retrieve the filled bailer to the surface. Try not to allow line to contact the ground.
8. Collect the samples in the following manor:
   - Fill VOC samples directly from bailer with as little agitation as possible. Fill until the sample forms a convex meniscus above the top edge of the vial, and then carefully cap the vial. Invert VOC sample bottles and tap to check for air bubbles.
   - Other samples will be placed directly in the appropriate container from the discharge tubing of the pump or bailer.
9. Add preservative (if needed), cap, seal and properly label all containers. Place filled containers into the cooler(s) immediately.
10. Record sample types and amounts collected, and time and date of collection in the field logbook. Prepare chain-of-custody. Prepare samples for shipment to the laboratory.
11. Decontaminate sampling equipment (as required) and dispose of lanyard.

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

4.2.3 Sampling Equipment Construction Materials Sampling equipment will be constructed of material appropriate for the matrix to be sampled and parameters to be analyzed for. This should prevent or minimize the chance for contamination of the sample by the equipment itself. Table 4-1 details appropriate construction materials that should be used for selected types of sampling equipment when sampling for specific parameters.

4.2.4 Analytical Program. Sample analyses range from screening techniques and field analysis to Level III, laboratory analyses. This section will discuss the laboratory analytical methods, and associated DQO levels, for the matrices to be sampled at NSB Kings Bay.

Soil and groundwater samples will be collected from each site for laboratory analysis. Laboratory analyses will be conducted in conformance with the USEPA approved methods for Appendix IX parameters. These analyses are intended to provide confirmatory information concerning the nature and distribution of contamination at the site. All laboratory analytical samples will be analyzed in conformance with Level III DQOs.

4.2.5 Sample Containers, Preservation, and Holding Times The origin of sample containers is noted in equipment room files. Pre-cleaned sample containers must meet NEESA and USEPA-CLP QA requirements. Sample container material and sizes are selected based on compatibility with the analyte and matrix.

Preservatives, controlled holding times, and selected container materials may be required to avoid sample degradation or alteration prior to laboratory analysis. Table 4-2 list the analyte, sample matrix, preservative, and the maximum holding times. Holding times are controlled to minimize the time between sample collection and analysis, which in turn minimize the reaction time for potential mechanisms of analyte loss or alteration.

4.2.5.1 Sample Containers In general, samples for organic analysis should be stored in glass containers and samples for inorganic analysis should be stored in plastic containers. As container specifications depend on the analyte and sample matrix types (as indicated in Table 4-2), separate samples should be taken when both organic and inorganic analyses are required. Containers should be kept in the dark (to minimize biological or photooxidation/photolysis breakdown of constituents) until they reach the analytical laboratory. The sample container should generally allow approximately 5-10 percent air space ("ullage") to allow for expansion/vaporization if the sample is heated during transport (1 liter of water at 4 °C expands by 15 milliliters if heated to 130 °F/55 °C). Important exceptions include Volatile Organic Analysis, Chemical Oxygen Demand, and Biological Oxygen Demand all of which do not allow headspace in the container. When sample containers are stored onsite, the containers should be kept sealed and as far as possible from solvents also being stored. Ideally, solvents should be kept in separate facilities from clean containers and organic-free water.

4.2.5.2 Preservation Techniques Preservation techniques for selected analytes are presented in Table 4-2. Samples will be preserved immediately upon collection in the field. Reagents required for sample preservation will

Table 4-1
Sampling Equipment, Restrictions, Materials and Appropriate Use

RFI/SI Sampling and Analysis
NSB Kings Bay
Kings Bay, Georgia

Equipment Type	Use	Permissible Parameter Group	Restrictions and Precautions
		WATER SAMPLING	
		Ground Water	
Pumps([1])			
1. Positive Displacement Pumps			
a. Submersible (turbine, helical rotor)	Purging	All parameter groups	1,2,3,4,5
	Sampling	Chemical and Biological	none
		Demands, nutrients,	1,2,3,4,6
		Metals	1,2,3,4,6
		Extractable Organics	
b. Submersible (gear drive)	Purging	All parameter groups	1,2,3,4,5,6
	Sampling	Chemical and Biological	none
		Demands, nutrients,	1,2,3,4,6
		Metals	1,2,3,4,6
		Extractable Organics	
c. Bladder pump (no gas contact)	Purging	All parameter groups	3,4,6
	Sampling	Chemical and Biological	none
		Demands, nutrients,	4,7
		Metals	3,4,6
		VOCs and Extractable Organics	
2. Suction Lift Pumps			
a. Centrifugal	Purging	All parameter groups	4,5,6,8
b. Peristaltic	Purging	All parameter groups	5,8
	Sampling	Chemical and Biological	none
		Demands, nutrients,	23
		Metals	9
		Extractable Organics	
3. Bailer Purging	All parameter groups	10,26	
	Sampling	Chemical and Biological	none
		Demands, nutrients,	11
		Metals	10
		VOCs and Extractable Organics	

[1]Pumps may not be used in sampling for volatile organic components except when pumps are permanently installed as a part of a drinking water system, or if positive displacement stainless steel and Teflon™ bladder pumps are used. If installed as a part of a drinking water system, the material construction of the pump and holding tank must be noted in the field documentation.

Table 4-1 (Continued)
Sampling Equipment, Restrictions, Materials and Appropriate Use

RFI/SI Sampling and Analysis
NSB Kings Bay
Kings Bay, Georgia

Equipment Type	Use	Permissible Parameter Group	Restrictions and Precautions
		Surface Water	
1. Automatic Sampler	Sampling	Chemical and Biological Demands, nutrients, metals	23
2. DO Dunker	Composited samples of water column	Chemical and Biological Demands, nutrients Metals VOCs and Extractable Organics	none 11 13
3. Kemmerer or Van Dorn	Grab samples at specified depth	Chemical and Biological Demands, nutrients, Metals VOCs and Extractable Organics	none 11
4. Peristaltic pump	Sampling	See 2b. above	
Field Filtration Units	Filtration for dissolved components	Trace Metals	15 16
		SOLID SAMPLING **Sediments and Soils**	
1. Core Barrel	Sampling	Chemical and Biological Demands, nutrients, Metals VOCs Extractable Organics	none 17 18,24 24
2. Trowel, scoop, spoon or spatula	Sampling and composition	Chemical and Biological Demands, nutrients, Trace Metals	none 11 12,19
3. Mixing Tray	Composition or homogenizing	Chemical and Biological Demands, nutrients, Trace Metals Extractable Organics	none 11 25
4. Shovel	Sampling	Chemical and Biological Demands, nutrients, Trace metals, VOCS and Extractable organics	none 20
5. Hand auger, Bucket auger	Sampling	Chemical and Biological Demands, nutrients, Trace metals, VOCs and Extractable organics	none 20

Table 4-1 (Continued)
Sampling Equipment, Restrictions, Materials and Appropriate Use

RFI/SI Sampling and Analysis
NSB Kings Bay
Kings Bay, Georgia

Equipment Type	Use	Permissible Parameter Group	Restrictions and Precautions
6. Split spoon	Sampling	Chemical and Biological Demands, nutrients,	none
		Trace metals, VOCs	18,21
		Extractable Organics	18
7. Shelby tube	Sampling	Chemical and Biological Demands, nutrients	none
		Metals	22
		VOCs	18
		Extractable organics	none
8. Dredges	Sampling	All parameter groups	19, 20
		Container Sampling	
1. Glass tubing	Sampling	All parameter groups	14
2. Coliwassa tube	Sampling	All parameter groups	13

Key to Restrictions and Precautions

1. Pump must be equipped with a check valve to prevent backflow of purged water into the well.

2. If purging or sampling for organics or metals, this device may be used when no other pumping device is available, since lines cannot be practically constructed of inert materials.

3. If purging or sampling for organics or metals, pump housing should be of stainless steel and Teflon™ construction.

4. If used as a non-dedicated system, pump must be cleaned between wells. Delivery tubing should be precleaned and precut at the base of operations or laboratory. If the same tubing is used during the sampling event, it must be cleaned and decontaminated between use.

5. When purging for organics or metals, the entire length of tubing (or pipe) or the portion which comes in contact with the formation water should be constructed of Teflon™ or stainless steel. If other materials (i.e., rigid PVC, polyethylene or polypropylene) are used, the following protocols must be followed: 1)contact with formation waters will be minimized by slowly withdrawing the pump from the water column during the last phase of purging, thus removing from the well any water which has contacted the exterior of the pump and/or tubing; 2) a single well volume must be removed with the sampling device before sampling begins.. Tygon™ must never be used for purging when organics are of interest.

6. If sampling for organics or metals, the entire length of tubing (or pipe) or the portion which will come in contact with the formation water must be constructed of Teflon™ or stainless steel.

7. Pump and delivery tubing must be constructed of stainless steel or suitable non-metallic materials.

8. Must be equipped with foot valve to prevent backflow of purged water into the well.

Table 4-1 (Continued)
Sampling Equipment, Restrictions, Materials and Appropriate Use

RFI/SI Sampling and Analysis
NSB Kings Bay
Kings Bay, Georgia

Key to Restrictions and Precautions--continued

9. All components of the sample collection system contacting the sample water must be constructed of Teflon™, stainless steel or glass. The system must be configured such that the sample is collected before the pump head.

10. If purging or sampling for organics or metals, construction must be of stainless steel or Teflon™.

11. Equipment must be constructed of stainless steel or suitable non metallic materials.

12. Must be constructed of stainless steel or coated with Teflon™.

13. Must be constructed of stainless steel or glass.

14. If sampling for volatile organics - no vacuum can be used to draw up sample.

15. Units must use filters with a pore size of 0.45 microns.

16. When sampling ground water, units must use high capacity filters with a pore size of 0.45 microns and be constructed of materials that will not contaminate the sample with trace metals. The system must be configured so that the sample does not come into contact with ambient air before the sample is filtered.

17. Liners must be constructed of stainless steel or a suitable non metallic material. If a carbon-steel liner is used with the core barrel, the samples for metals shall be taken from the interior part of the core sample.

18. If samples are sealed in the liner for transport to the laboratory, the sample for VOC analysis must be taken from the interior part of the core.

19. Samples for volatile organics should not be taken from a composite (mixed) sample.

20. Cannot be constructed of any metal other than stainless steel.

21. If constructed of materials other than stainless steel, then a Teflon™ insert must be used.

22. If constructed of materials other than stainless steel, the sample for metals analysis must be taken from the interior part of the core sample.

23. The flexible tubing used for the peristaltic pump should be medical grade silicone tubing. Delivery tubing must be constructed of suitable non-metallic materials.

24. Liners may be constructed of stainless steel, Teflon™, glass, aluminum or other suitable liner of metallic construction.

25. Must be constructed of stainless steel, Teflon™, glass or aluminum.

26. Purging by bailer is not recommended.

Source: ABB-ES Comprehensive Quality Assurance Program Plan.

Table 4-2
Sample Container and Preservation Requirements

RFI/SI Sampling and Analysis
NSB Kings Bay
Kings Bay, Georgia

Parameter	Matrix	Holding time (from time of collection)	Container	Preservative	Minimum[1] sample size
Volatile organic carbons	Water	14 days	Two 40 mℓ vials with Teflon™-lined caps	4 drops concentrated HCl, 4 °C	40 mℓ
	Soil	14 days	Glass with Teflon™-lined septum	4 °C	10 g
Volatile organic halogenated compounds	Water	14 days	Two 40 mℓ vials with Teflon™-lined caps	4 drops concentrated HCl, 4 °C	40 mℓ
	Soil	14 days	Glass with Teflon™-lined septum	4 °C	10 g
Extractable organics	Water	7 days extraction 40 days analytical	1 ℓ amber glass with Teflon™ liner,	4 °C	1,000 mℓ
	Soil	14 days extraction 40 days analytical	Amber glass jar with Teflon™ liner or core tube	4 °C	50 g
Acrolein	Water	14 days	Glass with Teflon™-lined septum	0.008% $Na_2S_2O_3$[4] adjust pH to 4 to 5, 4 °C	40 mℓ
	Soil	14 days	Glass with Teflon™-lined septum	4 °C	enough to fill (2) 40-mℓ vials
Organo-phosphorus pesticides	Water	7 days extraction 30 days analysis	1 ℓ borosilicate glass	Adjust pH to 5.0 to 9.0 with H_2SO_4 or 10 N NaOH, 4 °C	1,000 mℓ
	Soil	7 days extraction 30 days analysis	1 ℓ borosilicate glass	4 °C	100 g
Chlorinated herbicides	Water	7 days extraction 30 days analysis	1 ℓ borosilicate glass	4 °C	1,000 mℓ
	Soil	7 days extraction 30 days analysis	1 ℓ borosilicate glass	4 °C	100 g
Organochlorine pesticides and PCB	Water	7 days extraction 30 days analysis	1 ℓ borosilicate glass	Adjust pH to 5.0-9.0 with 1:1 H_2SO_4 or NaOH, 4 °C	1,000 mℓ
	Soil	7 days extraction 30 days analysis	1 ℓ borosilicate glass	4 °C	100 g
Metals (other than chromium IV and mercury)	Water	180 days	Polyethylene or glass	HNO_3 to pH <2[2]	100 mℓ
	Soil	180 days	Polyethylene or glass	4 °C	10 g
Chromium IV	Water	24 hours	Polyethylene or glass	4 °C	100 mℓ
	Soil	24 hours	Polyethylene or glass	4 °C	10 g
Mercury	Water	28 days	Polyethylene or glass	HNO_3 to pH <2[2]	100 mℓ
	Soil	28 days	Polyethylene or glass	4 °C	10 g

[1] Additional sample must be collected for matrix spike or matrix spike duplicate samples.
[2] Dissolved metals require filtration before pH adjustment.

Notes:
mℓ = milliliter.
g = gram.
$Na_2S_2O_3$ = sodium thiosulfate
HCl = hydrochloric acid.
ℓ = liter.
NaOH = sodium hydroxide.
°C = degrees Celsius
HNO_3 = nitric acid.
H_2SO_4 = sulfuric acid.

Table 4-2 (Continued)
Sample Container and Preservation Requirements

RFI/SI Sampling and Analysis Plan
NSB Kings Bay
Kings Bay, Georgia

Parameter	Matrix	Holding time (from time of collection)	Container	Preservative	Minimum[1] sample size
Cyanide	Water	14 days[3] 24 hours[5]	Polyethylene or glass	0.6 g ascorbic[2] acid, NaOH to pH >12, 4 °C	100 mℓ
	Soil	14 days	Polyethylene or glass	4 °C	10 g
Dioxins/ furans	Water	7 days extraction 40 days analytical	1 ℓ glass	4 °C	1,000 mℓ
	Soil/waste	14 days extraction 40 days analytical	Core tube	4 °C	50 g
Petroleum hydrocarbons as gasoline	Water	14 days	Two 40 mℓ vials with Teflon™ liners	4 °C, HCl to pH <2	40 mℓ
	Soil/waste	14 days	Core tube	4 °C	50 g
Total petroleum hydrocarbons as diesel	Water	14 days extraction 40 days analytical	1 ℓ glass	4 °C	500 mℓ
	Soil/waste	14 days extraction 40 days analytical	Core tube	4 °C	50 g
Petroleum hydrocarbons (TPH)	Water	28 days	1 ℓ glass	4 °C, HCl to pH <2	1,000 mℓ
	Soil	28 days	Glass jar with Teflon™ liner or core tube	4 °C	50 g
Oil and grease	Water	28 days	Glass bottle	Adjust pH to <2.0 with H_2SO_4, 4 °C	1,000 mℓ
	Soil	28 days	Glass jar with Teflon™ liner	4 °C	50 g
Residue, settleable	Water	48 hours	Polyethylene or glass bottle	4 °C	1,000 mℓ
Residue, all others (TSS, VSS, TDS)	Water	7 days	Polyethylene or glass bottle	4 °C	500 mℓ
Biochemical oxygen demand	Water	48 hours	Polyethylene or glass bottle	4 °C	1,000 mℓ
Chemical oxygen demand	Water	28 days	Polyethylene or glass bottle	Adjust pH to <2.0 with H_2SO_4, 4 °C	1,000 mℓ
Metals (ICP)	Water	6 months	Polyethylene	HNO_3 to pH <2	100 mℓ
	Soil/waste	6 months	Core tube or glass jar	4 °C	10 g
Arsenic (GFAA)	Water	6 months	Polyethylene	HNO_3 to pH <2	100 mℓ
	Soil/waste	6 months	Core tube or glass jar	4 °C	10 g
Mercury (CVAA)	Water	28 days	Polyethylene	HNO_3 to pH <2	100 mℓ
	Soil/waste	28 days	Core tube or glass jar	4 °C	10 g
Selenium (GFAA)	Water	6 months	Polyethylene	HNO_3 to pH <2	100 mℓ
	Soil/waste	6 months	Core tube or glass jar	4 °C	10 g
Thallium (GFAA)	Water	6 months	Polyethylene	HNO_3 to pH <2	100 mℓ
	Soil/waste	6 months	Core tube or glass jar	4 °C	10 g
Lead (GFAA)	Water	6 months	Polyethylene	HNO_3 to pH <2	100 mℓ
	Soil/waste	6 months	Core tube or glass jar	4 °C	10 g
Chromium (VI)	Water	24 hours	Polyethylene	4 °C	100 mℓ
	Soil/waste	24 hours	Core tube or glass jar	4 °C	10 g

Table 4-2 (Continued)
Sample Container and Preservation Requirements

RFI/SI Sampling and Analysis Plan
NSB Kings Bay
Kings Bay, Georgia

Parameter	Matrix	Holding time (from time of collection)	Container	Preservative	Minimum[1] sample size
Coliform, fecal and total	Water	6 hours	Polyethylene or glass bottle	0.08 % $Na_2S_2O_3$[4] 4 °C	500 mℓ
Fecal streptococci	Water	6 hours	Polyethylene or glass bottle	0.08 % $Na_2S_2O_3$[4] 4 °C	500 mℓ
Nitrogen, organic and Kjeldahl	Water	28 days	Polyethylene or glass bottle	Adjust pH to <2.0 with H_2SO_4, 4 °C	500 mℓ
Nitrate	Water	48 hours	Polyethylene or glass bottle	4 °	125 mℓ
Nitrate-nitrite	Water	28 days	Polyethylene or glass bottle	Adjust pH to <2.0 with H_2SO_4	125 mℓ
Phosphorus, total	Water	28 days	Polyethylene or glass bottle	Adjust pH to <2.0 with H_2SO_4	125 mℓ
Sulfate	Water	28 days	Polyethylene or glass bottle	4 °C	125 mℓ
Sulfide	Water	7 days	Polyethylene or glass bottle	Adjust pH to >9.0 with zinc acetate plus NaOH, 4 °C	500 mℓ
Surfactants	Water	48 hours	Polyethylene or glass bottle	4 °	1,000 mℓ
Radiological tests: alpha, beta, radium	Water	6 months	Polyethylene or glass bottle	Adjust pH to <2.0	
Total organic halogens	Water	28 days	Glass with Teflon™-lined cap	Adjust pH to <2.0 4 °C	40 mℓ

[1] Additional sample must be collected for matrix spike or matrix spike duplicate samples.
[2] Dissolved metals require filtration before pH adjustment.
[3] Holding time (14 days) applies to samples that do not contain sulfide.
[4] Only used in the presence of residual chlorine.
[5] Sulfides are determined with lead acetate paper, if detected a 24 hour hold time applies.

Notes:
mℓ = milliliter.
g = gram.
$Na_2S_2O_3$ = sodium thiosulfate
HCl = hydrochloric acid.
ℓ = liter.
NaOH = sodium hydroxide.
°C = degrees Celsius
HNO_3 = nitric acid.
H_2SO_4 = sulfuric acid.

generally be added to the sample containers by the subcontract laboratory prior to shipment. In some instances, preservatives may be added in the field.

Chemical preservation may have an effect on the sample, therefore the following should be considered before preserving a sample.

- Samples that have extremely low or high pH or samples that may generate potentially dangerous gases.
- Metal samples in a water matrix with a considerable solids content may require filtering prior to preservation with nitric acid. These samples can be preserved with ice and returned to the laboratory for filtering and preservation.
- All samples preserved with chemicals shall be clearly labelled.
- If containers are shipped to the site with the preserved already added to the bottle by subcontract laboratory, additional preservatives material will be provided by the laboratory from the same source.

The following subsections describe the procedures for preparing and adding chemical preservatives. Table 4-2 indicates specific analytes for which these preservatives are recommended.

Addition of Acid (H_2SO_4, HCl, OR HNO3) or Base (NaOH). Addition of the following acids or bases may be specified for sample preservation:

Acid or base	Concentration	Normality	Amount for acidification[1]
HCl	1:1 dilution of concentrated HCl	6N	5-10 mℓ
H_2SO_4	1:1 dilution of concentrated H_2SO_4	18N	2-5 mℓ
HNO_3	Undiluted concentrated HNO_3	16N	2-5 mℓ
NaOH	400 grams solid NaOH in 870 mℓ water	10N	2 mℓ[2]

[1] Amount of acid to add (at the specified strength) per liter of water to reduce the sample pH to less than 2, assuming that the water is initially at pH 7, and is poorly buffered and does not contain particulate matter.
[2] To raise pH of 1 liter of water to 12.

HCl, H_2SO_4, and N_aOH should be analytical reagent (AR) grade and should be diluted to the required concentration with double-distilled, deionized water in the laboratory performing the analyses or by field personnel. This procedure should be followed prior to conducting field sampling. Nitric acid (HNO_3) for metals preservation must be ultra purified metals grade HNO_3.

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

Sample acidification or base addition should proceed as follows:

1. Check initial pH of sample with wide range (0-14) pH paper.

2. Fill sample bottle to within 5-10 mℓ of final desired volume and add about 1/2 of estimated acid or base required, stir gently and check pH with medium range pH paper (pH 0-6 or pH 7.5-14, respectively).

3. Add acid or base a few drops at a time while stirring gently. Check for final pH using narrow range (0-2.5 or 11-13, respectively) pH paper; when desired pH is reached, cap sample bottle and seal.

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

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

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

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

4.2.6 Sample Identification Samples collected for laboratory analysis during the field investigation will be labeled with computer-generated labels. The labels will display a 14-digit sample identification code, which identifies the site sample location, sample type, horizontal and vertical locators, event number, and modifier as described below.

The sample identification system consists of 14 alphanumeric characters in 6 information groups preceded by the two-letter code, KB, for the NSB Kings Bay site.

KB - 1 2 - 3 4 - 5 6 7 - 8 9 10 - 11 12 - 13 14

- Site _____
- Type _____
- Horizontal Locator _____
- Vertical Locator _____
- Event Number _____
- Modifier _____

These information groups may contain the following entries. If no information is required for the particular sample, the spaces should be filled with an X. If only one character is needed in a multi-character field, the character must be right-justified and the leading spaces filled with an X.

Site. The two-character site code identifies a specific area of investigation. Examples:

05 - Site 5.

Type. The two-character sample type code identifies the general source type and media of the sample. The physical location coordinates are addressed in the horizontal and vertical codes.

Codes can include:

GW - groundwater
SW - surface water
WW - waste water
DW - drinking water
WS - water supply
LT - leachate
PC - primary clarifier effluent
SC - secondary clarifier effort
RW - raw water
RI - raw influent

FE - final effluent
SS - surface soil
SB - soil boring
TP - test pit
RC - rock core
SL - sludge
SD - sediment
WT - waste
WP - wipe

AA - ambient air, grab sample
LA - ambient air, long-term sample
SG - soil gas
LV - landfill vent gas

BT - blank, trip
BS - blank, sampler
BF - blank, filtration

Horizontal Locator. Also known as the "sampling point", this code locates the sampling/exploration on the surface of the site (x, y coordinates). The horizontal locator allows designation of a variety of samples (AA, headspace, SS, SB, MW) all from the same point onsite. Two approaches may be used:

(1) A number sequence for the exploration (e.g., MW-10). For wells and borings it is important to note that a boring #10 which subsequent-

ly has a monitoring well installed has the same horizontal locator, #10.

(2) Use of a grid system. If a sampling program utilizes a grid system, as surface soil sampling often does, it is recommended that the grid system be used for all horizontal locations. A three-character grid system allows about 2600 locations (A00 through Z99). If more locations are needed, the site may be subdivided and the two or more areas designated by the site code.

Vertical Locator. Two approaches may be used to identify the third coordinate of the "sampling point":

(1) Soil samples can be numbered from the surface downward corresponding to the boring or test pit log (e.g., S-21). In surface soil sampling programs, the vertical interval between samples may be specified in the workplan or the approach in #3 below used.

(2) Monitoring well clusters can use letters to designate the relative depth of the screened interval.

(3) For surface water investigations or surface soil sampling, it may be feasible to use this space for "feet below surface".

Event. Also known as the "round of sampling", these numbers will identify the sequence of multiple samples at the same location. This applies primarily to water sampling, for example, quarterly monitoring programs which continue over many years. In most cases, soil sampling will be limited at one location to one or two events.

Modifier. Examples of modifiers include:

D - duplicate sample
R - replicate sample
H - headspace portion of a sample
MS - matrix spike
MD - matrix spike duplicate
ER - equipment rinsate
FB - field blank

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

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

- ensure samples remain sealed in original containers,
- prevent breakage,
- prevent cross-contamination of individual samples,
- ensure sample characteristics are preserved,
- prevent contamination to receiving personnel, and
- ensure samples are protected against tampering when not in sampler's, possession.

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

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

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

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

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

<u>4.2.8 Quality Control Samples</u> An estimate of the number and types of QC samples to be collected for screening and laboratory analyses at each site is included in Table 3-1 (Section 3.0). A brief description of QC samples and frequency of collection is presented below.

<u>Duplicate Samples</u>. Two or more samples collected simultaneously into separate containers from the same source under identical conditions. One duplicate will be collected for every 10 samples of a single matrix (from a single site). Duplicate samples are intended to assess the homogeneity of the sampled media and the precision of the sampling protocol.

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

Equipment Rinsate Blanks. Equipment rinsate blanks are collected by running organic-free water over and/or through sample collection equipment after it has been decontaminated. Equipment rinsate blanks will be collected at a frequency of one per day per type of sampling tool used. These blanks are used to assess the adequacy of decontamination procedures and to trace potential cross-contamination.

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

Field Water Blanks. Field water blanks include a complete set of samples collected from each water source used in the investigation. One set of samples will be collected from each water source (tap, deionized and organic-free) used per sampling event. These samples should account for potential artifacts that could be introduced through decontamination procedures.

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

Background Samples. Background samples are collected from areas upgradient and away from known or suspected contaminated areas. Several background (also called upgradient) samples will be collected from each matrix. The estimated number and location of these samples at each site are presented in Section 3.0. Background samples allow identification of possible upgradient sources and/or confirm upgradient delineation. In addition, background inorganic analyses allow the estimation of concentrations for naturally occurring compounds.

4.2.9 Sampling Records Maintaining proper records is a significant aspect of sample collection. At the time samples are obtained, the following should be recorded by the sampler in the field logbook:

- sample site location,
- sample type and depth,
- date and time of sampling,

- project and sample designations,
- sampler identification, and
- analyses requested.

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

4.3 SAMPLE CUSTODY. The control of a sample is accomplished through a Chain-of-Custody (COC) record. Chain of custody is initiated during bottle preparation by the laboratory, will be maintained through sample collection, shipment, storage, and analysis as a legal record of possession of the sample. Possession will be traceable by means of a COC form which will remain with the samples at all times and bears the name of the person responsible for the samples. Procedures for maintaining the appropriate sample custody information will be in accordance with USEPA Region IV SOPs (USEPA, 1991).

Samples other than those collected for in-situ measurements analyses are identified by using a sample label which is attached to the sample container. The following information is included on the sample container label:

- project number;
- field identification or sample station number (a unique number identifying the sample);
- date and time of sample collection;
- sample (water, soil, sediment, etc.) and a brief description of the sampling location;
- the signature(s) of the sampler(s);
- whether the sample is preserved or unpreserved;
- the general types of analyses to be conducted; and
- any relevant comments regarding the sample.

A COC form is used to record the custody of all samples or other physical evidence. The following information must be supplied in the indicated spaces in detail to complete the Chain-of-Custody Record:

- project number;
- site name and address;
- project name;
- signature of sampler in the designated signature blank;
- the sampling station number, date, and time of sample collection, and a brief description of the type of sample and the sampling location;
- the sample bottle type (i.e., 40 mℓ G) plus the intended analysis (i.e., VOC-624);
- for each sample the number of containers for each bottle type; and
- field investigator and subsequent transferee(s) signatures. (Both the person relinquishing the samples and the person receiving them must sign the form along with the date and time this occurred.

When samples are relinquished to a shipping company for transport, the tracking number from the shipping bill/receipt shall be recorded on the sample COC form. In these cases the airbill becomes part of the chain-of-custody.

All samples shall be accompanied by the Chain-of-Custody Record. The original and one copy of the record will be shipped inside the shipping container if samples are shipped. One copy of the record will be retained by the field investigator. The original record will be transmitted to the field investigator after samples are accepted by the laboratory. This copy will become part of the project records.

In the event that a legal chain-of-custody is required for a project, custody will begin at the time of receipt of the clean sample containers from the contract laboratory. The chain-of-custody form has appropriate spaces to allow signatures and dates to document the transfer of the cleaned sample containers from the laboratory to the sample team. In addition, use of custody seals will be implemented during shipment of bottles and samples in order to document the integrity of the samples/bottles. The custody seal will be placed on the shipping container so that it cannot be opened without breaking the seal. The seal will be signed, dated, and the time recorded by the field investigator. By using a unique sample I.D. number for each sample all ancillary records can be traced to specific sampling events.

4.4 CALIBRATION PROCEDURES. Procedures and documentation required for calibration of laboratory instruments and equipment are contained in USEPA Region IV SOPs (USEPA, 1991a) and USEPA CLP procedure manuals for organic and inorganic analyses.

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

4.5 ANALYTICAL PROCEDURES. Laboratory analytical procedures will be conducted in conformance with USEPA approved methods for Appendix IX parameters. Table 4-3 provides a listing of Appendix IX parameters.

4.6 DATA ASSESSMENT. Data collected from investigation activities include survey data, field screening data, and laboratory analytical data. The ultimate data uses include site and waste characterization.

Laboratory data must be validated and assessed to determine the validity of the data and to ensure that DQOs are met. Sample results are validated through comparison to QA/QC data to assure that analytical results fall within acceptable accuracy and precision confidence limits, and to eliminate, correct, or flag matrix and other interference effects. Validated data are summarized and organized into formats that facilitate data evaluation. Data evaluation includes site characterization and analysis of contaminants, contaminant distribution, and transport, fate, and risk assessment.

Table 4-3
Appendix IX, Groundwater Monitoring List

RFI/SI Sampling and Analysis
NSB Kings Bay
Kings Bay, Georgia

Parameter	Methods	Parameter	Methods
Acenaphthylene	8100	delta-BHC	8080
	8270		8250
Acetone	8240	gamma-BHC; Lindane	8080
Acetophenone	8270		8250
Acetonitrile; Methyl cyanide	8015	Bis(2-chloroethoxy)methane	8270
2-Acetylaminofluorene; 2-AAF	8270	Bis(2-chloroethyl)ether	8270
Acrolein	8030	Bis(2-chloro-1-methylethyl) ether;	8010
	8240	2,4'Dichlorodisopropyl ether	8270
Acrylonitrile	8030	Bis(2-ethylhexyl)phthalate	8060
	8240		8270
Aldrin	8080	Bromodichloromethane	8010
	8270		8240
Allyl chloride	8010	Bromoform; Tribromomethane	8010
	8240		8240
4-Aminobiphenyl	8270	4-Bromophenyl phenyl ether	8270
Aniline	8270	Butyl benzyl phthalate; Benzyl	8060
Anthracene	8100	butyl phthalate	8270
	8270	Cadmium	6010
Antimony	6010		7130
	7040		7131
	7041	Carbon disulfide	8240
Aramite	8270	Carbon tetrachloride	8010
Arsenic	6010		8240
	7060	Chlordane	8080
	7061		8250
Barium	6010	p-Chloroaniline	8270
	7080	Chlorobenzene	8010
Benzene	8020		8020
	8240		8240
Benzo(a)anthracene; Benzanthracene	8100	Chlorobenzilate	8270
	8270	p-Chloro-m-cresol	8040
Benzo(b)fluoranthene	8100		8270
	8270	Chloroethane; Ethyl chloride	8010
Benzo(k)fluoranthene	8100		8240
	8270	Chloroform	8010
Benzo(ghi)perylene	8100		8240
	8270	2-Chloronaphthalene	8120
Benzo(a)pyrene	8100		8270
	8270	2-Chlorphenol	8040
Benzyl alcohol	8270		8270
Beryllium	6010	4-Chlorophenyl phenyl ether	8270
	7090	Chloroprene	8010
	7091		8240
alpha-BHC	8080	Chromium	6010
	8250		7190
beta-BHC	8080		7191
	8250	Chrysene	8100
Cobalt	6010	1,2-Dichloroethane; Ethylene	8010
	7200	dichloride	8240
	7201	1,,-Dichlorethylene; Vinyldene	8010
Copper	6010	chloride	8240
	7210	trans-1,2-Dichoroethylene	8010

Table 4-3 (Continued)
Appendix IX, Groundwater Monitoring List

RFI/SI Sampling and Analysis
NSB Kings Bay
Kings Bay, Georgia

Parameter	Methods	Parameter	Methods
			8240
		2,4-Dichlorophenol	8040
			8270
Cyanide	9010	2,6-Dichlorophenol	8270
2,4-D; 2,4-Dichlorophenoxyacetic acid	8150	1,2-Dichloropropane	8010
4,4'-DDD	8080		8240
	8270	cis-1,3-Dichloropropene	8010
4,4'-DDE	8080		8240
	8270	trans-1,3-Dichloropropene	8010
4,4-DDT	8080		8240
	8270	Dieldrin	8080
Diallate	8270		8270
Dibenz(a,h)anthracene	8100	Diethyl phthalate	8060
	8270		8270
Dibenzofuran	8270	0,0-Diethyl 0-2-pyrazinyl phosphoro-	8270
Dibromochloromethane;	8240	thioate; Thionazin	
Chlorodibromomethane		Dimethoate	8270
1,2-Dibromo-3-chloropropane; DBCP	8010	p-(Dimethylamino)azobenzene	8270
	8240	7,12-Dimethylbenz(a)anthracene	8270
	8270	3,3'-Dimethylbenzidine	8270
1,2-Dibromoethane; Ethylene dibromide	8010	alpha, alpha-Dimethylphenethylamine	8270
	8240	2,4-Dimethylphenol	8040
Di-n-butyl phthalate	8060		8270
	8270	Dimethyl phthalate	8060
0-Dichlorobenzene	8010		8270
	8020	m-Dinitrobenzene	8270
	8120	4,6-Dinitro-o-cresol	8040
	8270		8270
m-Dichlorobenzene	8010	2,4-Dinitrophenol	8040
	8020		8270
	8120	2,4-Dinitrotoluene	8090
	8270		8270
p-Dichlorobenzene	8010	2,6-Dinitrotoluene	8090
	8020		8270
	8120	Dinosepb; DNBP; 2-sec-Butyl-	8150
	8270	4,6-dinitrophenol	8270
3,3'Dichlorobenzidine	8270	D-n-octyl phthalate	8060
trans-1,4-Dichloro-2-butene	8240		8270
Dichlorodifluoromethane	8010	1,4-Dioxane	8015
	8240	Diphenylamine	8270
1,1-Dichloroethane	8010	Disulfoton	8140
	8240		8270
Endosulfan I	8080	Methacrylonitrile	8015
	8250		8240
Endosulfan II	8080	Methapyrilene	8270
Endosulfan sulfate	8080	Methoxychlor	8080
	8270		8270
Endrin	8080	Methyl bromide; Bromomethane	8010
	8250		8240
Endrin aldehyde	8080	Methyl chloride; Chloromethane	8010
	8270		8240

Table 4-3 (Continued)
Appendix IX, Groundwater Monitoring List

RFI/SI Sampling and Analysis
NSB Kings Bay
Kings Bay, Georgia

Parameter	Methods	Parameter	Methods
Ethylbenzene	8020	3-Methylcholanthrene	8270
	8240	Methylene bromide; Dibromomethane	8010
Ethyl methacrylate	8015		8240
	8240	Methylene chloride; Dichloromethane	8010
	8270		8240
Ethyl methanesul fonate	8270	Methyl ethyl ketone; MEK	8015
Famphur	8270		8240
Fluranthrene	8100	Methyl iodide; Iodomehtane	8010
	8270		8240
Fluorene	8100	Methyl methacrylate	8015
	8270		8240
Heptachlor	8080	Methyl methanesul fonate	8270
	8270	2-Methylnaphthalene	8270
Heptachlor epoxide	8080	methyl parathion; Parathion methyl	8140
	8270		8270
Hexachlorobenzene	8120	4-Methyl-2-pentanone; Methyl	8015
	8270	Isobutyl ketone	8240
Hexachlorobutadiene	8120	Naphthalene	8100
	8270		8270
Heachlorocyclopentadiene	8120	1,4-Naphthoquinone	8270
	8270	1-Naphthylamine	8270
Hexachloroethane	8120	2-Naphthylamine	8270
	8270	Nickel	6010
Hexachlorophene	8270		7520
Hexachloropropene	8270	o-Nitroaniline	8270
2-Hexanone	8240	m-Nitroaniline	8270
Indeno(1,2,3-cd)pyrene	8100	p-Nitroaniline	8270
	8270	Nitrobenzene	8090
Isobutyl alcohol	8015		8270
Isodrin	8270	o-Nitrophenol	8040
Isophorone	8090		8270
	8270	p-Nitrophenol	8040
Isosafrole	8270		8270
Kepone	8270	4-Nitroquinoline 1-oxide	8270
Lead	6010	N-Nitrosodi-n-butylamine	8270
	7420	N-Nitrosodiethylamine	8270
	7421	N-Nitrosodimethylamine	8270
Mercury	7470	N-Nitrosodiphenylamine	8270
N-Nitrosodipropylemine; Di-n-propyl-nitrosamine	8270	2,3,7,8-TCDD; 2,3,7,8-Tetrachloro-dibenzo-p-dioxin	8280
N-Nitrosomethylethylamine	8270	1,2,4,5-Tetrachlorobenzene	8270
N-Nitrosomorpholine	8270	1,1,1,2-Tetrachloroethane	8010
N-Nitrosopiperidine	8270		8240
N-Nitrosopyrrolidine	8270	1,1,2,2-Tetrachloroethane	8010
5-Nitro-o-toluidine	8270		8240
Parathion	8270	Tetrachloroethylene; Perchloro-	8010
Polychlorinated biphenyls; PCBs	8080	ethylene; Tetrachloroethene	8240
	8250	2,3,4,6-Tetrachlorophenol	8270
Polychlorinated dibenzo-p-dioxins; PCDDs	8280	Tetraethyl dithiopyrophosphate; Sulfotepp	8270
Polychlorinated dibenzofurans; PCDFs	8280	Thallium	8010
Pentachlorobenzene	8270		7840

Table 4-3 (Continued)
Appendix IX, Groundwater Monitoring List

RFI/SI Sampling and Analysis
NSB Kings Bay
Kings Bay, Georgia

Parameter	Methods	Parameter	Methods
Pentachloroethane	8240		7841
	8270	Tin	7870
Pentachloronitrobenzene	8270	Toluene	8020
Pentachlorophenol	8040		8240
	8270	o-Toluidine	8270
Phenacetin	8270	Toxaphene	8080
Phenanthrene	8100		8250
	8270	1,2,4-Trichlorobenzene	8270
Phenol	8040	1,1,1-Trichloroethane; Methyl-chloroform	8240
	8270		
p-Phenylenediamine	8270	1,1,2-Trichloroethane	8010
Phorate	8140		8240
	8270	Trichloroethylene; Trichloroethene	8010
2-Picoline	8240		8240
	8270	Trichloroefluromethane	8010
Pronamide	8270		8240
Propionitrile; Ethyl cyanide	8015	2,4,5-Trichlorophenol	8270
	8240	2,4,6-Trichlorophenol	8040
Pyrene	8100		8270
	8270	1,2,3-Trichloropropane	8010
Pyridine	8240		8240
Safrole	8270	0,0,0-Triethyl phosphorothioate	8270
Selenium	6010	sym-Trinitrobenzene	8270
	7740	Vanadium	6010
	7741		7910
Silver	6010		7911
	7760	Vinyl acetate	8240
Silvex; 2,4,5-TP	8150	Vinyl chloride	8010
Styrene	8020		8240
	8240	Xylene (total)	8020
Sulfide	9030		8240
2,4,5-T; 2,4,5-Trichlorophenoxyacetic acid	8150	Zinc	6010
			7950

4.6.1 Screening Data Screening data will include results from geophysical surveys (magnetometer, terrain conductivity, and GPR), soil sample screening at discrete depths, air quality monitoring, field parameters (pH, temperature, and specific conductivity) and groundwater samples.

Screening activities allow real-time or rapid analysis of contaminant distribution or of indicator parameters that may correlate with the presence of contamination. Quality control procedures used with qualitative screening instruments (e.g., pH meter, PID, etc.) include calibration and comparison of results. Analytical quality control procedures used with field GC screening include: reference standard calibration, retention time window control, analytical blanks, field blanks, internal standard recovery control, logbook documentation, and review of calculated results.

4.6.2 Laboratory Data Validation Precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters will be evaluated during validation of the laboratory analytical results, as described in Section 4.10.

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

4.6.2.1 Calculation of Precision, Accuracy, Representativeness, Completeness, and Comparability (PARCC) Parameters PARCC parameters will be evaluated during validation of laboratory analytical results.

The acceptance criteria for PARCC parameters for Level III and Level IV DQOs are defined by the CLP guidelines and by the laboratory analytical methods chosen. Appendix IX parameters will be analyzed according to appropriate USEPA methods. The precision, accuracy and minimum detection limit for each parameter is established in the method procedure.

Precision. Laboratory analytical precision is a quantitative measurement of reproducibility. Precision is the variability of a group of measurements compared to their average value, monitored and evaluated for this project through comparison of duplicate samples (including matrix spike duplicates).

Precision and reproducibility can be affected by both sample collection and laboratory analytical techniques. For example, VOC samples may exhibit variability due to improper collection (airspace in the sample) or to variability in purging on injection times. Duplicate samples, when taken from a homogenized sample, are primarily affected by analytical precision.

Precision is a parameter evaluated during the data validation process. Precision will be calculated as Relative Percent Difference (%RPD) using the formula:

$$\%RPD = \frac{D_1 - D_2}{(D_1 + D_2)/2} \times 100 \qquad (1)$$

where

%RFD - relative percent difference,
D_1 - first sample value, and
D_2 - duplicate sample value.

Duplicate samples and the comparison between matrix spike and matrix spike duplicate samples, calculated as %RPD, will be used to measure analytical precision. Matrix spike and matrix spike duplicates are also used to measure analytical recovery, or accuracy.

Accuracy. Accuracy is the quantitative measurement of the bias of a system, relating a reported sample concentration to its actual value. Analytical accuracy is quantified by calculating the laboratory control sample (LCs) and blank spike recovery. In the laboratory an aliquot of a specific target compound(s), at known concentrations is analyzed. The reported concentration is compared to the known concentration and expressed as a percent recovery (%R). The percent recovery is calculated by the formula:

$$Matrix\ spike\ \%\ recovery = \frac{SSR - SR}{SA} \times 100 \qquad (2)$$

where

SSR - spike sample results,
SR - sample results, and
SA - spike added from spiking mix.

The comparison of matrix spike and matrix spike duplicate samples to the original sample, as well as calculation of surrogate recoveries in original samples, will be used to measure accuracy.

Completeness Percent completeness (%C) is the number of valid measurements collected compared to the number of samples collected for analysis. Valid measurements refers to data validated in conformance with USEPA guidelines (USEPA, 1988a; 1988b). It is calculated by the formula:

$$\%C = \frac{N_A}{N_1} \times 100 \qquad (3)$$

where

N_A - actual number of valid measurements and
N_1 - number of samples collected.

CLP requirements for completeness are 80 to 85 percent. The program goal of 80 percent is consistent with these requirements.

Comparability. Comparability is qualitatively measured through an evaluation of the consistency of sample collection, handling, analysis, validation, and reporting. Sample collection through reporting will be conducted consistent with the DQO requirements outlined in USEPA Region IV SOPs (USEPA, 1991c), USEPA CLP requirements, and USEPA data validation requirements (USEPA, 1988a; 1988b).

PARCC Parameters for Level I and II DQOs. For Level I and II field measurement data the objective for precision is to achieve and maintain factory equipment specifications. For the pH meter, precision will be tested by multiple readings in the medium of concern. Consecutive readings should agree within ±0.1 standard pH units after the instrument has been field calibrated with standard buffers before each use. The thermometer will be visually inspected prior to each use. The OVA will be calibrated prior to field use. Water level indicator readings will be precise within ±0.01 foot for duplicate measurements. Because of the nonhomogeneity of soil gas samples, it is not valid to compare duplicate analyses. Precision for soil gas measurements will be assessed on duplicate analyses of a standard gas mixture near the upper quantitation limit. A relative percent recovery of ±20 percent will be used for the acceptance criteria.

As with precision, accuracy of field measurements is achieved through maintenance of equipment in accordance factory specifications and calibration instructions. For many instruments, accuracy can be assessed through comparison of instrument response to an independent known standard. The pH meter and conductivity meters are calibrated with solutions traceable to the National Bureau of Standards (NBS). A calibration check will be made on all water level indicators before the initiation of field work. The calibration check will be made using a surveyor's tape or other standard measuring device. If the calibration check is not within ±0.01 foot, the instrument will be returned for service. The OVA will be calibrated prior to shipment to the field. During the soil gas survey, the GC will be calibrated according to standard operating procedure a minimum of four times daily with standards for the target analytes.

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

Comparability of Level I and II data will be maintained through consistent sample collection, handling, analysis, data evaluation, record keeping, and reporting.

4.6.3 Data Management Plan Sampling locations and laboratory analytical data will be organized and reported in accordance with USEPA Locational Data Policy and Region IV Environmental Monitoring and Data Reporting Requirements (Appendix C). These requirements were developed to provide a standardized reporting system for locating and tracking environmental data.

These policy documents require: (1) the identification of sampling locations in terms of latitude/longitude coordinates in accordance with the FICCDC recommendations, and (2) the development of four databases or data files with electronic

copies in American Standard Code of International Interchange (ASCII) file format.

The four data files include the following.

- **STATION.DAT.** This file contains basic information about the type and location of the sampling or monitoring station. Data fields include information concerning the type, location, and elevation of sampling locations.

- **WELL.DAT.** This file contains detailed information about the construction and characteristics of groundwater monitoring stations. Data fields include information concerning well location, construction methods, construction materials, development methods, availability of lithologic logs, and the use of the well (i.e., monitoring, drinking water, irrigation, etc.).

- **SAMPLE.DAT.** This file contains basic information about the collection and characteristics of samples. Data fields include information concerning station status, field parameter measurements, water level, wind speed and direction, sample collection methods, and name of sampling agency.

- **PARM.DAT.** This file contains measured values and reporting units for specific parameters. Data fields include information concerning sampling station type and unique identifier characters, Chemical Abstract Service (CAS) number of the constituent(s) to be analyzed, the reported analytical result, reporting units, name or code of analytical method, date of analysis, detection limit, and the name of the analytical laboratory.

For USEPA computing purposes, the first line of EACH of the four files MUST contain the following text starting in position one: 19901001. USEPA Region IV "Interchange File Format for Electronic Data Reports" (Appendix C) details specific field names, field lengths, data types, and descriptions for each of the four data files.

Each data file must be updated as new stations or sampling locations are created and/or as new samples are collected. Data will be submitted in ASCII format using 5.25-inch flexible disk or nine-track magnetic tape and as a printed hardcopy.

4.6.4 Data Evaluation Chemical and physical data collected during the RFI/SI will be used to characterize the site and to evaluate the potential levels of risk posed to human health and the environment. Physical data (groundwater and surface water elevations and flow, soil composition, hydraulic conductivity, etc.) and chemical data (laboratory analyses and field screening data) will be integrated to form a conceptual overview of the site.

Data will be summarized and plotted on scaled maps to facilitate the analysis of contaminant distribution and potential mechanisms of transport. Chemical data will be compared to ARARs and contaminants of concern will be identified.

Physical and chemical data will be evaluated to determine the distribution of contaminants, contaminant interactions, transport mechanisms, and potential fate. This includes an evaluation of factors such as: groundwater transport, groundwater-surface water interactions, surface water transport, vadose zone transport, volatilization and advection, soil erosion, retardation, degradation, and transformation. The evaluation of the factors listed above will be subject to the availability of sufficient experimental and empirical reference data.

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

Plausible exposure pathways and exposure scenarios will be evaluated to assess potential levels of risk posed by the contaminants of concern. The risk assessment is based on an evaluation of exposure patterns, available toxicity data, and dose-response relationships.

Ultimately, the data collected will be evaluated to support no further action or remedial action decisions, treatability studies, and remedial design.

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

Data gaps will be addressed in Project Managers meetings, as described below. This approach allows additional data to be collected when it is needed and minimizes reporting, review, and mobilization costs. Where appropriate, data gaps may be addressed by integrating data from several sites and viewing the facility, or sections of the facility, on a larger scale. This should simplify addressing sites with overlapping plumes, surface water systems, and/or complex groundwater systems.

4.6.6 Address Data Gaps The RFI/SI process will be tailored to allow prioritization of sites according to potential threat to human health and the environment. The process will initially focus on source identification, with delineation of soil and sediment contamination and confirmation of groundwater and surface water contamination.

Decisions concerning data assessment and actions to be taken will be made during Project Management meetings that will include representatives from the Navy, USEPA, GEPD, and contractor. These meetings will provide a forum for discussion of investigative results and proposed actions. The verbal decisions made in these meetings may be final with no reporting or review time.

If initial data evaluation shows groundwater or surface water contamination to be an immediate threat to human health or the environment, interim or early remedial actions may be performed to mitigate further transport from the site.

If groundwater or surface water contamination is not judged to be an immediate threat, delineation may be performed at a later time and on a facility-wide or area-wide scale after source data on several sites has been gathered. This allows delineation on a larger scale by viewing local aquifer and surface water systems as an individual operable unit(s) that may be impacted by several sites simultaneously.

4.7 INTERNAL QUALITY CONTROL. Field and laboratory QC samples are discussed in Section 4.2.9 "Quality Control Samples" and an estimate of the number and types of QC samples to be collected for screening and laboratory analyses at each site is included in Table 3-1 (Section 3.0).

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

4.8 PERFORMANCE AND SYSTEMS AUDITS. Audits are performed to verify that work being completed within the RFI/SI program complies with quality assurance program goals. The contractor shall perform routine audits of laboratory subcontractors and subcontracted laboratories must be CLP qualified and NEESA approved.

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

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

All primary documents will receive internal technical reviews and a minimum of one internal audit will be scheduled for the RFI/SI field program. Technical reviews and internal audits will be performed in accordance with the Navy CLEAN Quality Assurance Program Plan.

4.9 PREVENTIVE MAINTENANCE. Preventive maintenance for laboratory equipment and instruments will be performed in accordance with CLP requirements and the individual laboratory QA/QC program.

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

- identifying possible problems that have a high probability of occurrence or a potentially significant negative impact on performance (e.g., quality of services performed, schedules, and costs.);

- identifying events, observations, or other signals possibly indicative of a developing problem;

- identifying the organizational level most likely to recognize a developing problem and the level with authority to react to the problem;

- developing preventive measures for avoiding or reducing the impact of a problem that preferably can be implemented at the same organizational level at which the problem is recognized; and

- communicating the information generated in the preceding steps to appropriate staff.

ATTACHMENT 1

TECHNICAL MEMORANDUM 1:
IN-SITU HYDRAULIC CONDUCTIVITY TEST

TECHNICAL MEMORANDUM

PREPARED BY: R. Michael Nugent

DATE: July 1989

TITLE: IN-SITU HYDRAULIC CONDUCTIVITY TEST

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

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

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

(1) Estimates are made in situ and errors incurred in laboratory testing of small or disturbed overburden samples are avoided.

(2) Tests are performed quickly at relatively low costs in that a pumping well and observation wells are not required.

(3) The hydraulic conductivity of discrete parts of an aquifer can be made.

(4) Treatment and disposal of contaminated groundwater as with a pumping well is not a consideration.

However, there are disadvantages in using slug tests that need to be considered. These include the following:

(1) Only the hydraulic conductivity of the aquifer in the immediate vicinity of the well is estimated. This estimate, by itself, may not be representative of the aquifer in toto.

(2) Often only a range of hydraulic conductivity values rather than an average estimate can be deduced from test results.

(3) Certain assumptions are made in the analysis process. If geologic and test conditions do not approximate the assumptions, the subsequent results may be erroneous.

(4) The aquifer storage coefficient, S, cannot be determined under most conditions.

(5) As noted previously, there exists constraints in the applicable range for aquifer K values. Beyond these limits the test procedure is either invalid (i.e., $K < -10^{-7}$ cm/sec) or data is difficult to obtain (i.e., $K > 10^{-3}$ cm/sec).

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

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

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

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

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

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

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

EQUIPMENT: (1) Electric water-level indicator

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

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

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

- test procedure (reference this technical memorandum) plus any deviations from the test procedure;
- serial number, pressure range, and voltage output range of pressure transducer;
- well or boreholes identification code;
- location and elevation of measuring (reference) point at which depth to water level measurements are made;
- date and time of test;
- well depth, screen length, screen slot size, riser pipe inside radius, well screen inside radius, sand/gravel pack size ranges and borehole radius;
- aquifer or groundwater zone being tested;
- slug volume;
- type of measuring device used; and
- names of personnel conducting slug test.

CONDUCTING THE SLUG TEST:

1. Water level indicator, transducer and cable, and the slug will be cleaned using a nonphosphate detergent wash and a distilled water rinse followed by a pesticide grade isopropanol rinse and allowed to air dry. Prior to use, the equipment shall undergo a distilled

water rinse. Water level indicator probe shall be cleaned after each use.

2. Wells will be opened, allowed to equilibrate, and depth to water level measured and recorded.

3. A slug will be selected based on well diameter and a line attached. The line will be marked at a distance from the bottom of the slug equal to the measured depth to water level plus the length of the slug.

4. The transducer will be lowered into the well to a depth of 10 feet below the static water level or as close to this depth as allowed by the well and water level configuration. (Note: Pressure transducer must lie at least 2 feet below the depth of the slug to dampen pressure waves and must be at least 1 foot above the bottom or sump section of the well to prevent silting.) Tape the pressure transducer to the well casing to fix the depth of the transducer in the well.

5. The following is specific to operation of the model EL-200 data logger.

   (a) Function B0 - Enter a two digit station ID number (00-99) and press <E> (Enter).
   (b) Function B1 - Enter the date in format YY/MM/DD and press <E>.

   (c) Function B2 - Enter time in format HH:MM:SS and press <E>
   (d) Function B4 - Press <E> until appropriate pressure transducer channel is reached and enter appropriate scale factor for transducer. Press <E> and then <F>.

Analog Channel Scale Factors

S/F	0%	100%	1 LSB	Remarks
000	--	--	--	Channel is off
001	0.000	2.307	.001	Input in psi
002	0.000	4.61	.01	Scaled output
005	0.000	11.53	.01	(ft)
010	0.000	23.07	.01	
015	0.000	34.60	.01	
025	0.00	57.67	.01	
050	0.00	115.3	.1	
100	0.00	230.7	.1	
250	0.00	5,767.00	.1	

(e) Function B6 - Check probe calibration by raising transducer in 0.5 intervals. Record depth to probe (below water surface) and displayed values.
(f) Function A3 - Places data logger in SILOG II status.
(g) Function 5 - Editing SILOG II Segments.
(h) Press 01200001 then <E> - will result in readings being taken at 1 second intervals (01200001) for 120 seconds (01200001).
(i) Press 0036005 then <E> will result in readings being taken at 5 second intervals for the next 3 minutes (i.e., 36 5-second intervals).
(j) Press <F> to exit editing mode

6. Lower the slug until the static water level is reached and then raise slug slightly above this mark. Secure slug line to well casing leaving sufficient slack so that slug can be completely submerged when test begins.

7. Press <3> then <B> to start data logger and after 5 seconds lower slug into water. Slug must be lowered into water as quickly as possible. However, do not allow slug to drop into the water but glide it in. This will prevent compression waves and faulty reading during the initial part of the test.

8. Press any key and then <B6> to display pressure head readings.

9. Upon termination of the test and the return of the water level to static conditions, press <A3>, <3>, and <B> then wait 5 seconds, and remove slug. This begins the rising head part of the test.

10. Press any key and then <B6> to display pressure head readings. Terminate test when pressure head reading indicates 90 to 100 percent recovery.

11. Press any key and then <AC> to power down. Remove power cord.

12. Decontaminate slug pressure transducer and slug line as outlined in Step 1.

NOTE: (A) For situations where static water level is within screen interval, only perform the rising head part of the test.

(B) RAM only holds 12,000 data points.

DATA ANALYSIS:

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

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

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

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

Pressurized slug test methods have been developed for testing extremely low conductivity (10^{-8} cm/sec or lower) materials (Bredehoeft and Papadopulos, 1980). Basically, the pressurized slug technique is a modification of the conventional slug test previously discussed. The advantage of the pressurized slug technique is the reduction of time required to perform a test in tight formations. This method involves creating an instantaneous pressure surge on

drawdown in the test zone, then closing a valve to shut in the well. Based on the rate of decay of the pressure slug and the geometry of the test zone, the transmissivity, hydraulic conductivity, and storativity may be calculated.

ATTACHMENT 2

SOUTHNAVFACENGCOM'S SEVEN POINT RATIONALE FOR USING PVC

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

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

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

Response: The DQOs for the RFI/SI at NSB Kings Bay are to provide information of sufficient quality to support risk assessment and feasibility study conclusions. The quality assurance and quality control (QA/QC) procedures are specified in the Sampling and Analysis Plan (SAP). Sample collection and accompanying QA/QC procedures are designed to meet Level III criteria.

2. The anticipated compounds and their concentration range.

Response: PVC material will not interfere with the anticipated compounds and their concentration range.

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

Response: Each well will be purged immediately before the sample is collected. The anticipated residence time of the water prior to sampling should be less than twenty minutes. The surficial aquifer is estimated to have a transmissivity range of 0.05 to 3.93 m^2/day.

4. The reason for not using a hybrid well.

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

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

Response: Two reprints are attached that evaluate the sorptive characteristics of stainless steel and PVC.

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

Response: No change in the annular space is required.

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

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

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

Special Report 89-32

September 1989

US Army Corps
of Engineers

Cold Regions Research &
Engineering Laboratory

Leaching of metal pollutants from four well casings used for ground-water monitoring

Alan D. Hewitt

Prepared for
U.S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
REPORT CETHA-TE-CR-89186

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Leaching of Metal Pollutants From Four Well Casings Used for Ground-Water Monitoring

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16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)		
FIELD	GROUP	SUB-GROUP	Ground-water monitoring	PTFE	Well casings
			Ground-water pollution	PVC	
			Metal pollutants	Stainless steel	

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

Polytetrafluoroethylene (PTFE), polyvinylchloride (PVC), stainless steel 304 (SS 304) and stainless steel 316 (SS 316) well casings were tested for suitability for ground-water monitoring. A laboratory experiment, testing for the leaching of Ag, As, Ba, Cd, Cr, Hg, Pb, Se and Cu, was run in triplicate by exposing sections of the well casings to ground water for four periods ranging from 1 to 40 days. The results showed that PTFE did not leach any of the nine analytes studied, while SS 316 and PVC showed significant leaching of Cr, Cd and Pb; SS 316 also leached significant amounts of Ba and Cu. Stainless steel 304 showed significant leaching of Cr and Pb. In every case where contamination was observed, the release of metal analyte, when averaged over all of the exposure periods, was the greatest from either SS 304 or SS 316. Released contaminants were sorbed back onto the well casings in several cases.

