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FINAL

ADDENDUM NO. 1

PLAN OF ACTION

PIER 33 AND BERTH 16/FORMER INCINERATOR

INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE - NEW LONDON
GROTON, CONNECTICUT

PREPARED FOR:

NORTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
PHILADELPHIA, PENNSYLVANIA

FEBRUARY 1993

ATLANTIC PROJECT NO.: 1256-15-01
NAVY CONTRACT NO. N62472-88-C-1294

ATLANTIC
ENVIRONMENTAL SERVICES, INC. 188 NORWICH AVENUE COLCHESTER, CONNECTICUT 06415 (203) 537-0751

FIELD SAMPLING PLAN

TABLE OF CONTENTS

SECTION		PAGE
1.0	INTRODUCTION	1
2.0	SITE BACKGROUND	3
2.1	Pier 33 Site Background	5
2.2	Berth 16/Former Incinerator Site Background	5
3.0	FIELD MOBILIZATION	13
3.1	Field Office	13
3.2	Equipment Storage and Decontamination Area	13
3.3	Field Laboratory	14
3.4	Establish Waste Storage Area	14
3.5	Sampling Locations	14
3.6	Heavy Equipment to the Site	14
3.7	Emergency Procedures	14
3.8	Onsite Safety Briefing	14
4.0	FIELD INVESTIGATION	16
4.1	General Procedures	16
	4.1.1 Field Screening	16
	4.1.2 Soil Gas Survey	17
	4.1.3 Well Construction	17
	4.1.4 Hydraulic Conductivity	19
	4.1.5 Waste Classification and Disposal	19
	4.1.6 Underground Utility Inspection	19
4.2	Field Sampling Program	19
	4.2.1 Pier 33 (Site 19)	20
	4.2.2 Berth 16/Former Incinerator (Site 20)	24
5.0	SAMPLE PRESERVATION AND SHIPPING	30
6.0	RECORDKEEPING AND DOCUMENTATION	31
7.0	SCHEDULE	32

TABLE OF CONTENTS
(continued)

SECTION		PAGE
TABLES:		
Table 2-1:	Summary of Existing Analytical Data Pier 33 and Berth 16/Former Incinerator	7
Table 4-1:	Atlantic Technical Procedures	17
Table 4-2:	Site Specific Modifications to QA Procedures	18
Table 4-3:	Rationale for Selection of Constituents for Analysis Pier 33 and Berth 16	21
Table 4-4:	Field Sampling Plan Pier 33 - NSB NLON	23
Table 4-5:	Field Sampling Plan Berth 16/Former Incinerator - NSB NLON	26
FIGURES:		
Figure 1-1:	Installation Restoration Study Sites	2
Figure 2-1:	Site Plan Pier 33	6
Figure 2-2:	**Geologic Section A-A Pier 33**	8
Figure 2-3:	Site Plan Berth 16/Former Incinerator	9
Figure 2-4:	**Geologic Section B-B Berth 16/Former Incinerator**	12
Figure 3-1:	Location of Atlantic's Drum Storage and Equipment Decontamination Areas	15
Figure 4-1:	Proposed Field Sampling Plan Pier 33	22
Figure 4-2:	Proposed Field Sampling Plan Berth 16/Former Incinerator	25
Figure 7-1:	Preliminary Project Schedule	33
APPENDICES:		
Appendix A:	**Tank Tightness Test Results**	
Appendix B:	Existing Chemical Analyses	
Appendix C:	Existing Boring Logs	
Appendix D:	Atlantic Technical Procedures	
Appendix E:	Overburden Monitoring Well Detail	

1.0 INTRODUCTION

This plan of action is prepared to address two additional sites identified as part of the Installation Restoration (IR) Program for the Naval Submarine Base Groton, New London, Connecticut (NSB-NLON). Soils containing petroleum hydrocarbons were discovered at these sites during a subsurface investigation performed for replacement of the quaywall conducted by Morrison Geotechnical Engineering in the Fall of 1989. The results of these analyses are discussed in Section 2.0. After identifying this condition, the **Navy decided that Step I** site inspections were appropriate for the Pier 33 and Berth 16 sites. **In addition, the USEPA and CTDEP requested that this site inspection also include the former incinerator located at Berth 16. Because of the proximity of the former incinerator to Berth 16, they are combined into one site for evaluation and investigation purposes (Site 20).** The new investigation sites at NSB-NLON are illustrated on Figure 1-1, along with the Step I and Step II sites previously investigated.

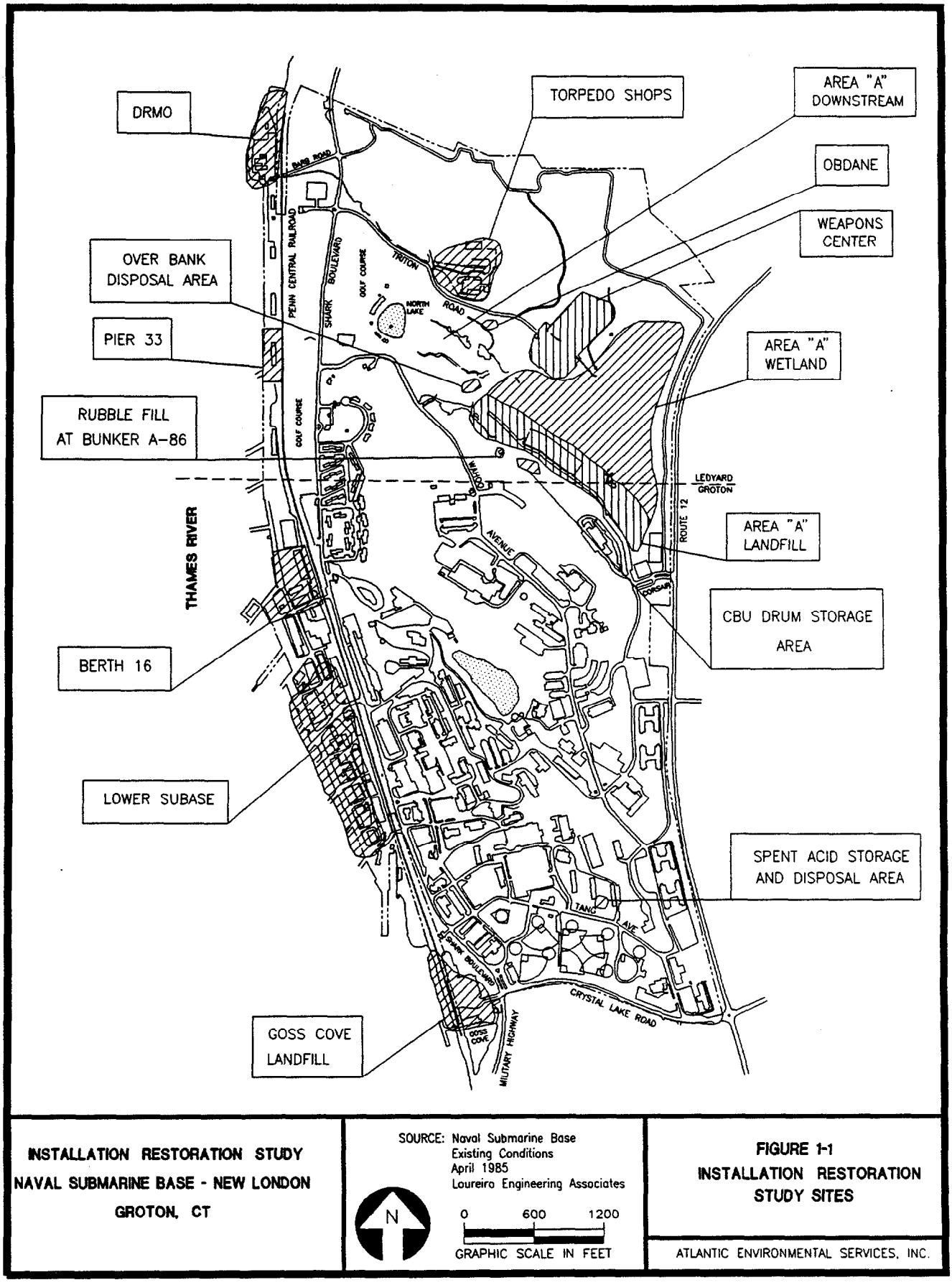
This Plan of Action for these additional sites is an addendum to the Final Plan of Action, dated April 1989, prepared for the original seven Step I and four Step II sites.

This report includes revisions to respond to TRC written arguments as enumerated below:

- **U.S. EPA, February 14, 1992**
- **CTDEP, December 18, 1991**
- **Town of Waterford, November 18, 1991**

Revisions to the report are in bold print.

Atlantic's point of contact (POC) at the Subase for this project is Mr. William Mansfield. Mrs. Deborah Stockdale is the Engineer-In-Charge (EIC) representing the Northern Division of the Naval Facilities Engineering Command, Lester, Pennsylvania.



INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE - NEW LONDON
GROTON, CT

SOURCE: Naval Submarine Base
Existing Conditions
April 1985
Loureiro Engineering Associates

FIGURE 1-1
INSTALLATION RESTORATION STUDY SITES

ATLANTIC ENVIRONMENTAL SERVICES, INC.

2.0 SITE BACKGROUND

Information regarding general site background for NSB-NLON can be found in the April 1989 Plan of Action. Site background information regarding the new sites that are to be investigated is presented below. **Site history information was obtained from a number of different sources which are listed below. The following sections on site background are based on information obtained from these sources.**

- **Previous Site Investigations/Reports:**

  - **Atlantic Environmental Services, Inc., 1989, *Plan of Action - Installation Restoration Study: Naval Submarine Base - New London, Groton, Connecticut*, final, prepared for Northern Division Naval Facilities Engineering Command.**

  - **U.S. Navy, 1991, Preliminary, *Draft Environmental Impact Statement: Thames River Dredging Project*.**

  - **Morrison Geotechnical Engineering, Nov. 1989, *Appendix D to a Geotechnical Data Report to Oak Point Associates on The U.S. Naval Submarine Base, Groton, Connecticut*.**

  - **Morrison Geotechnical Engineering, Dec. 1990, *A Supplement Geotechnical Data Report to Oak Point Associates on The U.S. Naval Submarine Base, Groton, Connecticut*.**

  - **Envirodyne Engineers, Inc., 1982, *Initial Assessment Study: Naval Submarine Base, New London, Connecticut*, prepared for Navy Assessment and Control of Installation Pollutants Department.**

  - **Naval Facilities Engineering Command, 1988, *Master Plan for Naval Submarine Base, New London*.**

- **Aerial Photographs:**

  - **U.S. Environmental Protection Agency (USEPA), March 1992, *Site Analysis: New London Submarine Base, Groton, Connecticut*.**

  - **U.S. Navy, May 23, 1959, Dec. 1963, May 24, 1964.**

  - **Connecticut Department of Environmental Protection, Aug. 24, 1952, Mar. 2, 1965, Mar. 27, 1975, Apr. 17, 1980, Mar. 23, 1986.**

- **Interviews with Base Personnel:**

  - **Mr. Robert Morgan - Department of Public Works, Engineering Division**
  - **Mr. William Mansfield - Department of Public Works, Environmental Division**

- **Base Records (only those containing pertinent data are listed):**

  - **U.S. Submarine Base, New London, Conn. Improvements to June 30, 1919, Drawing.**

  - **Map of U.S. Naval Submarine Base, New London, Conn. Showing conditions on June 30, 1943, Drawing No. A145.**

  - **U.S. Naval Submarine Base, New London, Conn. Dredging for Berthing of Reserve Fleet, Plan, Sept. 4, 1945, Drawing No. 420,045.**

  - **U.S. Naval Submarine Base, New London, Conn. Dredging for Berthing of Reserve Fleet, Borings and Sections, Sept. 4, 1945, Drawing No. 420,046.**

  - **Map of U.S. Naval Submarine Base, New London, Conn. Showing conditions on June 30, 1947, Drawing No. A197.**

  - **Dept. of the Navy, Bureau of Yards and Docks. Master Shore Station Development Plan, Part IV Section 6, Area Development Plan Utilities, Fuel Oil & Diesel Oil Distribution, February 15, 1954, Drawing No. 641219.**

  - **Dept. of the Navy, Bureau of Yards and Docks. Repairs to Low Pressure Compressed Air Line North of Pier 17, November 4, 1954, Drawing No. 659943.**

  - **Existing Storm Sewer System, Louriero Engineering Associates, April 28, 1981, Drawing Nos. 2049838; 2049839; 2049832 and 2049833.**

  - **Laboratory Resources, Inc., Brooklyn, Conn. Sample results for soil sample collected from trench dug next to building B-157. Report date: Oct. 18, 1991.**

  - **Petro-Tite tank test at fuel oil tank near Building 175, May 22, 1990.**

  - **Alpha Analytical Laboratories, Warwick, Rhode Island. Sample results for soil and ground water samples from boring B-30 and B-32. Report date: Sept. 27, 1989.**

- **Other:**

  - **Dept. of The Interior, United States Geological Survey, 1984, *Geologic Quadrangle Maps of the United States, Topographic Map of the Uncasville Quadrangle, Connecticut*, 1893, 1939, 1952, 1958 and 1984.**

2.1 Pier 33 Site Background

The current general layout of this site is shown on Figure 2-1. The site property is generally level and is covered by either buildings or pavement. Utilities at the site include storm drainage, sanitary sewers, telephone, electric, and compressed air.

This area of the Subase was undeveloped until around 1946. The mean high water elevation of the Thames River was at the toe of the railroad embankment slope at that time. In 1946 the waterfront was extensively renovated to berth the reserve fleet. The area was dredged and filled. Bulkheads, piers, and support buildings and utilities were constructed. Fill was obtained from a reported clean upland source near Dow Chemical. Building 175 was originally constructed for battery electrolyte (sulfuric acid) storage. The building was completely filled with large above ground storage tanks. These tanks were connected to the piers by underground pipes **located in the acid trenches as shown in Figure 2-1. There are no known or reported spills from the electrolyte storage and transfer** system.

Currently, no underground steam or fuel oil utilities service this building other than by its own underground fuel oil storage tank. This underground tank is located on the southern side of the building. **Based on a tank test performed on May 22, 1990, no leakage was identified. The tank test results are included as Appendix A.** On the northern side of this building there is another underground diesel storage tank that services an emergency generator for the sewage lift station. The acid storage tanks in Building 175 and underground acid piping have been removed. Building 175 is presently used for storage and administration.

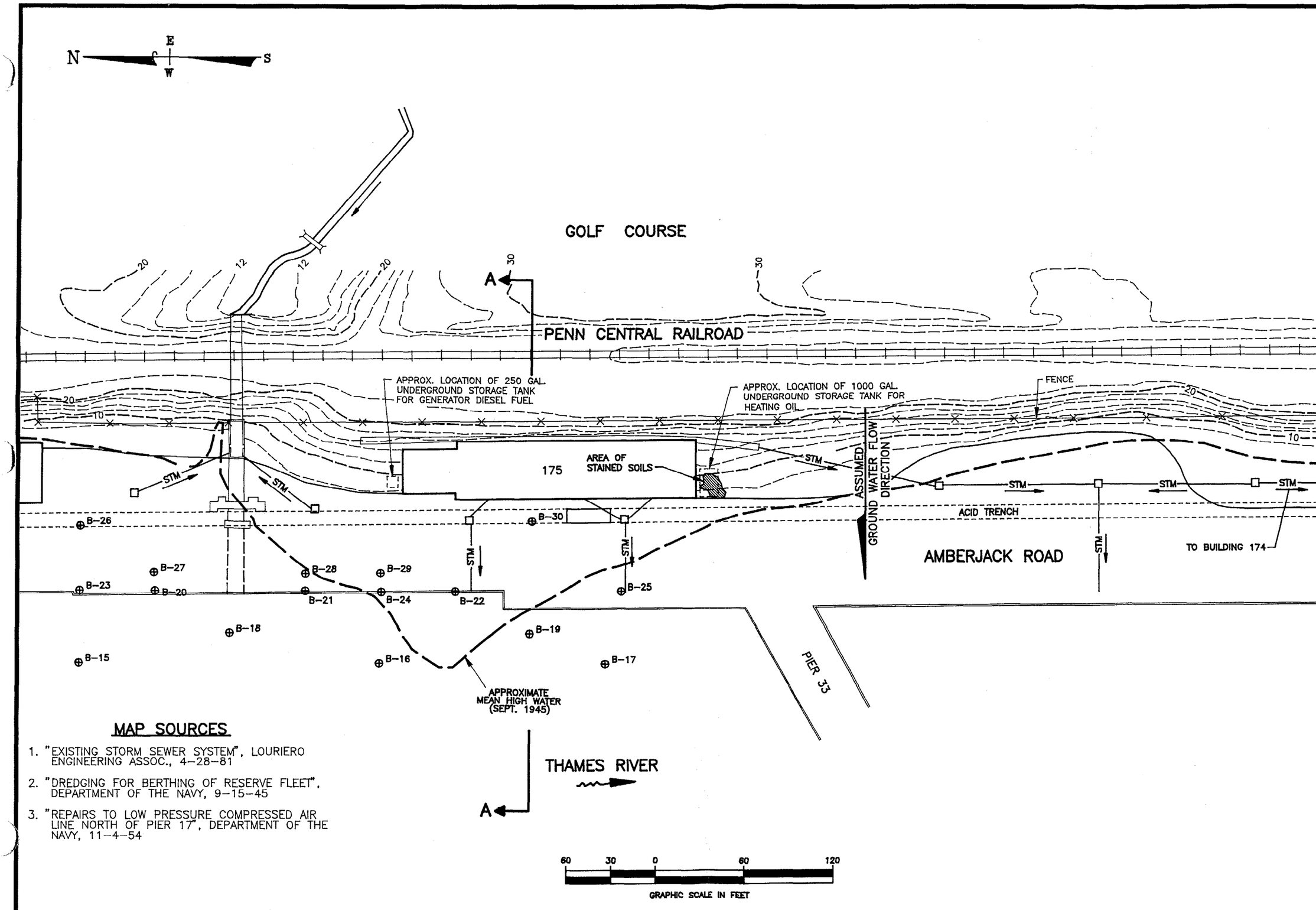
During a geotechnical investigation for replacement of the quaywall, #2 fuel oil was detected in subsurface soils at the Pier 33 site. Total petroleum hydrocarbons were detected at 1100 ppm at test boring B-30. The location of boring B-30 is shown in Figure 2-1. Fluorescence analysis indicated the hydrocarbons present to be #2 fuel oil. The laboratory report for sample B-30A and pertinent boring logs from the geotechnical investigation are included in Appendices B and C, respectively. Sample results from sample B-30A are summarized in Table 2-1. Samples were not collected from any other boring locations as no petroleum contamination was evident based on odor and visual examination.

Based on the boring logs from the geotechnical investigation, a geologic cross-section was prepared (Figure 2-2). As the cross-section shows, the fill placed in this area consists primarily of poorly sorted sands which overlay a grey quartzite and biotite granite gneiss bedrock. The depth to bedrock ranges from five to twenty feet. The bedrock slopes downward towards the Thames River. Ground water is present at approximately four feet below ground surface. The inferred ground water flow direction is to the west towards the Thames River.

A visual inspection of the site was conducted by Atlantic. The only evidence of potential contamination or spillage observed was a small area of what appeared to be oil stained soils near the fill pipes for the underground heating oil storage tank on the south side of the building.

2.2 Berth 16/Former Incinerator Site Background

The current general layout of this site is shown in Figure 2-3. The site topography is generally level and is either covered by buildings or pavement. Utilities at the site include storm drainage, sanitary sewers, telephone, steam, electric and compressed air.



MAP SOURCES

1. "EXISTING STORM SEWER SYSTEM", LOURIERO ENGINEERING ASSOC., 4-28-81
2. "DREDGING FOR BERTHING OF RESERVE FLEET", DEPARTMENT OF THE NAVY, 9-15-45
3. "REPAIRS TO LOW PRESSURE COMPRESSED AIR LINE NORTH OF PIER 17", DEPARTMENT OF THE NAVY, 11-4-54

FIGURE 2-1
SITE PLAN
PIER 33

ATLANTIC ENVIRONMENTAL SERVICES, INC.

LEGEND

- 123 — BUILDING NUMBER
- RAILROAD TRACKS
- STM — STORM SEWER
- B-19 — EXISTING TEST LOCATION
- UNDERGROUND STORAGE TANK
- 10 — EXISTING CONTOUR

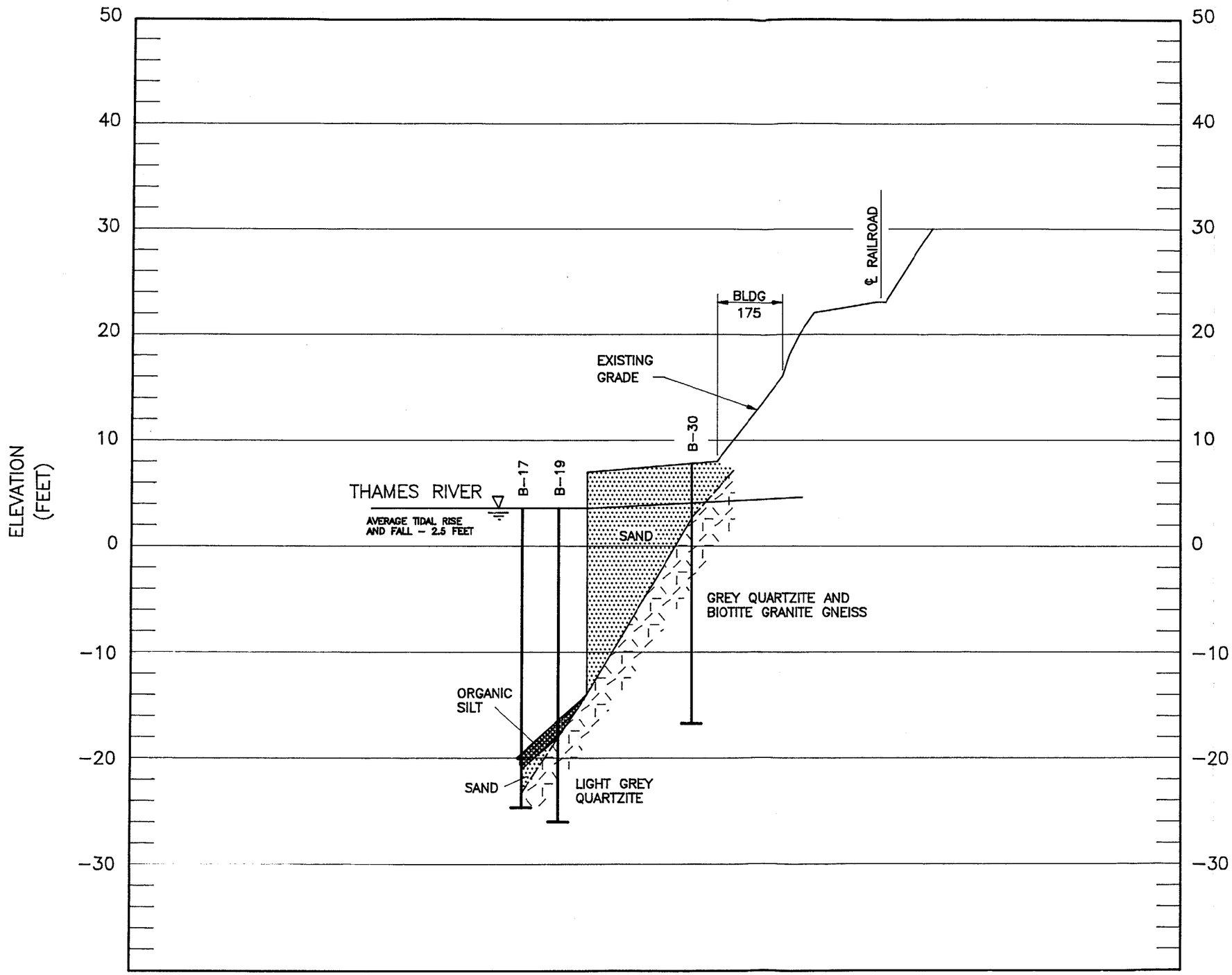
INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE-NEW LONDON
GROTON, CONN.

06521201Z

TABLE 2-1
SUMMARY OF EXISTING ANALYTICAL DATA
PIER 33 AND BERTH 16/FORMER INCINERATOR

Site	Pier 33		Berth 16/Former Incinerator		
Sample I.D.	B-30A	B-30	B-32A	B-32B	N.BLDG.175
Media	Soil	Water	Soil	Water	Soil
Date Collected	9-21-89	9-21-89	9-14-89	9-14-89	9-11-91
Toxicity Characteristic Leaching Procedure (TCLP) Metals (ppm)					
Arsenic	NA	NA	NA	NA	0.7
Barium	NA	NA	NA	NA	2.0
Cadmium	NA	NA	NA	NA	0.51
Chromium	NA	NA	NA	NA	ND
Lead	NA	NA	NA	NA	245
Mercury	NA	NA	NA	NA	ND
Selenium	NA	NA	NA	NA	0.2
Silver	NA	NA	NA	NA	ND
Total Metals (ppm)					
Arsenic	0.9	ND	0.4	NA	NA
Barium	ND	ND	13	NA	NA
Cadmium	0.18	0.0006	0.045	NA	NA
Chromium	10	ND	4	NA	NA
Lead	3.4	0.016	18.9	NA	NA
Mercury	ND	ND	ND	NA	NA
Selenium	ND	ND	ND	NA	NA
Silver	ND	ND	0.5	NA	NA
Volatile Organic Compounds (VOC) (ppb)					
Aromatics	ND	ND	ND	ND	ND
Halocarbons	ND	ND	ND	ND	1,100*
Total Petroleum Hydrocarbons (TPH) (ppm)					
Total Petroleum Hydrocarbons	1100	13	1200	NA	490
Oil Type ID	#2 Fuel	#2 Fuel	#2 Fuel	NA	NA
Polynuclear Aromatic Hydrocarbons (PAH) (ppb)					
PAH	NA	NA	NA	NA	ND
Pesticides (ppb)					
Pesticides	ND	ND	ND	NA	NA
Polychlorinated Biphenyls (PCBs) (ppb)					
PCBs	ND	ND	ND	NA	ND

Notes: * Volatile halocarbons detected in sample N.BLDG.175 consist of 1,100 ppb of trichloroethene
NA Not Analyzed
ND Not Detected



SECTION A–A

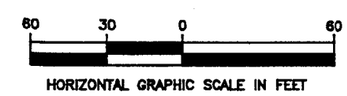


FIGURE 2–2
GEOLOGIC SECTION A–A
PIER 33

ATLANTIC ENVIRONMENTAL SERVICES, INC.

LEGEND

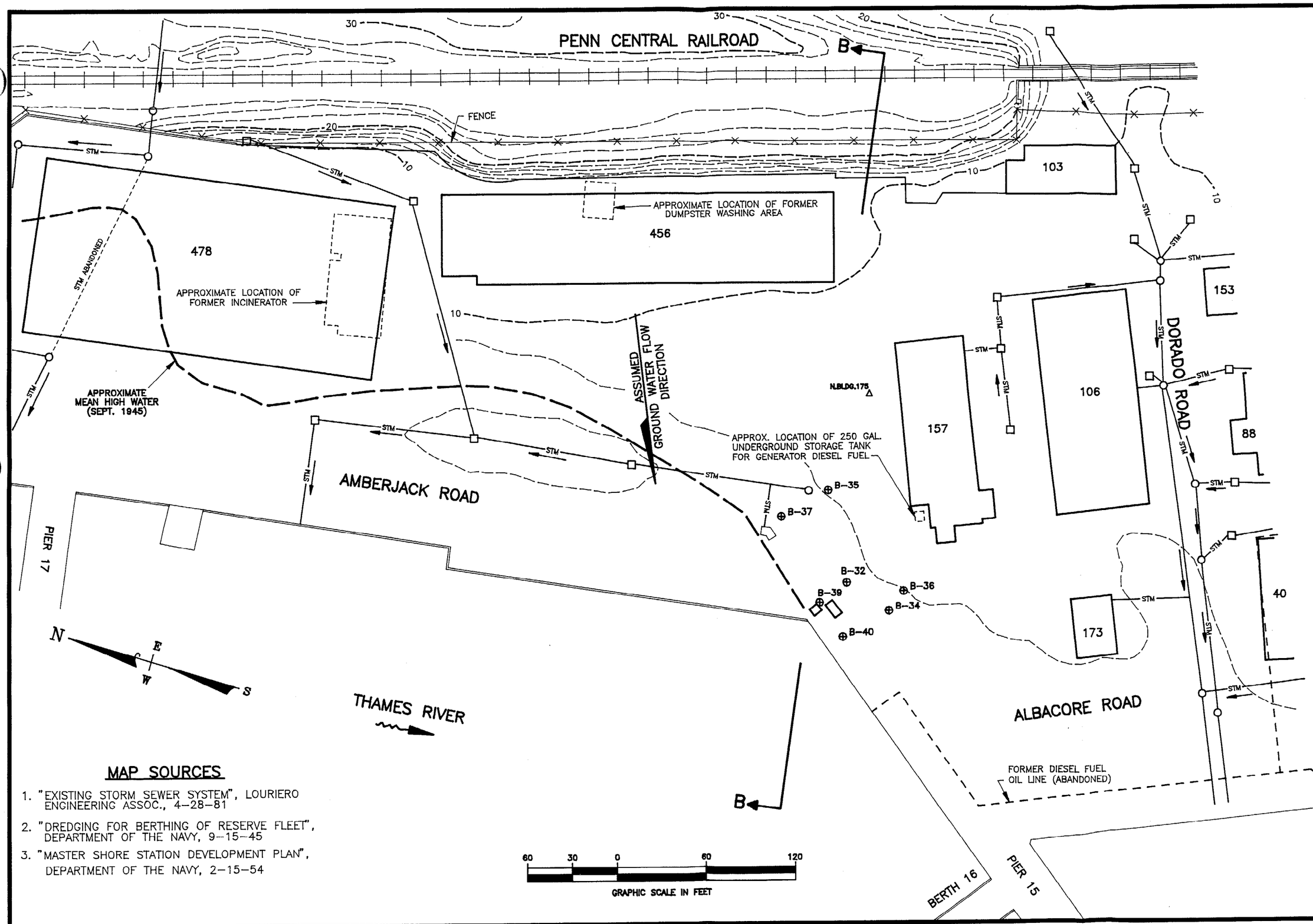
B–17 BORING

WATERTABLE

INFERRED CONTACT

INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE–NEW LONDON
GROTON, CONN.

06521202Z



MAP SOURCES

1. "EXISTING STORM SEWER SYSTEM", LOURIERO ENGINEERING ASSOC., 4-28-81
2. "DREDGING FOR BERTHING OF RESERVE FLEET", DEPARTMENT OF THE NAVY, 9-15-45
3. "MASTER SHORE STATION DEVELOPMENT PLAN", DEPARTMENT OF THE NAVY, 2-15-54

FIGURE 2-3
SITE PLAN
BERTH 16/FORMER INCINERATOR

ATLANTIC ENVIRONMENTAL SERVICES, INC.

LEGEND

- 123 — BUILDING NUMBER
- UNDERGROUND STORAGE TANK
- RAILROAD TRACKS
- DIESEL FUEL OIL
- ⊕ B-40 — EXISTING TEST BORING LOCATION
- △ N.BLDG.175 — EXISTING SOIL SAMPLE
- —STM— STORM SEWER
- —10— EXISTING CONTOUR

INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE-NEW LONDON
GROTON, CONN.

06521203Z

The southern portion of this site has been developed since the early days of Navy activity at this site. In a 1918 map, Building 40 (Engineering Laboratory) is shown in its present location. To the east of Building 40 were barracks. The northern portion of this site was used for coal storage at that time. Sometime between then and 1944, Buildings 103, 173, 157, 106 and the former garbage incinerator were constructed. **All materials generated by base operations that were not salvageable were incinerated, and the residues were disposed in the Area A Landfill.** These structures are shown in Figure 2-3. Locations are based on public works drawings. Adjacent to the incinerator was a dumpster cleaning operation. **The incinerator became inoperable in 1963 and ceased operations.** In 1946 the waterfront was extensively developed to accommodate berthing of the reserve fleet. **Sometime between 1974 and 1986** the incinerator was demolished and Buildings 456 and 478 were constructed. Original and present uses of the six main buildings at this site are presented below:

BUILDING	ORIGINAL USE	PRESENT USE
103	Instruction	Instruction
173	Substation	Electrical distribution
106	Photolab and electronics	Storage
157	Periscope Shop	Optical Shop
456, 478	Maintenance Shop	Maintenance Shop

Source: Navy Master Plan, Public Works Drawings and Interviews

Transformers, **which formerly contained PCBs,** were located at Building 173 (electrical substation) and **in an outdoor electrical vault at Building 157.**

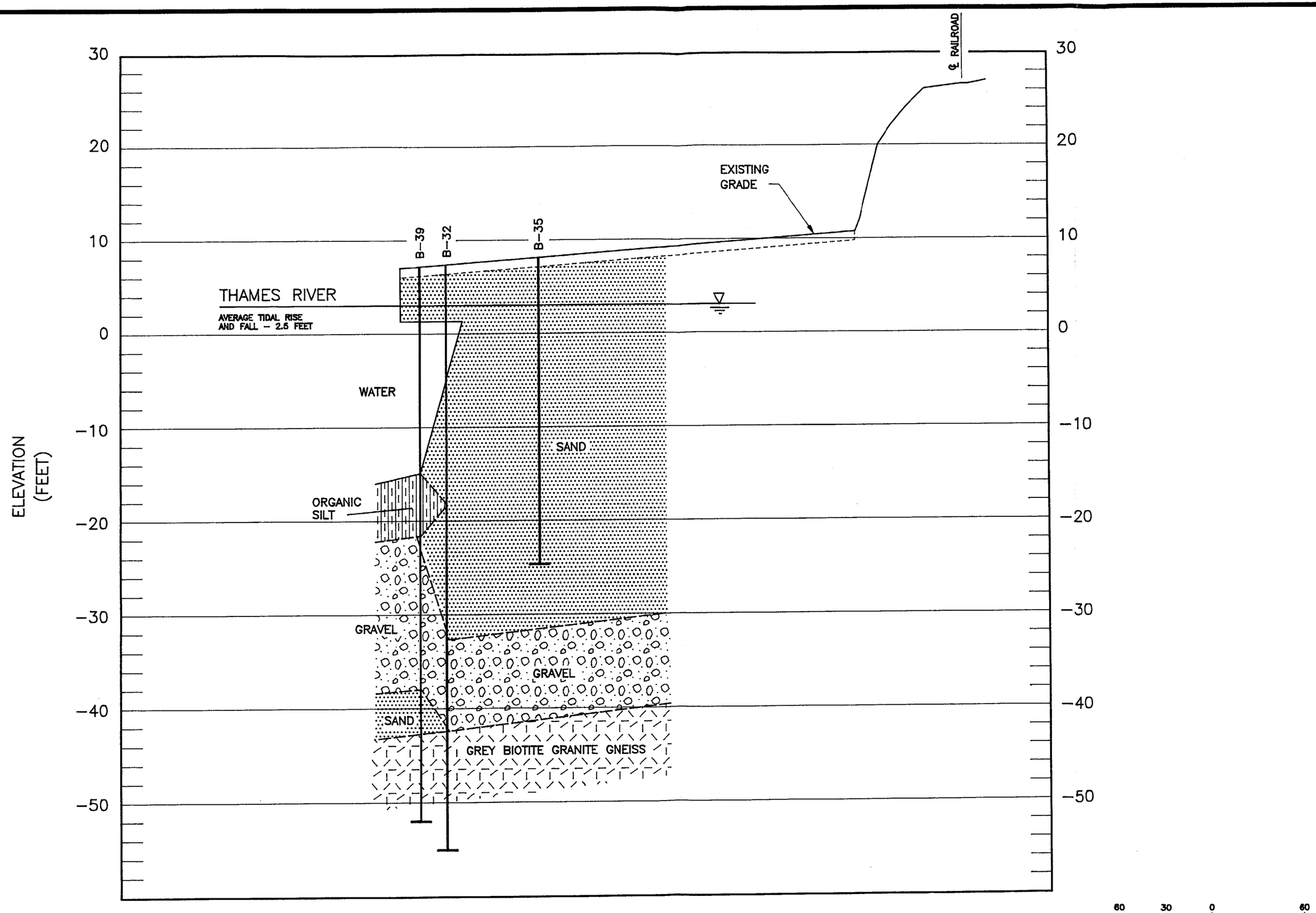
The only known underground tanks in this area are: a tank near Building 157 to power the emergency generator for the sewage lift station (250 gallon diesel) and a former septic tank **with a leaching field** that serviced Building 173. No other underground tank locations were reported by Navy Public Works Department personnel, or are evident on engineering drawings on file. **The locations of the former septic tank and leaching field that serviced Building 173 are unknown.**

As late as 1954 there were underground diesel fuel lines that serviced Berth 16. Presently, underground diesel lines do not go further north than Pier 13. The method of abandonment for these lines is unknown.

During a geotechnical investigation for replacement of the quaywall, #2 fuel oil was detected in subsurface soil at the Berth 16. Total petroleum hydrocarbons were detected at 1200 ppm at test boring 32. Fluorescence analysis indicated the hydrocarbons present to be #2 fuel oil. Another soil sample was collected from this site from a trench dug to the north of Building 157. This sample (N.BLDG.175) contained 490 ppm of total petroleum hydrocarbons, 1.1 ppm of trichloroethene, and TCLP lead at 245 ppm. The locations of boring 32 and sample N.BLDG.175 are shown in Figure 2-3. The laboratory reports for samples B-32A and N.BLDG.175 and pertinent boring logs from the geotechnical investigation are included in Appendices B and C, respectively. Sample results for sample B-32A and sample N.BLDG.175 are summarized in Table 2-1. Samples were not collected from any other boring locations as no petroleum contamination was evident based on odor and visual examination.

Based on the boring logs from the geotechnical investigation, a geologic cross-section was prepared (Figure 2-4). As the cross-section shows, natural soils and fill placed in this area consist primarily of poorly sorted sands and gravels which overlay a grey biotite granite gneiss bedrock. The depth to bedrock is approximately fifty feet below grade. Ground water is present at approximately four to five feet below ground surface. The inferred ground water flow direction is to the west towards the Thames River.

A visual inspection of this area did not detect any evidence of contamination or spillage.



SECTION B-B

FIGURE 2-4
GEOLOGIC SECTION B-B
BERTH 16/FORMER INCINERATOR

ATLANTIC ENVIRONMENTAL SERVICES, INC.

LEGEND

B-17 BORING

WATERTABLE

INFERRED CONTACT

INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE-NEW LONDON
GROTON, CONN.

06521204Z

3.0 FIELD MOBILIZATION

The field mobilization will consist of the following steps which are subsequently discussed in the following sections. Section 7.0 presents the complete operation schedule.

- Field Office
- Decontamination Area and Equipment Storage Area
- Field Laboratory
- Waste Storage Area
- Sampling Locations
- Heavy Equipment Mobilization
- Emergency Procedures
- Onsite Safety Briefing

3.1 Field Office

Atlantic's existing onsite trailer will serve as the field office/operations center. The trailer is located at the northern end of the Lower Subase, just north of Building 181 near the marina.

Electricity is available at the field office location. Telephones will be mobile units and water will be from a tank truck. Sanitary facilities are available in adjacent buildings. The field office will be designated as a "clean area" and only authorized personnel will be allowed access. The site trailer will serve as the main field operation and communication center throughout the field activities. Copies of all site reports, investigation plans, maps, sample log books, and chain-of- custody records will be maintained in this trailer. As specified in the project Health and Safety Plan (HASP), critical emergency situation information (e.g., emergency numbers, hospital location map) will be prominently displayed in the field office for quick reference.

3.2 Equipment Storage and Decontamination Area

The field office trailer will be used for the storage of field equipment, field instruments, and protective clothing and equipment. The trailer will have two separate areas to segregate the protective clothing and equipment from the field equipment and instruments.

The equipment decontamination area will be located in Area A and will be clearly marked. This is the same location as was used for the work conducted to date. Hand tools and drilling equipment (augers, drill rods, and core barrels) will be steam cleaned over a bermed plastic liner. Field sampling equipment will also be cleaned and decontaminated in this area. A personnel decontamination area will also be located next to the decontamination area. **This decontamination area will only be used for decontamination after leaving this area. Individual decontaminant areas located within the exclusion zone for each site are shown in the HASP.** Facilities for boot and glove washing, disposable coverall removal, and hand-washing will be available. Decontamination procedures are described in the site Health and Safety Plan (HASP). Wastewater generated from both personnel and equipment decontamination activities will be collected and stored in Department of Transportation (DOT) approved 55 gallon drums. Disposable gloves, boots and coveralls will also be drummed. Atlantic will provide for waste classification and disposal of the drums. However, the Navy will remain the generator of the waste and be responsible for signing waste profile sheets, shipping documents, and pre-approval of the ultimate disposition of the wastes.

Areas of equipment storage, and equipment and personnel decontamination are depicted in Figure 3-1.

3.3 Field Laboratory

A field laboratory will be located in a section of the field office trailer. The laboratory will contain a pH meter, conductivity meter, filtering apparatus, HNu photoionization detector, precleaned and pre-preserved sample containers, deionized water, decontamination solutions, sample shipping containers, mailing labels, and field notebooks. The HNu, Model PI101 will be used to monitor organic vapor emissions from field samples and ambient air quality in field work areas. The calibration and operation procedures for the HNu detector are outlined in Atlantic Procedure No. 1051 (Appendix D).

3.4 Establish Waste Storage Area

A waste storage area will be established onsite and will consist of various wastes generated during field operations. These wastes may include: decontamination solutions, disposable equipment, well development water, and drill cuttings. Generated wastes will be collected daily and stored in 55 gallon DOT-approved steel drums or portable tanks. The drum storage area is located in Area A just east of the deployed parking lot. It will be clearly marked and secured (Figure 3-1). As individual drums are filled, they will be labeled according to site name, date, volume, and type of material. Final drum disposition will be handled as described in Section 3.2.

3.5 Sampling Locations

All proposed test boring and monitoring well locations will be marked by using fluorescent paint and indicated by a circle. The sample location number will be painted adjacent to the marker. Locations for monitoring wells and test borings are identified in Section 4.0. Information concerning the locations of underground utilities has been developed as part of this plan from available Navy mapping. Navy personnel will be contacted 10 days in advance of subsurface investigation for clearance of drilling locations.

3.6 Heavy Equipment to the Site

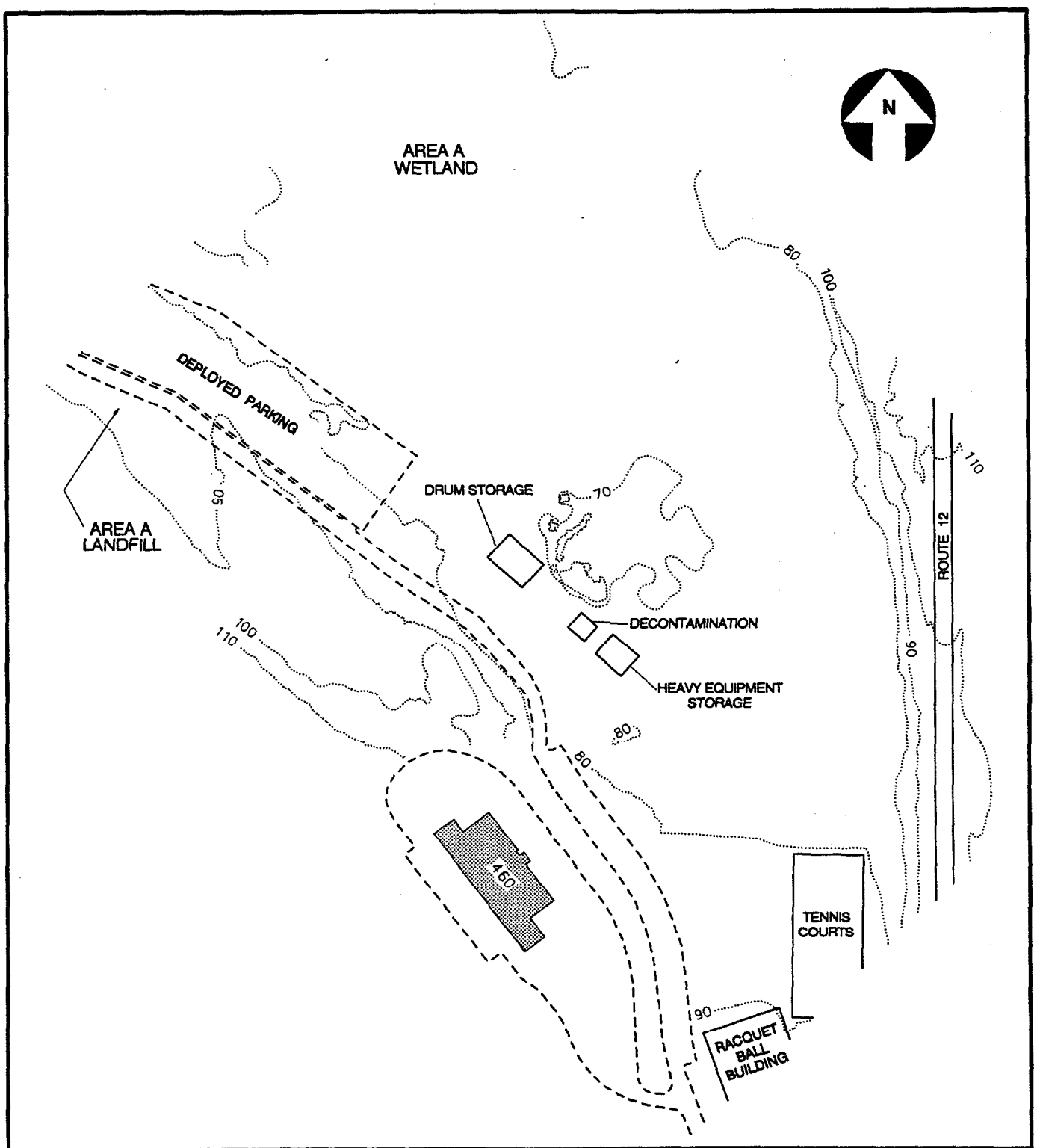
Drilling rigs will be mobilized to the site and will be parked in a designated section of the private contractors area at the Area A Landfill.