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PREFACE

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Leaching of Metal Pollutants From Four Well Casings Used for Ground-water Monitoring

ALAN D. HEWITT

INTRODUCTION

Ground-water monitoring requires the installation of conduits to transfer water to the surface for collection. Four commonly used well casings are made from 2-in. (5-cm) diameter polyvinylchloride (PVC), stainless steel 304 (SS 304), stainless steel 316 (SS 316) and polytetrafluoroethylene (PTFE) pipes. Representative sampling of ground water requires that materials employed in the saturated zone do not influence the concentration of analytes of interest.

Only a few studies have reported the influence of well-casing materials on the concentrations of inorganic substances in ground water during water quality analyses. Several studies have demonstrated that these materials (stainless steel, PVC and PTFE) sorb appreciable quantities of certain ionic species (Eichholz et al. 1965, Miller 1982, Hewitt 1989). Evidence also exists showing that metals are released into ground water from stainless steel and PVC pipes (Houghton and Berger 1984, Barcelona and Helfrich 1986, Hewitt 1989). The release of metal analytes by stainless steel has been associated with its corrosion, which in some instances has been observed to produce a hydrous iron precipitate (Barcelona and Helfrich 1986, Hewitt 1989).

Recently, a laboratory experiment was conducted testing the effects of ground-water composition on the well casings cited above (Hewitt 1989). In this experiment two concentrations of metals (As, Cd, Cr and Pb), pH and total organic carbon were introduced as ground-water solution variables. Results of this experiment indicated that PTFE was inert to the variables, whereas both PVC and stainless steel well casings were affected. These two materials leached and sorbed some of the metals introduced into the ground water. In addition, several stainless steel casing sections developed surface oxidation, which introduced a random source of variation by providing release mechanisms and active sites for sorption. PVC was a low-level source for Cd and provided sorption sites for Pb. Stainless steel 316 was a low-level source for Cd and provided sorption sites for As, Cr and Pb. Stainless steel 304 was also a low-level source for Cd and provided sorption sites for As and Pb. The extent of the sorption or release of metals was often influenced by the solution variables. This study concluded that the stainless steel casings were the least suitable for monitoring the metals studied (As, Cd, Cr and Pb) in the ground water solutions.

A concurrent study done at CRREL (Parker et al. 1989) looked at ground-water solutions spiked with organic compounds exposed to the same four well casings. In contrast to the results for metals, eight (cis and trans-1,2-dichloroethylene, m-nitrotoluene, trichloroethylene, chlorobenzene, o-,p- and m-dichlorobenzene) of the ten organic compounds studied sorbed more quickly and to a greater extent onto PTFE than PVC and did not sorb onto the stainless steels. The same results were obtained when the ground water was treated with 2.0 g NaCl/L to test for effects of ionic strength. These findings support the earlier work of Reynolds and Gillham (1985) who observed rapid sorption of tetrachloroethylene by PTFE well casing. They suggested that PTFE is the least desirable material for a well casing when organic compounds are monitored in ground water.

The results of these two recent CRREL studies (Hewitt 1989, Parker et al. 1989) and supporting evidence in the literature led to the suggestion that PVC may be the best compromise among these four well casings for monitoring ground water for both inorganic and organic analytes (Parker et al. 1988).

The objective of this study is to examine metal leaching characteristics of these four well-casing materials in ground water. Leaching studies that

compare these four well casings have not been reported in the literature. The results of this experiment will determine which casings are the most or the least susceptible to leaching the metals. The analytes analyzed included all of the metals on the Environmental Protection Agency's priority pollutant list, along with copper.

MATERIALS AND METHODS

Materials

The PVC and stainless steel well casings were obtained from Johnson Well Screen, and the PTFE was obtained from MIP, Inc. All well casings were specifically manufactured for ground-water monitoring. The casings all had approximately a 5-cm inner-wall diameter and were cut in lengths of approximately 2 cm. The exact length of the rings depended on the wall thickness and diameter of the pipe because we wanted to maintain a constant surface area of 80 cm^2. Cut surfaces composed 17% of the area for the PTFE and PVC well casings and 9% for the stainless steels.

Precautions were taken during pipe milling to prevent exposure to grease, dirt, oil and solvents, and to avoid excessive handling. After milling, the individual well-casing rings were rinsed with deionized water (Millipore, Type 1) and air dried before being placed into the ground-water-filled sample containers. During rinsing we made no attempt to remove surface discoloration or ink on the pipes; we used them as we had received them from the manufacturer. This limited cleaning was consistent with commonly employed field protocols.* The well-casing sections were handled with plastic gloves and nylon forceps after milling. Two sections of the SS 316 pipe were not used because excessive surface rust had formed. In general the stainless steel well casings appeared to have developed more rust during the 9-month storage period than they had when first obtained. All experimental work was performed in class 100 cleanrooms.

Polypropylene jars (69 mm od × 62 mm height, 125 mL, Model 6185-E37, Thomas Scientific) served as the sample containers. The jars were soaked in a 10% v/v concentrated, redistilled HNO_3 (G. Fredrick Smith [GFS]) deionized water solution, then rinsed with and soaked for several days in deionized water prior to use. Other materials, such as the 7.5-mL sample aliquot bottles (polyethylene, Nagle), pipette tips (Eppendorf), and the 2-L glass bottles (reagent grade HNO_3 bottles, Baker), were cleaned similarly.

Test design

Tests for the release of metals from PVC, PTFE, SS 304 and SS 316 well casings were done in triplicate by exposing sections of each to ground water for periods of 1, 5, 20 and 40 days. Three sample containers with no well casings served as controls for each of the exposure periods. The containers with and without well casings were filled with 98 mL of ground water collected from a 76-m-deep domestic well system in Weatherfield, Vermont; 60 containers, 12 with a single section of each of the four well-casing candidates (12 × 4) and 12 controls, made up the experimental sample setup. The well-casing rings were submerged in the ground-water-filled sample containers creating a pipe-surface-area-to-aqueous-volume ratio of 0.82 cm^2/cm^3. This experimental design provides a surface-area-to-solution ratio similar to that of well casings in ground-water monitoring wells below the saturated zone; however, the ratio is much lower than that which exists for well screens.

Samples were prepared by transferring weighed amounts of ground water into each jar from a single 2-L glass bottle. The jars were selected randomly for the experiment because the ground water was transported in three separate 2-L glass bottles. The pH and conductivity of the ground water from all of the bottles was 7.8 and 2.40×10^{-2} mho/cm, respectively. Ground water collected from this source previously showed similar pH and conductivity levels (Hewitt 1989). While the well casings were exposed to the ground water, the jars were sealed with a cap and stored in the dark at 24°C. After the well-casing sections had been removed from the jars at the end of each time interval, 2 mL of concentrated HNO_3 (GFS) was added to the ground water to bring the pH below 1.0. Studies have shown that acidification below pH 1.5 is effective in preventing the loss of trace metals from natural waters (Subramanian et al. 1978). The acidified, ground-water-filled jars were recapped, hand-swirled for 10 seconds, then left at rest for at least 72 hours before we transferred a 5-mL aliquot to a 7.5-mL sample vial (polyethylene, Nagle) for the subsequent determination of Ag, As, Ba, Cd, Cu, Cr, Pb and Se.

The entire experimental setup was duplicated for the analysis of Hg, except that we determined Hg immediately after the ground-water-filled jar was acidified.

In a preliminary experiment, ground water stored in the polypropylene jars was spiked with

* Personal communication with Louise V. Parker, CRREL, 1989.

Cd, Cr and Pb to see if sorption of metals ions on the jar walls would interfere with the test results. These metal ions, added to the ground water and stored for 6 days in the sample jars, were recovered upon acidification (Table 1). The desorption of metal ions from container walls has been reported by Choa et al. (1968). For this preliminary test, 5.00 µg/L of Cd, Cr and Pb was allowed to sit in ground-water-filled jars (100 mL) for 6 days. Then we added 2 mL of concentrated HNO_3 (GFS), hand swirled the solution for 10 seconds, and removed a 5-mL aliquot. A second 5-mL aliquot was removed 72 hours later, following the same procedure. The results in Table 1 show that an average of 95% of the aqueous metal was recovered immediately after acidification, and aliquots removed 3 days later showed only 2% (not significant at the 95% confidence level) additional analyte recovery. Thus the metals either remained in the laboratory ground-water solution or were desorbed from the jar walls quickly upon acidification.

Table 1. Recovery of Cd, Cr and Pb (4.90 µg/L) from ground water stored in the sample jars and allowed to equilibrate for 6 days before being acidified with 2 mL of concentrated HNO_3.

	Acidification period			
	Less than 10 minutes		*72 hours*	
	Amount ~~added~~ * *(µg/L)*	*Percent recovered*	*Amount* ~~added~~ * *(µg/L)*	*Percent recovered*
Cd	4.65	94.9	4.72	96.3
	4.72	96.3	4.85	99.0
Cr	4.48	91.4	4.58	93.5
	4.48	91.4	4.69	95.7
Pb	4.93	100.2	4.72	96.3
	4.72	96.3	5.01	102.2
Average recovery	95.1%		97.2%	

* determined

Analysis

Silver, arsenic, barium, cadmium, copper, chromium and lead were determined by Graphite Furnace Atomic Absorption (GFAA) using a Perkin-Elmer (PE) model 403 Atomic Absorption Spectrophotometer (AAS) coupled with a PE model 2200 heated graphite atomizer. Instrumental procedures followed the general guidelines provided in the manufacturer's instrument manual (Perkin-Elmer 1981). Hand injections of either 20, 50 or 100 µL were employed for the analytes mentioned above. For the determination of Se, a matrix modifier—0.015 mg Pd and 0.01 mg $Mg(NO_3)_2$—was added so that the charring temperature could be raised to 1200°C. Of this group, only As and Se determinations required deuterium background correction.

Mercury was determined by Cold Vapor Atomic Absorption (CVAA). We employed a 48-mL aliquot for the Hg determinations, following a modified Hatch and Ott (1968) procedure. Aliquots of 48 mL of ground water were reduced with 2 mL of 10% v/v stannous chloride and then sparged with Hg-free air. The reduced Hg vapor passed through a $Mg(ClO_4)_2$ water vapor trap into an optical cell designed to enhance detection (Tuncel and Atoman 1980). The optical cell was positioned in the light path of the PE model 403 AAS.

Mercury was determined the same day that well casings were removed from ground-water-filled jars to limit volatilization of Hg from solution (Coyne and Collins 1972, Lo and Wai 1975) and to avoid vapor contamination associated with storage in poly containers (Cragin 1979). All of the other metals were determined within 2 weeks after the last exposure period.

Analysis procedures were designed to achieve detection limits of 1% or less of the present domestic water quality levels set by the EPA (Table 2). Selenium, determined by graphite furnace, was the only metal with a detection limit slightly above this level (Table 2). Method Detection Limits (MDLs) were established following the procedure outlined in the Federal Register (1984) for the analysis of a sample in a given solution. The MDL estimate requires that a minimum of seven replicate determinations be made of an analyte concentration that is one to five times the estimated detection level.

Table 2. EPA interim primary drinking water quality levels (1983) and the method detection limits (MDL).

Metal	*EPA primary drinking water levels (µg/L)*	*MDL (µg/L)*
Ar	50	0.48
Ba	1000	2.4
Cd	10	0.059
Cu	1000	4.3
Cr	50	0.16
Pb	50	0.11
Hg	2.0	0.010
Se	10	0.21
Ag	50	0.12

Table 3. Summary of ANOVA and LSD determinations for average analyte concentrations (μg/L). Materials with common underlining are not different at the 95% confidence level as determined by the LSD.

Days	Well casing					LSD
	a. Barium					
1	Control	PTFE	PVC	SS304	SS316	1.4
	4.5	6.0	6.6	7.1	7.7	
5	PTFE	Control	PVC	SS304	SS316	2.1
	5.3	5.8	6.6	7.8	9.9	
20	PTFE	Control	PVC	SS304	SS316	2.2
	5.5	5.9	6.1	7.4	11.3	
40	PTFE	PVC	Control	SS304	SS316	2.0
	5.2	5.6	5.9	7.0	10.1	
	b. Chromium					
1	Control	PTFE	PVC	SS304	SS316	9.76
	0.20	0.22	1.23	1.60	6.06	
5	Control	PTFE	PVC	SS316	SS304	0.31
	0.20	0.22	1.12	1.79	3.34	
20	PTFE	Control	PVC	SS316	SS304	1.17
	0.19	0.22	1.20	3.30	4.61	
40	Control	PTFE	PVC	SS316	SS304	1.04
	0.21	0.21	1.11	2.53	5.13	

Days	Well casing					LSD
	c. Lead					
1	Control	PTFE	SS316	SS304	PVC	1.45
	0.16	0.35	0.90	1.14	2.46	
5	Control	PTFE	SS316	SS304	PVC	1.53
	0.21	0.27	1.27	1.56	2.23	
20	Control	PTFE	SS316	PVC	SS304	2.80
	0.14	0.35	1.00	1.04	2.86	
40	PTFE	Control	PVC	SS316	SS304	1.52
	0.21	0.33	0.78	1.26	2.06	
	d. Copper					
1	PVC	SS304	Control	PTFE	SS316	12.0
	9.4	10.7	11.9	12.1	35.8	
5	PTFE	PVC	Control	SS304	SS316	12.4
	7.8	9.9	10.1	11.0	42.6	
20	PVC	PTFE	Control	SS304	SS316	38.5
	6.8	8.3	10.1	26.1	81.2	
40	PVC	PTFE	SS304	Control	SS316	17.2
	4.4	5.2	11.5	14.0	82.3	

The MDL is obtained by multiplying the standard deviation of the replicate measurements by the appropriate one-sided t-statistic corresponding to $n-1$ degrees of freedom at the 99% confidence level.

Each sample aliquot with a determined analyte concentration above the MDL was analyzed at least twice. Analyte concentrations were based on the average peak heights from a strip chart recording.

Aqueous calibration standards for Ag, As, Cd, Cr, Cu, Pb, Hg and Se were prepared by diluting 1000-mg/L certified atomic absorption stock solutions (Fisher Scientific Corp.). A Ba stock standard was made by dissolving a weighed amount of $Ba(NO_3)_2$ (Baker, Reagent Grade) in deionized water. Working standards were prepared in deionized water acidified to 2% v/v with HNO_3 (GFS).

Calibrations were established by determining three different concentration standards in triplicate. Standards were randomly introduced throughout the course of sample analysis, and all of the calibration curves were linear over the concentration range examined. To see if the intercepts were significantly different from zero, we compared the residuals for the models with an intercept and for the models with zero intercept using the F-ratio at the 95% confidence level. Analyte concentrations in the samples and controls were determined based on the slope and intercept only if the intercept was deemed significant. Otherwise, a zero-intercept linear model was employed.

To assess leaching of metals from the surfaces of the four well-casing materials, an analysis of variance (ANOVA) was performed on those metals (Ba, Cr, Cu and Pb) that had been consistently found above the established MDL for the four well-casing materials and the control. If a significant

difference was detected by the ANOVA among the average analyte concentrations in the ground water for a given material, then a Least-Significant-Difference (LSD) analysis was performed. Both analyses (ANOVA and LSD) used the 95% confidence level. The results of these analyses established which well casings contributed particular analytes to the ground water over and above those contributed by other well casings or the control for the different exposure periods (Table 3). In addition the aqueous metal concentrations that exceed 1% of the EPA drinking water quality level were identified. This low-level warning criterion was chosen since this study did not always establish the native levels present in the ground water. Thus, the contribution of metals from the well casings could range from one or more orders of magnitude above the background concentrations.

RESULTS

Barium

The analysis of the 1-day exposure samples showed that all of the ground-water-filled vessels containing pipe sections had aqueous Ba concentrations that were significantly greater than that of the control; however, all of the values were low (Table 3a). The subsequent exposure periods do not follow this pattern but instead established that SS 316 was the only material that consistently contributed significant levels of Ba to the solution relative to the other samples and the controls (Fig. 1a). The average increase in aqueous concentration for the ground water exposed to SS 316 was about 70% compared to the control. After 5 days of exposure, ground water in contact with SS 316 developed aqueous Ba concentrations that exceeded 1% of the drinking water quality level established by the EPA. None of the other well casings tested produced aqueous Ba concentrations that exceeded 1% of the EPA drinking water quality criterion or were significantly different from the control after the initial exposure period.

Cadmium

We did not use ANOVA with Cd since the majority of concentrations determined were below the MDL (Appendix A). After 1 day of exposure, both ground-water solutions containing SS 316 and PVC had aqueous Cd that exceeded 1% of the EPA drinking water quality level.

Figure 1b shows the average Cd concentrations determined for the control and well casings. It appears that Cd is initially released from SS 316 and PVC but becomes resorbed onto the well casing with time. Stainless steel 316 contributes approximately an order of magnitude (more than 10% of the EPA drinking water quality level in some cases) more Cd than PVC for equivalent exposure periods.

Chromium

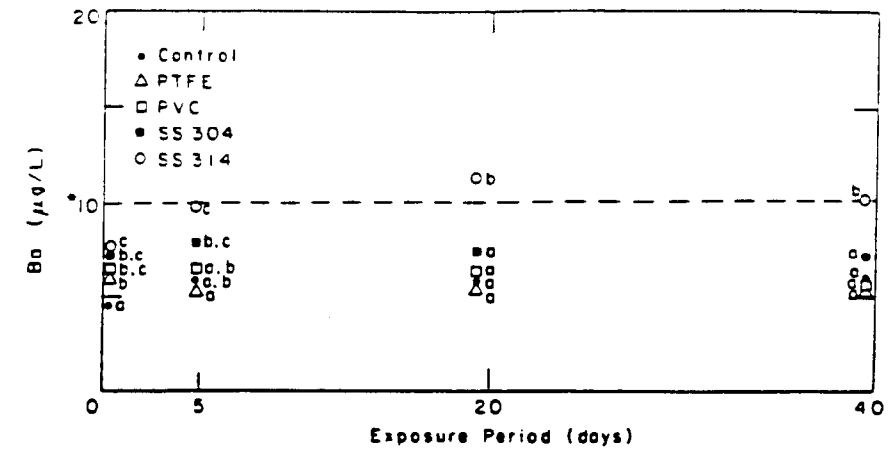
Beyond the 1-day exposure, the analysis consistently demonstrated that both stainless steel well casings contributed significantly greater quantities of Cr to the ground water than the control or the other materials tested (Table 3b). These metal well casings, along with PVC, increased Cr concentrations in the ground water above 1% of the EPA drinking water quality level (Fig. 1c). The extent of the Cr contamination coming from the PVC was three to five times less than that coming from the SS 304, which usually showed the highest average contamination for a given exposure period, the exception being the initial exposure period.

The ANOVA and LSD tests failed to distinguish any difference between the materials for the 1-day exposure because of the large variation among the the three SS 316 samples. If SS 316 is removed, the analysis shows both PVC and SS 304 to contribute significantly greater quantities of Cr to the ground water than do the control and PTFE. The only material that showed a consistent trend was SS 304 (Fig. 1c), which created increasing concentrations of Cr with time. Throughout the experiment there was no significant difference for Cr between the control and the PTFE well casing.

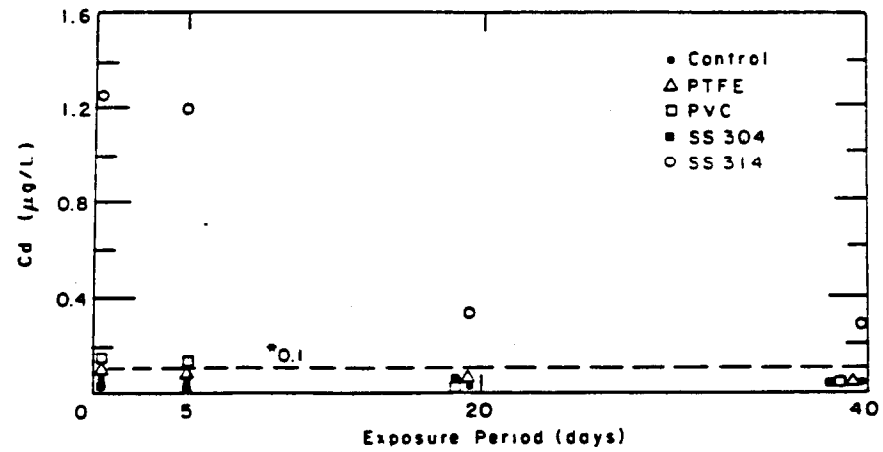
Lead

The first two exposure periods showed PVC to leach the greatest amount of Pb and to be significantly different from the control and PTFE. The two longest exposure periods showed that SS 304 leached the greatest amount of Pb to ground water; however, the levels observed in solution for SS 304 were only statistically different from the rest for the 40-day exposure period (Table 3c). The average levels obtained for both of the stainless steels and for PVC consistently exceeded 1% of the EPA drinking water quality standard (Fig. 1d).

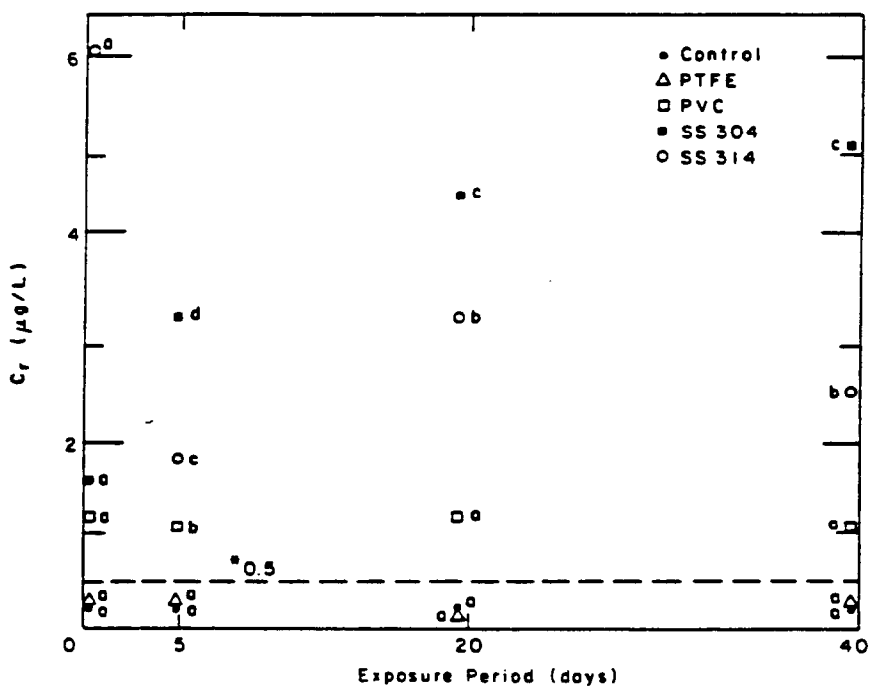
The most distinctive trend was the decrease in Pb with increasing time of exposure for PVC (Fig. 1d). Both stainless steel well casings showed slight decreases in Pb levels after aqueous concentration maxima were obtained. The Pb that was initially released was resorbed by the PVC and stainless steel well casings. Throughout the experiment, there was no significant difference among the control, SS 316 and PTFE.



a. Ba.

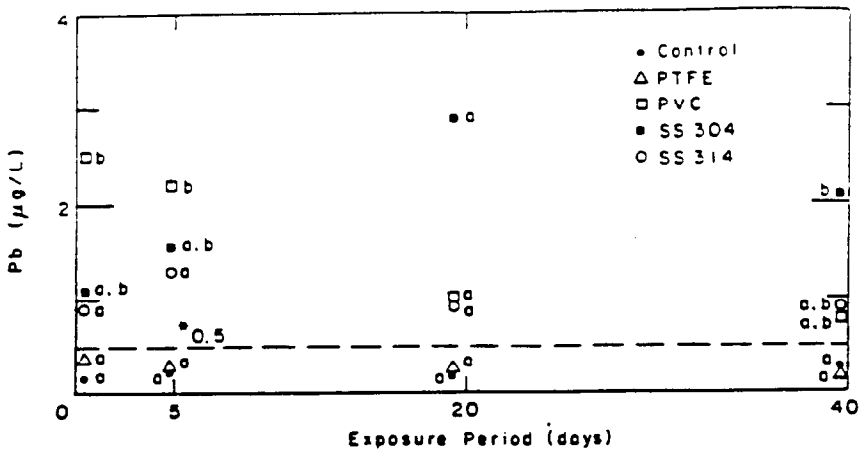


b. Cd.

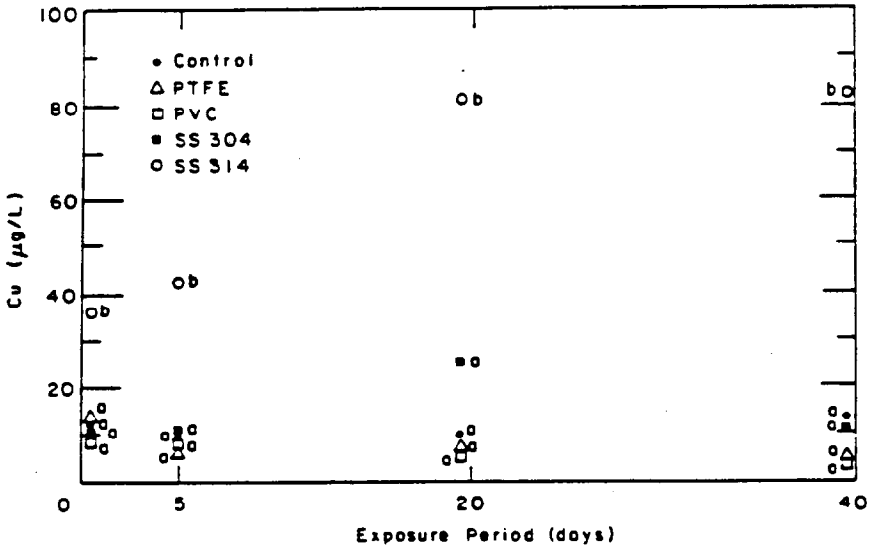


c. Cr.

Figure 1. Ground-water leaching of metals from well casings being examined. Common letters next to points denote no significant difference at the 0.05% confidence interval as determined by ANOVA and LSD.



d. Pb.



e. Cu.

Figure 1 (cont'd).

Copper

The statistical analysis distinguished SS 316 as the only material that contributed significantly more Cu when exposed to ground water than the other materials tested (Table 3d). Aqueous concentrations exceeded 80 µg/L for SS 316 versus about 10 µg/L for the other materials and the control.

Both PTFE and PVC well casing showed a general trend of decreasing Cu with increasing time of exposure and often showed concentrations below the control (Fig 1e). This trend, along with the lack of any trend with respect to the control, demonstrates that these two plastic pipes provided the substrate for sorption.

Arsenic, mercury, selenium and silver

The determinations for As, Hg, Se and Ag were not statistically analyzed because the majority of the concentrations were at or below the established MDLs. Based on the analysis methods employed, none of the well casings consistently contributed As, Hg or Ag above 1% or Se above 2% of the EPA drinking water quality level.

DISCUSSION

Ground water was collected from a domestic well system and stored in sealed 2-L glass bottles

for approximately 24 hours prior to being transferred into test jars. Ground water collected in this fashion is aerated at the faucet and exposed to an oxygen-rich environment every time the lid of the container is removed. Handling the ground water in this manner most likely changed the oxidation potential, facilitating oxidation reactions (Stumm and Morgan 1970). We made no attempt to simulate the natural ground-water redox state or to quantitatively assess the chemical equilibria that existed during the course of this experiment.

There was visible rust on 11 of 24 sections of the stainless steel pipes (Table 4). Each pipe section was carefully examined prior to submersion and after removal from the ground water. In this experiment and in a previous one (Hewitt 1989), oxidation on the stainless steel was predominantly found on the wall. If oxidation is providing sites for sorption or release mechanisms, then the freshly cut surfaces were most likely not a major factor in the behavior of these two materials. Fresh surfaces on the PVC pipe is not an experimental artifact since PVC well screen is made by slotting the pipe.

It was apparent from the values determined for the control samples that the three 2-L glass bottles used to transport the ground water had different concentrations of aqueous Cu (Appendix A). The range of aqueous Cu concentrations most likely reflect the residence time of the ground water in the household and well plumbing. Three distinct populations of Cu concentration were determined for the controls at the 99% confidence level (X_1 = 9.8±0.0, n = 4; X_2 = 10.3±0.22, n = 5; X_3 = 16.0±0.0, n = 3). Differences between adjacent mean concentrations were established by testing against the maximum variance determined for all of populations (i.e., X_1X_2 and X_2X_3).

The groups established by the three Cu populations were then tested to determine if any of the other metals found above its MDL were also significantly different. Table 5 presents the averages and standard deviations for the metal groups based on the Cu populations for the controls. Only Pb shows the same increasing mean concentration trend as the Cu groupings; however, the averages for the adjacent Pb groups were not significantly different at the 95% or even the 80% confidence level when analyzed in the same manner as the Cu populations. This analysis establishes that only Cu was significantly influenced by the sample preparation procedure. Mixing the ground water from the three collection bottles would have eliminated

Table 4. Physical state of stainless steel pipes after exposure to ground water.

	Section											
	1	2	3	4	5	6	7	8	9	10	11	12
SS 304	WR	WR	—	—	WR	—	WR	WR	ER	WR	WR	WR
SS 316	—	—	—	—	ER	—	—	—	—	—	—	ER

KEY: WR = rust on wall; ER = rust on edge; dash means no rust.

Table 5. Average metal concentrations for the controls based on the groups established by the Cu populations (µg/L).

Populations		*Cu*	*Cr*	*Pb*	*As*	*Ba*
1	Avg.	9.8*	0.22	0.11	0.55	5.2
	Std. Dev.	0.0	0.021	0.00	0.114	0.92
2	Avg.	10.3*	0.20	0.25	0.48	5.8
	Std. Dev.	0.19	0.032	0.154	0.00	0.29
3	Avg.	16.0*	0.22	0.28	0.48	5.6
	Std. Dev.	0.0	0.021	0.048	0.00	0.75

* Statistically different at the 99% confidence level.

Table 6. Summary of results.

	Ba	Cd	Cr	Pb	Cu
Materials that leached >1% of the EPA drinking water quality level in ground-water solutions.	SS 316 PVC	SS 316 PVC	SS 304 SS 316 PVC	SS 304 PVC SS 316	NA*
Material that showed the highest average overall amount of analyte leached	SS 316	SS 316	SS 304	SS 304	SS 316

* Does not apply.

this artifact. The level of Cu leached from the SS 316 far exceeded the difference between the established populations.

The results of this study support our previous work (Hewitt 1989) showing that PTFE is the least reactive material, whereas both PVC and stainless steel well casings influence aqueous concentrations of metals in laboratory ground-water solutions. As in the first study, the variance among the stainless steel replicates was often the greatest, indicating that this material is susceptible to producing random error. Both studies found that SS 316 and PVC leach and sorb Cd; in addition, these two materials, along with SS 304, sorb Pb. Studies in the future should be conducted under anoxic conditions to see if oxidation of the stainless steel is simply an artifact of these experiments. If corrosion of stainless steel is absent under reducing conditions, then we might expect less random variation and less of an influence on the metal analytes in ground-water solutions.

A summary of the results (Table 6) clearly shows that the stainless steels were the greatest sources of contamination under these experimental conditions. When PVC leached metals (Pb, Cr and Cd) that exceeded 1% of the EPA drinking water quality specifications into solution, there was always a trend showing a decrease in concentration with time of exposure. This would suggest that the leaching of Pb, Cr and Cd from PVC is a surface process and is small. Most likely the initial release could be decreased by more extensive cleaning before the pipes are used. The same statement does not apply to the stainless steel well casings. In the cases of leached Cu from SS 316 and leached Cr from SS 304, the concentrations of these metals continually increased with time over 40 days. It is possible that stainless steels could supply these analytes to ground water over an extended period of time, perhaps the entire life of the casing.

CONCLUSION

Among the four types of well casings tested, PTFE was the only material that did not leach any of the nine metals examined. The other materials tested in this experiment (PVC, SS 304 and SS 316) compromised laboratory ground-water samples by contributing analytes of interest (Ba, Cd, Cr, Pb and Cu). Investigations where only trace metals are of interest should use PTFE below the saturated zone. PVC would be the appropriate second choice since its influence on metal analytes appears predictable and small. In contrast, the two stainless steel materials should be avoided.

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APPENDIX A: LEVELS OF CD, PB, CR, BA AND CU DETERMINED IN GROUND-WATER SOLUTIONS (~~MG~~ µg/L).

Pipe	Replicate	Time (days)	Number	Cd	Pb	Cr	Ba	Cu
Cntrl	1	1	1	< D*	0.11	0.21	4.2	9.8
Cntrl	2	1	2	< D	0.11	0.19	4.6	9.8
Cntrl	3	1	3	< D	0.26	0.21	4.8	16.0
Cntrl	1	5	4	< D	0.40	0.15	5.5	10.5
Cntrl	2	5	5	< D	0.11	0.24	5.8	9.8
Cntrl	3	5	6	< D	0.11	0.20	6.1	10.1
Cntrl	1	20	7	< D	0.11	0.24	6.1	10.1
Cntrl	2	20	8	< D	0.11	0.22	6.1	9.8
Cntrl	3	20	9	< D	0.19	0.20	5.5	10.5
Cntrl	1	40	10	< D	0.42	0.20	5.8	10.1
Cntrl	2	40	11	< D	0.24	0.20	5.7	16.0
Cntrl	3	40	12	< D	0.33	0.24	6.3	16.0
PTFE	1	1	1	< D	0.40	0.19	5.9	10.8
PTFE	2	1	2	< D	0.26	0.28	6.1	9.8
PTFE	3	1	3	< D	0.40	0.19	5.9	15.7
PTFE	1	5	4	0.117	0.40	0.24	4.9	9.1
PTFE	2	5	5	< D	0.30	0.21	5.5	8.4
PTFE	3	5	6	< D	0.11	0.21	5.5	5.9
PTFE	1	20	7	0.117	0.40	0.21	5.8	15.3
PTFE	2	20	8	< D	0.30	0.16	5.2	4.9
PTFE	3	20	9	< D	0.36	0.19	5.5	4.6
PTFE	1	40	10	< D	0.11	0.21	4.9	4.3
PTFE	2	40	11	< D	0.11	0.16	5.5	7.0
PTFE	3	40	12	< D	0.40	0.26	5.2	4.3
PVC	1	1	1	0.109	2.19	1.13	6.7	9.4
PVC	2	1	2	0.125	3.09	1.40	7.0	9.8
PVC	3	1	3	0.175	2.11	1.15	6.1	9.1
PVC	1	5	4	0.075	2.39	1.15	7.3	8.0
PVC	2	5	5	0.142	2.43	1.30	6.4	13.2
PVC	3	5	6	0.109	1.87	0.91	6.1	8.4
PVC	1	20	7	< D	2.11	1.30	6.4	11.9
PVC	2	20	8	< D	0.66	1.40	5.8	4.3
PVC	3	20	9	< D	0.34	0.91	6.1	4.3
PVC	1	40	10	< D	0.93	1.08	6.1	4.3
PVC	2	40	11	< D	0.75	1.03	5.2	4.3
PVC	3	40	12	< D	0.66	1.22	5.5	4.6
SS 304	1	1	1	< D	0.48	1.22	6.7	9.8
SS 304	2	1	2	< D	0.88	1.13	7.0	13.2
SS 304	3	1	3	< D	2.05	2.45	7.6	9.1
SS 304	1	5	4	< D	1.25	3.33	7.3	9.8
SS 304	2	5	5	< D	0.96	3.21	8.2	8.0
SS 304	3	5	6	< D	2.47	3.48	7.9	15.3
SS 304	1	20	7	0.092	0.80	4.36	7.3	9.1
SS 304	2	20	8	< D	2.81	3.87	7.6	49.7
SS 304	3	20	9	< D	4.98	5.59	7.3	19.6
SS 304	1	40	10	< D	2.97	5.10	6.7	9.1
SS 304	2	40	11	< D	1.47	4.56	6.4	9.4
SS 304	3	40	12	< D	1.73	5.73	7.9	15.9
SS 316	1	1	1	2.629	0.41	1.48	7.0	27.5
SS 316	2	1	2	0.209	0.60	1.29	7.3	35.5
SS 316	3	1	3	0.926	1.70	15.36	8.7	44.5
SS 316	1	5	4	0.217	0.96	1.81	8.5	37.2
SS 316	2	5	5	2.930	2.30	1.69	11.5	37.6
SS 316	3	5	6	0.451	0.55	1.86	9.6	52.9
SS 316	1	20	7	0.326	1.50	3.45	12.3	102.2
SS 316	2	20	8	0.376	0.76	2.96	9.3	56.7
SS 316	3	20	9	0.326	0.75	3.50	12.3	84.8
SS 316	1	40	10	0.267	0.67	3.18	11.5	97.3
SS 316	2	40	11	0.384	0.75	1.94	9.0	77.2
SS 316	3	40	12	0.209	2.36	2.45	9.8	72.3

* Less than MDL

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Influence of Casing Materials on Trace-Level Chemicals in Well Water

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Abstract

Four well casing materials — polyvinyl chloride (PVC), polytetrafluoroethylene (PTFE), and stainless steel 304 (SS 304) and 316 (SS 316) — were examined to determine their suitability for monitoring inorganic and organic constituents in well water.

The inorganic study used a factorial design to test the effect of concentration of mixed metals (arsenic [As], chromium [Cr], lead [Pb], and cadmium [Cd]), pH, and organic carbon. Sample times were 0.5, 4, 8, 24, and 72 hours. Except for slow loss of Pb, PTFE well casings had no significant effect on the concentration of metals in solution. For the other casings, changes in analyte concentration often exceeded 10 percent in eight hours or less and, thus, could bias analyses of samples taken from wells constructed with these materials. Specifically, PVC casings sorbed Pb and leached Cd; SS 316 casings sorbed As and Pb and leached Cd; and SS 304 casings sorbed As, Cr, and Pb and leached Cd. Both stainless steel casing materials showed markedly poorer performance than the PVC casings.

The well casings were also tested for sorption/desorption of 10 organic substances from the following classes: chlorinated alkenes, chlorinated aromatics, nitroaromatics and nitramines. Sample times were 0, 1, 8, 24, and 72 hours, seven days, and six weeks. There were no detectable losses of analytes in any of the sample solutions containing stainless steel well casings. Significant loss of some analytes was observed in sample solutions containing plastic casings, although losses were always more rapid with the PTFE casings than with PVC. Chlorinated organic substances were lost most rapidly. For samples containing PTFE casings, losses of some of these compounds were rapid enough (>10 percent in eight hours) to be of concern for ground water monitoring. Losses of hydrophobic organic constituents in samples containing PTFE casings were correlated with the compound's octanol/water partition coefficient.

Introduction

The U.S. Environmental Protection Agency's (EPA's) RCRA Ground Water Monitoring Technical Enforcement Guidance Document (TEGD) (U.S. EPA 1986a) states that only fluorocarbon resins or stainless steel (SS) casings should be used for monitoring volatile organics in the saturated zone. The original draft of this document (U.S. EPA 1985) suggested that Teflon® or stainless steel 304 be used for all ground water monitoring at RCRA sites. The EPA was concerned that many of the casing materials used for ground water monitoring could either affect the quality of the ground water or did not have the long-term structural characteristics required of RCRA monitoring wells. With respect to the EPA's first concern, a review of the literature published prior to 1986 did not reveal substantial evidence to support the position taken by the EPA in either edition of this document (Parker et al. 1989).

Few studies have specifically addressed the possible interactions between well casing materials and metal species. There is considerable evidence, however, that sorption of metals by plastic and glass containers can be significant (Eicholz et al. 1965, Robertson 1968, Batley and Gardner 1977, and Masse et al. 1981). In one study of PVC well casings, there was negligible loss of chromium but large losses of lead from a deionized water solution (Miller 1982). Other studies with Pyrex glass and polyethylene also found that lead was the most rapidly lost analyte (Shendrikar et al. 1976). Barcelona and Helfrich (1986) compared the concentrations of several metal species in samples taken from adjacent PVC, PTFE, and SS wells. They found increased levels of iron in water samples from the non-purged SS well to be the only statistically significant difference. In a previous in situ study by Houghton and Berger (1984), a steel-cased well appeared to leach a number of metal species, including iron, cadmium, chromium, copper, manganese, molybdenum, selenium, and zinc, when compared with a PVC well and one constructed of acrylonitrile-butadiene-styrene (ABS).

Sorption of organic solutes by well casing materials has been reported in several publications. Miller (1982) tested PVC well casing for sorption of trace levels (2-14 ppb) of six halogenated organic compounds (bromo-

form, trichlorofluoromethane, trichloroethylene, 1,1,1-trichloroethane, 1,1,2-trichloroethane, and tetrachloroethylene) in aqueous solution and found slow losses of tetrachloroethylene (25-50 percent in six weeks).

Reynolds and Gillham (1986) tested both PVC and PTFE materials for sorption of trace levels (ppb) of five halogenated organics. They found rapid sorption of tetrachloroethylene by PTFE, slow sorption of 1,1,1-trichloroethane, 1,1,2,2-tetrachloroethane and hexachloroethane, and no sorption of bromoform. They also found slow sorption of all the analytes except trichloroethane by PVC. While 50 percent of the tetrachloroethylene was sorbed by the PVC in five weeks, the same amount was sorbed by PTFE in only eight hours. They attributed loss of these organics to absorption and developed a model where uptake of the compound proceeds by sorption/dissolution into the polymer surface, followed by diffusion into the polymer matrix. However, Reynolds and Gilham (1986) could not predict which organic chemicals were most susceptible to absorption.

Sykes et al. (1986) compared sorption of several organics by PVC, SS, and PTFE well casings. The casing materials were equilibrated for seven days (5 C) in analyte solution, placed in fresh analyte solution, and then tested for losses due to sorption after one and 24 hours. After 24 hours they did not find any significant losses for any of the casing materials.

While these studies indicate that sorption of some organics may be a significant problem for plastic casings over the long term, only the study by Miller (1982) examined desorption during the first two weeks. In that study, he observed some desorption (25 percent) of the tetrachloroethylene that had been previously sorbed by the PVC casings.

Casing materials may also leach a variety of organic substances. In two studies (Miller 1982, Parker and Jenkins 1986), analytical interferences in leachates from PVC well casings were sought but none were found. Curran and Tomson (1983) also examined the leachates from five plastics, including PVC and PTFE. They found that PTFE leached the fewest contaminants and that non-glued PVC was a close second. While it is possible that organic substances such as lubricants used during manufacture or inks from printing could leach from stainless or plastic casings, no information currently available in the literature confirms this.

It is interesting to note that despite the literature that is available regarding sorption of organics by PTFE, articles have recently been published that claim it is superior for sampling organic substances (e.g., Bryden and Smith 1989).

The purpose of the studies conducted by the authors was to determine the suitability of four well casing materials (PVC, PTFE, SS304, and SS316) for monitoring inorganic and organic solutes in ground water. To do this, two separate studies were conducted, one for inorganics and one for organics.

General Comments on the Inorganic and Organic Studies

Two-inch (inner) diameter well casings manufactured specifically for ground water monitoring were used in all studies. These casings were purchased specifically for the studies and were stored in a cool, dry room prior to use. Precautions were taken while the casings were being cut to prevent contamination from grease, dirt, oil, solvents, and excessive handling. The ground water used in the studies was obtained from a domestic well (249 feet [76m] deep) in Weathersfield, Vermont. No attempt was made to maintain the native dissolved oxygen level. As a general guideline for evaluating our results, we considered any change in concentration (relative to the control samples) of 10 percent in an eight-hour period to be the maximum change tolerable.

Inorganic Study

Experimental

Mixed metal solutions were prepared by spiking ground water with arsenic (As), cadmium (Cd), chromium (Cr) and lead (Pb) at two concentrations: 50 and 100 μg/L (ppb) for As, Cr, and Pb, and 10 and 2 μg/L for Cd. The higher concentrations are the current maximum concentration limits set by the EPA for drinking water (U.S. EPA 1986b). Prior to treatment, the ground water used in this study was analyzed and found to contain no detectable amounts of any of these metals at the sensitivity levels used for analysis. To simulate a wider range of ground water conditions, the tests were run at the natural pH (7.8) of the well water plus a lower pH (5.8) and at two levels of organic carbon. HCl (reagent grade) was added to lower the pH and 5 mg/L (ppm) of humic acid was added to raise the organic carbon content. A complete (2^3) factorial experiment was used to test the effect of these treatments (concentration of metals, pH and organic carbon content) (Table 1).

Because the wall thicknesses varied between the plastic and the two stainless steel casings, the casings

TABLE 1
Matrix Design for Inorganic Study

Test Condition	Metal Concentrations[1]	pH	Organic Carbon Added[2]
1	high	7.8	no
2	high	7.8	yes
3	high	5.8	no
4	high	5.8	yes
5	low	7.8	no
6	low	7.8	yes
7	low	5.8	no
8	low	5.8	yes

[1] High metal concentrations were 50 μg/L As, Cr, Pb, and 10 μg/L Cd. Low metal concentrations were 10 μg/L As, Cr, Pb, and 2 μg/L Cd.
[2] 5 mg/L humic acid was added as a source of organic carbon.

were cut to different lengths so that the surface area of each was constant (80 cm^2). Cut sections were rinsed with deionized water and air-dried before use. Individual well casings were then placed in 125mL polypropylene jars containing 100mL of test solution; the ratio of casing surface area to aqueous volume was 0.82 cm^2/mL. Similar jars that contained the test solutions without any casings were used for control samples. The sample vessels were covered, stored at 24 C and kept from natural light. Duplicates were run for each combination of variables and each casing material.

Sample aliquots (2.5mL) were taken from each container after 0.5, 4, 8, 24, and 72 hours. The aliquots were placed in clean 7.5mL polyethylene vials and acidified to a pH of less than 1 with nitric acid to prevent sorption by the containers. Metal concentrations were obtained by graphite furnace atomic absorption spectroscopy (Perkin-Elmer, model 703 atomic absorption spectrophotometer coupled with a PE model 2200 heated graphite atomizer). The concentrations of metals given in this study were measured as total.

The metal concentrations were normalized by dividing the values obtained for sample solutions that contained well casings by the values found for equivalent controls. This allowed the results for both concentrations to be analyzed by a single analysis of variance (ANOVA). Thus, it was possible to simultaneously test for the effect of solute concentration, pH and organic carbon at each sample time for each casing material. If a casing exerted no influence on analyte concentration, the expected value would be 1.00. An increase in the ratio indicates that the well casing released metal into the solution, while a decrease in the ratio indicates that metal was sorbed by the casing.

Results and Discussions

Approximately half of the stainless steel casings showed signs of surface rust. In some cases (SS 316 at a low pH), sufficient oxidation occurred to form a hydrous iron oxide precipitate. This precipitate was never observed in the control samples or those with PVC or PTFE casings. While the authors realize that rusting of the stainless casings is very condition-specific, the test conditions should be generally representative of shallow wells. Also, it was noticed that the casings had rusted some during storage prior to any testing.

Table 2 gives the normalized mean values and standard deviations for each analyte, well casing and time.

TABLE 2
Normalized Mean Metal Values[1] for Samples as a Function of Time

		Arsenic		Cadmium		Chromium		Lead	
Time (hr)	Pipe	Mean Value	Standard Deviation	Mean Value	Standard Deviation	Mean Value	Standard Deviation	Mean Value	Standard Deviation
0.5	PVC	0.991 ±	0.038	1.01 ±	0.025	1.01 ±	0.018	0.999 ±	0.009
	PTFE	0.999 ±	0.050	1.01 ±	0.011	1.01 ±	0.007	1.00 ±	0.026
	SS304	0.997 ±	0.057	1.06 ±	0.036	1.01 ±	0.016	1.02 ±	0.008
	SS316	0.994 ±	0.040	1.04 ±	0.021	1.02 ±	0.015	1.01 ±	0.025
4.0	PVC	1.02 ±	0.045	1.13 ±	0.037	0.999 ±	0.013	0.889 ±	0.030
	PTFE	0.993 ±	0.052	1.03 ±	0.054	1.01 ±	0.011	0.974 ±	0.019
	SS304	0.978 ±	0.063	1.17 ±	0.15	0.957 ±	0.037	0.784 ±	0.035
	SS316	0.945 ±	0.060	1.24 ±	0.49	0.921 ±	0.052	0.803 ±	0.077
8.0	PVC	1.00 ±	0.045	1.15 ±	0.037	1.00 ±	0.014	0.893 ±	0.035
	PTFE	1.01 ±	0.098	1.03 ±	0.016	0.989 ±	0.019	0.985 ±	0.032
	SS304	0.962 ±	0.057	1.16 ±	0.14	0.972 ±	0.16	0.699 ±	0.031
	SS316	0.945 ±	0.068	1.30 ±	0.47	0.872 ±	0.10	0.804 ±	0.10
24.0	PVC	0.994 ±	0.064	1.16 ±	0.056	1.00 ±	0.016	0.808 ±	0.051
	PTFE	0.992 ±	0.054	1.03 ±	0.017	1.01 ±	0.024	0.951 ±	0.040
	SS304	0.894 ±	0.051	1.12 ±	0.12	1.03 ±	0.37	0.538 ±	0.042
	SS316	0.853 ±	0.080	1.36 ±	0.68	0.855 ±	0.11	0.793 ±	0.19
72.0	PVC	1.03 ±	0.046	1.14 ±	0.049	1.01 ±	0.018	0.743 ±	0.064
	PTFE	1.02 ±	0.045	1.02 ±	0.022	1.00 ±	0.013	0.899 ±	0.034
	SS304	0.891 ±	0.084	1.03 ±	0.14	1.03 ±	0.42	0.452 ±	0.061
	SS316	0.874 ±	0.083	1.25 ±	0.66	0.836 ±	0.099	0.720 ±	0.17

[1] $\frac{\text{(Concentration for samples with casing)}}{\text{(Concentration for control samples)}}$ = Normalized mean value

These normalized values are the mean of all the treatments (i.e., for both pHs, organic carbon content, and concentration).

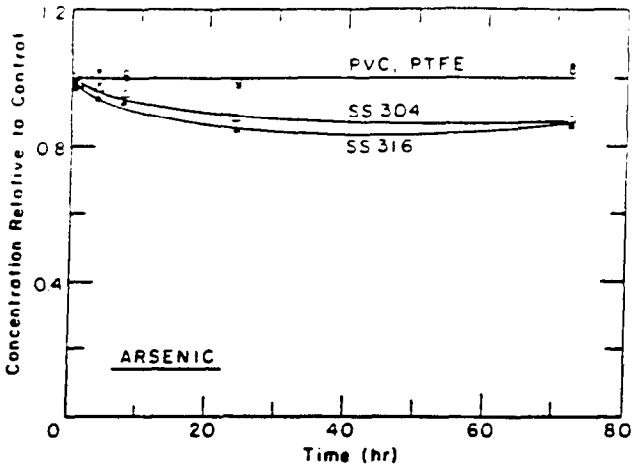

Figure 1. Trends in mean arsenic concentration for four well casing materials.

In general, there was no change in arsenic concentration for the sample solutions containing either the PVC or PTFE casings during the 72-hour test period (Figure 1), and no consistent pattern of effects was evident from the ANOVA. The reason As did not interact with these casings may be because As exists in natural waters in the anionic form (Fowler et al. 1979). Masse et al. (1981) found that anions do not strongly associate with plastic (polyethylene and PTFE) surfaces, which are known for their cation exchange capacity. The samples containing the stainless steel casings, on the other hand, showed a 10 percent decrease in aqueous arsenic concentration relative to the controls after 24 hours (Figure 1). It appears that there was no further loss of this analyte after 24 hours. Although these results cannot be used to predict exactly what losses might occur under field conditions, it is doubtful that this loss was rapid enough to impact water quality measurements (losses were less than 10 percent after eight hours).

The results for Cd are quite different. After only four hours, Cd concentrations in the samples containing PVC and stainless steel casings had increased by more than 10 percent (Figure 2), with the most leaching occurring in the samples containing the SS 316 casings. Cadmium may have been added to the PVC as a UV stabilizer (Wilson et al. 1982), and may have been added to the stainless steel to enhance resistance to chloride cracking (Sedricks 1979). The concentration of Cd in the samples containing PVC casings leveled off after eight hours. ANOVA revealed that pH had a significant effect (at the 95 percent confidence level) for this casing. Although the same amount of Cd leached in all the samples (approximately 0.5 mg/L), concentration was also significant (at the 95 percent confidence level), but only because relatively more was leached in the low-concentration samples. Concentrations in samples containing SS 304 casings decreased after eight hours and after 72 hours had returned to the same levels that were found in the control samples. Again, more Cd leached in the low pH samples. Cd was leached most rapidly in samples containing SS 316 casings. There was a large discrepancy between duplicate treatments for the samples that contained stainless steel casings. With the exception of the first set of samples (t = 0.5 hr), the relative standard deviations ranged from 12 to 15 percent for samples containing SS 304 and from 47 to 68 percent for those containing SS 316. In contrast, the standard deviations for samples containing PVC and PTFE casings were consistently below 6 percent. Because the variance in the samples containing SS 316 was so large, there was no consistent detectable effect of pH for these casings. However, surface oxidation appeared to be the major source of this variance. With respect to the leaching of metal stabilizers from PVC pipes, the literature indicates that loss can be a surface phenomenon that can be reduced or eliminated by either washing (with detergent) or soaking in dilute mineral acid before use (Packham 1971). It may be that the loss of Cd from PVC casings can also be reduced by a similar treatment, although we did not test this possibility.

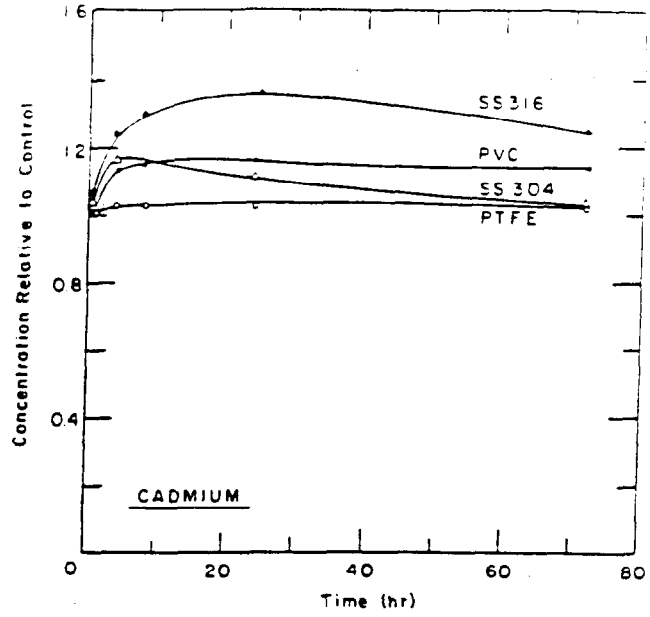

Figure 2. Trends in mean cadmium concentration for four well casing materials.

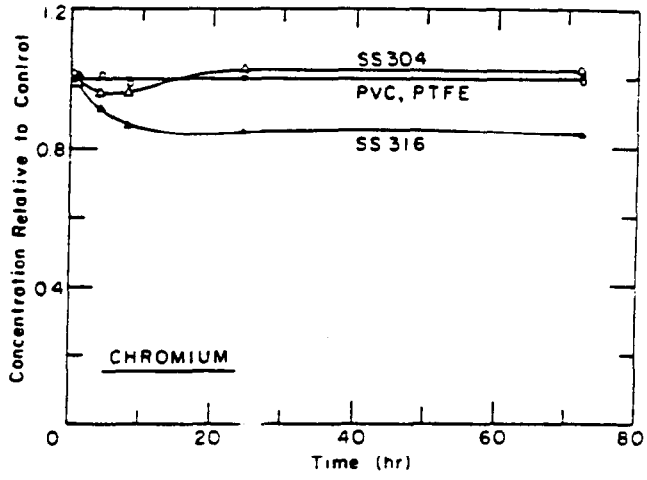

Figure 3. Trends in mean chromium concentration for four well casing materials.

There was no measurable sorption of chromium by the PTFE, PVC, and SS 304 casings (Figure 3). Absence

of interaction with the plastic casings may be due to chromium speciation. In solution, chromium exists predominantly as dichromate and chromate ($Cr_2O_7^{2-}$, CrO_4^{2-}) and, as mentioned previously, anions are not as likely to exchange with plastic surfaces. However, loss of chromium was rapid enough (13 percent after eight hours) for SS 316 casing material to be of concern for ground water monitoring. Losses were greater at the higher pH: Cr speciation is known to be affected by pH and may be responsible for some of these differences. Surface oxidation was greater at the lower pH, which likely contributed to the larger variability. Also, for those samples where a hydrous iron oxide precipitate was formed, co-precipitation may have contributed to the losses from solution. Again, the standard deviations were considerably greater for the samples containing the stainless steel casings. Humic acids apparently increased the stability of aqueous Cr, perhaps by acting as a complexing agent (Stumm and Morgan 1970s).

Lead was by far the most actively sorbed metal species. While all sample solutions containing casing materials showed some loss of Pb with time (Figure 4), PTFE was the least active surface and SS 304 was the most active. The losses for samples containing PTFE casings do not appear to be of concern with respect to ground water monitoring; losses were only 5 percent after 24 hours. However, losses for samples containing PVC and stainless casings are of concern: losses were 10 percent after only four hours in the samples containing PVC casings and 20 percent in those containing stainless casings. Although loss was initially rapid in samples containing SS 316 casings, it leveled off after eight hours. The standard deviation was higher for the samples containing SS 316 casings than for the other casings. For both stainless steel casings, there was less sorption of Pb at the lower pH where hydrogen ions may have competed for sorption sites. Added humic material apparently acted as a complexing agent in solution, making lead less prone to sorption. Concentration had no consistent effect.

Undoubtedly, there were shifts in the chemical equilibria of the well water solutions from the time the well water was collected until the end of the experiment. Ground water that is removed from an anoxic environment and exposed to oxygen-rich air may undergo redox and precipitation reactions (Stumm and Morgan 1970b). Also, lowering the pH shifts the carbonate equilibrium in solution from predominantly bicarbonate species toward carbon dioxide (Manahan 1972) and causes shifts in Cr speciation. Clearly, such changes would alter the trace metal species distribution. These possible changes were not monitored in this experiment.

For further details on this portion of the study, refer to Hewitt (1989).

Organic Study

Experimental

The four well casing materials were also tested for sorption/desorption of low levels of 10 organic substances. The substances tested were hexahydro-1,3,5-

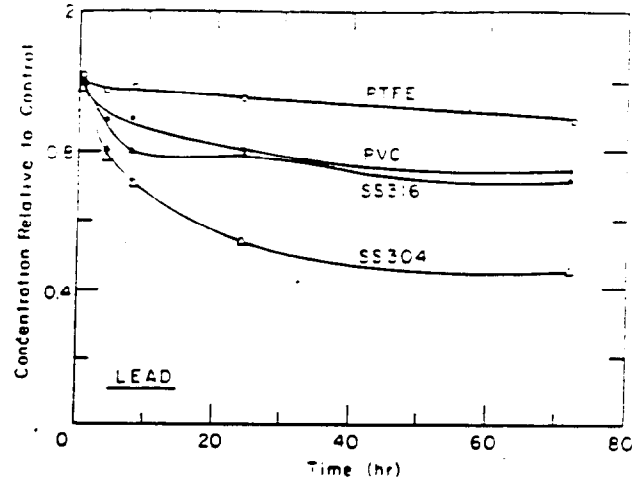

Figure 4. Trends in mean lead concentration for four well casing materials.

trinitro-1,3,5-triazine (RDX), 1,3,5-trinitrobenzene (TNB), cis- and trans-1,2-dichloroethylene (CDCE and TDCE), m-nitrotoluene (MNT), trichloroethylene (TCE), chlorobenzene (CLB), and o-, p- and m-dichlorobenzene (ODCB, PDCB, MDCB). The criteria used for selecting these analytes included being an EPA priority pollutant, molecular structure, solubility in water, K_{ow} value, and retention time (using reversed-phase high performance liquid chromatography [HPLC] analysis). HPLC analysis of the ground water used in these studies revealed no detectable levels of any of these substances.

For these experiments, casings were cut into 11- to 14mm-long sections, which were then cut into quarters. Again, the length was varied so that the surface area could be maintained constant. The casings were washed in solutions of detergent and deionized water, rinsed many times with deionized water, drained and left to air dry. Two pieces of each type of casing were placed in 40mL glass vials that were filled with the aqueous test solution so there was no head space, and capped with Teflon-lined plastic caps. Vials with test solution but no well casing material served as controls. These controls allowed us to eliminate any effects such as those that might be due to the vials or caps. The ratio of casing surface area to solution volume was 0.79 cm^2/mL. The ratio of solution volume to volume of casing material was approximately 10:1.

In the first experiment, the test solution was prepared by adding known amounts of each of the organic solutes directly to 2.2 L of well water in a glass-stoppered bottle, which was stirred overnight. The final concentration was approximately 2 mg/L for each organic constituent. The solution also contained 40 mg/L of $HgCl_2$, which was added to prevent biodegradation of the organics. Separate vials were prepared for each sample time so that the test solution could be discarded after sampling; there were three replicate samples for each material and time. Contact times were 0 hours, one hour, eight hours, 24 hours, 72 hours (three days), 168 hours (seven days), and approximately 1000 hours (six weeks).

After an aliquot was removed for analysis from each

TABLE 3
Normalized[1] Average Concentrations of Organic Analytes for the Four Well Casings with Time

Analyte	Treatment	1 Hour	8 Hours	24 Hours	72 Hours	168 Hours	1000 Hours
RDX	PTFE	1.03	1.00	1.00	1.02	0.91	0.99
	PVC	1.01	1.00	0.98	1.00	1.02	1.00
	SS304	0.99	0.99	1.01	1.02	1.10	0.98
	SS316	1.01	0.99	1.01	1.02	1.11	1.00
TNB	PTFE	1.01	1.00	1.00	0.98	0.95	1.01
	PVC	1.01	1.00	0.98	1.02	1.01	1.02
	SS304	0.99	1.00	1.00	1.05	1.07	1.00
	SS316	1.02	0.99	1.01	1.07	1.06	1.02
C12DCE	PTFE	1.01	0.96*	0.96*	0.94	0.91*	0.79*
	PVC	1.00	0.99	0.95*	0.96	0.95	0.90
	SS304	0.97	1.00	1.00	0.96	1.04	0.98
	SS316	0.95	0.99	1.00	1.01	0.98	0.99
T12DCE	PTFE	1.00	0.92*	0.88*	0.83	0.66	0.56*
	PVC	1.00	0.98	0.93*	1.06	0.83	0.83
	SS304	0.95*	1.00	1.00	0.96	1.11	1.00
	SS316	1.00	0.99	1.00	1.12	1.03	1.00
MNT	PTFE	1.03	1.00	0.99	0.99	0.90	0.90*
	PVC	1.02	1.00	0.98	1.05	0.99	0.94
	SS304	1.00	1.00	1.01	1.00	1.08	1.07
	SS316	1.02	1.00	1.02	1.08	1.10	0.99
TCE	PTFE	1.00	0.90*	0.85*	0.78*	0.64*	0.40*
	PVE	1.01	0.98	0.94*	0.99	0.94*	0.88*
	SS304	0.96	1.00	1.01	0.96	1.04	0.99
	SS316	1.00	0.99	1.00	1.04	0.98	1.00
CLB	PTFE	1.01	0.93*	0.90*	0.85*	0.74*	0.51*
	PVC	1.01	0.98	0.95*	0.98	0.94*	0.86*
	SS304	0.98	1.00	1.00	0.97	1.05	0.99
	SS316	0.99	0.99	1.01	1.04	0.98	0.99
ODCB	PTFE	1.01	0.91*	0.88*	0.81*	0.68*	0.43*
	PVC	1.02	0.97*	0.94*	0.98	0.93	0.86*
	SS304	0.98	0.99	1.00	0.99	1.04	1.00
	SS316	1.01	0.98*	1.01	1.03	0.98	1.00
PDCB	PTFE	0.92*	0.84*	0.77*	0.64*	0.47*	0.26*
	PVC	0.95	0.95*	0.92*	0.97	0.88*	0.80*
	SS304	0.91*	0.98	1.00	0.98	1.02	1.02
	SS316	0.94	0.97*	1.00	1.04	0.97	1.02
MDCB	PTFE	1.00	0.84*	0.78*	0.66*	0.48*	0.26*
	PVC	1.02	0.95*	0.92*	0.97	0.88*	0.80*
	SS304	0.99	0.96*	1.00	0.99	1.02	1.02
	SS316	1.03	0.96*	1.00	1.04	0.96	1.01

[1] Values are determined by dividing the mean concentration of a given analyte at a given time and for a particular well casing by the mean concentration (for the same analyte) of the control samples taken at the same time.

* Values significantly different from control values ($\alpha = 0.05$)

of the 1000-hour samples, the vials were emptied and the pieces of casing were rinsed with approximately 40mL of fresh well water to remove any residual solution adhering to the surfaces. The casing pieces were then placed in new vials, and fresh unspiked well water was added. The vials were capped with new caps and allowed to equilibrate for three days. Aliquots were then taken from these samples and analyzed to determine if desorption had occurred.

In the second experiment 2.0 g/L of NaCl was also added to the test solution to determine the effect of increased ionic strength on the rates of sorption. Sampling times were the same except that the last samples were taken after approximately 1200 hours (seven weeks).

All analytical determinations were made by reversed-phase high performance liquid chromatography. A modular system was employed that consisted of a Spectra Physics SP 8810 isocratic pump, a Dynatech LC-241 autosampler with a 100-μL loop injector, a Spectra-Physics SP8490 variable wavelength UV detector set at 210 nm, a Hewlett-Packard 3393A digital integrator, and a Linear model 555 strip chart recorder. Separations were obtained on a 25cm x 4.6mm (5 μm) LC-18 column (Supelco) eluted with 1.5 mL/min of 62/38 (v/v) methanol-water. Baseline separation was achieved for all 10 analytes. Detector response was obtained from the digital integrator operating in the peak height mode. Analytical precision ranged from 0.4 to 3.98 percent, as determined by the pooled standard deviation of triplicate initial measurements.

For each analyte and sample time, a one-way analysis of variance (ANOVA) was performed to determine if the well casing material had a significant effect on analyte concentration. Where significant differences were found, Duncan's multiple range test was performed to determine which samples were significantly different from the controls.

Before the two experiments described previously were performed, a preliminary leaching study was conducted to determine if any substances that could interfere with the analytical determinations leached from the casing materials. For this study, two pieces of each type of well casing were placed in each of two vials. The vials were filled with fresh well water so that there was no headspace, capped and allowed to sit for one week. An aliquot was taken from each vial and analyzed. No detectable peaks were observed in any of the samples.

Results and Discussion

The data for the first experiment are summarized in Table 3, where the normalized concentrations for solutions containing well casings are given as a function of time. Neither type of stainless steel casing affected the concentrations of any of the analytes in solution. However, significant loss of solute did occur in the solutions that contained plastic casings. While the rate of loss differed dramatically from analyte to analyte, losses were always greater for PTFE than PVC.

For RDX and TNB there was no loss of analyte from solutions containing either plastic casing, even after 1000 hours. There was some loss of MNT in the sample solutions that contained PTFE casings but the loss only became significant after 1000 hours (10 percent loss); there was no loss with the PVC casings. TDCE was lost much more readily in samples containing PTFE casings than was its isomer pair, CDCE (Figure 5). (The solid lines shown in this figure and Figures 6-9 were fitted manually.) Figure 6 shows the losses of TCE for the four well casings. Figure 7 shows the rate of loss of the three DCB isomers and CLB in the samples that contained PTFE casings. The order of loss was PDCB and MDCB > ODCB > CLB. While the rate of loss did not exceed 10 percent in eight hours for any of the previous solutes, it is noted that losses of PDCB and MDCB were 16 percent in eight hours and thus were rapid enough to be of concern with respect to ground

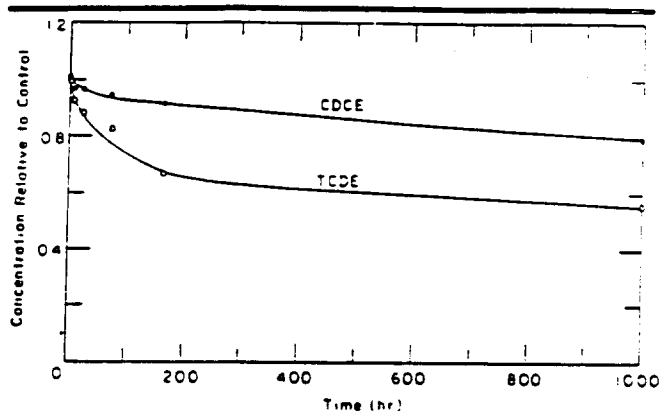

Figure 5. Sorption of CDCE and TDCE by PTFE well casings.

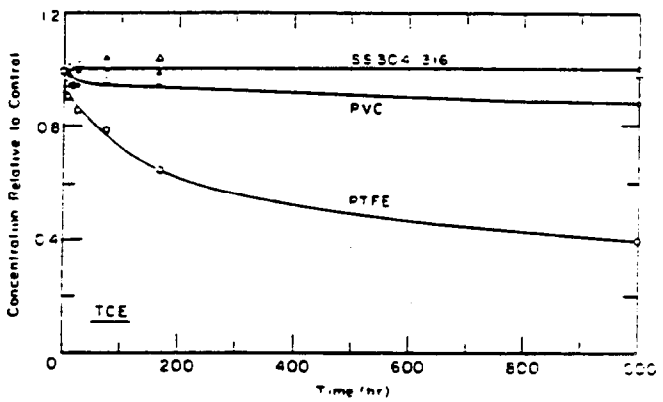

Figure 6. Sorption of TCE by the four well casing materials.

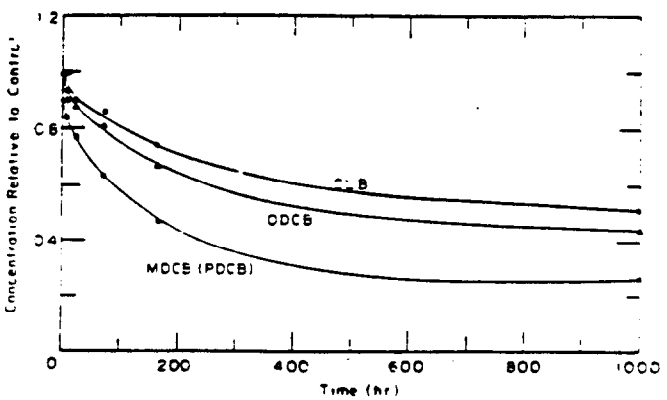

Figure 7. Sorption of CLB, ODCB, MDCB and PDCB by PTFE well casings.

TABLE 4
Results of Desorption Study

Casing Material	Concentration in mg/L after three days equilibration									
	RDX	TNB	CDCE	TDCE	MNT	TCE	CLB	ODCB	PDCB	MDCB
Teflon	ND	ND	0.20	0.43	0.075	0.47	0.28	0.38	0.30	0.35
	ND	ND	0.21	0.45	0.076	0.48	0.28	0.35	0.34	0.36
	ND	ND	*	*	0.074	*	*	*	*	*
PVC	ND	ND	0.079	0.15	0.046	0.14	0.10	0.15	0.17	0.18
	ND	ND	0.080	0.14	0.046	0.14	0.10	0.15	0.16	0.21
	ND	ND	0.080	0.15	0.043	0.13	0.11	0.16	0.16	0.20

* Results not presented because of additional loss of volatiles, probably resulting from a loose cap on this vial.
ND = Not detected.

water monitoring. For PVC, losses never reached 10 percent in eight hours for any of the organics tested, and thus the authors believe that PVC is clearly superior to PTFE for wells where water samples will be analyzed for organic constituents.

To determine if the loss of organic solutes was reversible, the pieces of casing that had been exposed to test solution for 1000 hours were rinsed and then exposed to fresh well water for three days. Measurable quantities of all the organics were recovered where significant losses had been observed (Table 4). Thus, loss was due to sorption and was at least partially reversible. Although this experiment did not give us information on the kinetics of desorption, the amount of analyte desorbed after three days generally paralleled the amount sorbed. However, PDCB and MDCB were sorbed to the greatest extent while TCE and TDCE were desorbed to the greatest extent. Therefore, it may be that diffusion out of the polymer is more rapid for smaller molecules.

In the second experiment NaCl was added to raise the chloride concentration above 1000 mg/L. High chloride concentrations are known to corrode 304 stainless steel. Specifically, tests were performed to determine if rusting would alter the sorptivity of the stainless steel surfaces. It is also possible that sorption on plastic materials would change with increasing ionic strength of the test solution.

While addition of NaCl caused rapid rusting of both stainless steel casings (<24 hr), it did not cause sorption of any of the organic solutes by them. In addition, the increased ionic strength had no detectable effect on the rate of sorption by either plastic casing (for example, Figures 8 and 9). These two figures also demonstrate the excellent reproducibility of the results from these two experiments.

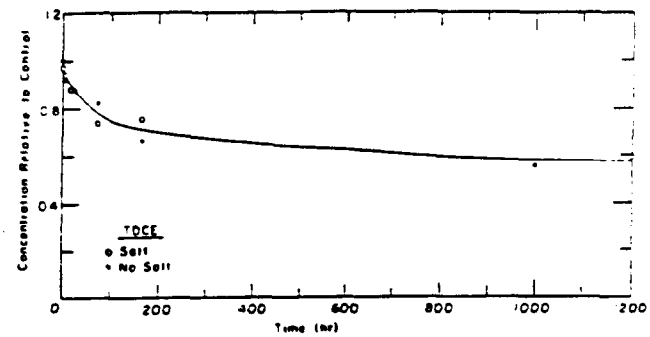

Figure 8. Sorption of TDCE by PTFE well casings in the presence and absence of salt.

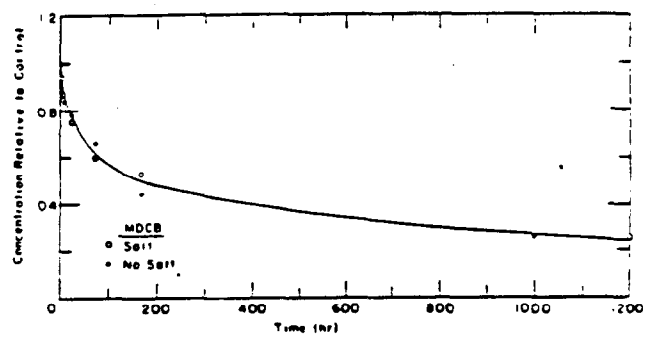

Figure 9. Sorption of MDCB by PTFE well casings in the presence and absence of salt.

Modeling the Sorption Process

These organic studies clearly demonstrated that the loss of organic chemicals from solutions exposed to plastic casing materials is via some reversible sorption process. However, it was uncertain whether this loss was due to sorption on the surface or whether there was penetration into the polymer matrix. The rate of sorption was found to be slow, with no established equilibrium after hundreds of hours. One explanation for this slow rate was that penetration into the polymer was occurring, with the rate controlled by slow diffusion within the bulk polymer and/or the rate of penetration into the small pores on the polymer surface. If it is assumed that this is the case, the process can be kinetically modeled by treating the plastic casing as an immiscible liquid phase in contact with water and relating the degree of partitioning for individual analytes to their octanol/water partition coefficients (K_{ow}). While there are immiscible liquids other than octanol that are better structural models for PTFE or PVC, the most extensive collection of partition coefficients is available for octanol.

If it is assumed that sorption is a reversible process,

$$A_w \underset{k_2}{\overset{k_1}{\rightleftharpoons}} A_s \quad (1)$$

and is first order in both directions, then the rate equation can be written as (Gould 1959):

$$\frac{d[A_w]}{dt} = -k_1 [A_w] + k_2 [A_s] \quad (2)$$

where $[A_w]$ is the concentration of solute A in aqueous solution, $[A_s]$ is the concentration of solute A in the plastic casing material, and k_1 and k_2 are the first-order rate constants for sorption and desorption, respectively.

Integration of the rate equation results in a non-linear relationship for A_w as a function of time t and two constants a and b (Equation 3), where a and b are defined in Equations 4 and 5:

$$\frac{\ln (a[A_w] + b)}{a} = t \quad (3)$$

$$a = k_1 + k_2 \quad (4)$$

$$b = 10k_2 [A_o] \quad (5)$$

where A_o is the initial concentration of solute A in aqueous solution.

Optimal values for a and b were obtained for each solute exposed to PTFE by application of the Gauss-Newton method of non-linear curve fitting using the measured concentrations at 1, 8, 24, 72, 128, and 1000 hours (Parker et al. 1989). Using determined values for a and b, the authors simultaneously solved Equations 4 and 5 for each solute to obtain estimates of k_1 and k_2. Because the process described is assumed to be reversible and first order, the ratio of the rate constants, k_1/k_2, is the equilibrium constant, K_{eq}.

When the eight values of K_{eq} were plotted vs. Log K_{ow}, six of the eight points appeared to fall on a straight line, while the points for MNT and ODCB did not (Figure 10). The poor fit for MNT and the lack of significant sorption for TNB and RDX can be explained by the tendency of nitro-containing organic molecules to form strong hydrogen bonds, which keeps them in solution. While octanol can be a donor in hydrogen bonding, PTFE cannot. Thus, if the authors predict partitioning into PTFE for these molecules based on their octanol/water coefficients, the amount of sorption for these types of compounds will be overestimated.

The poor prediction for ODCB can be explained by the well-documented "ortho effect," which is a complex combination of electronic and steric interactions that often results in ortho di-substituted aromatic molecules behaving much differently than the meta- and para-isomers.

A similar model predicting the loss of analyte for PVC was not created because the percent sorbed was small when compared with the experimental error and this would produce an unacceptable degree of uncertainty in the calculated rate constants.

Therefore, it is concluded that for hydrophobic

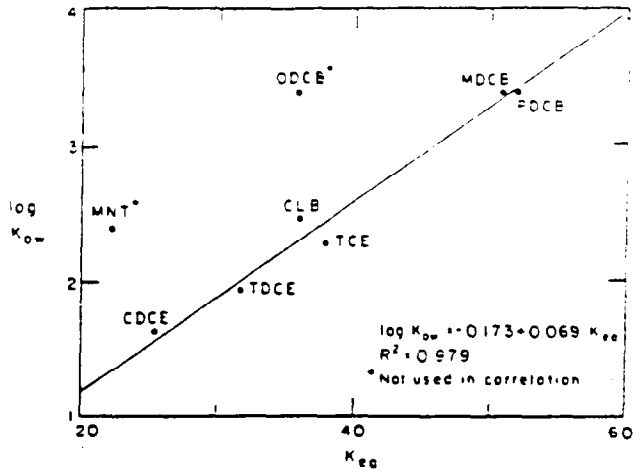

Figure 10. Correlation between log K_{ow} and K_{eq} for solutes exposed to PTFE casings.

organic molecules that are not subject to hydrogen bonding, the relationship presented in Figure 10 can be used to estimate the equilibrium partitioning of an analyte between the aqueous phase and PTFE. It is expected that losses in new wells would occur for some time until equilibrium with the water is achieved.

While K_{eq} will determine the equilibrium concentrations of each analyte in the water and plastic phases, it is the magnitude of k_1 that will determine how quickly various analytes are depleted. For small, planar molecules like TCE, the k_1 values are quite high compared to the other analytes. This may explain the rapid loss of tetrachloroethylene from solutions containing PTFE casings observed by Miller (1982) and Reynolds and Gillham (1986).

Because the rate of sorption appears to be first order, the relative concentration (concentration at a given time relative to its initial concentration) is independent of initial concentration (Castellan 1964). Thus, the percent loss at a given exposure time is expected to be independent of concentration, as was also predicted by the model of Reynolds and Gillham (1986). We did not confirm this, however, by conducting the test at several concentrations.

For further details on the organic portion of this study, refer to Parker et al. (1989).

Summary and Conclusions

In summary, the inorganic study indicated that three of the metals (As, Cr and Pb) were sorbed by one or more of the casing materials. Specifically, Cr was sorbed by SS 316 casings, As was sorbed by both 304 and 316 stainless steel casings, and Pb was sorbed by all four casings. On the other hand, Cd leached from the stainless steel and PVC casings, although subsequent sorption lowered concentrations in the samples containing stainless steel casings. While sorption of As was slow enough that it is probably not of concern for ground water monitoring, the changes in the Cr, Cd and Pb concentrations are of concern. Both SS 304 and 316 casings were subject to surface oxidation, presumably by galvanic action, which apparently provided active sites for sorption and release of major and minor constitu-

ents. Sorption and leaching of metal species was affected in some cases by the ground water composition (pH and organic carbon content). Specifically, there was more leaching of Cd and less sorption of Pb at the lower pH. Our results indicate that humic material may have acted as a complexing agent, making lead and chromium less prone to sorption. If chemical interactions are used as the only criterion, PTFE is clearly the best candidate for monitoring metal species in ground water. PVC would be a good second choice because its performance was considerably better than either SS 304 or SS 316 casing.

In contrast, the organic studies clearly indicated that PTFE was the poorest choice of the four well casing materials tested. PTFE casings sorbed all the chlorinated compounds and one nitroaromatic compound, and losses of PDCB and MDCB were rapid enough to be of concern for ground water monitoring. PVC casings also sorbed some of the same compounds, but always at rates that were considerably slower than those observed for PTFE casings. The rates of these losses on PVC were slow enough that they did not appear to be of concern for ground water monitoring. There was no loss of any of the organic solutes in the presence of either type of SS casing.

The desorption study showed that the loss of organics from aqueous solution is due to a sorption process that was reversible, or at least partially so. Desorption from contaminated casings could potentially result in falsely high concentrations of analytes if the concentrations of the analytes in the ground water were to drop.

The loss of hydrophobic organic constituents in the samples containing PTFE casings could be correlated with the substance's K_{ow} values. However, this correlation overestimates losses for hydrophilic organic substances.

There are several effects that make extrapolating these test data to a real monitoring situation difficult:

- Casings were tested and not well screens. The rate of sorption could be substantially greater in the screened portions of the well because the surface area of the screened portion would be greater.
- This experiment was conducted under static conditions. The effect of sorption under real conditions would be mitigated to some degree, depending on the rate of exchange of water between the aquifer and well casing.

Clearly, choosing one casing material for samples that will be analyzed for both trace metals and organics involves compromise. However, based on the results of the tests that the authors have performed to date, PVC appears to be the best compromise choice of the four casing materials tested.

Future studies will examine leaching of inorganic and organic solutes, the effect of low dissolved oxygen on interactions between the metals and well casings, and the suitability of other materials for ground water monitoring.

Acknowledgments

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APPENDIX B

HEALTH AND SAFETY PLAN

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OSHA Poster
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RFI/SI Health and Safety Plan

REFERENCES

The following chapters of the Comprehensive Long-term Environmental Action Navy (CLEAN) Program District I Generic HASP are applicable for the work anticipated at the Site.

✓ 2.0 AUTHORITY AND RESPONSIBILITY OF HEALTH AND SAFETY PERSONNEL

✓ 3.0 TRAINING PROGRAM

✓ 4.0 MEDICAL SURVEILLANCE PROGRAM

___ 5.0 ENGINEERING CONTROLS

✓ 6.0 PERSONAL PROTECTIVE LEVEL DETERMINATION

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___ 8.0 ZONATION

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- ___ TRISODIUM PHOSPHATE
- ✓ OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) POSTER
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1.0 GENERAL

1.1 SCOPE AND PURPOSE. This Health and Safety Plan (HASP) has been prepared in conformance with the ABB Environmental Services Inc. (ABB-ES) Generic HASP developed under the Comprehensive Long-Term Environmental Action - Navy (CLEAN) District I Contract (CLEAN HASP) and is intended to meet the requirements of 29 Code of Federal Regulations (CFR) 1910.120. As such, the HASP addresses those activities associated with field operations for this project. Compliance with this HASP is required for all ABB-ES personnel, contractor personnel, or third parties entering the Site.

1.1.1 RCRA Facility Investigation/Site Investigation (RFI/SI) Workplan The RFI/SI workplan describes regional environmental factors, reviews a history of the site, details previous investigative results, describes RFI/SI tasks, and describes site-specific investigative methodology, and project organization, and schedule. The RFI/SI workplan has included the Sample and Analysis (SAP), and Health and Safety Plan (HASP) as separate appendices.

The SAP (Appendix A) focuses on the field investigation, analytical methods and quality assurance/quality control (QA/QC) procedures. The SAP provides a project description, describes site management and field methods, details the technical approach and sampling plans for each site, and describes quality assurance and quality control requirements for sample collection, analysis, data assessment, corrective action, and reporting. The SAP focuses on the rationale for and details necessary to perform the field and laboratory sampling and analytical program. The Field Sampling Plan (FSP) and the Quality Assurance Project Plan (QAPP) are consolidated into one document (SAP) to provide one comprehensive document that can be used by field teams onsite. This also avoids triplication of many sections that are common to the Workplan, the SAP, and the QAPP (i.e., project purpose and description, site history, sampling methods, locations, and procedures, data quality objectives, laboratory analytical methods, data assessment and evaluation, and project organization and schedule). These common sections are currently duplicated or summarized in both the workplan and the SAP.

This HASP (Appendix B) outlines project personnel and corporate health and safety policies, provides a brief site characterization and description of the scope of work, outlines potential hazards, protective measures, and monitoring for each site, and summarizes decontamination procedures. In addition, the HASP includes material safety data sheets for chemicals that may be encountered at the site and provides emergency information, such as a map to the hospital, and emergency telephone numbers. The site-specific HASP references the CLEAN contract Generic HASP where possible. The CLEAN Generic HASP is included as an attachment for on-site reference.

1.1.2 Initial Definition of the Investigation (Sites 5, 11, and 16) As prescribed by the IR Program at Naval Submarine Base (NSB) Kings Bay, an Initial Assessment Study (IAS) was performed. The IAS report reviewed 16 potential sites and concluded that none of the sites needed additional investigation. The Georgia Environmental Protection Division issued a Hazardous Waste Permit [HW-014 (s)(2)] in which they required four landfill sites to undergo additional

investigation. The three facility Sites included in this investigation are listed below:

Investigative Sites

Site 5, Towhee Trail
Site 11, Camden Landfill
Site 16, Army Reserve Disposal Area near Old Sewage Lagoon 3990

The investigation of the fourth site, site 12, will consist of a literature search performed by the Navy.

The objectives of the RFI are to collect sufficient data to: characterize and quantify the extent of contamination, to assess potential risks to human health and the environment posed by contaminants of concern, to support a feasibility study (FS) at sites where remedial action is warranted, and to support a Record of Decision (ROD) at all sites.

The FS is designed to evaluate remedial alternatives, conduct treatability studies, and design remedial actions. Remedial actions are performed to mitigate threats to human health and the environment by removing, containing, or treating contaminated matrixes to established target levels.

1.2 PROJECT PERSONNEL.

1.2.1 Task Order Manager The Task Order Manager (TOM), Philip Georgariou, is the individual with overall project management responsibilities. Those responsibilities as they relate to health and safety include provision for the development of this site-specific HASP, the necessary resources to meet requirements of this HASP, the coordination of staff assignments to ensure that personnel assigned to the project meet medical and training requirements, and the means and materials necessary to resolve any health and safety issues that are identified or that develop on the project.

1.2.2 General Site Supervisor Robert Lunardini, Jr. is the General Site Supervisor and has vested authority from the TOM to carry out day-to-day site operations.

1.2.3 Health and Safety Officer The HSO will have at least an indirect line of reporting to the HSM through the HSS for the duration of his assignment as project HSO. The HSO is responsible for developing and implementing this site-specific HASP in accordance with the CLEAN HASP. The HSO will investigate all accidents, illnesses, and incidents occurring on site. The HSO will also conduct safety briefings and site-specific training for onsite personnel. As necessary, the HSO will accompany all USEPA, Occupational Safety and Health Administration (OSHA), or other governmental agency personnel visiting the NSB Kings Bay site in response to health and safety issues. The HSO, in consultation with the HSS or HSM, is responsible for updating and modifying this HASP as site or environmental conditions change.

1.3 TRAINING. Training is defined under the CLEAN HASP, and all personnel entering potentially contaminated areas at the NSB Kings Bay site must meet the requirements of 29 CFR 1910.120. Personnel without the required training **will not be permitted** in any area with potential for exposure to toxic substances or harmful physical agents (i.e., downrange). Refer to Chapter 3.0 of the CLEAN HASP for further information.

1.4 MEDICAL SURVEILLANCE. All personnel entering potentially contaminated areas of this site will be medically qualified for site assignment through a medical surveillance program outlined in the ABB-ES Generic HASP. Personnel who have not received medical clearance **will not be permitted** in any area with potential for exposure to toxic substances or harmful physical agents (i.e., downrange). Refer to Chapter 4.0 of the CLEAN HASP for further information.

2.0 SITE CHARACTERIZATION AND ANALYSIS

2.1 SITE NAME, LOCATION, AND SIZE. NSB Kings Bay is located in Camden County, in the southeastern corner of the state of Georgia (Figure 2-1). The base occupies an area of approximately 16,037 acres situated about 5 miles north of the city of St. Marys.

2.2 SITE HISTORY AND LAYOUT. The site was originally acquired by the U.S. Army in the early 1950's and was developed as Military Ocean Terminal, Kings Bay (MOTKI). It was constructed to meet Department of the Army requirements for east coast port facilities capable of shipping ammunition and other explosives in the event of a national emergency. In as much as there was no immediate operational need for this installation, it was placed in an inactive status and remained in that status until its transference to the Navy. The Navy selected NSB Kings Bay as the east coast base for its Fleet Ballistic Missile Submarine Support Facility and ownership was transferred July 1, 1978. NSB Kings Bay was a terminal and not a storage dump or depot, as it was not designed to store ammunition or explosives for more than short periods of time. NSB Kings Bay had no assigned military personnel and was operated by nineteen U.S. Government Civil Service employees, whose mission was to plan, program and perform repair and utilities and fire prevention and protection functions for the terminal.

Of the 16 sites identified during the IAS, four sites (5, 11, 12, and 16) were recommended for further evaluation. Three of the four sites, 5, 11, and 16, will be investigated during the RFI/SI. Brief histories of these three sites are presented in the following paragraphs.

Site 5 History

The Army used this site from 1969 to 1974. They excavated pits to a depth of 5 feet, then filled with waste. Waste materials included tree debris, metal ammo boxes, aluminum sheeting, railroad bed material, diesel and waste oil (used to ignite fires). The Army disposed an estimated total of 69,000 cubic yards of fill material.

Site 11 History

Most of the 35 acre site was used in the landfill's dredge and fill operation. The landfill was a trench and fill operation. Trenches were excavated into the water table, which is four to eight feet below the surface. At the end of each day, the wastes were compacted and covered with at least six inches of soil. Upon closure, a final soil cover of two feet was placed on the landfill. Estimated waste quantity is 500,000 cubic yards. Twenty to thirty percent of the material came from the Navy.

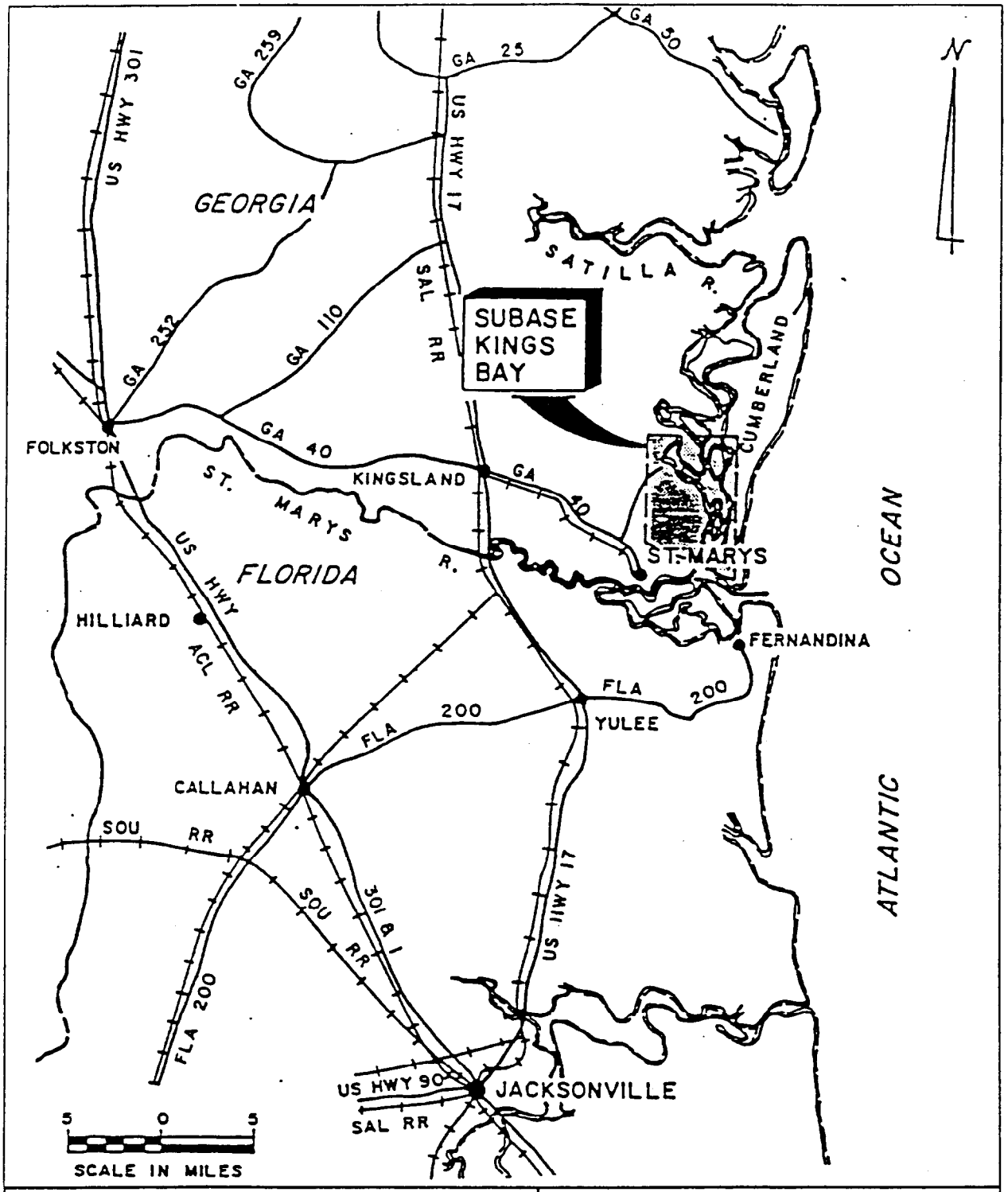

FIGURE 2-1
VICINITY MAP

HEALTH AND SAFETY PLAN
NSB KINGS BAY

Site 16 History

The site consists of a pit in a small area (approximately 50 by 100 feet) within a five acre cleared area. The exact location, within the field, has not been determined. The Army Reserves would dispose of their waste by excavating a pit 3 to 5 feet deep, filling it with material and finally covering the area. Fill material disposed at the site included tree debris, scrap metal, empty paint and solvent cans. This location received approximately 4,000 cubic yards total material.

2.3 SCOPE OF WORK (WORK PLAN). The field investigation at NSB Kings Bay will consist of surface geophysical investigations, monitoring well installation, well development and purging; soil, sediment, surface water, and groundwater sampling, soil borings, and aquifer testing.

The following lists investigative objectives for each of the three Sites and the methods proposed to achieve them.

Site 5:

Objective: To determine the location and orientation of the disposal pits.

Methods: Magnetometer survey
Terrain conductivity survey

Objective: To determine the composition, magnitude, and extent of soil contamination.

Methods: Subsurface soil sampling

Objective: To determine the composition and magnitude of groundwater contamination.

Methods: Monitoring well installation and sampling.

Site 11:

Objective: To determine if a contamination plume has migrated away from the site.

Method: Terrain conductivity survey

Objective: To determine the composition, magnitude, and direction of groundwater contamination.

Method: Monitoring well installation and sampling.

Site 16:

Objective: To determine the location and orientation of the disposal pits.

Methods: Magnetometer survey

Objective: To determine the composition, magnitude, and extent of soil contamination.

Methods: Subsurface soil sampling

Objective: To determine the composition and magnitude of groundwater contamination.

Methods: Monitoring well installation and sampling.

3.0 HAZARD ANALYSIS

3.1 TASK ONE - INVASIVE SAMPLING Invasive sampling at NSB Kings Bay will include soil boring, and monitoring well installation.

3.1.1 Hazardous Substances The contaminants of concern that may be present on the facility, along with any established exposure limits for those substances, are listed in Table 3-1.

3.1.2 Site Risks The following are the health hazards and safety hazards that are expected to be encountered at each Site.

3.1.2.1 **Health Hazards** Health hazards at NSB Kings Bay consist primarily of potential exposure to contaminated matrices. Contaminants to which personnel may be exposed to at landfill areas include solvents, household, pesticides and military material. The primary constituents of those hazardous substances that represent potential health hazards are summarized in Table 3-1.

All activities at NSB Kings Bay will be conducted in unconfined areas. This will minimize the potential for exposure by onsite personnel to either high vapor concentrations or strong liquid concentrations of any of the substances described above.

3.1.2.2 **Safety Hazards** Safety hazards include those hazards that personnel may be exposed to that are unrelated to hazardous wastes. These include hazards such as heat stress, operation and presence around heavy equipment, lifting of objects, vehicle traffic, and snake bites. Extreme caution should be exhibited by all personnel while conducting work around drill rigs, backhoes, and other heavy equipment. During hot days, personnel should take time to drink fluids and cool off to avoid overheating and symptoms related to heat stress.

Lifting of heavy objects should be done with caution. Personnel should assist one another with moving heavy objects or use the appropriate equipment to accomplish these tasks. During all site activities, personnel should be aware of the possibility of an encounter with poisonous snakes, particularly rattlesnakes.

Power substations, powerlines, underground utilities, and underground pipelines are to be avoided during drilling operations. Necessary work permits for activities at the Naval activities will be obtained from the Public Works Department or the appropriate department (e.g., fire department, etc.).

3.1.2.3 **Conclusions and Risk Assessment** Based on all of the available information (nature of the work, potential onsite chemicals and their properties, exposure limits, etc.), hazards associated with conducting the described field work are considered to be low, assuming appropriate health and safety practices are maintained.

Table 3-1
Common Solvents Found at Landfill

NSB Kings Bay
Kings Bay, Georgia

Chemical	Approximate odor threshold (ppm)	Permissible Exposure Limits (ppm)	Threshold Limit Value (ppm)	Physical Characteristics	Dermal Toxicity	Remarks
Benzene	4.7	1	1	Colorless liquid, pleasant aromatic odor.	Moderate skin irritant.	Inhalation of large amounts attacks central nervous system (CNS); chronic poisoning causes leukemia.
Ethyl benzene	140	100	100	Colorless liquid, aromatic odor.	Moderate skin irritant.	Liquid blisters skin, inhalation results in dizziness, depression.
Toluene	0.17	100	100	Colorless liquid, pleasant aromatic odor.	Mild skin irritant	Ingestion or aspiration can cause pulmonary edema, depressed respiration.
Xylene	0.05	100	100	Colorless liquid, aromatic odor.	Moderate skin irritant.	Inhalation causes headache and dizziness; vapors irritate eyes; can be fatal if ingested.
Naphthalene	–	10	10	Colorless to brown solid with an odor of mothballs.	Moderate skin irritant.	Inhalation causes headache and confusion; vapors irritate eyes.
Anthracene	–	–	–	White to yellow solid, weak odor.	–	Inhalation of dust irritates nose and throat.
Lead	–	–	–	Soft, ductile, gray, metal, soluble in water containing a weak acid.	–	Lead poisoning may cause fatigue, anemia, abdominal pains, and neurological damage.
Chlorobenzene	0.21	75	75	Colorless liquid, sweet almond odor.	Moderate skin irritant.	Chronic inhalation may result in damage to lungs, liver, and kidney.
0-Dichlorobenzene	4	50	50	Colorless liquid, pleasant odor.	Moderate skin irritant.	Chronic inhalation may result in damage to lungs, liver, and kidney.
Vinyl chloride	260	1	5	Colorless gas, sweet odor	May cause frostbite.	Inhalation may result in dizziness, anesthesia, lung irritation.
Trichloroethane	100	10	350	Colorless liquid, sweet odor.	Moderate skin irritant.	Inhalation may cause liver and kidney damage.
Trichloroethylene	50	–	50	Colorless liquid, sweet odor.	Can cause dermatitis.	Inhalation may cause eye and nose irritation, blurred vision, nausea, or central nervous system damage.
Tetrachloroethylene	5	–	50	Colorless liquid with an odor like chloroform.	Moderate skin irritant.	Inhalation may irritate eyes, nose and cause central nervous system damage.
Polychlorinated biphenyl	–	–	0.5-1	Oily liquid to solid powder, weak odor.	Acne from skin contact.	–
Methane	200	–	–	Colorless liquified gas, mild, sweet	–	High concentrations may cause asphyxiation, no systemic effects even at 5 % concentration in air.
Aluminum chloride	1-5	–	5	Yellow-orange to grayish-white, solid crystals to powder.	Causes thermal and acid burns in presence of moisture.	Contact with eyes causes burns

Notes: ppm = parts per million.

3.1.3 Protective Measures The following are the protective measures that will be used at the site.

3.1.3.1 **Engineering Controls** None anticipated.

3.1.3.2 **Levels of Protection** Level D protective equipment will be used at NSB Kings Bay. Level D protection should only be used when the atmosphere contains no known hazard, all potential airborne contaminants can be monitored for, and work functions preclude splash, immersion, or the potential for unexpected inhalation or contact with hazardous levels of any chemical.

3.1.4 Monitoring It is intended that real time monitoring instrumentation will be used to monitor the work environment in order to ensure the appropriate level of protection for the site team.

3.1.4.1 **Air Sampling** To the extent feasible, the presence of airborne contaminants will be evaluated through the use of direct reading instrumentation. Information gathered will be used to ensure the adequacy of the levels of protection being used at the site, and may be used as the basis for upgrading or downgrading the levels of protection in conformance with action levels provided in this HASP and at the direction of the site HSO.

The following sampling equipment will be used at the Site. Refer to Chapter 7.0 of the CLEAN HASP for information on the calibration and maintenance of the equipment.

1. Foxboro Organic Vapor Analyzer 128 (OVA)
2. HNU IS101 or Photovac TIP Photoionization Detector

If the OVA detects a steady measurable quantity of organic vapors greater than 5 parts per million (ppm) (above background conditions) in the breathing zone, the field team will withdraw from the Site until health and safety conditions at the site are re-evaluated.

3.1.4.2 **Personal Monitoring** All personnel onsite will be enrolled in the ABB-ES medical surveillance program. In addition, all personnel onsite will wear a thermoluminescent dosimetry body badge to measure possible exposure to radiation.

3.2 TASK 2, SAMPLING AT SITES. Because of the potential for encountering explosive hazards and/or bulk buried hazardous materials (including buried compressed toxic gases), drilling will not be performed into any known disposal area. Soil samples will be collected by hand auguring. Hand auguring will be stopped if debris other than tree refuse is encountered.

3.2.1 Hazardous Substances The contaminants of concern known or suspected to be present on the facility, along with any established exposure limits for those substances are listed in Table 3-1.

3.2.2 Site Risks The following are the health hazards and safety hazards that are expected to be encountered at the site.

3.2.2.1 **Health Hazards** Health hazards at Site 11 consist of potential exposure to contaminated matrices, as well as explosion, and release of toxic gases. Contaminants to which personnel may be exposed are household solvents and pesticides, PCBs, solvents, waste oil and fluids, diesel fuel, automobile gasoline, mineral spirits, and paint wastes and their constituents. The primary constituents of those hazardous substances that represent potential health hazards are summarized in Table 3-1.

3.2.2.2 **Safety Hazards** Safety hazards include those hazards which personnel may be exposed to that are unrelated to hazardous wastes. These include hazards such as heat stress, operation and presence around heavy equipment, lifting of objects, vehicle traffic, and snake bites. Extreme caution should be exhibited by all personnel while conducting work around drill rigs, backhoes, and other heavy equipment. During hot days, personnel should take time to drink fluids and cool off to avoid overheating and symptoms related to heat stress.

Lifting of heavy objects should be done with caution. Personnel should assist one another with moving heavy objects or use the appropriate equipment to accomplish these tasks. During all site activities, personnel should be aware of the possibility of an encounter with poisonous snakes, particularly rattlesnakes.

Power substations, powerlines, underground utilities, and underground pipelines are to be avoided during drilling operations. Necessary work permits for activities at the Naval activities will be obtained from the Public Works Department or the appropriate department (e.g., fire department, etc.).

3.2.2.3 **Conclusions and Risk Assessment** Based on the available information (nature of the work, potential onsite chemicals and their properties, exposure limits, etc.), hazards associated with conducting the described field work are considered to be low, assuming appropriate health and safety practices are maintained. Extra measures will be taken to reduce the potential hazards associated with possible unexploded ordnance and buried compressed gas cylinders.

3.2.3 Protective Measures All personnel on site will attend a safety briefing and will complete the HASP personnel information pages. All ABB-ES personnel will be qualified under the ABB-ES Corporate Safety and Medical Surveillance Program. All subcontract personnel will be qualified under similar programs in accordance with 29 CFR 1910.120.

The HSO will report any accident or incident to the NSB Kings Bay representative and the Task Order Manager immediately, or, where necessary, after emergency steps to control the situation have been initiated. An Accident-Incident Report must be filed within 24 hours.

3.2.3.1 **Engineering Controls** None anticipated.

3.2.3.2 **Levels of Protection** Level D personal protection will be used at NSB Kings Bay. Level D Protection should only be used when the atmosphere contains no known hazard, all potential airborne contaminants can be monitored for, and

work functions preclude splash, immersion, or the potential for unexpected inhalation or contact with hazardous levels of any chemical.

3.2.4 Monitoring It is intended that real time monitoring instrumentation will be used to monitor the work environment in order to ensure the appropriate level of protection for the site team.

3.2.4.1 **Air Sampling** To the extent feasible, the presence of airborne contaminants will be evaluated through the use of direct reading instrumentation. Information gathered will be used to ensure the adequacy of the levels of protection being used at the site, and may be used as the basis for upgrading or downgrading the levels of protection in conformance with action levels provided in this HASP and at the direction of the site HSO.

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2. HNU IS101 or Photovac TIP Photoionization Detector

If the OVA detects a steady measurable quantity of organic vapors greater than 5 ppm (above background conditions) in the breathing zone, the field team will withdraw from the Site until health and safety conditions at the site are reevaluated.

3.2.4.2 **Personal Monitoring** All personnel on-site will be enrolled in the ABB-ES medical surveillance program. In addition, all personnel on-site will wear a thermoluminescent dosimetry body badge to measure possible exposure to radiation.

4.0 DATA SHEETS FOR INVESTIGATIVE SET 1

BENZENE

ENZ

Common Synonyms	Watery liquid	Colorless	Gasoline-like odor
Benzol Benzole	Floats on water. Flammable, irritating vapor is produced. Freezing point is 42°F.		

Avoid contact with liquid and vapor. Keep people away.
Wear goggles and self-contained breathing apparatus.
Shut off ignition sources and call fire department.
Stop discharge if possible.
Stay upwind and use water spray to "knock down" vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

FLAMMABLE.
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Wear goggles and self-contained breathing apparatus.
Extinguish with dry chemical, foam, or carbon dioxide.
Water may be ineffective on fire.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause headache, difficult breathing, or loss of consciousness.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to skin and eyes.
Harmful if swallowed.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.

Water Pollution

HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS.
May be dangerous if it enters water intakes.

Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Issue warning-high flammability
Restrict access

2. LABEL

2.1 Category: Flammable liquid
2.2 Class: 3

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Aromatic Hydrocarbon
3.2 Formula: C_6H_6
3.3 IMO/UN Designation: 3.2/1114
3.4 DOT ID No.: 1114
3.5 CAS Registry No.: 71-43-2

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Aromatic, rather pleasant aromatic odor; characteristic odor

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Hydrocarbon vapor canister, supplied air or a hose mask; hydrocarbon-insoluble rubber or plastic gloves; chemical goggles or face splash shield; hydrocarbon-insoluble apron such as neoprene.
5.2 Symptoms Following Exposure: Dizziness, excitation, pallor, followed by flushing, weakness, headache, breathlessness, chest constriction. Coma and possible death.
5.3 Treatment of Exposure: SKIN: flush with water followed by soap and water, remove contaminated clothing and wash skin. EYES: flush with plenty of water until irritation subsides. INHALATION: remove from exposure immediately. Call a physician. IF breathing is irregular or stopped, start resuscitation, administer oxygen.
5.4 Threshold Limit Value: 10 ppm
5.5 Short Term Inhalation Limits: 75 ppm for 30 min.
5.6 Toxicity by Ingestion: Grade 3, LD_{50} = 50 to 500 mg/kg
5.7 Late Toxicity: Leukemia
5.8 Vapor (Gas) Irritant Characteristics: If present in high concentrations, vapors may cause irritation of eyes or respiratory system. The effect is temporary.
5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 Odor Threshold: 4.68 ppm
5.11 IDLH Value: 2,000 ppm

6. FIRE HAZARDS

6.1 Flash Point: 12°F C.C.
6.2 Flammable Limits in Air: 1.3%-7.5%
6.3 Fire Extinguishing Agents: Dry chemical, foam, or carbon dioxide
6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective
6.5 Special Hazards of Combustion Products: Not pertinent
6.6 Behavior in Fire: Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back
6.7 Ignition Temperature: 1097°F
6.8 Electrical Hazard: Class I, Group D
6.9 Burning Rate: 6.0 mm/min.
6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: No reaction
7.2 Reactivity with Common Materials: No reaction
7.3 Stability During Transport: Stable
7.4 Neutralizing Agents for Acids and Caustics: Not pertinent
7.5 Polymerization: Not pertinent
7.6 Inhibitor of Polymerization: Not pertinent
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: 32

8. WATER POLLUTION

8.1 Aquatic Toxicity:
5 ppm/6 hr/minnow/lethal/distilled water
20 ppm/24 hr/sunfish/TL_m/tap water
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): 1.2 lb/lb, 10 days
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

9.1 Grades of Purity:
Industrial pure _____99 + %
Thiophene-free _____99 + %
Nitration _____99 + %
Industrial 90% _____85 + %
Reagent _____99 + %
9.2 Storage Temperature: Open
9.3 Inert Atmosphere: No requirement
9.4 Venting: Pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-T-U-V-W

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Flammable liquid
11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	3
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	3
Water Pollution	
Human Toxicity	3
Aquatic Toxicity	1
Aesthetic Effect	3
Reactivity	
Other Chemicals	2
Water	1
Self Reaction	0

11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	3
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 78.11
12.3 Boiling Point at 1 atm: 176°F = 80.1°C = 353.2°K
12.4 Freezing Point: 42.0°F = 5.5°C = 278.7°K
12.5 Critical Temperature: 552.0°F = 288.9°C = 562.1°K
12.6 Critical Pressure: 710 psia = 48.2 atm = 4.85 MN/m²
12.7 Specific Gravity: 0.879 at 20°C (liquid)
12.8 Liquid Surface Tension: 28.8 dynes/cm = 0.0288 N/m at 20°C
12.9 Liquid Water Interfacial Tension: 35.0 dynes/cm = 0.035 N/m at 20°C
12.10 Vapor (Gas) Specific Gravity: 2.7
12.11 Ratio of Specific Heats of Vapor (Gas): 1.061
12.12 Latent Heat of Vaporization: 165 Btu/lb = 94.1 cal/g = 3.94 × 10⁴ J/kg
12.13 Heat of Combustion: −17,460 Btu/lb = −9696 cal/g = −406.0 × 10⁴ J/kg
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.17 Heat of Fusion: 30.45 cal/g
12.18 Limiting Value: Data not available
12.19 Reid Vapor Pressure: 3.22 psia

NOTES

ETHYLBENZENE

ETB

Common Synonyms	Liquid	Colorless	Sweet, gasoline-like odor
Phenylethane EB	Floats on water. Flammable, irritating vapor is produced.		

Avoid contact with liquid and vapor. Keep people away.
Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves).
Shut off ignition sources and call fire department.
Stop discharge if possible.
Stay upwind and use water spray to knock down vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

FLAMMABLE.
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves).
Extinguish with dry chemical, foam, or carbon dioxide.
Water may be ineffective on fire.
Cool exposed containers with water.

Exposure

[illegible]

VAPOR
Irritating to eyes, nose and throat.
Exposure will cause dizziness or difficult breathing.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Will burn skin and eyes.
Harmful if swallowed.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.
DO NOT INDUCE VOMITING.

Water Pollution

HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS.
Floating to shoreline.
May be dangerous if it enters water intakes.
Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Mechanical containment
Should be removed
Chemical and physical treatment

2. LABEL

2.1 Category: Flammable liquid
2.2 Class: 3

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Aromatic hydrocarbon
3.2 Formula: $C_6H_5CH_2CH_3$
3.3 IMO/UN Designation: 3.3/1175
3.4 DOT ID No.: 1175
3.5 CAS Registry No.: 100-41-4

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Aromatic

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Self-contained breathing apparatus; safety goggles.
5.2 Symptoms Following Exposure: Inhalation may cause irritation of nose, dizziness, depression. Moderate irritation of eye with corneal injury possible. Irritates skin and may cause blisters.
5.3 Treatment of Exposure: INHALATION: if ill effects occur, remove victim to fresh air, keep him warm and quiet, and get medical help promptly; if breathing stops, give artificial respiration. INGESTION: induce vomiting only upon physician's approval; material in lung may cause chemical pneumonitis. SKIN AND EYES: promptly flush with plenty of water (15 min. for eyes) and get medical attention; remove and wash contaminated clothing before reuse.
5.4 Threshold Limit Value: 100 ppm
5.5 Short Term Inhalation Limits: 200 ppm for 30 min.
5.6 Toxicity by Ingestion: Grade 2; LD_{50} = 0.5 to 5 g/kg (rat)
5.7 Late Toxicity: Data not available
5.8 Vapor (Gas) Irritant Characteristics: Vapors cause moderate irritation such that personnel will find high concentrations unpleasant. The effect is temporary.
5.9 Liquid or Solid Irritant Characteristics: Causes smarting of the skin and first-degree burns on short exposure; may cause secondary burns on long exposure.
5.10 Odor Threshold: 140 ppm
5.11 IDLH Value: 2,000 ppm

6. FIRE HAZARDS

6.1 Flash Point: 60°F O.C.; 59°F C.C.
6.2 Flammable Limits in Air: 1.0%-6.7%
6.3 Fire Extinguishing Agents: Foam (most effective), water fog, carbon dioxide or dry chemical.
6.4 Fire Extinguishing Agents Not to be Used: Not pertinent
6.5 Special Hazards of Combustion Products: Irritating vapors are generated when heated.
6.6 Behavior in Fire: Vapor is heavier than air and may travel considerable distance to the source of ignition and flash back.
6.7 Ignition Temperature: 860°F
6.8 Electrical Hazard: Not pertinent
6.9 Burning Rate: 5.8 mm/min
6.10 Adiabatic Flame Temperature: Data Not Available

(Continued)

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: No reaction
7.2 Reactivity with Common Materials: No reaction
7.3 Stability During Transport: Stable
7.4 Neutralizing Agents for Acids and Caustics: Not pertinent
7.5 Polymerization: Not pertinent
7.6 Inhibitor of Polymerization: Not pertinent
7.7 Molar Ratio (Reactant to Product): Data Not Available
7.8 Reactivity Group: 32

8. WATER POLLUTION

8.1 Aquatic Toxicity: 29 ppm/96 hr/bluegill/TL_m/fresh water
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): 2.8% (theor.), 5 days
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

9.1 Grades of Purity: Research grade: 99.98%; pure grade: 99.5%; technical grade: 99.0%
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Open (flame arrester) or pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-T-U

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Flammable liquid
11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	3
Health	
Vapor Irritant	2
Liquid or Solid Irritant	2
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	3
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	0

11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	3
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 106.17
12.3 Boiling Point at 1 atm: 277.2°F = 136.2°C = 409.4°K
12.4 Freezing Point: −139°F = −95°C = 178°K
12.5 Critical Temperature: 651.0°F = 343.9°C = 617.1°K
12.6 Critical Pressure: 523 psia = 35.6 atm = 3.61 MN/m²
12.7 Specific Gravity: 0.867 at 20°C (liquid)
12.8 Liquid Surface Tension: 29.2 dynes/cm = 0.0292 N/m at 20°C
12.9 Liquid Water Interfacial Tension: 35.48 dynes/cm = 0.03548 N/m at 20°C
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): 1.071
12.12 Latent Heat of Vaporization: 144 Btu/lb = 80.1 cal/g = 3.35 X 10⁵ J/kg
12.13 Heat of Combustion: −17,780 Btu/lb = −9877 cal/g = −41.3 X 10⁵ J/kg
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: Data Not Available
12.26 Limiting Value: Data Not Available
12.27 Reid Vapor Pressure: 0.4 psia

6. FIRE HAZARDS (Continued)

6.11 Stoichiometric Air to Fuel Ratio: Data Not Available
6.12 Flame Temperature: Data Not Available

TOLUENE

TOL

Common Synonyms	Watery liquid	Colorless	Pleasant odor
Toluol Methylbenzene Methylbenzol	Floats on water. Flammable, irritating vapor is produced.		

Stop discharge if possible. Keep people away.
Shut off ignition sources and call fire department.
Stay upwind and use water spray to "knock down" vapor.
Avoid contact with liquid and vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

FLAMMABLE.
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Wear goggles and self-contained breathing apparatus.
Extinguish with dry chemical, foam, or carbon dioxide.
Water may be ineffective on fire.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause nausea, vomiting, headache, dizziness, difficult breathing, or loss of consciousness.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing difficult, give oxygen.

LIQUID
Irritating to skin and eyes.
If swallowed, will cause nausea, vomiting or loss of consciousness.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.
DO NOT INDUCE VOMITING.

Water Pollution

Dangerous to aquatic life in high concentrations.
Fouling to shorelines.
May be dangerous if it enters water intakes.

Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Issue warning-high flammability
Evacuate area

2. LABEL

2.1 Category: Flammable liquid
2.2 Class: 3

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Aromatic Hydrocarbon
3.2 Formula: $C_6H_5CH_3$
3.3 IMO/UN Designation: 3.2/1294
3.4 DOT ID No.: 1294
3.5 CAS Registry No.: 108-88-3

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Pungent aromatic, benzene-like; distinct, pleasant

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Air-supplied mask; goggles or face shield; plastic gloves.
5.2 Symptoms Following Exposure: Vapors irritate eyes and upper respiratory tract, cause dizziness, headache, anesthesia, respiratory arrest. Liquid irritates eyes and causes drying of skin. If aspirated, causes coughing, gagging, distress, and rapidly developing pulmonary edema. If ingested causes vomiting, gaping, diarrhea, depressed respiration.
5.3 Treatment of Exposure: INHALATION: remove to fresh air, give artificial respiration and oxygen if needed; call a doctor. INGESTION: do NOT induce vomiting; call a doctor. EYES: flush with water for at least 15 min. SKIN: wipe off, wash with soap and water.
5.4 Threshold Limit Value: 100 ppm
5.5 Short Term Inhalation Limits: 600 ppm for 30 min.
5.6 Toxicity by Ingestion: Grade 2, LD_{50} = 0.5 to 5 g/kg
5.7 Late Toxicity: Kidney and liver damage may follow ingestion.
5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.
5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 Odor Threshold: 0.17 ppm
5.11 IDLH Value: 2,000 ppm

6. FIRE HAZARDS

6.1 Flash Point: 40°F C.C.; 55°F O.C.
6.2 Flammable Limits in Air: 1.27%-7%
6.3 Fire Extinguishing Agents: Carbon dioxide or dry chemical for small fires, ordinary foam for large fires.
6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective
6.5 Special Hazards of Combustion Products: Not pertinent
6.6 Behavior in Fire: Vapor is heavier than air and may travel a considerable distance to a source of ignition and flash back.
6.7 Ignition Temperature: 997°F
6.8 Electrical Hazard: Class I, Group D
6.9 Burning Rate: 5.7 mm/min.
6.10 Adiabatic Flame Temperature: Data not available

(Continued)

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: No reaction
7.2 Reactivity with Common Materials: No reaction
7.3 Stability During Transport: Stable
7.4 Neutralizing Agents for Acids and Caustics: Not pertinent
7.5 Polymerization: Not pertinent
7.6 Inhibitor of Polymerization: Not pertinent
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: 32

8. WATER POLLUTION

8.1 Aquatic Toxicity: 1180 mg/l/96 hr/sunfish/TL_m/fresh water
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): 0%, 5 days; 38% (theor), 5 days
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

9.1 Grades of Purity: Research, reagent, nitration-all 99.8 + %; industrial: contains 94 + %, with 5% xylene and small amounts of benzene and nonaromatic hydrocarbons; 90/120: less pure than industrial.
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Open (flame arrester) or pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-T-U

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Flammable liquid
11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	3
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	3
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	0

11.3 NFPA Hazard Classifications:

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	3
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 92.14
12.3 Boiling Point at 1 atm: 231.1°F = 110.6°C = 383.8°K
12.4 Freezing Point: −139°F = −95.0°C = 178.2°K
12.5 Critical Temperature: 605.4°F = 318.6°C = 591.8°K
12.6 Critical Pressure: 596.1 psia = 40.55 atm = 4.108 MN/m²
12.7 Specific Gravity: 0.867 at 20°C (liquid)
12.8 Liquid Surface Tension: 28.0 dynes/cm = 0.0280 N/m at 20°C
12.9 Liquid Water Interfacial Tension: 36.1 dynes/cm = 0.0361 N/m at 25°C
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): 1.089
12.12 Latent Heat of Vaporization: 155 Btu/lb = 86.1 cal/g = 3.61 X 10⁵ J/kg
12.13 Heat of Combustion: −17,430 Btu/lb = −9686 cal/g = −405.5 X 10⁵ J/kg
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.17 Heat of Fusion: 17.17 cal/g
12.18 Limiting Value: Data not available
12.19 Reid Vapor Pressure: 1.1 psia

6. FIRE HAZARDS (Continued)

6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

m-XYLENE

XLM

Common Synonyms			
3-Dimethylbenzene ,yol	Watery liquid	Colorless	Sweet odor
	Floats on water. Flammable, irritating vapor is produced.		

Stop discharge if possible. Keep people away.
Call fire department.
Avoid contact with liquid and vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

FLAMMABLE
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Wear self-contained breathing apparatus.
Extinguish with foam, dry chemical, or carbon dioxide.
Water may be ineffective on fire.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes, nose, and throat.
If inhaled, will cause headache, difficult breathing, or loss of consciousness.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to skin and eyes.
If swallowed, will cause nausea, vomiting, or loss of consciousness.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.
DO NOT INDUCE VOMITING.

Water Pollution

HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS.
Fouling to shoreline.
May be dangerous if in drinking water intakes.

Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Issue warning-high flammability
Evacuate area
Should be removed
Chemical and physical treatment

2. LABEL

2.1 Category: Flammable liquid
2.2 Class: 3

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Aromatic Hydrocarbon
3.2 Formula: $m\text{-}C_6H_4(CH_3)_2$
3.3 IMO/UN Designation: 3.2/1307
3.4 DOT ID No.: 1307
3.5 CAS Registry No.: 108-38-3

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Like benzene; characteristic aromatic

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Approved canister or air-supplied mask; goggles or face shield; plastic gloves and boots.
5.2 Symptoms Following Exposure: Vapors cause headache and dizziness. Liquid irritates eyes and skin. If taken into lungs, causes severe coughing, distress, and rapidly developing pulmonary edema. If ingested, causes nausea, vomiting, cramps, headache, and coma; can be fatal. Kidney and liver damage can occur.
5.3 Treatment of Exposure: INHALATION: remove to fresh air; administer artificial respiration and oxygen if required; call a doctor. INGESTION: do NOT induce vomiting; call a doctor. EYES: flush with water for at least 15 min. SKIN: wipe off, wash with soap and water.
5.4 Threshold Limit Value: 100 ppm
5.5 Short Term Inhalation Limits: 300 ppm for 30 min.
5.6 Toxicity by Ingestion: Grade 3; LD_{50} = 50 to 500 g/kg
5.7 Late Toxicity: Kidney and liver damage.
5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.
5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 Odor Threshold: 0.05 ppm
5.11 IDLH Value: 10,000 ppm

6. FIRE HAZARDS

6.1 Flash Point: 84°F C.C.
6.2 Flammable Limits in Air: 1.1%-6.4%
6.3 Fire Extinguishing Agents: Foam, dry chemical, or carbon dioxide
6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective.
6.5 Special Hazards of Combustion Products: Not pertinent
6.6 Behavior in Fire: Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back.
6.7 Ignition Temperature: 996°F
6.8 Electrical Hazard: Class I, Group D
6.9 Burning Rate: 5.8 mm/min.
6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: No reaction
7.2 Reactivity with Common Materials: No reaction
7.3 Stability During Transport: Stable
7.4 Neutralizing Agents for Acids and Caustics: Not pertinent
7.5 Polymerization: Not pertinent
7.6 Inhibitor of Polymerization: Not pertinent
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: 33

8. WATER POLLUTION

8.1 Aquatic Toxicity: 22 ppm/96 hr/bluegill/TL_m/fresh water
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): 0 lb/lb, 5 days; 0% (theor.), 8 days
8.4 Food Chain Concentration Potential: Data not available

9. SHIPPING INFORMATION

9.1 Grades of Purity: Research: 99.99%; Pure: 99.9%; Technical: 99.2%
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Open (flame arrester) or pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-T-U

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Flammable liquid
11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	3
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	3
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	0

11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	3
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 106.16
12.3 Boiling Point at 1 atm: 266.4°F = 131.9°C = 405.1°K
12.4 Freezing Point: −54.2°F = −47.9°C = 225.3°K
12.5 Critical Temperature: 650.8°F = 343.8°C = 617.0°K
12.6 Critical Pressure: 513.8 atm = 34.95 psia = 3.540 MN/m^2
12.7 Specific Gravity: 0.864 at 20°C (liquid)
12.8 Liquid Surface Tension: 28.6 dynes/cm = 0.0286 N/m at 20°C
12.9 Liquid Water Interfacial Tension: 36.4 dynes/cm = 0.0364 N/m at 30°C
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): 1.071
12.12 Latent Heat of Vaporization: 147 Btu/lb = 81.9 cal/g = 3.43 X 10^5 J/kg
12.13 Heat of Combustion: −17,554 Btu/lb = −9752.4 cal/g = −408.31 X 10^5 J/kg
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: 26.01 cal/g
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: 0.34 psia

NOTES

o-XYLENE

XLO

Common Synonyms	Watery liquid	Colorless	Sweet odor
1,2-Dimethylbenzene Xylol	Floats on water. Flammable, irritating vapor is produced.		

Stop discharge if possible. Keep people away.
Call fire department.
Avoid contact with liquid and vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

FLAMMABLE
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Wear self-contained breathing apparatus.
Extinguish with foam, dry chemical, or carbon dioxide.
Water may be ineffective on fire.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause headache, difficult breathing, or loss of consciousness.
Move to fresh air.
If breathing has stopped give artificial respiration.
If breathing is difficult give oxygen.

LIQUID
Irritating to skin and eyes.
If swallowed, will cause nausea, vomiting, or loss of consciousness.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.
DO NOT INDUCE VOMITING.

Water Pollution

Dangerous to aquatic life in high concentrations.
Fouling to shoreline.
May be dangerous if it enters water intakes.

Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)
Issue warning-high flammability
Evacuate area
Should be removed
Chemical and physical treatment

2. LABEL

2.1 Category: Flammable liquid
2.2 Class: 3

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Aromatic Hydrocarbon
3.2 Formula: $o\text{-}C_6H_4(CH_3)_2$
3.3 IMO/UN Designation: 3.2/1307
3.4 DOT ID No.: 1307
3.5 CAS Registry No.: 95-47-6

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Benzene-like; characteristic aromatic

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Approved canister or air-supplied mask; goggles or face shield; plastic gloves and boots.
5.2 Symptoms Following Exposure: Vapors cause headache and dizziness. Liquid irritates eyes and skin. If taken into lungs, causes severe coughing, distress, and rapidly developing pulmonary edema. If ingested, causes nausea, vomiting, cramps, headache, and coma. Can be fatal. Kidney and liver damage can occur.
5.3 Treatment of Exposure: INHALATION: remove to fresh air; administer artificial respiration and oxygen if required; call a doctor. INGESTION: do NOT induce vomiting; call a doctor. EYES: flush with water for at least 15 min. SKIN: wipe off, wash with soap and water.
5.4 Threshold Limit Value: 100 ppm
5.5 Short Term Inhalation Limits: 300 ppm for 30 min.
5.6 Toxicity by Ingestion: Grade 3; LD_{50} = 50 to 500 mg/kg
5.7 Late Toxicity: Kidney and liver damage.
5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.
5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 Odor Threshold: 0.05 ppm
5.11 IDLH Value: 10,000 ppm

6. FIRE HAZARDS

6.1 Flash Point: 63°F C.C.; 75°F O.C.
6.2 Flammable Limits in Air: 1.1%-7.0%
6.3 Fire Extinguishing Agents: Foam, dry chemical, or carbon dioxide
6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective.
6.5 Special Hazards of Combustion Products: Not pertinent
6.6 Behavior in Fire: Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back.
6.7 Ignition Temperature: 865°F
6.8 Electrical Hazard: Class I, Group D
6.9 Burning Rate: 5.8 mm/min.
6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: No reaction
7.2 Reactivity with Common Materials: No reaction
7.3 Stability During Transport: Stable
7.4 Neutralizing Agents for Acids and Caustics: Not pertinent
7.5 Polymerization: Not pertinent
7.6 Inhibitor of Polymerization: Not pertinent
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: 32

8. WATER POLLUTION

8.1 Aquatic Toxicity: > 100 mg/l/96 hr/D. magna/TL_m/fresh water
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): 0 lb/lb, 5 days; 2.5% (theor.), 2 days
8.4 Food Chain Concentration Potential: Data not available

9. SHIPPING INFORMATION

9.1 Grades of Purity: Research: 99.99%; Pure: 99.7%; Commercial: 95 – %
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No reaction
9.4 Venting: Open (flame arrester) or pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)
A-T-U

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Flammable liquid
11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	3
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	3
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	0

11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	3
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 106.16
12.3 Boiling Point at 1 atm: 291.9°F = 144.4°C = 417.6°K
12.4 Freezing Point: −13.3°F = −25.2°C = 248.0°K
12.5 Critical Temperature: 674.8°F = 357.1°C = 630.3°K
12.6 Critical Pressure: 541.5 atm = 36.84 psa = 3.732 MN/m²
12.7 Specific Gravity: 0.880 at 20°C (liquid)
12.8 Liquid Surface Tension: 30.53 dynes/cm = 0.03053 N/m at 15.5°C
12.9 Liquid Water Interfacial Tension: 36.06 dynes/cm = 0.03606 N/m at 20°C
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): 1.066
12.12 Latent Heat of Vaporization: 149 Btu/lb = 82.5 cal/g = 3.47 X 10⁵ J/kg
12.13 Heat of Combustion: −17,558 Btu/lb = −9754.7 cal/g = −408.41 X 10⁵ J/kg
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.17 Heat of Fusion: 30.64 cal/g
12.18 Limiting Value: Data not available
12.19 Reid Vapor Pressure: 0.25 psa

NOTES

p-XYLENE

XLP

Common Synonyms	Watery liquid	Colorless	Sweet odor
1, 4-Dimethylbenzene Xylol	Floats on water. Flammable. Irritating vapor is produced. *Freezing point is 56°F.*		

Stop discharge if possible. Keep people away.
Call fire department.
Avoid contact with liquid and vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

FLAMMABLE
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Wear self-contained breathing apparatus.
Extinguish with foam, dry chemical, or carbon dioxide.
Water may be ineffective on fire.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause dizziness, difficult breathing, or loss of consciousness.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to skin and eyes.
If swallowed, will cause nausea, vomiting, loss of consciousness.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.
DO NOT INDUCE VOMITING.

Water Pollution

HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS.
Floating to shoreline.
May be dangerous if it enters water intakes.

Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Issue warning-high flammability
Evacuate area
Should be removed
Chemical and physical treatment

2. LABEL

2.1 Category: Flammable liquid
2.2 Class: 3

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Aromatic Hydrocarbon
3.2 Formula: $p\text{-}C_6H_4(CH_3)_2$
3.3 IMO/UN Designation: 3.2/1307
3.4 DOT ID No.: 1307
3.5 CAS Registry No.: 106-42-3

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Like benzene; characteristic aromatic

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Approved canister or air-supplied mask; goggles or face shield; plastic gloves and boots.
5.2 Symptoms Following Exposure: Vapors cause headache and dizziness. Liquid irritates eyes and skin. If taken into lungs, causes severe coughing, distress, and rapidly developing pulmonary edema. If ingested, causes nausea, vomiting, cramps, headache, and coma. Can be fatal. Kidney and liver damage can occur.
5.3 Treatment of Exposure: INHALATION: remove to fresh air; administer artificial respiration and oxygen if required; call a doctor. INGESTION: do NOT induce vomiting; call a doctor. EYES: flush with water for at least 15 min. SKIN: wipe off, wash with soap and water.
5.4 Threshold Limit Value: 100 ppm
5.5 Short Term Inhalation Limits: 300 ppm for 30 min.
5.6 Toxicity by Ingestion: Grade 3; LD_{50} = 50 to 500 mg/kg
5.7 Late Toxicity: Kidney and liver damage.
5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.
5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 Odor Threshold: 0.05 ppm
5.11 IDLH Value: 10,000 ppm

6. FIRE HAZARDS

6.1 Flash Point: 81°F C.C.
6.2 Flammable Limits in Air: 1.1% to 6%
6.3 Fire Extinguishing Agents: Foam, dry chemical, or carbon dioxide
6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective.
6.5 Special Hazards of Combustion Products: Not pertinent
6.6 Behavior in Fire: Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back.
6.7 Ignition Temperature: 870°F
6.8 Electrical Hazard: Class I, Group D
6.9 Burning Rate: 5.8 mm/min.
6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: No reaction
7.2 Reactivity with Common Materials: No reaction
7.3 Stability During Transport: Stable
7.4 Neutralizing Agents for Acids and Caustics: Not pertinent
7.5 Polymerization: Not pertinent
7.6 Inhibitor of Polymerization: Not pertinent
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: 32

8. WATER POLLUTION

8.1 Aquatic Toxicity: 22 ppm/96 hr/bluegill/TL_m/fresh water
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): 0 lb/lb in 5 days
8.4 Food Chain Concentration Potential: Data not available

9. SHIPPING INFORMATION

9.1 Grades of Purity: Research: 99.99%; Pure: 99.8%; Technical: 99.0%
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Open (flame arrester) or pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-T-U

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Flammable liquid
11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	3
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	3
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	0

11.3 NFPA Hazard Classifications:

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	3
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 106.16
12.3 Boiling Point at 1 atm: 280.9°F = 138.3°C = 411.5°K
12.4 Freezing Point: 55.9°F = 13.3°C = 286.5°K
12.5 Critical Temperature: 649.4°F = 343.0°C = 616.2°K
12.6 Critical Pressure: 509.4 atm = 34.65 psia = 3.510 MN/m²
12.7 Specific Gravity: 0.861 at 20°C (liquid)
12.8 Liquid Surface Tension: 28.3 dynes/cm = 0.0283 N/m at 20°C
12.9 Liquid Water Interfacial Tension: 37.8 dynes/cm = 0.0378 N/m at 20°C
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): 1.071
12.12 Latent Heat of Vaporization: 150 Btu/lb = 81 cal/g = 3.4 X 10⁵ J/kg
12.13 Heat of Combustion: −17,559 Btu/lb = −9754.7 cal/g = −408.41 X 10⁵ J/kg
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.35 Heat of Fusion: 37.83 cal/g
12.36 Limiting Value: Data not available
12.37 Reid Vapor Pressure: 0.34 psia

NOTES

ANTHRACENE

ATH

Common Synonyms	Solid	White to yellow	Weak aromatic odor
Anthracin Paranaphthalene Green oil	Sinks in water.		

Stop discharge if possible. Avoid dust. Avoid contact with solid and dust. Isolate and remove discharged material. Notify local health and pollution control agencies.

Fire

Combustible.
Dust cloud may explode if ignited in an enclosed area.
Extinguish with water, dry chemicals, foam, or carbon dioxide.

Exposure

[illegible]

DUST
Irritating to eyes, nose and throat.
Exposure will cause coughing or difficult breathing.
If eyes are affected, flush eyes and lids with plenty of water.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

SOLID
Irritating to skin and eyes.
Harmful if swallowed.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES: hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS: have victim drink water or milk.
IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS: do nothing except keep victim warm.

Water Pollution

Effect of low concentrations on aquatic life is unknown.
May be dangerous if it enters water intakes.

Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Should be removed
Chemical and physical treatment

2. LABEL

2.1 Category: None
2.2 Class: Not pertinent

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Not listed
3.2 Formula: $C_{14}H_{10}$
3.3 IMO/UN Designation: Not listed
3.4 DOT ID No.: Data not available
3.5 CAS Registry No.: 120-12-7

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Solid
4.2 Color: White to yellow
4.3 Odor: Weak aromatic

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Dust mask; goggles or face shield, rubber gloves
5.2 Symptoms Following Exposure: Inhalation of dust irritates nose and throat. Contact with eyes causes irritation.
5.3 Treatment of Exposure: INHALATION: move to fresh air. EYES: flush with water for 15 min.
5.4 Threshold Limit Value: Data not available
5.5 Short Term Inhalation Limits: Data not available
5.6 Toxicity by Ingestion: Data not available
5.7 Late Toxicity: Data not available
5.8 Vapor (Gas) Irritant Characteristics: Data not available
5.9 Liquid or Solid Irritant Characteristics: Data not available
5.10 Odor Threshold: Data not available
5.11 IDLH Value: Data not available

6. FIRE HAZARDS

6.1 Flash Point: 250°F
6.2 Flammable Limits in Air: 0.6% LEL
6.3 Fire Extinguishing Agents: Water, foam, dry chemical, carbon dioxide
6.4 Fire Extinguishing Agents Not to be Used: Data not available
6.5 Special Hazards of Combustion Products: Data not available
6.6 Behavior in Fire: Data not available
6.7 Ignition Temperature: 1004°F
6.8 Electrical Hazard: Not pertinent
6.9 Burning Rate: Not pertinent
6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: No reaction
7.2 Reactivity with Common Materials: Data not available
7.3 Stability During Transport: Stable
7.4 Neutralizing Agents for Acids and Caustics: Not pertinent
7.5 Polymerization: Not pertinent
7.6 Inhibitor of Polymerization: Not pertinent
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: Data not available

8. WATER POLLUTION

8.1 Aquatic Toxicity: 5 ppm/24 hr/trout & bluegill/no effect
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): Data not available
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

9.1 Grades of Purity: Various fluorescence grades; Sensitization grade; Technical grade, 90-98%
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Open

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

II

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Not listed
11.2 NAS Hazard Rating for Bulk Water Transportation: Not listed
11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	0
Flammability (Red)	1
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Solid
12.2 Molecular Weight: 178.23
12.3 Boiling Point at 1 atm: 646.2°F = 341.2°C = 614.4°K
12.4 Freezing Point: 421.7°F = 216.5°C = 489.7°K
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 1.24 at 20°C (solid)
12.8 Liquid Surface Tension: Not pertinent
12.9 Liquid Water Interfacial Tension: Not pertinent
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): Not pertinent
12.12 Latent Heat of Vaporization: Not pertinent
12.13 Heat of Combustion: -17,100 Btu/lb = -8,510 cal/g = -356 X 10^3 J/kg
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: 36.70 cal/g
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: Data not available

NOTES

TETRAETHYL LEAD

TEL

Common Synonyms	Oily liquid	Colorless, but generally dyed red	Fruity odor
TEL Lead tetraethyl	Sinks in water. Poisonous. Flammable vapor is produced.		

AVOID CONTACT WITH LIQUID AND VAPOR. Keep people away.
Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves).
Stop discharge if possible.
Call fire department.
Stay upwind and use water spray to "knock down" vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

Combustible.
POISONOUS GASES ARE PRODUCED IN FIRE.
Containers may explode in fire.
Vapor may explode if ignited in an enclosed area.
Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves).
Combat fires from behind barrier or protected location.
Flood discharge area with water.
Extinguish with water, dry chemical, foam, or carbon dioxide.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.

VAPOR
POISONOUS IF INHALED OR IF SKIN IS EXPOSED.
Irritating to eyes.
Move to fresh air.
If breathing has ceased, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
POISONOUS IF SWALLOWED OR IF SKIN IS EXPOSED.
Will burn eyes.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk and have victim induce vomiting.
IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS, do nothing except keep victim warm.

Water Pollution

HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS.
May be dangerous if it enters water intakes.

Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Issue warning-poison.
water contaminant
Restrict access
Should be removed
Chemical and physical treatment

2. LABEL

2.1 Category: Poison
2.2 Class: 6

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Not listed
3.2 Formula: $Pb(C_2H_5)_4$
3.3 IMO/UN Designation: 6.1/1649
3.4 DOT ID No.: 1649
3.5 CAS Registry No.: 78-00-2

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Dyed red or other distinctive color.
4.3 Odor: Sweet

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Organic vapor type canister face mask for short periods; air line type for longer periods; neoprene-coated, liquid-proof gloves; protective goggles or face shield; white or light-colored clothing; rubber shoes or boots.
5.2 Symptoms Following Exposure: Increased urinary output of lead. If a large degree of absorption from inhalation or skin contact, may cause insomnia, excitability, delirium, coma and death. Do not confuse with inorganic lead.
5.3 Treatment of Exposure: Remove victim from contaminated area and consult physician immediately. INGESTION: induce vomiting. SKIN: wash immediately with kerosene or similar petroleum distillate followed by soap and water.
5.4 Threshold Limit Value: 0.1 mg/m³
5.5 Short Term Inhalation Limits: 0.15 mg Pb/m³ for 30 min.
5.6 Toxicity by Ingestion: Oral rat LD_{50} = 17 mg/kg
5.7 Late Toxicity: Lead poisoning
5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.
5.9 Liquid or Solid Irritant Characteristics: Causes smarting of the skin and first-degree burns on short exposure; may cause secondary burns on long exposure.
5.10 Odor Threshold: Data not available
5.11 IDLH Value: 40 mg/m³

6. FIRE HAZARDS

6.1 Flash Point: 200°F C.C.; 185°F O.C.
6.2 Flammable Limits in Air: Data not available
6.3 Fire Extinguishing Agents: Water, foam, dry chemical, or carbon dioxide
6.4 Fire Extinguishing Agents Not to be Used: Not pertinent
6.5 Special Hazards of Combustion Products: Toxic gases are generated in fires.
6.6 Behavior in Fire: May explode in fires.
6.7 Ignition Temperature: Decomposes above 230°F
6.8 Electrical Hazard: Not pertinent
6.9 Burning Rate: Data not available
6.10 Adiabatic Flame Temperature: Data not available

(Continued)

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: No reaction
7.2 Reactivity with Common Materials: Rust and some metals cause decomposition.
7.3 Stability During Transport: Stable below 230°F. At higher temperatures, may polymerize or explode when confined.
7.4 Neutralizing Agents for Acids and Caustics: Not pertinent
7.5 Polymerization: Not pertinent
7.6 Inhibitor of Polymerization: Not pertinent
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: Data not available

8. WATER POLLUTION

8.1 Aquatic Toxicity: 0.20 mg/l/96 hr/bluegill/TL_m/fresh water
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): Data not available
8.4 Food Chain Concentration Potential: Data not available

9. SHIPPING INFORMATION

9.1 Grades of Purity: Technical
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-X-Y

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Poison B
11.2 NAS Hazard Rating for Bulk Water Transportation: Not listed
11.3 NFPA Hazard Classification

Category	Classification
Health Hazard (Blue)	3
Flammability (Red)	2
Reactivity (Yellow)	3

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 323.44
12.3 Boiling Point at 1 atm: Decomposes
12.4 Freezing Point: −215°F = −137°C = 136°K
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 1.653 at 20°C (liquid)
12.8 Liquid Surface Tension: 28.5 dynes/cm = 0.0285 N/m at (est.) 25°C
12.9 Liquid Water Interfacial Tension: (est.) 40 dynes/cm = 0.04 N/m at 20°C
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): Not pertinent
12.12 Latent Heat of Vaporization: Not pertinent
12.13 Heat of Combustion (est.) −7,870 Btu/lb = −4,380 cal/g = −1.83 X 10⁷ J/kg
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: Data not available
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: Data not available

6. FIRE HAZARDS (Continued)

6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

CHLOROBENZENE

CRB

Common Synonyms

Monochlorobenzene
Phenyl chloride
Benzene chloride
MCB

Watery liquid — Colorless — Sweet almond odor

Sinks in water. Flammable vapor is produced.

Avoid contact with liquid and vapor. Keep people away.
Stop discharge if possible.
Call fire department.
Stay upwind and use water spray to "knock down" vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

FLAMMABLE
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Wear proper fire and self-contained breathing apparatus.
Extinguish with: dry chemical, foam, or carbon dioxide.

Exposure

CALL FOR MEDICAL AID.

VAPOR
If inhaled, will cause coughing or dizziness.
Not irritating to eyes, nose and throat.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to skin and eyes.
Harmful if swallowed.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eye open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.

Water Pollution

HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS.
May be dangerous if it enters water intakes.

Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Should be removed
Chemical and physical treatment

2. LABEL

2.1 Category: Flammable liquid
2.2 Class: 3

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Halogenated hydrocarbon
3.2 Formula: C_6H_5Cl
3.3 IMO/UN Designation: 3.3/1134
3.4 DOT ID No.: 1134
3.5 CAS Registry No.: 108-90-7

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Mild amine odor; sweet, almond-like; aromatic

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Organic vapor-acid gas respirator where appropriate; neoprene or vinyl gloves; chemical safety spectacles, plus face shield where appropriate; rubber footwear; apron or impervious clothing for splash protection; hard hat.
5.2 Symptoms Following Exposure: Irritating to skin, eyes and mucous membranes. Repeated exposure of skin may cause dermatitis due to defatting action. Chronic inhalation of vapors or mist may result in damage to lungs, liver, and kidneys. Acute vapor exposures can cause symptoms ranging from coughing to transient anesthesia and central nervous system depression.
5.3 Treatment of Exposure: Get medical attention for all eye exposures and any serious over-exposures. Treat the symptoms. INHALATION: remove to clean air; administer oxygen as needed. INGESTION: dilute by drinking water; if vomiting occurs, administer more water. Administer saline laxative. EYES: flush thoroughly with water. SKIN: remove contaminated clothing, wash exposed area with soap and water.
5.4 Threshold Limit Value: 75 ppm
5.5 Short Term Inhalation Limits: Data not available
5.6 Toxicity by Ingestion: Grade 2, LD_{50} = 0.5 to 5 g/kg (rat, rabbit)
5.7 Late Toxicity: Data not available
5.8 Vapor (Gas) Irritant Characteristics: Vapors are nonirritating to the eyes and throat.
5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 Odor Threshold: 0.21 ppm
5.11 IDLH Value: 2,400 ppm

6. FIRE HAZARDS

6.1 Flash Point: 84°F C.C.; 97°F O.C.
6.2 Flammable Limits in Air: 1.3%-7.1%
6.3 Fire Extinguishing Agents: Carbon dioxide, dry chemical, foam or water spray
6.4 Fire Extinguishing Agents Not to be Used: Not pertinent
6.5 Special Hazards of Combustion Products: Burning in open flame can form toxic phosgene and hydrogen chloride gases.
6.6 Behavior in Fire: Heavy vapor can travel a considerable distance to a source of ignition and flash back.
6.7 Ignition Temperature: 1184°F
6.8 Electrical Hazard: Data not available
6.9 Burning Rate: (est.) 4.8 mm/min.
6.10 Adiabatic Flame Temperature: Data not available

(Continued)

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: No reaction
7.2 Reactivity with Common Materials: No reaction
7.3 Stability During Transport: Stable
7.4 Neutralizing Agents for Acids and Caustics: Not pertinent
7.5 Polymerization: Not pertinent
7.6 Inhibitor of Polymerization: Not pertinent
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: 36

8. WATER POLLUTION

8.1 Aquatic Toxicity: 20 ppm/96 hr/bluegill/TL_m/fresh water
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): 0.3 lb/lb, 5 days
8.4 Food Chain Concentration Potential: Data not available

9. SHIPPING INFORMATION

9.1 Grades of Purity: 99.5%; technical
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-T-X

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Flammable liquid
11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	3
Health	
Vapor Irritant	0
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	3
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	0

11.3 NFPA Hazard Classifications:

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	3
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 18°C and 1 atm: Liquid
12.2 Molecular Weight: 112.56
12.3 Boiling Point at 1 atm: 27°F = 132°C = 405°K
12.4 Freezing Point: −50.1°F = −45.6°C = 227.6°K
12.5 Critical Temperature: 678°F = 359°C = 632°K
12.6 Critical Pressure: 656 psia = 44.6 atm = 4.52 MN/m²
12.7 Specific Gravity: 1.11 at 20°C (liquid)
12.8 Liquid Surface Tension: 33 dynes/cm = 0.033 N/m at 25°C
12.9 Liquid Water Interfacial Tension: 37.41 dynes/cm = 0.03741 N/m at 20°C
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): 1.064
12.12 Latent Heat of Vaporization: 125 Btu/lb = 75 cal/g = 3.140 X 10⁵ J/kg
12.13 Heat of Combustion: (est.) 12,000 Btu/lb = 6700 cal/g = 28.0 X 10⁶ J/kg
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: 20.40 cal/g
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: 0.5 psia

6. FIRE HAZARDS (Continued)

6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

o-DICHLOROBENZENE

DBO

Common Synonyms	Liquid	Colorless	Pleasant odor
1, 2-Dichlorobenzene Orthodichlorobenzene Dowtherm E	Sinks in water.		

Avoid contact with liquid.
Wear goggles and self-contained breathing apparatus.
Stop discharge if possible.
Call fire department.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

Combustible
POISONOUS GASES ARE PRODUCED IN FIRE.
Wear goggles and self-contained breathing apparatus.
Extinguish with water, dry chemical, foam, or carbon dioxide.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID

LIQUID
Irritating to skin and eyes.
Harmful if swallowed.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk and have victim induce vomiting.
IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS, do nothing except keep victim warm.

Water Pollution

Effect of low concentrations on aquatic life is unknown.
May be dangerous if it enters water intakes.

Notify local health and pollution control officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Issue warning-water contaminant
Should be removed
Chemical and physical treatment

2. LABEL

2.1 Category: None
2.2 Class: Not pertinent

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Halogenated hydrocarbon
3.2 Formula: $o\text{-}C_6H_4Cl_2$
3.3 IMO/UN Designation: 6.1/1591
3.4 DOT ID No.: 1591
3.5 CAS Registry No.: 95-50-1

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Aromatic characteristic

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Organic vapor-acid gas respirator; neoprene or vinyl gloves; chemical safety spectacles, face shield, rubber footwear, apron, protective clothing.

5.2 Symptoms Following Exposure: Chronic inhalation of mist or vapors may result in damage to lungs, liver, and kidneys. Acute vapor exposure can cause symptoms ranging from coughing to central nervous system depression and transient anesthesia. Irritating to skin, eyes, and mucous membranes. May cause dermatitis.

5.3 Treatment of Exposure: INHALATION: remove victim to fresh air, keep him quiet and warm, and call a physician promptly. INGESTION: no known antidote; treat symptomatically; induce vomiting and get medical attention promptly. EYES AND SKIN: flush with plenty of water; get medical attention for eyes; remove contaminated clothing and wash before reuse.

5.4 Threshold Limit Value: 50 ppm
5.5 Short Term Inhalation Limits: 50 ppm for 15 min.
5.6 Toxicity by Ingestion: Grade 2; LD_{50} = 0.5 to 5 g/kg
5.7 Late Toxicity: Causes kidney and liver damage in rats. Effects unknown in humans.
5.8 Vapor (Gas) Irritant Characteristics: Vapors cause moderate irritation such that personnel will find high concentrations unpleasant. The effect is temporary.
5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 Odor Threshold: 4.0 ppm; 50 ppm
5.11 IDLH Value: 1,700 ppm

6. FIRE HAZARDS

6.1 Flash Point: 165°F O.C.; 155°F C.C.
6.2 Flammable Limits in Air: 2.2%-9.2%
6.3 Fire Extinguishing Agents: Water, foam, dry chemical, or carbon dioxide
6.4 Fire Extinguishing Agents Not to be Used: Not pertinent
6.5 Special Hazards of Combustion Products: Irritating vapors including hydrogen chloride gas, chlorocarbons, chlorine
6.6 Behavior in Fire: Not pertinent
6.7 Ignition Temperature: 1198°F
6.8 Electrical Hazard: Not pertinent
6.9 Burning Rate: 1.3 mm/min.
6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: No reaction
7.2 Reactivity with Common Materials: No reaction
7.3 Stability During Transport: Stable
7.4 Neutralizing Agents for Acids and Caustics: Not pertinent
7.5 Polymerization: Not pertinent
7.6 Inhibitor of Polymerization: Not pertinent
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: 36

8. WATER POLLUTION

8.1 Aquatic Toxicity:
13 ppm/*/marine plankton/no gravity/salt water
*Time period not specified.
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): < 0.1% (Theor.), 1/8 day
8.4 Food Chain Concentration Potential: Data not available

9. SHIPPING INFORMATION

9.1 Grades of Purity: Technical: 99.5% min. dichlorobenzene (less ortho + para/meta: 80 min.) Technical: 85% orthodichlorobenzene, 14.0% paradichlorobenzene Technical: 82% ortho, 17% para, 2% meta Pure: not less than 99.5% ortho, not more than 0.5% para
9.2 Storage Temperature: Data not available
9.3 Inert Atmosphere: Data not available
9.4 Venting: Data not available

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-X-Y

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: ORM-A
11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	1
Health	
Vapor Irritant	2
Liquid or Solid Irritant	1
Poisons	1
Water Pollution	
Human Toxicity	3
Aquatic Toxicity	1
Aesthetic Effect	3
Reactivity	
Other Chemicals	2
Water	1
Self Reaction	0

11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	2
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 147.01
12.3 Boiling Point at 1 atm: 356.9°F = 180.5°C = 453.7°K
12.4 Freezing Point: 0.3°F = -17.6°C = 255.6°K
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 1.306 at 20°C (liquid)
12.8 Liquid Surface Tension: 37 dynes/cm = 0.037 N/m at 20°C
12.9 Liquid-Water Interfacial Tension: (est.) 40 dynes/cm = 0.04 N/m at 20°C
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): 1.080
12.12 Latent Heat of Vaporization: 115 Btu/lb = 63.5 cal/g = 2.66 X 10^5 J/kg
12.13 Heat of Combustion: −7965 Btu/lb = −4427 cal/g = −185.4 X 10^5 J/kg
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: 21.02 cal/g
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: 0.05 psia

NOTES

VINYL CHLORIDE

VCM

Common Synonyms	Gas	Colorless	Sweet odor
Chloroethylene VCL Vinyl C Monomer VCM	Liquid floats and boils on water. Flammable, irritating vapor cloud is produced.		

Stop discharge if possible. Keep people away.
Shut off ignition sources and call fire department.
Stay upwind and use water spray to "knock down" vapor.
Evacuate area in case of large discharge.
Avoid contact with liquid and vapor.
Notify local health and pollution control agencies.

Fire

FLAMMABLE.
POISONOUS GAS IS PRODUCED IN FIRE.
Flashback along vapor trail may occur.
May explode if ignited in an enclosed area.
Wear self-contained breathing apparatus.
Cool exposed containers and protect men attacking stubborn fire with water.
Stop flow of gas if possible.
Let fire burn.
Extinguish small fires with dry chemical.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes, nose, and throat.
If inhaled, will cause dizziness or difficult breathing.
Move to fresh air.
If breathing has stopped give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Will cause frostbite.
Flush affected areas with plenty of water.
DO NOT RUB AFFECTED AREAS.

Water Pollution

Not harmful to aquatic life.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Issue warning-high flammability
Evacuate area

2. LABEL

2.1 Category: Flammable gas
2.2 Class: 2

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Vinyl halides
3.2 Formula: $CH_2=CHCl$
3.3 IMO/UN Designation: 2.0/1086
3.4 DOT ID No.: 1086
3.5 CAS Registry No.: 75-01-4

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquefied compressed gas
4.2 Color: Colorless
4.3 Odor: Pleasant, sweet

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Rubber gloves and shoes; gas-tight goggles; organic vapor canister or self-contained breathing apparatus.
5.2 Symptoms Following Exposure: INHALATION: high concentrations cause dizziness, anesthesia, lung irritation. SKIN: may cause frostbite; phenol inhibitor may be absorbed through skin if large amounts of liquid evaporate.
5.3 Treatment of Exposure: INHALATION: remove patient to fresh air and keep him quiet; and warm; call a doctor; give artificial respiration if breathing stops. EYES AND SKIN: flush with plenty of water for at least 15 min.; for eyes, get medical attention; remove contaminated clothing.
5.4 Threshold Limit Value: 5 ppm
5.5 Short Term Inhalation Limits: 500 ppm for 5 min.
5.6 Toxicity by Ingestion: Not pertinent
5.7 Late Toxicity: Chronic exposure may cause liver damage.
5.8 Vapor (Gas) Irritant Characteristics: Vapors cause moderate irritation such that personnel will find high concentrations unpleasant. The effect is temporary.
5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of skin. May cause frostbite.
5.10 Odor Threshold: 260 ppm
5.11 IDLH Value: Data not available

6. FIRE HAZARDS

6.1 Flash Point: —110°F C.C.
6.2 Flammable Limits in Air: 4%-26%
6.3 Fire Extinguishing Agents: For small fires use dry chemical or carbon dioxide. For large fires stop flow of gas. Cool exposed containers with water.
6.4 Fire Extinguishing Agents Not to be Used: Not pertinent
6.5 Special Hazards of Combustion Products: Forms highly toxic combustion products such as hydrogen chloride, phosgene, and carbon monoxide.
6.6 Behavior in Fire: Container may explode in fire. Gas is heavier than air and may travel considerable distance to a source of ignition and flash back.
6.7 Ignition Temperature: 882°F
6.8 Electrical Hazard: Class I, Group D
6.9 Burning Rate: 4.3 mm/min.

(Continued)

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: No reaction
7.2 Reactivity with Common Materials: No reaction
7.3 Stability During Transport: Stable
7.4 Neutralizing Agents for Acids and Caustics: Not pertinent
7.5 Polymerization: Polymerizes in presence of air, sunlight, or heat unless stabilized by inhibitors.
7.6 Inhibitor of Polymerization: Not normally used except when high temperatures are expected. Then 40-100 ppm of phenol used.
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: 35

8. WATER POLLUTION

8.1 Aquatic Toxicity: None
8.2 Waterfowl Toxicity: None
8.3 Biological Oxygen Demand (BOD): None
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

9.1 Grades of Purity: Commercial or technical 99+ %
9.2 Storage Temperature: Under pressure; ambient At atm. pressure; low
9.3 Inert Atmosphere: No requirement
9.4 Venting: Under pressure; safety relief At atm. pressure; pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-B-C-D-E-F-G-Z

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Flammable gas
11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	4
Health	
Vapor Irritant	2
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	0
Aquatic Toxicity	0
Aesthetic Effect	0
Reactivity	
Other Chemicals	2
Water	0
Self Reaction	2

11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	4
Reactivity (Yellow)	1

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Gas
12.2 Molecular Weight: 62.50
12.3 Boiling Point at 1 atm: 7.2°F = 13.8°C = 259.4°K
12.4 Freezing Point: —244.8°F = —153.8°C = —119.4°K
12.5 Critical Temperature: 317.1°F = 158.4°C = 431.6°K
12.6 Critical Pressure: 775 psia = 52.7 atm = 5.34 MN/m²
12.7 Specific Gravity: 0.969 at —13°C (liquid)
12.8 Liquid Surface Tension: 18.0 dynes/cm = 0.0180 N/m at 25°C
12.9 Liquid Water Interfacial Tension (est.): 30 dynes/cm = 0.03 N/m at 20°C
12.10 Vapor (Gas) Specific Gravity: 2.2
12.11 Ratio of Specific Heats of Vapor (Gas): 1.186
12.12 Latent Heat of Vaporization: 160 Btu/lb = 88 cal/g = 3.7 X 10⁵ J/kg
12.13 Heat of Combustion: —8136 Btu/lb = —4520 cal/g = —189.1 X 10⁵ J/kg
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: —728 Btu/lb = —405 cal/g = 16.9 X 10⁵ J/kg
12.25 Heat of Fusion: 18.14 cal/g
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: 75 psia

6. FIRE HAZARDS (Continued)

6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: 5.48C (Est.)
6.12 Flame Temperature: Data not available

TRICHLOROETHANE

TCE

Common Synonyms	Watery liquid	Colorless	Sweet odor
1,1,1-Trichloroethane Methylchloroform Aerothene Chlorothene	Sinks in water, irritating vapor is produced.		

Stop discharge if possible. Keep people away.
Avoid contact with liquid and vapor.
Call fire department.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

Combustible.
POISONOUS GASES ARE PRODUCED IN FIRE.
Wear goggles and self-contained breathing apparatus.
Extinguish with dry chemical, carbon dioxide, or foam.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause dizziness or difficult breathing.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to skin and eyes.
If swallowed, may produce nausea.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk and have victim induce vomiting.
IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS, do nothing except keep victim warm.

Water Pollution

Effect of low concentrations on aquatic life is unknown.
May be dangerous if it enters water intakes.

Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)
Should be removed
Chemical and physical treatment

2. LABEL

2.1 Category: None
2.2 Class: Not pertinent

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Halogenated hydrocarbon
3.2 Formula: CH_3CCl_3
3.3 IMO/UN Designation: Not listed
3.4 DOT ID No.: 2831
3.5 CAS Registry No.: 71-55-6

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Chloroform-like, pungent

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Organic vapor-acid gas canister; self-contained breathing apparatus for emergencies; neoprene or polyvinyl-alcohol-type gloves; chemical safety goggles and face shield; neoprene safety shoes (or leather safety shoes plus neoprene footwear); neoprene or polyvinyl alcohol suit or apron for splash protection.

5.2 Symptoms Following Exposure: INHALATION: symptoms range from loss of equilibrium and incoordination to loss of consciousness; high concentration can be fatal due to simple asphyxiation combined with loss of consciousness. INGESTION: produces effects similar to inhalation and may cause some feeling of nausea. EYES: slightly irritating and lachrymatory. SKIN: defatting action may cause dermatitis.

5.3 Treatment of Exposure: Get medical attention for all eye exposures and any other serious over-exposures. Do NOT administer adrenalin or epinephrine; otherwise, treatment is symptomatic. INHALATION: remove victim to fresh air; if necessary, apply artificial respiration and/or administer oxygen. INGESTION: have victim drink water and induce vomiting. EYES: flush thoroughly with water. SKIN: remove contaminated clothing and wash exposed area thoroughly with soap and warm water.

5.4 Threshold Limit Value: 350 ppm
5.5 Short Term Inhalation Limits: 1,000 ppm for 60 min. in man
5.6 Toxicity by Ingestion: Grade 1; LD_{50} = 5 to 15 g/kg (rat, mouse, rabbit, guinea pig)
5.7 Late Toxicity: Data not available
5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.
5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 Odor Threshold: 100 ppm
5.11 IDLH Value: 1,000 ppm

6. FIRE HAZARDS

6.1 Flash Point: Data not available
6.2 Flammable Limits in Air: 7%-16%
6.3 Fire Extinguishing Agents: Dry chemical, foam, or carbon dioxide
6.4 Fire Extinguishing Agents Not to be Used: Not pertinent
6.5 Special Hazards of Combustion Products: Toxic and irritating gases are generated in fires.
6.6 Behavior in Fire: Not pertinent
6.7 Ignition Temperature: 932°F
6.8 Electrical Hazard: Not pertinent
6.9 Burning Rate: (est.) 2.8 mm/min.
6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: Reacts slowly, releasing corrosive hydrochloric acid.
7.2 Reactivity with Common Materials: Corrodes aluminum, but reaction is not hazardous.
7.3 Stability During Transport: Stable
7.4 Neutralizing Agents for Acids and Caustics: Not pertinent
7.5 Polymerization: Not pertinent
7.6 Inhibitor of Polymerization: Not pertinent
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: 36

8. WATER POLLUTION

8.1 Aquatic Toxicity:
75-150 ppm/*/pinfish/TL_m/salt water
*Time period not specified.
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): Data not available
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

9.1 Grades of Purity: Uninhibited; inhibited; industrial inhibited; white room; cold cleaning
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)
A-X-Y

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: ORM-A
11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	1
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	3
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	0

11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	1
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 133.41
12.3 Boiling Point at 1 atm: 165°F = 74°C = 347°K
12.4 Freezing Point: <−30°F = <−39°C = <234°K
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 1.31 at 20°C (liquid)
12.8 Liquid Surface Tension: 25.4 dynes/cm = 0.0254 N/m at 20°C
12.9 Liquid Water Interfacial Tension: (est.) 45 dynes/cm = 0.045 N/m at 20°C
12.10 Vapor (Gas) Specific Gravity: 4.6
12.11 Ratio of Specific Heats of Vapor (Gas): 1.104
12.12 Latent Heat of Vaporization: 100 Btu/lb = 56 cal/g = 2.4 X 10^5 J/kg
12.13 Heat of Combustion: (est.) 4700 Btu/lb = 2600 cal/g = 110 X 10^5 J/kg
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: Data not available
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: 4.0 psia

NOTES

TRICHLOROETHYLENE

TCL

Common Synonyms	Watery liquid	Colorless	Sweet odor
Trichloroethylene Trichene; Algylen Chlorylen Germalgene Trichlorylene Trichloran; Triene	Sinks in water. Irritating vapor is produced.		

Stop discharge if possible. Keep people away.
Avoid contact with liquid and vapor.
Call fire department.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

Combustible.
POISONOUS GASES ARE PRODUCED IN FIRE.
Wear goggles and self-contained breathing apparatus.
Extinguish with dry chemical, carbon dioxide, or foam.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause nausea, vomiting, difficult breathing, or loss of consciousness.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to skin and eyes.
If swallowed, will cause nausea, vomiting, difficult breathing, or loss of consciousness.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk and have victim induce vomiting.
IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS, do nothing except keep victim warm.

Water Pollution

Effect of low concentrations on aquatic life is unknown.
May be dangerous if it enters water intakes.

Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)
Should be removed
Chemical and physical treatment

2. LABEL

2.1 Category: None
2.2 Class: Not pertinent

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Halogenated hydrocarbon
3.2 Formula: $CHCl=CCl_2$
3.3 IMO/UN Designation: 6.0/1710
3.4 DOT ID No.: 1710
3.5 CAS Registry No.: 79-01-6

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Chloroform-like, ethereal

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Organic vapor-acid gas canister; self-contained breathing apparatus for emergencies; neoprene or vinyl gloves; chemical safety goggles; face-shield; neoprene safety shoes; neoprene suit or apron for splash protection.
5.2 Symptoms Following Exposure: INHALATION: symptoms range from irritation of the nose and throat to nausea, an attitude of irresponsibility, blurred vision, and finally disturbance of central nervous system resulting in cardiac failure. Chronic exposure may cause organic injury. INGESTION: symptoms similar to inhalation. SKIN: defatting action can cause dermatitis. EYES: slightly irritating sensation and lacrymation.
5.3 Treatment of Exposure: Do NOT administer adrenalin or epinephrine; get medical attention for all cases of overexposure. INHALATION: remove victim to fresh air; if necessary, apply artificial respiration and/or administer oxygen. INGESTION: have victim drink water and induce vomiting; repeat three times; then give 1 tablespoon epsom salts in water. EYES: flush thoroughly with water. SKIN: wash thoroughly with soap and warm water.
5.4 Threshold Limit Value: 50 ppm
5.5 Short Term Inhalation Limits: 200 ppm for 30 min.
5.6 Toxicity by Ingestion: Grade 3; LD_{50} = 50 to 500 mg/kg
5.7 Late Toxicity: Data not available
5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.
5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 Odor Threshold: 50 ppm
5.11 IDLH Value: 1,000 ppm

6. FIRE HAZARDS

6.1 Flash Point: 90°F C.C.; practically nonflammable
6.2 Flammable Limits in Air: 8.0%-10.5%
6.3 Fire Extinguishing Agents: Water fog
6.4 Fire Extinguishing Agents Not to Be Used: Not pertinent
6.5 Special Hazards of Combustion Products: Toxic and irritating gases are produced in fire situations.
6.6 Behavior in Fire: Not pertinent
6.7 Ignition Temperature: 770°F
6.8 Electrical Hazard: Not pertinent
6.9 Burning Rate: Not pertinent
6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: No reaction
7.2 Reactivity with Common Materials: No reaction
7.3 Stability During Transport: Stable
7.4 Neutralizing Agents for Acids and Caustics: Not pertinent
7.5 Polymerization: Not pertinent
7.6 Inhibitor of Polymerization: Not pertinent
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: 36

8. WATER POLLUTION

8.1 Aquatic Toxicity: 660 mg/l/40 hr/daphnia/fall/fresh water
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): Data not available
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

9.1 Grades of Purity: Technical; dry cleaning; degreasing; extraction
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)
A-X-Y

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: ORM-A
11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	1
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	2
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	1

11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	1
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 131.39
12.3 Boiling Point at 1 atm: 189°F = 87°C = 360°K
12.4 Freezing Point: −123.5°F = −86.4°C = 186.8°K
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 1.46 at 20°C (liquid)
12.8 Liquid Surface Tension: 29.3 dynes/cm = 0.0293 N/m at 20°C
12.9 Liquid-Water Interfacial Tension: 34.5 dynes/cm = 0.0345 N/m at 24°C
12.10 Vapor (Gas) Specific Gravity: 4.5
12.11 Ratio of Specific Heats of Vapor (Gas): 1.116
12.12 Latent Heat of Vaporization: 100 Btu/lb = 57.2 cal/g = 2.4×10^5 J/kg
12.13 Heat of Combustion: Not pertinent
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.26 Heat of Fusion: Data not available
12.36 Limiting Value: Data not available
12.27 Reid Vapor Pressure: 2.5 psia

NOTES

TETRACHLOROETHYLENE

TTE

Common Synonyms	Watery liquid	Colorless	Sweet odor
Tetracap Perclene Perchloroethylene Perk	Sinks in water, irritating vapor is produced.		

Stop discharge if possible
Avoid contact with liquid and vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

Not flammable.
Poisonous gases are produced when heated.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause difficult breathing, or loss of consciousness.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to skin and eyes.
Harmful if swallowed.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.

Water Pollution

Effect of low concentrations on aquatic life is unknown.
May be dangerous if enters water intakes.

Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)
Should be removed
Chemical and physical treatment

2. LABEL

2.1 Category: None
2.2 Class: Not pertinent

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Not listed
3.2 Formula: $Cl_2C=CCl_2$
3.3 IMO/UN Designation: 6.0/1897
3.4 DOT ID No.: 1897
3.5 CAS Registry No.: 127-18-4

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Ethereal; like chloroform; musty sweet

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: For high vapor concentrations use approved canister or air-supplied mask; chemical goggles or face shield; plastic gloves.
5.2 Symptoms Following Exposure: Vapor can affect central nervous system and cause anesthesia. Liquid may irritate skin after prolonged contact. May irritate eyes but causes no injury.
5.3 Treatment of Exposure: INHALATION: If illness occurs, remove patient to fresh air, keep him warm and quiet, and get medical attention. INGESTION: induce vomiting only on physician's recommendation. EYES AND SKIN: flush with plenty of water and get medical attention if irritation or injury occurs.
5.4 Threshold Limit Value: 50 ppm
5.5 Short Term Inhalation Limits: 100 ppm for 60 min.
5.6 Toxicity by Ingestion: Grade 2; LD_{50} = 0.5 to 5 g/kg
5.7 Late Toxicity: None
5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or throat if present in high concentrations. The effect is temporary.
5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 Odor Threshold: 5 ppm
5.11 IDLH Value: 500 ppm

6. FIRE HAZARDS

6.1 Flash Point: Not flammable
6.2 Flammable Limits in Air: Not flammable
6.3 Fire Extinguishing Agents: Not pertinent
6.4 Fire Extinguishing Agents Not to be Used: Not pertinent
6.5 Special Hazards of Combustion Products: Toxic, irritating gases may be generated in fires.
6.6 Behavior in Fire: Not pertinent
6.7 Ignition Temperature: Not flammable
6.8 Electrical Hazard: Not pertinent
6.9 Burning Rate: Not flammable
6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: No reaction
7.2 Reactivity with Common Materials: No reaction
7.3 Stability During Transport: Stable
7.4 Neutralizing Agents for Acids and Caustics: Not pertinent
7.5 Polymerization: Not pertinent
7.6 Inhibitor of Polymerization: Not pertinent
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: Data not available

8. WATER POLLUTION

8.1 Aquatic Toxicity: Data not available
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): None
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

9.1 Grades of Purity: Dry cleaning and industrial grades: 96+ %
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)
A-X

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: ORM-A
11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	0
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	3
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	1

11.3 NFPA Hazard Classification: Not listed

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 165.83
12.3 Boiling Point at 1 atm: 250°F = 121°C = 394°K
12.4 Freezing Point: −8.3°F = −22.4°C = 250.8°K
12.5 Critical Temperature: 657°F = 347°C = 620°K
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 1.63 at 20°C (liquid)
12.8 Liquid Surface Tension: 31.3 dynes/cm = 0.0313 N/m at 20°C
12.9 Liquid Water Interfacial Tension: 44.4 dynes/cm = 0.0444 N/m at 25°C
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): 1.116
12.12 Latent Heat of Vaporization: 90.2 Btu/lb = 50.1 cal/g = 2.10 X 10⁵ J/kg
12.13 Heat of Combustion: Not pertinent
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: Data not available
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: Data not available

NOTES

POLYCHLORINATED BIPHENYL

PCB

Common Synonyms			
PCB Chlorinated biphenyl Aroclor Halogenated waxes Polychlorobiphenyls	Oily liquid to solid powder Sinks in water.	Light yellow liquid, or white powder	Weak odor

Stop discharge if possible. Keep people away.
Avoid contact with liquid and solid.
Call fire department.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire	Combustible. Extinguish with water, foam, dry chemical, or carbon dioxide.
Exposure	CALL FOR MEDICAL AID. LIQUID OR SOLID Irritating to skin and eyes. Flush affected areas with plenty of water. IF IN EYES: hold eyelids open and flush with plenty of water.
Water Pollution	HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Issue warning-water contaminant
Should be removed
Chemical and physical treatment

2. LABEL

2.1 Category: None
2.2 Class: Not pertinent

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Not listed
3.2 Formula: $(C_{12}H_{10-n}Cl_n)$
3.3 IMO/UN Designation: Not listed
3.4 DOT ID No.: 2315
3.5 CAS Registry No.: 1336-36-3

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid or solid
4.2 Color: Pale yellow (liquid); colorless (solid)
4.3 Odor: Practically odorless

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Gloves and protective garments.
5.2 Symptoms Following Exposure: Acne from skin contact.
5.3 Treatment of Exposure: SKIN: wash with soap and water.
5.4 Threshold Limit Value: 0.5 to 1.0 mg/m³
5.5 Short Term Inhalation Limits: Data not available
5.6 Toxicity by Ingestion: Grade 2; oral rat LD_{50} = 3980 mg/kg
5.7 Late Toxicity: Causes chromosomal abnormalities in rats, birth defects in mice
5.8 Vapor (Gas) Irritant Characteristics: Vapors cause severe irritation of eyes and throat and cause eye and lung injury. They cannot be tolerated even at low concentrations.
5.9 Liquid or Solid Irritant Characteristics: Contact with skin may cause irritation.
5.10 Odor Threshold: Data not available
5.11 IDLH Value: 5 to 10 mg/m³

6. FIRE HAZARDS

6.1 Flash Point: > 286°F
6.2 Flammable Limits in Air: Data not available
6.3 Fire Extinguishing Agents: Water, foam, dry chemical, or carbon dioxide
6.4 Fire Extinguishing Agents Not to be Used: Not pertinent
6.5 Special Hazards of Combustion Products: Irritating gases are generated in fires.
6.6 Behavior in Fire: Not pertinent
6.7 Ignition Temperature: Data not available
6.8 Electrical Hazard: Not pertinent
6.9 Burning Rate: Data not available
6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: No reaction
7.2 Reactivity with Common Materials: No reaction
7.3 Stability During Transport: Stable
7.4 Neutralizing Agents for Acids and Caustics: Not pertinent
7.5 Polymerization: Not pertinent
7.6 Inhibitor of Polymerization: Not pertinent
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: Data not available

8. WATER POLLUTION

8.1 Aquatic Toxicity:
0.278 ppm/96 hr/bluegill/TL_m/fresh water
0.005 ppm/336-1080 hr/pinfish/TL_m/salt water
8.2 Waterfowl Toxicity: LD_{50} 2000 ppm (mallard duck)
8.3 Biological Oxygen Demand (BOD): Very low
8.4 Food Chain Concentration Potential: High

9. SHIPPING INFORMATION

9.1 Grades of Purity: 11 grades (some liquid, some solids) which differ primarily in their chlorine content (20%-68% by weight)
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Open

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

II

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: ORM-E
11.2 NAS Hazard Rating for Bulk Water Transportation: Not listed
11.3 NFPA Hazard Classification: Not listed

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 18°C and 1 atm: Solid
12.2 Molecular Weight: Not pertinent
12.3 Boiling Point at 1 atm: Very high
12.4 Freezing Point: Not pertinent
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 1.3—1.8 at 20°C (liquid)
12.8 Liquid Surface Tension: Not pertinent
12.9 Liquid Water Interfacial Tension: Not pertinent
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): Not pertinent
12.12 Latent Heat of Vaporization: Not pertinent
12.13 Heat of Combustion: Not pertinent
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.35 Heat of Fusion: Data not available
12.36 Limiting Value: Data not available
12.37 Reid Vapor Pressure: Data not available

NOTES

SULFURIC ACID

SFA

Common Synonyms	Oily liquid	Colorless	Odorless
Oil of vitriol Battery acid Fertilizer acid Chamber acid	Sinks and mixes violently with water. Irritating mist is produced.		

AVOID CONTACT WITH LIQUID. Keep people away.
Wear goggles, self-contained breathing apparatus, and rubber overclothing.
Stop discharge if possible.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

Not flammable.
May cause fire on contact with combustibles.
Flammable gas may be produced on contact with metals.
POISONOUS GAS MAY BE PRODUCED IN FIRE.
Wear goggles, self-contained breathing apparatus, and rubber overclothing.
DO NOT USE WATER ON ADJACENT FIRES.
Extinguish with dry chemical or carbon dioxide.