3.7 Emergency Procedures

In the event of an emergency, it is necessary to identify routes to the nearest hospital. Specific routes to both the emergency room at the Naval Submarine Base and New London Hospital are identified in the HASP and will be reviewed by site workers. Directions will be posted in the field office trailer.

3.8 Onsite Safety Briefing

Prior to field sampling activities, a safety briefing will be conducted by the Atlantic site safety engineer. The briefing will include a review of potential safety hazards inherent to each specific site and an explanation of the HASP. Documentation of safety training and medical histories of all site workers will be obtained at this time. No one will be allowed to work on any of the sites until this documentation has been obtained.



INSTALLATION RESTORATION STUDY NAVAL SUBMARINE BASE - NEW LONDON GROTON, CT	LEGEND ····· 95 ····· Existing Grade	- Building Approximate Scale 0 80 160'	FIGURE 3-1 LOCATION OF ATLANTIC'S DRUM STORAGE AND EQUIPMENT DECONTAMINATION AREAS ATLANTIC ENVIRONMENTAL SERVICES, INC.

4.0 FIELD INVESTIGATION

The field investigation proposed at each site is based on site history, available chemical data from previous investigations, available boring logs and Atlantic's site inspection. The field sampling activities for each individual site will include the following: soil gas survey, installation of monitoring wells, drilling of test borings, sampling of ground water and subsurface soil, surficial soils and sediments, and an underground utility manhole inspection. Section 4.1 documents general field sampling techniques which will be followed, and Section 4.2 provides the site-specific plans. Data collected will be used to develop a Step I site inspection report.

The contents of the report are specified in Task S2 of the Statement of Work for this IR study and are as follows:

- site background;
- site mapping;
- rationale for sampling and analyses performed;
- detailed description of field investigations;
- boring logs;
- geology and ground water flow direction discussion;
- potential contaminant migration assessment;
- comparison of contaminants detected to applicable standards;
- qualitative health and environmental risk assessment;
- recommendation regarding need for Step II evaluation; and
- safety documentation.

4.1 General Procedures

Atlantic has technical standards and procedures which will be followed during the field operations. The specific Atlantic procedures that will be used during this investigation are presented in Appendix D, and the procedure titles and corresponding number are presented in Table 4-1. Site specific modifications or clarifications for this site investigation are presented in Table 4-2. The project specific modifications to the procedures take into consideration previous USEPA and CTDEP comments regarding their review of the 1989 Plan of Action and recent comments by the TRC. The field sampling program designed for each site will refer to Atlantic's procedures as modified by Table 4-2 during field activities. The procedures will be referenced after each sampling technique by the Atlantic procedure number (e.g., Field Procedures for Collection of Subsurface Soils (Atlantic Procedure 1021)).

4.1.1 Field Screening

Atlantic will use a HNu 11.7 eV Photoionization detector to perform screening analysis during field activities. The HNu is useful in determining general levels of organic vapors in a soil headspace. Soil samples will be initially screened for level of organic vapors in the field, prior to laboratory analysis. The operation and calibration procedures for the HNu detector are described in Atlantic Procedure No. 1051.

Soil samples will also be screened for pH in the field using Method 9045 in SW-846 (EPA Test Methods for the Evaluation of Solid and Hazardous Waste). Ground water prior to sampling will also be screened in the field for pH, temperature, specific conductance and turbidity. Methods 9040 and 9050 in SW-846 will be used to determine pH and specific conductance, respectively.

TABLE 4-1
ATLANTIC TECHNICAL PROCEDURES

Procedure Number	Procedure Title
1020	Field Procedures for Collection of Surface Soil Samples
1021	Field Procedures for Collection of Subsurface Soils
1023	Field Procedures for Collection of Ground Water Samples for Hazardous Waste Determination
1024	**Field Procedures for Collection of TCDD Samples**
1030	Field Procedures for Logging Subsurface Conditions During Test Boring and Well Logging
1041	Sample Chain-of-Custody Procedure
1042	Shipping Procedures for Environmental Field Samples
1051	Operation and Calibration of the HNu Systems Photoionizer Model PI-101
1052	Operation of the Photovac 10S50 Portable Gas Chromatograph
1053	Soil Gas Screening for Volatile Organics
1060	Cleaning Procedure for Sampling Devices Used in Environmental Site Investigation
1070	Well Development Procedures for Small Diameter Monitoring Wells

4.1.2 Soil Gas Survey

A soil gas survey will be performed at both sites to detect levels of volatile compounds and potential "hot spots" which will be used to refine test boring locations. The soil gas surveys will be performed using a Photovac Model 10S50 portable field gas chromatograph with CPSIL 19 capillary column and a photoionization detector. Soil gas samples will be obtained by using a plunger bar and air sampling pump. Analytical procedures are specified in *Operation of the Photovac 10S50 Portable Gas Chromatograph* (Atlantic Procedure No. 1052). Sampling procedures are specified in *Soil Gas Screening for Volatile Organics* (Atlantic Procedure No. 1053).

4.1.3 Well Construction

All wells will be constructed using 2 inch I.D. PVC materials and the screened interval will be 10 feet in length and the screen slot size will be 0.020 inches. **In areas with a shallow depth to bedrock screens five feet in length may be used if necessary. The top of the screen will be placed approximately one foot above the high ground water elevation to allow for ground water fluctuations, but will also allow for the proper seal around the well at the ground surface. High ground water elevation will be determined based upon the elevation observed and adjusted based upon the corresponding river tidal stage. Based upon the tidal study performed for the Lower Subase Site, ground water elevations vary by approximately one foot along the river front based upon tidal stage. In selecting a screened interval the character of the soil will be considered to ensure that screens are not installed across confining layers (if they exist).** The screened interval will be packed with washed silica sand to at least one foot above the top of the screen and a bentonite pellet seal (minimum two feet thick) will be placed above the sand. The annulus will be sealed with cement/bentonite (6 to 1 ratio, respectively) grout. A protective steel curb box with locking cap will be installed above the well casing. An overburden monitoring well construction diagram is presented in Appendix E. The wells will be developed no sooner than one day after they have been installed.

TABLE 4-2
SITE SPECIFIC MODIFICATIONS
TO QA PROCEDURES

QA Procedure	Section Number	Modification/Clarification
1020 1021 1023	6.2 and 6.4 6.2 and 6.3 6.2 and 6.4 6.2 and 6.3	Sample volume, container and preservatives should be as specified in Table 6.1 of the Laboratory Quality Assurance Plan and Section 3.3 of this QA Plan. Samples to be analyzed for VOAs should not be composited.
1023	6.3 and 6.4	**Well purging flow rates will not exceed 500 ml/min and well sampling flow rates will not exceed 100 ml/min.** Samples to be analyzed for dissolved metals should be field filtered with a 0.45 micron filter prior to the addition of sample preservatives.
1023	6.3	**Well purging will be considered complete when three consecutive** measurements differ by less than five percent for pH, conductivity, and temperature, and a minimum of three well volumes have been purged. **Purging rates will not exceed those used for well development.** Samples for VOA analysis will only be collected with a teflon or stainless steel bailer.
1042	6.0	Sample packaging, marking, labeling, and shipment shall comply with Department of Transportation Hazardous Materials Regulations (49CFR).
1053	**5.1**	**Soil gas surveys will not be conducted after rainfall events when the ground appears to be saturated.**
1060	6.2 and 6.3	The decontamination procedure for sampling equipment shall be as presented below: 1. scrub with a brush in Alconox detergent 2. rinse in clean tap water 3. 10% nitric acid rinse or, for carbon steel, 1% (only for metals analysis) 4. distilled/deionized water rinse (only for metals analysis) 5. rinse with methanol 6. rinse with hexane 7. rinse with distilled water 8. allow to air dry The decontamination procedure for heavy equipment shall be as presented below: 1. scrub with a brush 2. steam clean
1070	6.0	**For this project the air development method and the jetting development method will not be used.** Well development will proceed until turbidity is less than 50 NTU, or for a maximum of four hours. Pumping rates will be measured and recorded during well development.
1070	6.1 and 6.2	**A minimum of two weeks must elapse between well development and the commencement of ground water sampling.** **At a minimum, 3 to 5 well volumes, plus the volume of water lost to the formation during drilling must be removed.**

Development will include the use of a surge block and simultaneously pumping to remove fines from the

Development will include the use of a surge block and simultaneously pumping to remove fines from the sand backfill. Development will continue until the discharged water's turbidity is less than 50 NTUs, or after four hours, whichever comes first (Atlantic Procedure 1070).

4.1.4 Hydraulic Conductivity

Hydraulic conductivity will be estimated based on grain size analysis, published data, and previous hydraulic conductivity testing performed by Atlantic at NSB-NLON. **Supplemental hydraulic conductivity analysis will be conducted if the site proceeds to Step II and it is deemed required for remediation evaluation.** Grain size analysis will be performed on samples collected from one half of the monitoring well borings. The sample will be collected from the screened interval of the monitoring well. Grain size analysis will be determined by ASTM Method D422.

4.1.5 Waste Classification and Disposal

All drill cuttings will be contained in 55 gallon drums. The drums will be labeled with the type of material within (soil, water or sludge), the date collected, the site location, and boring number (or some other sampling location designation if appropriate). The drums will be stored at Area A at NSB-NLON until Atlantic's waste disposal contractor can dispose of the drums **found to be contaminated. Soils will be properly characterized prior to disposal primarily based upon analyses of samples collected from the boring from which the contained drill cuttings originated. If necessary, supplemental analyses such as TCLP, VOC and SVO (semi-volatile organic) analyses will be performed. If the characterization indicates that any soils are not contaminated, these soils will be used as fill around the boring they came from or elsewhere onsite. Contaminated soils will be disposed in a properly permitted disposal facility.**

All monitoring well purge and development waters will be collected and properly disposed. Wastewaters will be characterized in the same manner as soils.

All waste collected will be disposed at facilities that are approved by the Navy and that are properly permitted for the specific waste type being disposed. Atlantic will arrange for waste classification and disposal. **The Navy will sign as the generator of the material if offsite disposal is required.**

4.1.6 Underground Utility Inspection

This inspection will consist of a visual examination supplemented by field screening with a photoionization detector of any sediments noted. Manhole covers will be removed and the type of underground utility will be noted, if possible, and visual evidence of contamination will be noted such as an oil sheen on water, discolored sediments or unusual odors such as petroleum. The manholes will not be entered. A pole with an attached scoop will be used to grab a sample of any sediments present. These sediments will be screened with the photoionization detector. The operation and calibration procedures for the photoionization detector are described in Atlantic Procedure No. 1051. Observations will be noted in a field log book and a video recording of each manhole inspection will be made.

4.2 Field Sampling Program

A field sampling program was developed by Atlantic in order to screen these new Step I sites for the presence of onsite contamination. Analytical data will be used to assess the nature of the

contamination and **qualitatively** evaluate health and environmental risks, and to prepare a site inspection report. Based upon these findings as presented in the site inspection report, a determination will be made whether or not to proceed to Step II.

4.2.1 Pier 33 (Site 19)

During a geotechnical investigation for replacement of the quaywall, #2 fuel oil was detected in subsurface soils at the Pier 33 site. Total petroleum hydrocarbons were detected at 1100 ppm at test boring B-30. Fluorescence analysis indicated the hydrocarbons present to be #2 fuel oil.

There are two underground storage tanks located at this site. In addition, due to the historical storage and transfer of large quantities of battery electrolyte (sulfuric acid) in this area, there is some concern that spillage/leakage might have occurred. There is, however, no record of any spills in this area. The purpose for the proposed field investigations is to screen for onsite soil and ground water contamination.

Prior to any subsurface investigations, soil gas surveys of the area will be conducted in order to locate contaminated areas. A detailed description of the soil gas survey methodology is presented in Section 4.1.2 and Atlantic Procedures 1052 and 1053. The sampling area is shown in Figure 4-1. **Samples will not be collected from areas beneath buildings. Samples will be collected at grid points 25 feet on center within the sampling area. If contamination is detected, the sampling grid will be extended as necessary to define the extent of any such area of contamination.**

A total of **eight** test borings will be drilled at this site. Each boring will be advanced with 4-inch hollow-stem augers to a depth at least ten feet below the water table **or refusal whichever is shallower, except for boring 19TB4, which will be drilled to refusal.** Four of these borings will be completed as shallow monitoring wells. Soil samples will be collected continuously in advance of the augers using a 2-inch split-spoon sampler in accordance with ASTM D-1586. Boring and well locations are shown on Figure 4-1. The actual location may vary based on results of the soil gas survey **and potential utility conflicts.**

Sediment samples will be collected from two catch basins as shown in Figure 4-1 using a stainless steel trowel. The catch basin sample locations were selected because they receive surface water runoff from the site and are at locations prior to discharge to the Thames River. A surface soil sample will be collected in an area of stained soils south of Building 175.

Soil/sediment sample(s) will be collected **from two catch basins, the area with stained soils,** each boring and ground water monitoring well location and analyzed for TCL organics and TAL inorganics in accordance with CLP. **In addition, one sample from each boring and the surface soil sample will also be analyzed for** TCLP metals, total petroleum hydrocarbons, and oil fingerprint fluorescence analysis; **and ground water and sediment samples will also be analyzed for TPH and oil fingerprint fluorescence analysis. At boring 19TB4, in addition to the sampling and analysis described above, every 2-foot soil increment will be analyzed for total lead.** Sample location 19MW1 will serve as a background/upgradient monitoring well and the soil sample will be used to assess background soil quality. The rationale for selection of the constituents to be analyzed is shown in Table 4-3. The sampling specifications and rationale for sampling locations/selection are provided in Table 4-4. **Two soil samples will be analyzed from each soil boring except 19MW-1. One will be a shallow sample collected from 0 to 4 feet below grade and the other will be a deep sample collected from below 4 feet below grade.**

- the highest HNu readings within the boring;
- visible contamination;
- **geologic characteristic (e.g., change in stratigraphy or grain size); and**
- lacking organic vapors, visible contamination, **or any geologic characteristic representative of intervals where contaminants might accumulate,** a soil sample will be collected immediately above or at the water table.

TABLE 4-3
RATIONALE FOR SELECTION OF CONSTITUENTS FOR ANALYSIS
PIER 33 AND BERTH 16

Parameter	Rationale
TCL Organics - VOC, SVOC	Present in #2 oil. Needed for risk assessment.
Pesticides **(part of TCL Organic analysis)**	Present at NSB-NLON. Can be eliminated from Step II study if not present above risk based standards.
PCB **(part of TCL Organic analysis)**	Present at NSB-NLON. Transformers used to be present at these sites. Can be eliminated from Step II study if not present above risk based standards.
TAL Inorganics	Present in #2 oil and battery acid. Needed for risk assessment.
TCLP Metals	**Needed to classify soils under CTDEP soil cleanup guidelines and RCRA.**
Total Petroleum Hydrocarbons and Oil Fingerprint Analysis	Needed to assess extent, degree and possibly origin of subsurface #2 oil contamination.
Dioxins	**Potentially presence in incinerator ash at Berth 16/Former Incinerator.**

NOTE: Laboratory analytical procedures are specified in the laboratory QA/QC Plan.

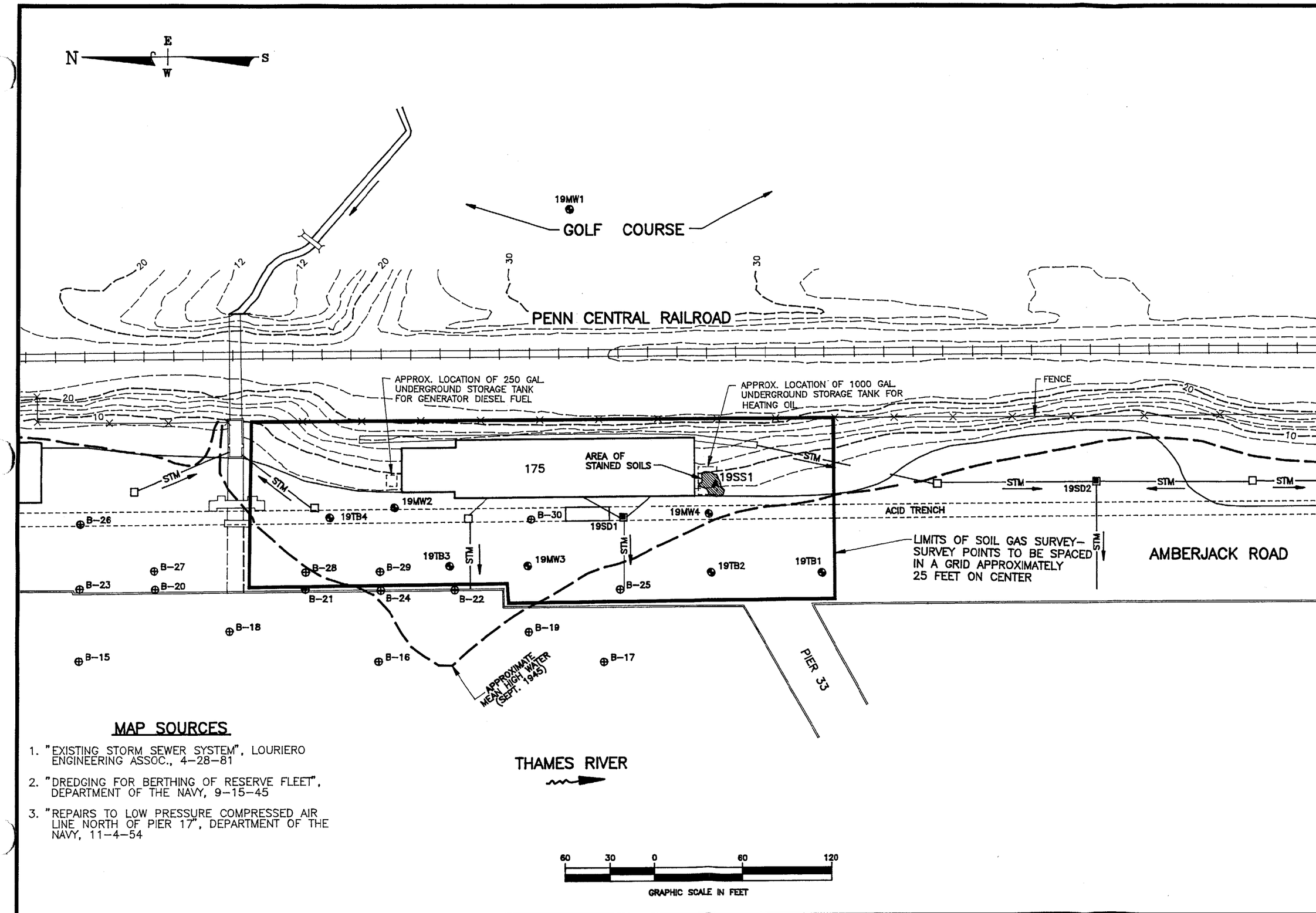
The shallow sample collected to evaluate near surface soil quality will only be analyzed for TCL organics and TAL inorganics. This sample will also be collected by the split-spoon sampler, and be a composite sample of the first two split-spoon samples, i.e., zero to four feet. The sample for VOC analysis will not be a composite but rather a grab sample from the sample interval. The sample for VOC analysis will be selected on the following basis:

- the highest HNu readings;
- visible contamination;
- **geologic characteristic (e.g., change in stratigraphy or grain size); and**
- lacking organic vapors, visible contamination, **or any geologic characteristic representative of intervals where contaminants might accumulate,** the sample will be collected randomly.

Should this sample exhibit a higher HNu reading or visible contamination greater than the deeper sample from the boring, it will replace the deeper sample for TPH, fluorescence, and TCLP metals analysis.

The four monitoring wells will be installed in the locations depicted in Figure 4-1 and constructed as specified in Section 4.1.3.

Figure 4-1: Proposed Field Sampling Plan Pier 33 (11" x 17")



MAP SOURCES

1. "EXISTING STORM SEWER SYSTEM", LOURIERO ENGINEERING ASSOC., 4-28-81
2. "DREDGING FOR BERTHING OF RESERVE FLEET", DEPARTMENT OF THE NAVY, 9-15-45
3. "REPAIRS TO LOW PRESSURE COMPRESSED AIR LINE NORTH OF PIER 17", DEPARTMENT OF THE NAVY, 11-4-54

FIGURE 4-1
PROPOSED FIELD SAMPLING PLAN
PIER 33

ATLANTIC ENVIRONMENTAL SERVICES, INC.

LEGEND

- 123 — BUILDING NUMBER
- UNDERGROUND STORAGE TANK
- RAILROAD TRACKS
- —STM— STORM SEWER
- —10— EXISTING CONTOUR
- 19TB1 — PROPOSED TEST BORING
- 19MW1 — PROPOSED MONITORING WELL
- B-19 — EXISTING TEST LOCATION
- 19SS1 — PROPOSED SOIL SAMPLE
- 19SD1 — PROPOSED SEDIMENT SAMPLE

INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE-NEW LONDON
GROTON, CONN.

06521205Z

TABLE 4-4
FIELD SAMPLING PLAN
PIER 33 - NSB NLON

Sample Location	Boring Depth/ Sampling Specifications	Screen Length/ Elevation Top of Screen	Location Rationale	Sample Designations[1]	Sample Type		Analysis[2]									
					Soil	Water	VOC[3]	SVOC[4]	Inor-ganics[5]	Pesti-cides	PCB[6]	TCLP[7] Metals	TPH[8]	Oil Finger-Print	pH	Grain[9] Size
19MW1	35'±/every 5' and change in soil stratum	10'/1' above high ground water elevation	Upgradient of site	19MW1 (depth)	●		●	●	●	●	●	●	●	●	●	●
				19GW1		●	●	●	●	●	●		●	●	●	
19MW2	15'±/continuous sampling	10'/1' above high groud water elevation	Downgradient of underground storage tank (UST) generator.	19MW2 (0-4')	●		●	●	●	●	●				●	
				19MW2 (depth)	●		●	●	●	●	●	●	●	●	●	●
				19GW2		●	●	●	●	●	●		●	●	●	
19MW3	15'±/continuous sampling	10'/1' above high ground water elevation	Downgradient of previous sample location where contamination was detected (B-30)	19MW3 (0-4')	●		●	●	●	●	●				●	
				19MW3 (depth)	●		●	●	●	●	●	●	●	●	●	●
				19GW3		●	●	●	●	●	●		●	●	●	
19MW4	15'±/continuous sampling	10'/1' above high ground water elevation	Downgradient of UST for building.	19MW4 (0-4')	●		●	●	●	●	●				●	
				19MW4 (depth)	●		●	●	●	●	●	●	●	●	●	●
				19GW4		●	●	●	●	●	●		●	●	●	
19TB1 19TB2	15'±/continuous sampling	NA	To define extent of contamination.	19TB1 (0-4')	●		●	●	●	●	●				●	
				19TB1 (depth)	●		●	●	●	●	●	●	●	●	●	
				19TB2 (0-4')	●		●	●	●	●	●				●	
				19TB2 (depth)	●		●	●	●	●	●	●	●	●	●	
19TB3	15'±/continuous sampling	NA	To define extent of contamination.	19TB3 (0-4')	●		●	●	●	●	●				●	
				19TB3 (depth)	●		●	●	●	●	●	●	●	●	●	
19TB4	15'±/continuous sampling to refusal	NA	To determine verticle extent of contamination from potential electrolyte spillage and extent of other contamination.	19TB4 (0-4')	●		●	●	●	●	●				●	
				19TB4 (depth)	●		●	●	●	●	●	●	●	●	●	
				19TB4 (0-2')	●				●[10]						●	
				19TB4 (2-4')	●				●[10]						●	
				19TB4 (4-6')	●				●[10]						●	
				19TB4 (6-8')	●				●[10]						●	
				19TB4 (8-10')	●				●[10]						●	
				19TB4 (10-12')	●				●[10]						●	
				19TB4 (12-14')	●				●[10]						●	
19SS1	0-12"	NA	To determine nature of contaminants in visually stained soils.	19SS1	●		●	●	●	●	●	●	●	●	●	
19SD1 19SD2	- -	NA	Sediments from storm sewer system at downgradient location	19SD1	●		●	●	●	●	●		●	●	●	
				19SD2	●		●	●	●	●	●		●	●	●	

[1] Soil sample from each location to be selected based upon results of screening with photoionization detector and visual observations. If no contamination is evident, sample will be collected of the depth of the water table interface, except for the shallow soil sample for VOC analysis that will be randomly selected. [2] Rationale for selection of analytical parameters is shown in Table 4-3. [3] VOC means volatile organic compounds. [4] SVOC means semi-volatile organic compound. [5] Ground water samples will be analyzed for filtered and non-filtered inorganics. [6] PCB means polychlorinated biphenyl. [7] TCLP means toxicity characteristic leaching procedure. [8] TPH means total petroleum hydrocarbons. [9] Grain size analysis to be peformed on representative soil sample from screened interval of monitoring well indicated. [10] Inorganic analysis only for lead.

Ground water samples will be collected from each well and analyzed for TCL organics and TAL metals in accordance with CLP, total petroleum hydrocarbons, and oil fingerprint analysis. Table 4-4 summarizes the specifics of the site sample location, boring depth, screen location, sample designation and type, analysis, and rationale. If free product is encountered, its thickness will be measured, **a sample will be collected for petroleum fingerprinting, and steps will be taken to immediately stabilize the migration of free product.**

Samples will be collected and handled in accordance with the specified Atlantic procedures. QA/QC samples will be collected as specified in the QA/QC plan.

In addition to the sampling and analysis described above, an inspection of the utility manholes within the study area for evidence of oil will be conducted as described in Section 4.1.6. This inspection will be videotaped and consist of an observation of water and sediment for any evidence of contamination such as an oil sheen or stained soils. The manholes will not be entered.

4.2.2 Berth 16/Former Incinerator (Site 20)

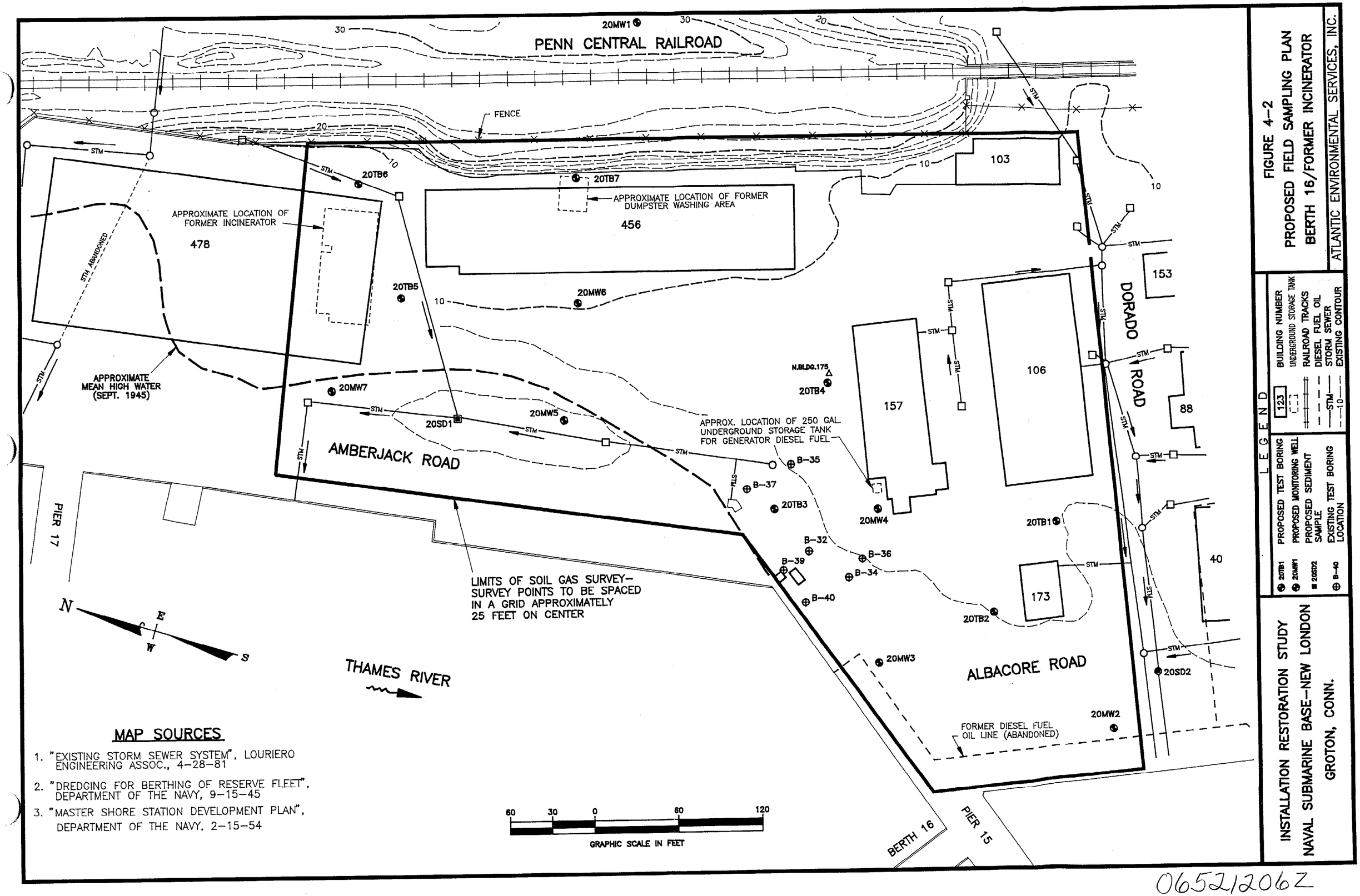
During a geotechnical investigation for replacement of the quay wall, #2 fuel oil was detected in subsurface soil near Berth 16. **In addition, a soil sample taken from a trench near Building 157 detected lead, total petroleum hydrocarbon and trichloroethene to be present in elevated concentrations.** There is one underground diesel storage tank located at this site and, historically, there were subsurface oil distribution lines. In addition, transformers and a septic tank have been located at this site. There was also a garbage **incinerator and** dumpster washing facility in this area. The purpose for the proposed field investigations is to screen for onsite soil and ground water contamination.

Prior to any subsurface investigations, soil gas surveys of the area will be conducted in order to locate contaminated areas. A detailed description of the soil gas survey methodology is presented in Section 4.1.2 and Atlantic Procedures 1052 and 1053. The sampling area is shown in Figure 4-2. **Samples will not be collected from areas beneath buildings.** Samples will be collected at grid points 25 feet on center within the sampling area. **If contamination is detected, the sampling grid will be extended as necessary to define the extent of any such area of contamination.**

A total of fourteen test borings will be drilled at this site. Each boring will be advanced with 4-inch hollow stem augers to a depth at least ten feet below the water table. Seven of these borings will be completed as shallow monitoring wells. Soil samples will be collected continuously in advance of the augers using a 2-inch split-spoon sampler in accordance with ASTM D-1586. **Due to limited access at boring location 20TB7 behind Building 456, this boring may be augered with a smaller diameter solid-stem auger and samples will be collected with a 1½-inch diameter tube sampler.** Boring and well locations are shown on Figure 4-2. The actual location may vary based on results of the soil gas survey **and potential utility conflicts**. The rationale for selection of these locations is shown in Table 4-5, and the rationale for selection of constituents to be analyzed provided in the previously referenced Table 4-3.

Sediment samples will be collected from two catch basins as shown in Figure 4-2 using a stainless steel trowel. The catch basin sample locations were selected because they receive surface water runoff from the site and are at locations prior to discharge to the Thames River.

Soil/sediment sample(s) will be collected from two catch basins, each boring and ground water monitoring well location and analyzed for TCL organics and TAL inorganics in accordance with CLP.


PENN CENTRAL RAILROAD
20MW1
FENCE
20TB6
20TB7
APPROXIMATE LOCATION OF FORMER DUMPSTER WASHING AREA
456
103
APPROXIMATE LOCATION OF FORMER INCINERATOR
478
STM ABANDONED
20TB5
20MW6
153
DORADO ROAD
APPROXIMATE MEAN HIGH WATER (SEPT. 1945)
20MW7
N.BLDG.175
20TB4
157
106
88
20SD1
20MW5
APPROX. LOCATION OF 250 GAL. UNDERGROUND STORAGE TANK FOR GENERATOR DIESEL FUEL
AMBERJACK ROAD
B-35
B-37
20TB3
20MW4
20TB1
B-32
B-36
B-39
B-34
40
173
B-40
20TB2
PIER 17
LIMITS OF SOIL GAS SURVEY- SURVEY POINTS TO BE SPACED IN A GRID APPROXIMATELY 25 FEET ON CENTER
N
E
W
S
THAMES RIVER
20MW3
ALBACORE ROAD
20SD2
20MW2
FORMER DIESEL FUEL OIL LINE (ABANDONED)
BERTH 16
PIER 15
60 30 0 60 120
GRAPHIC SCALE IN FEET
MAP SOURCES
1. "EXISTING STORM SEWER SYSTEM", LOURIERO ENGINEERING ASSOC., 4-28-81
2. "DREDGING FOR BERTHING OF RESERVE FLEET", DEPARTMENT OF THE NAVY, 9-15-45
3. "MASTER SHORE STATION DEVELOPMENT PLAN", DEPARTMENT OF THE NAVY, 2-15-54
FIGURE 4-2
PROPOSED FIELD SAMPLING PLAN
BERTH 16/FORMER INCINERATOR
ATLANTIC ENVIRONMENTAL SERVICES, INC.
LEGEND
123 BUILDING NUMBER
UNDERGROUND STORAGE TANK
RAILROAD TRACKS
DIESEL FUEL OIL
STM STORM SEWER
10 EXISTING CONTOUR
20TB1 PROPOSED TEST BORING
20MW1 PROPOSED MONITORING WELL
20SD2 PROPOSED SEDIMENT SAMPLE
B-40 EXISTING TEST BORING LOCATION
INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE-NEW LONDON
GROTON, CONN.

065212062

TABLE 4-5
FIELD SAMPLING PLAN
BERTH 16/FORMER INCINERATOR - NSB NLON

Sample Location	Boring Depth/ Sampling Specifications	Screen Length/ Elevation Top of Screen	Location Rationale	Sample Designations[1]	Sample Type		Analysis[2]										
					Soil	Water	VOC[3]	SVOC[4]	Inor-ganics[5]	Pesti-cides	PCB[6]	TCLP[7] Metals	TPH[8]	Oil Finger-Print	pH	Grain Size[9]	Dioxin[10]
20MW1	30'±/every 5' and change in soil stratum	10'/1' above high ground water elevation	Upgradient of site.	20MW1 (depth)	●		●	●	●	●	●	●	●	●	●	●	
				20GW1		●	●	●	●	●	●		●	●	●		
20MW2	15'±/continuous sampling	10'/1' above high ground water elevation	Adjacent to former underground fuel oil distribution lines. Downgradient of Buildings 173 and 106.	20MW2 (0-4')	●		●	●	●	●	●				●		
				20MW2 (depth)	●		●	●	●	●	●	●	●	●	●	●	
				20GW2		●	●	●	●	●	●		●	●	●		
20MW3	15'±/continuous sampling	10'/1' above high ground water elevation	Downgradient of former boring where contamination was detected and near former fuel oil distribution lines.	20MW3 (0-4')	●		●	●	●	●	●				●		
				20MW3 (depth)	●		●	●	●	●	●	●	●	●	●	●	
				20GW3		●	●	●	●	●	●		●	●	●		
20MW4	15'±/continuous sampling	10'/1' above high ground water elevation	Downgradient of underground storage tank. Shallow soil sample (0-4') is for qualitative risk assessment.	20MW4 (0-4')	●		●	●	●	●	●				●		
				20MW4 (depth)	●		●	●	●	●	●	●	●	●	●	●	
				20GW4		●	●	●	●	●	●		●	●	●		
20MW5	15'±/continuous sampling	10'/1' above high ground water elevation	Downgradient of former dumpster washing area and in area of depressed topography.	20MW5 (0-4')	●		●	●	●	●	●				●		●
				20MW5 (depth)	●		●	●	●	●	●	●	●	●	●	●	
				20GW5		●	●	●	●	●	●		●	●	●		
20MW6	15'±/continuous sampling	10'/1' above high ground water elevation	Directly downgradient of former dumpster washing area.	20MW6 (0-4')	●		●	●	●	●	●				●		●
				20MW6 (depth)	●		●	●	●	●	●	●	●	●	●	●	
				20GW6		●	●	●	●	●	●		●	●	●		
20MW7	15'±/continuous sampling	10'/1' above high ground water elevation	Downgradient of former incinerator.	20MW7 (0-4')	●		●	●	●	●	●				●		●
				20MW7 (depth)	●		●	●	●	●	●	●	●	●	●		
				20GW7		●	●	●	●	●	●		●	●	●	●	
20TB1	15'±/continuous sampling	NA	Downgradient of Building 106.	20TB1 (0-4')	●		●	●	●	●	●				●		
				20TB1 (depth)	●		●	●	●	●	●	●	●	●	●		
20TB2	15'±/continuous sampling	NA	Near former septic tank that serviced Building 173.	20TB2 (0-4')	●		●	●	●	●	●				●		
				20TB2 (depth)	●		●	●	●	●	●	●	●	●	●		
20TB3	15'±/continuous sampling	NA	To define extent of subsurface contamination. Near boring B-32.	20TB3 (0-4')	●		●	●	●	●	●				●		
				20TB3 (depth)	●		●	●	●	●	●	●	●	●	●		
20TB4	15'±/continuous sampling	NA	At sample location N.BLDG.175 where TCE was detected.	20TB4 (0-4')	●		●	●	●	●	●				●		
				20TB4 (depth)	●		●	●	●	●	●	●	●	●	●		

[1] Soil sample from each location to be selected based upon results of screening with photoionization detector and visual observations. If no contamination is evident, sample will be collected of the depth of the water table interface, except for the shallow soil sample for VOC analysis that will be randomly selected. [2] Rationale for selection of analytical parameters is shown in Table 4-3. [3] VOC means volatile organic compounds. [4] SVOC means semi-volatile organic compound. [5] Ground water samples will be analyzed for filtered and non-filtered inorganics. [6] PCB means polychlorinated biphenyl. [7] TCLP means toxicity characteristic leaching procedure. [8] TPH means total petroleum hydrocarbons. [9] Grain size analysis to be peformed on representative soil sample from screened interval of monitoring well indicated. [10] Dioxin analysis includes dioxins and dibenzofurans. The sample selected will be a sample containing ash, if present. If no ash is evident, the sample will be a composite at the 0-4 foot interval.

TABLE 4-5 (Continued)
FIELD SAMPLING PLAN
BERTH 16/FORMER INCINERATOR - NSB NLON

Sample Location	Boring Depth/ Sampling Specifications	Screen Length/ Elevation Top of Screen	Location Rationale	Sample Designations[1]	Sample Type		Analysis[2]										
					Soil	Water	VOC[3]	SVOC[4]	Inor-ganics[5]	Pesti-cides	PCB[6]	TCLP[7] Metals	TPH[8]	Oil Finger-Print	pH	Grain Size[9]	Dioxin[10]
20TB5	15'±/continuous sampling	NA	Adjacent to former incinerator.	20TB5 (0-4')	•		•	•	•	•	•				•		•
				20TB5 (depth)	•		•	•	•	•	•	•	•	•	•		
20TB6	15'±/continuous sampling	NA	Near former incinerator.	20TB6 (0-4')	•		•	•	•	•	•				•		•
				20TB6 (depth)	•		•	•	•	•	•	•	•	•	•		
20TB7	15'±/continuous sampling	NA	Near former incinerator in former dumpster washing area.	20TB7 (0-4')	•		•	•	•	•	•				•		•
				20TB7 (depth)	•		•	•	•	•	•	•	•	•	•		
20SD1	-	NA	Sediments from storm sewer system at downgradient location.	20SD1	•		•	•	•	•	•		•	•	•		
20SD2	-			20SD2	•		•	•	•	•	•		•	•	•		

[1] Soil sample from each location to be selected based upon results of screening with photoionizationdetector and visual observations. If no contamination is evident, sample will be collected of the depth of the water table interface, except for the shallow soil sample for VOC analysis that will be randomly selected. [2] Rationale for selection of analytical parameters is shown in Table 4-3. [3] VOC means volatile organic compounds. [4] SVOC means semi-volatile organic compound. [5] Ground water samples will be analyzed for filtered and non-filtered inorganics. [6] PCB means polychlorinated biphenyl. [7] TCLP means toxicity characteristic leaching procedure. [8] TPH means total petroleum hydrocarbons. [9] Grain size analysis to be peformed on representative soil sample from screened interval of monitoring well indicated. [10] Dioxin analysis includes dioxins and dibenzofurans. The sample selected will be a sample containing ash, if present. If no ash is evident, the sample will be a composite of the 0-4 foot interval.

In addition, one sample from each boring will also be analyzed for TCLP metals, total petroleum hydrocarbons, and oil fingerprint fluorescence analysis; **and ground water and sediment samples will also be analyzed for TPH and oil fingerprint fluorescence analysis.** Sample location 20MW1 will serve as a background/upgradient monitoring well and the soil sample will be used to assess background soil quality. **Two soil samples will be analyzed from each soil boring except 20MW-1, one will be a shallow sample collected from 0 to 4 feet below grade and the other will be a deeper sample collected from below 4 feet below grade.**

The actual **deep** sample sent for analysis will be selected on the following basis:

- the highest HNu readings within a boring;
- visible contamination;
- **geologic characteristic (e.g., change in stratigraphy or grain size);** and
- lacking organic vapors, visible contamination, **or any geologic characteristics representative of intervals where contaminants might accumulate,** a soil sample will be collected immediately above the water table.

The shallow sample collected to evaluate near surface soil quality will only be analyzed for TCL organics and TAL inorganics. This sample will also be collected by the split-spoon sample and be a composite sample of the first two split-spoon samples, i.e., zero to four feet. The sample for VOC analysis will not be a composite, but rather a grab sample from the sample interval. This sample for VOC analysis will be selected on the following basis:

- the highest HNu readings;
- visible contamination;
- **geologic characteristic (e.g., change in stratigraphy or grain size); and**
- lacking organic vapors, visible contamination, **or any geologic characteristics representative of intervals where contaminants might accumulate,** the sample will be collected randomly.

Should this sample exhibit a higher HNu reading or visible contamination greater than the deeper sample from the boring, it will replace the deeper sample for TPH, fluorescence, and TCLP metals analysis.

Testing dioxins/dibenzofurans will be performed on six soil samples; one each from sample locations 20TB5, 20TB6, 20TB7, 20MW5, 20MW6 and 20MW7. The sample selected at each location will be a sample containing ash, if any is present. If no ash is evident, the sample will be a composite of the 0- to 4-foot interval below grade.

The **seven** monitoring wells will be installed in the locations depicted in Figure 4-2 and constructed as specified in Section 4.1.3.

Ground water samples will be collected from each well and analyzed for TCL organics and TAL metals in accordance with CLP, total petroleum hydrocarbons, and oil fingerprint analysis. Table 4-5 summarizes the specifics of the site sample location, boring depth, screen location, sample designation and type, analysis, and rationale. If free product is encountered, its thickness will be measured, **a sample will be collected for petroleum fingerprinting and steps will be taken to immediately stabilize the migration of free product.**

Samples will be collected and handled in accordance with the specified Atlantic procedures.

QA/QC samples will be collected as specified in the QA/QC plan.

In addition to the sampling and analysis described above, the utility manholes within the study area will be inspected for evidence of oil as described in Section 4.1.6. This inspection will be videotaped and consist of an observation of water and sediment for any evidence of contamination such as an oil sheen or stained soils. The manholes will not be entered.

5.0 SAMPLE PRESERVATION AND SHIPPING

Precleaned sample containers will be provided by the analytical laboratory for Atlantic to use in the field.

Sample preservation standards for solid and liquid matrices are outlined in the QA/QC plan for this project. Typical preservation standards are listed in the QA/QC plan for parameters to be analyzed during the field sampling plan.

The preservation method will be noted on the sample jar and reported with designated sample number in the field notebook. A Chain-of-Custody form (A.P. 1041) will also record the preservation technique prior to shipment to the analytical laboratory. All samples and appropriate QA/QC samples will be shipped via Federal Express or courier to the laboratory. Sample shipment will occur at least every other day.

6.0 RECORDKEEPING AND DOCUMENTATION

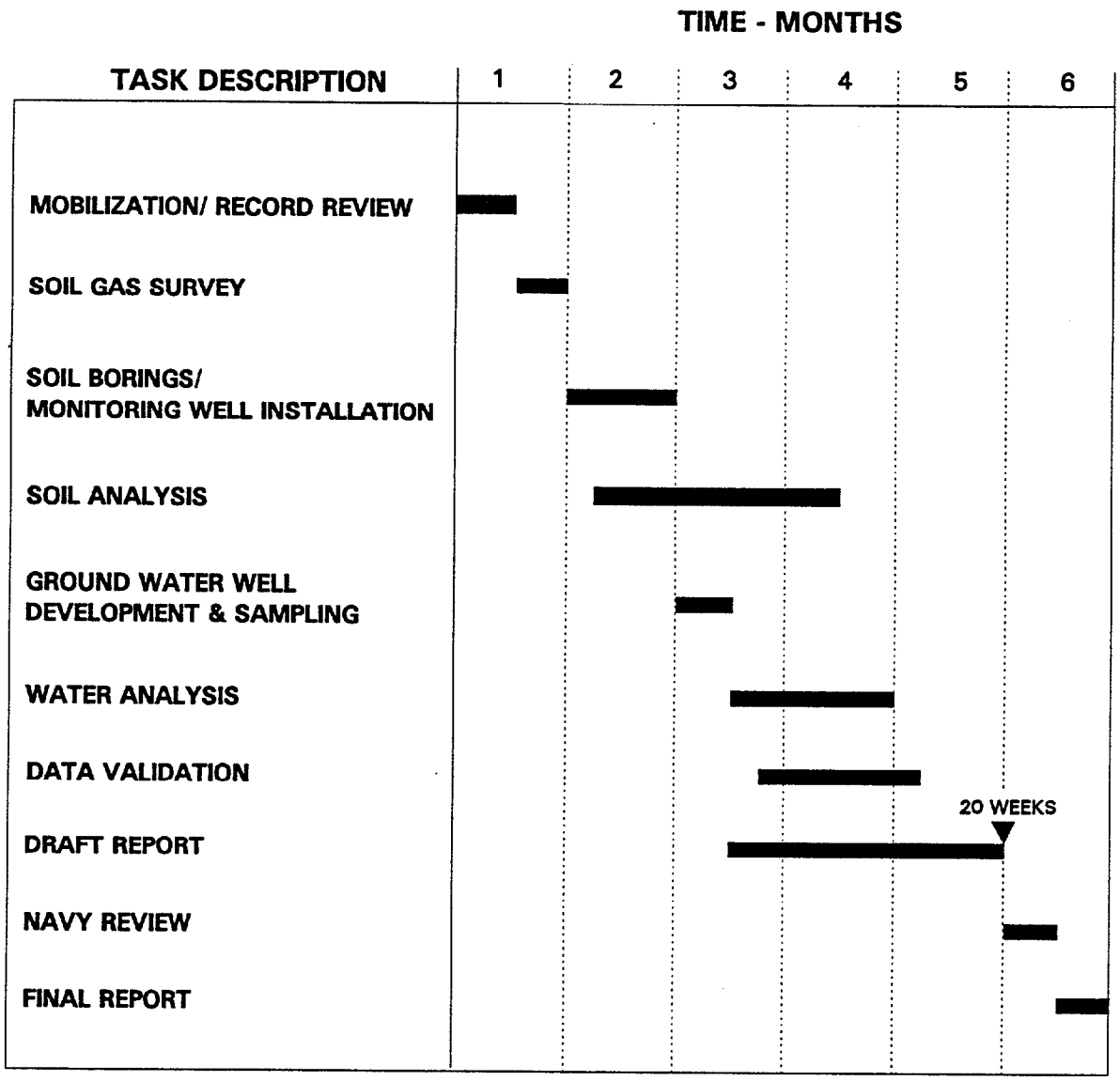
A recordkeeping and site documentation plan is required due to the number of soil and water samples, involvement of different field technicians and QA/QC procedures for document control. The following documents will be utilized for recordkeeping:

DOCUMENT	PURPOSE
Field Notebook	A designated notebook will be issued to each field technician and used during field activities.
Master Sample Log	Laboratory notebook which will remain in site office and record every sample collected. The field operations manager will log in all samples and those sent to analytical laboratory with waybill number at the end of each day.
Chain-of-Custody Record	Document custody of all samples from field to laboratory.
Waybills	Waybill receipt is obtained at time of accepted sample shipment by Federal Express or courier and will be attached to the Master Sample Log.
Accident Report/Daily First Air Report/Employer's First Report of Injury/OSHA 100 Forms	Data sheets that will document any accident occurring onsite during field activities. The sheets are attached to HASP and located in the site trailer.

Field logs and master sample log will be copied and added to the project file at Atlantic, at the conclusion of each week of field sampling.

7.0 SCHEDULE

The schedule to begin the field sampling plan is based on approval of the Navy. Other factors to consider are availability of drilling equipment and analytical laboratory turnaround time. The project schedule which is summarized below on Figure 7-1, shows the overall operations schedule and sampling schedule.



INSTALLATION RESTORATION STUDY NAVAL SUBMARINE BASE - NEW LONDON GROTON, CT		FIGURE 7-1 PRELIMINARY PROJECT SCHEDULE ATLANTIC ENVIRONMENTAL SERVICES, INC.

APPENDIX A

TANK TIGHTNESS TEST RESULTS

Data Chart for Tank System Tightness Test

petro Tite
TANK TESTER

PLEASE PRINT

1. OWNER Property ✓ Tank(s) ✓	US NAVY SUB BASE NEW LONDON GROTON CT — Name / Address — BILL MANSFIELD — Representative — 449-4481 — Telephone SAME — Name / Address — Representative — Telephone
2. OPERATOR	US NAVY SUB BASE NEW LONDON GROTON CT. — Name / Address — Telephone
3. REASON FOR TEST (Explain Fully)	SUSPECT LEAK DUE TO SHEEN PRESENCE DURING LEAVY RAINS
4. WHO REQUESTED TEST AND WHEN	[illegible] — Name — CONTRACT [illegible] — Title — US NAVY — Company or Affiliation — 18 MAY 90 — Date US NAVY SUB BASE NEW LONDON, GROTON, CT. — Address — Telephone
5. WHO IS PAYING FOR THIS TEST?	FLEET ACCOUNT [illegible] DISBURSING CENTER — Company/Agency or Individual — Person Authorizing — Title — Telephone NORFOLK VA — Billing Address — City — State — 23511 — Zip BILL MANSFIELD — Attention of: — N62472-90-M-3520 — Order No — Other Instructions

6. TANK(S) INVOLVED	Identify by Direction	Capacity	Brand/Supplier	Grade	Approx. Age	Steel Fiberglass
	BLDG 175	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

7. INSTALLATION DATA	Location	Cover	Fills	Vents	Siphones	Pumps
	SOUTH END BLDG	DIRT	4"	2"	- 0 -	SUPPLY [illegible]
	North inside driveway, Rear of station, etc.	Concrete, Black Top, Earth, etc.	Size, Titefill make, Drop tubes, Remote Fills	Size, Manifolded	Which tanks?	Suction, Remote Make if known

8. UNDERGROUND WATER — Depth to the Water table > 22" — Is the water over the tank? ☐ Yes ☑ No

9. FILL-UP ARRANGEMENTS — Tanks to be filled 0800 hr 5/21/90 Date — Arranged by BILL MANSFIELD — Name — 449-4481 — Telephone
Extra product to "top off" and run TSTT. How and who to provide? Consider NO Lead.
55 GAL DRUM SUPPLIED BY NAVY
Terminal or other contact for notice or inquiry — Company — JIM FITZPATRICK — Name — Telephone

10. CONTRACTOR, MECHANICS, any other contractor involved — ENERTECH

11. OTHER INFORMATION OR REMARKS — STOP AT SECURITY GATE, GET LOWER BASE PASS

Additional information on any items above. Officials or others to be advised when testing is in progress or completed. Visitors or observers present during test etc.

12. TEST RESULTS — Tests were made on the above tank systems in accordance with test procedures prescribed for petro Tite as detailed on attached test charts with results as follows:

Tank Identification	Tight	Leakage Indicated	Date Tested
FUEL TANK BLDG #175	PASS	+.013 GPH	5/22/90

13. CERTIFICATION — This is to certify that these tank systems were tested on the date(s) shown. Those indicated as "Tight" meet the criteria established by the National Fire Protection Association Pamphlet 329.

[illegible] 12/86 — Date
S/N 1431 — Serial No. of Thermal Sensor
PHIL WYGANT — Technicians
ENERTECH — Testing Contractor or Company
653 PINE ST. FOREST VILLE, CT — Address
By: Phil Wygant — Signature

9509 COPIER

14.

Name of Supplier, Owner or Dealer	Address No. and Street(s)	City	State	Date of Test

15. TANK TO TEST

#175 TANK
Identity by position

#2 DIESEL (HEATING)
Brand and Grade

16. CAPACITY

Nominal Capacity 1500 gal Gallons

By most accurate capacity chart available 1003 Gallons

Is there doubt as to True Capacity? ☐

See Section "DETERMINING TANK CAPACITY"

From
- ☐ Station Chart
- ☑ Tank Manufacturer's Chart
- ☐ Company Engineering Data
- ☐ Charts supplied with Petro Tite Tank Tester
- ☐ Other _____

17. FILL-UP FOR TEST

Stick Water Bottom before Fill-up 4.0 " to ⅛ in. _____ Gallons

Fill up. STICK BEFORE AND AFTER EACH COMPARTMENT DROP OR EACH METERED DELIVERY QUANTITY

Tank Diameter

	Stick Readings to ⅛ in.	Gallons	Total Gallons ea. Reading
Inventory			
Product in full tank (up to fill pipe)			

18. SPECIAL CONDITIONS AND PROCEDURES TO TEST THIS TANK

See manual sections applicable. Check below and record procedure in log (26).

☐ Water in tank ☐ High water table in tank excavation ☐ Line(s) being tested with LVLLT

VAPOR RECOVERY SYSTEM

☐ Stage I
☐ Stage II

19. TANK MEASUREMENTS FOR TSTT ASSEMBLY

Bottom of tank to Grade* ..... 82 "
Add 30" for 4" L ..... 19 "
Add 24" for 3" L or air seal ..... _____ "
Total tubing to assemble Approximate ..... _____ "

20. EXTENSION HOSE SETTING

Tank top to grade* ..... 19 "
Extend hose on suction tube 6" or more below tank top ..... -0- "

*If Fill pipe extends above grade, use top of fill.

21. TEMPERATURE/VOLUME FACTOR (a) TO TEST THIS TANK

Is Today Warmer? (✓) Colder? ( ) ___ °F Product in Tank ___ °F Fill-up Product on Truck ___ °F Expected Change (+ or −)

22. Thermal-Sensor reading after circulation 10925 digits 55-56 °F Nearest

23. Digits per °F in range of expected change 313 digits

24. 1003 total quantity in full tank (16 or 17) × .00046 coefficient of expansion for involved product = .46138 volume change in this tank per °F gallons

25. .46138 volume change per °F (24) ÷ 313 Digits per °F in test Range (23) = .001474 ≈ .0015 Volume change per digit. Compute to 4 decimal places. This is test factor (a)

26. LOG OF TEST PROCEDURES			30. HYDROSTATIC PRESSURE CONTROL		31. VOLUME MEASUREMENTS (V) RECORD TO .001 GAL.			34. TEMPERATURE COMPENSATION USE FACTOR (a) ≤ .0015			38. NET VOLUME CHANGES EACH READING	39. ACCUMULATED CHANGE
27. DATE 5/22/90 TIME (24 hr.)	28. Record details of setting up and running test. (Use full length of line if needed.)	29. Reading No.	Standpipe Level in Inches: Beginning of Reading	Standpipe Level in Inches: Level to which Restored	32. Product in Graduate: Before Reading	32. Product in Graduate: After Reading	Product Replaced (−) / Product Recovered (+)	35. Thermal Sensor Reading	36. Change Higher + Lower − (c)	37. Computation (c) × (a) = Expansion + Contraction −	Temperature Adjustment: Volume Minus Expansion (+) or Contraction (−) #33(V) − #37(T)	At High Level record Total End Deflection / At Low Level compute Change per Hour (NFPA criteria)
13:00	ARRIVE											
	L[illegible]TE TANK SET UP											

Petro Tite TANK TESTER

HEATH CONSULTANTS
100 TOSCA DRIVE
P.O. BOX CS-200
STOUGHTON, VA 02072-1531

9509 COPIES

☐ Water in tank ☐ High water table in tank excavation ☐ Line(s) being tested with LVLLT

☐ Stage I
☐ Stage II

19. TANK MEASUREMENTS FOR TSTT ASSEMBLY

Bottom of tank to Grade* ..... 82 "
Add 30" for 4" L ..... 19 "
Add 24" for 3" L or air seal ..... "
Total tubing to assemble Approximate ..... "

20. EXTENSION HOSE SETTING

Tank top to grade* ..... 19" "
Extend hose on suction tube 8" or more below tank top ..... -0- "

*If Fill pipe extends above grade, use top of fill.

21. TEMPERATURE/VOLUME FACTOR (a) TO TEST THIS TANK

Is Today Warmer? (✓) Colder? ( ) ___° F Product in Tank ___° F Fill-up Product on Truck ___° F Expected Change (+ or −)

22. Thermal-Sensor reading after circulation 10925 digits 55-56 Nearest °F

23. Digits per °F in range of expected change 313 digits

24. 1003 total quantity in full tank (16 or 17) × .00046 coefficient of expansion for involved product = .46138 volume change in this tank per °F gallons

25. .46138 volume change per °F (24) ÷ 313 Digits per °F in test Range (23) = .001474 ≈ .0015 Volume change per digit. Compute to 4 decimal places. This is test factor (a)

26. LOG OF TEST PROCEDURES			30. HYDROSTATIC PRESSURE CONTROL		31. VOLUME MEASUREMENTS (V) RECORD TO .001 GAL.			34. TEMPERATURE COMPENSATION USE FACTOR (a) ≈ .0015			38. NET VOLUME CHANGES EACH READING	39. ACCUMULATED CHANGE
27. DATE 5/22/90 TIME (24 hr)	28. Record details of setting up and running test. (Use full length of line if needed.)	29. Reading No.	Standpipe Level in Inches: Beginning of Reading	Level to which Restored	32. Product in Graduate: Before Reading	After Reading	Product Replaced (−) / Product Recovered (+)	35. Thermal Sensor Reading	36. Change Higher + Lower − (c)	37. Computation (c) × (a) = Expansion + Contraction −	Temperature Adjustment: Volume Minus Expansion (+) or Contraction (−) #33(V) − #37(T)	At High Level record Total End Deflection / At Low Level compute Change per Hour (NFPA criteria)
13:00	ARRIVE											
	LOCATE TANK SET UP											
14:30	HRS - START CIRC TIME	1	37									
15:00	START Hi LEVEL	2	36.5					10925				
	PLUS TRUCK BED 37"											
	8" GRADE TO TOP OF TANK											
15:15		3	36.3					10932				
15:30		4	36.3					10948				
15:45		5	36.3					10965				
16:00		6	36.3					10980				
16:15	DROP TO LOW LEVEL	1	12.0			.792		11099				
16:30		2	12.7	12.0	.792	.835		11020				
16:45		3	12.6	12.0	.835	.860	+.025	11035	+15	.0225	+.0025	
17:00		4	12.5	12.0	.860	.890	+.030	11049	+14	.0210	+.009	+.0115
17:15		5	12.4	12.0	.890	.908	+.018	11061	+12	.0180	-0-	+.0115
17:30		6	12.5	12.0	.908	.938	+.030	11080	+19	.0285	+.0015	+.013

APPENDIX B

EXISTING CHEMICAL ANALYSES

Quaywall Replacement, P-413, New London
Fuel Oil Contamination - Lab Results

RECEIVED
OCT 9 1989
3131

ALPHA ANALYTICAL LABORATORIES
55 Access Drive
Warwick, RI 02886-9911
(401) 732-1680

CERTIFICATE OF ANALYSIS

Client: Morrison Geotech Engineering

Address: PO Box 399

Waterville, ME 04901

Attn: Dale Doughty

Job Number: 891117

Invoice Number: 9299

Date In: 09/22/89

Date Reported: 10/06/89

Sample Description: One soil and one water sample

MGE Job# 3131

REFERENCES:

1. Test Methods for Evaluating Solid Waste: Physical/Chemical Methods. EPA SW-846. 1986.

2. Standard Methods for Examination of Water and Waste Water. APHA-AWWA-WPCF. 16th Edition. 1985.

3. Methods for Chemical Analysis of Water and Wastes. EPA 600/4-82-055. 1983.

4. Oil Spill Identification System. CG-D-52-77 U. S. Coast Guard. 1977.

Authorized by: Scott McLean
Scott McLean--Laboratory Director

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

Client: Morrison Geotech Engineering

Sample Number: 891117.1

Analysis Requested: Analysis as Listed Below

Date Received: 09/22/89

Date Reported: 10/06/89

Client Ident: B30A

Near Bldg 175
North of Pier 33

Sample Location:

Sample Description: Soil

Sample Container: Glass bottle & VOA vial

# of Containers: 2

Field Prep: None

PARAMETER	RESULT	UNITS	MDL*	INST	REF**	METHOD	EXTRACT	ANALYSIS
Total Metals								
Arsenic	0.9	mg/Kg	0.2	HGA	1	7060	———	10/05/89
Barium	ND	mg/Kg	5	AAS	1	7080	———	10/05/89
Cadmium	0.18	mg/Kg	0.02	HGA	1	7131	———	10/05/89
Chromium	10	mg/Kg	2	AAS	1	7190	———	10/05/89
Lead	3.4	mg/Kg	0.1	HGA	1	7420	———	10/05/89
Mercury	ND	mg/Kg	0.2	CV	1	7470	———	10/05/89
Selenium	ND	mg/Kg	0.2	HGA	1	7740	———	10/05/89
Silver	ND	mg/Kg	0.5	AAS	1	7760	———	10/05/89
Volatile Organics **								
Volatile Halocarbons	ND	ug/Kg	1*	GC/MS	1	8240	———	09/29/89
Volatile Aromatics	ND	ug/Kg	1*	GC/MS	1	8240	———	09/29/89
PCB	ND	ug/Kg	250	GC	1	8080	———	10/03/89
Pesticides	ND	ug/Kg	50	GC	1	8080	———	10/03/89
Petroleum Scan								
Fuel Oil #2	1,100	mg/Kg	5	GC	4	———	———	10/05/89
% Total Solids	93.1	%	—	Grav	2	209A	———	10/03/89

All results reported on a dry weight basis.

**Note: All compounds were below the detection limits except those listed above.

1* A list of volatile halocarbons, volatile aromatics, PCB's and pesticides analyzed for and their detection limits accompanies this report.

* MDL—Method Detection Limits (same units as the Results)
** REF—Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

Client: Morrison Geotech Engineering

Sample Number: 891117.2

Analysis Requested: Analysis as Listed Below

Date Received: 09/22/89

Date Reported: 10/06/89

Client Ident: B30 Near Bldg 175, North of Pier 33
Sample Location:
Sample Description: Water
Sample Container: Glass bottle & VOA vial
Field Prep: None

# of Containers: 2

PARAMETER	RESULT	UNITS	MDL*	INST	REF**	METHOD	EXTRACT	ANALYSIS
Total Metals								
Arsenic	ND	mg/L	0.005	HGA	1	7060	——	10/05/89
Barium	ND	mg/L	0.1	AAS	1	7080	——	10/05/89
Cadmium	0.0006	mg/L	0.0005	HGA	1	7131	——	10/05/89
Chromium	ND	mg/L	0.05	AAS	1	7190	——	10/05/89
Lead	0.016	mg/L	0.003	HGA	1	7420	——	10/05/89
Mercury	ND	mg/L	0.0005	CV	1	7470	——	10/05/89
Selenium	ND	mg/L	0.005	HGA	1	7740	——	10/05/89
Silver	ND	mg/L	0.01	AAS	1	7760	——	10/05/89
Volatile Organics **								
Volatile Halocarbons	ND	ug/L	1*	GC/MS	1	8240	——	09/29/89
Volatile Aromatics	ND	ug/L	1*	GC/MS	1	8240	——	09/29/89
PCB	ND	ug/L	2.5	GC	1	8080	——	10/03/89
Pesticides	ND	ug/L	0.25	GC	1	8080	——	10/03/89
Petroleum Scan								
Fuel Oil #2	13	mg/L	0.1	GC	4	——	——	10/05/89

**Note: All compounds were below the detection limits except those listed above.

1* A list of volatile halocarbons, volatile aromatics, PCB's and pesticides analyzed for and their detection limits accompanies this report.

* MDL—Method Detection Limits (same units as the Results)
** REF—Reference as cited on the cover (first) page of this report.

VOLATILE ORGANIC BY GC/MS
Method 624 and 8240

Parameter	Method Detection Limit
Methylene chloride	2.8 ug/L
1,1-Dichloroethane	4.7 ug/L
Chloroform	1.6 ug/L
Carbon tetrachloride	2.8 ug/L
1,2-Dichloropropane	6.0 ug/L
Dibromochloromethane	3.1 ug/L
1,1,2-Trichloroethane	5.0 ug/L
2-Chloroethylvinyl ether	10.0 ug/L
Tetrachloroethene	4.1 ug/L
Chlorobenzene	6.0 ug/L
Trichlorofluoromethane	5.0 ug/L
1,2-Dichloroethane	2.8 ug/L
1,1,1-Trichloroethane	3.8 ug/L
Bromodichloromethane	2.2 ug/L
trans-1,3-Dichloropropene	5.0 ug/L
Cis-1,3-Dichloropropene	5.0 ug/L
Bromoform	4.7 ug/L
1,1,2,2-Tetrachloroethane	6.9 ug/L
Benzene	4.4 ug/L
Toluene	6.0 ug/L
Ethyl benzene	7.2 ug/L
Xylenes	10.0 ug/L
Chloromethane	8.0 ug/L
Bromomethane	7.0 ug/L
Vinyl chloride	6.5 ug/L
Chloroethane	7.5 ug/L
1,1-Dichloroethene	2.8 ug/L
1,2-Dichloroethene	1.6 ug/L
Trichloroethene	1.9 ug/L
1,2-Dichlorobenzene	10.0 ug/L
1,3-Dichlorobenzene	10.0 ug/L
1,4-Dichlorobenzene	10.0 ug/L
Styrene	10.0 ug/L

NOTE: Detection limits in soil and sediment are 50X higher.

POLYCHLORINATED BIPHENYLS

PARAMETER
PCB 1016
Arochlor 1221
Arochlor 1232
Arochlor 1242
Arochlor 1248
Arochlor 1254
Arochlor 1260
Arochlor 1262
Arochlor 1268

Method Detection Limit:

891117.1 MDL = 250 ug/Kg
891117.2 MDL = 2.5 ug/L

PESTICIDE PARAMETER
Alpha BHC
Lindane (gamma BHC)
Beta BHC
Delta BHC
Heptachlor
Alachlor
Aldrin
Atrazine
Heptachlor epoxide
Endrin
Endrin aldehyde
Endrin ketone
Dieldrin
p,p'-DDE
p,p'-DDD
p,p'-DDT
Endosulfan I
Endosulfan II
Endosulfan Sulfate
Methoxychlor
Chlordane
Toxaphene

Method Detection Limit:

891117.1 MDL = 50 ug/Kg

891117.2 MDL = 0.25 ug/L

RECEIVED
OCT 4 1989
3131

ALPHA ANALYTICAL LABORATORIES
55 Access Road
Warwick, Rhode Island 02886-9911
(401) 732-1680
FAX (401) 738-8202

CERTIFICATE OF ANALYSIS

Client: Morrison Geotech Engineering

Job Number: 891066

Address: PO Box 399

Invoice Number: 2102

Waterville, ME 04901

Date In: 09/14/89

Attn: Dale Doughty

Date Reported: 09/27/89

Sample Description: One soil sample, one water sample

REFERENCES:

1. Test Methods for Evaluating Solid Waste: Physical/Chemical Methods. EPA SW-846. 1986.

2. Standard Methods for Examination of Water and Waste Water. APHA-AWWA-WPCF. 16th Edition. 1985.

3. Methods for Chemical Analysis of Water and Wastes. EPA 600/4-82-055. 1982.

4. Oil Spill Identification System. CG-D-52-77 U. S. Coast Guard. 1977.

5. Analysis of PCB's in Transformer Fluid and Waste Oil. EPA 600/4-81-045. 1981.

Authorized by: James R. Roth
James R. Roth, Ph.D. Laboratory Manager

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

Client: Morrison Geotech Engineering

Sample Number: 891066.1

Analysis Requested: Listed below

Date Received: 09/14/89

Date Reported: 09/27/89

Client Ident: B-32A Beth16
Sample Location:
Sample Description: Soil
Sample Container: Glass bottle, vial
Field Prep: None

# of Containers: 2

PARAMETER	RESULT	UNITS	MDL*	INST	REF**	METHOD	EXTRACT	ANALYSIS
PCB	ND	ug/Kg	250	GC	1	8080	——	09/27/89
Pesticides	ND	ug/Kg	50	GC	1	8080	——	09/27/89
Petroleum Scan								
Fuel Oil #2	1,200	mg/Kg	5	GC	4	——	——	09/27/89
Volatile Organics ***								
Volatile Halocarbons	ND	ug/Kg	1*	GC/MS	1	8240	——	09/27/89
Volatile Aromatics	ND	ug/Kg	1*	GC/MS	1	8240	——	09/27/89
Total Metals	——	——	——	——	——	3050	——	09/27/89
Arsenic	0.4	mg/Kg	0.2	HGA	1	7060	——	09/27/89
Barium	13	mg/Kg	5	AAS	1	7080	——	09/27/89
Cadmium	0.045	mg/Kg	0.02	AAS	1	7131	——	09/27/89
Chromium	4	mg/Kg	2	AAS	1	7190	——	09/27/89
Lead	18.9	mg/Kg	0.2	AAS	1	7421	——	09/27/89
Mercury	ND	mg/Kg	0.02	CV	1	7471	——	09/27/89
Selenium	ND	mg/Kg	0.2	HGA	1	7740	——	09/27/89
Silver	0.5	mg/Kg	0.5	AAS	1	7760	——	09/27/89

***Note: All compounds were below the detection limits except those listed above.

1* A list of volatile halocarbons and volatile aromatics analyzed for and their detection limits accompanies this report.

* MDL—Method Detection Limits (same units as the Results)
** REF—Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

Client: Morrison Geotech Engineering

Sample Number: 891066.2

Analysis Requested: Volatile Organics (624)

Date Received: 09/14/89

Date Reported: 09/27/89

Client Ident: B-32B Beth 16
Sample Location:
Sample Description: Water
Sample Container: vial
Field Prep: None

# of Containers: 1

PARAMETER	RESULT	UNITS	MDL*	INST	REF**	METHOD	EXTRACT	ANALYSIS
Volatile Organics **								
Volatile Halocarbons	ND	ug/L	1*	GC/MS	1	8240	----	09/19/89
Volatile Aromatics	ND	ug/L	1*	GC/MS	1	8240	----	09/19/89

**Note: All Compounds were below the detection limits except those listed above.

1* A list of volatile halocarbons and volatile aromatics analyzed for and their detection limits accompanies this report.

* MDL—Method Detection Limits (same units as the Results)
** REF—Reference as cited on the cover (first) page of this report.

ALPHA ANALYTICAL LABORATORIES
CERTIFICATE OF ANALYSIS

Client: Morrison Geotech Engineering

Sample Number: 891066.1& .2

Analysis Requested: Volatile Organics (624) (Surrogate Recovery)

Date Received: 09/14/89

Date Reported: 09/27/89

Client Ident: 891066.1 & 891066.2
Sample Location:
Sample Description: Soil & Water
Sample Container: vials
Field Prep: None

# of Containers: 2

COMPOUNDS	891066.1	891066.2
1,2-Dichloroethane-d4	111%	109%
Toluene-d8	110%	98%
4-Bromofluorobenzene	107%	99%

* MDL—Method Detection Limits (same units as the Results)
** REF—Reference as cited on the cover (first) page of this report.

POLYCHLORINATED BIPHENYLS

PARAMETER

PCB 1016
Arochlor 1221
Arochlor 1232
Arochlor 1242
Arochlor 1248
Arochlor 1254
Arochlor 1260
Arochlor 1262
Arochlor 1268

Method Detection Limit: 250 ug/Kg

PESTICIDE

PARAMETER

Alpha BHC
Lindane (gamma BHC)
Beta BHC
Delta BHC
Heptachlor
Alachlor
Aldrin
Atrazine
Heptachlor epoxide
Endrin
Endrin aldehyde
Endrin ketone
Dieldrin
p,p'-DDE
p,p'-DDD
p,p'-DDT
Endosulfan I
Endosulfan II
Endosulfan sulfate
Methoxychlor
Chlordane
Toxaphene

Method Detection Limit: 50 ug/Kg

VOLATILE ORGANIC by GC/MS
Method 624 and 8240

PARAMETER	METHOD DETECTION LIMIT
Methylene chloride	2.8 ug/L
1,1-Dichloroethane	4.7 ug/L
Chloroform	1.6 ug/L
Carbon tetrachloride	2.8 ug/L
1,2-Dichloropropane	6.0 ug/L
Dibromochloromethane	3.1 ug/L
1,1,2-Trichloroethane	5.0 ug/L
2-Chloroethylvinyl ether	10.0 ug/L
Tetrachloroethene	4.1 ug/L
Chlorobenzene	6.0 ug/L
Trichlorofluoromethane	5.0 ug/L
1,2-Dichloroethane	2.8 ug/L
1,1,1-Trichloroethane	3.8 ug/L
Bromodichloromethane	2.2 ug/L
trans-1,3-Dichloropropene	5.0 ug/L
Cis-1,3-Dichloropropene	5.0 ug/L
Bromoform	4.7 ug/L
1,1,2,2-Tetrachloroethane	6.9 ug/L
Benzene	4.4 ug/L
Toluene	6.0 ug/L
Ethyl benzene	7.2 ug/L
Xylenes	10.0 ug/L
Chloromethane	8.0 ug/L
Bromomethane	7.0 ug/L
Vinyl chloride	6.5 ug/L
Chloroethane	7.5 ug/L
1,1-Dichloroethene	2.8 ug/L
1,2-Dichloroethene	1.6 ug/L
Trichloroethene	1.9 ug/L
1,2-Dichlorobenzene	10.0 ug/L
1,3-Dichlorobenzene	10.0 ug/L
1,4-Dichlorobenzene	10.0 ug/L
Styrene	10.0 ug/L

NOTE: Detection limits in soil and sediment are 50X higher.
Detection limits are 2X higher in 891066.2

LABORATORY RESOURCES, INC.

EASTERN SCIENTIFIC DIVISION
RTE 205 THE REGIONAL BLDG.
P.O. BOX 700
BROOKLYN, CT 06234
TEL.-(203)774-6814 FAX-(203)774-2689

Report to:
FACILITIES SUPPORT CNTR. MAN.
BOX 400 CODE 805
NAVAL SUB BASE NEW LONDON
GROTON, CT 06349-5400

Page: 1

Work ID: 9142770BS SOIL FROM TRENCH
NORTH SIDE BLDG. 157
Sample #: E110039
Line Items#: 0001BJ, 0001BY
te Received: 09/30/91
PO Number: N62472-89-D-3466

alysis rformed	Results	Detection Limits	Date of Analysis	Method of Analysis
mple ID: 9142770BS SOIL FROM TRENCH RTH SIDE BLDG. 157		Date Collected: 09/11/91		
H (mg/kg)	490	5	10/02/91	EPA 418.1
SENIC (TCLP)	0.7	0.2	10/02/91	EPA 6010
RIUM (TCLP)	2.00	0.005	10/02/91	EPA 6010
OMIUM (TCLP)	0.51	0.005	10/02/91	EPA 6010
ROMIUM (TCLP)	ND	0.05	10/02/91	EPA 6010
D (TCLP)	245	0.05	10/02/91	EPA 6010
RCURY (TCLP)	ND	0.0005	10/02/91	EPA 7470
LENIUM (TCLP)	0.2	0.2	10/02/91	EPA 6010
LVER (TCLP)	ND	0.05	10/02/91	EPA 6010

All measurements are in mg/l unless otherwise specified
ND = None Detected/Below stated detection limit

Report is an accurate analysis of sample received at this laboratory.

Robert LaFerriere 10/18/91

T.F. McCommas, Director Date
Robert LaFerriere, Tech. Lab. Director
CT Laboratory PH 0465

(203) 774-6814

CT LABORATORY PH #0465

LABORATORY RESOURCES, INC.
EASTERN SCIENTIFIC DIV.
P.O. BOX 700
BROOKLYN, CT 06234

REPORT TO:
FACILITIES SUPPORT CNTR. MAN.
BOX 400 CODE 805
NAVAL SUB BASE NEW LONDON
GROTON, CT. 06349-5400

SOIL FROM TRENCH NORTH SIDE
SOURCE OF SAMPLE: 9142770BS
BLDG. 157
LINE ITEM:0001BS
SAMPLE #:E1-10-039

TYPE OF SUPPLY: SOLIDS

DATE/TIME COLLECTED: 09/11/91
RECEIVED: 09/30/91

PO #:N62472-89-D-3466

PCBs — METHOD SW-846 8080

PARAMETERS	RESULTS (UG/KG)	DETECTION LIMITS (UG/KG)
AROCLOR		
PCB-1016	ND	100
PCB-1221	ND	100
PCB-1232	ND	100
PCB-1242	ND	100
PCB-1248	ND	100
PCB-1254	ND	100
PCB-1260	ND	100
PCB-1262	ND	100

% SURROGATE RECOVERY

DBC - 110%

ND=NONE DETECTED

DATE OF ANALYSIS: 10/05/91

REPORT IS AN ACCURATE ANALYSIS OF SAMPLE RECEIVED IN THIS LABORATORY.

Robert Laferriere 10/11/91

T.F. McCOMMAS, DIRECTOR DATE
ROBERT LAFERRIERE, TECHNICAL LAB. DIRECTOR

FM/PCB8080/KP
0391A

(203) 774-6814

LABORATORY PH 0465

LABORATORY RESOURCES, INC.
EASTERN SCIENTIFIC DIV.
P.O. BOX 700
BROOKLYN, CT 06234

SOIL FROM TRENCH NORTH SIDE BLDG. 157
SOURCE OF SAMPLE: 9142770BS
LINE ITEM:0001BS
SAMPLE #:E1-10-039

REPORT TO:
FACILITIES SUPPORT CNTR. MAN.
BOX 400 CODE 805
NAVAL SUB BASE NEW LONDON
GROTON, CT. 06349-5400
PO #:N62472-89-D-3466

DATE/TIME COLLECTED: 09/11/91
RECEIVED: 09/30/91

HALOGENATED VOLATILE ORGANICS — METHOD 8010

PARAMETER	RESULTS(UG/KG)	SWA 846 3RD EDITION DETECTION LIMITS(UG/KG)
BENZYL CHLORIDE	ND	10
BROMOBENZENE	ND	10
BROMODICHLOROMETHANE	ND	10
BROMOFORM	ND	10
BROMOMETHANE	ND	10
CARBON TETRACHLORIDE	ND	10
CHLOROBENZENE	ND	10
CHLOROETHANE	ND	10
CHLOROFORM	ND	10
2-CHLOROETHYL VINYL ETHER	ND	10
CHLOROMETHANE	ND	10
DIBROMOCHLORMETHANE	ND	10
DIBROMOMETHANE	ND	10
1,2-DICHLOROBENZENE	ND	10
1,3-DICHLOROBENZENE	ND	10
1,4-DICHLOROBENZENE	ND	10
DICHLORODIFLUOROMETHANE	ND	10
1,1-DICHLOROETHANE	ND	10
1,2-DICHLOROETHANE	ND	10
1,1-DICHLOROETHYLENE	ND	10
TRANS-1,2-DICHLOROETHYLENE	ND	10
DICHLOROMETHANE	ND	10
1,2-DICHLOROPROPANE	ND	10
TRANS-1,3-DICHLOROPROPENE	ND	10
1,1,2,2-TETRACHLOROETHANE	ND	10
1,1,1,2-TETRACHLOROETHANE	ND	10
TETRACHLOROETHYLENE	ND	10
1,1,1-TRICHLOROETHANE	ND	10
1,1,2-TRICHLOROETHANE	ND	10
TRICHLOROETHYLENE	1,100	10
TRICHLOROFLUOROMETHANE	ND	10
1,2,3-TRICHLOROPROPANE	ND	10
VINYL CHLORIDE	ND	10
CIS-1,3-DICHLOROPROPENE	ND	10

AROMATIC VOLATILE ORGANICS — METHOD 8020

BENZENE	ND	10
TOLUENE	ND	10
ETHYL-BENZENE	ND	10
TOTAL XYLENES	ND	10
TOTAL DICHLOROBENZENE	ND	10
CHLOROBENZENE	ND	10
MTBE	ND	10

% SURROGATE RECOVERY

1-CHLORO-2-FLUOROBENZENE 108%

ND = NONE DETECTED DATE OF ANALYSIS: 10/01/91

REPORT IS AN ACCURATE ANALYSIS OF SAMPLE RECEIVED IN THIS LABORATORY.

Robert Laferriere 10/11/91

T.F. McCOMMAS, DIRECTOR DATE
ROBERT LAFERRIERE, TECHNICAL LAB. DIRECTOR

FM/SC102SO/KP
039A1

(203) 774-6814 CT LABORATORY PH 0465

LABORATORY RESOURCES, INC.
EASTERN SCIENTIFIC DIV.
P.O. BOX 700
BROOKLYN, CT 06234

REPORT TO:
FACILITIES SUPPORT CNTR. MAN.
BOX 400 CODE 805
NAVAL SUB BASE NEW LONDON
GROTON, CT. 06349-5400

SOIL FROM TRENCH NORTH SIDE BLDG. 157
SOURCE OF SAMPLE: 9142770BS
LINE ITEM: 0001BS

SAMPLE #:E1-10-039

TYPE OF SUPPLY: SOLIDS

DATE/TIME COLLECTED: 09/11/91
RECEIVED: 09/30/91

PO #:N62472-89-D-3466

EPA METHOD 8270
PAH'S

ANALYSIS PERFORMED	RESULTS UG/KG	DETECTION LIMITS UG/KG
ACENAPHTHENE	ND	500
ACENAPHTHYLENE	ND	500
ANTHRACENE	ND	500
BENZO(a)ANTHRACENE	ND	500
BENZO(a)PYRENE	ND	500
BENZO(b)FLUROANTHENE	ND	500
BENZO(ghi)PERYLENE	ND	500
BENZO(k)FLUORANTHENE	ND	500
CHRYSENE	ND	500
DIBENZO(a,h)ANTHRACENE	ND	500
FLUORANTHENE	ND	500
INDENO(1,2,3-cd)PYRENE	ND	500
NAPHTHALENE	ND	500
PHENATHRENE	ND	500
PYRENE	ND	500

ND = NONE DETECTED DATE OF ANALYSIS: 10/08/91

THIS IS A CERTIFIED SAMPLE TAKEN BY LAB. PERSONNEL. IF NOTED BELOW.

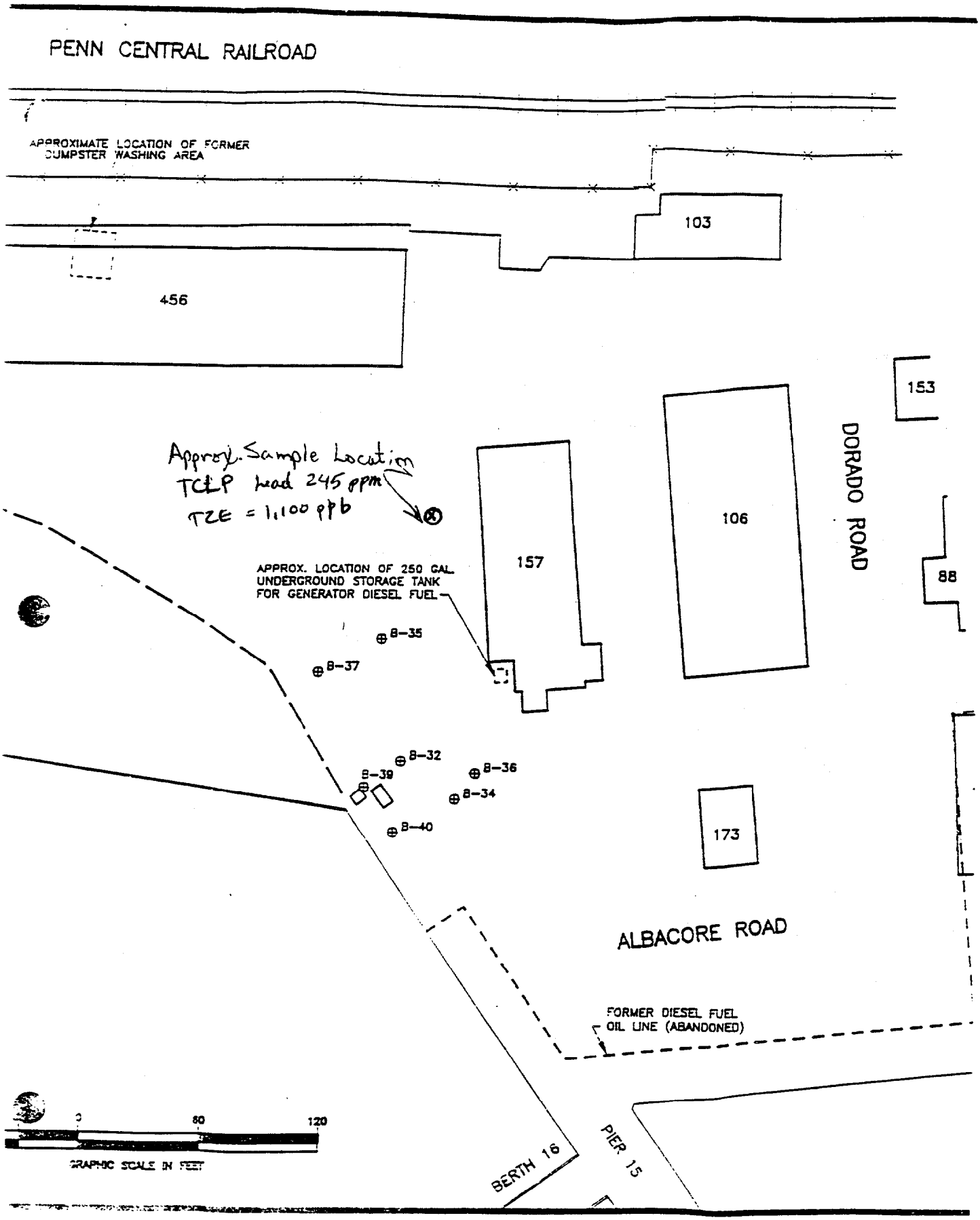
VERIFIED BY:

REPORT IS AN ACCURATE ANALYSIS OF SAMPLE RECEIVED IN THIS LABORATORY

10/11/91

T.F. McCOMMAS, DIRECTOR DATE
ROBERT LAFERRIERE, TECH. LAB. DIRECTOR

FM/8270PAH/KP
00391A


PENN CENTRAL RAILROAD
APPROXIMATE LOCATION OF FORMER DUMPSTER WASHING AREA
103
456
153
Approx. Sample Location
TCLP lead 245 ppm
TZE = 1,100 ppb
106
DORADO ROAD
157
88
APPROX. LOCATION OF 250 GAL. UNDERGROUND STORAGE TANK FOR GENERATOR DIESEL FUEL
B-35
B-37
B-32
B-39
B-36
B-34
B-40
173
ALBACORE ROAD
FORMER DIESEL FUEL OIL LINE (ABANDONED)
0
60
120
GRAPHIC SCALE IN FEET
BERTH 16
PIER 15

APPENDIX C

EXISTING BORING LOGS

LOG OF EXPLORATIONS

Hole No. **B–17**

Contractor: Clarence Welti Associates
Driller: Don Moodie
Type of Drill: Barge
Size & Type of Casing: 3"
Drilling Fluid: none
Other:

Project: Oakpoint Associates
No. 3131 Observer: Julie M. Churchill
Location:
Elevation: 0.00
Date Start: 8/31/89 Complete: 8/31/89
Weather:

FIELD DATA									LAB DATA	
DEPTH	ELEV	PROFILE	SAMPLE EQ TEST	SAMPLE TYPE & #	SAMPLE LENGTH	PENE-TRATION RESIST-TANCE PER 6"	RECOVERY FT. OR %	Field Description	Engineering Description	Test Data
								water		
20.0	-20.0									
22.0	-22.0			S-1	2.0	1/0/1/3	1.4	Organic silt, trace gravel, saturated, black, medium stiff, OL/OH	MH:Sandy elastic silt, subangular, hard, and durable, with shells	W, G, D, e, AL, GS W/HYDRO
24.5	-24.5			S-2	1.5	4/9/40/50	.9	Sand, f–c, trace gravel, trace silt, saturated, black, very dense, SP	SM:Silty sand, 0.86% organics	W, OC
								Refusal at 24.5'		

Remarks: **Exploration logs were recorded by Clarence Welti Associates, their complete exploration logs are also attached.**

GROUNDWATER DATA

Date	Time	Depth

MGE

Sheet 1 of 1

Hole No **B–17**

CLARENCE WELTI ASSOC., INC. P.O. BOX 397 GLASTONBURY, CONN 06033	CLIENT MORRISON GEOTECHNICAL	PROJECT NAME SUBMARINE BASE LOCATION GROTON, CT

DRILLING PROCEDURES: 2 1., 2., 3., 4.. (Select one or more)

1. HOLLOW STEM AUGER. Diameter
2. DRIVEN CASING. Diameter 3" NW
3. DRILLED CASING. Diameter
4. ROCK CORING. Diameter & type

HOLE NO. B-17 Surface Elevation

GROUND WATER OBSERVATIONS
AT FT AFTER 0 HOURS
AT FT AFTER HOURS

START DATE 8/31/89
FINISH DATE 8/31/89

DEPTH	SAMPLE NO.	BLOWS/6"	DEPTH	A	STRATUM DESCRIPTION + DEPTH	REMARKS
5						
10					WATER	
15						
20						
	1	1-0-1-3	22.0'-24.0'	14"	22.0'	
					BLK.SLUDGE,TR.COBBLES	
25	2	4-9-40-50/0"	25.0'-26.5'	11"	25.5'	
					** 26.5'	
					BOTTOM OF BORING 26.5'	
30					**BLK/GR.FINE-CRS.SAND, TR.GRAVEL & COBBLES & SLUDGE	
35						
40						

LEGEND: Col. A SAMPLE RECOVERY &/OR CORING TIME MINUTES/FT

140lb Wt. x 30" fall on 2" O.D. Sampler

Sample Type	Proportions Used		Cohesionless Density	Cohesive Consistency
D = Dry C = Cored W = Washed	trace	0 to 10%	0-10 Loose	0-4 Soft
UP = Undisturbed Piston	little	10 to 20%	10-30 Med.Dense	4-8 M/Stiff
TP = Test Pit A = Auger V = Vane Test	some	20 to 35%	30-50 Dense	8-15 Stiff
UT = Undisturbed Thinwall	and	35 to 50%	50 + VeryDense	15-30 V-Stiff

Driller: HOODIE
Helper:
Inspector CHURCHILL
Sheet 1 of 1

1 Unless otherwise agreed, ***samples*** will be held by Welti Associates a maximum of 60 days after boring completion
2 ***Water readings*** represent driller observations — not interpretations.