Exposure

CALL FOR MEDICAL AID

MIST
Irritating to eyes, nose and throat.
If inhaled, will cause coughing, difficult breathing, or loss of consciousness.
Move to fresh air.
IF IN EYES, hold eyelids open and flush with plenty of water.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Will burn skin and eyes.
Harmful if swallowed.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.
DO NOT INDUCE VOMITING.

Water Pollution

HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS.
May be dangerous if it enters water intakes.

Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Issue warning-corrosive
Restrict access
Dispose and flush with care

2. LABEL

2.1 Category: Corrosive
2.2 Class: 8

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Sulfuric acid
3.2 Formula: H_2SO_4
3.3 IMO/UN Designation: 8.0/1830
3.4 DOT ID No.: 1830
3.5 CAS Registry No.: 7664-93-9

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless (pure) to dark brown
4.3 Odor: Odorless unless hot, then choking

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Safety shower; eyewash fountain; safety goggles; face shield; approved respirator (self-contained or airline); rubber safety shoes; rubber apron.
5.2 Symptoms Following Exposure: Inhalation of vapor from hot, concentrated acid may injure lungs. Swallowing may cause severe injury or death. Contact with skin or eyes causes severe burns.
5.3 Treatment of Exposure: Call a doctor. INHALATION: observe victim for delayed pulmonary reaction. INGESTION: have victim drink water if possible; do NOT induce vomiting. EYES AND SKIN: wash with large amounts of water for at least 15 min.; do not use oils or ointments in eyes; treat skin burns.
5.4 Threshold Limit Value: 1 mg/m³
5.5 Short Term Inhalation Limits: 10 mg/m³ for 5 min.; 5 mg/m³ for 10 min.; 2 mg/m³ for 30 min.; 1 mg/m³ for 60 min.
5.6 Toxicity by Ingestion: No effects except those secondary to tissue damage.
5.7 Late Toxicity: None
5.8 Vapor (Gas) Irritant Characteristics: Vapors from hot acid (77-98%) cause moderate irritation of eyes and respiratory system. Effect is temporary.
5.9 Liquid or Solid Irritant Characteristics: 77-98% acid causes severe second- and third-degree burns of skin on short contact; and is very injurious to the eyes.
5.10 Odor Threshold: Greater than 1 mg/m³
5.11 IDLH Value: 80 mg/m³

6. FIRE HAZARDS

6.1 Flash Point: Not flammable
6.2 Flammable Limits in Air: Not flammable
6.3 Fire Extinguishing Agents: Not pertinent
6.4 Fire Extinguishing Agents Not to be Used: Water used on adjacent fires should be carefully handled.
6.5 Special Hazards of Combustion Products: Not pertinent
6.6 Behavior in Fire: Not flammable
6.7 Ignition Temperature: Not flammable
6.8 Electrical Hazard: None
6.9 Burning Rate: Not flammable
6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: Reacts violently with evolution of heat. Scattering occurs when water is added to the compound.
7.2 Reactivity with Common Materials: Extremely hazardous in contact with many materials, particularly metals and combustibles. Dilute acid reacts with most metals, releasing hydrogen which can form explosive mixtures with air in confined spaces.
7.3 Stability During Transport: Stable
7.4 Neutralizing Agents for Acids and Caustics: Dilute with water, then neutralize with lime, limestone, or soda ash.
7.5 Polymerization: Not pertinent
7.6 Inhibitor of Polymerization: Not pertinent

(Continued)

8. WATER POLLUTION

8.1 Aquatic Toxicity:
34.5 ppm/24 hr/bluegill/lethal/fresh water
42.5 ppm/48 hr/prawn/LC_{50}/salt water
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): None
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

9.1 Grades of Purity: CP; USP; Technical, at 33% to 98% (50° Be to 66° Be).
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Open

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-P-O

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Corrosive material
11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	0
Health	
Vapor Irritant	2
Liquid or Solid Irritant	4
Poisons	2
Water Pollution	
Human Toxicity	2
Aquatic Toxicity	3
Aesthetic Effect	2
Reactivity	
Other Chemicals	4
Water	3
Self Reaction	0

11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	3
Flammability (Red)	0
Reactivity (Yellow)	2
	W

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 98.08
12.3 Boiling Point at 1 atm: 644°F = 340°C = 613°K
12.4 Freezing Point: Not pertinent
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 1.84 at 20°C (liquid)
12.8 Liquid Surface Tension: Not pertinent
12.9 Liquid Water Interfacial Tension: Not pertinent
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): Not pertinent
12.12 Latent Heat of Vaporization: Not pertinent
12.13 Heat of Combustion: Not pertinent
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: −418.6 Btu/lb = −232.2 cal/g = -8.715×10^4 J/kg
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: Data not available
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: Low

*Physical properties apply to concentrated (98%) acid unless otherwise stated. More dilute acid is more water-like.

7. CHEMICAL REACTIVITY (Continued)

7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: 2

CHROMIC ANHYDRIDE

CMA

Common Synonyms			
Chromic oxide Chromium trioxide Chromic acid	Solid flakes or powder	Dark red	Odorless
	Sinks and mixes with water.		

Avoid contact with solid and dust. Keep people away.
Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves).
Stay upwind and use water spray to "knock down" dust.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

Not flammable.
May cause fire on contact with combustibles.
Containers may explode when heated in a fire.
Extinguish with water.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.

SOLID
Will burn skin and eyes.
Harmful if swallowed.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.
DO NOT INDUCE VOMITING.

Water Pollution

HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS.
May be dangerous if it enters water intakes.

Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Issue warning-water contamination
Dilute and flush

2. LABEL

2.1 Category: Oxidizer
2.2 Class: 5

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Not listed
3.2 Formula: CrO_3
3.3 IMO/UN Designation: 5.1/1463
3.4 DOT ID No.: 1463
3.5 CAS Registry No.: 1333-82-0

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Solid
4.2 Color: Dark red
4.3 Odor: None

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Goggles and respirator. (Special chromic acid filters are available for respirators to prevent inhalation of dust or mist.)
5.2 Symptoms Following Exposure: Very irritating to eyes and respiratory tract. Ingestion causes severe gastrointestinal symptoms. Contact with eyes or skin causes burns; prolonged contact produces dermatitis ("chrome sores").
5.3 Treatment of Exposure: INGESTION: call a physician, do NOT induce vomiting. SKIN OR EYES: wash eyes thoroughly for at least 15 min.; flush contacted skin areas with water; remove contaminated clothing and wash before reuse.
5.4 Threshold Limit Value: 0.05 mg/m³
5.5 Short Term Inhalation Limits: Not pertinent
5.6 Toxicity by Ingestion: Grade 3: LD_{50} = 50 to 500 mg/kg
5.7 Late Toxicity: Lung cancer
5.8 Vapor (Gas) Irritant Characteristics: Not pertinent
5.9 Liquid or Solid Irritant Characteristics: Severe skin irritant. Causes second- and third-degree burns on short contact; very injurious to the eyes.
5.10 Odor Threshold: Not pertinent
5.11 IDLH Value: 30 mg/m³

6. FIRE HAZARDS

6.1 Flash Point: Not flammable
6.2 Flammable Limits in Air: Not flammable
6.3 Fire Extinguishing Agents: Water
6.4 Fire Extinguishing Agents Not to be Used: Not pertinent
6.5 Special Hazards of Combustion Products: Not pertinent
6.6 Behavior in Fire: Containers may explode
6.7 Ignition Temperature: May ignite organic materials on contact.
6.8 Electrical Hazard: Not pertinent
6.9 Burning Rate: Not flammable
6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: No reaction
7.2 Reactivity with Common Materials: May react with organic materials rapidly enough to generate sufficient heat to cause ignition. Prolonged contact, particularly on wood floors, may produce a fire hazard.
7.3 Stability During Transport: Stable
7.4 Neutralizing Agents for Acids and Caustics: Flood with water, rinse with sodium bicarbonate solution.
7.5 Polymerization: Not pertinent
7.6 Inhibitor of Polymerization: Not pertinent
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: Data not available

8. WATER POLLUTION

8.1 Aquatic Toxicity:
0.01 ppm/48 hr/daphnia/TL_m
52 ppm/96 hr/goldfish/dead
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): None
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

9.1 Grades of Purity: Technical; technical flake: 99.75%
9.2 Storage Temperature: Data not available
9.3 Inert Atmosphere: Data not available
9.4 Venting: Data not available

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

SS

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Oxidizer
11.2 NAS Hazard Rating for Bulk Water Transportation: Not listed
11.3 NFPA Hazard Classification

Category	Classification
Health Hazard (Blue)	3
Flammability (Red)	0
Reactivity (Yellow)	1
	ory

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Solid
12.2 Molecular Weight: 100.01
12.3 Boiling Point at 1 atm: Not pertinent
12.4 Freezing Point: Not pertinent
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 2.70 at 20°C (solid)
12.8 Liquid Surface Tension: Not pertinent
12.9 Liquid Water Interfacial Tension: Not pertinent
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): Not pertinent
12.12 Latent Heat of Vaporization: Not pertinent
12.13 Heat of Combustion: Not pertinent
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: 37.7 cal/g
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: Data not available

NOTES

ALUMINUM CHLORIDE

ACL

Common Synonyms Anhydrous aluminum chloride	Solid crystal or powder — Yellow-orange to grayish-white — Irritating odor Sinks in water. Poisonous gas is produced on contact with water

Keep people away. Evacuate area in case of large discharge
Avoid contact with solid or dust
Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves)
Isolate and remove discharged material
Notify local health and pollution control agencies

Fire	Not flammable Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves) Do not use water on adjacent fires Extinguish adjacent fires with dry chemical or foam
Exposure	CALL FOR MEDICAL AID DUST Irritating to eyes, nose and throat Harmful if inhaled Move to fresh air If breathing has stopped, give artificial respiration If breathing is difficult, give oxygen SOLID Will burn skin and eyes Harmful if swallowed Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk DO NOT INDUCE VOMITING
Water Pollution	HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS. May be dangerous if it enters water intakes Notify local health and wildlife officials Notify operators of nearby water intakes

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Disperse and flush with care
Issue warning-corrosive

2. LABEL

2.1 Category: None
2.2 Class: Not pertinent

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Not listed
3.2 Formula: $AlCl_3$
3.3 IMO/UN Designation: 8 0/1726
3.4 DOT ID No.: 1726
3.5 CAS Registry No.: 7446-70-0

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Solid
4.2 Color: Orange to yellow through gray to white
4.3 Odor: Like hydrogen chloride, like hydrochloric acid

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: All personnel in the area should wear safety clothing, including fully closed goggles, rubber or plastic-coated gloves, rubber shoes, and coveralls of acid-resistant material. An acid-vapor canister mask should be carried in case of emergency. In certain applications, it may be advisable to wear this equipment on a routine basis.
5.2 Symptoms Following Exposure: Contact with the skin or eyes in the presence of moisture causes thermal and acid burns.
5.3 Treatment of Exposure: INGESTION: if victim is conscious have him drink water or milk. Do NOT induce vomiting. SKIN: flush immediately with plenty of water. For eye contact, flush with water for at least 15 mins. and get medical attention immediately.
5.4 Threshold Limit Value: 5 ppm (hydrogen chloride)
5.5 Short Term Inhalation Limits: 5 ppm for 5 min.; 30 ppm for 10 min.; 20 ppm for 20 min.; 10 ppm for 60 min. (all for hydrogen chloride)
5.6 Toxicity by Ingestion: No systemic effects, but severe burns of mouth.
5.7 Late Toxicity: None recognized
5.8 Vapor (Gas) Irritant Characteristics: Vapor (of hydrogen chloride) is moderately irritating such that personnel will not usually tolerate moderate or high vapor concentrations.
5.9 Liquid or Solid Irritant Characteristics: Fairly severe skin irritant, may cause pain and second-degree burns after a few minutes' contact.
5.10 Odor Threshold: 1-5 ppm (hydrogen chloride)
5.11 IDLH Value: 100 ppm

6. FIRE HAZARDS

6.1 Flash Point: Not flammable
6.2 Flammable Limits in Air: Not flammable
6.3 Fire Extinguishing Agents: Not pertinent
6.4 Fire Extinguishing Agents Not to be Used: Do not use water on adjacent fires
6.5 Special Hazards of Combustion Products: Not pertinent
6.6 Behavior in Fire: Reacts violently with water used in extinguishing adjacent fires
6.7 Ignition Temperature: Not flammable
6.8 Electrical Hazard: Not pertinent
6.9 Burning Rate: Not flammable
6.10 Adiabatic Flame Temperature: Not pertinent
6.11 Stoichiometric Air to Fuel Ratio: Not pertinent
6.12 Flame Temperature: Not pertinent

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: Reacts violently with water liberating hydrogen chloride gas and heat
7.2 Reactivity with Common Materials: None if dry. If wet it attacks metals because of hydrochloric acid formed; flammable hydrogen is formed
7.3 Stability During Transport: Stable if kept dry and protected from atmospheric moisture
7.4 Neutralizing Agents for Acids and Caustics: Hydrochloric acid formed by reaction with water can be flushed away with water. Rinse with sodium bicarbonate or lime solution.
7.5 Polymerization: Not pertinent
7.6 Inhibitor of Polymerization: Not pertinent
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: Data not available

8. WATER POLLUTION

8.1 Aquatic Toxicity: Not pertinent
8.2 Waterfowl Toxicity: Not pertinent
8.3 Biological Oxygen Demand (BOD): Not pertinent
8.4 Food Chain Concentration Potential: Not pertinent

9. SHIPPING INFORMATION

9.1 Grades of Purity: Pure, 95.7%; technical, 94.5%
9.2 Storage Temperature: Data not available
9.3 Inert Atmosphere: Data not available
9.4 Venting: Data not available

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

RR-C

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Not listed
11.2 NAS Hazard Rating for Bulk Water Transportation: Not listed
11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	3
Flammability (Red)	0
Reactivity (Yellow)	2
	W

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Solid
12.2 Molecular Weight: 133.34
12.3 Boiling Point at 1 atm: Not pertinent
12.4 Freezing Point: 361°F = 183.9°C = 457.1°K
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 2.44 at 25°C (solid)
12.8 Liquid Surface Tension: Not pertinent
12.9 Liquid Water Interfacial Tension: Not pertinent
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): Not pertinent
12.12 Latent Heat of Vaporization: Not pertinent
12.13 Heat of Combustion: Not pertinent
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: 63.8 cal/g
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: Data not available

NOTES

GASOLINES: AUTOMOTIVE (<4.23g lead/gal)

GAT

Common Synonyms	Watery liquid	Colorless to pale brown or pink	Gasoline odor
Motor spirit Petrol	Floats on water. Flammable, irritating vapor is produced.		

Stop discharge if possible. Keep people away.
Shut off ignition sources and call fire department.
Stay upwind and use water spray to "knock down" vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire	FLAMMABLE. Flashback along vapor trail may occur. Vapor may explode if ignited in an enclosed area. Extinguish with dry chemical, foam, or carbon dioxide. Water may be ineffective on fire. Cool exposed containers with water.
Exposure	CALL FOR MEDICAL AID. VAPOR Irritating to eyes, nose and throat. If inhaled, will cause dizziness, headache, difficult breathing or loss of consciousness. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. LIQUID Irritating to skin and eyes. If swallowed, will cause nausea or vomiting. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk. DO NOT INDUCE VOMITING.
Water Pollution	HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS. Fouling to shoreline. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Issue warning-high flammability
Evacuate area
Disperse and flush

2. LABEL

2.1 Category: Flammable liquid
2.2 Class: 3

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Miscellaneous Hydrocarbon Mixtures
3.2 Formula: (Mixture of hydrocarbons)
3.3 IMO/UN Designation: 3.1/1203
3.4 DOT ID No.: 1203
3.5 CAS Registry No.: Data not available

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless to brown
4.3 Odor: Gasoline

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Protective goggles, gloves.
5.2 Symptoms Following Exposure: Irritation of mucous membranes and stimulation followed by depression of central nervous system. Breathing of vapor may also cause dizziness, headache, and incoordination or, in more severe cases, anesthesia, coma, and respiratory arrest. If liquid enters lungs, it will cause severe irritation, coughing, gagging, pulmonary edema, and, later, signs of bronchopneumonia and pneumonitis. Swallowing may cause irregular heartbeat.
5.3 Treatment of Exposure: INHALATION: maintain respiration and administer oxygen; enforce bed rest if liquid is in lungs. INGESTION: do NOT induce vomiting; stomach should be lavaged (by doctor) if appreciable quantity is swallowed. EYES: wash with copious quantity of water. SKIN: wipe off and wash with soap and water.
5.4 Threshold Limit Value: 300 ppm
5.5 Short Term Inhalation Limits: 500 ppm for 30 min.
5.6 Toxicity by Ingestion: Grade 2; LD_{50} = 0.5 to 5 g/kg.
5.7 Late Toxicity: None
5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.
5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 Odor Threshold: 0.25 ppm
5.11 IDLH Value: Data not available

6. FIRE HAZARDS

6.1 Flash Point: −36°F C.C.
6.2 Flammable Limits in Air: 1.4%-7.4%
6.3 Fire Extinguishing Agents: Foam, carbon dioxide, dry chemical
6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective
6.5 Special Hazards of Combustion Products: None
6.6 Behavior in Fire: Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back.
6.7 Ignition Temperature: 853°F
6.8 Electrical Hazard: Class I, Group D
6.9 Burning Rate: 4 mm/min.
6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: No reaction
7.2 Reactivity with Common Materials: No reaction
7.3 Stability During Transport: Stable
7.4 Neutralizing Agents for Acids and Caustics: Not pertinent
7.5 Polymerization: Not pertinent
7.6 Inhibitor of Polymerization: Not pertinent
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: 33

8. WATER POLLUTION

8.1 Aquatic Toxicity:
90 ppm/24 hr/juvenile American shad/TL_m/fresh water
91 mg/l/24 hr/juvenile American shad/TL_m/salt water
8.2 Waterflow Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): 8%, 5 days
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

9.1 Grades of Purity: Various octane ratings; military specifications
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Open (flame arrester) or pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-T-U-V-W

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Flammable liquid
11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	3
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	2
Aesthetic Effect	2
Reactivity	
Other Chemicals	0
Water	0
Self Reaction	0

11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	1
Flammability (Red)	3
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: Not pertinent
12.3 Boiling Point at 1 atm:
140—390°F
= 60—199°C = 333—472°K
12.4 Freezing Point: Not pertinent
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity:
0.7321 at 20°C (liquid)
12.8 Liquid Surface Tension:
19-23 dynes/cm
= 0.019—0.023 N/m at 20°C
12.9 Liquid Water Interfacial Tension:
49-51 dynes/cm
= 0.049—0.051 N/m at 20°C
12.10 Vapor (Gas) Specific Gravity: 3.4
12.11 Ratio of Specific Heats of Vapor (Gas): (est.) 1.054
12.12 Latent Heat of Vaporization:
130—150 Btu/lb = 71—81 cal/g
= 3.0 — 3.4 X 10^5 J/kg
12.13 Heat of Combustion: −18,720 Btu/lb
= −10,400 cal/g = 435.1 X 10^5 J/kg
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: Data not available
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: 7.4 psia

NOTES

OILS, MISCELLANEOUS: MOTOR

OMT

Common Synonyms	Oily liquid	Yellow-brown	Lube oil odor
Crankcase oil Lubricating oil Transmission oil	Floats on water.		

Stop discharge if possible.
Call fire department.
Avoid contact with liquid.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

Combustible.
Extinguish with dry chemical, foam, or carbon dioxide.
Water may be ineffective on fire.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.

LIQUID
Irritating to skin and eyes.
Harmful if swallowed.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.
DO NOT INDUCE VOMITING.

Water Pollution

Effect of low concentrations on aquatic life is unknown.
Fouling to shorelines.
May be dangerous if it enters water intakes.
Notify local health and pollution officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)
Mechanical containment
Should be removed
Chemical and physical treatment

2. LABEL

2.1 Category: None
2.2 Class: Not pertinent

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Miscellaneous Hydrocarbon Mixtures
3.2 Formula: Not applicable
3.3 IMO/UN Designation: 3.3/1270
3.4 DOT ID No.: 1270
3.5 CAS Registry No.: Data not available

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Yellow fluorescent
4.3 Odor: Characteristic

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Protective gloves; goggles or face shield.
5.2 Symptoms Following Exposure: INGESTION: minimal gastrointestinal irritation; increased frequency of bowel passage may occur. ASPIRATION: pulmonary irritation is normally minimal but may become more severe several hours after exposure.
5.3 Treatment of Exposure: INGESTION: do NOT lavage or induce vomiting. ASPIRATION: treatment probably not required; delayed development of pulmonary irritation can be detected by serial chest x-rays. EYES: wash with copious amounts of water. SKIN: wipe off oil and wash with soap and water.
5.4 Threshold Limit Value: Data not available
5.5 Short Term Inhalation Limits: Data not available
5.6 Toxicity by Ingestion: Grade 1; LD_{50} = 5 to 15 g/kg
5.7 Late Toxicity: Data not available
5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.
5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 Odor Threshold: Data not available
5.11 IDLH Value: Data not available

6. FIRE HAZARDS

6.1 Flash Point: 275—600°F C.C.
6.2 Flammable Limits in Air: Data not available
6.3 Fire Extinguishing Agents: Dry chemical, foam, or carbon dioxide
6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective
6.5 Special Hazards of Combustion Products: Not pertinent
6.6 Behavior in Fire: Not pertinent
6.7 Ignition Temperature: 325—625°F
6.8 Electrical Hazard: Not pertinent
6.9 Burning Rate: 4 mm/min.
6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: No reaction
7.2 Reactivity with Common Materials: No reaction
7.3 Stability During Transport: Stable
7.4 Neutralizing Agents for Acids and Caustics: Not pertinent
7.5 Polymerization: Not pertinent
7.6 Inhibitor of Polymerization: Not pertinent
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: 33

8. WATER POLLUTION

8.1 Aquatic Toxicity: Data not available
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): Data not available
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

9.1 Grades of Purity: Various viscosities
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Open (flame arrester)

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)
A-T-U

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Not listed
11.2 NAS Hazard Rating for Bulk Water Transportation: Not listed
11.3 NFPA Hazard Classification: Not listed

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: Not pertinent
12.3 Boiling Point at 1 atm: Very high
12.4 Freezing Point: —29.9°F = —34.4°C = 238.8°K
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 0.84—0.96 at 15°C (liquid)
12.8 Liquid Surface Tension: 36-37.5 dynes/cm = 0.036—0.0375 N/m at 20°C
12.9 Liquid Water Interfacial Tension: 33—54 dynes/cm = 0.033—0.054 N/m at 20°C
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): Not pertinent
12.12 Latent Heat of Vaporization: Not pertinent
12.13 Heat of Combustion: —18,486 Btu/lb = —10,270 cal/g = —429.96 X 10^4 J/kg
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: Data not available
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: Data not available

NOTES

OILS, MISCELLANEOUS: LUBRICATING

OLB

Common Synonyms	Oily liquid	Yellow-brown	Lube oil odor
Crankcase oil Transmission oil Motor oil	Floats on water.		

Stop discharge if possible.
Call fire department.
Avoid contact with liquid.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire	Combustible. Extinguish with dry chemical, foam or carbon dioxide. Water may be ineffective on fire. Cool exposed containers with water.
Exposure	CALL FOR MEDICAL AID LIQUID Irritating to skin and eyes. Harmful if swallowed. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk. DO NOT INDUCE VOMITING
Water Pollution	Effect of low concentrations on aquatic life is unknown. Floating to shoreline. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Mechanical containment
Should be removed
Chemical and physical treatment

2. LABEL

2.1 Category: None
2.2 Class: Not pertinent

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Miscellaneous Hydrocarbon Mixtures
3.2 Formula: Not applicable
3.3 IMO/UN Designation: 3.3/1270
3.4 DOT ID No.: 1270
3.5 CAS Registry No.: Data not available

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Yellow fluorescent
4.3 Odor: Characteristic

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Protective gloves; goggles or face shield.
5.2 Symptoms Following Exposure: INGESTION: minimal gastrointestinal tract irritation; increased frequency of bowel passage may occur. ASPIRATION: pulmonary irritation is normally minimal but may become more severe several hours after exposure.
5.3 Treatment of Exposure: INGESTION: do NOT lavage or induce vomiting. ASPIRATION: treatment probably not required; delayed development of pulmonary irritation can be detected by serial chest x-rays. EYES: wash with copious quantity of water. SKIN: wipe off and wash with soap and water.
5.4 Threshold Limit Value: Data not available
5.5 Short Term Inhalation Limits: Data not available
5.6 Toxicity by Ingestion: Grade 1; LD_{50} = 5 to 15 g/kg
5.7 Late Toxicity: Data not available
5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.
5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 Odor Threshold: Data not available
5.11 IDLH Value: Data not available

6. FIRE HAZARDS

6.1 Flash Point: 300°F C.C.
6.2 Flammable Limits in Air: Data not available
6.3 Fire Extinguishing Agents: Dry chemical, foam, or carbon dioxide
6.4 Fire Extinguishing Agents Not to be Used: Water or foam may cause frothing.
6.5 Special Hazards of Combustion Products: Not pertinent
6.6 Behavior in Fire: Not pertinent
6.7 Ignition Temperature: 500°F-700°F
6.8 Electrical Hazard: Not pertinent
6.9 Burning Rate: 4 mm/min.
6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: No reaction
7.2 Reactivity with Common Materials: No reaction
7.3 Stability During Transport: Stable
7.4 Neutralizing Agents for Acids and Caustics: Not pertinent
7.5 Polymerization: Not pertinent
7.6 Inhibitor of Polymerization: Not pertinent
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: 33

8. WATER POLLUTION

8.1 Aquatic Toxicity: Data not available
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): Data not available
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

9.1 Grades of Purity: Various viscosities
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Open (flame arrester)

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-T-U

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Not listed
11.2 NAS Hazard Rating for Bulk Water Transportation: Not listed
11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	0
Flammability (Red)	1
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: Not pertinent
12.3 Boiling Point at 1 atm: Very high
12.4 Freezing Point: Not pertinent
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: (est.) 0.902 at 20°C (liquid)
12.8 Liquid Surface Tension: 26-37.5 dynes/cm = 0.026—0.0375 N/m at 20°C
12.9 Liquid Water Interfacial Tension: 33—54 dynes/cm = 0.033—0.054 N/m at 20°C
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): Not pertinent
12.12 Latent Heat of Vaporization: Not pertinent
12.13 Heat of Combustion: —18,486 Btu/lb = —10,270 cal/g = —429.56 X 10^3 J/kg
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: Data not available
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: Data not available

NOTES

5.0 SITE CONTROL

5.1 ZONATION. The general zonation protocols that should be employed at hazardous waste sites are described in Chapter 8.0 of the CLEAN HASP. The site-specific zonation that will be used for this project is described as follows.

Each Site will divided into three zones: (1) the work area, considered the Exclusion Zone; (2) a perimeter area serving as the Support Zone; and (3) an area for decontamination, called the Contamination Reduction Zone (CRZ).

5.2 COMMUNICATIONS. When radio communication is not used, the following air horn signals will be employed:

HELP	three short blasts	(. . .)
EVACUATION	three long blasts	(_ _ _)
ALL CLEAR	alternating long and short blasts	(_ . _ .)

The air horn will be kept in the Exclusion Zone or Support Zone.

5.3 WORK PRACTICES. General work practices to be used during ABB-ES projects are described in Chapter 9.0 of the CLEAN HASP. Work at the Site will be conducted according to these established protocol and guidelines for the safety and health of all involved. Specific work practices necessary for this project or those that are of significant concern are described as follows.

- Work and sampling will be conducted in Level D clothing and equipment.

6.0 DECONTAMINATION AND DISPOSAL

All personnel and/or equipment leaving contaminated areas of the Site will be subject to decontamination, which will take place in the contamination reduction zone. Figure 6-1 illustrates a typical decontamination station. General decontamination practices used during ABB-ES projects are described in Chapter 13.0 of the CLEAN HASP.

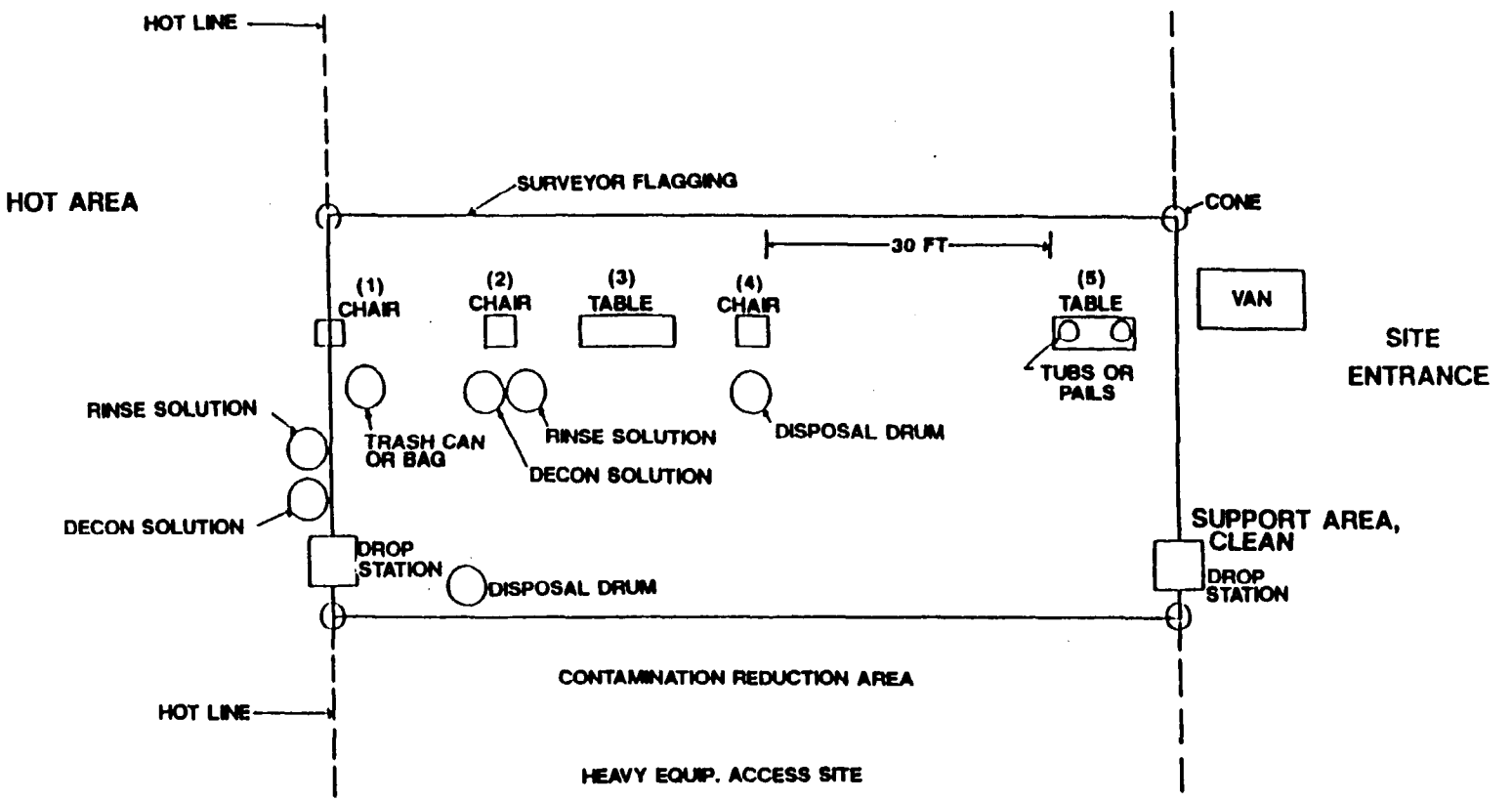
6.1 PERSONNEL DECONTAMINATION. All personnel will follow standard decontamination practices when leaving hazardous waste Sites, including proper decontamination, removal, and disposal of personal protective equipment and tools. Personal protection levels for decontamination will correspond with the level of protection used during the field activity.

6.1.1 Small Equipment Decontamination Small equipment will be protected from contamination as much as possible by keeping the equipment covered when at the site and placing the equipment on plastic sheeting, not the ground. Sampling equipment used at the site will be used only once or will be field cleaned between samples in accordance with USEPA Region IV Standard Operating Procedures (SOPs).

6.1.2 Heavy Equipment Decontamination Drilling rigs and other heavy equipment will be cleaned with high-pressure water or steam, followed by a soap and water wash and rinse. Loose material will be removed with a brush. Downhole tools and heavy equipment will be decontaminated in accordance with USEPA Region IV SOPs.

A decontamination pit will be constructed upwind of the Site to allow collection of decontamination fluids.

6.2 COLLECTION AND DISPOSAL OF INVESTIGATION DERIVED WASTES. Decontamination fluids will be drummed and sent to the industrial waste water treatment plant. Water collected during well development will be screened for volatile organics and disposed appropriately at the discretion of the Engineer-in-Charge (EIC) of the base and the Task Order Manager of ABB. The disposal will consist of either releasing the water on site or carrying it back to the industrial waste water plant. Drill cuttings and other solid wastes at the Sites 5, 11, and 16 will be collected, screened for volatiles organics and deposited on site. In general, discarded materials, waste materials, or other objects shall be handled in such a way as to preclude the potential for spreading contamination, creating a sanitary hazard, or causing litter to be left on site. Potentially contaminated materials, e.g., clothing, gloves, etc., will be drummed and segregated for disposal. Contaminated waste materials shall be disposed of as required by the provisions included in the contract and consistent with Naval Submarine Support Base and regulatory provisions. All non-contaminated materials shall be collected and bagged for appropriate disposal as normal domestic waste.



NOT TO SCALE

TASK

(1) WASH BOOTS

(2) WASH GLOVES - RINSE GLOVES

(3) SCBA TANK CHANGE OVER TABLE WITH SPARE TANKS

(4) REMOVE BOOTS, GLOVES

(5) REMOVE SCBA, WASH MASK IN PAILS OR TUBS

FIGURE 6-1

TYPICAL PERSONNEL DECONTAMINATION STATION

RFI/SI
HEALTH AND SAFETY PLAN

NSB KINGS BAY
KINGS BAY, GEORGIA

7.0 EMERGENCY AND CONTINGENCY PLAN

This section identifies emergency and contingency planning that has been undertaken for operations at this site. Most sections of the HASP provide information that would be used under emergency conditions. General emergency planning information is addressed in Chapter 14.0 of the CLEAN HASP. The following subsections present site-specific emergency and contingency planning information.

7.1 PERSONNEL ROLES, LINES OF AUTHORITY, AND COMMUNICATION. The site HSO or the Health and Safety designee is the primary authority for directing operations at the site under emergency conditions. All communications both on- and off-site will be directed through the HSO or designee.

7.2 EVACUATION. In the event of an emergency situation such as fire, explosion, significant release of toxic gases, etc., an air horn or other appropriate device will be sounded for three long blasts indicating the initiation of evacuation procedures. All personnel will evacuate the work area. The location of safe areas shall be upwind of the Site. For efficient and safe site evacuation and assessment of the emergency situation, the HSO will have authority to initiate proper action if outside services are required. Under no circumstances will incoming personnel or visitors be allowed to proceed into the area once the emergency signal has been given. The HSO must see that access for emergency equipment is provided and that all combustible apparatus have been shut down once the alarm has been sounded. Once the safety of all personnel is established, the NSB Kings Bay Environmental Coordinator, Jim Moore, will be notified by telephone of the emergency (912-673-4759).

The HSO will notify local fire and police departments, and other appropriate emergency response groups, if LEL values are above 25 percent in the work zone, or if an actual fire or explosion has taken place.

Fire Department: 911 or 673-3333 Police Department: 911 or 882-4344

7.3 EMERGENCY MEDICAL TREATMENT AND FIRST AID. Any personnel injured on-site will be rendered first aid as appropriate and transported to competent medical facilities for further examination and/or treatment. The preferred method of transport would be through professional emergency transportation means; however, when this is not readily available or would result in excessive delay, other transport will be authorized. Under no circumstances will injured persons transport themselves to a medical facility for emergency treatment.

8.0 ADMINISTRATION

8.1 PERSONNEL AUTHORIZED DOWNRANGE. Personnel authorized to participate in downrange activities at this site have been reviewed and certified for site operations by the Project Manager and the HSS. Certification involves the completion of appropriate training, a medical examination, and a review of this site-specific HASP. All persons entering the site must use the buddy system, and check in with the Site Manager and/or HSO before going downrange.

CERTIFIED ABB ENVIRONMENTAL TEAM PERSONNEL:

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

OTHER CERTIFIED PERSONNEL:

_____	_____
_____	_____
_____	_____
_____	_____

* FIRST-AID-TRAINED
\+ CPR-TRAINED

8.2 HEALTH AND SAFETY PLAN (HASP) APPROVALS. By their signatures, the undersigned certify that this HASP will be used for the protection of the health and safety of all persons entering this site.

_____	_____
Health and Safety Officer	Date
_____	_____
Project Manager	Date
_____	_____
Health and Safety Manager/Supervisor	Date

8.3 FIELD TEAM REVIEW. I have read and reviewed the health and safety information in the HASP. I understand the information and will comply with the requirements of the HASP.

NAME: _____

DATE: _____

SITE/PROJECT: _____

8.4 MEDICAL DATA SHEET. This Medical Data Sheet will be completed by all on-site personnel and kept in the Support Zone during site operations. It is not a substitute for the Medical Surveillance Program requirements consistent with the CLEAN HASP. This data sheet will accompany any personnel when medical assistance or transport to hospital facilities is required. If more space is required, use the back of this sheet.

Project: _____

Name: _____

Address: _____

Home Telephone: Area Code ( ) _____

Age: _____ Height: _____ Weight: _____

In case of emergency, contact: _____

Address: _____

Telephone: Area Code ( ) _____

Do you wear contact lenses? Yes ( ) No ( )

Allergies: _____

List medication(s) taken regularly: _____

Particular sensitivities: _____

Previous/current medical conditions or exposures to hazardous chemicals:

_____

Name of Personal Physician: _____

Telephone: Area Code ( ) _____

8.5 EMERGENCY TELEPHONE NUMBERS.

Base Security	(912) 673-4444
Rescue Service	(912) 673-3333
Primary Hospital (Gilman Hospital)	(912) 882-4227
Alternate Hospital (Bronzwik Hospital)	(912) 264-7000
Base Fire Department	(912) 673-3333
Off-site Emergency Services	(912) 673-3333
Poison Control Center	(800) 962-1253
National Response Center	(800) 424-8802
Regional USEPA Emergency Response	(800) 414-8802
Site HSO: _____	(904) 656-1293
General Site Supervisor: _____	(904) 656-1293
Project Manager: _____	(904) 656-1293
ABB Environmental HSM: C.E. Sundquist	(800) 341-0460 x101
Environmental Coordinator: Jim More	(912) 673-4759

8.6 ROUTES TO EMERGENCY MEDICAL FACILITIES. The primary source of medical assistance for the site is:

Gilman Hospital
805 Bilworpth Street
St. Marys, Georgia 31558

DIRECTIONS TO PRIMARY: From Lookout Tower on Patton Drive travel 1/4th mile (west), take a left on state route 40, travel about 3 miles on 40 (south), take a right (west) on Bilworpth Street, travel past 2 blocks, to your right is the hospital (see Figure 8-1).

The alternate source of medical assistance for the site is:

Bronzwik Hospital
3100 Kemble Avenue
Parkwood, Georgia 31520

DIRECTIONS TO ALTERNATE: From Lookout Tower on Patton Drive travel 1/4th mile (west), take a left on state route 40, travel about 5 miles (south) on 40, take a right on 40 west, continue on 40 west for another 5 miles, take an exit to interstate 95 (north), travel about 30 miles, take an exit on Highway 17, continue on north, take a left on Parkwood Drive, travel past 10 blocks on Parkwood Drive.

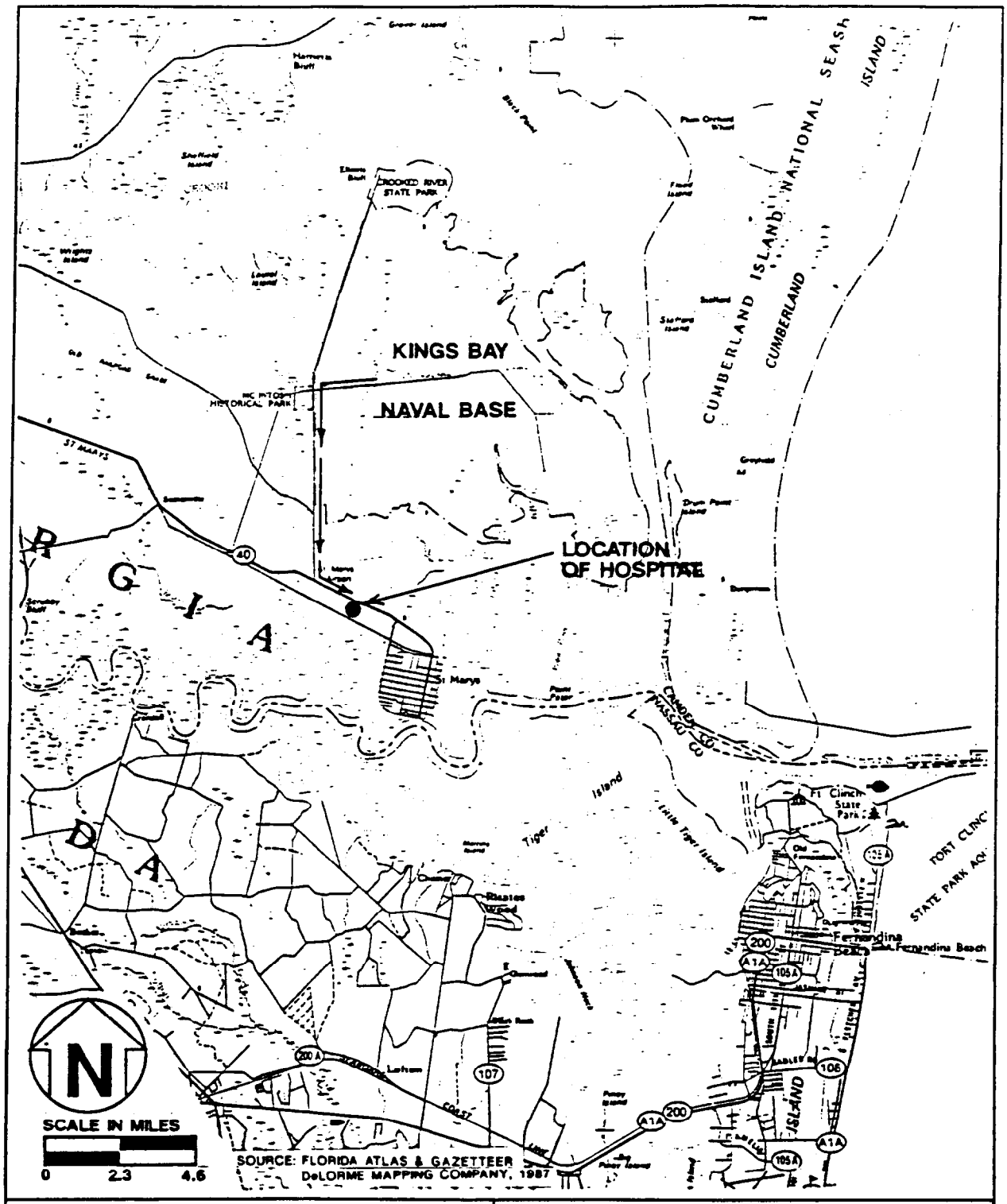


FIGURE 8-1

ROUTE TO HOSPITAL

HEALTH AND SAFETY PLAN
NSB KINGS BAY

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. Requirements 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 or 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 the 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 discrimination.

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 penalties against employers of up to $1,000 for each serious violation and for optional penalties of up to $1,000 for each nonserious violation. Penalties of up to $1,000 per day may be proposed for failure to correct violations within the proposed time period. Also, any employer who willfully or repeatedly violates the Act may be assessed penalties of up to $10,000 for each such violation.

Criminal penalties are also provided for in the Act. Any willful violation resulting in death of an 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 by both. Conviction of an employer after a first conviction doubles these maximum penalties.

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 emplyee 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 proivde considerable help and advice on solving safety and health problems or can refer you to other sources for health 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. Thse programs are usually administered by the State labor or Health department or a State university.

POSTING INSTRUCTIONS

Employees in States operating OSHA approved State Plans should obtain and post the State's equivalent poster.

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, Georgia	(404) 347-3573
Boston, Massachusetts	(617) 565-7164
Chicago, Illinois	(312) 353-2220
Dallas, Texas	(214) 767-4731
Denver, Colorado	(303) 844-3061
Kansas City, Missouri	(816) 426-5861
New York, New York	(212) 337-2325
Philadelphia, Pennsylvania	(215) 596-1201
San Francisco, California	(415) 995-5672
Settle, Washington	(206) 442-5930

Washington, D.C.
1989 (Revised)
OSHA 2203

Elizabeth Dole, Secretary of Labor

U.S. Department of Labor

Occupational Safety and Health Adminstration

Under provisions of Title 29, Code of Federal Regualtions, Part 1903.2(a)(1) employers must post this notice (or a facsimile) in a conspicuous place where notices to employees are customarily posted.

CLEAN GENERIC HASP

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY

DISTRICT I

GENERIC HEALTH AND SAFETY PLAN

APPROVED FOR:

ABB ENVIRONMENTAL SERVICES, INC.

Jack Davis 3/29/91

Health and Safety Supervisor Date
Jack Davis

3-29-91

Program Manager Date
R. Anthony Allen, III

APPROVED BY:

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND

Program Manager Date
Jerry Hudson

Health and Safety Date
Manager

Copy No. _____

GENERIC HEALTH AND SAFETY PLAN

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CHAPTER 1. INTRODUCTION

1.1 PURPOSE. ABB Environmental Services, Inc. (ABB-ES) has developed this Generic Health and Safety Plan (HASP) to guide activities conducted under the Comprehensive Long-term Environmental Action Navy (CLEAN) Program in a safe and efficient manner. This document describes the training, monitoring, and work procedures that will be employed to ensure that the program is implemented as designed. The objectives of this Generic HASP are as follows:

- to provide a safe work environment,
- to minimize the risk of human and economic losses,
- to comply with all applicable safety and health laws and regulations,
- to ensure that project work activities are carried out in a safe, efficient manner and satisfy project goals.

1.2 ORGANIZATION. The individual chapters of this Generic HASP describe personnel responsibilities; training and medical monitoring requirements; protection and monitoring equipment; work practices; special requirements for work in confined spaces and excavations; decontamination procedures; and emergency planning requirements.

1.3 IMPLEMENTATION. Each project site is classified hazardous or non-hazardous after a review of available data. Prior to on-site activities at those sites classified as hazardous, a site-specific health-specific health and safety plan (Appendix A) must be completed by the project engineer or scientist. This is accomplished by a review of available information on the site to assess the potential risks and provide an initial determination of personal protection requirements. The HASP is subsequently reviewed and must be approved by the Health and Safety Supervisor (HSS) (see Chapter 2). The designated Site Health and Safety Officer (HSO) monitors actual site conditions and may alter these requirements as needed. In all cases, personnel safety is the paramount factor in decision-making.

CHAPTER 2. AUTHORITY AND RESPONSIBILITY OF HEALTH AND SAFETY PERSONNEL

This section describes the health and safety personnel and their general responsibilities for the project.

2.1 HEALTH AND SAFETY MANAGER. The Health and Safety Manager (HSM) for ABB-ES can be reached by telephone at (207) 775-5401 in Portland, Maine. The HSM has final authority over health and safety issues that are not resolved at the site or through the Health and Safety Supervisor (HSS), and has overall responsibility for ensuring that the policies and procedures of this HASP are implemented by the Health and Safety Officer (HSO). In the various regions, the HSM may delegate additional functions to the Regional HSS.

2.2 HEALTH AND SAFETY SUPERVISOR. The HSS is the health and safety professional serving as the ABB-ES HSM's designee for this project. As such, the HSS will be responsible for (1) approval of the individual chosen to serve as the site HSO for this field operation; (2) review and approval of site-specific HASPs developed by the HSO, as well as any significant changes made over time to the site HASP; (3) oversight of the daily efforts of the HSO; (4) resolution of site disputes involving health and safety issues; and (5) implementation of the HASP by the HSO. The HSS will notify the HSM of any Stop Work Orders issued by an HSO.

2.3 HEALTH AND SAFETY OFFICER. The HSO is responsible for developing and implementing the site-specific HASP in accordance with the CLEAN Generic HASP. The HSO will conduct safety inspections and investigations of all accidents, illnesses, and incidents occurring on-site. The HSO will also conduct safety briefings and site-specific training for on-site personnel. As necessary, the HSO will accompany all U.S. Environmental Protection Agency (USEPA), Occupational Safety and Health Administration (OSHA), or other governmental agency personnel visiting the site in response to health and safety issues. The HSO, in consultation with the HSS, is responsible for updating and modifying the site-specific HAS as site or environmental conditions change.

The HSO is vested with the authority to stop site operations by ABB-ES or subcontractor personnel (STOP WORK AUTHORITY) if he or she determines that an imminent health or safety hazard or other potentially dangerous situation exists. The HSO is to immediately notify the HSS of any Stop Work Orders issued. The HSO may also recommend to the HSS or HSM that the downrange authorization of individual site personnel be revoked for health or safety reasons.

The HSO, through the HSS, ensures that all personnel entering the site are qualified for downrange deployment, in accordance with the CLEAN HASP requirements.

CHAPTER 3. TRAINING PROGRAM

All personnel working on an ABB-ES site who potentially may be exposed to toxic substances or hazardous materials will participate in an initial training program on hazardous waste site operations and an annual refresher training or supervisory training (as appropriate), as well as site-specific training before commencement of the on-site assignment. The initial Health and Safety Training Program consists of the 40-hour training program required by the Occupational Safety and Health Administration (OSHA) in standard 29 Code of Federal Regulations (CFR) 1910.120. In addition to the initial training, ABB-ES uses 8-hour annual refresher and 8-hour supervisory training elements, which are augmented by site-specific training regarding site hazards and specialized problems and protocols.

3.1 INITIAL TRAINING. All site-assigned personnel who are potentially exposed to toxic substances or hazardous materials will be required to participate in a training course on hazardous waste site operations. This training is required under provisions of the OSHA standard, and must consist of 40 hours covering the following areas:

- familiarity with the regulations and implications of OSHA regulations in 29 CFR 1910.120;
- familiarity with the organizational structure responsible for site health and safety;
- explanation of the medical surveillance requirements, including recognition of health hazards;
- instruction in the use and maintenance of personal protective equipment;
- identification and analysis of site chemical and physical hazards;
- instruction regarding monitoring equipment, including personnel and environmental sampling instruments;
- instruction in site control and decontamination procedures;
- instruction in contingency planning; and
- instruction in confined-space entry procedures.

3.2 ANNUAL REFRESHER AND SUPERVISORY TRAINING. Annually, all personnel required to participate in the initial training will take an 8-hour refresher training course as required by 29 CRF 1910.120. Those personnel with either site supervisory or health and safety responsibilities will participate in an 8-hour supervisory training course. The 8-hour supervisory training meets requirements of the annual refresher.

3.3 SITE-SPECIFIC TRAINING. All personnel assigned to an ABB-ES site must participate in the site-specific training presentation, which will cover major elements of the site HASP, as well as health and safety procedures regarding an individual's specific job responsibilities and tasks. The site HSO or health and safety designee will provide this training before an individual is permitted to work in a downrange position.

3.4 OTHER TRAINING. Additional training will be provided as determined by the HSM or the HSS, and may include additional refreshers on personal protective equipment, instrumentation, cardiopulmonary resuscitation (CPR), first aid, or any other pertinent health- or safety-related subject.

CHAPTER 4. MEDICAL SURVEILLANCE PROGRAM

4.1 HEALTH MONITORING PROGRAM. All on-site ABB-ES personnel and laboratory staff must be enrolled in the Health Monitoring Program, which is implemented through Environmental Medicine Resources, Inc., a company consisting of a team of physicians and support personnel who specialize in occupational medicine. The health monitoring program consists of an initial medical examination to establish the employee's general health profile, which provides important baseline laboratory data for later comparative study and annual examinations. The contents of the initial comprehensive physical examination and laboratory testing routine are listed in Table 4-1. Follow-up examinations are completed annually for all personnel enrolled in the health monitoring program, or more frequently if project assignments warrant testing following specific field activities. Employees are certified fit for specific activities based on the results of the medical examination (see Figure 4-1).

4.2 REVIEW OF EXPOSURE SYMPTOMS. Symptoms of exposure to hazardous materials will be reviewed for each site to indicate to personnel the recognized signs of possible exposure to those materials. This information will be supplemented with a discussion of the need for objectivity in the personal health assessment to account for normal reaction to stressful situations. The HSO will watch for outward evidence of changes in worker health. Symptoms may include skin irritations, skin discoloration, eye irritation, muscular soreness, fatigue, nervousness or irritability, intolerance to heat or cold, or loss of appetite. Employees will routinely be asked to assess their general state of health during the project. Special medical monitoring may be identified for certain sites. All on-site personnel are required to review and sign the site-specific health and safety plan describing site-specific hazards and assoicated risks (see Appendix A, Section 8.3).

TABLE 4-1
BASELINE HEALTH MONITORING PROGRAM

PHYSICAL EXAMINATION

medical history
medical examination
vision:
- near/distant
- color
audiometry
radiology: PA/LAT
spirometry
electrocardiogram

LABORATORY ANALYSIS

Complete Blood Counts and Chemistries

white blood count
differential cell counts
methemoglobin
uric acid
lactic dehydrogenase
alkaline phosphatase
calcium
phosphorus
cholesterol
urea nitrogen
glucose
albumin
globulin
total protein
total bilirubin
serum glutamic oxalacetic transaminase
hemoglobin and/or hematocrit

Urine Analysis

color and character
specific gravity
pH
protein
acetone
glucose
microscopic examination

Medical Summary
Environmental Medicine Resources, Inc.
4360 Chamblee Dunwoody Road
Atlanta, GA 30241

Ms. Cindy Sundquist
ABB Environmental Services, Inc.
261 Commercial Street
P. O. Box 7050
Portland, ME 04112

Employee:
SSN#:

Exam Date:

Re-evaluation of Toxin Exposure 06.A
Report Date:

The individual identified above has completed a medical surveillance examination. Review of the data from this examination resulted in the following conclusions:

MEDICAL AND SAFETY RESTRICTIONS/RECOMMENDATIONS

None

APPRAISAL OF LIFTING CAPACITY

Lifting Capacity for this individual appears to be II/II
(I-up to 25 lbs., II-up to 60 lbs., III-up to 100 lbs. frequently)

CLEARANCE FOR WORK WITH HAZARDOUS MATERIALS

In compliance with 29 CFR 1910.120 (f), medical clearance is issued for individual to work with hazardous materials.

USE OF RESPIRATORY EQUIPMENT

In compliance with 29 CFR 1910.134, medical clearance is issued for unrestricted use of respiratory equipment.

EXPOSURE TO TEMPERATURE EXTREMES

Exposures to temperature extremes are acceptable providing that reasonable precautions are taken.

PUBLIC LAW 100-690

Not a requirement of this examination.

DEPARTMENT OF TRANSPORTATION CERTIFICATION

Not requested.

The employee has been informed of the results of this medical examination and also advised of any specific health implications of their employment to the extent required by existing law.

David L. Barnes, M.D., FACS, FACPM
V.P. Medical Affairs/Medical Director

FIGURE 4-1
PHYSICIAN CERTIFICATION

CHAPTER 5. ENGINEERING CONTROLS

Whenever feasible, engineering controls will be used at the site to reduce employee exposure to hazardous substances. Feasible engineering controls may include the following:

- the use of pressurized cabs or control booths,
- the use of remotely operated materials-handling equipment, and
- the use of industrial-sized fans to blow hazardous vapors from the breathing zone when exposure is from a point source and a power source is available.

CHAPTER 6. PERSONAL PROTECTIVE EQUIPMENT

6.1 PERSONAL PROTECTION LEVEL DETERMINATION. The level of personal protective equipment required will be determined by the type and levels of waste or spill material present at the site where project personnel may be exposed. In situations where the types of waste or spill material on-site are unknown, the hazards are not clearly established, or the situation changes during on-site activities, the HSO must make a reasonable determination of the level of protection that will ensure the safety of investigators and response personnel until potential hazards have been determined through monitoring, sampling, informational assessment, laboratory analyses, or other reliable methods. Once the hazards have been determined, protective levels commensurate with the hazards will be used. Protection requirements will be evaluated on a continuous basis to reflect new information as it is acquired.

6.2 LEVELS OF PROTECTION. The following subsections describe the basic composition of the generally recognized protective ensembles to be used for site operations. Specific components for any level of protection will be selected based on hazard assessment; additional elements will be added as necessary. Disposable protective clothing, gloves, and other equipment, exclusive of respirators, should be used when feasible to minimize risks during decontamination and possible cross-contamination during sample handling.

6.2.1 Level A Level A protection provides the highest level of protection for skin, eyes, and the respiratory system. It is appropriate for conditions where there are potential or actual high concentrations of atmospheric vapors, gases, or particulates. Level A should be used if site operations or work functions involve a high potential for splash, immersion, or exposure to unexpected vapors, gases, or particulates of materials that are harmful to the skin or capable of being absorbed through the intact skin. Level A is used primarily for emergency situations or when the following conditions exist: (1) vapors or mists of strong acids; (2) known or probable immediately dangerous to life and health (IDLH) atmospheres with dermally active compounds; (3) high atmospheric concentrations of compounds that can be absorbed through the skin; and (4) operations that must be conducted in a confined, poorly ventilated area, where conditions requiring Level A have not yet been eliminated. The fully encapsulating suit and the pressure-demand self-contained breathing apparatus (SCBA) or hoseline respirator are the key elements in Level A personal protective equipment (PPE).

Level A equipment includes the following items:

- SCBA (pressure demand) or supplied air respirator (pressure demand with escape mask);
- total encapsulating suit;
- coveralls (optional);
- gloves (outer, chemical-resistant);

- gloves (inner, chemical-resistant);
- boots (chemical-resistant, steel-toed, steel shank);
- hardhat (optional);
- disposable protective suit, gloves, and boots (to be worn over or under encapsulating suit); and
- two-way radios.

6.2.2 Level B Level B protection should be used when the type and atmospheric concentration of substances have been identified and require a high level of respiratory protection; however, the atmospheric contaminant, splashing liquid, or other direct contact will not adversely affect or be absorbed through any exposed skin. This includes atmospheres with IDLH concentrations of specific substances that do not (1) represent a severe skin hazard, or (2) meet the criteria for use of air-purifying respirators. Level B has the same respiratory protection criteria as Level A; however, the danger of dermal exposure is not as severe.

Level B equipment includes the following items:

- SCBA (pressure demand) or supplied air respirator (pressure demand with escape SCBA),
- hooded chemical-resistant clothing (coated Tyvek)™,
- coveralls (optional),
- gloves (outer, chemical-resistant),
- gloves (inner, chemical-resistant),
- boots (chemical-resistant, steel-toed, steel shank),
- boot covers (chemical-resistant) (optional),
- hardhat (optional),
- two-way radio (optional, to be worn outside protective clothing), and
- face shield (optional).

Wrist and ankle openings should be sealed with duct tape.

6.2.3 Level C Level C protection should be used when the atmospheric contaminant, liquid splashes, or other direct contact will not adversely affect or be absorbed through any exposed skin. In addition, the types of air contaminants must have been identified, the concentration measured, and an air-purifying res-

pirator must be available that can remove the contaminants. An air-purifying respirator can only be used if the oxygen content in the air is at least 19.5 percent, the contaminant has adequate warning properties (e.g., odor, taste, and irritating effect thresholds within two times the Threshold Limit Value), the concentration of the contaminant does not exceed the IDLH, and the worker's respirator has been fit-tested. Level C has the same splash protection as Level B; however, cartridge respirators are used instead of SCBAs.