LABORATORY TEST RESULTS

Boring 17, Sample 1

Water Content (ASTM D2216):

Water Content:	88.9

Specific Gravity (ASTM D-854):

Specific Gravity of Soil:	2.633

Dry Unit Weight (See Note 1):

Dry Unit Weight Of Soil:	88.4

Void Ratio (See Note 2):

Void Ratio Of Soil:	0.86

Atterberg Limit (ASTM D-4318):

Liquid Limit:	73.4
Plastic Limit:	49.5
Plasticity Index:	23.9

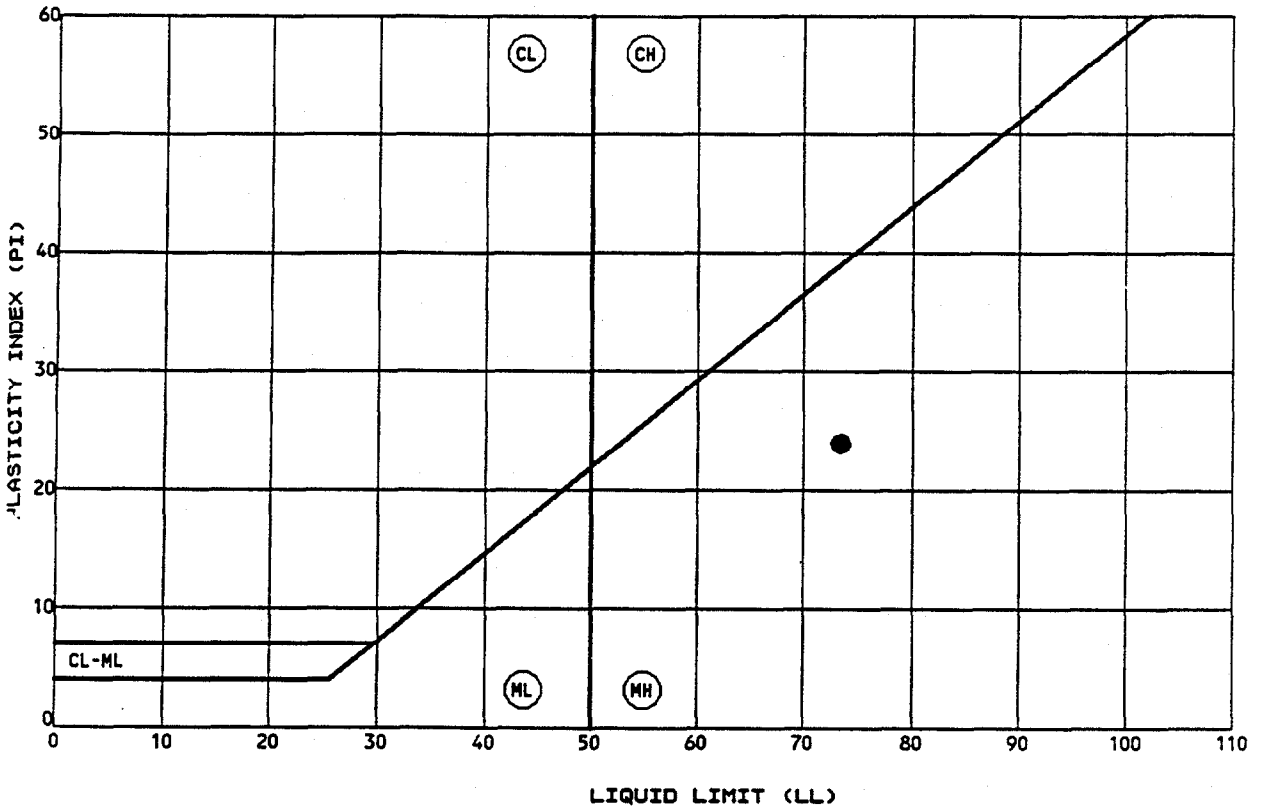
LABORATORY TEST RESULTS

Boring 17, Sample 1 (Con't)

Grain-Size Analysis (ASTM D422 With Hydrometer):

- Gravel, passing 3 inch and retained on No. 4 sieve 13.3%
- Sand, passing No. 4 and retained on No. 200 sieve 29.9%
  - Coarse sand, passing No. 4 and retained on No. 10 sieve 2.4%
  - Medium sand, passing No. 10 and retained on No. 40 sieve 9.0%
  - Fine sand, passing No. 40 and retained on No. 200 sieve 18.5%
- Silt, 0.074 mm (No. 200) to 0.005 mm 49.8%
- Clay, smaller than 0.005 mm 7.0%

ATTERBERG LIMITS' RESULTS



	BORING	DEPTH	LL	PL	PI	FINES	CLASSIFICATION
●	B-17,S1	20.0	73	50	24		

MGE

MORRISON GEOTECHNICAL ENGINEERING

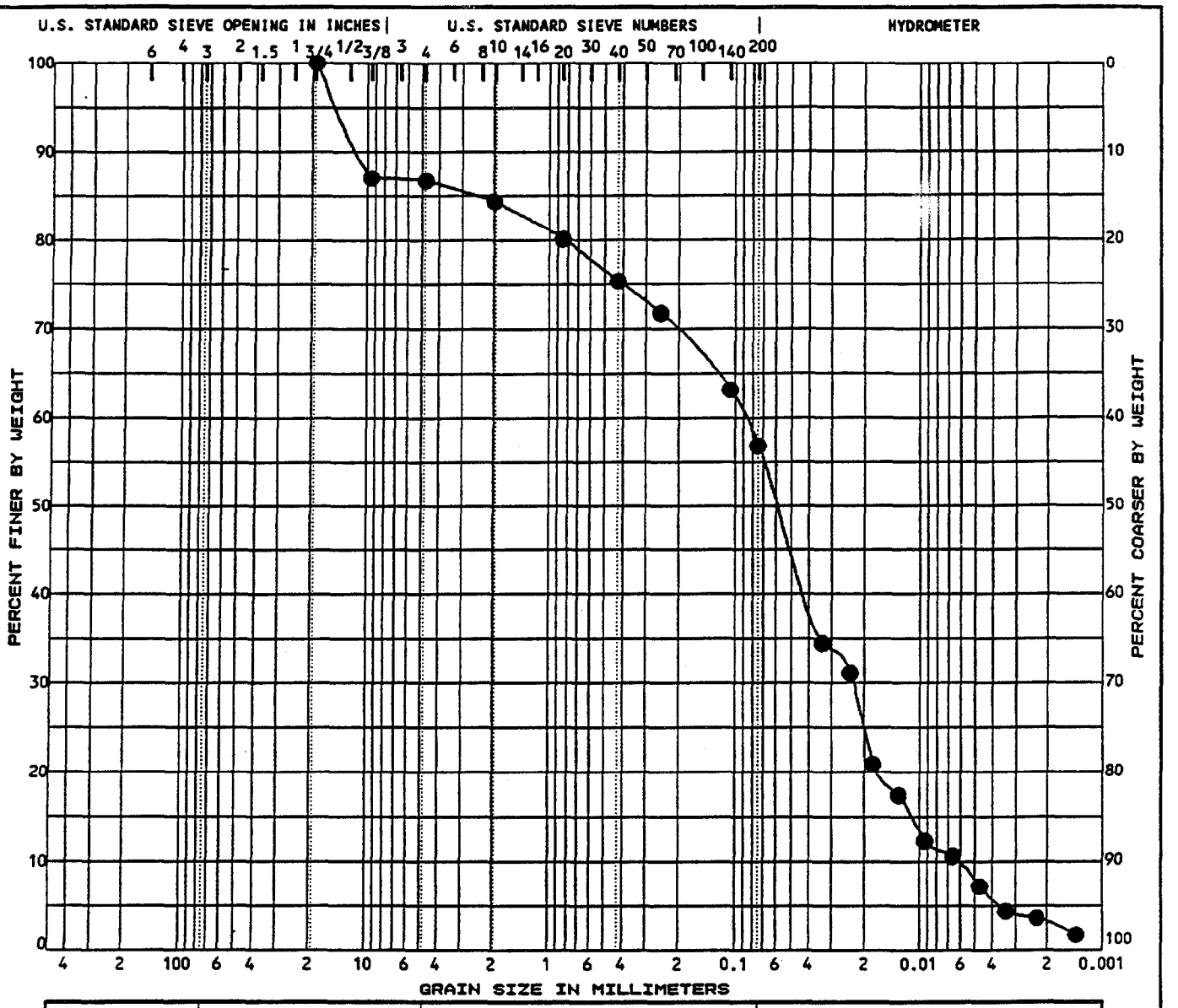
PROJECT NAME:

Oakpoint Associates

JOB NO.: 3131

BORING: B-17,S1

DEPTH: 20.0



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
●	B-17,S1	20.0	Sandy Elastic Silt MH		73	50	24		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-17,S1	20.0	19.00	0.09	0.023	0.0062	13.3	29.9	48.9	7.8

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date November 1989	GRADATION CURVES

LABORATORY TEST RESULTS

Boring 17, Sample 2

Water Content (ASTM D2216):

Water Content:	12.4

Organic Content (ASTM D-2974):

Percent Organic Matter:	0.86

ORGANIC CONTENT

Project Oakpoint Associates Groton, CT, Submarine Base

Source B-17 S-2 Project Number 3131

Date Tested 10-4-89 Tested By TJG

Moisture:

Tare Number	11
A. Weight of Wet Soil + Tare	306.01
B. Weight of Dry Soil + Tare	291.62
C. Weight of Water, Ww = (A-B)	14.39
D. Weight of Tare	175.75
E. Weight of Dry Soil, Ws = (B-D)	115.87
F. Water Content, W = (C/E X 100)	12.4

Ash:

Tare Number	
A. Weight of Dry Soil + Tare	175.38
B. Weight of Tare	59.62
C. Weight of Dry Soil, (A-B)	115.76
D. Weight of Ash + Tare	174.39
E. Weight of Tare	59.63
F. Weight of Ash, (D-E)	114.76
G. Percent Ash, (F/C + 100)	99.14

Organic Matter:

Percent Organic Matter, (100-G)	0.86

Remarks:

LOG OF EXPLORATIONS

Hole No. **B-18**

Contractor: Clarence Welti Associates
Driller: Don Moodie
Type of Drill: Barge
Size & Type of Casing: 4"
Drilling Fluid: none
Other:

Project: Oakpoint Associates
No. 3131 Observer: Julie M. Churchill
Location:
Elevation: 0.00
Date Start: 8/28/89 Complete: 8/28/89
Weather:

FIELD DATA									LAB DATA	
DEPTH	ELEV	PROFILE	SAMPLE EQ TEST	SAMPLE TYPE & #	SAMPLE LENGTH	PENE-TRATION RESIST-TANCE PER 6"	RECOVERY FT. OR %	Field Description	Engineering Description	Test Data
								water		
9.0	-9.0							* Soil		
13.0	-13.0			S-1	10.0		90	Gray biotite granite gneiss		
23.0	-23.0							End of rock core at 23.0'		

GROUNDWATER DATA

Date	Time	Depth

Remarks: **Exploration logs were recorded by Clarence Welti Associates, their complete exploration logs are also attached. * No sample taken**

MGE

Sheet 1 of 1

Hole No **B-18**

Project Abbrev. Submarine Base, Groton
Project No. 3131

Date 8/30/89
Logged by JMC

LOG OF ROCK CORE

Boring No. B-18
Depth of Boring 13'
Size of Core 2.1"
Type of Core Barrel NX

Location Area B
Boring Elev. 0 mean low
Elev. Top of Bedrock -13.0'
Elev. Groundwater

Depth	Run No.	Recovery 90%	RQD %	Graphic Log	Fractures	Lithology
13					Weathered surface Weathered, biotite foliation Weathered break	Gray, biotite granite gneiss
14		4.7/ 5.0	.5			
15	1		.5		Weathered biotite foliation planes Weathered joint/cleavage plane	
16			.7		Mechanical Mechanical	Becoming more felsic, trace biotite
17					Mechanical	
18			.8		Mechanical Mechanical	
19	2	4.3/ 5.0	1.9			
20					Mechanical	Average drilling time 7 min/ft at 300 psi
21			1.3			
22					Mechanical Mechanical Mechanical	
23						

CLARENCE WELTI ASSOC., INC. P.O. BOX 397 GLASTONBURY, CONN 06033	CLIENT MORRISON GEOTECHNICAL	PROJECT NAME SUBMARINE BASE LOCATION GROTON, CT

DRILLING PROCEDURES: 2 1., 2., 3., 4., (Select one or more)

1. HOLLOW STEM AUGER, Diameter
2. DRIVEN CASING, Diameter 4" HW
3. DRILLED CASING, Diameter
4. ROCK CORING, Diameter 2.980 & type NX

HOLE NO. B-18 | Surface Elevation

GROUND WATER OBSERVATIONS
AT FT. AFTER 0 HOURS
AT FT. AFTER HOURS

START DATE 8/28/89
FINISH DATE 8/28/89

DEPTH	SAMPLE NO.	BLOWS/6"	DEPTH	A	STRATUM DESCRIPTION + DEPTH	REMARKS
5					WATER	
					9.0'	
10					BLK.SAND,SLUDGE & COBBLES, TR.GRAVEL	
					13.0'	
					DRILLED ROCK	
15					RUN #1 13.0'-18.0' REC.56"	
					RUN #2 18.0'-23.0' REC.52"	
20						
					23.0'	
25					BOTTOM OF BORING 23.0'	
30						
35						
40						

LEGEND: Col. A SAMPLE RECOVERY &/OR CORING TIME MINUTES/FT

140lb Wt. x 30" fall on 2" O.D. Sampler

Sample Type	Proportions Used	Cohesionless Density	Cohesive Consistency
D = Dry C = Cored W = Washed	trace 0 to 10%	0-10 Loose	0-4 Soft
UP = Undisturbed Piston	little 10 to 20%	10-30 Med Dense	4-8 M/Stiff
TP = Test Pit A = Auger V = Vane Test	some 20 to 35%	30-50 Dense	8-15 Stiff
UT = Undisturbed Thinwall	and 35 to 50%	50 + Very Dense	15-30 V-Stiff

Driller: MOODIE
Helper:
Inspector: CHURCHILL
Sheet 1 of 1

1. Unless otherwise agreed, ***samples*** will be held by Welti Associates a maximum of 60 days after boring completion.
2. ***Water readings*** represent driller observations — not interpretations.

LOG OF EXPLORATIONS

Hole No. **B-19**

Contractor: Clarence Weltl Associates
Driller: Don Moodie
Type of Drill: Barge
Size & Type of Casing: 4"
Drilling Fluid: none
Other:

Project: Oakpoint Associates
No. 3131 Observer: Julie M. Churchill
Location:
Elevation: 0.00
Date Start: 8/30/89 Complete: 8/30/89
Weather:

FIELD DATA									LAB DATA	
DEPTH	ELEV	PROFILE	SAMPLE EQ TEST	SAMPLE TYPE & #	SAMPLE LENGTH	PENE-TRATION RESIST-TANCE PER 6"	RECOVERY FT. OR %	Field Description	Engineering Description	Test Data
								water		
16.0	-16.0									
18.0	-18.0				2.0			* Soil		
					8.0		75	Light gray quartzite		
26.0	-26.0									
								Stopped coring at 26.0', rod broke		

Remarks: **Exploration logs were completed by Clarence Weltl Associates, their complete exploration logs are also attached.**
***No Sample Taken**

GROUNDWATER DATA

Date	Time	Depth

MGE

Sheet 1 of 1

Hole No B-19

Project Abbrev. Submarine Base, Groton
Project No. 3131

Date 8/31/89
Logged by JMC

LOG OF ROCK CORE

Boring No. B-19
Depth of Boring 18'
Size of Core 2.1"
Type of Core Barrel NX

Location Area B
Boring Elev. mean low
Elev. Top of Bedrock -18.0'
Elev. Groundwater

Depth	Run No.	Recovery 75%	RQD %	Graphic Log	Fractures	Lithology
18.0					Weathered surface	Gray quartzite with minor amounts of biotite
					Mechanical break	
	1		.5		Weathered	
19.0		100%	.45		Mechanical break	
20.0			.8		Weathered surface	
21.0	2	22/24	1.8			
22.0		92%			Weathered surface	
			.65		Mechanical	
23.0		37/42			Mechanical	Average drilling time 14 min/ft at 100 - 200 psi
	3		.7		Mechanical	
24.0		88%				
			.6		Mechanical	
25.0						
			.6		Weathered/joint plane 20°	
26.0	4	.5/2.5	.5		Mechanical break	
27.0		20%				
28.0					Lost at 1.5' Mechanical failure w/drilling conditions Competent rock Offshore drilling	

CLARENCE WELTI ASSOC., INC. P.O. BOX 397 GLASTONBURY, CONN 06033	CLIENT MORRISON GEOTECHNICAL	PROJECT NAME SUBMARINE BASE LOCATION GROTON, CT

DRILLING PROCEDURES: 2 & 4 1., 2., 3., 4., (Select one or more)

1. HOLLOW STEM AUGER, Diameter _____
2. DRIVEN CASING, Diameter 4" HW
3. DRILLED CASING, Diameter _____
4. ROCK CORING, Diameter 2.080 & type NX

HOLE NO. B-19 | Surface Elevation _____

GROUND WATER OBSERVATIONS
AT _____ FT AFTER 0 HOURS
AT _____ FT AFTER _____ HOURS

START DATE 8/30/89
FINISH DATE 8/30/89

DEPTH	SAMPLE NO.	BLOWS/6"	DEPTH	A	STRATUM DESCRIPTION + DEPTH	REMARKS
5					WATER	
10						
15					16.0'	
					SLUDGE & SAND, TR. GRAVEL & COBBLES	
				9	18.0'	
				16	CORED: ROCK	
20				14		
				18	RUN #1 18.0'-20.0' REC.24"	
				12	RUN #2 20.0'-22.0' REC.22"	
				17	RUN #3 22.0'-25.5' REC.37"	
				16	RUN #4 25.5'-26.0' REC.5"	
25				10/6		
				14/6	26.0'	
					BOTTOM OF BORING 26.0'	
30						
35						
40						

LEGEND: Col. A SAMPLE RECOVERY &/OR CORING TIME MINUTES/FT

140lb Wt. x 30" fall on 2" O.D. Sampler

Sample Type	Proportions Used	Cohesionless Density	Cohesive Consistency
D = Dry C = Cored W = Washed	trace 0 to 10%	0-10 Loose	0-4 Soft
UP = Undisturbed Piston	little 10 to 20%	10-30 Med.Dense	4-8 M/Stiff
TP = Test Pit A = Auger V = Vane Test	some 20 to 35%	30-50 Dense	8-15 Stiff
UT = Undisturbed Thinwall	and 35 to 50%	50 + VeryDense	15-30 V-Stiff

Driller: MOODIE
Helper: _____
Inspector: CHURCHILL
Sheet 1 of 1

1. Unless otherwise agreed, ***samples*** will be held by Welti Associates a maximum of 60 days after boring completion
2. ***Water readings*** represent driller observations — not interpretations.

LOG OF EXPLORATIONS

Hole No. **B-20**

Contractor: Clarence Welti Associates
Driller: Dave Bromley
Type of Drill: Truck Mounted
Size & Type of Casing: 4"
Drilling Fluid: none
Other:

Project: Oakpoint Associates
No. 3131 Observer: Julie M. Churchill
Location:
Elevation: 8.00
Date Start: 8/29/89 Complete: 8/29/89
Weather:

FIELD DATA									LAB DATA	
DEPTH	ELEV	PROFILE	SAMPLE EQ TEST	SAMPLE TYPE & #	SAMPLE LENGTH	PENE-TRATION RESIST-TANCE PER 6"	RECOVERY FT. OR %	Field Description	Engineering Description	Test Data
								Quaywall		
8.0	0.0									
				S-1	2.0	13/14/26/	25	Gravel, little sand, f-c, little silt, saturated, brown, very dense, GM	GP-GM:Poorly graded gravel with silt and sand, subangular,hard, and durable	GS
13.0	-5.0				10.0		100	Pink-gray biotite granite gneiss		
23.0	-15.0							End of rock core at 23.0'		

GROUNDWATER DATA

Date	Time	Depth
8/29/89	1:30 pm	7.0

Remarks:

MGE

Sheet 1 of 1

Hole No **B-20**

Project Abbrev. Submarine Base, Groton
Project No. 3131

Date 8/29/89
Logged by JMC

LOG OF ROCK CORE

Boring No. B-20
Depth of Boring 13'
Size of Core 2.1"
Type of Core Barrel NX

Location Area B
Boring Elev. +7.72
Elev. Top of Bedrock -5.28
Elev. Groundwater

Depth	Run No.	Recovery %	RQD %	Graphic Log	Fractures	Lithology
		100				
13.0					Weathered surface	Pink biotite granite gneiss
			.9		Weathered break	
14.0		5.0			Mechanical break	
			.5		Weathered break along joint 20°	
15.0	1					
16.0			1.3		Weathered break along joint 20°	Becoming gray
17.0					Biotitic weathering	
			1.8			Secondary crystal growth along weathered fractures
18.0						
			.4		Weatheredjoint plane fracture 15°	
19.0			.35		Weathered	
					Weathered	
			.7		Weathered	
20.0	2	5.0			Mechanical	Average drilling time 8 min/ft at 300 psi
					Mechanical	
21.0			1.2			
					Mechanical	
					Weathered	
22.0			.6		Foliation/weathered biotitic	
23.0			1.0			

CLARENCE WELTI ASSOC., INC. P.O. BOX 397 GLASTONBURY, CONN 06033	CLIENT MORRISON GEOTECHNICAL	PROJECT NAME SUBMARINE BASE LOCATION GROTON, CT

DRILLING PROCEDURES: ~~3 & 4~~ 1., 2., 3., 4., (Select one or more)

1. HOLLOW STEM AUGER. Diameter _____
2. DRIVEN CASING. Diameter 4" HW
3. DRILLED CASING. Diameter _____
4. ROCK CORING. Diameter ~~2.980~~ & type ~~NX~~

HOLE NO. B-20 | Surface Elevation _____

GROUND WATER OBSERVATIONS
AT ____ FT AFTER 0 HOURS
AT ____ FT AFTER ____ HOURS

START DATE 8/29/89
FINISH DATE 8/28/89

DEPTH	SAMPLE NO.	BLOWS/6"	DEPTH	A	STRATUM DESCRIPTION + DEPTH	REMARKS
					TOP OF CONCRETE WALL	
5					7.0'	
	1	13-14-26-29	8.0'-10.0'	8"	WATER 8.0'	
10					GR/BR.FINE-CRS.SAND & GRAVEL, SOME SHELLS & ORGANIC SILT	
		60/0"	13.0'	0	13.0'	
				8	CORED:GR.GRANITE GNEISS & QUARTZ	
15				8		
				8	RUN #1 13.0'-18.0' REC.60"	
				9	(MODERATELY FRACTURED)	
				8		
				8	RUN #2 18.0'-23.0' REC.60"	
20				8	(MODERATELY FRACTURED)	
				8		
				8		
				8	23.0'	
25					BOTTOM OF BORING 23.0'	
					NOTE: NO WATER READING @ 0 HRS.	
30						
35						
40						

LEGEND: Col. A SAMPLE RECOVERY &/OR CORING TIME MINUTES/FT

140lb Wt. x 30" fall on 2" O.D. Sampler

Sample Type	Proportions Used		Cohesionless Density	Cohesive Consistency
D = Dry C = Cored W = Washed	trace	0 to 10%	0-10 Loose	0-4 Soft
UP = Undisturbed Piston	little	10 to 20%	10-30 Med.Dense	4-8 M/Stiff
TP = Test Pit A = Auger V = Vane Test	some	20 to 35%	30-50 Dense	8-15 Stiff
UT = Undisturbed Thinwall	and	35 to 50%	50 + VeryDense	15-30 V-Stiff

Driller: BROMLEY
Helper: _____
Inspector: _____
Sheet 1 of 1

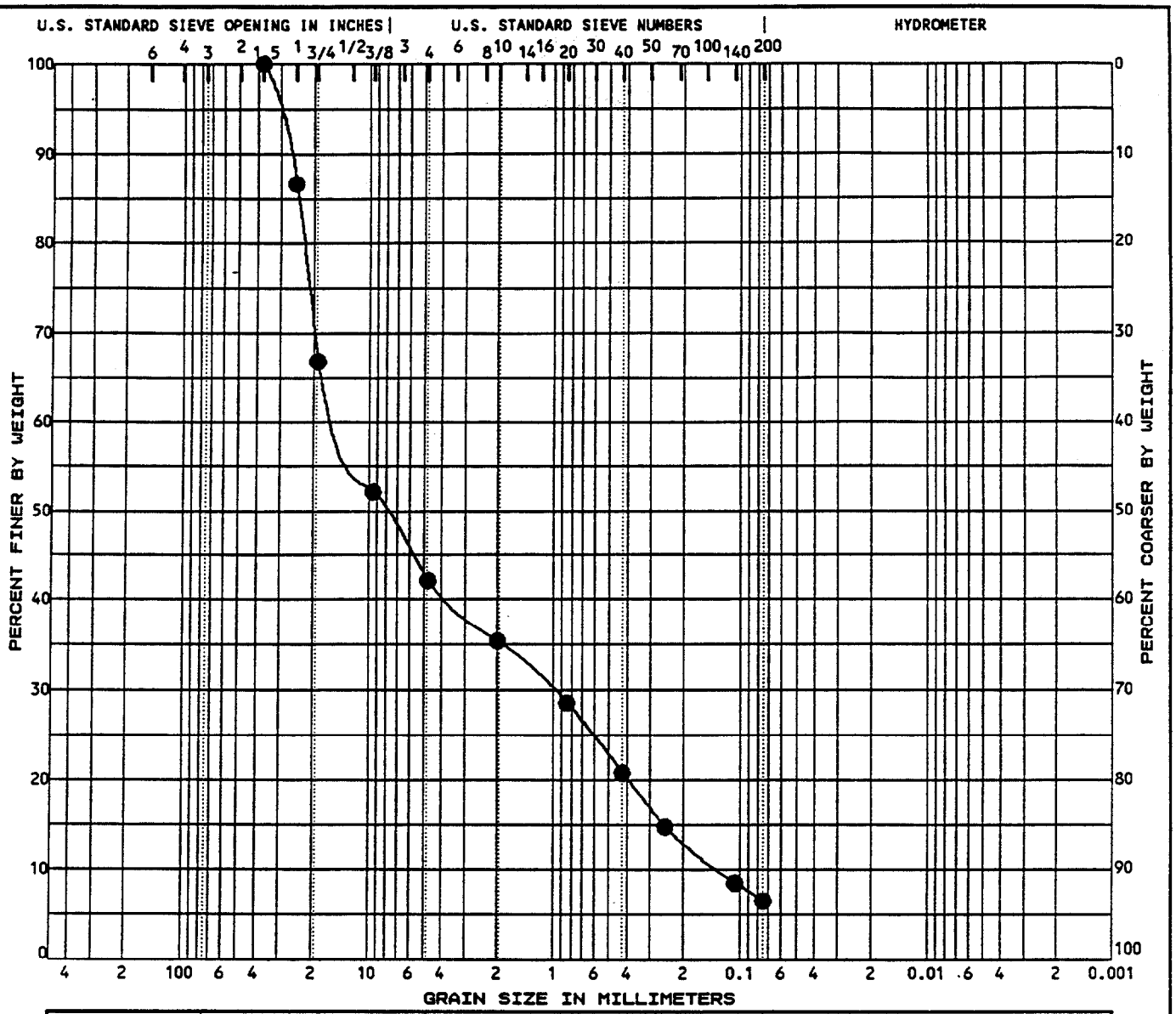
1. Unless otherwise agreed, ***samples*** will be held by Welti Associates a maximum of 60 days after boring completion.
2. ***Water readings*** represent driller observations — not interpretations.

LABORATORY TEST RESULTS

Boring 20, Sample 1

Gradation (ASTM D-422):

Sieve Size	Percent Passing Sieve By Weight	
	Sample	Specification
1 1/2"	100	
1"	86.7	
3/4"	66.8	
3/8"	52.1	
No. 4	42.1	
No. 10	35.4	
No. 20	28.6	
No. 40	20.8	
No. 60	14.8	
No. 140	8.5	
No. 200	6.5	



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
●	B-20,S1	8.0	Poorly Graded Gravel with Silt and Sand GP-GM		NP	NP	NP	0.57	106.0

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-20,S1	8.0	37.50	13.79	1.014	0.1300	57.9	35.6	6.5	

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date October 1989	GRADATION CURVES

LOG OF EXPLORATIONS

Hole No. **B-21**

Contractor: Clarence Welti Associates
Driller: Dave Bromley
Type of Drill: Truck Mounted
Size & Type of Casing: 4"
Drilling Fluid: none
Other:

Project: Oakpoint Associates
No. 3131 Observer: Julie M. Churchill
Location:
Elevation: 8.00
Date Start: 9/6/89 Complete: 9/6/89
Weather:

FIELD DATA										LAB DATA	
DEPTH	ELEV	PROFILE	SAMPLE EQ TEST	SAMPLE TYPE & #	SAMPLE LENGTH	PENE-TRATION RESIST-TANCE PER 6"	RECOVERY FT. OR %	Field Description		Engineering Description	Test Data
								Quaywall			
8.0	0.0										
				S-1	1.5	7/7/6	67	Gravel and sand, f-c, little silt, little shells, saturated with petroleum, brown, medium dense, SM		SP:Poorly graded snad with gravel, rounded, hard, and durable,1.81% organics	OC
12.5	-4.5			S-2	1.5	6/6/8	67			SP:Poorly graded sand with gravel, subangular, hard, and durable	GS
					10.0		95				
								Gray fine grained, biotite granitic gneiss			
22.5	-14.5							End of rock core at 22.5'			

Remarks:

GROUNDWATER DATA

Date	Time	Depth
9/6/89		.5'

MGE

Sheet 1 of 1

Hole No B-21

Project Abbrev. Submarine Base, Groton
Project No. 3131

Date 9/6/89
Logged by JMC

LOG OF ROCK CORE

Boring No. B-21
Depth of Boring
Size of Core 2.1"
Type of Core Barrel NX

Location Area B
Boring Elev. +8.0'
Elev. Top of Bedrock -4.5'
Elev. Groundwater

Depth	Run No.	Recovery 95%	RQD %	Graphic Log	Fractures	Lithology
12.5					Weathered surface Mechanical break	Gray, fine grained biotite granite gneiss
13.5			1.0		Mechanical	
14.5	1					
15.5			3.2			
16.5						
17.5					Mechanical break Mechanical	
			.8			
18.5					Weathered	
			.85			
19.5	2				Weathered	biotitic
20.5			3.05			
21.5						biotitic
22.5					Mechanical Mechanical	Average drilling time 6 min/ft at 300 psi

CLARENCE WELTI ASSOC., INC. P.O. BOX 397 GLASTONBURY, CONN 06033	CLIENT MORRISON GEOTECHNICAL	PROJECT NAME SUBMARINE BASE LOCATION GROTON, CT

DRILLING PROCEDURES: 2 & 4 1., 2., 3., 4., (Select one or more)

1. HOLLOW STEM AUGER, Diameter _____
2. DRIVEN CASING, Diameter 4" HW
3. DRILLED CASING, Diameter _____
4. ROCK CORING, Diameter 2.980 & type NX

HOLE NO. B-21 Surface Elevation _____

GROUND WATER OBSERVATIONS
AT _____ FT AFTER 0 HOURS
AT _____ FT AFTER _____ HOURS

START DATE 9/6/89
FINISH DATE 9/6/89

DEPTH	SAMPLE NO.	BLOWS/6"	DEPTH	A	STRATUM DESCRIPTION + DEPTH	REMARKS
					TOP OF CONCRETE WALL	
5						
	1	7-7-6	8.0'-9.5'	12"	8.0'	
10	2	6-6-8	10.0'-11.5'	12"		
					GR/BR.FINE-CRS.SAND & GRAVEL,	
					OIL SOAKED,TR.SILT & COBBLES	
				8	12.5'	
				8	CORED: GR.QUARTZ & GRANITE GNEISS	
15				8		
				6	RUN # 1 12.5'-17.5' REC.54"	
				6	(SOLID)	
				6		
				5	RUN #2 17.5'-22.5' REC.60"	
20				5	(SOLID)	
				5		
				5		
					22.5'	
25					BOTTOM OF BORING 22.5'	
					NO WATER READING @ COMPLETION OF BORING	
30						
35						
40						

LEGEND: Col. A SAMPLE RECOVERY &/OR CORING TIME MINUTES/FT

140lb Wt. x 30" fall on 2" O.D. Sampler

Sample Type	Proportions Used		Cohesionless Density	Cohesive Consistency
D = Dry C = Cored W = Washed	trace	0 to 10%	0-10 Loose	0-4 Soft
UP = Undisturbed Piston	little	10 to 20%	10-30 Med.Dense	4-8 M/Stiff
TP = Test Pit A = Auger V = Vane Test	some	20 to 35%	30-50 Dense	8-15 Stiff
UT = Undisturbed Thinwall	and	35 to 50%	50 + Very Dense	15-30 V-Stiff

Driller: BROMLEY
Helper: _____
Inspector CHURCHILL
Sheet 1 of 1

1 Unless otherwise agreed, ***samples*** will be held by Welti Associates a maximum of 60 days after boring completion.
2 ***Water readings*** represent driller observations — not interpretations.

LABORATORY TEST RESULTS

Boring 21, Sample 1

Organic Content (ASTM D-2974):

Percent Organic Matter:	1.81

ORGANIC CONTENT

Project Oakpoint Associates Groton, CT, Submarine Base

Source B-21 S-1 Project Number 3131

Date Tested 10-6-89 Tested By BH

Moisture:

Tare Number	
A. Weight of Wet Soil + Tare	
B. Weight of Dry Soil + Tare	
C. Weight of Water, Ww = (A-B)	
D. Weight of Tare	
E. Weight of Dry Soil, Ws = (B-D)	
F. Water Content, W = (C/E X 100)	

Ash:

Tare Number	D
A. Weight of Dry Soil + Tare	139.09
B. Weight of Tare	57.93
C. Weight of Dry Soil, (A-B)	81.16
D. Weight of Ash + Tare	137.62
E. Weight of Tare	57.93
F. Weight of Ash, (D-E)	79.69
G. Percent Ash, (F/C + 100)	98.19

Organic Matter:

Percent Organic Matter, (100-G)	1.81

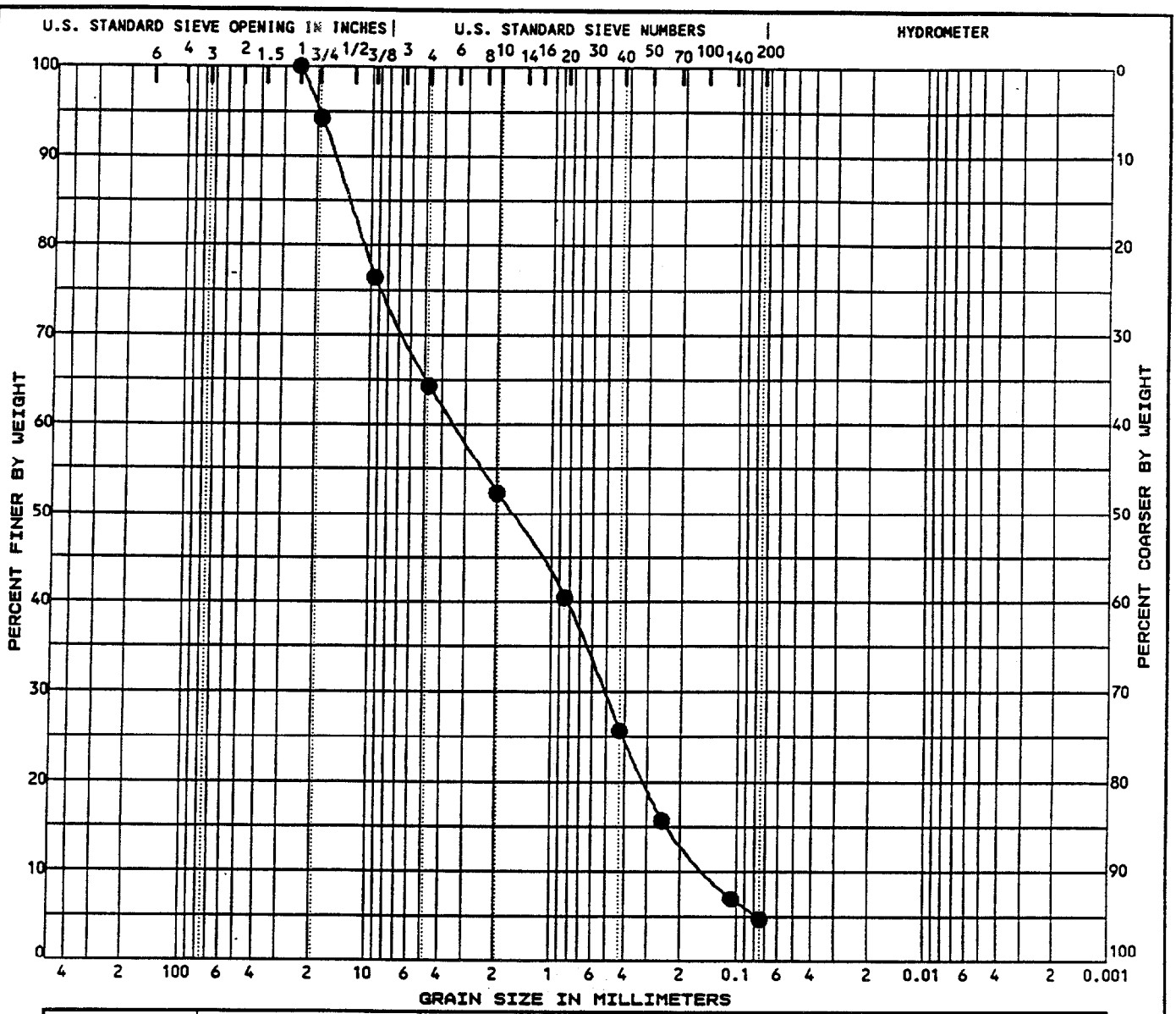
Remarks:

LABORATORY TEST RESULTS

Boring 21, Sample 2

Gradation (ASTM D-422):

Sieve Size	Percent Passing Sieve By Weight: Sample	Specification
1"	100	
3/4"	94.3	
3/8"	76.4	
No. 4	64.3	
No. 10	52.3	
No. 20	40.5	
No. 40	25.7	
No. 60	15.7	
No. 140	7.0	
No. 200	4.7	



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
●	B-21,S2	10.0	Poorly Graded Sand with Silt and Gravel SP-SM		NP	NP	NP	0.54	24.5

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-21,S2	10.0	25.00	3.48	0.520	0.1425	35.7	59.6	4.7	

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date October 1989	GRADATION CURVES

LOG OF EXPLORATIONS

Hole No. **B–22**

Contractor: Clarence Welti Associates
Driller: Dave Bromley
Type of Drill: Truck Mounted
Size & Type of Casing: 4"
Drilling Fluid: none
Other:

Project: Oakpoint Associates
No. 3131 Observer: Julie M. Churchill
Location:
Elevation: 8.00
Date Start: 9/6/89 Complete: 9/6/89
Weather:

FIELD DATA									LAB DATA	
DEPTH	ELEV	PROFILE	SAMPLE EQ TEST	SAMPLE TYPE & #	SAMPLE LENGTH	PENE-TRATION RESIST-TANCE PER 6"	RECOVERY FT. OR %	Field Description	Engineering Description	Test Data
								Quaywall		
8.0	0.0									
				S-1	1.5	6/6/6	73	Sand, f-c, some gravel, little silt, saturated, brown, medium dense, SM	GW-GM:Well graded gravel with silt and sand, subangular, mostlyhard, and durable	W, G, D, e, GS W/HYDRO, DS
16.0	-8.0			S-2	1.5	4/10/41	47		SP:Poorly graded sand with gravel, subangular, hard, and durable	
					10.0		100	Dark gray biotite schist grading into a gray biotite granite gneiss at 13.0'		UR
26.0	-18.0							End of rock core at 26.0'		

Remarks:

GROUNDWATER DATA

Date	Time	Depth
9/6/89		6.0

MGE

Sheet 1 of 1

Hole No **B–22**

Project Abbrev. Submarine Base, Groton
Project No. 3131

Date 9/7/89
Logged by JMC

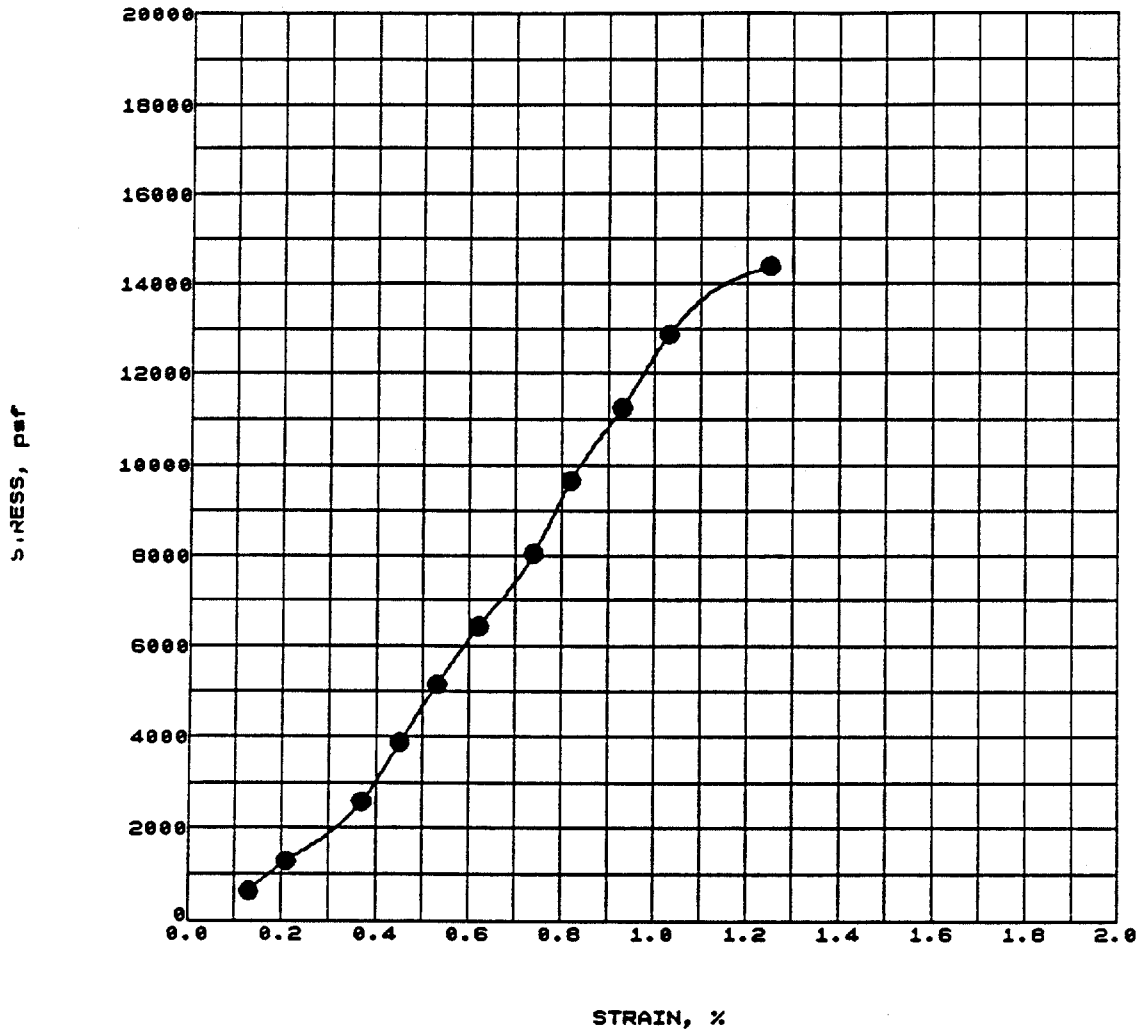
LOG OF ROCK CORE

Boring No. B-22
Depth of Boring 16'
Size of Core 2.1"
Type of Core Barrel NX

Location Area B
Boring Elev. +8.0'
Elev. Top of Bedrock -8.0'
Elev. Groundwater

Depth	Run No.	Recovery % 100	RQD %	Graphic Log	Fractures	Lithology
16.0					Weathered surface	Dark gray biotite schist grading into a gray biotite granite gneiss with biotite stringers, banding and pods
			.4		Weathered cleavage	
17.0						
			.5		Fracture 45°	
18.0					Weathered breaks	
	1					
19.0			.85		Weathered	
			.8		Weathered breaks	
20.0					Mechanical	
			.5			
			.4		Mechanical	
21.0			.35		Mechanical	gneissic
22.0						
	2					
23.0			3.6			Average drilling time 3 min/ft at 300 psi
24.0						
					Mechanical breaks	
25.0					Fracture plane 55° along biotite	
					Mechanical	
26.0			1.0		Mechanical	

Unconfined Compression on Rock



Strength, psi: 14,390

MORRISON GEOTECHNICAL ENGINEERING

Project Name:

Oakpoint Associates

Job No. : 3131

Boring : B-22

Depth : 17.0'

CLARENCE WELTI ASSOC., INC. P.O. BOX 397 GLASTONBURY, CONN 06033	CLIENT MORRISON GEOTECHNICAL	PROJECT NAME SUBMARINE BASE LOCATION GROTON, CT

DRILLING PROCEDURES: 2 & 4 1., 2., 3., 4., (Select one or more)

1. HOLLOW STEM AUGER. Diameter
2. DRIVEN CASING. Diameter 4" HW
3. DRILLED CASING. Diameter
4. ROCK CORING. Diameter 2.980 & type NX

HOLE NO. B-22 Surface Elevation

GROUND WATER OBSERVATIONS
AT FT AFTER 0 HOURS
AT FT AFTER HOURS

START DATE 9/6/89
FINISH DATE 9/6/89

DEPTH	SAMPLE NO.	BLOWS/6"	DEPTH	A	STRATUM DESCRIPTION + DEPTH	REMARKS
					TOP OF CONCRETE WALL	
5						
					6.0'	
					WATER	
					8.0'	
	1	6-6-6	9.0'-10.5'	13"		
10						
					DRK/BR.FINE-CRS.SAND & GRAVEL,	
					LITTLE COBBLES	
					13.0'	
	2	4-10-41	14.0'-15.5'	8"	GR/BR.FINE-MED.SAND,TR.	
15					FINE-CRS.GRAVEL & SILT	
					16.0'	
				2	CORED: GR.GRANITE GNEISS,SOME	
				2	QUARTZITE	
				2		
20				2	RUN #1 16.0'-21.0' REC.60"	
				2	(WEATHERED ZONES)	
				2		
				3	RUN #2 21.0'-26.0' REC.60"	
				3		
25				3		
				4	26.0'	
					BOTTOM OF BORING 26.0'	
30					NO WATER READING @ COMPLETION OF BORING	
35						
40						

LEGEND: Col A SAMPLE RECOVERY &/OR CORING TIME MINUTES/FT

140lb Wt. x 30" fall on 2" O.D. Sampler

Sample Type	Proportions Used		Cohesionless Density	Cohesive Consistency
D = Dry C = Cored W = Washed	trace	0 to 10%	0-10 Loose	0-4 Soft
UP = Undisturbed Piston	little	10 to 20%	10-30 Med.Dense	4-8 M/Stiff
TP = Test Pit A = Auger V = Vane Test	some	20 to 35%	30-50 Dense	8-15 Stiff
UT = Undisturbed Thinwall	and	35 to 50%	50 + VeryDense	15-30 V-Stiff

Driller: BROMLEY
Helper
Inspector: CHURCHILL
Sheet 1 of 1

1 Unless otherwise agreed, *samples* will be held by Welti Associates a maximum of 60 days after boring completion
2 ***Water readings*** represent driller observations — not interpretations

LABORATORY TEST RESULTS

Boring 22, Sample 1

Water Content (ASTM D2216):

Water Content: 9.5

Specific Gravity (ASTM D-854):

Specific Gravity of Soil: 2.735

Dry Unit Weight (See Note 1):

Dry Unit Weight Of Soil: 100.36

Void Ratio (See Note 2):

Void Ratio Of Soil: 0.40

Grain-Size Analysis (ASTM D422 With Hydrometer):

- Gravel, passing 3 inch and retained on No. 4 sieve 59.0%
- Sand, passing No. 4 and retained on No. 200 sieve 35.8%
  - Coarse sand, passing No. 4 and retained on No. 10 sieve 9.2%
  - Medium sand, passing No. 10 and retained on No. 40 sieve 13.0%
  - Fine sand, passing No. 40 and retained on No. 200 sieve 13.6%
- Silt, 0.074 mm (No. 200) to 0.005 mm 4.2%
- Clay, smaller than 0.005 mm 1.0%

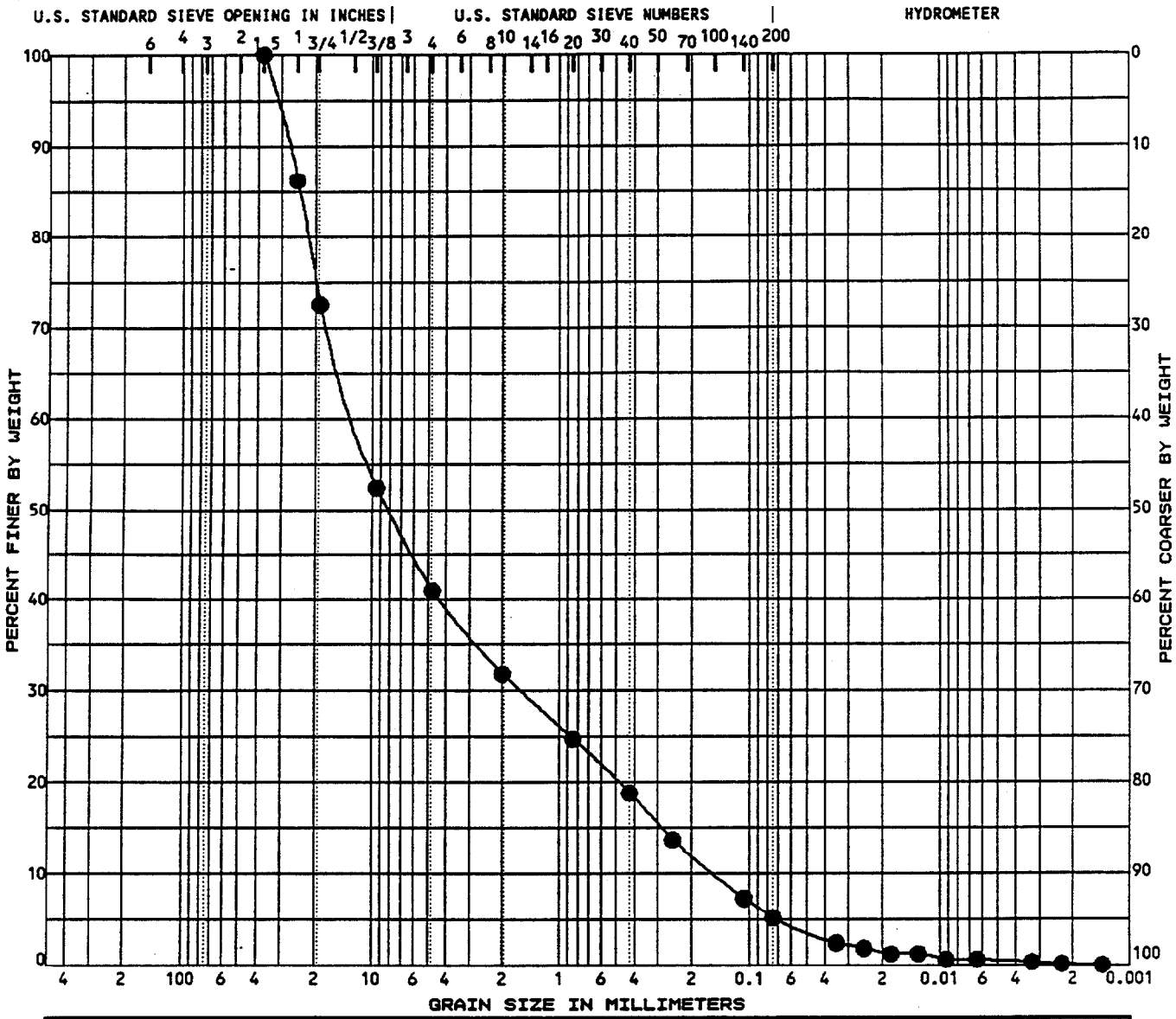
LABORATORY TEST RESULTS

Boring 22, Sample 1 (Con't)

Direct Shear (ASTM D-3080):

Trial No.	Initial Moisture Content,%	Initial Thickness inches	Initial Unit Weight Dry, pcf	Normal Stress, psf	Maximum Shear Stress, psf
1	12.4	0.78	114.8	390.29	476.47
2	13.4	0.79	113.2	779.71	767.65
3	13.4	0.82	112.5	1169.71	1252.94

friction angle = 45
cohesion = 55



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

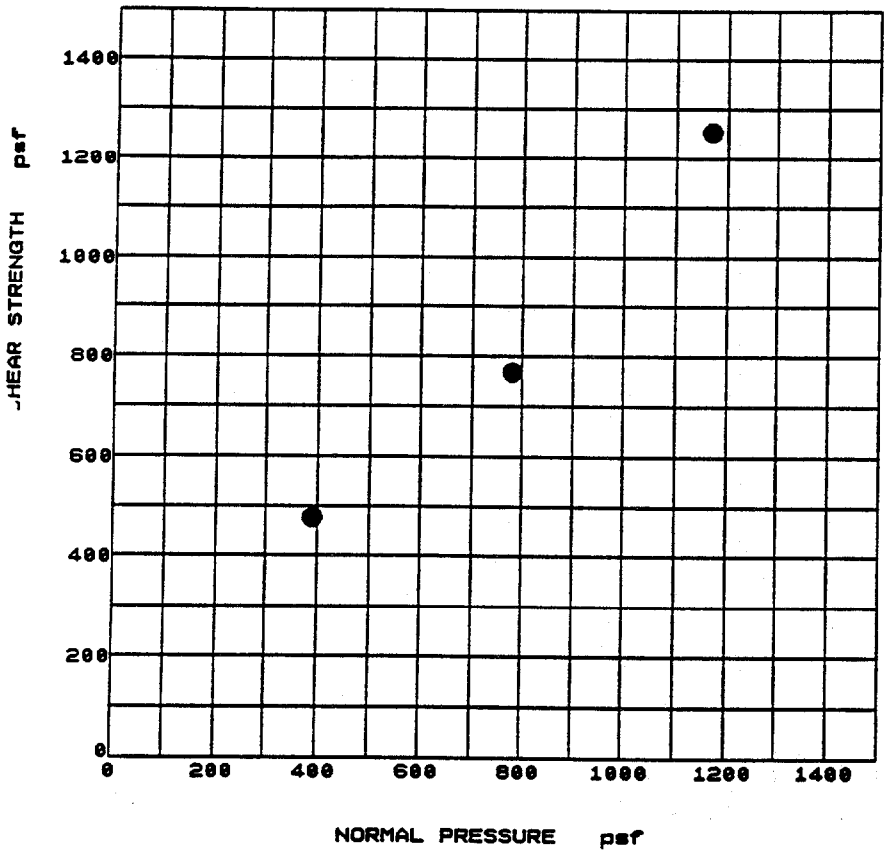
	Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
●	B-22,S1	9.0	Well Graded Gravel with Silt and Sand GW-GM	10	NP	NP	NP	1.38	81.1

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-22,S1	9.0	37.50	12.35	1.610	0.1522	59.0	35.8	4.7	0.5

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date October 1989	GRADATION CURVES

DIRECT SHEAR RESULTS



FRICTION ANGLE: 45

COHESION: 55

MORRISON GEOTECHNICAL ENGINEERING

PROJECT NAME:

Oakpoint Associates

JOB NO.: 3131

BORING: B-22,S1

DEPTH: 9.0

MGE

LOG OF EXPLORATIONS

Hole No. **B-23**

Contractor: Clarence Welti Associates
Driller: Dave Bromley
Type of Drill: Truck Mounted
Size & Type of Casing: 4"
Drilling Fluid: none
Other:

Project: Oakpoint Associates
No. 3131 Observer: Julie M. Churchill
Location:
Elevation: 8.00
Date Start: 8/29/89 Complete: 8/29/89
Weather:

FIELD DATA									LAB DATA	
DEPTH	ELEV	PROFILE	SAMPLE EQ TEST	SAMPLE TYPE & #	SAMPLE LENGTH	PENE-TRATION RESIST-TANCE PER 6"	RECOVERY FT. OR %	Field Description	Engineering Description	Test Data
								Quaywall		
8.0	0.0			S-1	1.5	50/16/16	20	Gravel, little sand, f-c, brown, saturated, dense, GM	GP:Poorly graded gravel with sand, subrounded, hard, and durable	
16.0	-8.0			S-2	1.0 10.0	6/60	0 85	Dark gray biotite granite gneiss		UR
26.0	-18.0							End of rock core at 26.0'		

Remarks:

GROUNDWATER DATA

Date	Time	Depth
8/30/89	9:30 am	5.0'

MGE

Sheet 1 of 1

Hole No **B-23**

Project Abbrev. Submarine Base, Groton
Project No. 3131

Date 8/30/89
Logged by JMC

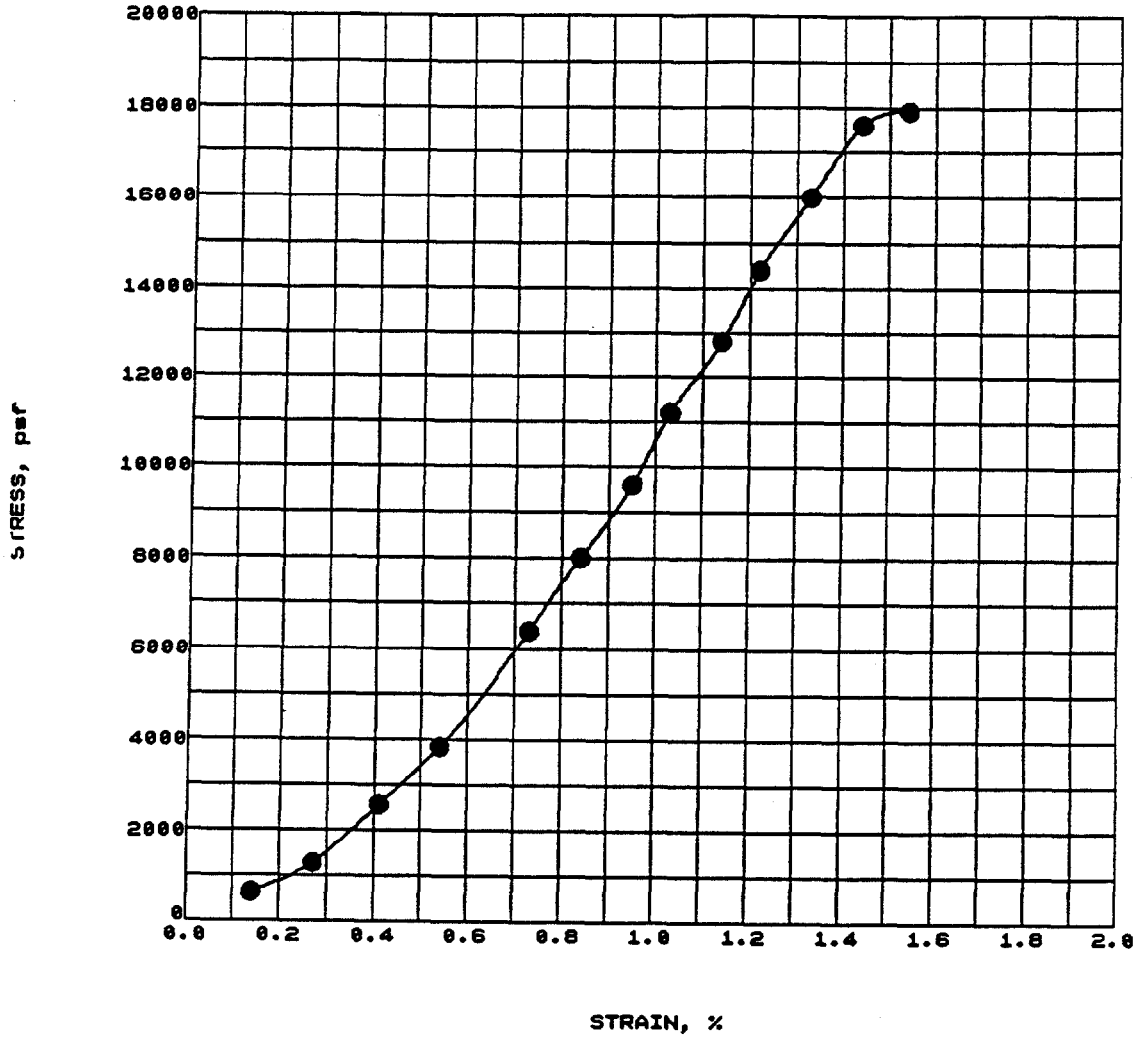
LOG OF ROCK CORE

Boring No. B-23
Depth of Boring 16.0'
Size of Core 2.1"
Type of Core Barrel NX

Location Area B
Boring Elev. +8.0'
Elev. Top of Bedrock -8.0
Elev. Groundwater

Depth	Run No.	Recovery %	RQD %	Graphic Log	Fractures	Lithology
16.0					Weathered surface	
					Mechanical break	Biotite granite gneiss
17.0		3.5	1.3			
					Mechanical break	
18.0						
	1					
			1.3			
19.0					Weathered break	
			.4			
20.0						
					Uncovered rock	
21.0					Mechanical break	
			.6		Weathered break	
22.0		5.0				
			.6		Weathered	
23.0	2		1.05			Very biotitic
					Weathered	
			.35		Weathered foliation (biotite)	
24.0			.35		Mechanical	Average drilling time 7 min/ft at 300 psi
					Weathered foliation (biotite)	
25.0			1.0			
			.35		Weathered foliation (biotite)	
					Cleavage plane, biotite,	
26.0			.6		Weathered	

Unconfined Compression on Rock



Strength, psi: 17,920

MORRISON GEOTECHNICAL ENGINEERING

Project Name:

Oakpoint Associates

Job No. : 3131

Boring : B-23

Depth : 21.5'

MGE

CLARENCE WELTI ASSOC., INC. P.O. BOX 397 GLASTONBURY, CONN 06033	CLIENT MORRISON GEOTECHNICAL	PROJECT NAME SUBMARINE BASE LOCATION GROTON, CT

DRILLING PROCEDURES: 2 & 4 1., 2., 3., 4., (Select one or more)

1. HOLLOW STEM AUGER. Diameter
2. DRIVEN CASING. Diameter 4" HW
3. DRILLED CASING. Diameter
4. ROCK CORING. Diameter 2.980 & type NX

HOLE NO. B-23 Surface Elevation

GROUND WATER OBSERVATIONS
AT ___ FT AFTER 0 HOURS
AT ___ FT AFTER ___ HOURS

START DATE 8/29/89
FINISH DATE 8/30/89

DEPTH	SAMPLE NO.	BLOWS/6"	DEPTH	A	STRATUM DESCRIPTION + DEPTH	REMARKS
					TOP OF CONCRETE WALL	
5					7.0'	
	1	50-16-16	8.0'-9.5'	3"	WATER 8.0'	
10					GR.FINE-CRS.SAND & GRAVEL,LITTLE SHELLS & SILT,TR.WOOD	
					12.0'	
15		6-60	15.0'-16.0'	0	GR/BR.FINE SAND,LITTLE SILT, TR.CRS.GRAVEL	
				10	16.0'	
				15	CORED: GR.GRANITE GNEISS & QUARTZ	
				17		
				6	RUN #1 16.0'-21.0' REC.42"	
20				6	(SOME SEAMS & MODERATELY FRACTURED)	
				6		
				6	RUN #2 21.0'-26.0' REC.60" (SOLID)	
				6		
				6		
25				6		
					26.0'	
					BOTTOM OF BORING 26.0'	
30					NOTE: NO WATER READING @ 0 HRS.	
35						
40						

LEGEND: Col. A SAMPLE RECOVERY &/OR CORING TIME MINUTES/FT

140lb Wt. x 30" fall on 2" O.D. Sampler

Sample Type	Proportions Used		Cohesionless Density	Cohesive Consistency
D = Dry C = Cored W = Washed	trace	0 to 10%	0-10 Loose	0-4 Soft
UP = Undisturbed Piston	little	10 to 20%	10-30 Med.Dense	4-8 M/Stiff
TP = Test Pit A = Auger V = Vane Test	some	20 to 35%	30-50 Dense	8-15 Stiff
UT = Undisturbed Thinwall	and	35 to 50%	50 + VeryDense	15-30 V-Stiff

Driller: BROMLEY
Helper:
Inspector CHURCHILL
Sheet 1 of 1

1 Unless otherwise agreed, ***samples*** will be held by Welti Associates a maximum of 60 days after boring completion
2 ***Water readings*** represent driller observations — not interpretations.

Project Abbrev. Submarine Base, Groton
Project No. 3131

Date 9/6/89
Logged by JMC

LOG OF ROCK CORE

Boring No. B-24
Depth of Boring 14'
Size of Core 2.1"
Type of Core Barrel NX

Location Area B
Boring Elev. +8.0
Elev. Top of Bedrock -6.0'
Elev. Groundwater

Depth	Run No.	Recovery 100%	RQD %	Graphic Log	Fractures	Lithology
14.0					Weathered breaks Weathered fracture plane 45°	Black biotite schist
15.0			.35			
			.4		Weathered breaks	Biotitic planes, highly weathered
16.0						
	1		.5		Weathered break	
17.0						
18.0			2.5			Gray granite gneiss fine grained
19.0					Mechanical breaks	
			.4		Mechanical breaks Mechanical breaks	
20.0			.45		Mechanical breaks	Average drilling time 5 min/ft at 300 psi
21.0	2		1.3			
					Foliation plane 10°	
22.0						
			1.65			
23.0					Fracture plane 35°	
			.35		Mechanical break	
24.0			.6		Mechanical break	

LOG OF EXPLORATIONS

Hole No. **B-24**

Contractor: Clarence Weltl Associates
Driller: Dave Bromley
Type of Drill: Truck Mounted
Size & Type of Casing: 4"
Drilling Fluid: none
Other:

Project: Oakpoint Associates
No. 3131 Observer: Julie M. Churchill
Location:
Elevation: 8.00
Date Start: 9/5/89 Complete: 9/5/89
Weather:

FIELD DATA										LAB DATA	
DEPTH	ELEV	PROFILE	SAMPLE EQ TEST	SAMPLE TYPE & #	SAMPLE LENGTH	PENE-TRATION RESIST-TANCE PER 6"	RECOVERY FT. OR %	Field Description		Engineering Description	Test Data
								Quaywall			
8.0	0.0										
				S-1	1.5	4/6/9	67	Gravel, some sand, f-c, little silt, little shells, saturated, gray, medium dense, GM		SP-SM:Poorly graded sand with silt and gravel, subangular,hard, and durable, 0.80% organics	W, G, D, e, OC, GS W/HYDRO
14.0	-6.0				1.0	16/60	0				
					10.0		100	Dark gray biotite granite gneiss			
24.0	-16.0							End of rock core at 24.0'			

Remarks:

GROUNDWATER DATA

Date	Time	Depth
09/05/89	10:00 am	6.0'

MGE

Sheet 1 of 1

Hole No B-24

CLARENCE WELTI ASSOC., INC. P.O. BOX 397 GLASTONBURY, CONN 06033	CLIENT MORRISON GEOTECHNICAL	PROJECT NAME SUBMARINE BASE LOCATION GROTON, CT

DRILLING PROCEDURES: 2 & 4 1., 2., 3., 4., (Select one or more)

1. HOLLOW STEM AUGER. Diameter
2. DRIVEN CASING. Diameter 4" HW
3. DRILLED CASING. Diameter
4. ROCK CORING. Diameter 2.980 & type NX

HOLE NO. B-24 Surface Elevation

GROUND WATER OBSERVATIONS
AT FT AFTER 0 HOURS
AT FT AFTER HOURS

START DATE 9/5/89
FINISH DATE 9/5/89

DEPTH	SAMPLE NO.	BLOWS/6"	DEPTH	A	STRATUM DESCRIPTION + DEPTH	REMARKS
					TOP OF CONCRETE WALL	
5					6.0'	
					WATER	
	1	4-6-9	8.0'-9.5'	12"	8.0'	
10					GR/BR.FINE-CRS.SAND,SOME FINE-CRS.GRAVEL,TR.BLK.	
		16-60	13.0'-14.0'	0"	ORGANIC SILT	
					14.0'	
15				3	CORED: GR.GRANITE GNEISS & QUARTZ	
				4		
				4	RUN #1 14.0'-19.0' REC.60"	
				4	(SLIGHTLY FRACTURED)	
				4		
20				6	RUN #2 19.0'-24.0' REC.60"	
				6	(SOLID)	
				5		
				5		
				6	24.0'	
25					BOTTOM OF BORING 24.0'	
					NO WATER READING @ COMPLETION OF BORING	
30						
35						
40						

LEGEND: Col A SAMPLE RECOVERY &/OR CORING TIME MINUTES/FT

140lb Wt. x 30" fall on 2" O.D Sampler

Sample Type	Proportions Used		Cohesionless Density	Cohesive Consistency
D = Dry C = Cored W = Washed	trace	0 to 10%	0-10 Loose	0-4 Soft
UP = Undisturbed Piston	little	10 to 20%	10-30 Med.Dense	4-8 M/Stiff
TP = Test Pit A = Auger V = Vane Test	some	20 to 35%	30-50 Dense	8-15 Stiff
UT = Undisturbed Thinwall	and	35 to 50%	50 + VeryDense	15-30 V-Stiff

Driller: BROMLEY
Helper
Inspector CHURCHILL
Sheet 1 of 1

1 Unless otherwise agreed, *samples* will be held by Welti Associates a maximum of 60 days after boring completion
2 *Water readings* represent driller observations — not interpretations

LABORATORY TEST RESULTS

Boring 24, Sample 1

Water Content (ASTM D2216):

Water Content: 13.5

Specific Gravity (ASTM D-854):

Specific Gravity of Soil: 2.781

Dry Unit Weight (See Note 1):

Dry Unit Weight Of Soil: 104.0

Void Ratio (See Note 2):

Void Ratio Of Soil: 0.67

Organic Content (ASTM D-2974):

Percent Organic Matter: 0.80

Grain-Size Analysis (ASTM D422 With Hydrometer):

- Gravel, passing 3 inch and retained on No. 4 sieve 27.6%
- Sand, passing No. 4 and retained on No. 200 sieve 61.4%
  - Coarse sand, passing No. 4 and retained on No. 10 sieve 17.9%
  - Medium sand, passing No. 10 and retained on No. 40 sieve 11.9%
  - Fine sand, passing No. 40 and retained on No. 200 sieve 31.6%
- Silt, 0.074 mm (No. 200) to 0.005 mm 10.9%
- Clay, smaller than 0.005 mm 0.1%

ORGANIC CONTENT

Project Oakpoint Associates Groton, CT, Submarine Base

Source B-24 S-1 Project Number 3131

Date Tested 10-7-89 Tested By BH

Moisture:

Tare Number	
A. Weight of Wet Soil + Tare	
B. Weight of Dry Soil + Tare	
C. Weight of Water, Ww = (A-B)	
D. Weight of Tare	
E. Weight of Dry Soil, Ws = (B-D)	
F. Water Content, W = (C/E X 100)	

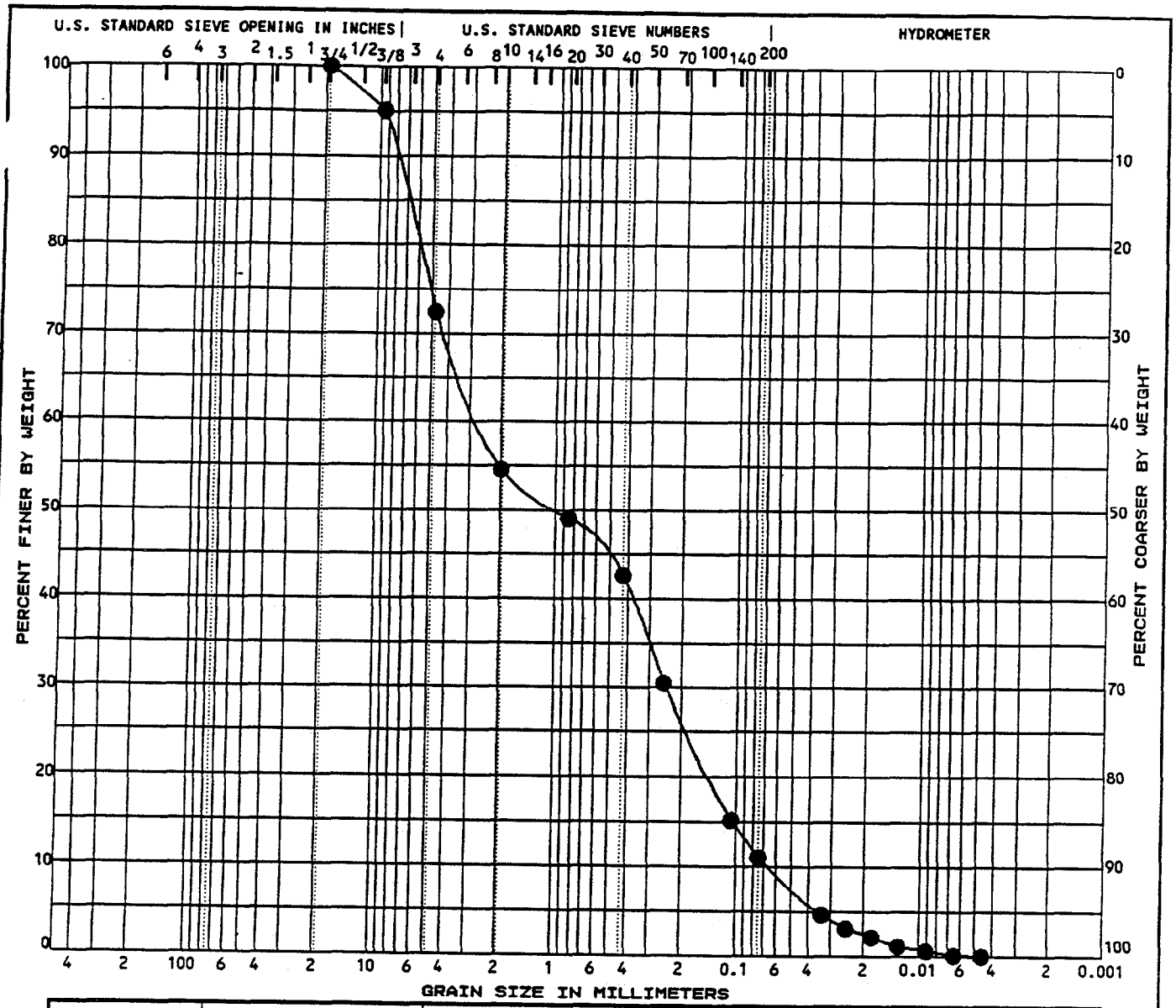
Ash:

Tare Number	
A. Weight of Dry Soil + Tare	111.15
B. Weight of Tare	59.63
C. Weight of Dry Soil, (A-B)	51.52
D. Weight of Ash + Tare	110.74
E. Weight of Tare	59.63
F. Weight of Ash, (D-E)	51.11
G. Percent Ash, (F/C + 100)	99.20

Organic Matter:

Percent Organic Matter, (100-G)	0.80

Remarks:



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
●	B-24,S1	8.0	Poorly Graded Sand with Silt and Gravel SP-SM	14	NP	NP	NP	0.32	37.3

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-24,S1	8.0	19.00	2.61	0.243	0.0663	27.6	61.4	10.9	0.0

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date October 1989	GRADATION CURVES

LOG OF EXPLORATIONS

Hole No. **B-25**

Contractor: Clarence Welti Associates
Driller: Dave Bromley
Type of Drill: Truck Mounted
Size & Type of Casing: 4"
Drilling Fluid: none
Other:

Project: Oakpoint Associates
No.: 3131 Observer: Julie M. Churchill
Location:
Elevation: 8.00
Date Start: 9/7/89 Complete: 9/7/89
Weather:

FIELD DATA									LAB DATA	
DEPTH	ELEV	PROFILE	SAMPLE EQ TEST	SAMPLE TYPE & #	SAMPLE LENGTH	PENE-TRATION RESIST-TANCE PER 6"	RECOVERY FT. OR %	Field Description	Engineering Description	Test Data
								Quaywall		
8.0	0.0									
				S-1	2.0	6/6/14/31	50	Sand, f-c, little silt, little gravel, little shells, saturated with petroleum, dk. gray, dense, SM	GP-GM:Poorly graded gravel with silt and sand, subrounded,hard, and durable, 0.93% organics	OC, GS
12.0	-4.0				10.0		100			
								Pink biotite pegmatite gneiss		
22.0	-14.0							End of rock core at 22.0'		

Remarks:

GROUNDWATER DATA

Date	Time	Depth
09/07/89		6.0'

MGE

Sheet 1 of 1

Hole No B-25

Project Abbrev. Submarine Base, Groton
Project No. 3131

Date 9/7/89
Logged by JMC

LOG OF ROCK CORE

Boring No. B-25
Depth of Boring 12.0'
Size of Core 2.1"
Type of Core Barrel NX

Location Area B
Boring Elev. +8.0
Elev. Top of Bedrock -4.0
Elev. Groundwater

Depth	Run No.	Recovery % 100	RQD %	Graphic Log	Fractures	Lithology
12.0					Weathered surface	Pink biotite pegmatite gneiss w/ biotite stringers
13.0			.7		Mechanical	
			1.1		Mechanical	
14.0					Mechanical	
			.4		Weathered fracture	
15.0			.7		Weathered fracture	
16.0			.6		Mechanical	
			.4		Mechanical	Average drilling time 7 min/ft at 300 psi
17.0			.6		Mechanical	
18.0			1.5		Mechanical	
19.0			1.1		Mechanical	
20.0			1.5		Mechanical	
21.0			.9		Mechanical	
22.0						

CLARENCE WELTI ASSOC., INC. P.O. BOX 397 GLASTONBURY, CONN 06033	CLIENT MORRISON GEOTECHNICAL	PROJECT NAME SUBMARINE BASE LOCATION GROTON, CT

DRILLING PROCEDURES: 2 & 4 1., 2., 3., 4., (Select one or more)

1. HOLLOW STEM AUGER. Diameter _____
2. DRIVEN CASING. Diameter 4" HW
3. DRILLED CASING. Diameter _____
4. ROCK CORING. Diameter 2.980 & type NX

HOLE NO. B-25 Surface Elevation _____

GROUND WATER OBSERVATIONS
AT _____ FT. AFTER 0 HOURS
AT _____ FT. AFTER _____ HOURS

START DATE 9/7/89
FINISH DATE 9/7/89

DEPTH	SAMPLE NO.	BLOWS/6"	DEPTH	A	STRATUM DESCRIPTION + DEPTH	REMARKS
					TOP OF CONCRETE WALL	
5						
	1	6-6-14-31	8.0'-10.0'	12"	8.0'	
10					BR.FINE-CRS.SAND & GRAVEL, TR.COBBLES (OIL IN SOIL)	
					12.0'	
				6	CORED: GR.GRANITE GNEISS & QUARTZITE	
				7		
15				7	RUN #1 12.0'-17.0' REC.60"	
				7		
				7	RUN #2 17.0'-22.0' REC.60"	
				8		
				8		
20				8		
				8		
				8	22.0'	
					BOTTOM OF BORING 22.0'	
25					NO WATER READING @ COMPLETION OF BORING	
30						
35						
40						

LEGEND: Col. A SAMPLE RECOVERY &/OR CORING TIME MINUTES/FT

140lb Wt. x 30" fall on 2" O.D. Sampler

Sample Type	Proportions Used		Cohesionless Density	Cohesive Consistency
D = Dry C = Cored W = Washed	trace	0 to 10%	0-10 Loose	0-4 Soft
UP = Undisturbed Piston	little	10 to 20%	10-30 Med.Dense	4-8 M/Stiff
TP = Test Pit A = Auger V = Vane Test	some	20 to 35%	30-50 Dense	8-15 Stiff
UT = Undisturbed Thinwall	and	35 to 50%	50 + VeryDense	15-30 V-Stiff

Driller: BROMLEY
Helper: _____
Inspector: CHURCHILL
Sheet 1 of 1

1 Unless otherwise agreed, ***samples*** will be held by Welti Associates a maximum of 60 days after boring completion.
2 ***Water readings*** represent driller observations — not interpretations

LABORATORY TEST RESULTS

Boring 25, Sample 1

Organic Content (ASTM D-2974):

Percent Organic Matter: 0.93

Gradation (ASTM D-422):

	Percent Passing Sieve By Weight	
Sieve Size	Sample	Specification
1 1/2"	100	
1"	85.8	
3/4"	72.5	
3/8"	59.9	
No. 4	52.3	
No. 10	45.6	
No. 20	37.6	
No. 40	26.9	
No. 60	17.6	
No. 140	8.5	
No. 200	6.2	

ORGANIC CONTENT

Project Oakpoint Associates Groton, CT, Submarine Base

Source B-25 S-1 Project Number 3131

Date Tested 10-6-89 Tested By BH

Moisture:

Tare Number	
A. Weight of Wet Soil + Tare	
B. Weight of Dry Soil + Tare	
C. Weight of Water, Ww = (A-B)	
D. Weight of Tare	
E. Weight of Dry Soil, Ws = (B-D)	
F. Water Content, W = (C/E X 100)	

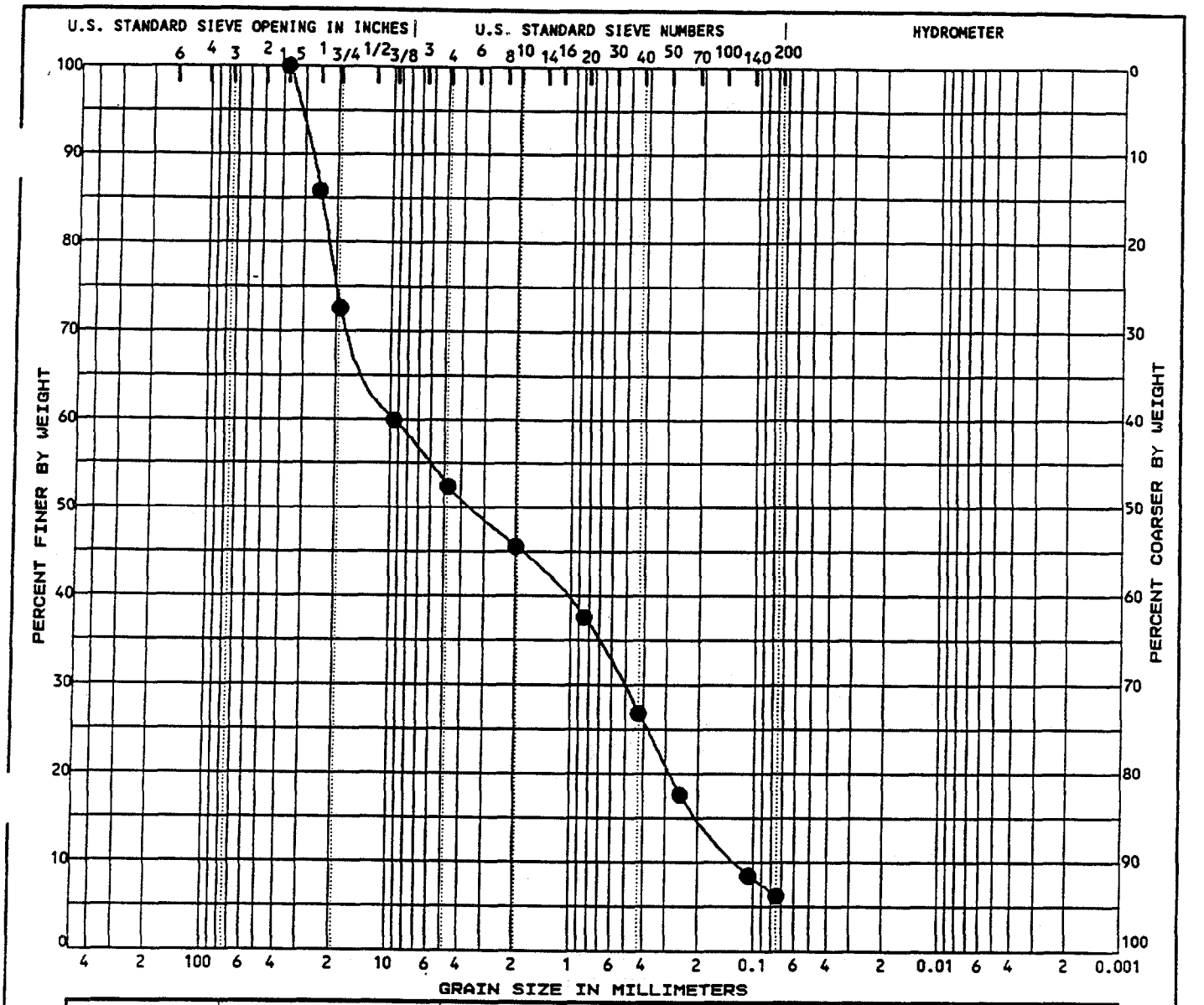
Ash:

Tare Number	
A. Weight of Dry Soil + Tare	101.60
B. Weight of Tare	59.62
C. Weight of Dry Soil, (A-B)	41.98
D. Weight of Ash + Tare	101.22
E. Weight of Tare	59.63
F. Weight of Ash, (D-E)	41.59
G. Percent Ash, (F/C + 100)	99.07

Organic Matter:

Percent Organic Matter, (100-G)	0.93

Remarks:



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
● B-25,S1	8.0	Poorly Graded Gravel with Silt and Sand GP-GM		NP	NP	NP	0.23	78.2

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-25,S1	8.0	37.50	9.55	0.520	0.1221	47.7	46.1	6.2	

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date October 1989	GRADATION CURVES

LOG OF EXPLORATIONS

Hole No. **B–26**

Contractor: Clarence Welti Associates
Driller: Dave Bromley
Type of Drill: Truck Mounted
Size & Type of Casing: 4"
Drilling Fluid: none
Other:

Project: Oakpoint Associates
No. 3131 Observer: Julie M. Churchill
Location:
Elevation: 7.10
Date Start: 8/28/89 Complete: 8/29/89
Weather:

FIELD DATA									LAB DATA	
DEPTH	ELEV	PROFILE	SAMPLE EQ TEST	SAMPLE TYPE & #	SAMPLE LENGTH	PENE-TRATION RESIST-TANCE PER 6"	RECOVERY FT. OR %	Field Description	Engineering Description	Test Data
1.0	6.1			S-1	1.5	13/10/8	73	Concrete and asphalt	SM:Silty sand with gravel, subrounded, hard, and durable,with asphalt	GS
				S-2	1.5	10/9/9	33	Sand, f-c, some gravel. little silt, brown, saturated, medium dense, SM	SP:Poorly graded sand with gravel, subrounded, hard, and durable	
11.5	-4.4			S-3	1.5	27/31/30	87	Very dense	SP-SM:Poorly graded sand with silt and gravel, subanguiar,hard, and durable	W, G, D, e, GS, DS
					10.0		92	Pink biotite granite gneiss		
21.5	-14.4							End of rock core at 21.5'		

Remarks:

GROUNDWATER DATA

Date	Time	Depth
8/30/89	9:30 am	4.6'

MGE

Sheet 1 of 1

Hole No B–26

Project Abbrev. Submarine Base, Groton
Project No. 3131

Date 8/29/89
Logged by JMC

LOG OF ROCK CORE

Boring No. B-26
Depth of Boring 11.5'
Size of Core 2.1"
Type of Core Barrel NX

Location Area B
Boring Elev. +7.10
Elev. Top of Bedrock -4.4
Elev. Groundwater

Depth	Run No.	Recovery 92 %	RQD %	Graphic Log	Fractures	Lithology
11.5					Weathered surface	Pink biotite granite gneiss with pegmatitic fabric. Secondary crystallization (quartz) evident along weathered fractures
12.5	1	4.2	.75		Weathered fractures	
			.7		Weathered	
13.5					Weathered	
			1.1			
14.5					Weathered	
15.5			1.1		Weathered	
					Weathered	
					Weathered	
16.5					Weathered	Average drilling time 11 min/ft at 300 psi
					Weathered	
17.5			1.6			
18.5	2	5.0			Weathered	
					Mechanical	
19.5			1.0		Mechanical	
			.5		Weathered	
20.5			1.25			
					Weathered	
21.5			.4		Mechanical	

CLARENCE WELTI ASSOC., INC. P.O. BOX 397 GLASTONBURY, CONN 06033	CLIENT MORRISON GEOTECHNICAL	PROJECT NAME SUBMARINE BASE LOCATION GROTON, CT

DRILLING PROCEDURES: ~~2 & 4~~ 1., 2., 3., 4.. (Select one or more)

1. HOLLOW STEM AUGER. Diameter _____
2. DRIVEN CASING. Diameter 4" HW
3. DRILLED CASING. Diameter _____
4. ROCK CORING. Diameter ~~2.080~~ & type NX

HOLE NO. B-26 | Surface Elevation _____

GROUND WATER OBSERVATIONS
AT 4.8' FT AFTER 0 HOURS
AT _____ FT AFTER _____ HOURS

START DATE 8/28/89
FINISH DATE 8/29/89

DEPTH	SAMPLE NO.	BLOWS/6"	DEPTH	A	STRATUM DESCRIPTION + DEPTH	REMARKS
	1	13-10-8	1.0'-2.5'		** 1.0'	
					GR/BR.FINE-MED.SAND,TR.SILT	
					4.0'	
5	2	10-9-9	5.0'-6.5'			
					GR/BR.FINE-CRS.SAND & GRAVEL,	
					TR.SILT & COBBLES	
10	3	27-31-30	10.0'-11.5'			
				8	11.5'	
				9	CORED: PINK & GR.QUARTZ & GRANITE GNEISS	
				9		
15				10	RUN #2 11.5'-16.5' REC.50"	
				11	(SLIGHTLY FRACTURED)	
				15		
				16	RUN #2 16.5'-21.5' REC.60"	
				18	(SLIGHTLY FRACTURED)	
20				6		
				6		
					21.5'	
					BOTTOM OF BORING 21.5'	
25						
					**BR.FINE-CRS.SAND & GRAVEL	
30						
35						
40						

LEGEND: Col. A SAMPLE RECOVERY &/OR CORING TIME MINUTES/FT

140lb Wt. x 30" fall on 2" O.D Sampler

Sample Type	Proportions Used		Cohesionless Density	Cohesive Consistency
D = Dry C = Cored W = Washed	trace	0 to 10%	0-10 Loose	0-4 Soft
UP = Undisturbed Piston	little	10 to 20%	10-30 Med.Dense	4-8 M/Stiff
TP = Test Pit A = Auger V = Vane Test	some	20 to 35%	30-50 Dense	8-15 Stiff
UT = Undisturbed Thinwall	and	35 to 50%	50 + VeryDense	15-30 V-Stiff

Driller: BROMLEY
Helper: _____
Inspector CHURCHILL
Sheet 1 of 1

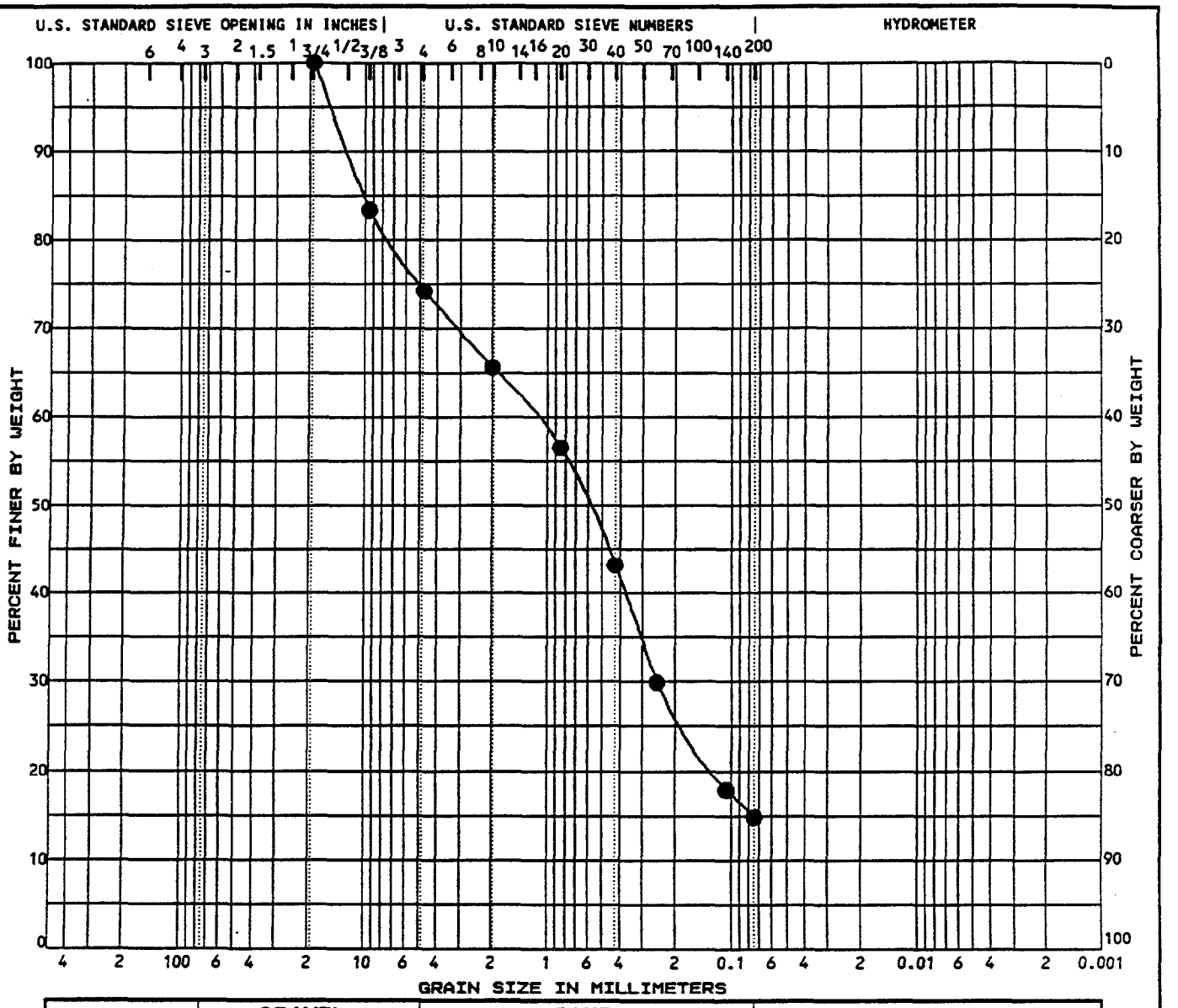
1. Unless otherwise agreed, ***samples*** will be held by Welti Associates a maximum of 60 days after boring completion
2. ***Water readings*** represent driller observations — not interpretations.