Level C equipment includes the following items:

- full-face respirator (cartridge),
- hooded chemical-resistant clothing (coated Tyvek),
- coveralls (optional),
- gloves (inner, chemical-resistant),
- gloves (outer, chemical-resistant),
- boots (chemical-resistant, steel-toed, steel shank),
- boot covers (chemical-resistant) (optional),
- hardhat (optional),
- escape mask (optional),
- two-way radios (optional, worn outside protective clothing), and
- face shield (optional).

Wrist and ankle openings should be sealed with duct tape.

6.2.4 Level D Level D is a work uniform affording minimal protection and is used for nuisance contaminants only. Level D protection should only be used when the atmosphere contains no known hazard, all potential airborne contaminants can be monitored for, and work functions preclude splash, immersion, or the potential for unexpected inhalation or contact with hazardous levels of any chemical.

Level D equipment includes the following items:

- coveralls,
- gloves (optional),
- boots (chemical-resistant, steel-toed, steel shank),
- boot covers (chemical-resistant) (optional),
- safety glasses or chemical splash goggles (optional),
- hardhat (optional),
- escape mask (optional), and
- face shield (optional).

CHAPTER 7. MONITORING EQUIPMENT

The work environment will be monitored to ensure that IDLH or other dangerous conditions are identified. At a minimum, monitoring will include evaluations for combustible atmospheres, oxygen-deficient environments, hazardous concentrations of airborne contaminants, and radioactivity.

7.1 AIR SAMPLING: EQUIPMENT, CALIBRATION, AND MAINTENANCE. To the extent feasible, the presence of airborne contaminants will be evaluated through the use of direct-reading instrumentation. Information gathered will be used to ensure the adequacy of the levels of protection being used at the site, and may be used as the basis for upgrading or downgrading levels of protection, at the discretion of the site HSO.

7.1.1 ISD Dual Detector This meter monitors for combustible gases and oxygen. It can be used to determine (1) if an area contains concentrations of combustible gases with readings as a percentage of the lower explosive limit (LEL); and (2) the percentage of oxygen. This equipment will be calibrated in accordance with the manufacturer's instructions.

7.1.2 NMS MX-241 (Explosimeter) This instrument is calibrated to detect methane and monitors combustible gases as a percentage of the lower explosive limit. It will be calibrated in accordance with the manufacturer's instructions.

7.1.3 ISD HS267 This instrument monitors for the presence of hydrogen sulfide in parts per million (ppm). It will be calibrated in accordance with the manufacturer's instructions.

7.1.4 Photovac™ Organic Vapor Analyzer 10S50 The Photovac™ Organic Vapor Analyzer (OVA) is a total organic vapor analyzer capable of detecting volatile organic compounds (VOC) that can be ionized by ultraviolet (UV) light. Model 10S50 is commonly used on-site to estimate the presence of VOCs for purposes of crew protection, well screen placement, and selection of samples for further analysis. The principle of operation is twofold: (1) the ambient temperature gas chromatograph, which breaks down mixtures of VOC into individual components identified by retention time; and (2) detection accomplished by ionization in UV light. The charged component then moves to an electrode which, in turn, results in a meter deflection proportional to the concentration of the contaminant. This instrument does not read out directly in ppm unless calibrated against the material being measured; therefore, results must be interpreted conservatively and with care. Calibration and maintenance will be performed in accordance with the manufacturer's instructions.

7.1.5 HNU IS101 and Photovac TIP Photoionization Detector Like the OVA, the photoionization detector (PID) operates on the basis of ionization of the contaminant, which results in a meter deflection proportional to the concentration of the contaminant. In the PID, ionization is caused by a UV light source. The strength of the UV, measured in electron volts (eV), determines which contaminants can be ionized. The HNU can use three different-strength UV sources, including 9.6, 10.2, and 11.7 eV; only the 10.2- and 11.7-eV probes are

currently available for field use. The TIP operates using a UV light source of 10.6 eV. Calibration and maintenance will be performed in accordance with the manufacturer's instructions.

7.1.6 Detector Tubes (MSA and Draegcr™) A colorimetric detector tube is a direct-reading instrument consisting of a glass tube impregnated with an indicating chemical, which is connected to a piston cylinder or bellows-type pump. A known volume of air is drawn through the glass tube. The contaminant in the air reacts with the indicator chemical, producing a stain the length of which is proportional to the contaminant's concentration. Care must be taken when using the detector tubes because reliability of the results depends on the proper pump calibration, the degree of stability of the reacting chemical, and the ambient temperature. Interfering gases or vapors can also positively or negatively affect measured results. Calibration and maintenance will be performed in accordance with the manufacturer's instructions.

7.2 PERSONAL MONITORING: EQUIPMENT, CALIBRATION, AND MAINTENANCE. Personal monitoring will be undertaken to characterize exposure of high-risk employees to hazardous substances encountered on-site.

7.2.1 Personal Sampling Pumps These devices can be worn by an employee to draw air samples through appropriate collection media. The units can be used to draw volumes from 2 to 3 liters per minute. Calibration will be conducted using standard industrial hygiene protocols before and after each sampling session (i.e., each day's use).

7.2.2 Passive Dosimeters or Gas Badges These devices are nonmechanical collection devices used to monitor for organic vapors and various gases. The device is worn by an employee and then sent to an industrial hygiene laboratory for analysis.

7.2.3 Thermoluminescent Dosimetry Body Badges These devices are nonmechanical collection devices used to monitor for x-ray, beta, and gamma radiation exposure. The badges are worn by ABB-ES employees and sent quarterly to Tech/Ops Landauer, Inc., for analysis.

CHAPTER 8. ZONATION

The site itself will normally be divided into three zones: (1) the majority of the work area, considered the Exclusion Zone; (2) limited areas serving as the Support Zone; and (3) an area for decontamination called the Contamination Reduction Zone (CRZ).

8.1 EXCLUSION ZONE. The Exclusion Zone isolates the area of contaminant generation and restricts (to the extent possible) the spread of contamination from active areas of the site to support areas and off-site locations. The Exclusion Zone is demarcated by the Hot Line (i.e., a tape line or physical barrier). Personnel entering the Exclusion Zone must (1) enter through the CRZ; (2) wear the prescribed level of protection; and (3) be otherwise authorized to enter the Exclusion Zone. Any personnel, equipment, or materials exiting the Exclusion Zone will be considered contaminated. Personnel will be subject to decontamination; equipment and materials will either be subject to decontamination or containerized in uncontaminated devices.

Within the Exclusion Zone, specific locations or restricted areas (clearly marked or identified) will be established (as necessary) for particular locations or around specific site operations. In the case of well drilling or excavation operations, a restricted area will be established that includes a minimum 30-foot radius from the drill rig or excavation operation. Other restricted areas may include drum areas, active site areas, sources of combustible gases or air contaminants, or other dangerous areas as they are identified. Access for emergency services to areas of specific site operations will be established.

8.2 CONTAMINATION REDUCTION ZONE. Moving out from the Exclusion Zone, starting at the Hot Line and continuing to the Contamination Control Line, is the CRZ. The CRZ is a transition zone between contaminated and uncontaminated areas of the site. When "hot" or contaminated personnel, equipment, or materials cross the Hot Line, they are assumed to be as hot or contaminated as they are going to be from site operations. Being subjected to the decontamination process, they become less contaminated; when they reach the Contamination Control Line, they are clean and can exit the CRZ without spreading contamination.

Within the CRZ is the Contamination Reduction Corridor, where materials necessary for full personnel and portable equipment decontamination are kept. A separate facility will be established for heavy equipment decontamination. In addition, certain safety equipment (e.g., emergency eye wash, fire extinguisher, stretcher, and first aid kit) are staged in this zone.

8.3 SUPPORT ZONE. The Support Zone is the outermost zone of the site, separated from the CRZ by the Contamination Control Line; it is considered a clean area. Movement of personnel and materials from the Support Zone into the CRZ is generally unrestricted, except as required through access points controlled for administrative purposes. However, only uncontaminated or decontaminated personnel or materials may enter the Support Zone from the CRZ.

The Support Zone contains the necessary support facilities (including personal hygiene facilities) for site operations. It also serves as the communications center and source of emergency assistance for operations in the Exclusion Zone and CRZ. A log of all persons entering the site will be maintained by the HSO, the field operations leader, or the site designee.

CHAPTER 9. WORK PRACTICES

9.1 GENERAL. Workers will be expected to adhere to the established safe work practices for their respective specialties (e.g., drilling, laboratory analysis, and construction). The need to exercise caution in the performance of specific work tasks is made more acute due to (1) weather conditions; (2) restricted mobility and reduced peripheral vision caused by the protective gear itself; (3) the need to maintain integrity of the protective gear; and (4) the increased difficulty in communicating caused by respirators. Work at the site will be conducted according to established protocol and guidelines for the safety and health of all involved. Among the most important of these principles for working at a hazardous waste site are the following.

- In any unknown situation, always assume the worst conditions and plan. responses accordingly.

- Use the buddy system. Under no conditions will any person be permitted to enter the Exclusion Zone alone. Establish and maintain communications. In addition to radio communications, it is advisable to develop a set of hand signals, because conditions may greatly impair verbal communications.

- Because no personal protective equipment is 100 percent effective, all personnel must minimize contact with excavated or contaminated materials. Plan work areas, decontamination areas, and procedures accordingly. Do not place equipment on drums or the ground. Do not sit on drums or other materials. Do not sit or kneel on the ground in the Exclusion Zone or CRZ. Avoid standing in or walking through puddles or stained soil.

- Disposable items will be used, when possible, to minimize risks during decontamination and possible cross-contamination during sample-handling.

- Smoking, eating, or drinking in the work area and before decontamination will not be allowed. Oral ingestion of contaminants is a likely means of introducing toxic substances into the body.

- Avoid heat and other work stresses related to wearing protective gear. Work breaks should be planned to prevent stress-related accidents or fatigue.

- Maintain monitoring systems. Conditions can change quickly if subsurface areas of contamination are penetrated.

- Conflicting situations that may arise concerning safety requirements and working conditions must be addressed and resolved rapidly by the HSO to avoid any motivation or pressure to circumvent established safety policy.

- To the extent feasible, handling of contaminated materials should be done in a remote area, particularly when drummed or other containerized hazardous waste materials are found on-site. Every effort should be made to

identify the contents of containers found on-site before they are subject to material-handling applications.

- Personnel must be observant of not only their own immediate surroundings but also that of others. Everyone will be working under constraints; therefore, a team effort is needed to notice and warn of impending dangerous situations. Extra precautions are necessary when working near heavy equipment while using personnel protective gear because vision, hearing, and communication can be restricted.

- Contact lenses are not allowed to be worn on-site; if corrosive or lachrymose substances enter the eyes, proper flushing is impeded.

- All facial hair that interferes with the face piece fit must be removed before donning a respirator at all sites requiring Level C or Level B protection.

- Rigorous contingency planning and dissemination of plans to all personnel minimizes the impact of rapidly changing safety protocols in response to changing site conditions.

- Personnel must be aware that chemical contaminants may mimic or enhance symptoms of other illnesses or intoxication. Avoid excess use of alcohol or working while ill during field investigation assignments.

- The site leader, HSO, and sampling personnel will maintain project records in a bound notebook (e.g., daily activities, meetings, incidents, and data). Notebooks will remain on-site for the project duration so that replacement personnel may add information, thereby maintaining continuity. The notebooks and daily records will become part of the permanent project file.

- Appropriate provisions of the U.S. Army Corps of Engineers "Safety and Health Requirements Manual" (EM385-1-1) will be followed.

9.2 SITE ENTRY PROCEDURES. In most cases, ABB-ES teams are not the first on-site investigators. Considerable knowledge of site history and current status allows preparation of a HASP with reasonable assurance that personnel are adequately protected. In the event that sufficient site information is not available to perform a summary risk assessment and assign the appropriate level of personal protective equipment, the following procedures should be followed. It must be understood that verification of the level of contamination (even with background information) will always require some of the following steps.

1. Recognize that ABB-ES's presence on-site implies a perceived contamination potential by the client.

2. Assume that the site is contaminated and conduct a site safety reconnaissance, consisting of the following activities:

   - establish a CRZ (decontamination area),

- survey the site at the highest level of protection practicable, beginning with a perimeter survey and gradually covering all areas of proposed activity with the following (as appropriate):

    - HNU PID
    - OVA
    - radiation survey meter
    - personal air sampling pumps
    - chemically reactive indicator tubes
    - oxygen-deficiency meter
    - explosive mixture meter,

- Establish a "hot zone,"

- Review data, assess risk, and select the appropriate level of protection.

3. Prepare a summary site HASP and document all data acquired.

CHAPTER 10. CONFINED-SPACE ENTRY PROCEDURES

10.1 CONFINED SPACE CLASSIFICATION. Confined spaces are classified according to existing or potential chemical and physical hazards. Classification is based on characteristics of the confined space, oxygen level, flammability, and toxicity. Table 10-1 defines the parameters of each classification. If any hazard presents a situation that is IDLH, the confined space is classified as Class A. Classification is determined by the most hazardous condition of entering, working in, and exiting a confined space. Class B confined spaces have the potential for causing injury and illness but are not IDLH. Class C entry is one in which the chemical hazard potential is minimal and does not require any special modification in work procedures.

10.2 ENTRY PROCEDURES

10.2.1 Team Size A minimum of three workers is required for each confined space activity; that is, two entry and one standby, or one entry, one rescue, and one standby. If the former arrangement is used, all three workers must be ABB-ES employees. If the latter arrangement is used, the standby could be a non-ABB-ES team member, assuming he or she has comparable training, is proficient in the assigned duties, and is capable of using all safety equipment.

The one entry, one rescue, one standby arrangement should only be used when the confined space is relatively small or the entry person will be in the line of sight at all times. In this instance, the rescue person acts as the second person in the "buddy system."

The two entry, one standby arrangement is used when the area of the confined space is larger, and the tasks may take the worker away from the entryway. Again, care must be taken using this arrangement because the standby person cannot enter the confined space and attempt rescue unless adequately protected (i.e., respiratory and dermal) and replaced by another qualified standby person.

Three workers is the minimum number required for these activities and, in most cases, should only be used for relatively nonhazardous confined spaces. Additional crew may be needed if entering a Class A or Class B confined space, including rescue, decontamination, and line-of-sight personnel.

10.2.2 General Entry Procedures The following steps must be taken when entering a confined space.

1. Inspect all pieces of equipment to ensure they are in good working order. DO NOT ENTER CONFINED SPACE WITH DEFECTIVE EQUIPMENT.

2. Conduct a background check to identify all potential hazards that may be encountered in the confined space. Determine whether there is potential for fire or explosion hazards, as well as a toxic or oxygen-deficient atmosphere.

CONFINED SPACE CLASSIFICATION TABLE

PARAMETERS	CLASS A (LEVEL A OR B PPE)	CLASS B (LEVEL B OR C PPE)	CLASS C (LEVEL D PPE)
Characteristics	Immediately dangerous to life: Rescue procedures require the entry of more than one individual fully equipped with life-support equipment; maintenance of communication requires an additional standby person stationed within the confined space.	Dangerous, but not immediately life-threatening: Rescue procedures require the entry of no more than one individual fully equipped with life-support equipment; indirect visual or auditory communication with workers.	Potential hazard requires no modification of work procedures: Standard rescue procedures, direct communication with workers from outside the confined space.
Oxygen	19.4 percent or less *(122-mm Hg) or greater than 25 percent *(190 mm Hg)	19.5 to 21.4 percent *(122- to 147-mm Hg) or 21.5 to 25 percent (163- to 190-mm Hg)	19.5 to 21.4 percent *(148- to 163-mm Hg)
Flammability Characteristics	20-percent or greater LEL	10- to 19-percent LEL	10-percent LEL or less
Toxicity	**IDLH	Between the TLV/PEL and the **IDLH. If air-purifying respirators are used, maximum level based on breakthrough time (1,000 ppm maximum).	Less than the TLV/PEL
Respiratory Protection	SCBA or supplied air respirator with escape bottle.	SCBA, supplied air respirator with escape bottle or air-purifying respirator.	None.

* Based on total atmospheric pressure of 760-mm Hg (sea level).

** Immediately Dangerous to Life or Health, as referenced in NIOSH Registry of Toxic and Chemical Substances, Manufacturing Chemists data sheets, industrial hygiene guides, or other recognized authorities.

NOTES: Hg = mercury; LEL = Lower Explosive Limit; PEL = Permissible Exposure Limit; SCBA = Self Contained Breathing Apparatus; TLV = Threshold Limit Value PPE = Personal Protective Equipment

3.88.94T
1.0.0

3. Before entry, the atmosphere inside the confined space must be tested. An attempt should be made to test the atmosphere without opening the entryway (i.e., through a vent line or a small opening). If the entryway must be opened to test and only low levels are expected in the confined space, crack open the entryway, test the breathing zone first, and then test the confined space. If potentially high levels are expected in the breathing zone, respiratory protection should be worn before opening the entryway cover.

4. If an explosive, toxic, or oxygen-deficient atmosphere is detected, purge or ventilate the confined space prior to entry. Retest the atmosphere three times at 5-minute intervals. A person can enter the confined space without respiratory protection only if all three test results are below the Permissible Exposure Limit/Threshold Limit Value (PEL/TLV), 10 percent of the LEL, and above 19.5-percent oxygen (all three conditions must be met). (NOTE: Any downward deflection of the readings on the oxygen meter from background [i.e., 20.9 percent] should be viewed as potential for an IDLH atmosphere. Unless contaminants are known to be nontoxic, do not enter the confined space without respiratory protection if the oxygen level is below background.)

5. Install a blank or a block, or otherwise isolate, lockout, and tag all chemical, physical, and/or electrical hazards wherever possible.

6. If using an air-purifying respirator or if an IDLH and/or explosive atmosphere exists, air monitoring must be on a continuous basis. If respiratory protection is not used and there is potential for atmospheric conditions to change due to work practices or conditions, air monitoring should be done periodically. In all these cases, a 5-minute escape pack must be used.

7. Record all results of the tests for hazardous conditions including the location, time, date, and weather (if applicable); and readings on the PID, combustible gas meter, oxygen-deficiency meter, Draeger tubes,. and any other equipment used on the Confined-Space Entry Checklist-General Entry form (Figure 10-1) and the Confined-Space Entry Checklist (Figure 10-2). Send a copy of the completed form to the HSM or the HSS.

8. Wear appropriate clothing for site conditions, as determined by the HSO.

   A safety belt or harness with lifeline must be worn if hazardous conditions exist, although good safety precautions dictate their use regardless of "existing" conditions. If the diameter of the entryway is less than 18 inches, the wrist-type harness must be used and special provisions made if a supplied-air respirator is necessary.

9. One person (i.e., standby) must remain at the entryway at all times and must keep continuous contact with the person entering the confined space. Contact can be maintained by line of sight, listening for sounds, the safety line, and/or radio. The standby person must not enter the confined space unless another trained person is available to act as standby, and he

CONFINED SPACE ENTRY CHECKLIST
GENERAL ENTRY

Site Name: _____ Entry Date: _____

Site Location: _____

Type of Confined Space: _____ Weather: (if applicable) _____

Work to be Performed: _____

Level of Personal Protection: _____

Potential Hazards: (Check all that apply)

☐ Corrosive	☐ Reactive	☐ Radioactive	☐ Hot Equipment
☐ Ignitable	☐ Volatiles	☐ Noise	☐ Falling Objects
☐ Toxic	☐ Biological	☐ Sharp Objects	☐ Pressure Systems

☐ Other: (list) _____

Yes	No	N/A	
			Will work performed produce additional hazards (e.g. cleaning)? List: _____
			Were instruments calibrated prior to entry?
			Was confined space ventilated prior to entry?
			Will ventilation continue during entry?
			Is air intake of the ventilation system located in an area free of exhaust and combustible/toxic substances?
			Has space been isolated from other systems?
			Has mechanical equipment been locked-out or disconnected?
			Has mechanical equipment been blocked, chocked, disengaged, and/or disconnected where necessary?
			Are safety lines and harnesses used?
			Will wrist-type harnesses be used if entryway is less than 18 in.?
			Are nonsparking tools and intrinsically safe/explosion-proof powered tools and lighting used?

Entry Person(s): _____

Standby Person: _____ Rescue Person: _____

Other: _____

HSO: _____

FIGURE 10-1

CONFINED SPACE ENTRY CHECKLIST WORKSHEET

INITIAL ATMOSPHERE TESTING RESULTS: Record time and results of initial testing. If ventilation is necessary, record readings when the atmosphere stabilized and at 5-minute intervals.

	Breathing Zone	Initial	Atmosphere Stabilized	@ 5 min.	@ 10 min.
Time					
Combustible Gas Meter (%LEL)					
Oxygen Meter (%Oxygen)					
Hydrogen Sulfide Meter (ppm)					
PID Meter (ppm)					
Draeger Tube (ppm) Tube:					
Other List:					

ENTRY ATMOSPHERE TESTING RESULTS: Record time and the results of monitoring at initial entry and at 10-minute intervals. If no change in levels, extend to every 15 minutes. If significant fluctuations occur, reduce to every 5 minutes. (Note: Meters should be operated continuously in the confined space.)

	Initial				Final
Time					
Combustible Gas Meter (%LEL)					
Oxygen Meter (%Oxygen)					
Hydrogen Sulfide Meter (ppm)					
PID Meter (ppm)					
Draeger Tube (ppm) Tube:					
Other List:					

FIGURE 10-2

or she is equipped with adequate respiratory and dermal protection. (In most cases, respiratory protection would be an airline respirator or SCBA.)

10. Do not smoke when working in or near confined spaces and do not take flash-lit photographs when explosive gases are known or suspected to be present.

11. Do not rely on permanent ladders because they are often in poor condition. If they must be used, be sure of footing. Inspect permanent ladders for deterioration before entering and while descending. Try each step with one foot, while standing on the step above. When in doubt, use either a portable ladder of adequate height to reach 3 feet above opening or a rope ladder, or lower the entry person using the tripod. If a portable ladder is used, it should be tied off, if possible; otherwise, it should be held in place by the standby person.

12. Do not work without adequate lighting. Use only "explosion-proof" lights or hand lamps if combustible atmospheres are possible.

13. The entry person must not remain in the confined space if he or she becomes even slightly drowsy, faint, dizzy, or otherwise uncomfortable. Many of the gases that cause the most problems are odorless, tasteless, and invisible.

10.2.3 Manhole/Sewer Entry When preparing to enter a manhole/sewer, the following safety measures must be taken.

1. Inspect all pieces of equipment to ensure they are in good working order. DO NOT ENTER CONFINED SPACE WITH DEFECTIVE EQUIPMENT.

2. Park the vehicle near the manhole (DO NOT leave the vehicle running). If the manhole is in the street, it is best to park so as to detour oncoming traffic around the manhole. The vehicle's emergency flashers and portable yellow warning beacon must be ON. The vehicle serves as protection from oncoming traffic, can be used to store emergency equipment (e.g., SCBA and first aid kit), and can be used in an extreme emergency to slowly pull an injured person from the confined space if a tripod with hoist attachment is unavailable or inoperative.

3. Erect portable barricades or cones around the manhole and in front of the vehicle to see that traffic is adequately diverted and to prevent pedestrians from falling in. Reflective vests should be worn so that workers are visible to approaching traffic.

4. If there are openings large enough to admit sampling tubes, test for the presence of explosive and toxic gases before removing each manhole cover. Otherwise, raise one side of the cover using the cover hook or pick, prop it slightly open, and conduct the tests.

5. If toxic or explosive gases are detected in the sewer, report this immediately to the local fire department and/or department of public works.

6. Using the Manhole/Sewer Entry Log Form, record the results of tests for hazardous conditions, including location, manhole number (if applicable), time, date, weather (if applicable), and readings on the PID, combustible gas meter, oxygen-deficiency meter, and Draeger tube (Figure 10-3). Send a completed copy of the form to the HSS.

7. Remove manhole covers with a cover hook or pick; do not improvise. Be careful of fingers and toes; the cover is usually heavy and difficult to handle. Unless the cover is extremely heavy, it is safer for only one worker to handle it.

8. Test the atmosphere; if a toxic, flammable, or oxygen-deficient atmosphere exists, ventilate the sewer. Depending on the hazard, ventilation can be accomplished in various ways, for example: (1) remove and vent the adjoining upstream and downstream manhole covers, as soon as possible and well in advance of entering the manhole (high hazard); and (2) vent the manhole in which entry will occur (very low hazard). If a blower is used, it is desirable to establish a flow of air in the sewer, <u>in</u> one manhole and <u>out</u> another. Ensure that the air intake is well away from automobile exhaust, and combustible and/or toxic atmospheres. Appropriate traffic control measures must be taken by barricading or otherwise marking the open manholes.

9. After ventilating, test for explosive and toxic gases and oxygen deficiency in the manhole at ground level and at the bottom; record the results. If entering the sewer itself, make the same tests at the manholes at either end. If ventilation is necessary, monitor the atmosphere in the manhole while work progresses, or continue operation of the blower. Continuous monitoring (i.e., equipment ON during entire entry) is imperative because conditions within the sewer may change rapidly. Do not enter a manhole while there is an oxygen deficiency without a pressure-demand, air-supplied breathing apparatus. If the oxygen level is below background, i.e., less than 20.9 percent, caution must be taken because an IDLH atmosphere may exist.

10. When entering manholes or tanks, wear hardhats, protective clothing, and unless inappropriate, respiratory protection and safety belt or harness with lifeline. If the manhole is less than 18 inches in diameter, a wrist-type harness must be used and special provisions made if air-supplied respirators are necessary. When working in manholes greater than 12 feet deep, in the sewer itself, or where potential exists for gases to appear unexpectedly, a 5-minute emergency egress air supply is required (unless the time required to don the emergency respirator is greater than what would be needed to exit the manhole).

11. At least one person (i.e., standby) must remain at the manhole at all times and must keep continuous contact with the person entering the sewer. Contact can be maintained by line of sight, listening for sounds, and the

MANHOLE/SEWER ENTRY LOG

Location:_____ Date:_____

Crew Chief:_____ Others:_____

HSO:____ _____ _____

Two-way radio available and working?_____

Traffic control equipment in place?_____

Location of nearby emergency telephone:_____

Level of personal protective equipment to use:_____

Safety harness with lifeline used?_____

Monitoring equipment calibrated prior to use?_____

INITIAL ATMOSPHERE TESTING RESULTS

	Time	Hydrogen Sulfide	PID	Oxygen	LEL	Other
Manhole Opened						
Begin Ventilation						
Atmos. Stabilized						
@ 5 minutes						
@ 10 minutes						

ENTRY ATMOSPHERE TESTING RESULTS

	Time	Hydrogen Sulfide	PID	Oxygen	LEL	Other
Entry						
@ 10 minutes*						
@ 20 minutes*						
@ 30 minutes*						

* More often if needed

FIGURE 10-3

safety line and/or radio. The standby person must not enter the manhole unless another trained person is available to act as standby and has adequate respiratory and dermal protection available. (In most cases, respiratory protection will be an airline respirator or SCBA.) The standby/rescue person should be suited up (but not yet on air) before the work crew enters the confined space.

12. Do not smoke when working in or near manholes. Do not take flash-lit photographs when explosive gases are known or suspected to be present.

13. Do not rely on the manhole ladders because they are often in poor condition. If they must be used, be sure of footing. Inspect manhole ladders for deterioration before entering and while descending. Try each step with one foot, while standing on the step above. When in doubt, use a portable ladder of adequate height to reach 3 feet above the manhole opening, a rope ladder, or lower the entry person using the tripod. If a portable ladder is used, it should be tied off if possible; otherwise, it should be held in place by the standby person.

14. Do not work without adequate lighting. Use only "explosion-proof" lights or hand lamps in the manhole or sewer.

15. The entry person must not remain in the manhole or sewer if he or she becomes even slightly drowsy, faint, dizzy, or otherwise uncomfortable. Remember that carbon monoxide, carbon dioxide, methane, and hydrogen sulfide, which cause the most trouble, are odorless (hydrogen sulfide has a distinct odor only during initial exposure), tasteless, and invisible.

CHAPTER 11.0 EXCAVATION AND TRENCHING

11.1 EXCAVATION PROCEDURES. Because excavations and trenches pose a hazard to employees, structures, and equipment, all excavations created during site operations will be done in accordance with 29 CFR 1926 Subpart P. The following steps summarize the excavation procedures that will be followed by all ABB-ES personnel.

- Prior to excavating or trenching, all surface encumbrances located so as to create a hazard to the employees will be removed or supported, and all underground utilities will be determined and located.

- Entry into excavations will be avoided whenever possible. If entry is unavoidable, the excavation will be considered a confined space; as such, entry will be done in accordance with the Confined Space Entry Program (see Chapter 10.0).

- Under no circumstances will site personnel enter excavations that are not adequately protected from cave-ins by shoring or sloping.

- Stairways, ladders, or ramps will be located in trenches deeper than 4 feet and situated to require no more than 25 feet of lateral travel.

- Excavations below the base of a building or structure will not be permitted unless the building or structure is adequately supported or a registered professional engineer determines that the excavation will not pose a hazard to the employee.

- All equipment will be kept at least 2 feet from the edge of the excavation.

- Any excavation left open and unattended will be barricaded or covered until it can be backfilled.

11.2 SLOPING. Acceptable options for sloping or benching include the following:

Option 1. a slope of 1½ horizontal to 1 vertical (34 degrees measured from the horizontal);

Option 2. determination of the maximum allowable slope based on soil conditions and in accordance with the conditions and requirements set forth in 29 CFR 1926 Subpart P, Appendices A and B;

Option 3. designs of sloping or benching systems using tabulated data approved by a registered professional engineer; and

Option 4. other systems designed by a registered professional engineer;

11.3 SHORING. Acceptable options for shoring include the following:

Option 1. designs using Appendices A, C, and D of 1910.126 Subpart P;

Option 2. designs using manufacturers tabulated data;

Option 3. designs using tabulated data approved by a registered professional engineer, and

Option 4. other support systems designed by a registered professional engineer.

CHAPTER 12. TEMPERATURE EXTREMES

12.1 HEAT STRESS. Due to the increase in ambient air temperatures and the effects of protective outer wear decreasing body ventilation, there is increased potential for injury, specifically heat casualties. Site personnel will be instructed in the identification of a heat stress victim, the first-aid treatment procedures for the victim, and the prevention of heat stress casualties.

12.1.1 Identification and Treatment

12.1.1.1 Heat Exhaustion.

Symptoms. Heat exhaustion usually begins with muscular weakness, dizziness, nausea, and a staggering gait. Vomiting is frequent. The bowels may move involuntarily. The victim is very pale, the skin is clammy, and he or she may perspire profusely. The pulse is weak and fast; breathing is shallow. The victim may faint unless he or she lies down. This may pass; however, sometimes it persists and, while heat exhaustion is generally not considered life threatening, death could occur.

First Aid. Immediately remove the victim to the CRZ in a shady or cool area with good air circulation. Remove all protective outer wear. Call a physician. Treat the victim for shock (i.e., have the victim lie down, raise the feet 6 to 12 inches, and maintain body temperature but loosen all clothing). If the victim is conscious, it may be helpful to give sips of water. Transport the victim to a medical facility.

12.1.1.2 Heat Stroke.

Symptoms. This is the most serious of heat casualties because the body excessively overheats. Body temperatures often are between 107 and 110° F. The victim will have a red face and may not be sweating. First there is often pain in the head, dizziness, nausea, oppression, and dryness of the skin and mouth. Unconsciousness follows quickly and death is imminent if exposure continues. The attack will usually occur suddenly. Heat stroke is always serious.

First Aid. Immediately evacuate the victim to a cool and shady area in the CRZ. Remove all protective outer wear and all personal clothing. Lay the victim on his or her back with the head and shoulders slightly elevated. It is imperative that the body temperature be lowered immediately. This can be accomplished by applying cold wet towels or ice bags to the head and groin. Sponge off the bare skin with cool water or rubbing alcohol, if available, or even place the victim in a tub of cool water. The main objective is to cool without chilling. Do not give stimulants. Transport the victim to a medical facility as soon as possible.

12.1.2 Prevention of Heat Stress

One of the major causes of heat casualties is the depletion of body fluids and salts through sweating. Fluids should be maintained in the Support Zone. Salts can be replaced by either a 0.1 percent salt solution, more heavily salted foods,

or commercial mixes such as Gatorade™. The commercial mixes are advised for personnel on low-sodium diets.

During warm weather, a work schedule will be established that allows most work to be conducted during the morning hours, before ambient air temperature levels reach highs.

A work rest schedule will be implemented for personnel required to wear Level B or C protection (i.e., an impervious outer garment) with sufficient time allowed for personnel to "cool down" (this may require working in shifts). Two hours is the maximum time between breaks at Level B or C, regardless of temperature. At elevated temperatures, breaks should be scheduled as follows:

Ambient Temperatures	Maximum Time Between Cool Down Breaks
Above 90 °F	¼ hour
85 to 90 °F	½ hour
80 to 85 °F	1 hour
70 to 80 °F	1½ hours

12.1.3 Heat Stress Monitoring Monitoring of personnel wearing impervious clothing should commence when the ambient temperature reaches 70 °F, with increased frequency if ambient temperature increases or as slow recovery rates are indicated. When temperatures exceed 85 °F, workers should be monitored for heat stress after every work period. As a screening mechanism of the body's recuperative ability to excess heat, one or more of the following techniques should be used.

1. Measure the heart rate (HR) for 30 seconds, by radial pulse, as early in the resting period as possible. At the beginning of the rest period, the HR should not exceed 110 beats per minute. If the HR is higher, the next work period should be shortened by 10 minutes (or 33 percent), with the length of the rest period staying the same. If the pulse rate is still above 110 beats per minute at the beginning of the next rest period, the following work cycle should again be shortened by 33 percent.

2. Measure oral body temperature with a clinical thermometer, as early as possible in the resting period. At the beginning of the rest period, oral temperature (OT) should not exceed 99 °F. If OT exceeds 99 °F, the next work period should be shortened by 10 minutes (or 33 percent), with the length of the rest period staying the same. If the OT again exceeds 99 °F at the beginning of the next period, the following work cycle should be further shortened by 33 percent. OT should also be measured at the end of the rest period to ensure that it has dropped below 99 °F.

3. Maintain good hygienic standards by changing clothes frequently, showering daily, and allowing clothing to dry during rest periods. Persons who notice skin problems should immediately consult medical personnel.

12.2 COLD STRESS. Cold weather may often cause problems for personnel working outside, even at temperatures above freezing. As temperatures drop below freezing, the potential for cold weather injuries increases dramatically, as does the potential for equipment failure. Because of the considerable danger to personnel, outdoor work should be suspended if the ambient temperature drops below 0 °F (-18 °C) or if the windchill factor drops below -29 °F (-34 °C). These levels represent guidelines that should be used as an action level unless the HSO determines and documents otherwise. Table 12-1, which shows equivalent temperatures (i.e., windchill) for a range of ambient conditions, should also be referred to.

Snow and ice increase the risks to personnel and operations through reduced visibility, increased potential for falling injuries, reduced on-site mobility, and the increased time required to access the site (or off-site support services).

In view of these factors, it is critical that the HSO establish site-specific safety and operating protocols, and that all on-site personnel be made aware of the risks.

12.2.1 Local Cold Injuries Local cold injuries affect specific areas of the body (e.g., fingers, ears, or toes), including the more commonly recognized injuries described in the following subsections.

12.2.1.1 Chilblains Chilblains is a chronic condition affecting the skin and peripheral capillary circulation, resulting from prolonged exposure of the bare skin, primarily in the extremities, to temperatures at or below 60 °F. The best method of preventing and treating chilblains is to cover and protect the skin, thereby avoiding prolonged exposure to the cold.

12.2.1.2 Frostbite Frostbite is freezing of the hands, feet, ears, and exposed parts of the face as a result of exposure to very low temperatures. Frostbite occurs when ice crystals form in the fluid in cells of the skin and tissue. As long as blood circulation remains good, frostbite will not occur.

There are three stages of frostbite: incipient frost bite (frostnip), superficial frostbite, and deep frostbite. The classification depends on severity and can range from incipient frostbite (frostnip), which affects the skin; to superficial frostbite, which involves the skin and the tissues immediately beneath it; to deep frostbite, which is much more serious with damage that may affect deeper tissue and even bone.

Symptoms. Symptoms for each of the three stages of frostbite are described as follows.

- Frostnip. Skin first turns red and then later becomes pale or waxy white. There may be tingling, stinging, aching, an uncomfortable sensation of coldness or numbness, or no noticeable symptoms.

- Superficial Frostbite. The skin turns white or gray-white and is waxy in appearance. It is firm to touch (i.e., does not move

TAB 2-1

COOLING POWER OF WIND ON EXPOSED FLESH EXPRESSED
AS AN EQUIVALENT TEMPERATURE (UNDER CALM CONDITIONS)

HEALTH AND SAFETY PLAN
PART II

ESTIMATED WIND SPEED (in mph)	ACTUAL TEMPERATURE READING (°F)											
	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
	EQUIVALENT CHILL TEMPERATURE (°F)											
calm	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
5	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68
10	40	28	16	4	-9	-24	-33	-46	-58	-70	-83	-95
15	36	22	9	-5	-18	-32	-45	-58	-72	-85	-99	-112
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-121
25	30	16	0	-15	-29	-44	-59	-74	-88	-104	-118	-133
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109	-125	-140
35	27	11	-4	-20	-35	-51	-67	-82	-98	-113	-129	-145
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116	-132	-148

(Wind speeds greater than 40 mph have little additional effect.)	LITTLE DANGER In <hour with dry skin. Maximum danger of false sense of security.	INCREASING DANGER Danger from freezing of exposed flesh within 1 minute.	GREAT DANGER Flesh may freeze within 30 seconds.

Trenchfoot and immersion foot may occur at any point on this chart.

Source: Developed by U.S. Army Research Institute of Environmental Medicine, Natick, Massachusetts.

easily) and the tissue beneath the skin is soft and resilient. There is a lack of sensation in the area.

- Deep Frostbite. The tissue is pale, cold, and solid with possible blisters and swelling. The hands and feet are especially susceptible to deep frostbite.

Emergency Treatment of Frostbite. Frostnip is easily treated in the field by the application of body heat, which should be applied before the affected area becomes numb. If frostnip affects your fingers and hands, place them against the skin of your chest or in your armpits. To warm your face, hold a mitten or scarf over the lower part of your face and breathe into it. Thaw frozen spots immediately. Do not rub affected areas.

Superficial frostbite usually responds to the application of body heat, as described previously. If the skin does not respond to body heat or if it resembles the early stages of deep frostbite, follow the emergency treatments listed in the following paragraphs. DO NOT rub affected areas.

For deep frostbite, if possible, the injured person should be taken to a heated shelter to avoid further frostbite. If it can be done without the danger of further frostbite, remove all constricting items (e.g., boots, gloves, and socks) from the injured area. RAPID REWARMING WILL MINIMIZE TISSUE LOSS. If possible, warm the extremities in a carefully controlled water bath (104 to 106 °F) until tips of the fingers or toes turn pink and feeling is restored. If a water bath is not available, either apply wet packs (100 to 112 °F) to the person's body, or gently wrap frostbitten area in blankets or some other warm material.

DO NOT attempt to thaw the affected parts by exercising them or heating them in front of an open fire, heat lamp, radiator, or stove. The person could receive a heat injury as a result of sensation loss.

DO NOT use snow to thaw frostbite. DO NOT rub, massage, or use pressure on the affected areas. Keep the frostbitten parts elevated if possible. Watch to see if CPR is necessary. Give the victim warm drinks such as tea, coffee, or soup. DO NOT GIVE ALCOHOLIC BEVERAGES. Have the victim exercise fingers or toes as soon as possible, but only after they are warmed. DO NOT allow a person with frostbitten feet to walk; walking may cause additional damage.

Medical Treatment of Frostbite.

- Frostnip. Usually does not require medical care.
- Superficial Frostbite. Blisters may require medical care.
- Deep Frostbite. EARLY MEDICAL TREATMENT IS URGENT! Transport the victim to medical care facilities at once.

Prevention of Frostbite. It is far easier to prevent or stop frostbite in earlier stages than to thaw and take care of badly frozen flesh. To protect the body against frostbite, the following precautions should be taken:

- Wear enough clothing to protect against the cold and wind.
- Wear warm gloves and boots.
- Pull a scarf or jacket flap over the lower part of the face or pull a hood tightly around the face.
- Occasionally exercise the face, fingers, and toes to keep them warm and to detect any areas that may have become numb.
- Crew members should watch each other closely, especially the face, for signs of frostbite.

12.2.1.3 Immersion Foot. Immersion foot (formerly called trenchfoot) is a cold injury resulting from prolonged exposure to near-freezing temperatures when standing or walking on wet or swampy ground.

Symptoms. In the early stages, the feet and toes are pale, cold, numb, and stiff, and walking is difficult. If preventive action is not taken, the feet will swell and ache; in extreme cases, this may result in irreversible damage to the tissues of the foot or leg.

Emergency Treatment of Immersion Foot. Handle feet very gently. DO NOT rub or massage. If necessary, clean feet carefully with soap and warm water, then dry, elevate, and expose to warm but not hot air.

Prevention of Immersion Foot. Because the early stages of immersion foot are not painful, crew members must be constantly on the alert and check feet often when working in cold, wet conditions. Keep feet dry by wearing waterproof footgear and changing socks frequently because perspiration, trapped inside waterproof boots or heavy footgear, can contribute to immersion foot symptoms. Avoid standing in wet areas. If feet get wet, dry them as soon as possible, warm them with your hands, then use foot powder, and change to dry socks. If you cannot change wet boots and socks, exercise your feet frequently by wriggling your toes and moving your ankles. Never wear tight boots.

12.2.2 Systemic Cold Injuries Systemic injuries are those that affect the entire body system. Severe body cooling, known as systemic hypothermia, can occur at temperatures well above freezing. Hypothermia, which can be fatal, is the progressive lowering of body temperature accompanied by rapid, progressive mental and physical collapse. A large percentage of wilderness deaths are the result of hypothermia.

Hypothermia is caused by exposure to cold, and is aggravated by moisture, cold winds, fatigue, hunger, inadequate clothing or shelter, and excessive perspiration from strenuous exercise followed by too rapid cooling.

Hypothermia often occurs between temperatures of 30 to 50 °F, which most people believe are not dangerous. Crew members should be alert for symptoms of hypothermia, especially when temperatures are dropping rapidly or when they must work in rain, snow, or ice.

Hypothermia may occur on land or following submersion in even moderately cold water (i.e., 65 °F or lower). On land, hypothermia may take a full day or more of exposure to develop; however, if the conditions are extremely severe, death may occur within a few hours of initial symptoms.

In cold water, death may seem to be from drowning; in reality, it is usually the result of hypothermia. In water, skin and nearby tissues chill very fast; in 10 to 15 minutes, the temperature of the heart and brain may drop. When the core (i.e., internal body) temperature reaches 90 °F, unconsciousness may occur; when body temperature drops to 80 °F, heart failure is possible.

12.2.2.1 Symptoms In the early stages of hypothermia, the body begins to lose heat faster than it can be produced, making an effort to stay warm by shivering. When the body can no longer generate enough heat to overcome heat loss and the energy reserves of the body become exhausted, body temperature begins to drop. This affects the ability of the brain to make judgments and also results in loss of muscular control. As the body temperature drops, hypothermia symptoms become increasingly severe, as shown in the following table:

SYMPTOMS OF HYPOTHERMIA	APPROXIMATE CORE TEMPERATURE
Person is conscious, alert with increased respiration. Shivering may become uncontrollable as core temperature nears 95 °F.	Above 95 °F
Person is conscious but disoriented and apathetic. Shivering is present but diminishes as temperature drops. Below 92 °F, respiratory rate gradually diminishes and pupils begin to dilate.	95 to 90 °F
Person is semiconscious. Shivering is replaced by muscular rigidity. Pupils are fully dilated at about 86 °F.	90 to 86 °F
Unconscious; diminished respiration.	Below 86 °F
Barely detectable or nondetectable respiration.	Below 80 °F

12.2.2.2 Emergency Treatment of Hypothermia Move hypothermia victim to shelter and warmth as rapidly as possible. In very mild cases, dry clothing and shelter may be all that is needed. Gently remove all of the victim's wet clothing (so energy is not expended by warming and drying wet clothing) and replace it with a dry set. Give the person something warm to drink. DO NOT GIVE ALCOHOLIC BEVERAGES.

ALL OTHER HYPOTHERMIA CASES SHOULD BE CONSIDERED MEDICAL EMERGENCIES. PROVIDE EXTERNAL HEAT IN ANY WAY POSSIBLE! A warm bath (with the water kept between 105 and 110 °F) is the most effective way of warming a victim of hypothermia. NEVER put an UNCONSCIOUS VICTIM in a bathtub.

If it is not possible to give the person a warm bath, use one of the following.

ALTERNATE METHODS.

- Wrap warm moist towels (or other fabric) around the victim's head, neck, sides, and groin. As the packs cool, rewarm them by adding warm water (approximately 105 °F). Check the temperature of the water with your elbow or the inside of your arm; it should be warm but not hot.

- If you are at a remote outdoor location and cannot use the other method, make a "human sandwich" by placing the unclothed victim in a sleeping bag (or between blankets) with two other undressed persons to provide body-to-body heat transfer. THIS WILL SAVE LIVES. Additional sleeping bags or blankets can be placed over and under the victim.

DO NOT wrap a hypothermia victim in a blanket without an auxiliary source of heat unless it is to protect against any further heat loss before treatment can begin, or you need to go for help and there is no other alternative.

Continue treatment once the victim has stabilized. Give warm liquids and nourishing food if the person is conscious. Check the person for symptoms of frostbite and, if necessary, give treatment.

Handle the patient gently and do not allow him or her to walk. Exertion can circulate cold stagnant blood from extremities to the central body and cause "after-drop," in which the patient's core temperature drops below the level that will sustain life. ALCOHOL CONTRIBUTES TO AFTER-DROP.

12.2.2.3 **Medical Care for Hypothermia** HYPOTHERMIA IS A SEVERE EMERGENCY. GET MEDICAL TREATMENT AS SOON AS POSSIBLE. Even persons with mild hypothermia should see a doctor.

12.2.2.4 **Prevention of Hypothermia** In cold weather, never go into the field without wearing adequate clothing. Take a complete change of warm clothes and one or two extra pairs of socks (in plastic bags). Wear or carry a windproof, water-resistant outer jacket and, in rain or snow, wear adequate raingear.

Stay dry. If your clothing becomes wet from perspiration, rain, snow, or immersion in water, change it as soon as possible. If you start to shiver in a prolonged or violent way, seek shelter at once. Shivering may produce heat but it also uses up energy. Violent shivering may be an early sign of hypothermia.

Avoid accidental immersion in water. Practice boat safety and learn cold water survival techniques. If you fall into water and you are not very close to shore, remain quiet. Keep your head out of water, climb onto the boat, or hold or climb onto any other object that will support you and keep you up out of the water.

12.2.3 Safety and First Aid Equipment In view of the causes, results, and appropriate treatment of cold weather injuries discussed previously, as a minimum, the following safety equipment should be included during cold weather operations:

- extra clothing for all personnel
- blankets and/or sleeping bag
- high-energy food and drinking water supply
- toboggan
- tow ropes

In extreme cold conditions, add the following safety items:

- electric blanket (if an electrical source is available)
- portable emergency generator (with fuel, oil, and cords)
- space heater and fuel

12.2.4 General Winter Operations Cold weather conditions can severely affect winter operations. The Site Manager and HSO must plan work schedules and project tasks accordingly.

12.2.4.1 **Preliminary Assessment** If you will be working outdoors in cold weather, assess the local weather conditions through the news media (i.e., radio, television, and newspapers) to determine whether work should progress and the amount of preparation needed. Carefully consider questions such as the following.

- What are the typical wind and weather conditions for the period in which you will be working?

- Are the areas in which you will work sheltered or open to the wind?

- Is there a place nearby for periodic warming breaks? Can you obtain or heat warm food and beverages there? Is there a source of drinking water?

- Are there ways to minimize the length of time that crew members will have to work outdoors in the cold?

- If you use a vehicle for a warming area or will use a heater in a closed room, how can you ensure there is adequate ventilation to prevent carbon monoxide poisoning?

12.2.4.2 Scheduling Wherever possible, try to schedule work during the least severe weather. Rotate crew members to keep cold exposures short and allow sufficient time for frequent warming breaks. Remember that workers in heavy clothing often need more time to complete the tasks and may become fatigued more easily. Be aware that operations may have to be discontinued if winds increase or the temperature drops.

Because winter days are short, scheduling should allow time for taking care of equipment and supplies before nightfall. Once it becomes dark, it is more difficult to gauge terrain, and temperatures are likely to drop.

12.2.4.3 Site Access Snow and ice could make travel on site access roads impossible, or treacherous at best. Personnel should not be allowed to work on-site if conditions could severely hamper the arrival or departure of emergency vehicles. If the route to off-site medical facilities is blocked by snow or ice, an otherwise minor injury could result in a major medical emergency. If conditions warrant, the following provisions should be made:

- snow removal and plowing services for site access roads;
- a dependable, four-wheel-drive vehicle available to on-site personnel for transporting an injured person to an off-site medical facility; and
- sleeping bags, blankets, a food supply, and water kept on-site in the event a sudden storm requires personnel to remain overnight

The HSO is responsible for deciding when weather conditions make site access unsafe, thereby requiring work to stop until conditions improve.

12.2.4.4 Equipment and Supplies Obtain equipment and supplies that will help prevent cold stress and will help in the treatment of cold stress disorders. Required equipment includes a reliable ambient temperature thermometer, a wind gauge, and a windchill chart. If the site is potentially windy due to a lack of natural or manmade windbreaks (e.g., trees, valleys, and structures), try to provide means of shielding workers from the wind. If working at a remote location, carry extra food and water because hunger and dehydration contribute to cold stress. If possible, make provisions for hot food and beverages. Ensure that emergency communication equipment is available and operational for crew members working in the cold, at heights, or in remote locations.

Close attention must be given to the effects of cold weather on field equipment. Batteries can be severely affected by cold resulting in disabled radios, air monitoring equipment, sampling pumps, and vehicles. A supply of fresh batteries, a sufficient number of charging units, and a set of automotive jumper cables should be maintained on-site. In addition, the electronics in many field instruments such as PI, LEL, and oxygen meters, as well as the chemical reactions

in detector tubes (e.g., Draeger tubes) can also be adversely affected by the cold. The manufacturers' literature must be consulted for minimum operating temperatures.

If at all possible, monitoring well sampling tasks should not be scheduled during cold weather. These tasks generally require the use of relatively delicate pumps; long, uninsulated stretches of tubing; and significant quantities of decontamination solutions. Unless considerable effort is expended to prevent pumps, hoses, decontamination solutions, and sample containers from freezing, attempting to sample monitoring wells in cold weather may be counter-productive. Portable shelters should be considered if cold weather sampling is necessary.

CHAPTER 13. DECONTAMINATION

13.1 PERSONNEL DECONTAMINATION. Decontamination procedures are followed by all personnel leaving hazardous waste sites. Under no circumstances (except emergency evacuation) will personnel be allowed to leave the site prior to decontamination. A typical personnel decontamination station is shown in Figure 13-1. Generalized procedures for removal of protective clothing are as follows.

1. Drop tools, monitors, samples, and trash at designated drop stations (i.e., plastic containers or drop sheets).

2. Step into the designated shuffle pit area and scuff feet to remove gross amounts of dirt from outer boots.

3. Scrub outer boots and outer gloves with decon solution or detergent and water. Rinse with water.

4. Remove tape from outer boots and remove boots; discard tape and boots in disposal container.

5. Remove tape from outer gloves and remove gloves; discard tape and gloves in disposal container.

6. If the worker has left the Exclusion Zone to change the air tank on the SCBA or the canister on the air-purifying respirator, this will be the last step in the decontamination procedure. The tank or cartridge should be exchanged, new outer gloves and boot covers donned, and the joints taped; the worker then returns to duty.

7. Remove outer garments and discard in disposal container.

8. Remove respirator and place or hang in the designated area.

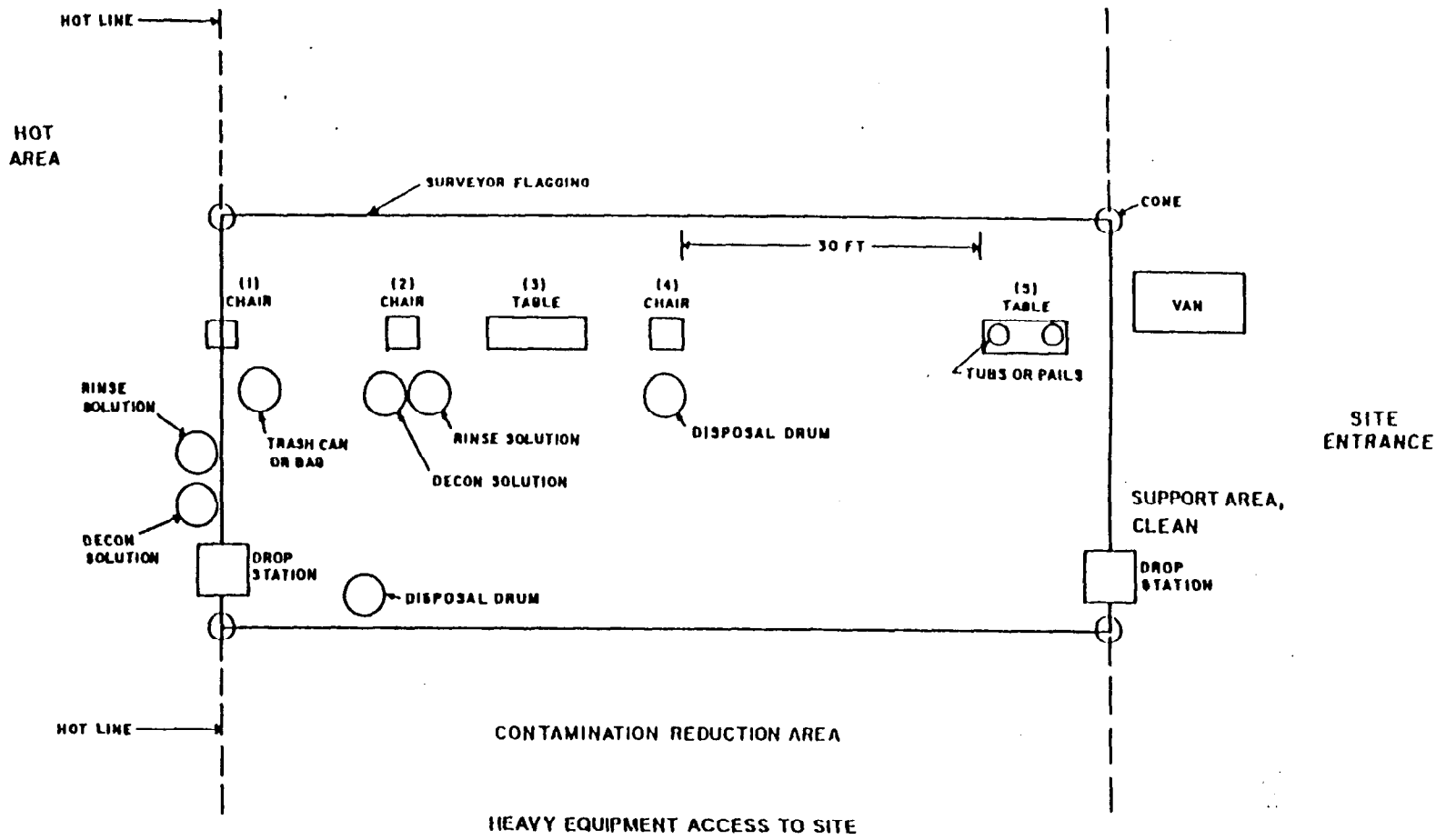
9. Remove inner gloves and discard in disposal container.

10. If the site requires use of a decontamination trailer, all personnel must shower before leaving the site at the end of the work day.

NOTE: Disposable items (i.e., Tyvek™ coveralls, inner gloves, and latex overboots) will be changed daily unless there is reason to change sooner. Dual respirator canisters will be changed daily, unless more frequent changes are deemed appropriate by site surveillance data or personnel assessment.

Maximum and minimum decontamination layouts for PPE Levels A through C are shown in Figures 13-2 through 13-6.

Pressurized sprayers or other designated equipment will be available in the decontamination area for washdown and cleaning of personnel, samples, and equipment.



TASK

(1) WASH OUTER BOOTS - RINSE BOOTS - DISPOSE
(2) WASH OUTER GLOVES - RINSE GLOVES - DISPOSE
(3) SCBA TANK CHANGE OVER TABLE W/SPARE TANKS
(4) REMOVE OUTER GARMENT - DISPOSE
(5) REMOVE SCBA, WASH MASK IN PAILS OR TUBS
(6) REMOVE INNER GLOVES - DISPOSE

NOT TO SCALE

FIGURE 13-1
TYPICAL PERSONNEL DECONTAMINATION STATION

EC JORDAN CO.