LABORATORY TEST RESULTS

Boring 26, Sample 1

Gradation (ASTM D-422):

Sieve Size	Percent Passing Sieve By Weight	
	Sample	Specification
3/4"	100	
3/8"	83.4	
No. 4	74.1	
No. 10	65.6	
No. 20	56.5	
No. 40	43.2	
No. 60	29.9	
No. 140	17.9	
No. 200	14.9	



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
●	B-26,S1	1.0	Silty Sand with Gravel SM		NP	NP	NP		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-26,S1	1.0	19.00	1.18	0.251		25.9	59.2	14.9	

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date October 1989	GRADATION CURVES

LABORATORY TEST RESULTS

Boring 26, Sample 3

Water Content (ASTM D2216):

Water Content: 9.9

Specific Gravity (ASTM D-854):

Specific Gravity of Soil: 2.708

Dry Unit Weight (See Note 1):

Dry Unit Weight Of Soil: 130.9

Void Ratio (See Note 2):

Void Ratio Of Soil: 0.29

Gradation (ASTM D-422):

	Percent Passing Sieve By Weight	
Sieve Size	Sample	Specification
1"	100	
3/4"	90.3	
3/8"	75.1	
No. 4	61.8	
No. 10	49.0	
No. 20	37.9	
No. 40	25.4	
No. 60	15.9	
No. 140	8.4	
No. 200	6.3	

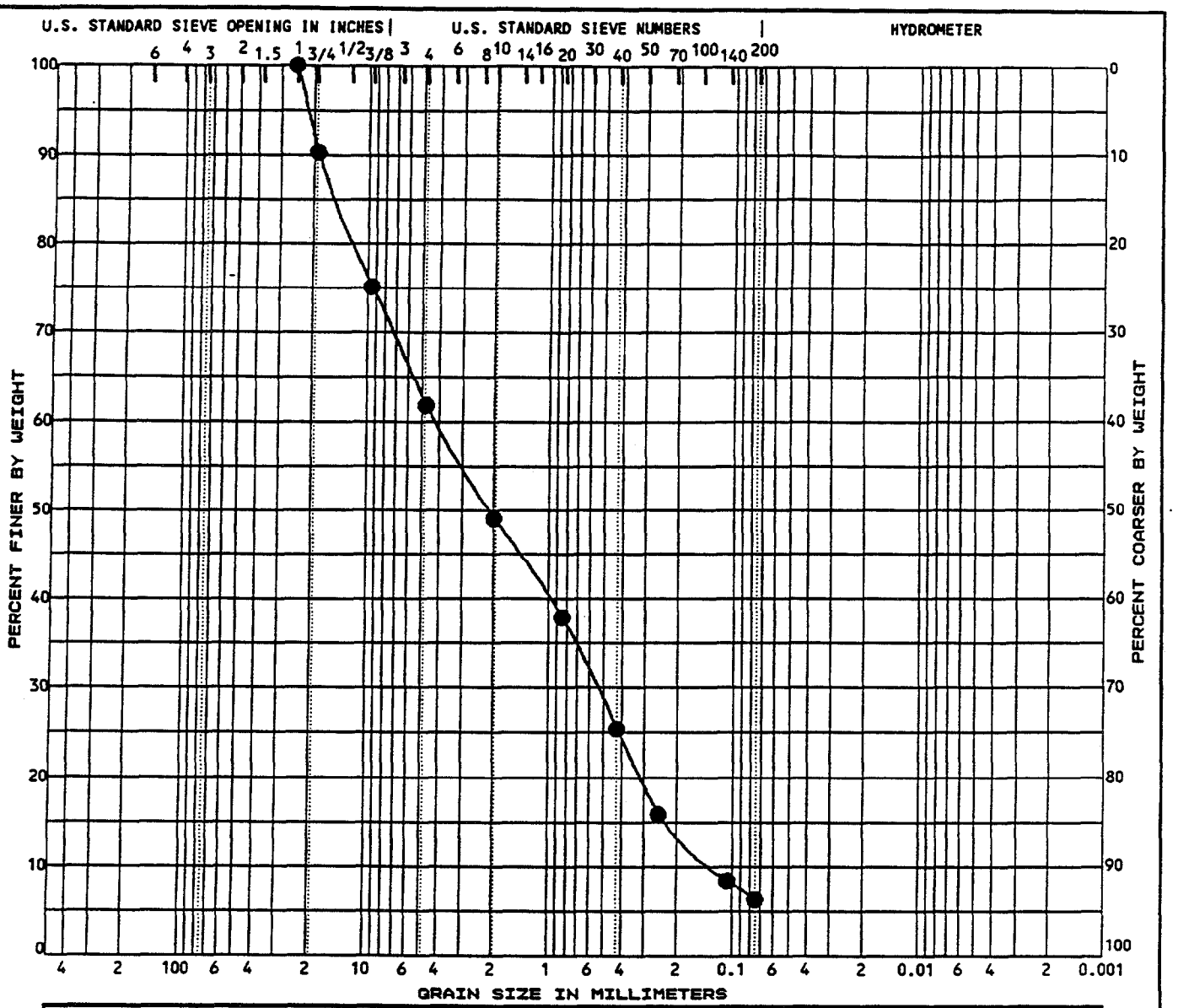
LABORATORY TEST RESULTS

Boring 26, Sample 3 (Con't)

Direct Shear (ASTM D-3080):

Trial No.	Initial Moisture Content,%	Initial Thickness inches	Initial Unit Weight Dry, pcf	Normal Stress, psf	Maximum Shear Stress, psf
1	11.9	0.81	112.2	389.12	414.70
2	13.6	0.78	109.9	779.41	767.65
3	11.7	0.80	107.2	1169.71	1111.76

friction angle = 42
cohesion = 69



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

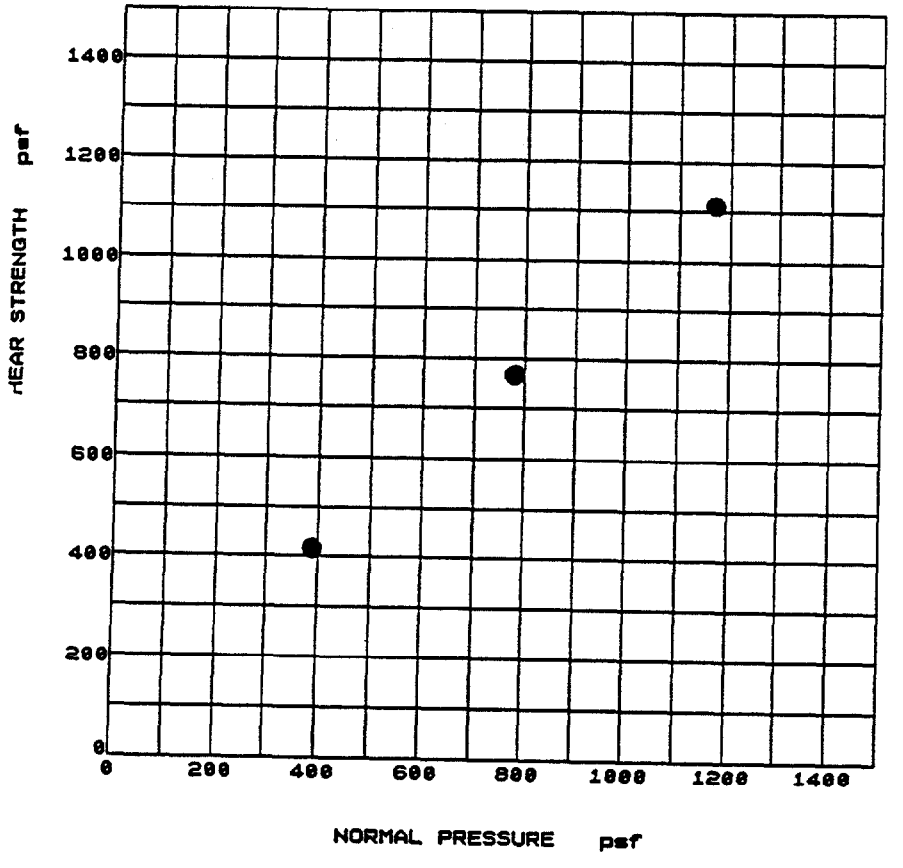
	Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
●	B-26,S3	10.0	Poorly Graded Sand with Silt and Gravel SP-SM	10	NP	NP	NP	0.56	33.0

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-26,S3	10.0	25.00	4.21	0.549	0.1273	38.2	55.5	6.3	

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date October 1989	GRADATION CURVES

DIRECT SHEAR RESULTS



FRICTION ANGLE: 42

COHESION: 69

MGE

MORRISON GEOTECHNICAL ENGINEERING

PROJECT NAME:

Oakpoint Associates

JOB NO.: 3131

BORING: B-26,S3

DEPTH: 10.0

LOG OF EXPLORATIONS

Hole No. **B-27**

Contractor: Clarence Weltl Associates
Driller: Dave Bromley
Type of Drill: Truck Mounted
Size & Type of Casing: 4"
Drilling Fluid: none
Other:

Project: Oakpoint Associates
No. 3131 Observer: Julie M. Churchill
Location:
Elevation: 7.74
Date Start: 9/1/89 Complete: 9/1/89
Weather:

FIELD DATA									LAB DATA	
DEPTH	ELEV	PROFILE	SAMPLE EQ TEST	SAMPLE TYPE & #	SAMPLE LENGTH	PENE-TRATION RESIST-TANCE PER 6"	RECOVERY FT. OR %	Field Description	Engineering Description	Test Data
1.0	6.7							Concrete and asphalt		
				S-1	1.5	14/31/28	87	Sand, f-c, little gravel, little silt, moist to saturated, brown, very dense to medium dense, SM	SP-SM:Poorly graded sand with silt and gravel, angular,hard, and durable, with asphalt, 1.16% organics	W, G, D, e, OC, AL, GS W/HYDRO, DS
				S-2	1.5	21/10/10	53		SW:Well graded sand with gravel, subrounded, subangular,hard, and durable	GS, DS
10.0	-2.3									
11.0	-3.3			S-3	1.0 / 10.0	8/67	53 / 83	Gravel, some sand, f-c, little silt, saturated brown, very dense, GM	SP-SM:Poorly graded sand with silt and gravel, subrounded,hard, and durable, with asphalt	GS
								Gray biotite granite gneiss		
21.0	-13.3							End of rock core at 21.0'		

Remarks:

GROUNDWATER DATA

Date	Time	Depth
9/1/89	9:50 am	4.8'
9/4/89	10:00 am	6.8'

MGE

Sheet 1 of 1

Hole No B-27

Project Abbrev. Submarine Base, Groton
Project No. 3131

Date 9/5/89
Logged by JMC

LOG OF ROCK CORE

Boring No. B-27
Depth of Boring 11'
Size of Core 2.1
Type of Core Barrel NX

Location Area B
Boring Elev. 7.74
Elev. Top of Bedrock -3.26
Elev. Groundwater

Depth	Run No.	Recovery 83%	RQD %	Graphic Log	Fractures	Lithology
11.0					Weathered surface	Gray biotite granite gneiss with biotitic stingers
			1.4			
12.0						
	1	53/60			Mechanical	
					Fracture plane 15°	
13.0						
			1.6			
14.0						Average drilling time 7 min/ft at 300 psi
					Mechanical	
15.0			1.0			
					Mechanical	
16.0					Mechanical	
17.0						
	2	46/60	2.0			
18.0					Mechanical	
			.5		Weathered	
					Weathered	
19.0					Fracture plane 25°	
					Fracutre plane 25°	
20.0			.4			
					Mechanical	
21.0						

CLARENCE WELTI ASSOC., INC. P.O. BOX 397 GLASTONBURY, CONN 06033	CLIENT MORRISON GEOTECHNICAL	PROJECT NAME SUBMARINE BASE LOCATION GROTON, CT

DRILLING PROCEDURES: ~~1 & 4~~ 1., 2., 3., 4., (Select one or more)

1. HOLLOW STEM AUGER. Diameter 3.75"ID
2. DRIVEN CASING. Diameter
3. DRILLED CASING. Diameter
4. ROCK CORING. Diameter ~~2.980~~ & type ~~NX~~

HOLE NO. B-27 | Surface Elevation

GROUND WATER OBSERVATIONS
AT 4.8' FT. AFTER 0 HOURS
AT ___ FT AFTER ___ HOURS

START DATE 9/1/89
FINISH DATE 9/1/89

DEPTH	SAMPLE NO.	BLOWS/6"	DEPTH	A	STRATUM DESCRIPTION + DEPTH	REMARKS
	1	14-31-28	1.0'-2.5'	15"	** 1.0'	
5	2	21-10-10	5.0'-6.5'	10"	GR/BR.FINE-CRS.SAND & GRAVEL, LITTLE COBBLES,TR.SILT	
10	3	8-67	10.0'-11.0'	10"	11.0'	
				7	CORED: GR.GRANITE GNEISS & QUARTZITE	
				7		
				6	RUN #1 11.0'-16.0' REC.53" (SOLID)	
15				6		
				6	RUN #2 16.0'-21.0' REC.46" (SOLID)	
				7		
				7	NOTE: RUN #2 CORE STUCK ON BOTTOM	
				7	WOULD NOT BREAK OFF	
20				8		
				8	21.0'	
					BOTTOM OF BORING 21.0'	
25					**ASPHALT & CONCRETE	
30						
35						
40						

LEGEND: Col. A SAMPLE RECOVERY &/OR CORING TIME MINUTES/FT

140lb Wt. x 30" fall on 2" O.D. Sampler

Sample Type	Proportions Used		Cohesionless Density	Cohesive Consistency
D = Dry C = Cored W = Washed	trace	0 to 10%	0-10 Loose	0-4 Soft
UP = Undisturbed Piston	little	10 to 20%	10-30 Med.Dense	4-8 M/Stiff
TP = Test Pit A = Auger V = Vane Test	some	20 to 35%	30-50 Dense	8-15 Stiff
UT = Undisturbed Thinwall	and	35 to 50%	50 + VeryDense	15-30 V-Stiff

Driller BROMLEY
Helper
Inspector CHURCHILL
Sheet 1 of 1

1. Unless otherwise agreed, **samples** will be held by Welti Associates a maximum of 60 days after boring completion
2. ***Water readings*** represent driller observations — not interpretations.

LABORATORY TEST RESULTS

Boring 27, Sample 1

Water Content (ASTM D2216):

Water Content:	3.0

Specific Gravity (ASTM D-854):

Specific Gravity of Soil:	..680

Dry Unit Weight (See Note 1):

Dry Unit Weight Of Soil:	129.4

Void Ratio (See Note 2):

Void Ratio Of Soil:	0.29

Organic Content (ASTM D-2974):

Percent Organic Matter:	1.16

Atterberg Limit (ASTM D-4318):

Liquid Limit:	
Plastic Limit:	NON-PLASTIC
Plasticity Index:	

LABORATORY TEST RESULTS

Boring 27, Sample 1 (Con't)

Grain-Size Analysis (ASTM D422 With Hydrometer):

- Gravel, passing 3 inch and retained on No. 4 sieve 24.2%
- Sand, passing No. 4 and retained on No. 200 sieve 65.4%
  - Coarse sand, passing No. 4 and retained on No. 10 sieve 11.6%
  - Medium sand, passing No. 10 and retained on No. 40 sieve 26.3%
  - Fine sand, passing No. 40 and retained on No. 200 sieve 27.5%
- Silt, 0.074 mm (No. 200) to 0.005 mm 9.4%
- Clay, smaller than 0.005 mm 1.0%

Direct Shear (ASTM D-3080):

Trial No.	Initial Moisture Content,%	Initial Thickness inches	Initial Unit Weight Dry, pcf	Normal Stress, psf	Maximum Shear Stress, psf
1	3.9	0.82	103.9	390.29	370.59
2	10.5	0.77	111.2	779.71	750.00
3	11.2	0.76	108.4	1169.71	977.06

friction angle = 39
cohesion = 79

ORGANIC CONTENT

Project Oakpoint Associates Groton, CT, Submarine Base

Source B-27 S-1 Project Number 3131

Date Tested 10-10-89 Tested By BH

Moisture:

Tare Number	
A. Weight of Wet Soil + Tare	
B. Weight of Dry Soil + Tare	
C. Weight of Water, Ww = (A-B)	
D. Weight of Tare	
E. Weight of Dry Soil, Ws = (B-D)	
F. Water Content, W = (C/E X 100)	

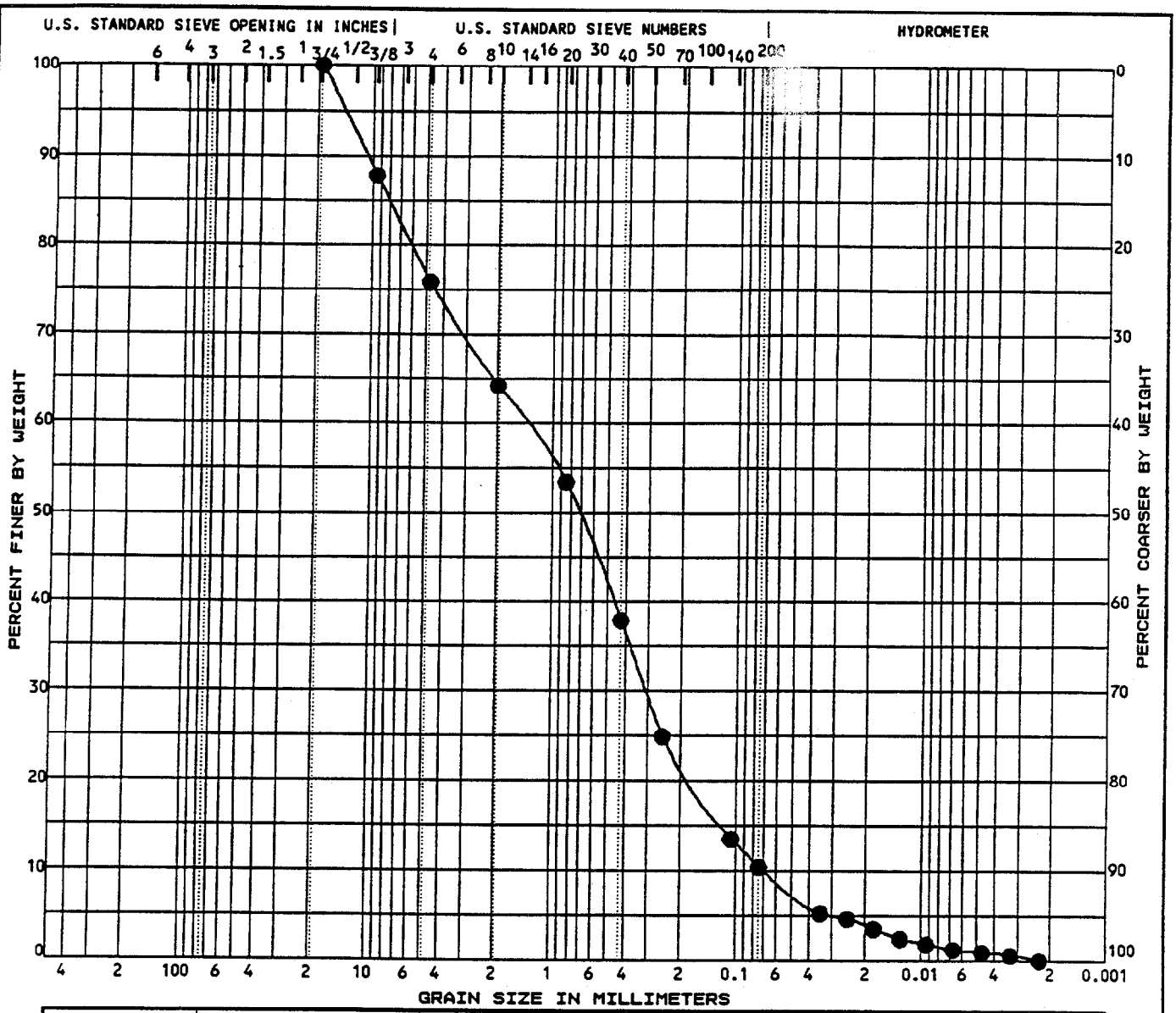
Ash: Contained Asphalt

Tare Number	F
A. Weight of Dry Soil + Tare	145.02
B. Weight of Tare	57.36
C. Weight of Dry Soil, (A-B)	87.66
D. Weight of Ash + Tare	144.00
E. Weight of Tare	57.36
F. Weight of Ash, (D-E)	86.64
G. Percent Ash, (F/C + 100)	98.84

Organic Matter:

Percent Organic Matter, (100-G)	1.16

Remarks:



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

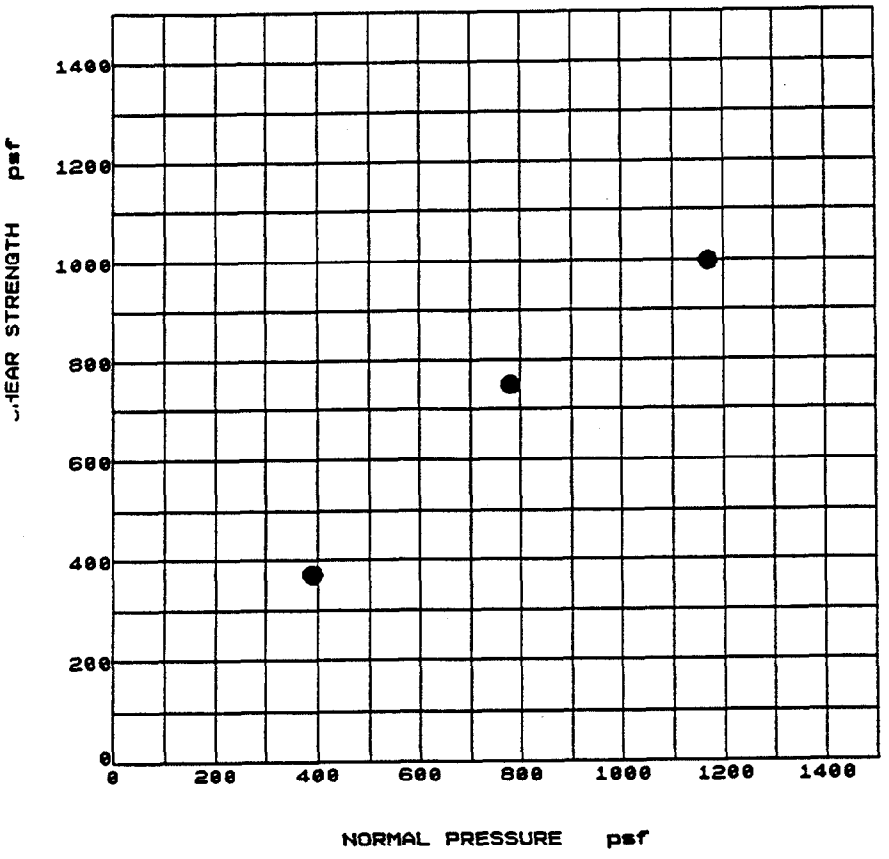
Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
● B-27,S1	1.0	Poorly Graded Sand with Silt and Gravel SP-SM	3	NP	NP	NP	0.94	20.5

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-27,S1	1.0	19.00	1.43	0.308	0.0707	24.2	65.4	9.4	1.0

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date October 1989	GRADATION CURVES

DIRECT SHEAR RESULTS



FRICTION ANGLE: 39

COHESION: 79

MORRISON GEOTECHNICAL ENGINEERING

PROJECT NAME:

Oakpoint Associates

JOB NO.: 3131

BORING: B-27,S1

DEPTH: 1.0

MGE

LABORATORY TEST RESULTS

Boring 27, Sample 2

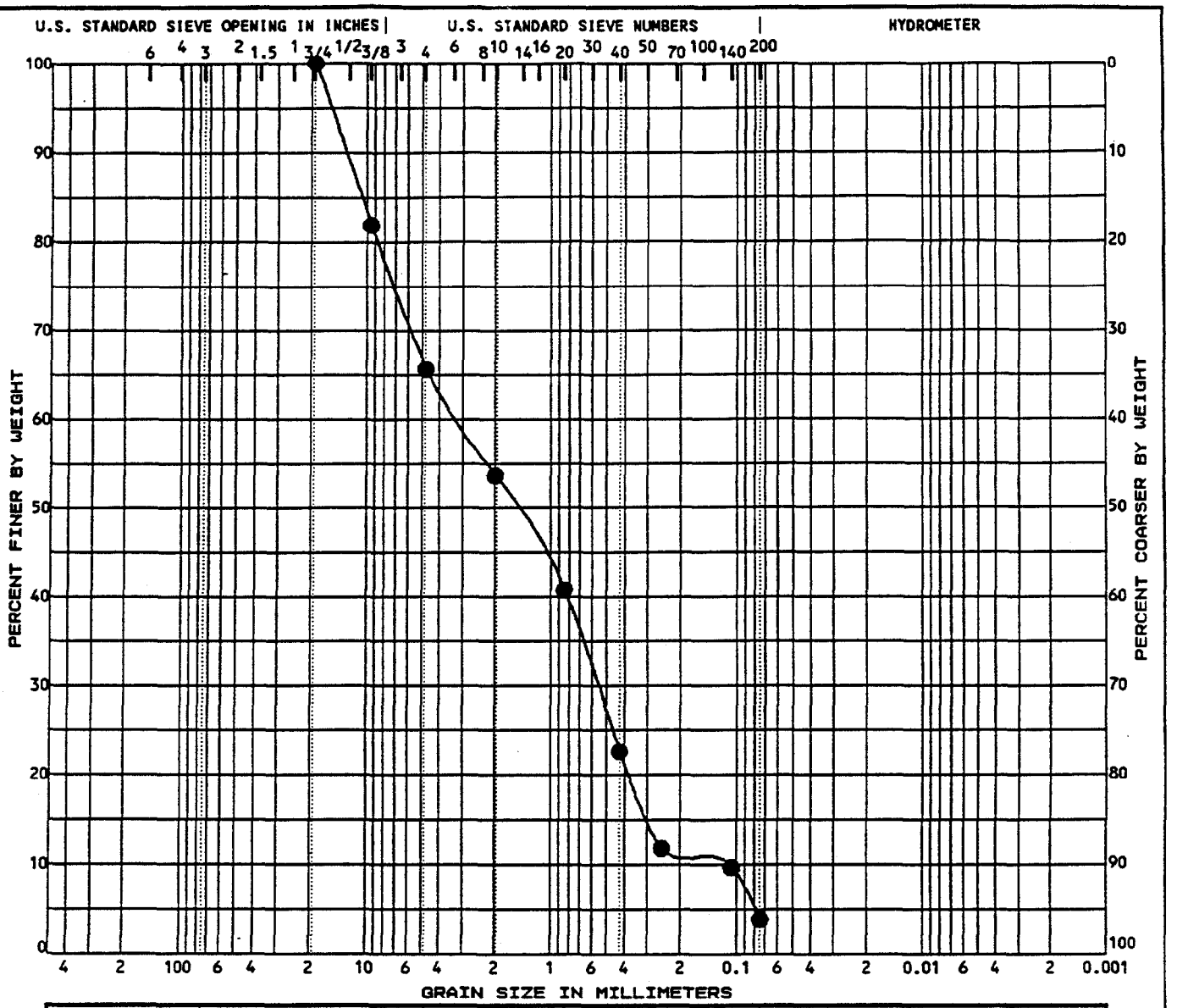
Gradation (ASTM D-422):

Sieve Size	Percent Passing Sieve By Weight: Sample	Specification
3/4"	100	
3/8"	81.9	
No. 4	65.6	
No. 10	53.6	
No. 20	40.8	
No. 40	22.6	
No. 60	11.8	
No. 140	9.7	
No. 200	3.9	

Direct Shear (ASTM D-3080):

Trial No.	Initial Moisture Content,%	Initial Thickness inches	Initial Unit Weight Dry, pcf	Normal Stress, psf	Maximum Shear Stress, psf
1	10.5	0.87	113.4	390.29	458.82
2	14.9	0.83	111.4	779.71	847.06
3	13.1	0.81	117.1	1169.71	1111.76

friction angle = 40
cohession = 153



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

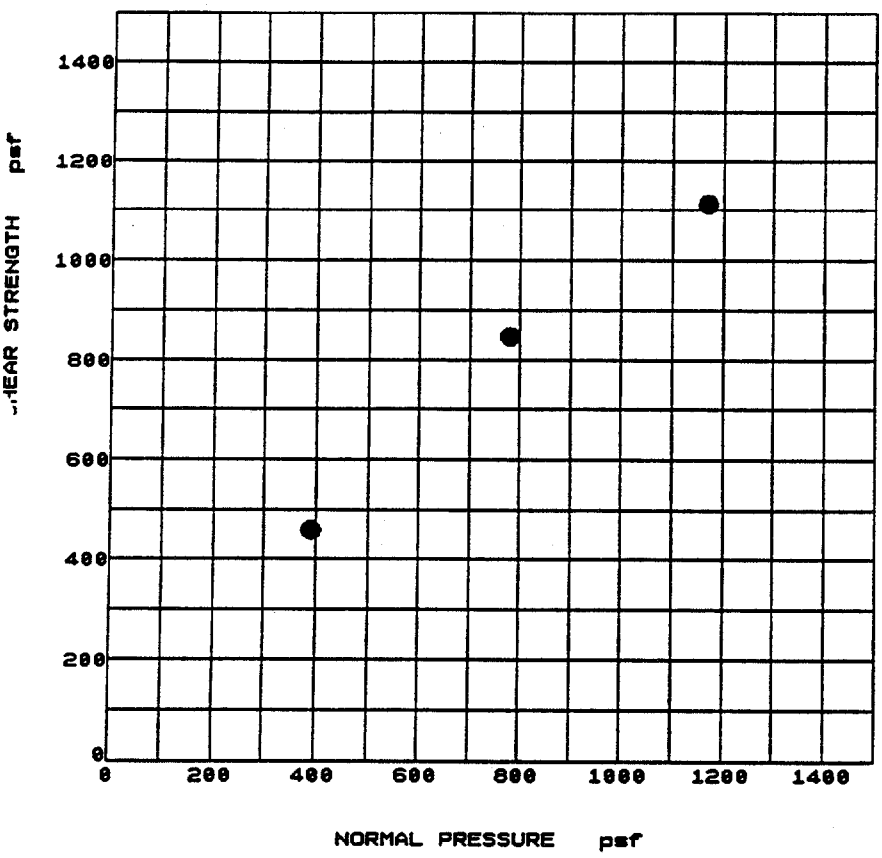
	Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
●	B-27,S2	5.0	Poorly Graded Sand with Gravel SP					0.83	26.5

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-27,S2	5.0	19.00	3.17	0.563	0.1198	34.4	61.7	3.9	

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date October 1989	GRADATION CURVES

DIRECT SHEAR RESULTS



FRICTION ANGLE: 40

COHESION: 153

MORRISON GEOTECHNICAL ENGINEERING

PROJECT NAME:

Oakpoint Associates

JOB NO.: 3131

BORING: B-27,S2

DEPTH: 5.0

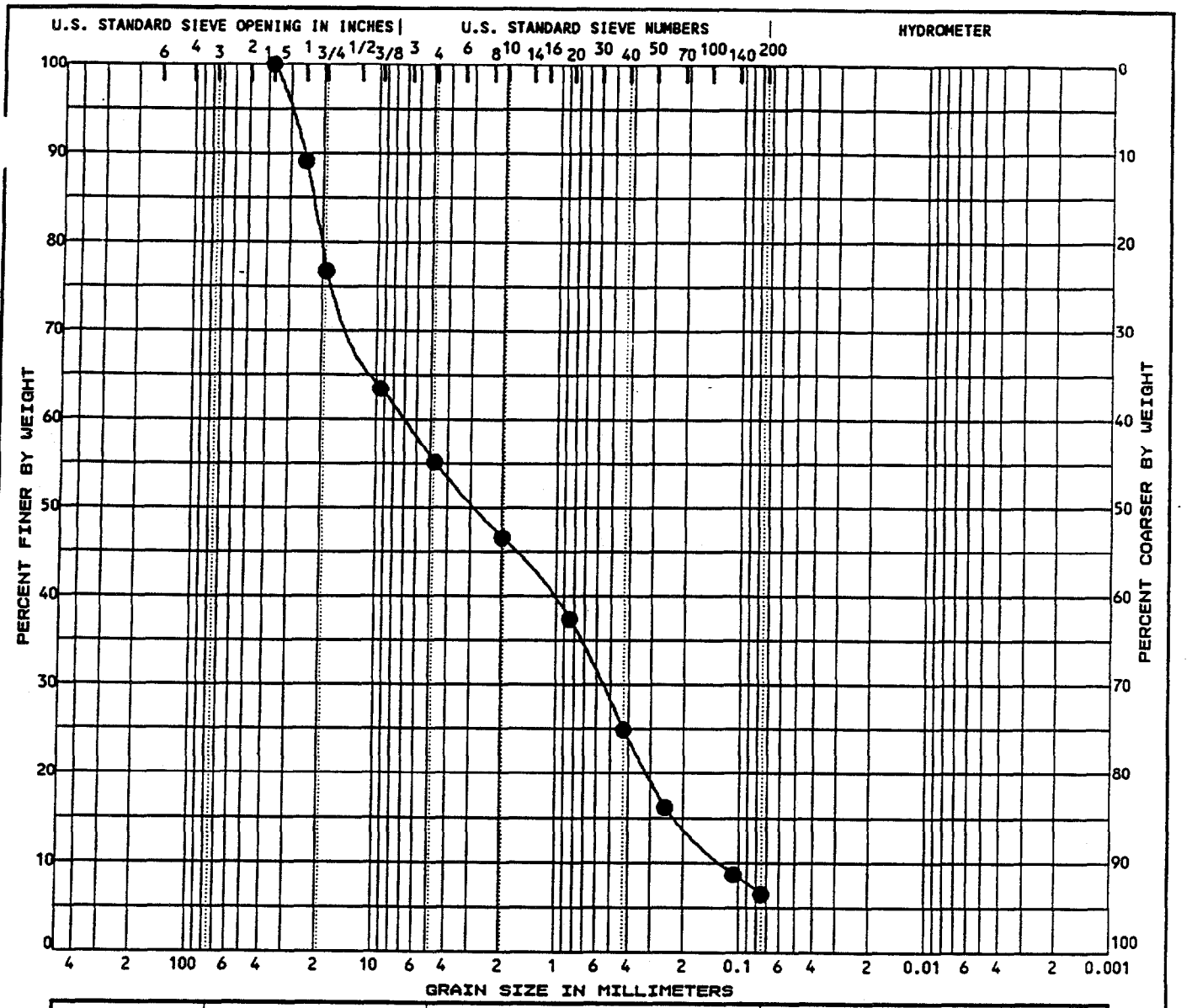
MGE

LABORATORY TEST RESULTS

Boring 27, Sample 3

Gradation (ASTM D-422):

Sieve Size	Percent Passing Sieve By Weight: Sample	Specification
1 1/2"	100	
1"	89.1	
3/4"	76.8	
3/8"	63.4	
No. 4	55.1	
No. 10	46.6	
No. 20	37.4	
No. 40	24.9	
No. 60	16.2	
No. 140	8.7	
No. 200	6.5	



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
● B-27,S3	10.0	Poorly Graded Sand with Silt and Gravel SP-SM		NP	NP	NP	0.36	58.1

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-27,S3	10.0	37.50	7.15	0.564	0.1230	44.9	48.6	6.5	

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date October 1989	GRADATION CURVES

LOG OF EXPLORATIONS

Hole No. **B-28**

Contractor: Clarence Welti Associates
Driller: Dave Bromley
Type of Drill: Truck Mounted
Size & Type of Casing: 4"
Drilling Fluid: none
Other:

Project: Oakpoint Associates
No. 3131 Observer: Julie M. Churchill
Location:
Elevation: 7.88
Date Start: 9/1/89 Complete: 9/5/89
Weather:

FIELD DATA									LAB DATA	
DEPTH	ELEV	PROFILE	SAMPLE EQ TEST	SAMPLE TYPE & #	SAMPLE LENGTH	PENE-TRATION RESIST-TANCE PER 6"	RECOVERY FT. OR %	Field Description	Engineering Description	Test Data
1.0	6.9				1.0			Concrete and asphalt	SP:Poorly graded sand	
				S-1	1.5	3/5/12	73	Sand, f-c, trace-little silt, moist, brown, medium dense, SM		
				S-2	1.5	22/29/30	67		SP:Poorly graded sand with gravel, subangular and angular, hard,and durable, 0.36% organics	W, G, D, e, OC, GS, DS
10.0	-2.1			S-3	0.5	74	33	Saturated, very dense	SP-SM:Poorly graded sand with silt and gravel, subrounded,hard, and durable, 1.11% organics	OC, GS
					10.0			Quartzite-gray biotite granite gneiss		UR
20.5	-12.6							End of rock core at 20.5'		

Remarks:

GROUNDWATER DATA

Date	Time	Depth
9/1/89	11:45 am	4.8'
9/5/89	12:15 pm	6.8'

MGE

Sheet 1 of 1

Hole No B-28

Project Abbrev. Submarine Base, Groton
Project No. 3131

Date 9/5/89
Logged by JMC

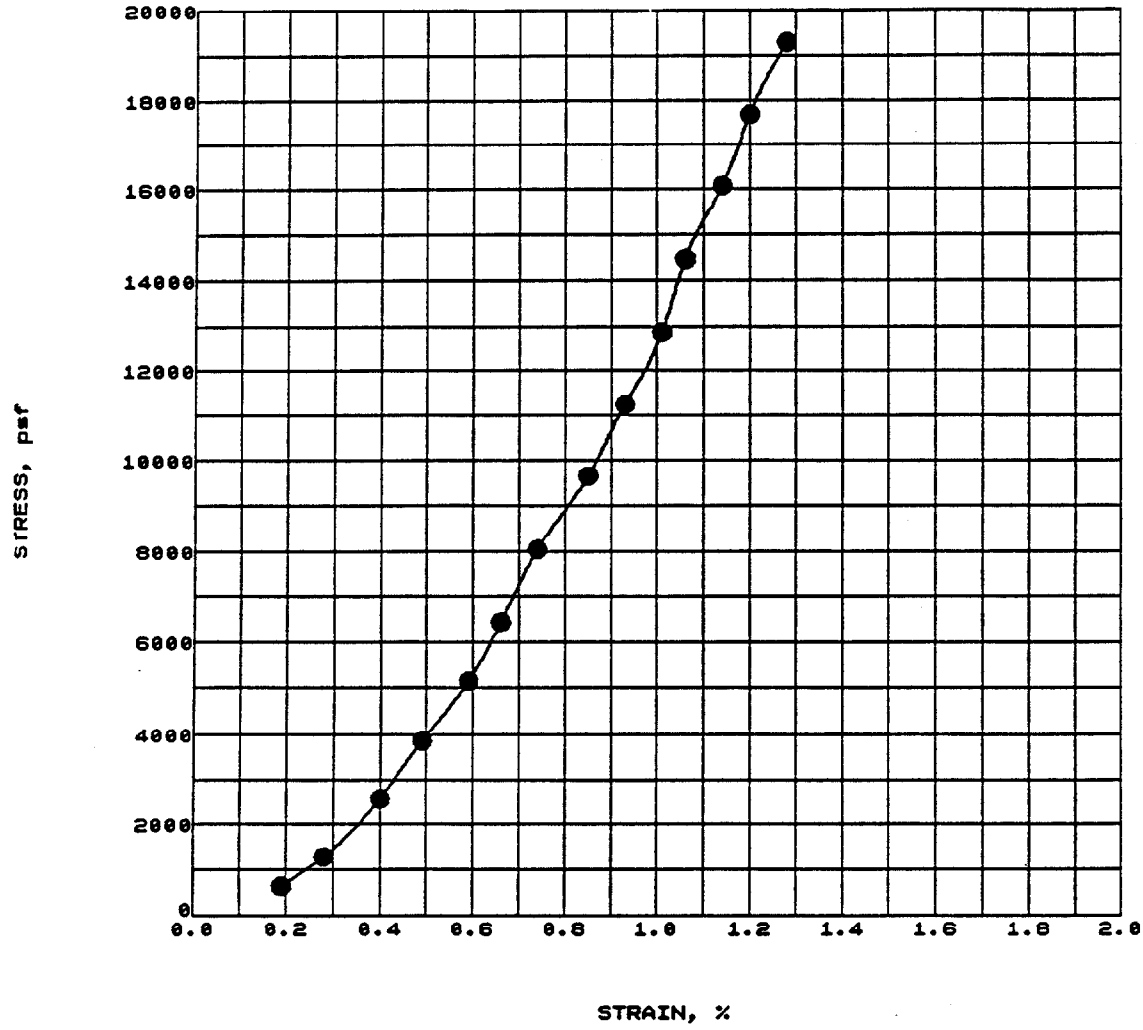
LOG OF ROCK CORE

Boring No. B-28
Depth of Boring 10.5'
Size of Core 2.1"
Type of Core Barrel NX

Location Area B
Boring Elev. 7.88
Elev. Top of Bedrock -2.62
Elev. Groundwater

Depth	Run No.	Recovery 96%	RQD %	Graphic Log	Fractures	Lithology
10.5					Weathered surface	Quartzite, gray biotite granite gneiss with biotite stringers
			.35		Mechanical break	
11.5			.45		Weathered surface Weathered surface	
			.6		Fracture, jointing 15°	
12.5		53/60	.35		Mechanical Fracture, jointing 15°	
			.6			
13.5			.5		Mechanical Jointing 15°	Average drilling time 6 min/ft at 300 psi
			.5		Mechanical	
14.5					Mechanical Mechanical	
			.35			
			.35		Mechanical	
15.5						
			.95		Jointing 25°	
16.5						
			.85		Mechanical	
17.5		46/60			Mechanical Mechanical	
18.5			1.2			
					Mechanical	
19.5						
			7.5		Mechanical	
20.5					Mechanical	

Unconfined Compression on Rock



Strength, psi: 20,900

MORRISON GEOTECHNICAL ENGINEERING

Project Name:

Oakpoint Associates

Job No. : 3131

Boring : B-28

Depth : 16.0'

MGE

CLARENCE WELTI ASSOC., INC. P.O. BOX 397 GLASTONBURY, CONN 06033	CLIENT MORRISON GEOTECHNICAL	PROJECT NAME SUBMARINE BASE LOCATION GROTON, CT

DRILLING PROCEDURES: 1 & 4 1., 2., 3., 4., (Select one or more)

1. HOLLOW STEM AUGER, Diameter 3.75"ID
2. DRIVEN CASING, Diameter
3. DRILLED CASING, Diameter
4. ROCK CORING, Diameter 2.980 & type NX

HOLE NO. B-28 Surface Elevation

GROUND WATER OBSERVATIONS
AT 4.8' FT AFTER 0 HOURS
AT FT AFTER HOURS

START DATE 9/1/89
FINISH DATE 9/5/89

DEPTH	SAMPLE NO.	BLOWS/6"	DEPTH	A	STRATUM DESCRIPTION + DEPTH	REMARKS
	1	3-5-12	1.0'-2.5'	13"	** 1.0'	
					*** 2.0'	
					GR/BR.FINE-MED.SAND	
5	2	22-39-30	5.0'-6.5'	12"	5.0'	
					GR/BR.FINE-CRS.SAND,SOME	
					FINE-CRS.GRAVEL & COBBLES,	
10	3	74/6"	10.0'-10.5'	6"	LITTLE SILT & BOULDERS	
				8	10.5'	
				8	CORED: GR.GRANITE GNEISS & QUARTZITE	
				8		
				6	RUN #1 10.5'-15.5' REC.60"	
15				5	(SOLID)	
				5		
				4	RUN #2 15.5'-20.5' REC.55"	
				4	(SOLID	
				5		
20				5		
					20.5'	
					BOTTOM OF BORING 20.5'	
25					**ASPHALT & CONCRETE	
					***BR.FINE-CRS.SAND & GRAVEL	
30						
35						
40						

LEGEND: Col. A SAMPLE RECOVERY &/OR CORING TIME MINUTES/FT

140lb Wt. x 30" fall on 2" O.D. Sampler

Sample Type	Proportions Used	Cohesionless Density	Cohesive Consistency
D = Dry C = Cored W = Washed	trace 0 to 10%	0-10 Loose	0-4 Soft
UP = Undisturbed Piston	little 10 to 20%	10-30 Med.Dense	4-8 M/Stiff
TP = Test Pit A = Auger V = Vane Test	some 20 to 35%	30-50 Dense	8-15 Stiff
UT = Undisturbed Thinwall	and 35 to 50%	50 + VeryDense	15-30 V-Stiff

Driller: BROMLEY
Helper:
Inspector: CHURCHILL
Sheet 1 of 1

1 Unless otherwise agreed, ***samples*** will be held by Welti Associates a maximum of 60 days after boring completion
2 ***Water readings*** represent driller observations — not interpretations.

LABORATORY TEST RESULTS

Boring 28, Sample 2

Water Content (ASTM D2216):

Water Content: 2.4

Specific Gravity (ASTM D-854):

Specific Gravity of Soil: 2.675

Dry Unit Weight (See Note 1):

Dry Unit Weight Of Soil: 116.3

Void Ratio (See Note 2):

Void Ratio Of Soil: 0.43

Organic Content (ASTM D-2974):

Percent Organic Matter: 0.36

Gradation (ASTM D-422):

	Percent Passing Sieve By Weight	
Sieve Size	Sample	Specification
1"	100	
3/4"	93.0	
3/8"	85.5	
No. 4	81.0	
No. 10	75.2	
No. 20	66.0	
No. 40	45.1	
No. 60	19.4	
No. 140	5.1	
No. 200	3.3	

LABORATORY TEST RESULTS

Boring 28, Sample 2 (Con't)

Direct Shear (ASTM D-3080):

Trial No.	Initial Moisture Content,%	Initial Thickness inches	Initial Unit Weight Dry, pcf	Normal Stress, psf	Maximum Shear Stress, psf
1	2.7	0.85	98.8	390.29	361.76
2	12.3	0.75	102.6	779.71	697.06
3	15.2	0.77	97.7	1169.71	1014.71

friction angle = 40
cohesion = 38

ORGANIC CONTENT

Project Oakpoint Associates Groton, CT, Submarine Base

Source B-28 S-2 Project Number 3131

Date Tested 10-17-89 Tested By TJG

Moisture:

Tare Number	
A. Weight of Wet Soil + Tare	
B. Weight of Dry Soil + Tare	
C. Weight of Water, Ww = (A-B)	
D. Weight of Tare	
E. Weight of Dry Soil, Ws = (B-D)	
F. Water Content, W = (C/E X 100)	

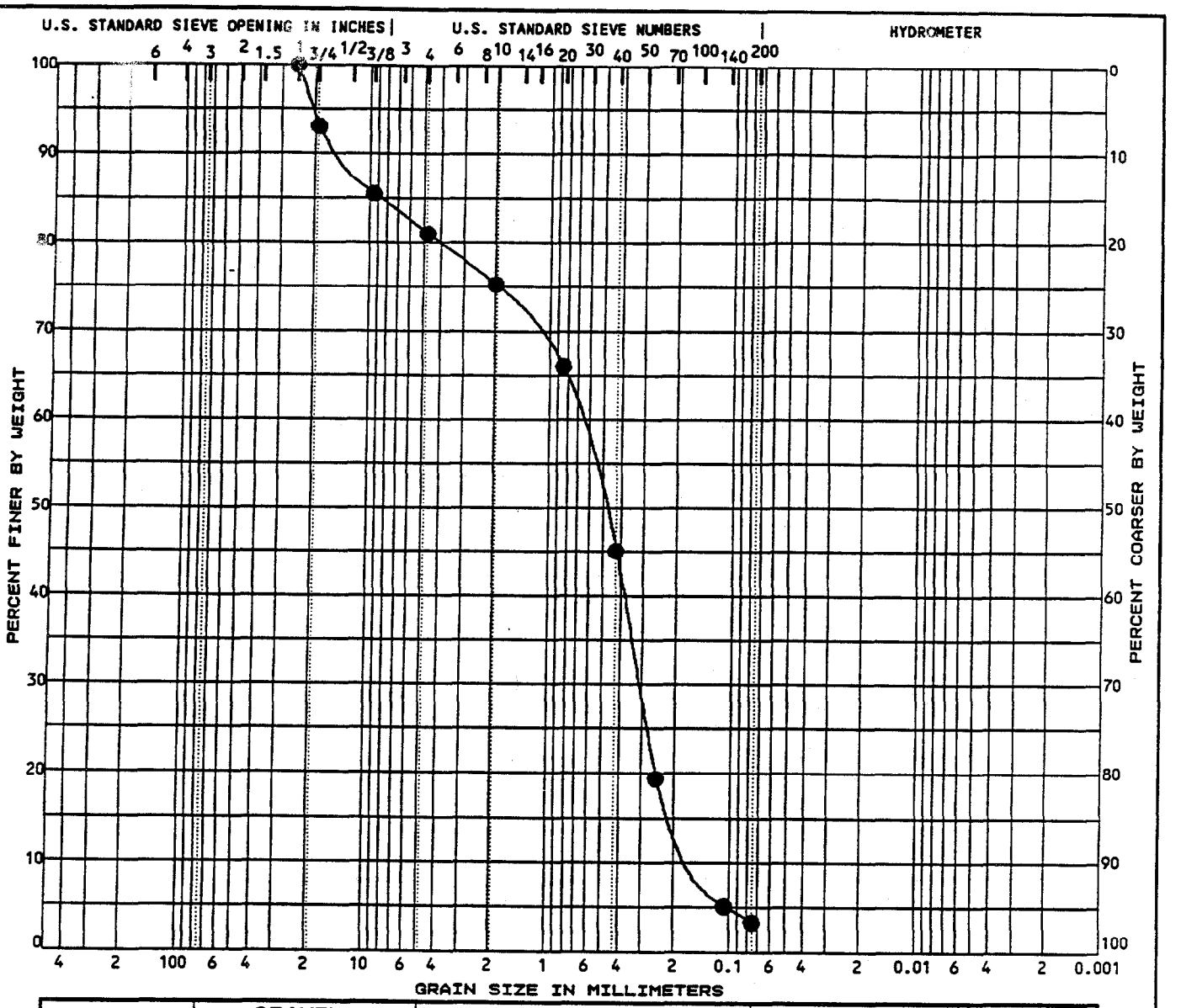
Ash:

Tare Number	
A. Weight of Dry Soil + Tare	93.95
B. Weight of Tare	57.92
C. Weight of Dry Soil, (A-B)	36.03
D. Weight of Ash + Tare	93.82
E. Weight of Tare	57.92
F. Weight of Ash, (D-E)	35.90
G. Percent Ash, (F/C + 100)	99.64

Organic Matter:

Percent Organic Matter, (100-G)	0.36

Remarks:



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

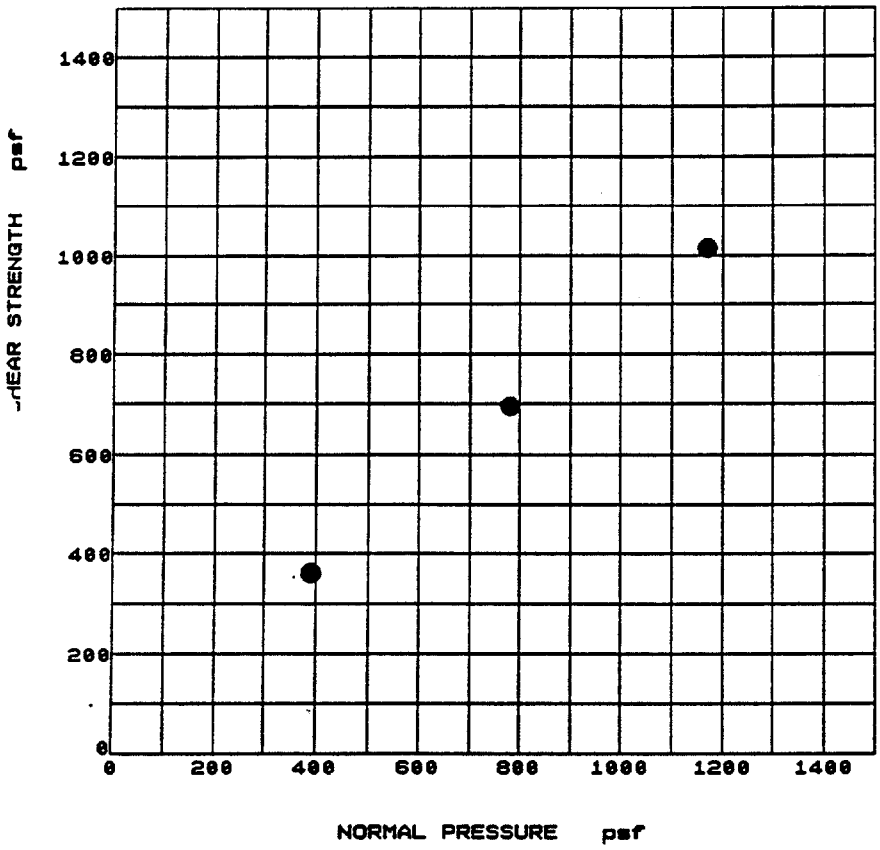
Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
● B-28,S2	5.0	Poorly Graded Sand with Gravel SP					0.98	4.9

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-28,S2	5.0	25.00	0.70	0.311	0.1422	19.0	77.7	3.3	

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date November 1989	GRADATION CURVES

DIRECT SHEAR RESULTS



FRICTION ANGLE: 40

COHESION: 38

MORRISON GEOTECHNICAL ENGINEERING

PROJECT NAME:

Oakpoint Associates

JOB NO.: 3131

BORING: B-28,S2

DEPTH: 5.0

LABORATORY TEST RESULTS

Boring 28, Sample 3

Organic Content (ASTM D-2974):

Percent Organic Matter: 1.11

Gradation (ASTM D-422):

Sieve Size	Percent Passing Sieve By Weight: Sample	Specification
1 1/2"	100	
1"	91.2	
3/4"	81.7	
3/8"	72.8	
No. 4	65.5	
No. 10	57.5	
No. 20	48.0	
No. 40	34.6	
No. 60	22.5	
No. 140	11.6	
No. 200	8.6	

ORGANIC CONTENT

Project Oakpoint Associates Groton, CT, Submarine Base

Source B-28 S-3 Project Number 3131

Date Tested 10-07-89 Tested By CEM

Moisture:

Tare Number	
A. Weight of Wet Soil + Tare	
B. Weight of Dry Soil + Tare	
C. Weight of Water, Ww = (A-B)	
D. Weight of Tare	
E. Weight of Dry Soil, Ws = (B-D)	
F. Water Content, W = (C/E X 100)	

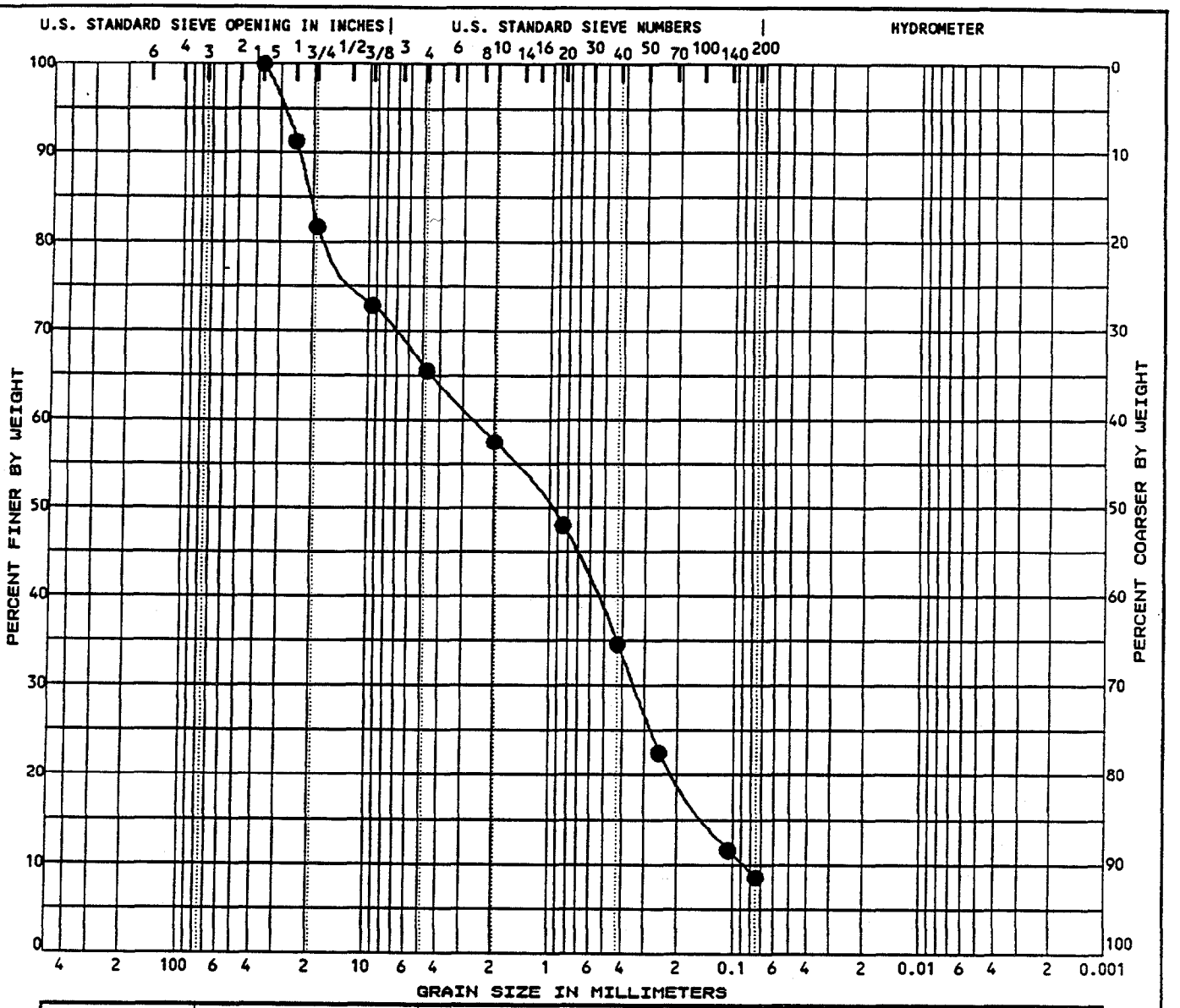
Ash:

Tare Number	
A. Weight of Dry Soil + Tare	102.33
B. Weight of Tare	58.11
C. Weight of Dry Soil, (A-B)	44.22
D. Weight of Ash + Tare	101.84
E. Weight of Tare	58.11
F. Weight of Ash, (D-E)	43.73
G. Percent Ash, (F/C + 100)	98.89

Organic Matter:

Percent Organic Matter, (100-G)	1.11

Remarks:



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
●	B-28,S3	10.0						0.52	29.7

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-28,S3	10.0	37.50	2.62	0.347	0.0881	34.5	56.9	8.6	

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date November 1989	GRADATION CURVES

LOG OF EXPLORATIONS

Hole No. **B-29**

Contractor: Clarence Weltl Associates
Driller: Dave Bromley
Type of Drill: Truck Mounted
Size & Type of Casing: 4"
Drilling Fluid: none
Other:

Project: Oakpoint Associates
No. 3131 Observer: Julie M. Churchill
Location:
Elevation: 7.72
Date Start: 9/5/89 Complete: 9/5/89
Weather:

FIELD DATA									LAB DATA	
DEPTH	ELEV	PROFILE	SAMPLE EQ TEST	SAMPLE TYPE & #	SAMPLE LENGTH	PENE-TRATION RESIST-TANCE PER 6"	RECOVERY FT. OR %	Field Description	Engineering Description	Test Data
1.0	6.7							Concrete and asphalt		
				S-1	1.5	7/13/21	40	Sand, f-c, some gravel, little silt, moist becoming saturated with depth, brown, medium dense-very dense, SM	SP-SM:Poorly graded sand with silt and gravel, subangular,hard, and durable, 0.77% organics	OC, GS
				S-2	1.5	6/7/9	33		GP:Poorly graded gravel with sand, subangular, angular, mostlyhard, and durable, 0.30% organics	W, G, D, e, OC, GS, DS
11.0	-3.3			S-3	1.0 11.0	16/79	20 100	Pink biotite pegmatite gneiss	SP-SM:Poorly graded snad with silt and gravel, subangular,subrounded, hard, and durable	
22.0	-14.3							End of rock core at 22.0'		

Remarks:

GROUNDWATER DATA

Date	Time	Depth
9/5/89	9:00 am	4.9'
9/6/89	12:25 pm	6.9'

MGE

Sheet 1 of 1

Hole No B-29

Project Abbrev. Submarine Base, Groton
Project No. 3131

Date 9/5/89
Logged by JMC

LOG OF ROCK CORE

Boring No. 29
Depth of Boring 11
Size of Core 2.1"
Type of Core Barrel NX

Location Area B
Boring Elev. 7.72
Elev. Top of Bedrock -3.28
Elev. Groundwater

Depth	Run No.	Recovery % 100	RQD %	Graphic Log	Fractures	Lithology
11.0					Weathered	Pink coarse grained granitic gneiss almost pegmatitic in fabric
12.0	1		1.6		Weathered Weathered	
13.0			.35		Mechanical break	
14.0			1.1		Mechanical break	
15.0			.7		Mechanical break	
			.35		Weathered surface	
16.0			.5		Mechanical	Schistose, mostly biotitic
17.0			2.05			
18.0					Weathered Fracture plane25°	
			.5		Mechanical break	
19.0	2		.7			Gray granite gneiss fine grained, minor biotite
					Mechanical break Mechanical break	
20.0						
21.0			2.1			
22.0					Mechanical break	Average drilling time 6 min/ft at 300 psi
					Overcored 1' to retrieve core	

CLARENCE WELTI ASSOC., INC. P.O. BOX 397 GLASTONBURY, CONN 06033	CLIENT MORRISON GEOTECHNICAL	PROJECT NAME SUBMARINE BASE LOCATION GROTON, CT

DRILLING PROCEDURES: 1 & 4 1., 2., 3., 4., (Select one or more)

1. HOLLOW STEM AUGER. Diameter 3.75"ID
2. DRIVEN CASING. Diameter
3. DRILLED CASING. Diameter
4. ROCK CORING. Diameter 2.080 & type NX

HOLE NO. B-29 Surface Elevation

GROUND WATER OBSERVATIONS
AT 4.9' FT AFTER 0 HOURS
AT FT AFTER HOURS

START DATE 9/5/89
FINISH DATE 9/5/89

DEPTH	SAMPLE NO.	BLOWS/6"	DEPTH	A	STRATUM DESCRIPTION + DEPTH	REMARKS
	1	7-13-21	1.0'-2.5'		** 1.0'	
					GR.& BR.FINE-CRS.SAND,SOME	
					FINE-MED.GRAVEL,LITTLE SILT	
					4.0'	
5	2	6-7-9	5.0'-6.5'			
					GR/BR.FINE-CRS.SAND & GRAVEL,	
					SOME COBBLES & SMALL BOULDERS,	
					TR.SILT	
10	3	16-79	10.0'-11.0'			
					11.0'	
				8	CORED: GR.GRANITE GNEISS & QUARTZITE	
				8		
				7	RUN #1 11.0'-16.0' REC.60"	
15				6		
				5	RUN #2 16.0'-22.0' REC.72"	
				5	(SOLID-SLIGHTLY FRACTURED)	
				6		
				6		
20				7		
				7		
					22.0'	
25					BOTTOM OF BORING 22.0'	
					**ASPHALT & CONCRETE	
30						
35						
40						

LEGEND: Col. A SAMPLE RECOVERY &/OR CORING TIME MINUTES/FT

140lb Wt. x 30" fall on 2" O.D. Sampler

Sample Type	Proportions Used		Cohesionless Density	Cohesive Consistency
D = Dry C = Cored W = Washed	trace	0 to 10%	0-10 Loose	0-4 Soft
UP = Undisturbed Piston	little	10 to 20%	10-30 Med.Dense	4-8 M/Stiff
TP = Test Pit A = Auger V = Vane Test	some	20 to 35%	30-50 Dense	8-15 Stiff
UT = Undisturbed Thinwall	and	35 to 50%	50 + VeryDense	15-30 V-Stiff

Driller: BROMLEY
Helper:
Inspector: CHURCHILL
Sheet 1 of 1

1 Unless otherwise agreed, ***samples*** will be held by Welti Associates a maximum of 60 days after boring completion
2 ***Water readings*** represent driller observations — not interpretations

LABORATORY TEST RESULTS

Boring 29, Sample 1

Organic Content (ASTM D-2974):

Percent Organic Matter: 0.77

Gradation (ASTM D-422):

Sieve Size	Percent Passing Sieve By Weight: Sample	Specification
1"	100	
3/4"	90.5	
3/8"	65.5	
No. 4	57.1	
No. 10	48.2	
No. 20	38.5	
No. 40	28.0	
No. 60	18.8	
No. 140	9.6	
No. 200	7.1	

ORGANIC CONTENT

Project Oakpoint Associates Groton, CT, Submarine Base

Source B-29 S-1 Project Number 3131

Date Tested 10-09-89 Tested By TJG

Moisture:

Tare Number	
A. Weight of Wet Soil + Tare	
B. Weight of Dry Soil + Tare	
C. Weight of Water, Ww = (A-B)	
D. Weight of Tare	
E. Weight of Dry Soil, Ws = (B-D)	
F. Water Content, W = (C/E X 100)	

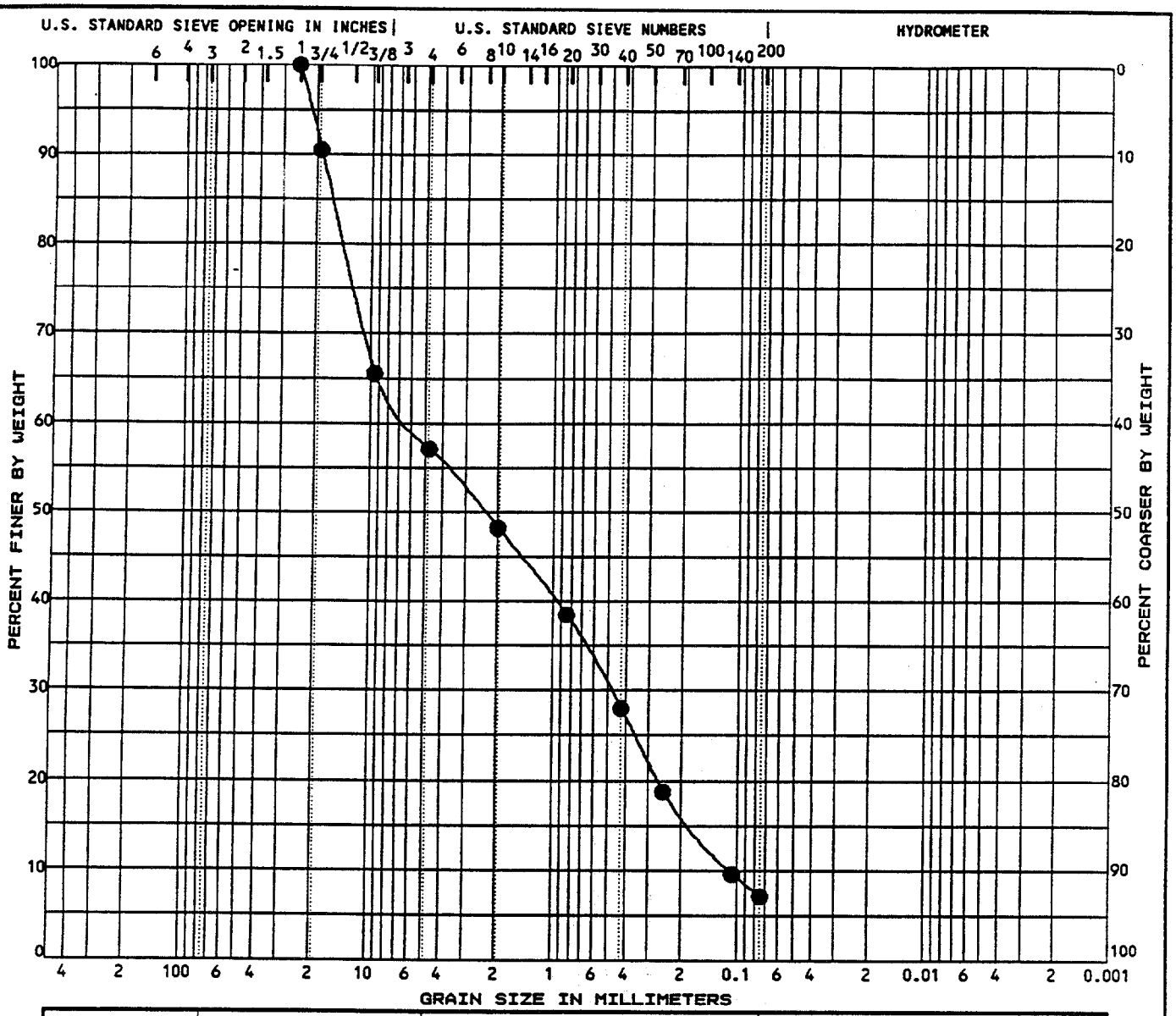
Ash:

Tare Number	
A. Weight of Dry Soil + Tare	108.75
B. Weight of Tare	57.93
C. Weight of Dry Soil, (A-B)	50.82
D. Weight of Ash + Tare	108.36
E. Weight of Tare	57.93
F. Weight of Ash, (D-E)	50.43
G. Percent Ash, (F/C + 100)	99.23

Organic Matter:

Percent Organic Matter, (100-G)	0.77

Remarks:



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
● B-29,S1	1.0	Poorly Graded Sand with Silt and Gravel SP-SM		NP	NP	NP	0.35	54.8

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-29,S1	1.0	25.00	6.03	0.485	0.1100	42.9	50.0	7.1	

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date October 1989	GRADATION CURVES

LABORATORY TEST RESULTS

Boring 29, Sample 2

Water Content (ASTM D2216):

Water Content: 5.9

Specific Gravity (ASTM D-854):

Specific Gravity of Soil: 2.726

Dry Unit Weight (See Note 1):

Dry Unit Weight Of Soil: 104.5

Void Ratio (See Note 2):

Void Ratio Of Soil: 0.63

Organic Content (ASTM D-2974):

Percent Organic Matter: 0.30

Gradation (ASTM D-422):

	Percent Passing Sieve By Weight	
Sieve Size	Sample	Specification
1 1/2"	100	
1"	72.9	
3/4"	72.9	
3/8"	59.8	
No. 4	45.1	
No. 10	34.9	
No. 20	26.7	
No. 40	18.2	
No. 60	12.4	
No. 140	6.6	
No. 200	4.7	

LABORATORY TEST RESULTS

Boring 29, Sample 2 (Con't)

Direct Shear (ASTM D-3080):

Trial No.	Initial Moisture Content,%	Initial Thickness inches	Initial Unit Weight Dry, pcf	Normal Stress, psf	Maximum Shear Stress, psf
1	11.6	0.92	106.8	390.29	600.00
2	6.2	0.80	108.3	779.71	723.53
3	12.2	0.89	117.9	1169.71	1288.23

friction angle = 41
cohesion = 182

ORGANIC CONTENT

Project Oakpoint Associates Groton, CT, Submarine Base

Source B-29 S-2 Project Number 3131

Date Tested 10-15-89 Tested By TJG

Moisture:

Tare Number	
A. Weight of Wet Soil + Tare	
B. Weight of Dry Soil + Tare	
C. Weight of Water, Ww = (A-B)	
D. Weight of Tare	
E. Weight of Dry Soil, Ws = (B-D)	
F. Water Content, W = (C/E X 100)	

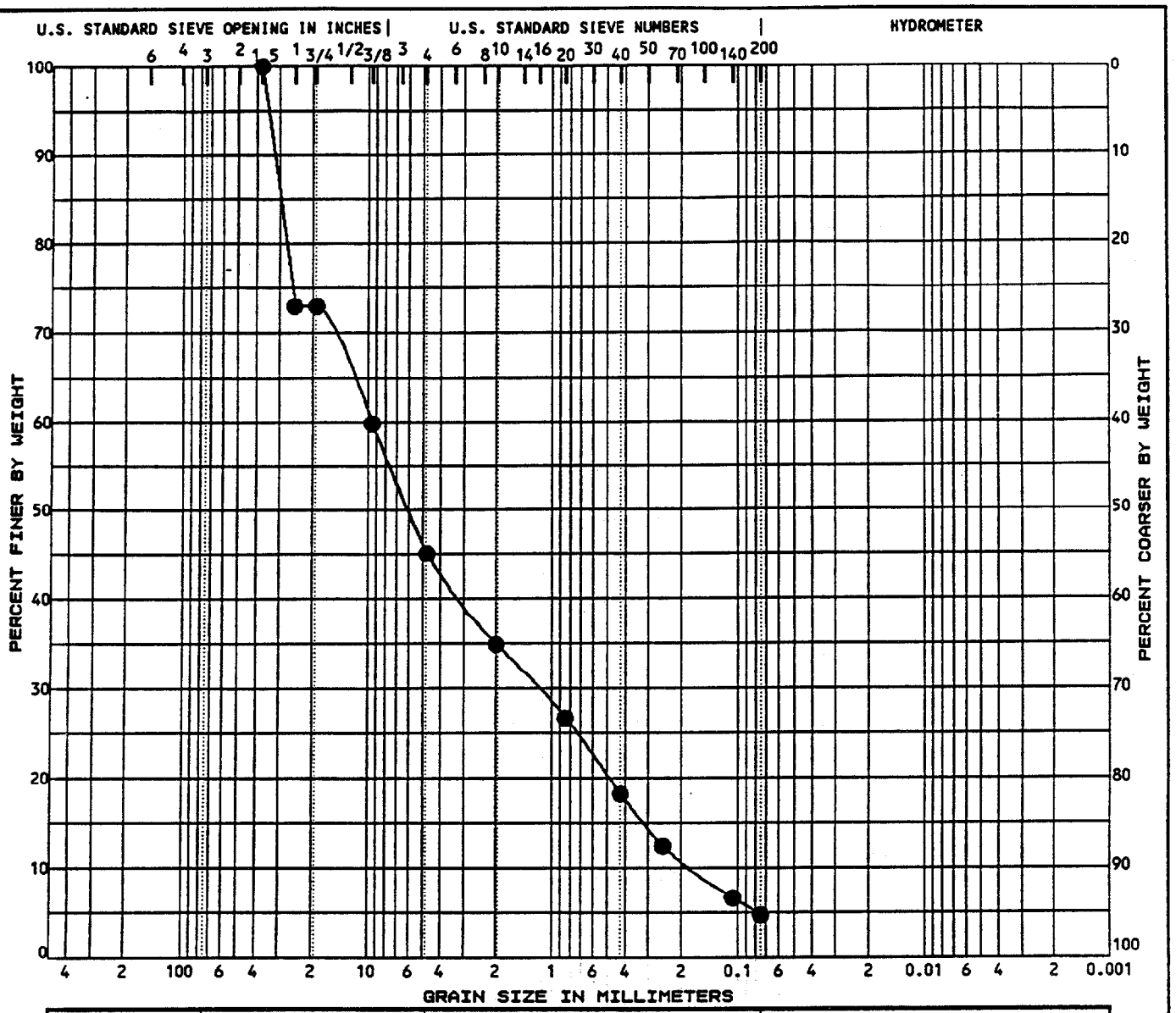
Ash:

Tare Number	A
A. Weight of Dry Soil + Tare	151.14
B. Weight of Tare	58.11
C. Weight of Dry Soil, (A-B)	93.03
D. Weight of Ash + Tare	150.87
E. Weight of Tare	58.12
F. Weight of Ash, (D-E)	92.75
G. Percent Ash, (F/C + 100)	99.70

Organic Matter:

Percent Organic Matter, (100-G)	0.30

Remarks:



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

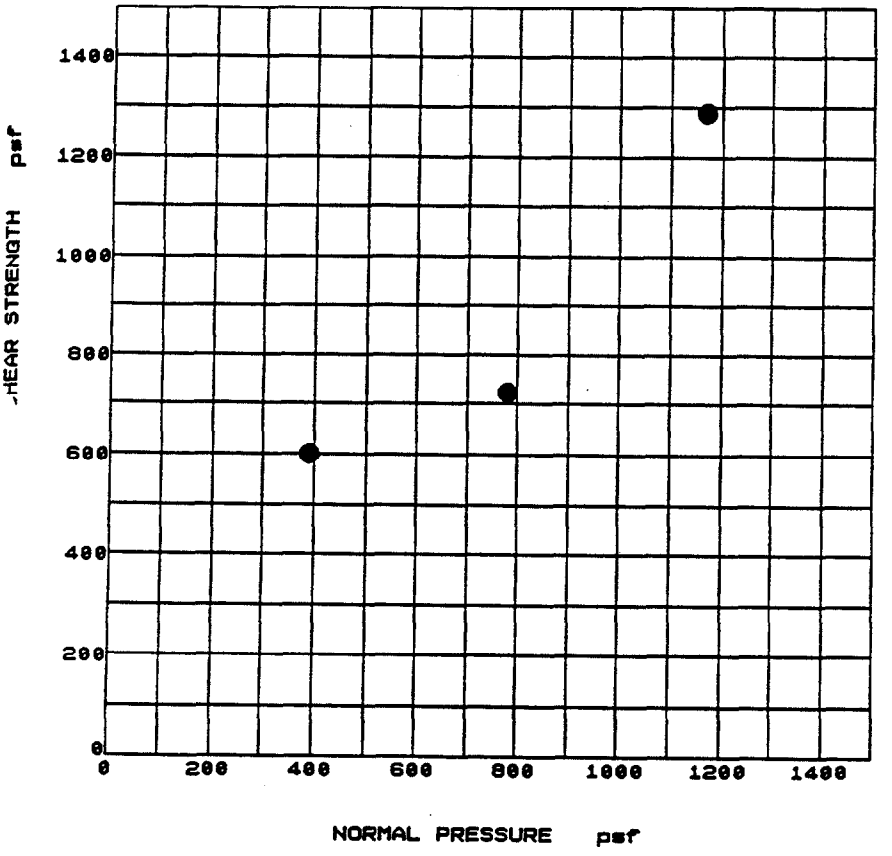
	Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
●	B-29,S2	5.0	Poorly Graded Gravel with Sand GP	6				0.85	54.8

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-29,S2	5.0	37.50	9.60	1.199	0.1753	54.9	40.4	4.7	

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date October 1989	GRADATION CURVES

DIRECT SHEAR RESULTS



FRICTION ANGLE: 41

COHESION: 182

MORRISON GEOTECHNICAL ENGINEERING

PROJECT NAME:

Oakpoint Associates

JOB NO.: 3131

BORING: B-29,S2

DEPTH: 5.0

MGE

LOG OF EXPLORATIONS

Hole No. **B-30**

Contractor: Clarence Welti Associates
Driller: Dave Bromley
Type of Drill: Truck Mounted
Size & Type of Casing: 4"
Drilling Fluid: none
Other:

Project: Oakpoint Associates
No. 3131 Observer: Julie M. Churchill
Location:
Elevation: 7.41
Date Start: 9/6/89 Complete: 9/7/89
Weather:

FIELD DATA									LAB DATA	
DEPTH	ELEV	PROFILE	SAMPLE EQ TEST	SAMPLE TYPE & #	SAMPLE LENGTH	PENE-TRATION RESIST-TANCE PER 6"	RECOVERY FT. OR %	Field Description	Engineering Description	Test Data
1.0	6.4			S-1	1.5	16/10/14	40	Concrete and asphalt	SP:Poorly graded sand with gravel, subrounded, hard, and durable	
5.0	2.4			S-2	0.5 11.0	70	60	Sand, f-c, little gravel, little silt, saturated with petroleum, gray, medium dense, SM	GP-GM:Poorly graded gravel with silt, subangular, hard, anddurable, 0.73% organics	W, G, D, e, OC, GS W/HYDRO, DS
								Gray quartzite		
16.5	-9.1							End of rock core at 16.5'		

Remarks:

GROUNDWATER DATA

Date	Time	Depth
9/11/89	10:50 am	4.2'

MGE

Hole No **B-30**

Project Abbrev. Submarine Base, Groton
Project No. 3131

Date 9/7/89
Logged by JMC

LOG OF ROCK CORE

Boring No. B-30
Depth of Boring 5.5
Size of Core 2.1"
Type of Core Barrel NX

Location Area B
Boring Elev. 7.41
Elev. Top of Bedrock 1.91
Elev. Groundwater

Depth	Run No.	Recovery 100%	RQD %	Graphic Log	Fractures	Lithology
5.5					Weathered surface	Gray quartzite
			.35		Mechanical	
6.5						
	1		1.8			
7.5					Weathered	
8.5			.65		Weathered	
9.5			1.0		Mechanical	Average drilling time 9 min/ft at 300 psi
10.5						
11.5	2		3.5			
12.5						
					Weathered	
13.5			.7		Mechanical	
					Mechanical	
14.5			.95		Mechanical	
			1.0			
15.5					Mechanical	

CLARENCE WELTI ASSOC., INC. P.O. BOX 397 GLASTONBURY, CONN 06033	CLIENT MORRISON GEOTECHNICAL	PROJECT NAME SUBMARINE BASE LOCATION GROTON, CT

DRILLING PROCEDURES: 2 & 4 1., 2., 3., 4., (Select one or more)

1. HOLLOW STEM AUGER. Diameter _____
2. DRIVEN CASING. Diameter 4" HW
3. DRILLED CASING. Diameter _____
4. ROCK CORING. Diameter 2.980 & type NX

HOLE NO. B-30 Surface Elevation _____

GROUND WATER OBSERVATIONS
AT 4.0' FT AFTER 0 HOURS
AT _____ FT AFTER _____ HOURS

START DATE 9/6/89
FINISH DATE 9/7/89

DEPTH	SAMPLE NO.	BLOWS/6"	DEPTH	A	STRATUM DESCRIPTION + DEPTH	REMARKS
	1	16-10-14	1.0'-2.5'	8"	** 0.5'	
					BR.FINE-CRS.SAND & GRAVEL,	
					OIL OR CHEMICAL ODOR VISIBLE	
5	2	70/6"	5.0'-5.5'	5"	IN SOIL (STRONG)	
				8	5.5'	
				10	CORED GR.QUARTZITE & GRANITE	
				14		
				18	RUN #1 5.50-10.5' REC.60"	
10				6		
				6	RUN #2 10.5'-15.5' REC.60"	
				6		
				6		
				6		
15				6		
					15.5'	
					BOTTOM OF BORING 15.5'	
20					**ASPHALT	
25						
30						
35						
40						

LEGEND: Col. A SAMPLE RECOVERY &/OR CORING TIME MINUTES/FT 140lb Wt. x 30" fall on 2" O.D. Sampler

Sample Type	Proportions Used	Cohesionless Density	Cohesive Consistency
D = Dry C = Cored W = Washed	trace 0 to 10%	0-10 Loose	0-4 Soft
UP = Undisturbed Piston	little 10 to 20%	10-30 Med Dense	4-8 M/Stiff
TP = Test Pit A = Auger V = Vane Test	some 20 to 35%	30-50 Dense	8-15 Stiff
UT = Undisturbed Thinwall	and 35 to 50%	50 + Very Dense	15-30 V-Stiff

Driller: BROMLEY
Helper: _____
Inspector: CHURCHILL
Sheet 1 of 1

1 Unless otherwise agreed, ***samples*** will be held by Welti Associates a maximum of 60 days after boring completion.
2 ***Water readings*** represent driller observations — not interpretations.