FIGURE 13-2
Maximum Decontamination Layout
Level A Protection

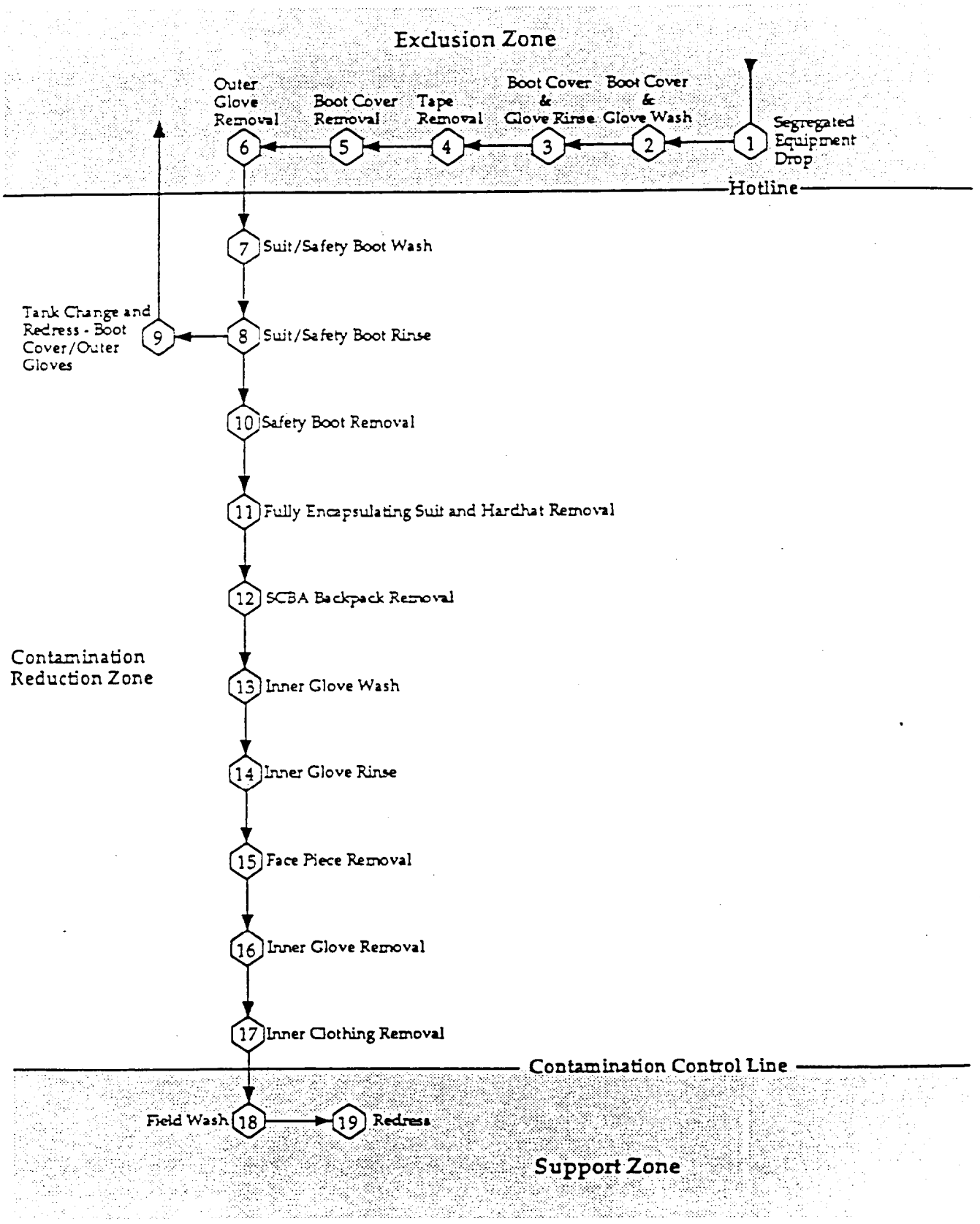
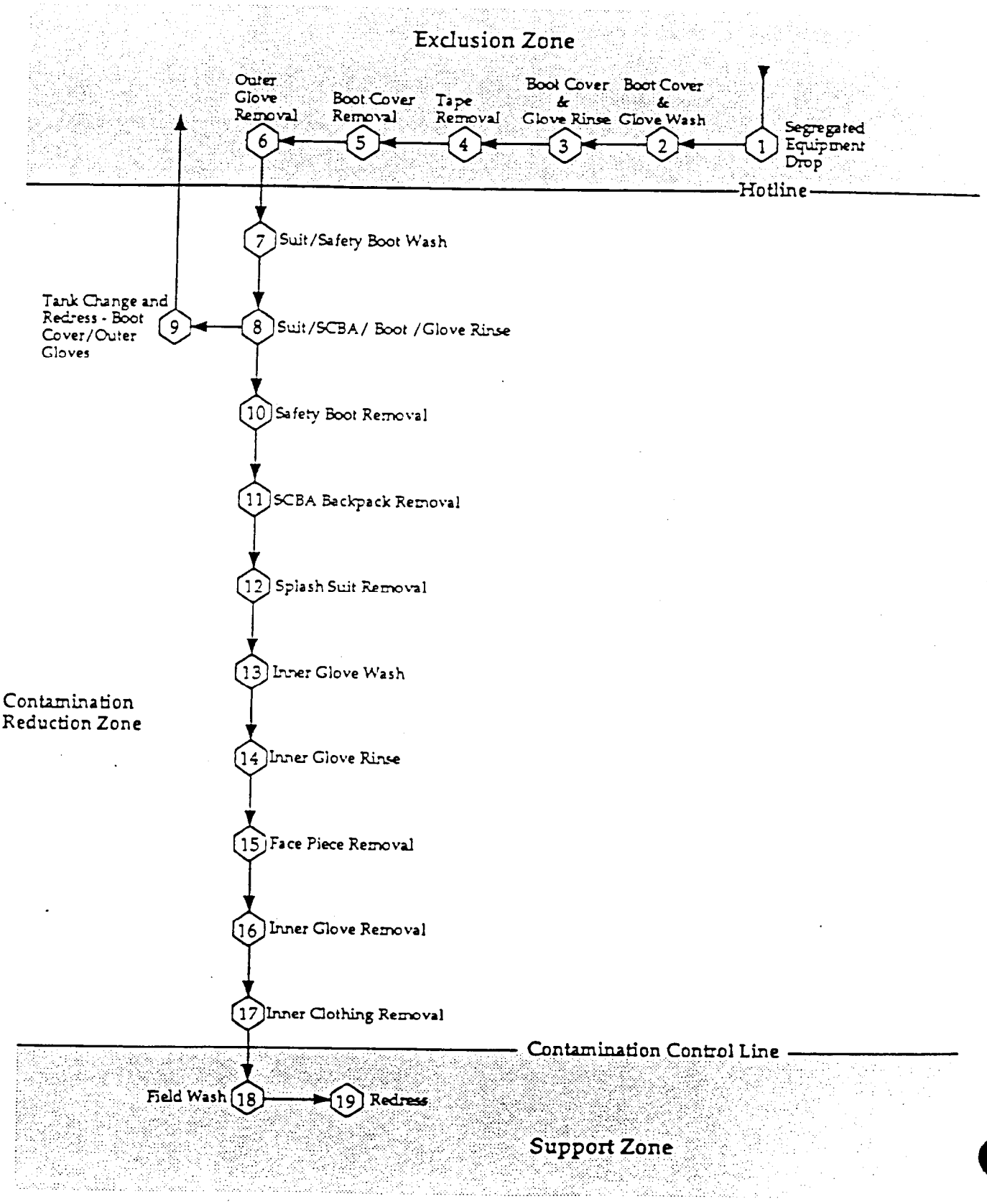


FIGURE 13-3

Maximum Decontamination Layout
Level B Protection



1870-04D

FIGURE 13-4

Maximum Decontamination Layout
Level C Protection

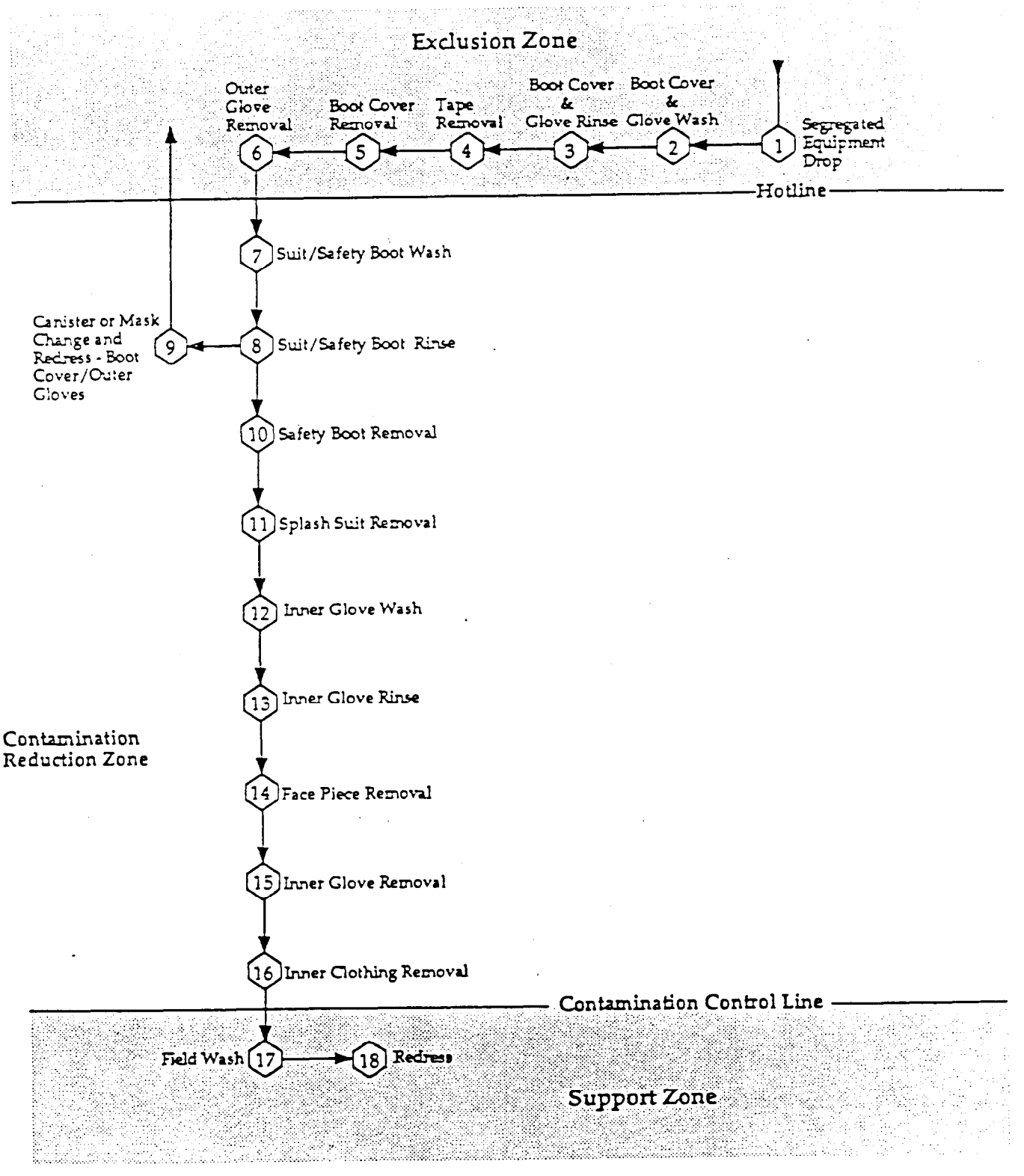


FIGURE 13-5

Minimum Decontamination Layout
Levels A and B Protection

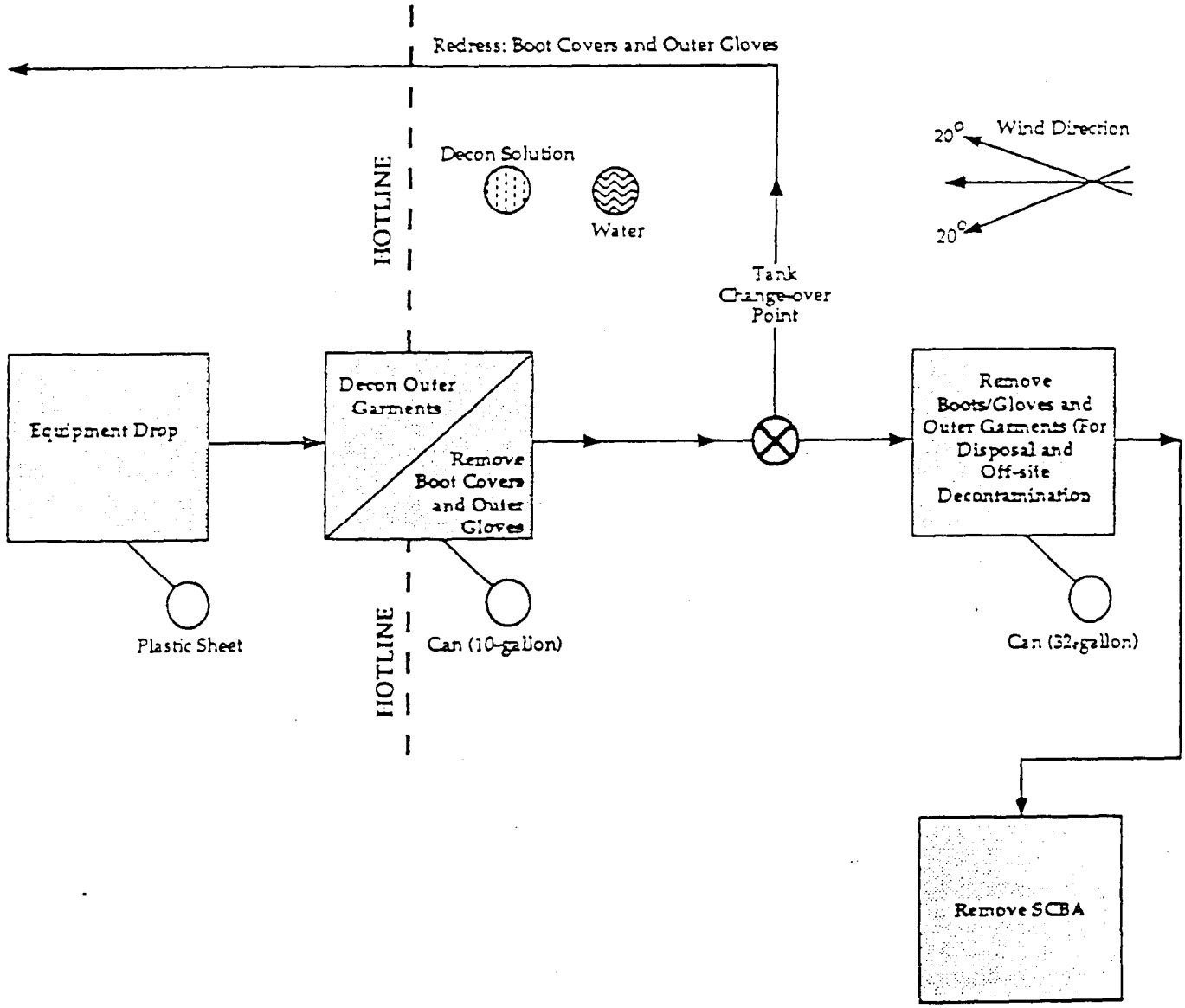


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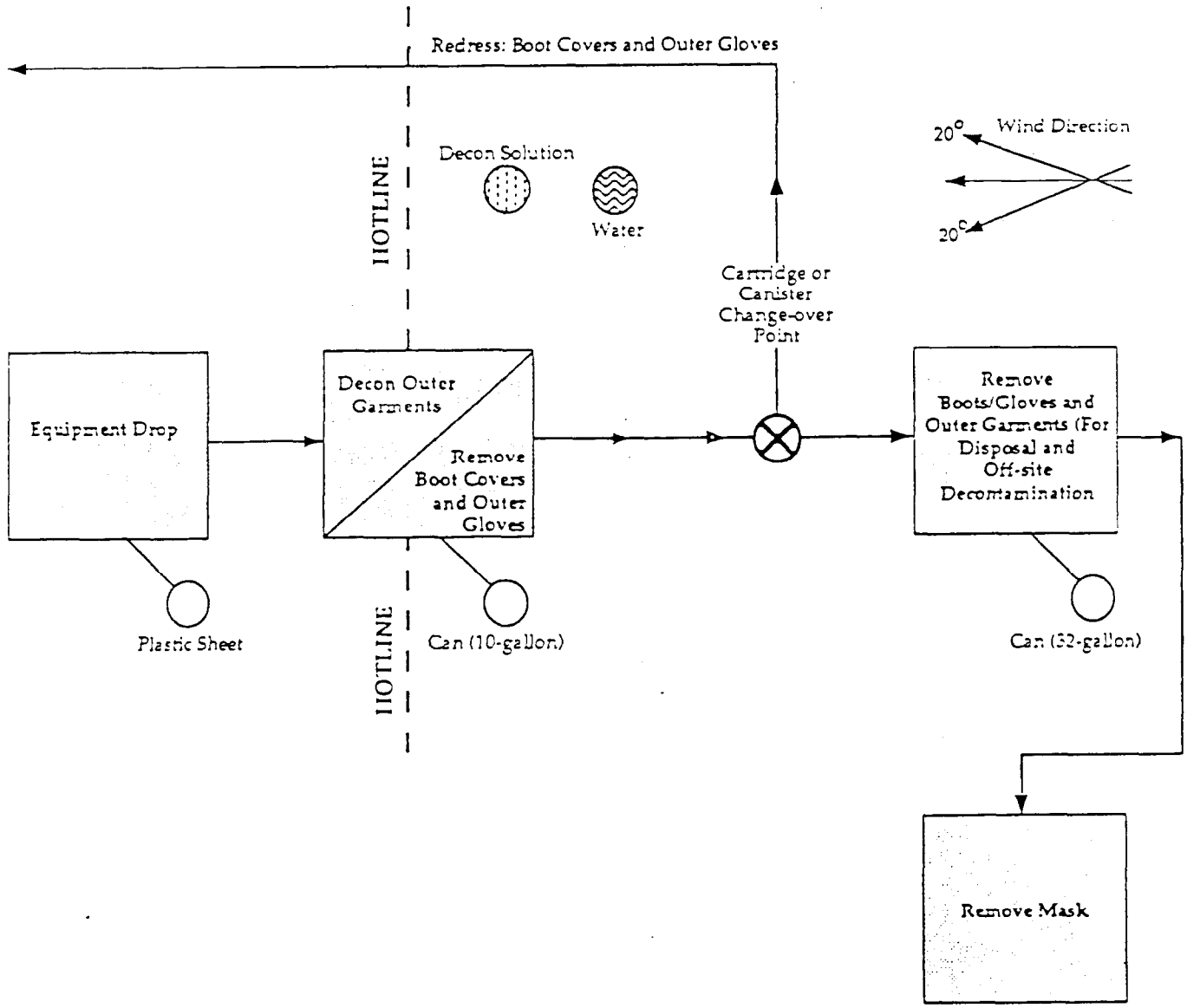
FIGURE 13-6

Minimum Decontamination Layout
Level C Protection



Respirators will be decontaminated daily and taken from the drop area. The masks will be disassembled, the cartridges set aside, and all other parts placed in a cleansing solution. Parts will be pre-coded (e.g., #1 on all parts of Mask #1). After an appropriate time in the solution, the parts will be removed and rinsed with tap water. Old cartridges will be marked to indicate length of use (i.e., if it is possible to evaluate the remaining utility of the cartridge), or discarded in the contaminated trash container for disposal. In the morning, the masks will be reassembled and new cartridges installed, if appropriate. Personnel will inspect their own masks and readjust the straps for proper fit.

13.2 SMALL EQUIPMENT DECONTAMINATION. Small equipment will be protected from contamination as much as possible by draping, masking, or otherwise covering the instruments with plastic (to the extent feasible), without hindering operation of the unit. For example, the HNU meter can be placed in a clear plastic bag to allow for reading the scale and operating the knobs. The HNU sensor can be partially wrapped, keeping the sensor tip and discharge port clear.

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

13.3 HEAVY EQUIPMENT DECONTAMINATION. It is anticipated that drilling rigs and backhoes will become contaminated during borehole and test-pitting activities. They will be cleaned with high-pressure water or steam, followed by a soap and water wash and rinse. Loose material will be removed with a brush. The person performing this activity will usually be at least at the level of protection used during the personnel and monitoring equipment decontamination.

A decontamination pad will be constructed to allow collection and storage of contaminated decontamination fluids in Department of Transportation (DOT)-approved 55-gallon drums.

13.4 DISPOSAL OF DECONTAMINATED MATERIALS. All protective gear, decontamination fluids (for both personnel and equipment), and other disposable materials will be disposed of at each site.

Decontamination fluids (i.e., Liqui-nox™, used to decontaminate sampling equipment such as split spoons and groundwater sampling pumps) will be stored in DOT-approved 55-gallon drums. Disposable materials (e.g., gloves and Tyveks™) will be double-bagged and stored as is, or placed in DOT-approved 55-gallon drums.

CHAPTER 14. EMERGENCY PLANNING

14.1 EMERGENCY MEDICAL SERVICES. Prior to site investigation or activity on hazardous sites, nearby health facilities will be evaluated to determine their ability to provide for the needs of on-site project staff and notified of site operations as appropriate. Criteria such as emergency department physician coverage, decontamination capabilities, and available medical specialists will be evaluated.

14.1.1 On-site First Aid An industrial first-aid kit will be provided at the work site; contents of the kit will be checked weekly and restocked as necessary. Other equipment may include oxygen, backboard and straps, splints, and a cervical collar.

At least one person qualified to perform first aid will be present on-site at all times during work activity. This person will have earned a certificate in first-aid training from the American Red Cross or will have received equivalent training. Designated first aides will receive regular review training from the American Red Cross or the equivalent.

An emergency shower and eye-wash station will be provided at the work site, as well as flushing water for decontamination of boots, gloves, clothing, and tools.

14.1.2 Transportation to Emergency Treatment A vehicle will be available at all times to transport personnel to the hospital (in the event an ambulance is unnecessary or unavailable). Stretchers will be located at the work site to transport personnel to the vehicle. Under no circumstances will injured persons transport themselves to a medical facility for emergency treatment.

14.2 CONTINGENCY PLANNING. Prior to commencement of on-site activities, the HSO will review safety considerations with the field crew. The HSO has overall responsibility for adherence to the designated safety precautions and assumes the role of on-site coordinator in an emergency response situation.

All on-site personnel will be familiar with both the primary and secondary route to the nearest hospital (which may be shown on a figure or a local map), as well as the location of the nearest working telephone or radio communication device. At remote locations a mobile phone or radio will be provided. A list of emergency telephone numbers will be readily available on-site.

When extensive Level B operations are planned, the local hospital and emergency response team will be advised in advance of the work to be performed. The hospital will also be briefed on the availability of personnel health data and technical support through Environmental Medicine Resources, Inc.

Emergency communication will be required to ensure positive preplanned notification of emergency authorities in the event of episodes requiring initiation of contingency plans. Emergency communication will include all or parts of the following.

- Coordinate with local agencies, fire and police departments, the ambulance service, and the hospital emergency room.

- Establish two-way radio communication and a site alarm capable of warning site personnel and summoning assistance (i.e., airhorn).

- Design an emergency evacuation plan for residents of nearby homes. Although evacuation is an unlikely event, as a contingency, the HSO will be designated as on-site coordinator and will be responsible for implementing the plan. The HSO will be made aware of the total number of households within a 2,000-foot radius. The Health and Safety Plan will provide the emergency contacts required and a table will provide a list of residences and identifiable operations in the area in the event that evacuation is deemed a possibility for a particular site.

- Investigate possible routes of evacuation prior to any activity.

- If an accident occurs, a copy of an accident report form, provided in Chapter 15, should be filled out by the HSO and filed with the individual's supervisor, the HSM or HSS, and Human Resources. A copy should also be retained in the project records.

14.3 POTENTIAL HAZARDS. The most common hazards associated with hazardous waste site investigation include (1) accidents; (2) inhalation, contact, or ingestion of hazardous materials; (3) explosion; and (4) fire.

14.3.1 Accidents Accidents must be handled on a case-by-case basis. Minor cuts, bruises, muscle pulls, and the like will still allow the injured person to undergo reasonably normal decontamination procedures before receiving direct first aid. More serious injuries may not permit complete decontamination procedures to be undertaken, particularly if the nature of the injury is such that the victim should not be moved. In these cases, arrangements will be made with the medical facility and transporter to allow them to take proper precautions. The nature and degree of surface contamination at a site is generally low enough that emergency vehicles could reach the victim on-site without undue hazard. However, if on-site access is limited, accident victims may be transported by ABB-ES personnel trained for this response to a point accessible by an ambulance.

14.3.2 Contact and/or Ingestion of Hazardous Materials Properly prescribed and maintained protective clothing and adherence to established safety procedures are designed to minimize this hazard. However, it is still possible that contact or ingestion of materials may occur. For example, puncture of a buried drum of liquid during drilling operations might cause the drum contents to contact personnel. Standard first-aid procedures should be followed. The drilling rig will have a tank of water that may be useful in some circumstances, particularly to flush contaminants from any exposed skin areas. Eye-wash bottles will also be maintained at the site for emergencies. In cases of ingestion or anything other than minor contact with known substances, the local Poison Control Center

and hospital should be notified and the victim taken there immediately for further treatment and observation.

14.3.3 Explosion The drilling crew should be keenly aware of combustible gas meter readings and should withdraw at any indication of imminently hazardous conditions (i.e., greater than 20 percent LEL). The detection of such conditions will be reported to local agencies for potential execution of the evacuation plan, if the situation is assessed to warrant such response.

14.3.4 Fire The combustible gas meter also warns of imminent fire hazards at borings. The greatest fire hazard at the site should be recognized as handling the fluids (e.g., methanol and acetone) used for certain decontamination procedures. No smoking or open flames are allowed on-site. Carbon dioxide fire extinguishers will be kept at the drilling rig and in the decontamination area/field office. The fire department, previously informed of site activities, will be called as needed.

14.4 EVACUATION RESPONSE LEVELS. Evacuation responses will occur at three levels: (1) withdrawal from immediate work area (100 feet or more upwind), (2) site evacuation, and (3) evacuation of surrounding area. Anticipated conditions that require these responses are described in the following subsections.

14.4.1 Withdrawal Upwind (100 Feet or More) Withdrawing upwind (100 feet or more) will be required when (1) ambient air conditions contain greater contaminant concentrations than guidelines allow for the type of respiratory protection being worn (the work crew may return after donning greater respiratory protection and/or assessing the situation as transient and past); (2) a breach in protective clothing or minor accident occurs (the work crew may return when the tear or other malfunction is repaired and first aid or decontamination has been administered); or (3) the respirator malfunctions requiring replacement.

14.4.2 Site Evacuation Evacuation of the site will be required when (1) ambient air conditions contain explosive and persistent levels of combustible gas or excessive levels of toxic gases; (2) a fire or major accident occurs; or (3) explosion is imminent or has occurred.

14.4.3 Surrounding Area Evacuation The area surrounding the site will be evacuated when persistent, unsuppressible toxic or explosive vapors from test pits or borings (e.g., pressure release from punctured drum) are released, or air quality monitored at several points downwind assess danger to the surrounding area.

14.5 EVACUATION PROCEDURES

14.5.1 Withdrawal Upwind The work crew will continually observe general wind directions while on-site. (A simple wind sock may be set up near the work site for visual determinations.) Upon observing conditions that warrant moving away from the work site, the crew will relocate upwind a distance of approximately 100 feet or farther, as indicated by the site monitoring instruments. Donning SCBA and a safety harness and line, the HSO and a member of the crew may return to the

work site to determine whether the conditions noted were transient or persistent. If persistent, an alarm should be raised to notify on-site personnel of the situation and the need to leave the site or don SCBA. An attempt should be made to decrease emissions only if greater respiratory protection is donned. The HSM, HSS, and client will be notified of conditions. When access to the site is restricted and escape is thereby hindered, the crew may be instructed to evacuate the site rather than move upwind, especially if withdrawal upwind moves the crew away from escape routes.

14.5.2 Site Evacuation After determining that site evacuation is warranted, the work crew will proceed upwind of the work site and notify the security force, HSO, and field office of site conditions. If the decontamination area is upwind and more than 500 feet from the work site, the crew will pass quickly through decontamination to remove contaminated outer suits. If the hazard is toxic gas, respirators will be retained. The crew will proceed to the field office to assess the situation, where the respirators may be removed (if instrumentation indicates an acceptable condition). As more facts are determined from the field crew, they will be relayed to the appropriate agencies. The advisability and type of further response action will be coordinated and implemented by the HSO.

14.5.3 Evacuation of Surrounding Area When the HSO determines that conditions warrant evacuation of downwind residences and commercial operations, the local agencies will be notified and assistance requested. Designated on-site personnel will initiate evacuation of the immediate off-site area without delay.

CHAPTER 15. HEALTH AND SAFETY FORMS AND DATA SHEETS

This chapter contains examples of ABB-ES's Health and Safety Audit Form, Accident Report Form, HSO checklist for Field Operations, Material Safety Data Sheets for Liqui-nox™ and trisodium phosphate, OSHA's Job Safety and Health Protection notice, and ABB-ES's Daily Health and Safety Audit Form.

15.1 HEALTH AND SAFETY AUDIT FORM

Site Name: _____ Date _____

Auditor: _____

SEND A COPY OF COMPLETED FORM TO THE HEALTH AND SAFETY MANAGER.

GENERAL	YES	NO	COMMENTS
HASP on-site?	___	___	_____
HASP completely signed off and approved?	___	___	_____
OSHA poster posted in trailer?	___	___	_____
Emergency telephone numbers posted in trailer?	___	___	_____
Emergency eyewash on-site?	___	___	_____
Emergency shower on-site?	___	___	_____
Stretcher on-site?	___	___	_____
First-aid kit on-site?	___	___	_____
Adequately stocked?	___	___	_____
Proper sanitation facilities?	___	___	_____
DOCUMENTATION AND RECORDKEEPING			
Only personnel listed and approved in HASP on-site?	___	___	_____
All personnel properly trained?	___	___	_____
All personnel in health monitoring program?	___	___	_____
Daily field records kept by the Site Manager?	___	___	_____
Levels of PPE recorded?	___	___	_____
Contaminant levels recorded?	___	___	_____
Site surveillance records kept by HSO?	___	___	_____

DOCUMENTATION AND RECORDKEEPING (Cont)	YES	NO	COMMENTS
Calibration records maintained?	___	___	_____
Accident/incident forms on-site?	___	___	_____
Field team review sheets signed?	___	___	_____
Medical data sheets completed?	___	___	_____
Spare hospital directions available?	___	___	_____
Visitors logbook completed?	___	___	_____
MSDSs for chemicals on-site?	___	___	_____
HASP revisions recorded?	___	___	_____
First-aid kit inspected weekly?	___	___	_____
Are daily safety meetings held?	___	___	_____
Emergency procedures discussed during safety meetings?	___	___	_____
EMERGENCY RESPONSES			
Vehicle available on-site for transportation to the hospital?	___	___	_____
Fire extinguishers on-site?	___	___	_____
At least two persons trained in CPR and first-aid on-site at all times?	___	___	_____
All personnel know who is trained?	___	___	_____
PERSONNEL PROTECTIVE EQUIPMENT			
Proper PPE being worn as specified in the HASP?	___	___	_____
Level of PPE being worn:	_____		
PPE adequate for work conditions?	___	___	_____
If not, give reason:	_____		
Upgrade/downgrade to PPE level:	_____		

PERSONNEL PROTECTIVE EQUIPMENT (Cont.)	YES	NO	COMMENTS
Has facial hair that would interfere with fit of respirators been removed?	___	___	_____
If not, willing to shave if necessary?	___	___	_____
Fit-tested within the last year?	___	___	_____
If Level B, back-up/emergency person suited up (except for air)?	___	___	_____
HSO periodically inspects PPE and equipment?	___	___	_____
PPE not in use properly stored?	___	___	_____
MONITORING EQUIPMENT			
All equipment listed in HASP on-site?	___	___	_____
Properly calibrated?	___	___	_____
In good condition?	___	___	_____
Used properly?	___	___	_____
Other equipment needed?	___	___	_____
List: _____			
Monitoring equipment covered with plastic to minimize contamination?	___	___	_____
DECONTAMINATION			
Decon line set up properly?	___	___	_____
Proper cleaning fluid used for known or suspected contaminants?	___	___	_____
Proper decon procedures used?	___	___	_____
Decon personnel wearing proper PPE?	___	___	_____
Equipment decontaminated?	___	___	_____
Samples decontaminated?	___	___	_____
Disposable items changed twice a day or more often if needed?	___	___	_____

WORK PRACTICES	YES	NO	COMMENTS
Proper collection and disposal of contaminated PPE?	___	___	_____
Proper collection and disposal of decon fluid?	___	___	_____
Water available for decon?	___	___	_____
Buddy system used?	___	___	_____
Equipment kept off drums and ground?	___	___	_____
Kneeling or sitting on drums or ground not allowed?	___	___	_____
Personnel avoid standing or walking through puddles or stained soil?	___	___	_____
Zones established?	___	___	_____
If night work to be conducted, adequate illumination?	___	___	_____
Smoking, eating, or drinking in the Exclusion Zone or CRZ not allowed?	___	___	_____
To the extent feasible, contaminated materials handled remotely?	___	___	_____
Contact lenses not allowed on-site?	___	___	_____
Entry into excavations not allowed unless properly shored or sloped?	___	___	_____
All unusual situations on-site listed in HASP?	___	___	_____

If not, what? _____

Action taken? _____

HASP revised? ___ ___ _____

CONFINED SPACE ENTRY

All confined spaces identified?

If not, list: _____

CONFINED SPACE ENTRY	YES	NO	COMMENTS
All appropriate equipment available and in good working order?	___	___	_____
Equipment properly calibrated?	___	___	_____
Confined Space Checklists used?	___	___	_____
Checklists completely and correctly filled out?	___	___	_____

15.2 ACCIDENT REPORT FORM

Site: _____ Project No.: _____
Location: _____
Location of Accident if different from above: _____
_____
Name and Address of Injured: _____
_____
SSN: _____ DOB: _____ Sex: _____
Years of Service: _____ Time on Current Job: _____ Dept. No.: ____
Title/Classification: _____
Date of Accident: _____ Time of Accident: _____
Name of Witness: _____ Telephone No.: _____

Accident Category: __ Motor Vehicle __ Property Damage __ Fire
__ Chemical Exposure __ Near Miss __ Other

Severity of Injury or Illness __ Non-disabling __ Disabling
__ Medical Treatment __ Fatality

Amount of Damage: $ _____ Property Damaged: _____

CLASSIFICATION OF INJURY

__ Fracture
__ Dislocation
__ Sprain
__ Abrasion
__ Laceration
__ Puncture
__ Bite
__ Respiratory Allergy
__ Heat Burn
__ Chemical Burn
__ Radiation Burn
__ Concussion
__ Toxic-Respiratory
__ Toxic-Ingestion
__ Toxic-Dermal
__ Cold Exposure
__ Heat Stroke
__ Faint/Dizziness
__ Blister
__ Bruise
__ Poison Ivy
__ Headache
__ Other (explain) _____

Parts of Body Affected: _____

Degree of Disability: _____

Date Medical Care Received: _____ Emergency Service?: _____

Name and Address of Medical Facility: _____
_____

Follow-up Exam Required?: _____ Estimated No. of Days Away from Job: _____

ACCIDENT LOCATION (use other side of sheet as needed)

Causative agent most directly related to accident (i.e., object, substance, material, machinery, equipment, and conditions):

Was weather a factor? How?

Unsafe mechanical/physical/environmental condition at time of accident (be specific):

Unsafe act by injured person and/or others contributing to the accident (be specific, must be answered):

Personal factors (improper attitude, lack of knowledge or skill, slow reaction, fatigue, inattention, horseplay):

MODIFICATIONS

Level of personal protective equipment required in site safety plan: _____
Was injured person using required equipment? _____
If not, how did actual equipment use differ from plan?

Was personal protective equipment required in site safety plan adequate for site conditions? _____

If no, what additional equipment was needed?:

What can be done to prevent a reoccurrence of this type of accident (i.e., modification of machine, mechanical guards, modification of work practices, training)?:

DETAILED NARRATIVE DESCRIPTION (How did accident occur and why; objects, equipment, tools used, circumstances, assigned duties; be specific):

Signature of Preparer: _____ Date: _____

Signature of Site Manager: _____ Date: _____

SEND COPIES OF COMPLETED FORM TO HUMAN RESOURCES
AND THE HEALTH AND SAFETY MANAGER OR SUPERVISOR.

15.3 HSO CHECKLIST FOR FIELD OPERATIONS

The following is a list of the minimum equipment and materials needed to fulfill the requirements for health and safety at a site. This list does not include monitoring equipment, decontamination equipment, or personal health and safety equipment (e.g., respirators, tyveks, and boots).

Need	Posted?	Paperwork
		Health and Safety Plan
		Health and Safety Plan Appendix
		Field Team Review Sheets
		Medical Data Sheets
		OSHA Job Safety & Health Protection Poster
		Emergency Information Sheet
		Spare Hospital Directions
		Blank Accident Report Forms
		Visitors Logbook
		H & S Audit Form
		Confined Space Entry Forms
		Site-specific HASP Attachments
		MSDSs for Chemicals Taken On-site (other than those in HASP Appendix)
		1.
		2.

Need	Quantity	Equipment
		First Aid Kit
		Emergency Eye Wash Station
		Fire Extinguisher
		Emergency Horn
		Emergency Stretcher/Backboard

FR: ALCONOX Inc.

Quality Products for Laboratory Hospital Industry
215 PARK AVENUE SOUTH
NEW YORK, NEW YORK 10003

TO: CE Environmental
ATTN Bill Thurston
FAX: 207-773-0011

DATE: 1/19/90
PAGE 1 OF 1
FROM: Malcolm

Material Safety Data Sheet
May be used to comply with OSHA's Hazard Communication Standard, 29 CFR 1910.1200. Standard must be consulted for specific requirements.

U.S. Department of Labor
(Non-Mandatory Form)
Form Approved
OMB No. 1218-0072

Note: Blank spaces are not permitted. If any item is not applicable, or no information is available, the space must be marked to indicate that.

Trade Name (As Used on Label and List): LIQUI-NOX

Section I

Manufacturer's Name: ALCONOX, INC.
Address (Number, Street, City, State, and ZIP Code): 215 PARK AVENUE SOUTH, NEW YORK, NEW YORK 10003
Emergency Telephone Number: (212) 473-1308
Telephone Number for Information: (212) 473-1300
Date Prepared: JULY 1, 1987
Signature of Preparer (Optional):

Section II — Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity; Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (Optional)
THERE ARE NO INGREDIENTS IN LIQUI-NOX WHICH APPEARED ON THE OSHA STANDARD 29 CFR 1910 SUBPART Z.				

Section III — Physical/Chemical Characteristics

Boiling Point (°F)	212°F	Specific Gravity (H2O = 1)	1.075
Vapor Pressure (mm Hg)	NO DATA	Melting Point	N.A.
Vapor Density (AIR = 1)	NO DATA	Evaporation Rate (Butyl Acetate = 1)	NO DATA

Solubility in Water: COMPLETELY SOLUBLE IN ALL PROPORTIONS

Appearance and Odor: YELLOW LIQUID - PRACTICALLY ODORLESS

Section IV — Fire and Explosion Hazard Data

Flash Point (Method Used): NONE (CLEVELAND OPEN CUP)
Flammable Limits: LEL N.A. UEL N.A.

Extinguishing Media: WATER, DRY CHEMICAL, FOAM, CO_2, 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 — Reactivity Data

Stability	Unstable		Conditions to Avoid: NONE
	Stable	XX	

Incompatibility (Materials to Avoid): NONE

Hazardous Decomposition or Byproducts: SO_x MAY BE RELEASED ON BURNING

Hazardous Polymerization	May Occur		Conditions to Avoid: NONE
	Will Not Occur	XX	

Section VI — Health Hazard Data

Route of Entry:	Inhalation?	Skin?	Ingestion?
	NO	YES	YES

Health Hazards (Acute and Chronic): SKIN CONTACT MAY PROVE LOCALLY IRRITATING. INGESTION MAY CAUSE DISCOMFORT AND/OR DIARRHEA.

Carcinogenicity:	NTP?	IARC Monographs?	OSHA Regulated?
	NO	NO	NO

Signs and Symptoms of Exposure: PROLONGED SKIN CONTACT MAY CAUSE DRYING AND/OR CHAPPING.

Medical Conditions Generally Aggravated by Exposure: NONE

Emergency and First Aid Procedures: EYES-FLUSH WITH PLENTY OF WATER FOR 15 MINUTES. SKIN-FLUSH WITH WATER. INGESTION-DRINK LARGE QUANTITIES OF WATER. GET MEDICAL ATTENTION FOR DISC[illegible]

Section VII — Precautions for Safe Handling and Use

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 BIODEGRADAB[illegible]

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 ORDINA[illegible]

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.

Section VIII — Control Measures

Respiratory Protection (Specify Type): NONE

Ventilation	Local Exhaust: NORMAL	Special: N.A.	
	Mechanical (General): N.A.	Other: N.A.	
Protective Gloves: RECOMMENDED		Eye Protection: RECOMMENDED	

Other Protective Clothing or Equipment: NOT REQUIRED

Work/Hygienic Practices: NO SPECIAL PRACTICES REQUIRED

Page 2

LIQUI-NOX

Monsanto MATERIAL SAFETY DATA

NER CODE A-111

MONSANTO PRODUCT NAME

TRISODIUM PHOSPHATE CRYSTALLINE

MONSANTO COMPANY
800 N. LINDBERGH BLVD.
ST. LOUIS, MO 63167

Emergency Phone No.
(Call Collect)
314-694-1000

PRODUCT IDENTIFICATION

Synonyms:	TSP/C; Trisodium orthophosphate; Sodium phosphate, tribasic; Phosphoric acid, trisodium salt; Trisodium phosphate dodecahydrate
Chemical Formula:	$Na_3PO_4 \cdot 12H_2O \cdot 1/4\ NaOH$ (approximately)
CAS No.:	10101-89-0*
DOT Proper Shipping Name:	Sodium Phosphate, Tribasic (see NOTE below)
DOT Hazard Class/ I.D. No.:	ORM-E/NA9148
DOT Label(s):	Not Applicable
Hazardous Substance(s)/ RQ(s):	Yes/5,000 lbs.
U.S. Surface Freight Classification:	Trisodium Phosphate

Note: Bagged material is not regulated.

*Since hydrated materials could not be reported on the TSCA Initial Inventory List, Trisodium Phosphate Crystalline was reported as anhydrous with the CAS No. 7601-54-9.

WARNING STATEMENTS

DANGER!
CAUSES EYE BURNS
CAUSES SKIN IRRITATION

PRECAUTIONARY MEASURES

Do not get in eyes, on skin, on clothing.
Avoid breathing dust.
Keep container closed.
Use with adequate ventilation.
Wash thoroughly after handling.

EMERGENCY AND FIRST AID PROCEDURES

FIRST AID: IF IN EYES, immediately flush with plenty of water for at least 15 minutes. Call a physician.

IF ON SKIN, immediately flush with plenty of water. Remove contaminated clothing. Wash clothing before reuse.

MATERIAL SAFETY DATA

OCCUPATIONAL CONTROL PROCEDURES

Eye Protection: Wear chemical safety goggles to prevent eye contact. Have eye baths immediately available where eye contact can occur.

Skin Protection: Wear appropriate impervious gloves and protective clothing to prevent skin contact. Launder contaminated clothing and clean protective equipment before reuse.

Respiratory Protection: Use NIOSH approved equipment suitable for nuisance dust when airborne exposure is excessive. Consult respirator manufacturer to determine appropriate type equipment for given application.

Ventilation: Provide ventilation to minimize exposure. Local exhaust ventilation preferred.

Airborne Exposure Limits: Product: Trisodium phosphate dodecahydrate

Although no specific exposure limit has been established for this material, OSHA and ACGIH have established limits for nuisance dusts:

OSHA PEL/TWA: Total 15 mg/m^3; Respirable 5 mg/m^3
ACGIH TLV/TWA: Total 10 mg/m^3; Respirable 5 mg/m^3

Keep exposure below these limits.

FIRE PROTECTION INFORMATION

This material is not combustible.

REACTIVITY DATA

Materials to Avoid: Trisodium Phosphate Crystalline could be corrosive to aluminum surfaces because of high pH. Sealed containers should be kept free of water because of its corrosivity when wet.

Hazardous Decomposition Products: None.

Hazardous Polymerization: Does not occur..

PHYSIOLOGICAL EFFECTS SUMMARY

Oral LD_{50} (Rat): 6,500 mg/kg, Practically Nontoxic
Dermal LD_{50} (Rabbit): 7,940 mg/kg, Practically Nontoxic
Eye Irritation (Rabbit): (FHSA) Corrosive
Skin Irritation (Rabbit): (FHSA) 3.3 on a scale of 8.0, Moderately Irritating

PHYSICAL DATA

Appearance and Odor: White, crystalline, free-flowing granules or powder; odorless

pH (1% solution @ 25°C): 12.0

Bulk Density (lbs./cu. ft.): Powder 61-65
Granular 58-64

Solubility (g/100 g H_2O) (Anhydrous Salt Basis):
11.6 @ 25°C
17.5 @ 40°C
35.3 @ 60°C
61.3 @ 80°C
84.5 @ 100°C

Note: These physical data are typical values based on material tested but may vary from sample to sample. Typical values should not be construed as a guaranteed analysis of any specific lot or as specification items.

SPILL, LEAK & DISPOSAL INFORMATION

Waste Disposal: Dispose of in a landfill in accordance with all local, state and federal regulations.

Spill or Leakage Procedures: Sodium phosphate, tribasic, as currently defined, is a *hazardous substance* in the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (Superfund) and in the current federal regulations 40 CFR, Part 116 (Section 311, Clean Water Act) with a reportable quantity of 5,000 pounds when released to the environment. Since federal, state and local laws may vary, consult your attorney or appropriate regulatory officials for information relating to spill reporting.

Sweep, scoop or vacuum up all spilled material, contaminated soil and other contaminated material and place in containers. If possible, complete cleanup on a dry basis. After all practical dry cleanup has been done, residual contamination can be flushed with plenty of water.

ADDITIONAL COMMENTS

Environmental Toxicity Information:

96-hr LC_{50} (Bluegill) : 440 mg/l, Practically Nontoxic
96-hr LC_{50} (Trout) : 260 mg/l, Practically Nontoxic

DATE: 8/1/83 **REVISED:** X **SUPERSEDES:** 5/78
MSDS NO.: 010101890

FOR ADDITIONAL NON-EMERGENCY INFORMATION, CONTACT:

Product Acceptability Coordinator
Detergent Materials
Monsanto Industrial Chemicals Co.
314-694-2096
(A Unit of Monsanto Company)

Although the information and recommendations set forth herein (hereinafter "Information") are presented in good faith and believed to be correct as of the date hereof, Monsanto Company makes no representations as to the completeness or accuracy thereof. Information is supplied upon the condition that the persons receiving same will make their own determination as to its suitability for their purposes prior to use. In no event will Monsanto Company be responsible for damages of any nature whatsoever resulting from the use of or reliance upon Information. NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR OF ANY OTHER NATURE ARE MADE HEREUNDER WITH RESPECT TO INFORMATION OR THE PRODUCT TO WHICH INFORMATION REFERS.

This form has been approved by the Occupational Safety and Health Administration as "equivalent to" OSHA Form 20.

15.5 OSHA POSTER

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. Requirements 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 discrimination.

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 penalties against employers of up to $1,000 for each serious violation and for optional penalties of up to $1,000 for each nonserious violation. Penalties of up to $1,000 per day may be proposed for failure to correct violations within the proposed time period. Also, any employer who willfully or repeatedly violates the Act may be assessed penalties of up to $10,000 for each such violation.

Criminal penalties are also provided for in the Act. Any willful violation resulting in death of an employee, upon conviction, is punishable by a fine of not more than $10,000, or by imprisonment for not more than six months, or by both. Conviction of an employer after a first conviction doubles these maximum penalties.

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.

Such voluntary action should initially focus on the identification and elimination of hazards that could cause death, injury, or illness to employees and supervisors. 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 consultative assistance, without citation or penalty, is available to employers, on request, through OSHA supported programs in most State departments of labor or health.

[illegible] OFFICE

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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, Georgia
Boston, Massachusetts
Chicago, Illinois
Dallas, Texas
Denver, Colorado
Kansas City, Missouri
New York, New York
Philadelphia, Pennsylvania
San Francisco, California
Seattle, Washington

Telephone numbers for these offices, and additional area office locations, are listed in the telephone directory under the United States Department of Labor in the United States Government listing.

Washington, D.C.
1985
OSHA 2203

William E. Brock, Secretary of Labor

U.S. Department of Labor
Occupational Safety and Health Administration

Under provisions of Title 29, Code of Federal Regulations, Part 1903.2(a)(1) employers must post this notice (or a facsimile) in a conspicuous place where notices to employees are customarily posted.

15.6 DAILY HEALTH AND SAFETY AUDIT

Site Name: _____ Date: _____

Auditor: _____

SEND A COPY OF COMPLETED FORM TO THE HEALTH AND SAFETY MANAGER

	YES	NO	N/A	COMMENTS (Use back of form if more space is needed)
1. Safety meeting held today?				
2. Emergency procedures discussed during safety meeting?				
3. Vehicle available on-site for transportation to the hospital?				
4. At least two persons trained in CPR and first-aid on-site?				
5. Proper PPE being worn as specified in the HASP?				
Level of PPE being worn: _____				
6. PPE adequate for work conditions?				
If not, give reason: _____				
Upgrade/downgrade to PPE level: _____				
7. If Level B, back-up/emergency person suited up (except for air)?				
8. Monitoring equipment calibrated?				
9. Monitoring equipment in good condition?				
10. Monitoring equipment used properly?				
11. Other monitoring equipment needed?				
List: _____				
12. Monitoring equipment covered with plastic to minimize contamination?				
13. Decon line set up properly?				
14. Proper cleaning fluid used for known or suspected contaminants?				
15. Proper decon procedures used?				
16. Decon personnel wearing proper PPE?				
17. Equipment decontaminated?				
18. Samples decontaminated?				
19. Disposable items changed twice a day or more often if needed?				
20. Proper collection and disposal of contaminated PPE?				
21. Proper collection and disposal of decon fluid?				
22. Buddy system used?				
23. Equipment kept off drums and ground?				
24. Kneeling or sitting on drums or ground not allowed?				
25. Personnel avoid standing or walking through puddles or stained soil?				
26. Zones established?				
27. If night work to be conducted, adequate illumination?				
28. Smoking, eating, or drinking in the Exclusion Zone or CRZ not allowed?				
29. To the extent feasible, contaminated materials handled remotely?				
30. Entry into excavations not allowed unless properly shored or sloped?				
31. All unusual situations on-site listed in HASP?				
If not, what? _____				
Action taken? _____				
HASP revised? _____				
32. All confined spaces identified?				
If not, list: _____				
33. Confined Space Checklists used?				
34. Confined Space Checklists completely and correctly filled out?				

ALL DEFICIENCIES MUST BE CORRECTED IMMEDIATELY!

CHAPTER 16. RESPIRATORY PROTECTION PROGRAM

16.1 INTRODUCTION. This program was developed to govern the selection and use of respiratory protective devices by ABB-ES personnel. The program is intended to comply with OSHA requirements as set forth in 29 CFR 1910.134(b). The scope of this program is limited to activities related to field investigations of potentially hazardous waste disposal sites.

16.2 PERSONNEL REQUIREMENTS. All personnel assigned to field activities at hazardous or potentially hazardous locations are currently required by ABB-ES's health and safety policies to be enrolled in the corporate health monitoring program. Part of this program involves spirometry, a measure of the respiratory system status. No personnel may be assigned to the use of or may withdraw from stock any respiratory protective device without a physician's certification that use of the device will not be injurious to health. Psychological limitations (e.g., claustrophobia) are also considered in personnel assignments. Training in the use of the selected device and fit testing, as described herein, are also required.

Personnel will not be assigned duties that require a respirator when facial hair, skullcaps, or eyeglasses will interfere with a proper fit. Contact lenses may not be worn with any respiratory protective device. Eyeglass frames that fit inside the respirator facepiece are provided as necessary.

16.3 APPLICABLE EQUIPMENT. ABB-ES maintains the following respiratory protective equipment:

- full-face chemical/mechanical air-purifying respirators
- SCBA
- full-face airline-supplied breathing apparatus
- 5-minute escape air supply

This equipment is intended for use on an as-needed basis, to be determined by an evaluation of on-site conditions. Respiratory protective equipment should not be used arbitrarily by any ABB-ES personnel. Selection criteria are presented separately; training is required in the use of each type of equipment before drawing from stock.

16.4 PERSONNEL TRAINING. Training of personnel in the proper use and care of respiratory protective equipment is considered essential to the success of the program. Training encompasses the following topics:

- respiratory protection principles
- selection of appropriate equipment
- use of equipment
- maintenance of equipment
- fit testing

Information regarding each topic is presented as standard respiratory protection procedures in the corporate health and safety program manual.

16.5 PROGRAM ADMINISTRATION AND DOCUMENTATION. Administration of the ABB-ES Respiratory Protection Program is the responsibility of the HSM, and includes the following:

- respirator selection
- personnel training
- fit testing
- respirator maintenance
- documentation
- program evaluation and improvements
- personnel pulmonary testing and certification

Fit testing and respirator maintenance is performed by the equipment manager of ABB-ES's Sample Control and Staging Center in Portland, Maine, and designated, trained employees at the other offices. All fit-testing and respirator maintenance is conducted under the administration of the HSM. Major maintenance is performed by manufacturer-certified technicians only. Personnel training in respiratory protection is one aspect of the HSM's ongoing personnel training programs. Program evaluation is a dynamic process, occurring each time a project HASP is prepared.

Medical supervision of personnel occurs as part of the ABB-ES health monitoring program, also administered by the HSM. Medical surveillance is required for all personnel assigned to hazardous or potentially hazardous site activities.

Documentation of the various elements of the ABB-ES respiratory protection program is achieved through several media, as follows:

- Documentation of respirator selection is included in the hazard assessment of each site's HASP.

- Documentation of personnel training is maintained in both hardcopy and computerized files.

- Documentation of medical surveillance is achieved indirectly by maintaining a list of enrolled employees in the health monitoring program, and directly through physician certification of personnel allowed to be assigned respiratory protective devices.

- Using the appropriate form, documentation of fit-testing is maintained on file with the equipment manager of the Sample Control and Staging Center and with the HSM or designee.

- Documentation of site surveillance is required both by this program and by the HASP for each site. Records of site surveillance are created by the HSO and maintained in project files.

- Respirator inspection and maintenance records are created and maintained by the equipment manager for each respirator, SCBA, and escape respirator.

Inspection and documentation occurs either before each unit is removed from stock and when it is returned, or monthly.

16.6 INSPECTION, MAINTENANCE, AND STORAGE

16.6.1 Introduction Respirator maintenance is an integral part of the overall respirator program. Wearing a poorly maintained or malfunctioning respirator, in one sense, is more dangerous than not wearing a respirator at all. Personnel wearing defective devices think they are protected when, in reality, they are not. Emergency escape and rescue devices are particularly vulnerable to poor maintenance because they generally are used infrequently, and then in the most hazardous and demanding circumstances. Serious injury or death can result from wearing a defective device during an emergency escape or rescue. The respirator program includes the following components:

- inspection for defects (including a leak check)
- cleaning and disinfecting
- repair as required
- proper and sanitary storage of equipment

16.6.2 Inspection for Defects The most important part of a respirator maintenance program is continual inspection of the devices. If properly performed, inspections will identify damaged or malfunctioning respirators before they can be used. Two types of inspections will be performed: (1) while the respirator is in use, and (2) while it is being cleaned. Because the use and cleaning will be performed primarily by the same personnel, these inspections may become concurrent.

16.6.3 Frequency of Inspection OSHA requires that "All respirators be inspected before and after each use," and that those not used routinely (i.e., emergency escape and rescue devices) "shall be inspected after each use and at least monthly...." Obviously, emergency escape and rescue devices do not require inspection before each use.

16.6.4 Inspection Procedures Respirator inspection will include checking of the following:

- tightness of the connections
- facepiece
- valves
- connecting tubes
- canisters, filters, or cartridges

In addition, the regulator and warning devices on a SCBA will be checked for proper functions.

16.6.5 Field Inspection of Air-purifying Respirators Routinely used air-purifying respirators will be checked as follows before and after each use:

1. Examine the facepiece for:

   - excessive dirt
   - cracks, tears, holes, or physical distortion of shape from improper storage
   - inflexibility of rubber facepiece (stretch and knead to restore flexibility)
   - cracked or badly scratched lenses in full facepieces
   - incorrectly mounted full facepiece lenses, or broken or missing mounting clips
   - cracked or broken air-purifying element holder(s), badly worn threads, or missing gasket(s)

2. Examine the head straps or head harness for:

   - breaks
   - loss of elasticity
   - broken or malfunctioning buckles and attachments
   - excessively worn serrations on head harness, which might permit slippage (full facepieces only)

3. Examine the exhalation valve for the following after removing the cover:

   - foreign material (e.g., detergent residue, dust particles, or human hair under valve seat)
   - cracks, tears, or distortion in the valve material
   - improper insertion of the valve body in the facepiece
   - cracks, breaks, or chips in the valve body, particularly the sealing surface
   - missing or defective valve cover
   - improper installation of the valve in the valve body

4. Examine the air-purifying element(s) for:

   - incorrect cartridge, canister, or filter for the hazard
   - incorrect installation, loose connections, missing or worn gasket, or cross-threading in the holder

- expired shelf-life date on the cartridge or canister

- cracks or dents in the outside case of the filter, cartridge, or canister indicated by the absence of sealing material, tape, or foil over the inlet

- identical cartridges if more than one are used

16.6.6 Care and Cleaning of Self-contained Breathing Apparatus The proper care of SCBAs involves the following:

- inspection for defects
- cleaning and disinfecting
- repair
- storage

The following checklist is to be used by personnel whenever they check out a SCBA. (Note: Any discrepancy found should be cause to set the unit aside until it can be repaired by a certified repair person.)

1. Preliminary Inspection. Check to ensure that:

   - high-pressure hose connector is tight on cylinder fitting
   - bypass valve is closed
   - mainline valve is closed
   - there is no cover or obstruction on regulator outlet
   - pressure in the tank is at least 1,800 psi

2. Backpack and Harness Assembly.

   - Straps

     - visually inspect for complete set
     - visually inspect for frayed or damaged straps that may break during use

   - Buckles

     - visually inspect for mating ends
     - check locking function

   - Backplate and Cylinder Lock

     - visually inspect backplate for cracks and for missing rivets or screws
     - visually inspect cylinder hold-down strap and physically check strap tightener and lock to ensure that it is fully engaged

3. Cylinder and Cylinder Valve Assembly.

- Cylinder

  - physically check cylinder to ensure that it is tightly fastened to backplate
  - check hydrostatic test date to ensure that it is current
  - visually inspect cylinder for large dents or gouges in metal

- Head and Valve Assembly

  - visually inspect cylinder for presence of valve lock
  - visually inspect cylinder gauge for condition of face, needle, and lens
  - open cylinder valve and listen or feel for leakage around packing (if leakage is noted, do not use until repaired); note function of valve lock

4. Regulator and High-pressure Hose.

- High-pressure Hose and Connector. Listen or feel for leakage in hose or at hose-to-cylinder connector. (Bubble in outer hose covering may be caused by seepage of air through hose when stored under pressure. This does not necessarily mean a faulty hose.)

- Regulator and Low-pressure Alarm

  - Cover outlet of regulator with palm of hand. Open mainline valve and read regulator gauge (must read at least 1,800 psi and not more than rated cylinder pressure).

  - Close cylinder valve and slowly move hand from regulator outlet to allow slow flow of air. Gauge should begin to show immediate loss of pressure as air flows. Low-pressure alarm should sound between 650 and 550 psi. Remove hand completely from outlet and close mainline valve.

  - Place mouth onto or over regulator outlet and blow. A positive pressure should be created and maintained for 5 to 10 seconds without any loss of air. Next, establish a slight negative pressure in regulator and hold for 5 to 10 seconds. Vacuum should remain constant. This tests the integrity of the diaphragm. Any loss of pressure or vacuum during this test indicates a leak in the apparatus.

  - Open cylinder valve.

  - Place hand over regulator outlet and open mainline valve. Remove hand from outlet and replace in rapid movement. Repeat twice. Air should escape when hand is removed each time,

indicating a positive pressure in chamber. Close mainline valve and remove hand from outlet.

- Ascertain that no obstruction is in or over the regulator outlet. Open and close the bypass valve momentarily to ensure flow of air through bypass system.

5. Facepiece and Corrugated Breathing Tube.

- Facepiece

  - Visually inspect head harness for damaged serrations and deteriorated rubber. Visually inspect rubber facepiece body for signs of deterioration or extreme distortion.

  - Retaining clamp properly in place, visually inspect lens for proper seal in rubber facepiece, and for cracks or large scratches.

  - Visually inspect exhalation valve for visible deterioration or foreign materials buildup.

- Breathing Tube and Connector

  - Stretch breathing tube and visually inspect for deterioration and holes.

  - Visually inspect connector to ensure good condition of threads and for presence and proper condition of "O" ring or rubber gasket seal.

  - Perform a negative pressure test on facepiece.

    a. Don backpack and facepiece.

    b. With facepiece held tightly to face or facepiece properly donned, stretch breathing tube to open corrugations and place thumb or hand over end of connector.

    c. Inhale. Negative pressure should be created inside mask, causing it to pull tightly to face. This negative pressure should be maintained for 5 to 10 seconds. If negative pressure leaks down, the facepiece assembly is not adequate and should not be worn.

6. Storage of Units. Check that:

- cylinder is refilled as necessary and unit is cleaned and inspected

- cylinder valve is closed

- high-pressure hose connector is tight on cylinder
- pressure is bled off high-pressure hose and regulator
- bypass valve is closed
- mainline valve is closed
- all straps are completely loosened and laid straight
- facepiece is properly stored to protect against dust, sunlight, heat, extreme cold, excess moisture, and damaging chemicals

16.6.7 Cleaning and Sanitizing Any good detergent may be used, followed by a disinfecting rinse or a combination disinfectant-detergent for a one-step operation. Reliable, effective disinfectants can be made from readily available household solutions, including the following:

- Hypochlorite solution (50 ppm of chlorine) can be made by adding approximately 2 milliliters of bleach (e.g., Clorox) to 1 liter of water, or 2 tablespoons of bleach per gallon of water. A 2-minute immersion disinfects the respirators.
- Aqueous solution of iodine (50 ppm of iodine) can be made by adding approximately 0.8 milliliter of tincture of iodine per liter of water, or 1 teaspoon of tincture of iodine per gallon of water. A 2-minute immersion is sufficient to disinfect the respirators.

To prevent damaging the rubber and plastic in the respirator facepieces, the cleaning water should not exceed 140 °F; however, to ensure adequate cleaning, it should not be less than 120 °F.

16.6.8 Rinsing The cleaned and disinfected respirators should be rinsed thoroughly in water (140 °F maximum) to remove all traces of detergent and disinfectant. This is important for preventing dermatitis.

16.6.9 Drying The respirators may be allowed to dry in room air on a clean surface. They may also be hung from a horizontal wire, like drying clothes; however, care must be taken not to damage or distort the facepieces.

16.6.10 Reassembly and Inspection To avoid contamination, the clean, dry respirator facepieces should be reassembled and inspected in an area separate from the disassembly area. The inspection procedures were discussed previously; special emphasis should be given to inspecting the respirators for detergent or soap residue left by inadequate rinsing. This appears most often under the seat of the exhalation valve, and can cause valve leakage or sticking. The respirator should be thoroughly inspected and all defects corrected. New or retested cartridges and canisters should be installed, and the completely reassembled respirator should be tested for leaks. For SCBA devices, the facepiece should be combined with the tested regulator and the fully charged cylinder, and an operational check should be performed.

16.6.11 Maintenance and Repair Replacement or repair should be done only by trained, experienced persons using parts designed for the respirator. Besides being contrary to OSHA requirements, substitution of parts from a different brand or type of respirator invalidates approval of the device. This restriction applies particularly to maintenance of the more complicated devices, especially SCBA, and more specifically, regulator valves and low-pressure warning devices. These devices should be returned to the manufacturer or to a trained technician for adjustment or repair. No problems are anticipated in repairing and maintaining most simple respirators, particularly the commonly used air-purifying type.

16.6.12 Respirator Storage Respirators must be stored properly to protect against the following:

- dust
- sunlight
- heat
- extreme cold
- excessive moisture
- damaging chemicals
- mechanical damage

Damage and contamination of respirators may occur if they are stored on a workbench; in a tool cabinet or toolbox among heavy tools, greases, and dirt; or in a vehicle.

CHAPTER 17. OTHER CONSIDERATIONS

17.1 ILLUMINATION. Site operations will not be permitted without adequate lighting. Therefore, unless provisions are made for artificial light, downrange operations must halt in time to permit personnel and equipment to exit the Exclusion Zone and proceed through decontamination before dusk. Conversely, operations will not be permitted to begin until lighting is adequate.

17.2 SANITATION. Provisions must be made for sanitation facilities for the site work force. At a minimum, the provision of toilet facilities must meet the requirements of 29 CFR 1910.120(n), which includes one facility for less than 20 employees, or one toilet and one urinal for every 40 employees, up to 200; then one of each for every 50 employees. If it is a mobile crew and they have transport readily available, the requirements do not apply.

17.3 HEALTH AND SAFETY AUDIT PROCEDURES Regular health and safety audits will be conducted to ensure compliance with health and safety policy and procedures. The HSO will perform periodic audits, with the goal of one audit per shift, using the health and safety audit form (see Chapter 15.0). Auditing may be performed on any ABB-ES site by the HSS or the HSM, and will include health and safety evaluations of all work activities. The audits will be an unannounced evaluation of sites selected at the discretion of the HSM or HSS, with the goal of 10 percent of active sites being subject to audits each quarter.

Results of each site health and safety audit will be summarized in an audit report provided to the site HSO, the Project Manager, and the Operational Group Manager charged with responsibility for the project. Where the audit report identifies deficiencies, it will be the Project Manager's responsibility to promptly implement corrective action. The corrective action undertaken will be outlined in a written report submitted to the HSS and the HSM. The HSM or the HSS will retain the original audit report that has been signed by the Project Manager and the HSO to acknowledge receipt of the audit's findings. Any mitigating comments submitted to the HSM or the HSS will be appended to the original report.

CLEAN DISTRICT I

GENERIC HEALTH AND SAFETY PLAN

APPENDIX A

SITE-SPECIFIC HEALTH AND SAFETY PLAN

SITE SPECIFIC
HEALTH AND SAFETY PLAN

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HEALTH AND SAFETY PLAN

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REFERENCES

The following chapters of the Navy CLEAN Program District I Generic HASP are applicable for the work anticipated at the site:

___ 2.0 AUTHORITY AND RESPONSIBILITY OF HEALTH AND SAFETY PERSONNEL

___ 3.0 TRAINING PROGRAM

___ 4.0 MEDICAL SURVEILLANCE PROGRAM

___ 5.0 ENGINEERING CONTROLS

___ 6.0 PERSONAL PROTECTIVE LEVEL DETERMINATION

___ 7.0 MONITORING EQUIPMENT

___ 8.0 ZONATION

___ 9.0 WORK PRACTICES

___ 10.0 CONFINED SPACE ENTRY PROCEDURES

___ 11.0 EXCAVATION AND TRENCHING

___ 12.0 TEMPERATURE EXTREMES
- ___ HEAT STRESS
- ___ COLD STRESS

___ 13.0 DECONTAMINATION

___ 14.0 EMERGENCY PLANNING

___ 15.0 HEALTH AND SAFETY FORMS AND DATA SHEETS
- ___ HEALTH AND SAFETY AUDIT FORM
- ___ ACCIDENT REPORT FORM
- ___ HSO CHECKLIST FOR FIELD OPERATIONS
- ___ MATERIAL SAFETY DATA SHEETS
- ___ LIQUI-NOX
- ___ ETHYL ALCOHOL (denatured)
- ___ TRISODIUM PHOSPHATE
- ___ OSHA POSTER
- ___ DAILY HEALTH AND SAFETY AUDIT FORM

HEALTH AND SAFETY PLAN
PART I

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REFERENCES (continued)

___ 16.0 RESPIRATORY PROTECTION PROGRAM

___ 17.0 OTHER
- ___ ILLUMINATION
- ___ SANITATION
- ___ HEALTH AND SAFETY AUDIT PROCEDURES

1.0 GENERAL

1.1 SCOPE AND PURPOSE. This Health and Safety Plan (HASP) has been prepared in conformance with the Navy CLEAN Program District I (CLEAN) HASP and is intended to meet the requirements of 29 CFR 1910.120. As such, the HASP addresses those activities associated with field operations for this project. Compliance with this HASP is required for all ABB-ES personnel, contractor personnel, or third parties entering the site.

1.2 PROJECT PERSONNEL.

1.2.1 Project Manager The project manager (PM) is the individual with overall project management responsibilities. Those responsibilities as they relate to health and safety include provision for the development of this site-specific HASP; the necessary resources to meet requirements of this HASP; the coordination of staff assignments to ensure that personnel assigned to the project meet medical and training requirements; and the means and materials necessary to resolve any health and safety issues that are identified or that developed on the project.

1.2.2 General Site Supervisor The General Site Supervisor is either the PM or the PM's designee who is on-site and vested with the authority by the PM to carry out day-to-day site operations, including interfacing with the site Health and Safety Officer (HSO).

1.2.3 Health and Safety Officer The HSO for this project has been designated by the PM with concurrence of the Health and Safety Supervisor (HSS) or Health and Safety Manager (HSM). The HSO will have at least an indirect line of reporting to the HSM through the HSS for the duration of his/her assignment as project HSO. The HSO is responsible for developing and implementing this site-specific HASP in accordance with the CLEAN HASP. The HSO will investigate all accidents, illnesses, and incidents occurring on-site. The HSO will also conduct safety briefings and site-specific training for on-site personnel. As necessary, the HSO will accompany all U.S. Environmental Protection Agency (USEPA), Occupational Safety and Health Administration (OSHA), or other governmental agency personnel visiting an ABB-ES site in response to health and safety issues. The HSO, in consultation with the HSS or HSM, is responsible for updating and modifying this HASP as site or environmental conditions change.

1.2.4 Other Functional Titles The following is a list of other personnel who will be involved in this project and their general responsibilities:

Position Title	Responsibilities

1.3 TRAINING. Training is defined under the CLEAN HASP, and all personnel entering potentially contaminated areas of this site must meet the requirements of 29 CFR 1910.120. Personnel without the required training will not be permitted in any area with potential for exposure to toxic substances or harmful physical agents (i.e., downrange). Refer to Chapter 3.0 of the CLEAN HASP for further information.

1.4 MEDICAL SURVEILLANCE. All personnel entering potentially contaminated areas of this site will be medically qualified for site assignment through a medical surveillance program outlined in the CLEAN HASP. Personnel who have not received medical clearance will not be permitted in any area with potential for exposure to toxic substances or harmful physical agents (i.e., downrange). Refer to Chapter 4.0 of the CLEAN HASP for further information.

2.0 SITE CHARACTERIZATION AND ANALYSIS

2.1 SITE NAME, LOCATION, AND SIZE.

2.2 SITE HISTORY AND LAYOUT.

2.3 SCOPE OF WORK (WORK PLAN)

4.0 DATA SHEETS

See RFSI/SI HASP

5.0 SITE CONTROL

5.1 ZONATION. The general zonation protocols that should be employed at hazardous waste sites are described in Chapter 8.0 of the CLEAN HASP. The site-specific zonation that will be used for this project is described as follows:

5.2 COMMUNICATIONS

When radio communication is not used, the following air horn signals will be employed:

HELP	three short blasts	(. . .)
EVACUATION	three long blasts	(_ _ _)
ALL CLEAR	alternating long and short blasts	(_ . _ .)

5.3 WORK PRACTICES. General work practices to be used during ABB-ES projects are described in Chapter 9.0 of the CLEAN HASP. Specific work practices necessary for this project or those that are of significant concern are described as follows:

6.0 DECONTAMINATION/DISPOSAL

All personnel and/or equipment leaving contaminated areas of the site will be subject to decontamination, which will take place in the contamination reduction zone.

6.1 PERSONNEL DECONTAMINATION

6.1.1 Small Equipment Decontamination

6.1.2 Heavy Equipment Decontamination

6.2 COLLECTION AND DISPOSAL OF DECONTAMINATION PRODUCTS

7.0 EMERGENCY/CONTINGENCY PLAN

This section identifies emergency/contingency planning that has been undertaken for operations at this site. Most sections of the HASP provide information that would be used under emergency conditions. General emergency planning information is addressed in Chapter 14.0 of the CLEAN HASP. The following subsections present site-specific emergency/contingency planning information.

7.1 PERSONNEL ROLES, LINES OF AUTHORITY, AND COMMUNICATION. The site HSO or the Health and Safety designee is the primary authority for directing operations at the site under emergency conditions. All communications both on- and off-site will be directed through the HSO or designee.

7.2 EVACUATION.

7.3 EMERGENCY MEDICAL TREATMENT/FIRST AID. Any personnel injured on-site will be rendered first aid as appropriate and transported to competent medical facilities for further examination and/or treatment. The preferred method of transport would be through professional emergency transportation means; however, when this is not readily available or would result in excessive delay, other transport will be authorized. Under no circumstances will injured persons transport themselves to a medical facility for emergency treatment.

8.0 ADMINISTRATION

8.1 PERSONNEL AUTHORIZED DOWNRANGE. Personnel authorized to participate in downrange activities at this site have been reviewed and certified for site operations by the Project Manager and the HSS. Certification involves the completion of appropriate training, a medical examination, and a review of this site-specific HASP. All persons entering the site must use the buddy system, and check in with the Site Manager and/or HSO before going downrange.

CERTIFIED ABB ENVIRONMENTAL TEAM PERSONNEL:

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

OTHER CERTIFIED PERSONNEL:

_____	_____
_____	_____
_____	_____
_____	_____

* FIRST-AID-TRAINED
\+ CPR-TRAINED

8.2 HEALTH AND SAFETY PLAN (HASP) APPROVALS. By their signatures, the undersigned certify that this HASP will be used for the protection of the health and safety of all persons entering this site.

_____	_____
Health and Safety Officer	Date
_____	_____
Project Manager	Date
_____	_____
Health and Safety Manager/Supervisor	Date

8.3 FIELD TEAM REVIEW. I have read and reviewed the health and safety information in the HASP. I understand the information and will comply with the requirements of the HASP.

NAME: _____

DATE: _____

SITE/PROJECT: _____

8.4 MEDICAL DATA SHEET. This Medical Data Sheet will be completed by all on-site personnel and kept in the Support Zone during site operations. It is not a substitute for the Medical Surveillance Program requirements consistent with the CLEAN HASP. This data sheet will accompany any personnel when medical assistance or transport to hospital facilities is required. If more space is required, use the back of this sheet.

Project: _____

Name: _____

Address: _____

Home Telephone: Area Code ( ) _____

Age: _____ Height: _____ Weight: _____

In case of emergency, contact: _____

Address: _____

Telephone: Area Code ( ) _____

Do you wear contact lenses? Yes ( ) No ( )

Allergies: _____ _____

List medication(s) taken regularly: _____

Particular sensitivities: _____

Previous/current medical conditions or exposures to hazardous chemicals:

_____

Name of Personal Physician: _____

Telephone: Area Code ( ) _____

8.5 EMERGENCY TELEPHONE NUMBERS

Police Department	( ) -
Rescue Service	( ) -
Primary Hospital	( ) -
Alternate Hospital	( ) -
Fire Department	( ) -
Off-site Emergency Services	( ) -
Poison Control Center	(800) 962-1253
National Response Center	(800) 424-8802
Regional USEPA Emergency Response	( ) -
Site HSO: _____	( ) -
General Site Supervisor: _____	( ) -
Project Manager: _____	( ) -
ABB Environmental HSM: C.E. Sundquist	(207) 775-5401 x101

8.6 ROUTES TO EMERGENCY MEDICAL FACILITIES

The primary source of medical assistance for the site is:

DIRECTIONS TO PRIMARY:

The alternate source of medical assistance for the site is:

DIRECTIONS TO ALTERNATE:

8.6 ROUTES TO EMERGENCY MEDICAL FACILITIES

The primary source of medical assistance for the site is:

DIRECTIONS TO PRIMARY:

The alternate source of medical assistance for the site is:

DIRECTIONS TO ALTERNATE:

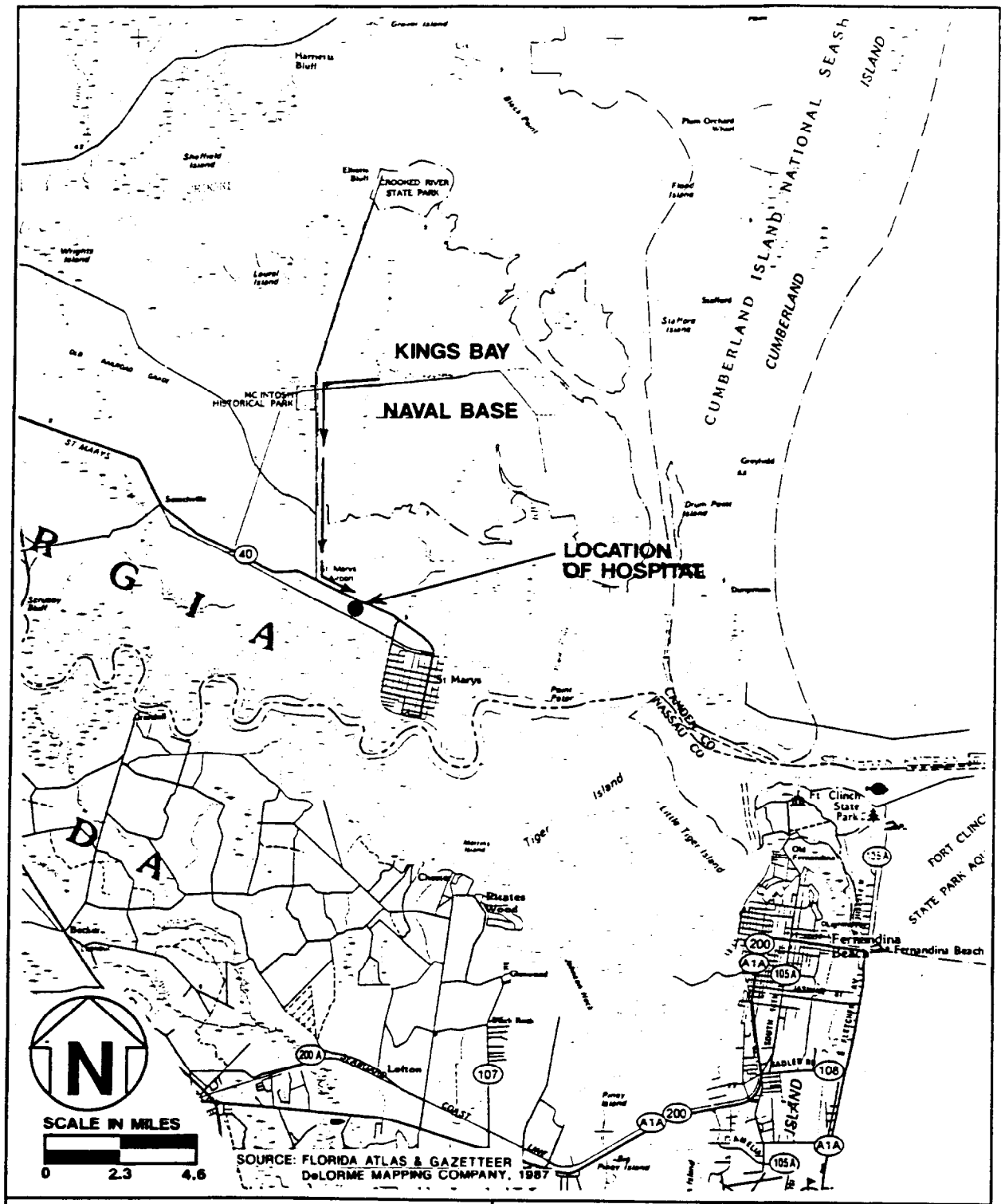

FIGURE 8-1

ROUTE TO HOSPITAL

HEALTH AND SAFETY PLAN
NSB KINGS BAY

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. Requirements 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 or 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 the 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 discrimination.

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 penalties against employers of up to $1,000 for each serious violation and for optional penalties of up to $1,000 for each nonserious violation. Penalties of up to $1,000 per day may be proposed for failure to correct violations within the proposed time period. Also, any employer who willfully or repeatedly violates the Act may be assessed penalties of up to $10,000 for each such violation.

Criminal penalties are also provided for in the Act. Any willful violation resulting in death of an 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 by both. Conviction of an employer after a first conviction doubles these maximum penalties.

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 emplyee 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 proivde considerable help and advice on solving safety and health problems or can refer you to other sources for health 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. Thse programs are usually administered by the State labor or Health department or a State university.

POSTING INSTRUCTIONS

Employees in States operating OSHA approved State Plans should obtain and post the State's equivalent poster.

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, Georgia	(404) 347-3573
Boston, Massachusetts	(617) 565-7164
Chicago, Illinois	(312) 353-2220
Dallas, Texas	(214) 767-4731
Denver, Colorado	(303) 844-3061
Kansas City, Missouri	(816) 426-5861
New York, New York	(212) 337-2325
Philadelphia, Pennsylvania	(215) 596-1201
San Francisco, California	(415) 995-5672
Settle, Washington	(206) 442-5930

Washington, D.C.
1989 (Revised)
OSHA 2203

Elizabeth Dole, Secretary of Labor

U.S. Department of Labor

Occupational Safety and Health Adminstration

Under provisions of Title 29, Code of Federal Regualtions, Part 1903.2(a)(1) employers must post this notice (or a facsimile) in a conspicuous place where notices to employees are customarily posted.

APPENDIX C

USEPA LOCATIONAL DATA POLICY AND REGION IV ENVIRONMENTAL MONITORING AND DATA REPORTING REQUIREMENTS

EPA LOCATIONAL DATA POLICY

EPA's Officer of Information Resources Management (OIRM) has developed a policy to be adopted by EPA, and its delegates and representatives, for collecting and documenting locational data about the entities tracked under Federal Environmental programs within EPA's jurisdiction. The policy clearly defines responsibilities for obtaining locational measurements for all facilities, sites and monitoring and observation points of primary interest to EPA. In addition, the policy explicitly specifies latitude and longitude, in an intentionally-compatible format, as the Agency's preferred locational coordinate system. Implementation of this policy will allow Agency data to be integrated based upon location, thereby promoting enhanced use of EPA's extensive data resources for cross-media environmental analyses and management decisions.

1. PURPOSE. This policy establishes the principles for collecting and documenting latitude/longitude coordinates for facilities, sites and monitoring and observation points regulated or tracked under Federal environmental programs within the jurisdiction of the Environmental Protection Agency (EPA). The intent of this policy is to extend environmental analyses and allow data to be integrated based upon location, thereby promoting the enhanced use of EPA's extensive data resources for cross-medial environmental analyses and management decisions. This policy underscores EPA's commitment to establishing the data infrastructure necessary to enable data sharing and secondary data use.

2. SCOPE AND APPLICABILITY. This policy applies to all Environmental Protection Agency (EPA) organizations and personnel of agents (including contractors and grantees) of EPA who design, develop, compile, operate or maintain EPA information collections developed for environmental program support. The requirements of this policy apply to existing as well as new data collections.

3. BACKGROUND.

   a. Fulfillments of EPA's mission to protect and improve the environment depends upon improvements in cross-programmatic, multi-media data analyses. A need for available and reliable location identification information is a commonality which all regulatory tracking programs share.

   b. Standard location identification data will provide a return yet unrealized on EPA's sizable investment in environmental data collection by improving the utility of these data for a variety of valued-added secondary applications often unanticipated by the original data collectors.

   c. EPA is committed to implementing its locational policy in accordance with the requirements specified by the Federal Interagency Coordinating Committee for Digital Cartography (FICCDC). The FICCDC has identified the collection of latitude/longitude as the most preferred coordinate system for identifying location.

4. AUTHORITIES

a. 15 CFR Part 6 Subtitle A, Standardization of Data Elements and Representations.

b. Geological Survey Circular 878-B, A U.S. Survey Data Standard, Specifications for Representation of Geographic Point Locations for Information Interchange.

c. Federal Interagency Coordinating Committee on Digital Cartography (FICCDC)/U.S. Office of Management and Budget, Digital Cartographic Data Standards: An Interim Proposed Standard.

d. EPA Regulations 40 CFR 30.503 and 40 CFR 31.45, Quality Assurance Practices under EPA's General Grant Regulations.

5. POLICY.

a. It is EPA policy that latitude/longitude ("lat/long") coordinated be collected and documented with environmental and related data. This is in addition to, and not precluding, other critical location identification data that may be needed to satisfy individual program or project needs, such ag depth, street address, elevation or altitude.

b. This policy serves as a framework for collecting and documenting location identification data. It does not include a requirement that a particular level of precision or accuracy be achieved; managers of individual data collection efforts determine the levels precision and accuracy necessary to support their mission. However, this policy does serve as a starting point for acquiring these critical data.

c. To implement this policy, program data managers must collect and document the following:

(1) Latitude/longitude coordinates in accordance with Federal Interagency Coordinating Committee for Digital Cartography (FICCDC) recommendations. The coordinates may be present singly or multiple times, to define a point, line or area, according to the most appropriate data type for the entry being represented.

This format for representing this information is:

+/-DD MN SS.SSSS (latitude)
+/-DDD MM SS.SSSS (longitude)

where:

- Latitude is always presented before longitude,

- DD represents degrees of latitude; a digit decimal number ranging from 00 through 90,

- DDD represents degrees of longitude; a three digit decimal number ranging from 000 through 180,

- MM represents minutes of latitude or longitude, a two-digit decimal number ranging from 00 through 60,

- SS.SSSS represents seconds of latitude or longitude, with a format allowing possible precisions to the ten-thousandths of seconds actual accuracy to be program and case specific.

- + specifies latitudes north of the equator and longitudes east of the prime meridian, and

- - specifies latitudes south of the equator and longitudes west of the prime meridian.

(2) Specific method used to determine the lat/long coordinates (e.g., remote sensing techniques, map interpolation, cadastral survey);

(3) Textual description of the entity to which the latitude/longitude coordinates refer (e.g., north-east corner of site, entrance to facility, point of discharge, drainage ditch);

(4) Estimate of accuracy in terms of the most precise units of measurements used (e.g., if the coordinates are given to tenths-of-seconds precision, the accuracy estimate should be expressed the terms of the range of tenths of-seconds within which the true value should fall, such as "+/- 0.5 seconds").

d. Recommended labeling of the above information is as follows:

- "Latitude"
- "Longitude"
- "Method"
- "Description"
- "Accuracy"

e. This policy does not preclude or rescind more stringent regional or program-specific policy and guidance .

f. Formats, standards, coding conventions or other specifications for the method, description and accuracy information shall be as specified by the Regional Program as appropriate.

6. RESPONSIBILITY FOR IMPLEMENTATION. Assistant Administrators, Associate Administrators, Regional Administrators, Laboratory Directors and the General Counsel shall establish procedures within their respective organizations to ensure information collection and reporting systems under their direction are in compliance with this policy

Interchange File Format for
Electronic Data Reports

This document establishes, for EPA Region Iv, the required format for electronic reporting of monitoring data.

Data will be transported as a set of four ASCII files:

STATION.DAT - contains basic information about monitoring station location and type. Detailed description of the structure is contained in Appendix A.

WELL.DAT - contains detailed information about construction and characteristics of groundwater monitoring stations. See Appendix B.

SAMPLE.DAT - contains basic information about the collection and characteristics of samples. See Appendix C.

PARM.DAT - contains measured values and reporting units for specific parameters. See Appendix D.

The first line of EACH of the four files MUST contain the following text starting in position one: 19901001

These files are to be transmitted in ASCII format using 5.25 inch flexible disk, nine-track magnetic tape (1600 or 6250 bpi) or, in the future, via communications channels yet to be defined. Hardcopy reporting requirements will continue as currently required until further notice. Additional files may be defined in the future for non-groundwater station types should the need arise.

Several of these files will contain data that is usually static in nature. For example, the basic information contained in STATION.DAT will not normally change for any single station, therefore once the data has been submitted for a particular station, it will not be required to resubmit that information. If, however, the station record is updated or corrected the record would have to be resubmitted. After the initial report then, STATION.DAT would be submitted only when new stations are created, or when an old station record is modified, and need only contain the new or modified records. The same is true of file WELL.DAT. SAMPLE.DAT would, of course, be submitted each time one or more new samples were to be reported, or any sample record required updating. Again, the file need only contain the new or updated records. PARM.DAT is expected to be submitted at each required reporting interval, since it will contain the analytical results needed to determine compliance. It must contain all new results for the reporting interval, and may contain corrections and updates to older records. As may be observed, the format allows for asynchronous reporting, provided that no sample may be reported before the station with which it is associated, and no parametric record before its sample record.

For each file described in the appendices, all fields must be reported. The null, or "no data", value for all fields is the pound sign (#), and must appear in the first column position of its field. Field values may be listed one per line in the export file, or multiple values may be reported on a single line, provided that field values are reported in the specified order, and each value is terminated by a comma (,). Lines containing multiple values may not exceed 80 characters in length, including the delimiters. Since the comma is used as a delimiter for data values, the values themselves may not contain any comma, even though the value may be a text stream.

Attachment A

Datafile STATION.DAT

Field No.	Field Name	Field Description
1	STATION_KEY *	Unique station identifier. Consists of a twenty-seven character alphanumeric field, left justified, containing:

Column:	Description:
1 - 12	Unique site identifier as assigned by EPA. Must be alphanumeric.
13 - 17	Unique solid waste management unit designator. Must be alphanumeric.
18	Media status indicator. Must contain one of the following: C - compliance monitoring station B - baseline monitoring station A - other ambient monitoring station.
19 - 27	Unique station identifier. Must be alphanumeric.

If this data is to be used with the Region IV Query menu, the naming convention recommended for stations is as follows. Monitoring wells should contain 'MW',test pits 'TP',boreholes 'BH', surface soil 'SS'.

2	TYPE	*	Type of monitoring station. Consists of a four character alphanumeric field, left justified, containing one of the following: AIR, SWTR, GWTR, SOIL, SED, and SLDG. The meanings of these abbreviations are as follows: AIR - Air sampling station SWTR - Surface water sampling station GWTR - ground water sampling station SOIL - soil sampling station SED - Stream bed sediment SLDG - process sludge sampling
3	LATITUDE	*	Geographic position of the station in degrees north of the equator. Must be in the format DDMMSS.xxxx, where DD represents degrees, MM represents minutes, and SS.xxxx represents seconds, with available precision to four decimal places.

* = required field

4	LONGITUDE	*	Geographic position of the station in degrees west of the Prime Meridian. Must be in the format DDDMMSS.xxxx, where DDD represents degrees, MM represents minutes, and SS.xxxx represents seconds, with available precision to four decimal places.
5	LSDAT	*	Elevation in feet (MSL) of land surface at the location of the monitoring station. Must be a DECIMAL NUMERIC field with a maximum of twelve characters (including the decimal point) and may have up to two digits after the decimal point.
6	RFDAT	*	Elevation in feet (MSL) of the point from which height above ground, water level and sampling depth measurements are taken. DECIMAL NUMERIC field with a maximum of twelve characters (including the decimal point) and may have up to two digits after the decimal point.
7	CONDT		Date construction of the station was completed. Eight character integer field consisting of:

Columns	Content
1-4	year including century, e.g. 1989
5-6	numeric month
7-8	numeric day of month

Column numbers are relative to the beginning of the CONDT Field. Each subfield described above must be right justified, and may contain leading zeros.

8	ACCUR	*	Estimated accuracy for the reported latitude and longitude, in meters. DECIMAL NUMERIC field with a maximum of six characters (including the decimal point) and may have up to two digits after the decimal point.
9	LLMETH	*	One character alphanumeric field which indicates the method used to determine the latitude and longitude. Contains one of the following:

C - Calculated from map
D - Digitized from a map
G - Global Positioning System
L - Loran-C
U - Unknown

10	OMETH	Any method for which there is no code. This field consists of 32 character ALPHANUMERIC field, left justified.
11	COMMENT	Any additional information the user feels necessary, required field which may not be accommodated in a defined field. Must be ALPHANUMERIC consisting of up to 40 characters.

* - required field

Attachment B

Datafile WELL.DAT

Field No.	Field Name	Field Description
1	STATION KEY *	Unique station identifier. Consists of a twenty-seven character alphanumeric field, left justified, consisting:

Column:	Description:
1 - 12	Unique site identifier as assigned by EPA. Must be alphanumeric.
13 - 17	Unique solid waste management unit designator. Must be alphanumeric.
18	Media status indicator. Must contain one of the following: C - compliance monitoring station B - baseline monitoring station A - other ambient monitoring station.
19 - 27	Unique station identifier. Must be alphanumeric.

2	AQNAM *	USGS Aquifer Code for aquifer from which samples are obtained. Alphanumeric field with up to eight characters.
3	TOTDP	Total depth to which the hole was drilled, bored or dug in feet below land surface datum. DECIMAL NUMERIC field with a maximum of twelve characters (including the decimal point) and may have up to two digits after the decimal point.
4	DRMTH	Method by which well was constructed. Must be ALPHANUMERIC, consisting of a single character. The character must be one of the followings:

H - hollow stem auger	S - solid stem auger
C - cable tool	R - rotary
V - reverse rotary	D - dug
J - water jet	A - air percussion
O - other	

* = required field

5	DRPLD	Fluid used to lubricate cutting tool and/or remove materials from hole. Must be ALPHANUMERIC, consisting of a single character. The character must be one of the followings: A - air B - bentonite W - water M - other mud N - none O - other fluid
6	DVMTH	Method by which well wag developed. Must be ALPHANUMERIC, consisting of a single character. The character must be one of the following: A - air lift pump C - compressed air P - other pump Z - other method B - bailed J - jetted S - surged N - none
7	DVHRS	Time in hours during which well was developed. Must be INTEGER NUMERIC, consisting of up to 5 digits.
8	SPLTRT	Any special treatment that was applied during the well development process. Must be ALPHANUMERIC, consisting of a single character, which must be one of the following: C - chemicals E - explosives H - hydrofracturing Z - other D - dry ice F - deflocculant M - mechanical N - none
9	LIFT	Type of lift indicator. Must be Alphanumeric, consisting of a single character. The character must be one of the followings: A - air lift B - bucket C - centrifugal pump J - jet pump P - Piston pump R - rotary pump S - submersible pump T - turbine U - unknown Z - other
10	NOSEG	Number of bore hole sections. A bore hole section is defined as a length of bore hole of constant diameter. Bore hole sections are designated numerically from top to bottom of bore hole. INTEGER NUMERIC field containing a value of one or two.
11	SGDIA1	Diameter of first bore hole section, in inches.
12	SGDIA2	Diameter of second bore hole section, in inches.

* = required field

13	SGDIA3	Diameter of third bore hole section, in inches. Each of the SGDIAx fields is DECIMAL NUMERIC, containing up to twelve characters (including the decimal point), and may have up to two digits following the decimal point.
14	STELV1	The depth to the top of the first bore hole section.
15	STELV2	The depth to the top of the second bore hole section.
16	STELV3	The depth to the top of the third bore hole section. Each of the STELYx fields is DECIMAL NUMERIC with a maximum of twelve characters (including the decimal point) and may have up to two digits after the decimal point. These depths are measured relative to land surface datum.
17	SBELV1	The depth to the bottom of the first bore hole section.
18	SBELV2	The depth to the bottom of the second bore hole section.
19	SBELV3	The depth to the bottom of the third bore hole section. Each of the SBELVx fields is DECIMAL NUMERIC with a maximum of twelve characters (including the decimal point) and may have up to two digits after the decimal point. These depths are measured relative to land surface datum.
20	NOCAS	Number of casing sections. A casing section is defined as a length of casing of constant diameter and uniform material. Casing sections are designated numerically from top to bottom of well. INTEGER NUMERIC field containing a value of one or two.
21	TCELV1	The depth to the top of the first section of casing (in feet).
22	TCELV2	The depth to the top of the second section of casing (in feet).
23	TCELV3	The depth to the top of the third section of casing (in feet). The TCELVx fields are DECIMAL NUMERIC, each with a maximum of twelve characters (including the decimal point) and may have up to two digits after the decimal point. These depths are measured relative to land surface datum.
24	BCELV1	The depth to the bottom of the first section of casing, in feet.

* - required field

25	BCELV7	The depth to the bottom of the second section of casing,in feet.
26	BCELV3	The depth to the bottom of the third section of casing,in feet.
		The BCELVx fields are DECIMAL NUMERIC,each with a maximum of twelve characters (including the decimal point) and may have up to two digits after the decimal point. These depths are measured relative to land surface datum.
27	CIDIA1	Inside diameter of the first section of casing, in inches.
28	CIDIA2	Inside diameter of the second section of casing, in inches.
29	CIDIA3	Inside diameter of the third section of casing, in inches.
		The CIDIAx fields are DECIMAL NUMERIC, each with a maximum of twelve characters (including the decimal point) and may have up to two digits after the decimal point.
30	CODIA1	Outside diameter of the first section of casing, in inches.
31	CODIA2	Outside diameter of the second section of casing, in inches.
32	CODIA3	Outside diameter of the third section of casing, in inches.
		The CODIAx fields are DECIMAL NUMERIC, each with a maximum of twelve characters (including the decimal point) and may have up to two digits after the decimal point.
33	CMATR1	Description or name of casing material from which the first section of casing is made.
34	CMATR2	Description or name of casing material from which the second section of casing is made.
35	CMATR3	Description or name of casing material from which the third section of casing is made.
		The CMATRx fields are ALPHANUMERIC, each with a maximum of eight characters.
		OPEN INTERVAL - any portion of the well in which the interior of the well is not isolated from the surrounding soil and rock by unbreached casing.

* = required field

36 OPTYP

Indicator of the type of opening in the open interval. The field is ALPHANUMERIC, consisting of a single character. The character must be one of the following:

O - open end
S - screened
W - walled
Z - other
P - perforated or slotted
T - sand point
X - open hole

37 TOELV

The depth to the top of the open interval. The TOELV field is DECIMAL NUMERIC with a maximum of twelve characters (including the decimal point) and may have up to two digits after the decimal point. Measured relative to land surface.

38 BOELV

The depth to the bottom of the open interval. The BOELV field is DECIMAL NUMERIC with a maximum of twelve characters (including the decimal point) and may have up to two digits after the decimal point. Measured relative to land surface.

39 OMATR

Description or name of material used to screen the open interval. The OMATR field is ALPHANUMERIC with a maximum of eight characters.

40 OWIDT

Width or short dimension of slot or mesh of screen material for the open interval, in inches. The OWIDT field is DECIMAL NUMERIC with up to twelve characters (including the decimal), and may have up to 3 digits following the decimal point.

41 OLENG

Length or long dimension of slot or mesh of screen material for the open interval, in inches. The OLENG field is DECIMAL NUMERIC with up to twelve characters (including the decimal), and may have up to 3 digits following the decimal point.

FILTER PACK - material placed in the annulus of the well between the borehole wall and the well screen to prevent formation material from entering through the well screen.

42 FPMTH

Indicator for method of filter pack placement. Must be ALPHANUMERIC consisting of a single character. The character must be one of the following:

A - dropping material down the hole and tamping
B - dropping material down hollow-stem auger
T - tremie pipe
O - other

43 FPMAT

Description or name of the material which forms the filter pack. Must be ALPHANUMERIC, consisting of up to eight (8) characters.

44 FPGRN

Grain size of the material which forms the filter pack, in mesh gauge. Must be INTEGER NUMERIC, with up to four characters.

45	TFELV	The depth to the top of the filter pack. The TFELV field is DECIMAL NUMERIC with a maximum of twelve characters (including the decimal point) and may have up to two digits after the decimal point. Measured relative to land surface.
46	BFELV	The depth to the bottom of the filter pack. The BFELV field is DECIMAL NUMERIC with a maximum of twelve characters (including the decimal point) and may have up to two digits after the decimal point. Measured relative to land surface.

ANNULAR SEALANT - material used to seal the space between the borehole and the casing of the well. The annular sealant is placed directly above the filter pack to prevent the migration of contaminants to the sampling zone from the surface or intermediate zones and prevent cross contamination between strata.

47	SLMTH	Indicator for method of sealant placement. Must be ALPHANUMERIC consisting of a single character. The character must be one of the following: A - dropping material down the hole and tamping B - dropping material down hollow-stem auger T - tremie pipe O - other
48	SLMATR	Description or name of the material which forms the seal above the filter pack against entry of surface water. Must be ALPHANUMERIC, consisting of a single character. The character must be one of the following: B - bentonite G - cement N - none C - other clay Z - other
49	TSLELV	The depth to the top of the annular seal. The TSLELV field is DECIMAL NUMERIC with a maximum of twelve characters (including the decimal point) and may have up to two digits after the decimal point. Measured relative to land surface.

* = required field

50	BSLELV	The depth to the bottom of the annular seal. The BSLELV field is DECIMAL NUMERIC with a maximum of twelve characters (including the decimal point and may have up to two digits after the decimal point. Measured relative to land surface.
51	SRFSL	Surface seal Indicator. Indicates whether or not the upper portion of the borehole is sealed to prevent inflow of surface water. Single character ALPHANUMERIC, containing "Y" if well is sealed. Otherwise contains "Nn".
52	DNGRAD	Downgradient indicator. Indicates whether or not, the well has been installed hydraulically downgradient of the source of potential groundwater pollution, and is capable of detecting the migration of contaminants. Single character ALPHANUMERIC, containing "y" if well is downgradient from waste disposal site. Otherwise contains "N".
53	DRLOG	Drillers log indicator. Indicates availability of drillers log. Single character ALPHANUMERIC, containing "Y if log is available. Otherwise contains "N".
54	LTHLG	Lithologic log indicator. Lithologic log shows distribution of lithology with depth in the bore hole. Single character ALPHANUMERIC, containing "Y" if log is available. Otherwise contains "N".
55	WLUSE *	Well use indicator. Must be ALPHANUMERIC, consisting of a single character. The character must be one of the followings D - domestic (private) water supply I - industrial water supply M - monitoring well P - public water supply O - other
56	COMMENT	Supplemental information as needed. May contain up to 80 alphanumeric characters.

* = required field

Attachment C
Datafile SAMPLE.DAT

Field No.	Field Name	Field Description
1	SAMPLE_KEY *	Unique sample identifier. Consists of a forty-two character field, left justified, containing:

Columns:	Description:
1 - 12	Unique site identifier as assigned by EPA. Must be alphanumeric.
13 - 17	Unique solid waste management unit designator. Must be alphanumeric.
18	Media status indicator. Must contain one of the following: C - compliance monitoring station B - baseline monitoring station A - other ambient monitoring station.
19 - 27	Unique station identifier. Must be alphanumeric.
28 - 42	Unique sample identifier. Must be alphanumeric.

2 DELTH * Vertical displacement of sample from the reference elevation (in feet) of the sampling station. For surface water, soils, and groundwater stations this would be the depth of the sample and for air monitoring stations, the height above ground. Must be DECIMAL NUMERIC consisting of a maximum of 8iX characters (including the decimal) and may have up to two digits after the decimal point.

3 DATE * Date of sample collection. Eight character integer field consisting of:

Columns	Content
1 - 4	year including century, e.g. 1989
5 - 6	numeric month
7 - 8	numeric day of month

Column numbers are relative to the beginning of the DATE Field. Each subfield described above must be right justified, and may contain leading zeros.

4	TIME	*	Time (in military format) of sample collection. INTEGER NUMERIC consisting of four characters.
5	SSTAT	*	Station status or condition. Used primarily for groundwater monitoring stations. ALPHANUMERIC consisting of one character. The character must be one of the following: D - Dry O - obstructed W - Destroyed Z - other F - Flowing P - Pumping X - Surficial inflow
			FIELD MEASUREMENTS
6	TEMP		Sample temperature in degrees Celsius. DECIMAL NUMERIC consisting of six characters (including the decimal) and may have up to two digits after the decimal point.
7	PH		Sample pH in standard units. DECIMAL NUMERIC consisting of four characters (including the decimal) and may have one digit after the decimal point.
8	COND		Specific Conductance in uMhos. INTEGER NUMERIC consisting of a maximum of six characters.
9	TURB		Turbidity. INTEGER NUMERIC consisting of a maximum of eight characters. May be reported in JTU or NTU, as required by program.
10	WLEVEL		Well water level, or stream gage height, in feet. Measured relative to the reference datum. Item is DECIMAL NUMERIC consisting of a maximum of six characters (including the decimal) and may have up to two digits following the decimal point.
11	WINDSP		Wind speed in km/h. DECIMAL NUMERIC consisting of a maximum of six characters (including the decimal), and may have up to two digits after the decimal point.
12	WINDIR		Wind direction in degrees. INTEGER NUMERIC consisting of a maximum of four characters.
13	SAMMETH		Method used to collect sample. ALPHANUMERIC field, left justified, consisting of up to 20 characters.
14	SAMPLER		Name of Agency of Organization that collected the sample. Must be ALPHANUMERIC consisting of up to 20 characters.

15	COMMENT	Any additional information the user feels necessary, which may not be accommodated in a defined field. Must be ALPHANUMERIC consisting of up to 40 characters.

* - required field

Attachment D

Datafile PARM.DAT

Field No.	Field Name	Field Description
1	PARAM_KEY *	Unique data record identifier. Consists of a fifty-four character field, left justified, containing:

Columns	Description
1 - 12	Unique site identifier as assigned by EPA. Must be alphanumeric.
13 - 17	Unique solid waste management unit designator. Must be alphanumeric.
18	Media status indicator. Must contain one of the following: C - compliance monitoring station B - baseline monitoring station A - other ambient monitoring station.
19 - 27	Unique station identifier. Must be alphanumeric.
28 - 42	Unique sample identifier. Must be alphanumeric.
43 - 54	Parameter identifier. For chemical constituents for which CAS number exist, the CAS number will be the identifier. For other constituents, the identifier will be determined on an as-needed basis.
55 - 58	Replicate number. Identifies the value as one of two or more analytical results for the same parameter on the same sample. INTEGER NUMERIC, right justified, up to four characters. Not used unless replicate results are reported.

2	QUALF	Qualifier field. ALPHANUMERIC, may contain up to four STORET qualifier codes.

* = required field

3	VALUE	*	The reported analytical result for the chemical. Must be DECIMAL NUMERIC, consisting of up to twelve character (including the decimal), and may have up to four digits after the decimal point.
4	UNITS	*	The units of measurement in which analytical results are reported. ALPHANUMERIC, consisting of up to six characters.
5	METHOD		The name or code of the analytical method or technique used to obtain the reported value. ALPHANUMERIC, containing up to fourteen characters.
6	DATE	*	Date of analysis. Eight character integer field consisting of:

Columns	Content
1 - 4	year including century, e.g. 1989
5 - 6	numeric month
7 - 8	numeric day of month

Column numbers are relative to the beginning of the DATE Field. Each subfield described above must be right justified, and may contain leading zeros.

7	DETLIM	Detection limit. Must be in same units as the reported value. Must be DECIMAL NUMERIC, consisting of up to twelve characters (including the decimal), and may have up to four digits after the decimal point.
8	LAB	Name of Lab that performed the analysis. ALPHANUMERIC field containing up to 28 characters.
9	COMMENT	Any additional information the user feels necessary, which may not be accommodated in a defined field. Must be ALPHANUMERIC consisting of up to 40 characters.

* = required field

APPENDIX D

Southern Division Naval Facilities Engineering Command Guidelines for Groundwater Monitoring Well Installation

SOUTHERN DIVISION NAVAL FACILITIES
ENGINEERING COMMAND

GUIDELINES FOR GROUNDWATER MONITORING WELL INSTALLATION

PART 1: GENERAL

1.1 Introduction

Groundwater monitoring wells shall be located at sites approved by the Southern Division Engineer-In-Charge (EIC) and the Activity Environmental Coordinator (EC). All applicable local, state and federal regulations concerning well installations or soil borings shall be followed.

1.2 Applicable Publications

The publications listed below form a part of this guideline to the extent referenced. The publications are referred to in this text by designation only. The latest revision of the specifications shall be followed.

1.2.1 American Association of State Highway and Transportation Officials (AASHTO)

Document No.	Title
M 220	Epoxy Coatings Specifications

1.2.2 American Society of Testing and Materials (ASTM)

Document No.	Title
A 120	Pipe, Steel, Black and Hot-dipped, Zinc coated, welded and seamless
A 312	Seamless and Welded Austenitic Stainless Steel Pipe
B 209	Aluminum and Aluminum-alloy Sheet and Plate
C 150	Portland Cement
C 778	Standard Sand
D 1457	Polytetrafluoroethylene (PTFE) Molding and Extrusion Materials

Document No.	Title
D 1785	Standard Specification of Polyvinyl Chloride Pipe (PVC Pipe, Schedules 40, 80, 120)
D 1586	Method for Penetration Test and Split Barrel Sampling of Soils
D 1587	Practice for Thin Wall Tube Sampling of Soils.
D 2113	Diamond Core Drilling for Site Investigation
F 480	Thermoplastic Water Well Casing, Pipe and Couplings Made in Standard Dimension Ratios
F 883	Padlocks

1.2.3 **American Petroleum Institute (API)**

Document No.	Title
13-A	Oil Well Drilling Fluid Specifications

1.3 **Submittals**

1.3.1 A completed "Southern Division Naval Facilities Engineering Command Groundwater Monitoring Well Installation Report" will be submitted for each well installation.

1.3.2 Certificates of Conformance: A certificate of conformance shall be provided to the EIC for any of the items below that are used in a well installation. The certificate shall describe in detail how the material meets or exceeds the required specifications for the following, as appropriate:

a) Casing
b) Screen
c) Grout
d) Drilling Mud
e) Gravel Pack
f) Caps and Plugs
g) Centralizers
h) Surface Casing
i) Well Protective Cover
j) Flush Mount Protective Cover
k) Padlock
l) Protective Post
m) Well Designation Sign
o) Epoxy Paint

1.4 **Delivery and Storage**

All materials shall be delivered in undamaged condition, stored in accordance with manufacturer's recommendations (off the ground) and protected from the weather in an area designated by the EC. All defective or damaged material will be replaced with new material at no cost to the government.

PART 2: PRODUCTS

2.1 All materials shall conform to the respective specifications and other requirements as specified herein.

2.1.1 **Well Casing**

Material type will be approved by the EIC. The material provided will have adequate strength to resist external forces both during and after installation. The casing threads shall be compatible with the screen listed in 2.2.2. Markings, writing or paint strips are not allowable on any of the materials. The casing shall conform to the specifications listed below.

a. PVC, flush threaded joints (schedule 40) ASTM F480 and ASTM D1785

All PVC flush threaded joints will meet or exceed the water pressure ratings (at 73 degrees Fahrenheit) for the size and schedule of PVC pipe used in the project, as listed in ASTM D1785: Table XI.2.

b. Polytetrafluoroethylene (PT-E), flush threaded joints, ASTM D1457

Virgin materials shall be used to meet the ASTM specification. Certification of compliance and joint evaluation are required. Shall be shipped in sealed containers that are capable of preventing contact with any foreign substances. PTEF "O" rings are required to seal all joints.

c. 316 stainless steel, flush threaded joints, ASTM A312
d. 304 stainless steel, flush threaded joints, ASTM A312

End fittings shall be double entry flush screw threads. The casing shall be cleaned prior to delivery in the following manner: 5-minute immersion in static bath of dilute acid, pressure -ash with detergent and cool water, rinse with warm water and allow to air dry.

2.1.2 **Well Screen**

Material type will be approved by the EIC. The material provided will have adequate strength to resist external forces both during and after installation. Water velocity through the screen openings shall not exceed 0.1 feet/sec. The opening size will be determined from an analysis of the material in geologic formation to be screened and/or the size of the filter pack material. Markings, writing or paint strips are not allowable on any of the materials. The screens shall conform to the specifications listed below.

a. PVC, flush threaded joints (schedule 40), slotted, ASTM F480 and ASTM D1785

Two inch I.D. screens will have 3 rows of slots with a spacing of 1/8 inch between slots. Four inch I.D. screens will have six rows of slots with a spacing of 1/8 inch between slots. All PVC flush threaded joints will meet or exceed the water pressure ratings (at 73 degrees Fahrenheit) for the size and schedule of PVC pipe as listed in ASTM D1785, Table XI.2.

b. Polytetrafluoroethylene (PTFE), flush threaded joints, slotted, ASTM D1457

Virgin materials shall be used to meet the ASTM specification. Certification of compliance and joint evaluation are required. Shall be shipped in sealed containers. PTEF "O" rings will be used to seal all joints.

c. 316 stainless steel, wire wrapped, flush threaded joints, ASTM A312
d. 304 stainless steel, wire wrapped, flush threaded joints, ASTM A312

The well screen shall be of a continuous slot, wire wound design. It shall be fabricated by circumferentially wrapping a triangularly shaped wire around a circular array of internal rods. The configuration must produce sharp outer edges, widening inward. PTFE "O" rings will be used to seal all joints. End fittings will be welded to the screen body.

2.1.3 End Plugs

The end plug shall be flush threaded and shall be constructed of the same type of material selected for the screen or casing above. All ASTM specifications that apply to the screen and casing materials shall apply to the end plugs. Markings, writing or paint strips are not allowable on any of the above materials.

2.1.4 Well Caps

The well cap shall be flush threaded and be constructed of the same type of material selected for the casing above. All ASTM specifications that apply to the casing materials shall apply to the well caps. Markings, writing or paint strips are not allowable on any of the above materials.

2.1.5 Adjustable Centralizers

The centralizer shall be capable of maintaining the casing and screen straight and plumb in the borehole during well installation. The material type shall be the same type of material selected for the casing/screen above. No solvents or glues will be used.

2.1.6 Annular Space Fill Materials

a. Filter pack shall be 98% pure silica, cleaned with potable water, have a uniformity coefficient of 1-3, and a specific gravity of 2.6 - 2.7. The filter pack shall meet ASTM C 775 standard sand specifications.

b. 1/4-inch bentonite pellets shall be 90- montmorillonite clay, with a bulk dry density 80 lbs/cu ft, a specific gravity 1.2, and a pH of 8.5-10.5.

c. Granular bentonite shall conform to API std 13-A for bentonite. -

d. Portland Cement shall conform to ASTM C 150 Type I.

2.1.7 Surface Casing: shall be constructed of steel meeting ASTM A 120 and shall have a wall thickness as specified below.

a. 24 inch diameter 0.25 inch wall thickness
b. 20 inch diameter 0.25 inch wall thickness
c. 16 inch diameter 0.25 inch wall thickness
d. 10.75 inch diameter 0.25 inch wall thickness
e. 24 inch diameter 0.50 inch wall thickness
f. 20 inch diameter 0.50 inch wall thickness
g. 16 inch diameter 0.50 inch wall thickness
h. 10.75 inch diameter 0.365 inch wall thickness

2.1.8 **Surface Completion**: all materials provided for a well surface completion shall conform to the specifications listed below.

a. Locking 16-gauge steel protective well cover, round or square and 5-ft in length

b. Flush mount 22-gauge steel, water resistant welded box with 3/8-inch steel lid, locking device and padlock guard

c. Concrete pad at ground surface (3' X 4' X 6") ASTM C 150

d. Padlock (brass, corrosion resistant, keyed alike) ASTM F 883

e. Steel protective post (4-inch diameter, 6-ft length, 1/4-inch thickness, concrete filled) ASTM A 120.

f. Well designation sign, sheet aluminum, ASTM B 209, 1/8 inch by 18 inch by 6 inch, anchors and fasteners compatible with sign, designation to be provided by EIC, the designation shall be stamped into the plate with 4-inch letters and numbers.

g. High visibility yellow epoxy paint AASHTO M220.

PART 3: EXECUTION

3.1 Drilling Method

The proposed drilling method must be approved by the EIC. Hollow-stem auger methods will be given first preference, rotary methods second and any other methods will require detailed evaluation by the EIC and written approval.

3.2 Well Installation

Well depths, length of screen and sump will be determined on a site specific basis with approval of the EIC. Screen lengths will be limited to 10 feet unless longer lengths are specifically approved in writing by the EIC. Two inch well diameters will be specified for shallow well installations. Deeper well installations or wells that will be converted to recovery wells may require four inch wells. Recovery well specifications will be approved by the EIC.

Well installation shall follow commonly accepted professional drilling procedures. The borehole will be logged by a qualified geologist/hydrogeologist as drilling proceeds. The minimum qualifications are those describing a "Geologist-in-Training", as described in Article 1, Chapter 23, Title 1, Code of Laws of South Carolina: Rules of the South Carolina State Board of Registration for Geologists. Soil samples shall be collected according to one of the following methods: ASTM D 1586-Method for Penetration Test and Split Barrel Sampling of Soils or ASTM D 1587-Practice for Thin Wall Tube Sampling of Soils. Consolidated Rock will be sampled according to ASTM D2113 Diamond Core Drilling for Site Investigation.

Gravel pack, seals, and grout will be installed using tremie methods. Bentonite seals shall be allowed to hydrate the time period specified by the manufacturer. Accurate measurements shall be made to the top of the gravel pack and seals with a weighted steel tape and adjusted to reflect the top of casing.

If water is used in the drilling process, a sample shall be collected from the source and analyzed for the parameters specified in the investigation. Results will be included in the investigation report.

3.3 Well Development

Well development shall commence no sooner than 24 hours after placement of the grout. The development method shall be approved by the EIC. The selected method shall be capable of removing all drilling fluids and cuttings from inside the well, within the gravel pack and from within the formation. The development method shall not introduce any type of contamination into the aquifer. Introduction of outside water to the well shall be minimized. Any water introduced into the well shall be recovered to the maximum extent possible. A written report will be required describing the reasons why any introduced water could not be recovered.

The development process should result in wells that are sediment free. A well that produces turbid water (as defined by the Safe Drinking Water Act PL 93-523) may be rejected by the EIC.

3.4 Material Disposal

All borehole cuttings and development water will be contained in - DOT 17-C Open-top 55-gallon drums, permanently labeled by well number and stored in a location designated by the EC. The material will be handled as hazardous waste until laboratory results are reviewed and certification of the waste is submitted to the Navy. This requirement may be waived if approval is given in writing by the EIC. The material may then be disposed of as normal solid waste if it does not

exceed any state or federal regulatory limits for the type of waste in question. The Navy will be responsible for disposal of all waste unless other direction is given by the EIC.

3.5 Decontamination

All down-hole drilling equipment the drill rig, tools, etc.) will be decontaminated according to the approved Quality Control Plan prior to beginning work, between each well location and after the last well is completed. The drill rig will be placed on 10-mil polyethylene sheeting at each drilling site to contain any spillage or leaking of hydraulic fluid or fuel. All of the decontamination waste will be handled according to section 3.4 above.

3.6 Well Protection

A steel, hinged, locking protective casing will be installed within a 3-ft by 4-ft by 6-inch thick concrete pad. The pad will be set level and 4-inches below grade. The pad shall be installed so that surface runoff does not pond around the well casing and protective cover. The concrete mix shall obtain a minimum 28-day compressive strength of 3000 pounds per square inch.

If designated by the EIC, four steel protective posts will be installed 0.5 ft from the corners of the pad but not set within the pad. The post will be 6-ft in length, 4-inch in diameter and have a wall thickness of 0.25-inch. The post will be filled with concrete and set three feet below grade in a 10-inch diameter hole with concrete backfill (as above).

The protective casing and any protective post installed shall be cleaned, primed- and then painted with two coats of high visibility yellow epoxy paint that meets the specifications of AASHTO M 200. The protective casing will be locked with a Type Pol (Key Operated), Option E (Corrosion Resistant) padlock that conforms to ASTM F 883. When multiple wells are installed, the padlocks for each well at an activity shall be keyed alike. The original and two copies of all keys shall be delivered to the EIC and two copies shall be delivered to the EC. All keys shall be tested to ensure performance prior to delivery.

3.7 Well Designation

A permanent well designation sign will be attached to the protective casing. The sign shall be a 18-inch by 6-inch by 1/8-inch thick sheet aluminum plate, bolted to 1/4-inch studs welded to the casing. The sign shall be stamped with 4-inch letters and numbers in accordance with the numbering system in section 4.0 of this specification.

PART 4. INSTALLATION RESTORATION PROGRAM WELL NUMBERING SYSTEM

The purpose of this well numbering system is to locate a particular well by activity, key it to the Initial Assessment Study (IAS) and sequentially number each well at each site. The EIC will provide designations for sites not included in the IAS.

Example:	CEF-1-1	Cecil Field, Site 1, Well number 1
	KYW-5-8	Key West, Site 5, Well Number 8

FLORIDA

Cecil Field		CEF
Ft. Lauderdale		FLD
Key West		KYW
NavHosp Key West		KWH
Homestead		HST
Jacksonville		JAX
Mayport	MPT	
Panama City		PCY
Whiting Field		WHF
Andros Island		AIS
Pensacola		PEN
Saufley	SFY	
Correy Station		CRY
Orlando	OLD	

GEORGIA

Albany	ALB	
Atlanta	ATL	
Kings Bay		KBA
Athens	ATH	

SOUTH CAROLINA

Parris Island		PAI
Beaufort		BFT
NavHosp Beaufort		BFH
NWS Charleston		NWS
NS Charleston		CSY

LOUISIANA

NAS New Orleans		NOA
NSA New Orleans		NOS

MISSISSIPPI

Gulfport	GPT
NavHome Gulfport	GPH
Meridian	MRD

TENNESSEE

Memphis	MPH
Bristol	BRT

TEXAS

Corpus Christi	CCT
Chase Field	CAF
Kingsville	KVE
NAS Dallas	DNA
NWIRP Dallas	DWP
McGregor	MGR