LABORATORY TEST RESULTS

Boring 30, Sample 2

Water Content (ASTM D2216):

Water Content:	8.2

Specific Gravity (ASTM D-854):

Specific Gravity of Soil:	2.683

Dry Unit Weight (See Note 1):

Dry Unit Weight Of Soil:	133.2

Void Ratio (See Note 2):

Void Ratio Of Soil:	0.26

Organic Content (ASTM D-2974):

Percent Organic Matter:	0.73

Grain-Size Analysis (ASTM D422 With Hydrometer):

- Gravel, passing 3 inch and retained on No. 4 sieve 48.0%
- Sand, passing No. 4 and retained on No. 200 sieve 46.5%
  - Coarse sand, passing No. 4 and retained on No. 10 sieve 6.3%
  - Medium sand, passing No. 10 and retained on No. 40 sieve 21.3%
  - Fine sand, passing No. 40 and retained on No. 200 sieve 18.9%
- Silt, 0.074 mm (No. 200) to 0.005 mm 4.5%
- Clay, smaller than 0.005 mm 1.0%

LABORATORY TEST RESULTS

Boring 30, Sample 2 (Con't)

Direct Shear (ASTM D-3080):

Trial No.	Initial Moisture Content,%	Initial Thickness inches	Initial Unit Weight Dry, pcf	Normal Stress, psf	Maximum Shear Stress, psf
1	9.6	0.79	101.8	390.29	417.71
2	13.9	0.81	111.6	779.71	820.59
3	14.9	0.82	115.2	1169.71	1182.35

friction angle = 44
cohesion = 42

ORGANIC CONTENT

Project Oakpoint Associates Groton, CT, Submarine Base

Source B-30 S-2 Project Number 3131

Date Tested 10-10-89 Tested By TJG

Moisture:

Tare Number	
A. Weight of Wet Soil + Tare	
B. Weight of Dry Soil + Tare	
C. Weight of Water, Ww = (A-B)	
D. Weight of Tare	
E. Weight of Dry Soil, Ws = (B-D)	
F. Water Content, W = (C/E X 100)	

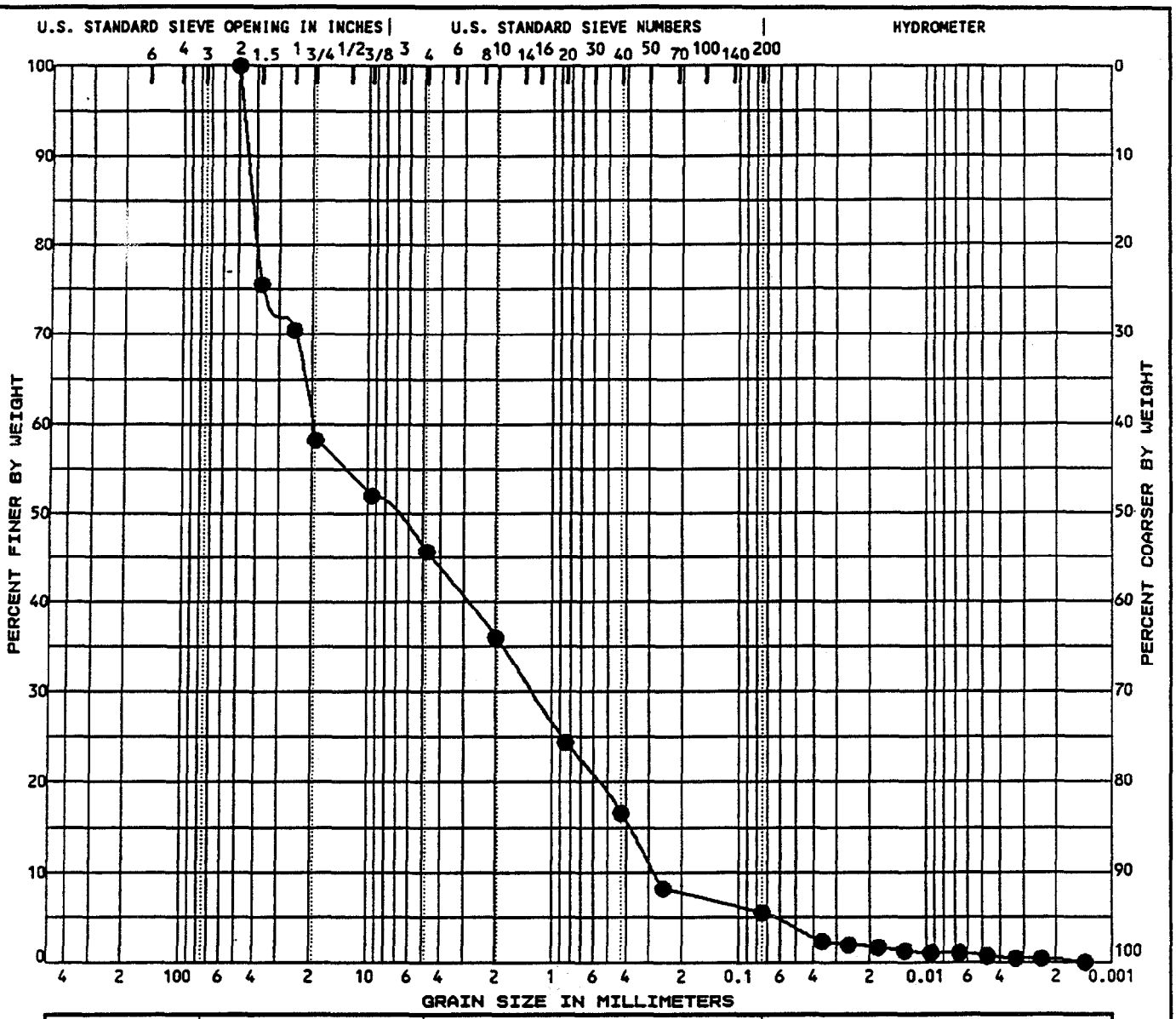
Ash:

Tare Number	E
A. Weight of Dry Soil + Tare	129.41
B. Weight of Tare	58.12
C. Weight of Dry Soil, (A-B)	71.29
D. Weight of Ash + Tare	128.88
E. Weight of Tare	58.11
F. Weight of Ash, (D-E)	70.77
G. Percent Ash, (F/C + 100)	99.27

Organic Matter:

Percent Organic Matter, (100-G)	0.73

Remarks:



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

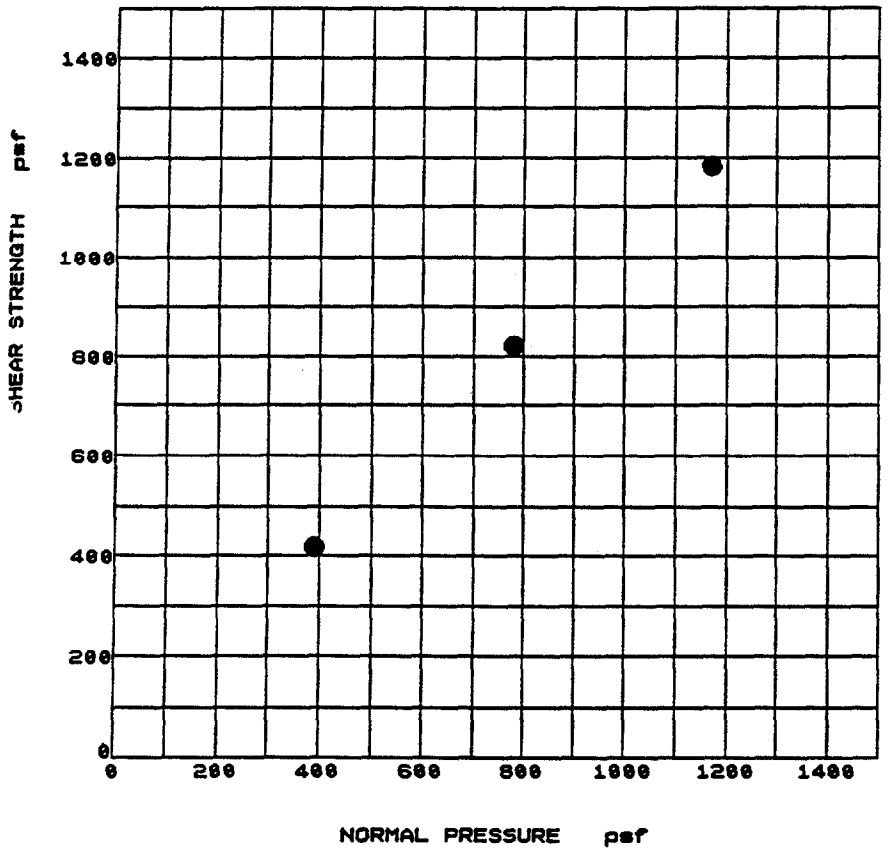
Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
● B-30,S2	5.0	Poorly Graded Gravel with Silt and Sand GP-GM	8	NP	NP	NP	0.30	70.6

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-30,S2	5.0	50.00	19.79	1.285	0.2801	54.3	40.2	4.7	0.8

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date October 1989	GRADATION CURVES

DIRECT SHEAR RESULTS



FRICTION ANGLE: 44

COHESION: 42

MORRISON GEOTECHNICAL ENGINEERING

PROJECT NAME:

Oakpoint Associates

JOB NO.: 3131

BORING: B-30,S2

DEPTH: 5.0

MGE

LOG OF EXPLORATIONS

Hole No. **B-32**

Contractor: Clarence Weltl Associates
Driller: Dave Bromley
Type of Drill: Truck Mounted
Size & Type of Casing: 4"
Drilling Fluid: none
Other:

Project: Oakpoint Associates
No. 3131 Observer: Julie M. Churchill
Location:
Elevation: 7.58
Date Start: 9/13/89 Complete: 9/14/89
Weather:

FIELD DATA									LAB DATA	
DEPTH	ELEV	PROFILE	SAMPLE EQ TEST	SAMPLE TYPE & #	SAMPLE LENGTH	PENE-TRATION RESIST-TANCE PER 6"	RECOVERY FT. OR %	Field Description	Engineering Description	Test Data
1.0	6.6			S-1	0.0 1.5	16/8/10	67	Concrete and asphalt	SP-SM:Poorly graded sand with silt and gravel, subangular andangular, hard, and durable, with asphalt, 2.88% organics	W, G, OC, GS, DS
6.0	1.6			S-2	1.5	6/14/6	53	Sand, f-c, and gravel, little silt, gray, saturated with petroleum, medium dense, GM-SM	SM:Silty sand, subrounded, hard, and durable	
								Water		
12.0	-4.4							Sand, f-c, and gravel, little silt, gray, saturated with petroleum, medium dense, Creosote saturation, GM-SM		
				S-3	1.5	6/8/8	67		SM:Silty sand, subrounded, hard, and durable	
				S-4	1.5	6/7/9	33		SP-SM:Poorly graded sand with silt, subangular, hard, and durable	
				S-5	1.5	8/8/12	67		SP-SM:Poorly graded sand with silt and gravel, subangular,hard, and durable	
				S-6	1.5	6/6/7	67		SP-SM:Poorly graded sand with silt and gravel, subangular,hard, and durable, 0.65% organics	W, G, D, e, OC, AL, GS W/HYDRO, DS
				S-7	1.5	35/36/5	67		SW-SM:Well graded sand with silt and gravel, subangular,subrounded, hard, and durable	
				S-8	1.5	29/12/35	60		GP-GM:Poorly graded gravel with silt and sand, subangular, hard,and durable, 0.43% organics	W, G, D, e, OC, GS
				S-9	1.0	46/60	40		GP-GM:Poorly graded gravel with silt and sand, subangular,hard, and durable	
47.0	-39.4							Gravel and weathered bedrock		
50.0	-42.4				5.0		50	Gray biotite granite gneiss		
55.0	-47.4							End of boring at 55.0'		

Remarks:

GROUNDWATER DATA

Date	Time	Depth
9/14/89	8:15 am	4.2'
9/15/89	8:45 am	4.1'

MGE

Sheet 1 of 1

Hole No B-32

Project Abbrev. Submarine Base, Groton
Project No. 3131

Date 9/14/89
Logged by JMC

LOG OF ROCK CORE

Boring No. 32
Depth of Boring 50.0
Size of Core 2.1"
Type of Core Barrel NX

Location Area C
Boring Elev. + 7.55
Elev. Top of Bedrock -42.45
Elev. Groundwater

Depth	Run No.	Recovery 50%	RQD %	Graphic Log	Fractures	Lithology
50.0					Mechanical fracture	Weathered biotite granite gneiss, coarse grained becoming less biotitic and more feldspathic at 51.6'
			.35		Mechanical fracture	
51.0					Mechanical fracture	
					Mechanical fracture	
			.45		Weathered fracture	
52.0					Weathered fracture	
					Mechanical fracture	
			.55		Mechanical fracture	
53.0					Mechanical fracture	
54.0						
55.0						Average drilling time 4 min/ft at 300 psi

Drilling very difficult. Hit refusal at 47', however, drove casing down to 50'. Bedrock must be highly weathered, appears so from sample and drilling mechanics. We stopped coring due to core barrel tilting, which may be a result of high angle dipping on the edge of the outcrop.
Bedrock dropped from 47' (B-32) to 90' (B-34) only 12' away

CLARENCE WELTI ASSOC., INC. P.O. BOX 397 GLASTONBURY, CONN 06033	CLIENT MORRISON GEOTECHNICAL	PROJECT NAME SUBMARINE BASE LOCATION GROTON, CT

DRILLING PROCEDURES: 2 1., 2., 3., 4.. (Select one or more)

1. HOLLOW STEM AUGER. Diameter
2. DRIVEN CASING. Diameter 4" HW
3. DRILLED CASING. Diameter
4. ROCK CORING. Diameter 2.980 & type NX

HOLE NO. B-32 Surface Elevation

GROUND WATER OBSERVATIONS
AT 6.2' FT AFTER 0 HOURS
AT FT AFTER HOURS

START DATE 9/13/89
FINISH DATE 9/13/89

DEPTH	SAMPLE NO.	BLOWS/6"	DEPTH	A	STRATUM DESCRIPTION + DEPTH	REMARKS
	1	16-8-10	1.0'-2.5'	12"	** 1.0'	
					DRK/BR.FINE-MED.SAND & GRAVEL (FUEL OIL SOAKED)	
5	2	6-4-0	5.0'-6.5'	10"	6.0'	
					WATER	
10					12.0'	
					CREOSOTE, WOOD	
					13.5'	
15	3	6-8-8	15.0'-16.5'	14"		
20	4	6-7-9	20.0'-21.5'	12"		
					GR.FINE-MED.SAND,SOME FINE-MED.GRAVEL (CREOSOTE ODOR)	
25	5	8-8-12	25.0'-26.5'	13"		
30	6	6-6-7	30.0'-31.5'	11"		
					34.0'	
35	7	29-20-22	35.0'-36.5'	13"		
					GR.FINE-MED.SAND,SOME FINE-MED.GRAVEL,LITTLE SILT	
40	8	29-12-35	40.0'-41.5'	12"		

LEGEND: Col. A SAMPLE RECOVERY &/OR CORING TIME MINUTES/FT 140lb Wt. x 30" fall on 2" O.D. Sampler

Sample Type	Proportions Used		Cohesionless Density	Cohesive Consistency
D = Dry C = Cored W = Washed	trace	0 to 10%	0-10 Loose	0-4 Soft
UP = Undisturbed Piston	little	10 to 20%	10-30 Med.Dense	4-8 M/Stiff
TP = Test Pit A = Auger V = Vane Test	some	20 to 35%	30-50 Dense	8-15 Stiff
UT = Undisturbed Thinwall	and	35 to 50%	50 + Very Dense	15-30 V-Stiff

Driller BROMLEY
Helper:
Inspector CHURCHILL
Sheet 1 of 2

1 Unless otherwise agreed, ***samples*** will be held by Welti Associates a maximum of 60 days after boring completion.
2 ***Water readings*** represent driller observations — not interpretations.

CLARENCE WELTI ASSOC., INC. P.O. BOX 397 GLASTONBURY, CONN 06033	CLIENT MORRISON GEOTECHNICAL	PROJECT NAME SUBMARINE BASE LOCATION GROTON, CT

DRILLING PROCEDURES: 2 1., 2., 3., 4., (Select one or more)

1. HOLLOW STEM AUGER. Diameter
2. DRIVEN CASING. Diameter 4" HW
3. DRILLED CASING. Diameter
4. ROCK CORING. Diameter 2.980 & type NX

HOLE NO. B-32 Surface Elevation

GROUND WATER OBSERVATIONS
AT 4.2' FT. AFTER 0 HOURS
AT FT AFTER HOURS

START DATE 9/13/89
FINISH DATE 9/14/89

DEPTH	SAMPLE NO.	BLOWS/6"	DEPTH	A	STRATUM DESCRIPTION + DEPTH	REMARKS
					GR.FINE-MED.SAND,SOME	
					FINE-MED.GRAVEL,LITTLE SILT	
45						
	9	46-60	45.0'-46.0'	12"	46.0'	
					GR.WEATHERED GRANITE GNEISS WITH	
					HARD ZONES,SOME GRANITE	
50					ROLLER BIT TO 50.0'	
				6		
				6	RUN #1 50.0'-55.0' REC.37"	
				4	(VERY SEAMY & WEATHERED)	
				1		
55				4	55.0'	
					BOTTOM OF BORING 55.0'	
					**ASPHALT & CONCRETE	
60						
					NOTE: INSTALLED WOODEN PLUG	
					IN DECK AT 7.0' + 2.0' BENTONITE	
					PELLETS ON TOP	
65						
70						
75						
80						

LEGEND: Col A SAMPLE RECOVERY &/OR CORING TIME MINUTES/FT 140lb Wt. x 30" fall on 2" O.D. Sampler

Sample Type	Proportions Used		Cohesionless Density	Cohesive Consistency
D = Dry C = Cored W = Washed	trace	0 to 10%	0-10 Loose	0-4 Soft
UP = Undisturbed Piston	little	10 to 20%	10-30 Med.Dense	4-8 M/Stiff
TP = Test Pit A = Auger V = Vane Test	some	20 to 35%	30-50 Dense	8-15 Stiff
UT = Undisturbed Thinwall	and	35 to 50%	50 + VeryDense	15-30 V-Stiff

Driller: BROMLEY
Helper:
Inspector CHURCHILL
Sheet 2 of 2

1 Unless otherwise agreed *samples* will be held by Welti Associates a maximum of 60 days after boring completion
2 *Water readings* represent driller observations — not interpretations.

LABORATORY TEST RESULTS

Boring 32, Sample 1

Water Content (ASTM D2216):

Water Content: 4.0

Specific Gravity (ASTM D-854):

Specific Gravity of Soil: 2.636

Organic Content (ASTM D-2974):

Percent Organic Matter: 2.88

Gradation (ASTM D-422):

	Percent Passing Sieve By Weight	
Sieve Size	Sample	Specification
1"	100	
3/4"	95.6	
3/8"	90.7	
No. 4	79.8	
No. 10	70.0	
No. 20	58.1	
No. 40	42.5	
No. 60	29.7	
No. 140	14.8	
No. 200	10.9	

Direct Shear (ASTM D-3080):

Trial No.	Initial Moisture Content,%	Initial Thickness inches	Initial Unit Weight Dry, pcf	Normal Stress, psf	Maximum Shear Stress, psf
1	5.9	0.78	97.6	390.29	370.59
2	16.0	0.80	113.4	779.71	820.59
3	15.3	0.85	112.7	1169.71	1217.65

friction angle = 47
cohession = 0

ORGANIC CONTENT

Project Oakpoint Associates Groton, CT, Submarine Base

Source B-32 S-1 Project Number 3131

Date Tested 11-13-89 Tested By TJG

Moisture:

Tare Number	C
A. Weight of Wet Soil + Tare	158.27
B. Weight of Dry Soil + Tare	155.66
C. Weight of Water, Ww = (A-B)	2.61
D. Weight of Tare	90.73
E. Weight of Dry Soil, Ws = (B-D)	64.93
F. Water Content, W = (C/E X 100)	4.0

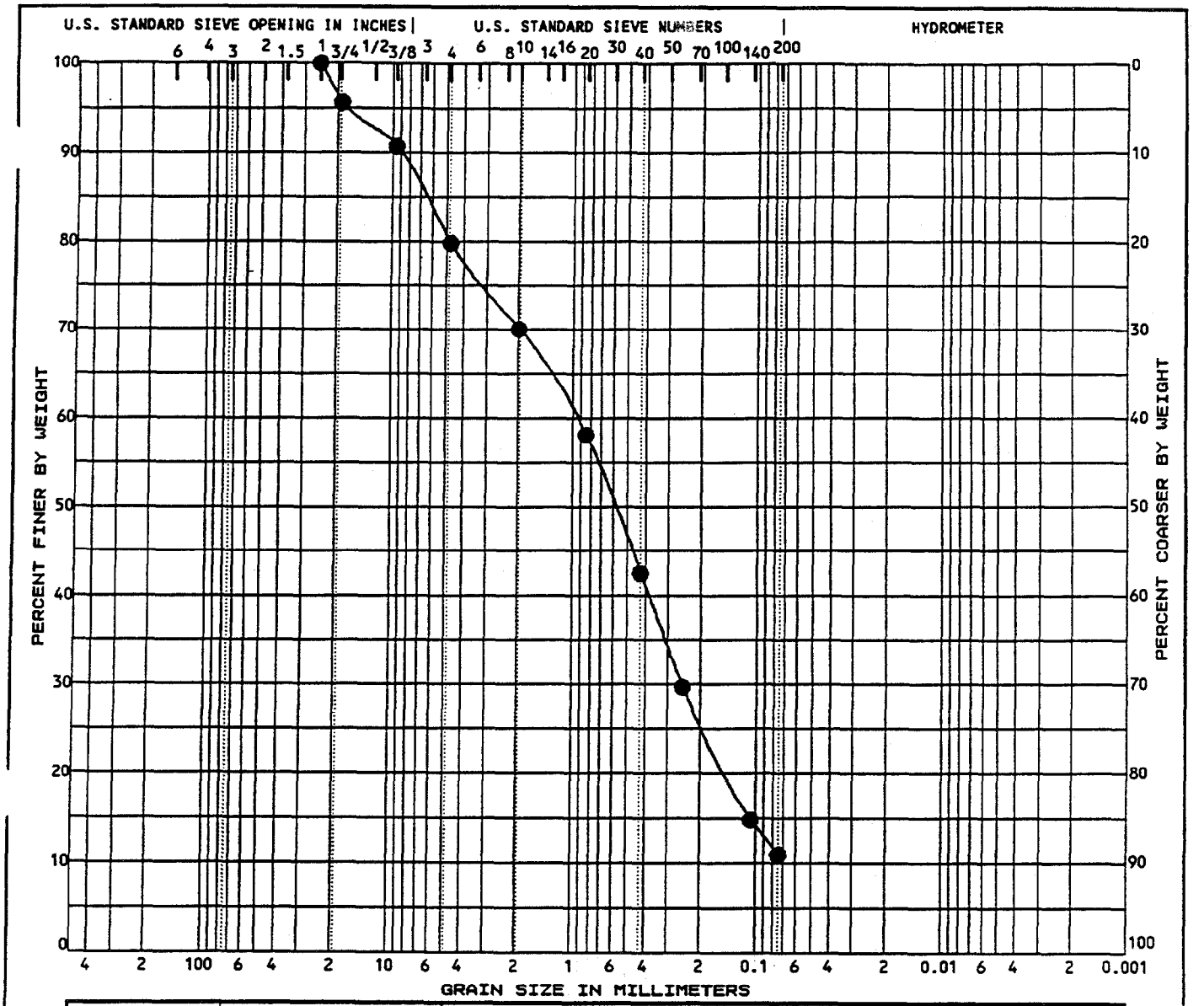
Ash:

Tare Number	
A. Weight of Dry Soil + Tare	120.19
B. Weight of Tare	55.24
C. Weight of Dry Soil, (A-B)	64.95
D. Weight of Ash + Tare	118.32
E. Weight of Tare	55.24
F. Weight of Ash, (D-E)	63.08
G. Percent Ash, (F/C + 100)	97.12

Organic Matter:

Percent Organic Matter, (100-G)	2.88

Remarks:



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

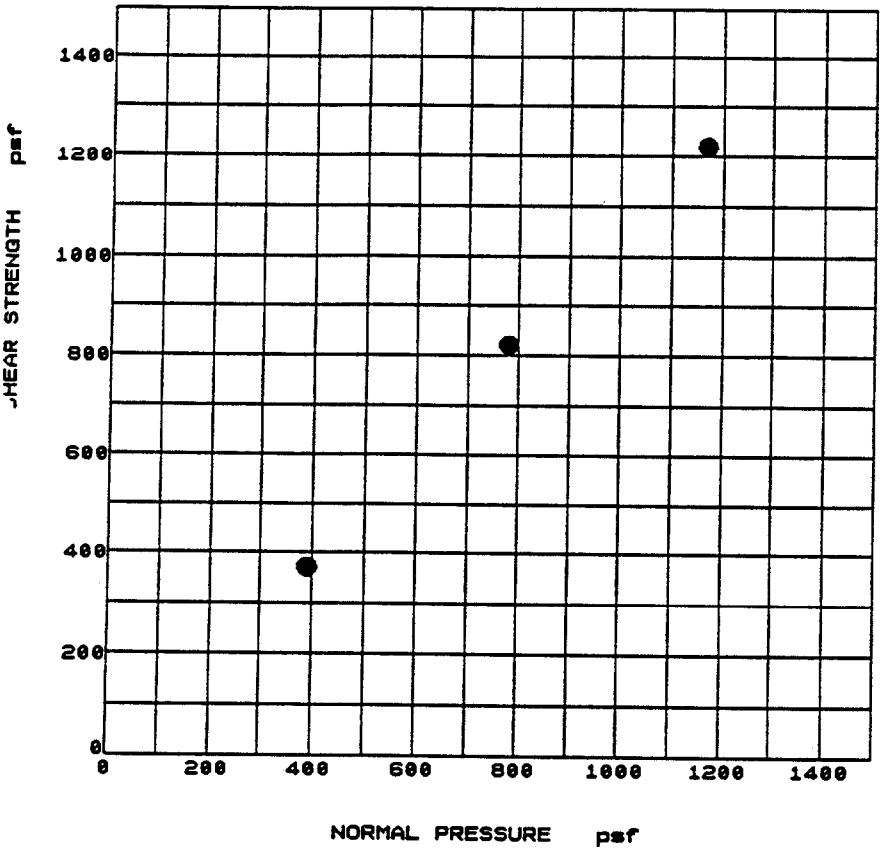
Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
● B-32,S1	1.0	Poorly Graded Sand with Silt and Gravel SP-SM	4	NP	NP	NP	0.94	13.9

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-32,S1	1.0	25.00	0.97	0.253		20.2	68.9	10.9	

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date October 1989	GRADATION CURVES

DIRECT SHEAR RESULTS



FRICTION ANGLE: 47

COHESION: 0

MORRISON GEOTECHNICAL ENGINEERING

PROJECT NAME:

Oakpoint Associates

JOB NO.: 3131

BORING: B-32,S1

DEPTH: 1.0

MGE

LABORATORY TEST RESULTS

Boring 32, Sample 6

Water Content (ASTM D2216):

Water Content:	12.5

Specific Gravity (ASTM D-854):

Specific Gravity of Soil:	2.748

Dry Unit Weight (See Note 1):

Dry Unit Weight Of Soil:	101.2

Void Ratio (See Note 2):

Void Ratio Of Soil:	0.69

Organic Content (ASTM D-2974):

Percent Organic Matter:	0.65

Atterberg Limit (ASTM D-4318):

Liquid Limit:	
Plastic Limit:	NON-PLASTIC
Plasticity Index:	

LABORATORY TEST RESULTS

Boring 32, Sample 6 (Con't)

Grain-Size Analysis (ASTM D422 With Hydrometer):

- Gravel, passing 3 inch and retained on No. 4 sieve 33.0%
- Sand, passing No. 4 and retained on No. 200 sieve 61.2%
  - Coarse sand, passing No. 4 and retained on No. 10 sieve 8.6%
  - Medium sand, passing No. 10 and retained on No. 40 sieve 21.9%
  - Fine sand, passing No. 40 and retained on No. 200 sieve 30.7%
- Silt, 0.074 mm (No. 200) to 0.005 mm 5.7%
- Clay, smaller than 0.005 mm 0.1%

Direct Shear (ASTM D-3080):

Trial No.	Initial Moisture Content,%	Initial Thickness inches	Initial Unit Weight Dry, pcf	Normal Stress, psf	Maximum Shear Stress, psf
1	13.0	0.82	115.2	390.29	458.82
2	15.5	0.79	112.0	779.71	882.35
3	13.3	0.85	112.7	1169.71	1261.76

friction angle = 46
cohesion = 64

ORGANIC CONTENT

Project Oakpoint Associates Groton, CT, Submarine Base

Source B-32 S-6 Project Number 3131

Date Tested 11-13-89 Tested By TJG

Moisture:

Tare Number	G
A. Weight of Wet Soil + Tare	177.79
B. Weight of Dry Soil + Tare	169.09
C. Weight of Water, Ww = (A-B)	8.70
D. Weight of Tare	90.78
E. Weight of Dry Soil, Ws = (B-D)	78.31
F. Water Content, W = (C/E X 100)	11.1

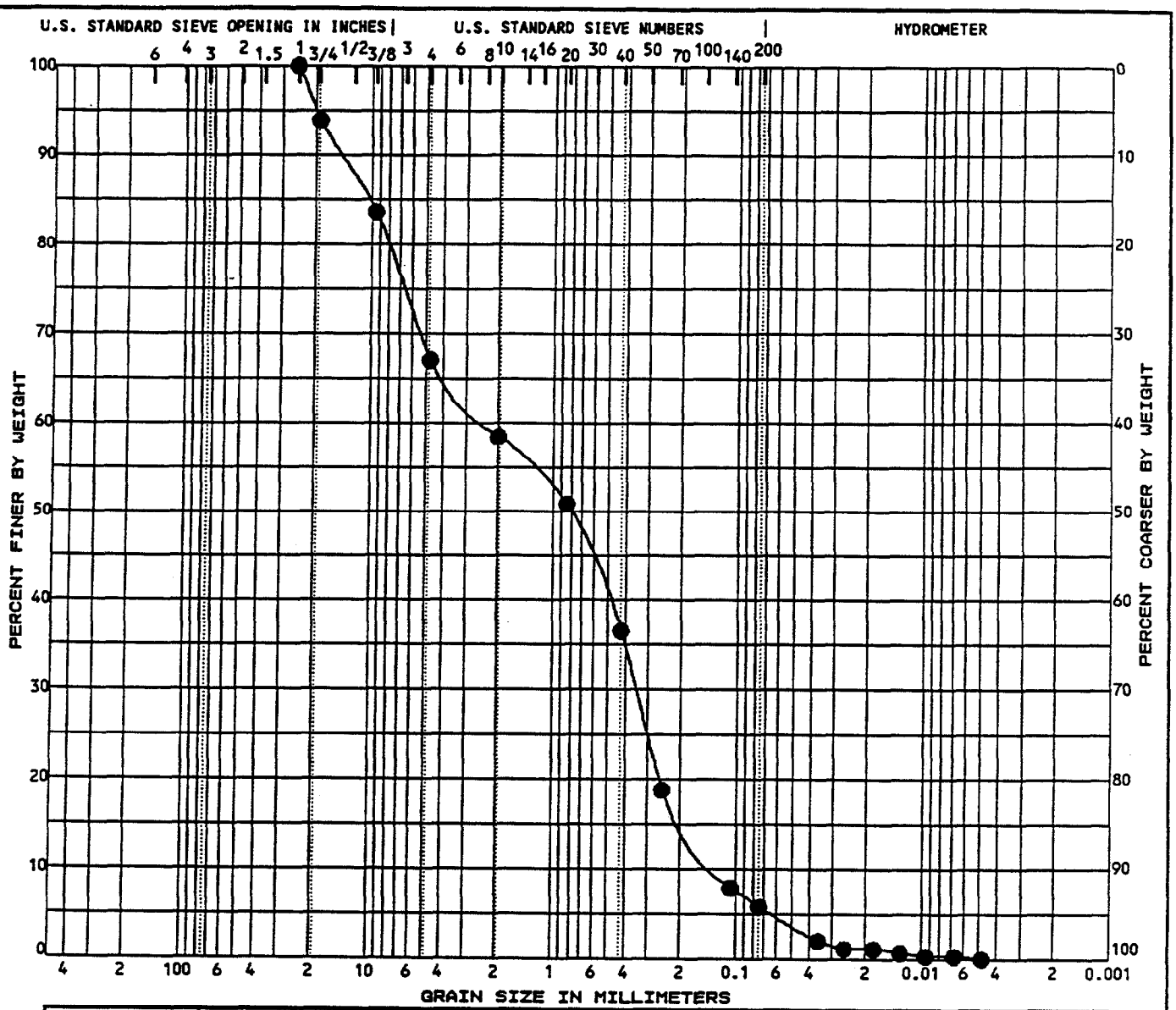
Ash:

Tare Number	
A. Weight of Dry Soil + Tare	135.65
B. Weight of Tare	57.36
C. Weight of Dry Soil, (A-B)	78.29
D. Weight of Ash + Tare	135.14
E. Weight of Tare	57.36
F. Weight of Ash, (D-E)	77.78
G. Percent Ash, (F/C + 100)	99.35

Organic Matter:

Percent Organic Matter, (100-G)	.65

Remarks:



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

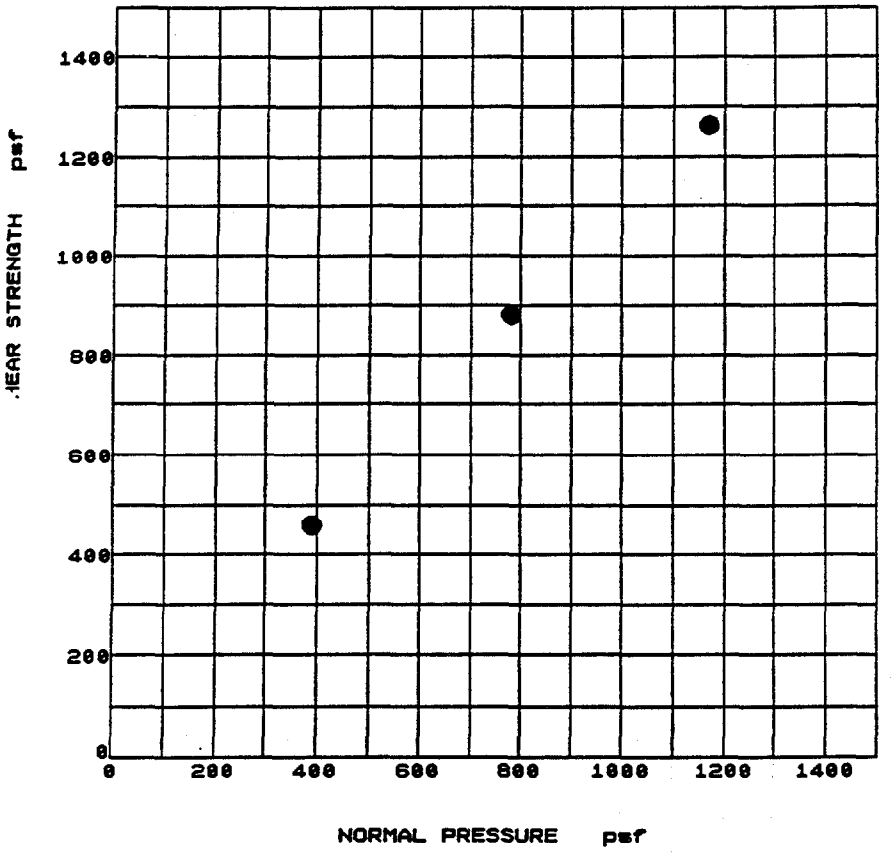
	Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
●	B-32,S6	30.0						0.42	18.8

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-32,S6	30.0	25.00	2.35	0.350	0.1251	33.0	61.2	5.8	0.0

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date November 1989	GRADATION CURVES

DIRECT SHEAR RESULTS



FRICTION ANGLE: 46

COHESION: 64

MORRISON GEOTECHNICAL ENGINEERING

PROJECT NAME:

Oakpoint Associates

JOB NO.: 3131

BORING: B-32,S6

DEPTH: 30.0

MGE

LABORATORY TEST RESULTS

Boring 32, Sample 8

Water Content (ASTM D2216):

Water Content: 6.6

Specific Gravity (ASTM D-854):

Specific Gravity of Soil: 2.700

Dry Unit Weight (See Note 1):

Dry Unit Weight Of Soil: 125.2

Void Ratio (See Note 2):

Void Ratio Of Soil: 0.35

Organic Content (ASTM D-2974):

Percent Organic Matter: 0.43

Gradation (ASTM D-422):

	Percent Passing Sieve By Weight	
Sieve Size	Sample	Specification
1 1/2"	100	
1"	68.2	
3/4"	68.2	
3/8"	53.4	
No. 4	46.3	
No. 10	36.1	
No. 20	28.8	
No. 40	22.5	
No. 60	16.1	
No. 140	8.8	
No. 200	6.6	

ORGANIC CONTENT

Project Oakpoint Associates Groton, CT, Submarine Base

Source B-32 S-8 Project Number 3131

Date Tested 11-11-89 Tested By TJG

Moisture:

Tare Number	
A. Weight of Wet Soil + Tare	
B. Weight of Dry Soil + Tare	
C. Weight of Water, Ww = (A-B)	
D. Weight of Tare	
E. Weight of Dry Soil, Ws = (B-D)	
F. Water Content, W = (C/E X 100)	

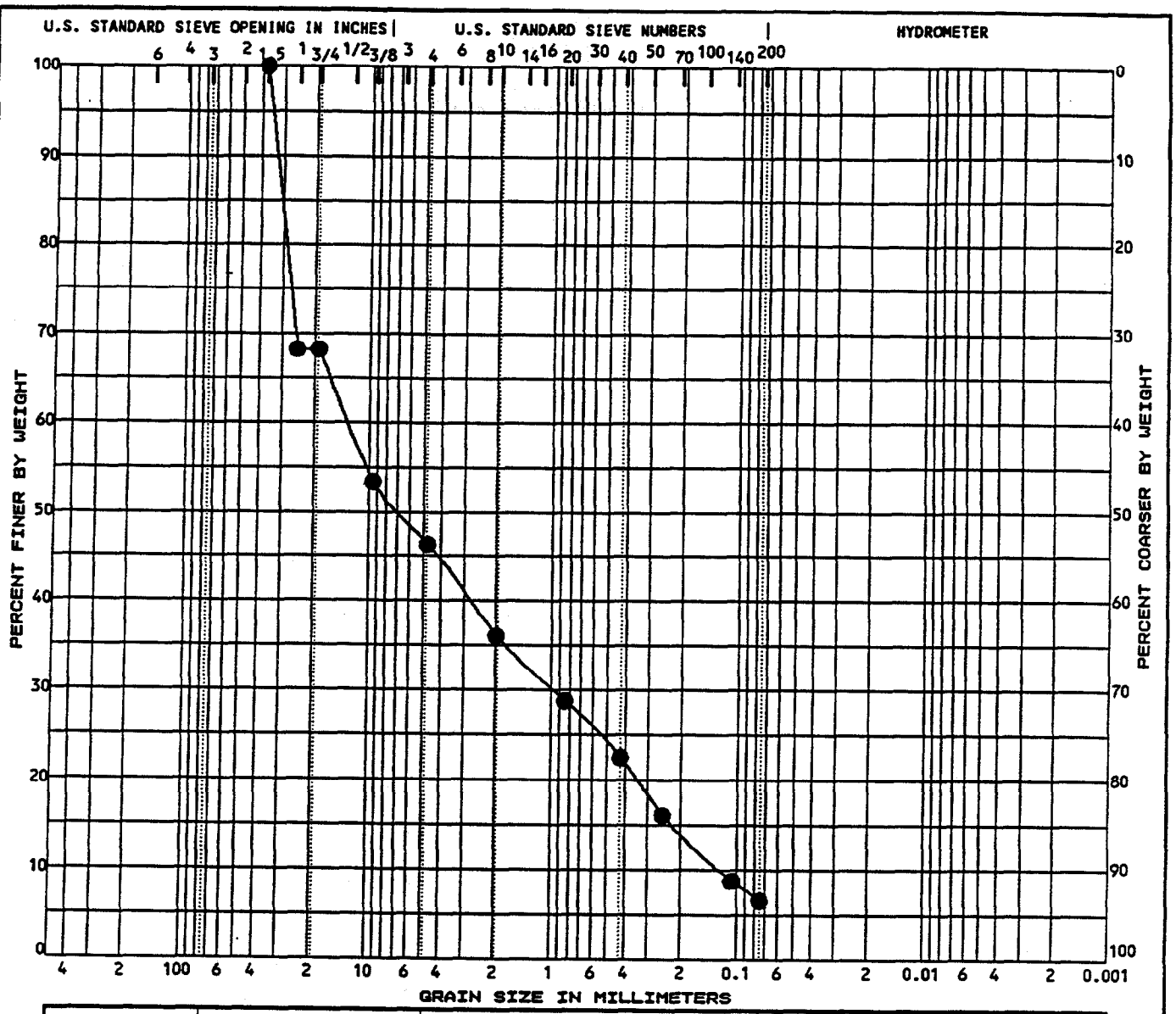
Ash:

Tare Number	A
A. Weight of Dry Soil + Tare	148.01
B. Weight of Tare	58.11
C. Weight of Dry Soil, (A-B)	89.90
D. Weight of Ash + Tare	147.63
E. Weight of Tare	58.12
F. Weight of Ash, (D-E)	89.51
G. Percent Ash, (F/C + 100)	99.57

Organic Matter:

Percent Organic Matter, (100-G)	0.43

Remarks:



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● B-32,S8 40.0						0.61	106.0

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-32,S8 40.0	37.50	12.94	0.978	0.1221	53.7	39.7	6.6	

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date November 1989	GRADATION CURVES

LOG OF EXPLORATIONS

Hole No. **B-34**

Contractor: Clarence Welti Associates
Driller: Dave Bromley
Type of Drill: Truck Mounted
Size & Type of Casing: 4"
Drilling Fluid: none
Other:

Project: Oakpoint Associates
No. 3131 Observer: Julie M. Churchill
Location:
Elevation: 7.56
Date Start: 9/11/89 Complete: 9/12/89
Weather:

DEPTH	ELEV	SAMPLE EQ TEST	SAMPLE TYPE & #	SAMPLE LENGTH	PENE-TRATION RESIST-TANCE PER 6"	RECOVERY FT. OR %	Field Description	Engineering Description	Test Data
1.0	6.6		S-1	1.5	10/10/12	67	Concrete and asphalt	SP-SM:Poorly graded sand with silt	
			S-2	1.0	6/60	33	Sand, f-c, and gravel, little silt, saturated with petroleum, creosote at 8.0', brown, medium dense, SM-GM	GP-GM:Poorly graded gravel with silt and sand, subangular andangular, hard, and durable	W, G, D, e, GS W, OC
			S-3	0.5	60	60		SP-SM:Poorly graded sand with silt, 4.05% organics SP-SM:Poorly graded sand with silt	
			S-4	1.5	7/10/10	47		SP:Poorly graded sand with gravel, subrounded, hard, and durable	W, GS
			S-5	1.5	8/12/4	13		SP-SM:Poorly graded sand with silt	
			S-6	1.5	7/4/7	7		SP-SM:Poorly graded sand with gravel and silt, subrounded,subangular, hard, and durable	
30.0	-22.4		S-7	1.5	6/9/9	33	Trace silt, SP-GP	GP:Poorly graded gravel with sand, subrounded, hard, anddurable, 0.58% organics	W, OC, GS
			S-8	1.5	27/65/30	47		SP-SM:Poorly graded sand with silt and gravel, subangular,hard, and durable	W, G, GS
			S-9	1.5	10/8/7	47		GP-GM:Poorly graded gravel with silt and sand, subangular,subrounded, hard, and durable	
			S-10	1.5	9/9/9	33		SP-SM:Poorly graded sand with silt and gravel, subangular,hard, and durable	
			S-11	1.5	6/6/7	33		SP-SM:Poorly graded sand with silt and gravel, subrounded,hard, and durable	
			S-12	1.5	12/4/4	67		MH:Elastic silt with sand, 6.74% organics SP-SM:Poorly graded sand with silt and gravel, subrounded, hard,and durable	W, OC
60.0	-52.4			1.5	7/7/8	0	Organic silt, little wood, little sand, fine, saturated, gray, very stiff, OL/OH		
				1.5	7/8/8	0			
			S-13	1.5	6/7/7	100		MH:Elastic silt, 10.35% organics	W, G, D, e, OC, AL, GS W/HYDRO
			S-14	1.5	1/0/0	100		MH:Elastic silt, 12.42% organics	W, G, D, e, OC, AL, GS W/HYDRO
80.0	-72.4								

Remarks:

GROUNDWATER DATA

Date	Time	Depth
9/11/89	8:30 am	5.1'
9/13/89	10:00 am	4.9'

MGE

LOG OF EXPLORATIONS

Hole No. **B-34**

FIELD DATA									LAB DATA	
DEPTH	ELEV	PROFILE	SAMPLE EQ TEST	SAMPLE TYPE & #	SAMPLE LENGTH	PENE-TRATION RESIST-TANCE PER 6"	RECOVERY FT. OR %	Field Description	Engineering Description	Test Data
				S-15	1.5	41/20/19	80	Gravel and sand, f-c, trace silt, saturated, gray, dense, GP-SP	SW-SM:Well graded sand with silt and gravel, subrounded, hard,and durable	
				S-16	1.5	21/20/35	100		SP-SM:Poorly graded sand with silt, subangular, hard, anddurable, 0.44% organics	W, G, D, e, OC, GS, DS
90.0	-82.4				11.0		82	Dark gray mica schist grading into a higher grade gray, coarse grained biotite granite gneiss		
101.0	-93.4							End of rock core at 101.0'		

MGE

Hole No **B-34**

Project Abbrev. Submarine Base, Groton
Project No. 3131

Date 9/12/89
Logged by JMC

LOG OF ROCK CORE

Boring No. 34
Depth of Boring 90.0
Size of Core 2.1"
Type of Core Barrel NX

Location Area C
Boring Elev. 7.56
Elev. Top of Bedrock 82.44
Elev. Groundwater

Depth	Run No.	Recovery % 100	RQD % 85	Graphic Log	Fractures	Lithology
90.0					Weathered surface	Gray mica Schist grading into a gray coarse grained biotite granite, gneiss at 92.0'
			.35		Weathered break, biotitic plane of weakness	
91.0			.6		Mechanical	
92.0			.8		Mechanical	
			.5		Fracture plane 45°	
93.0	1		.35		Fracture plane 45°	Average drilling time 7 min/ft at 300 psi
			.55		Fracture plane 45° Mechanical break	
94.0			1.05			
95.0					Mechanical break	
96.0			1.9			
97.0	2				Fracture plane 45°	
98.0			3.3			
99.0						
100.0					Fracture plane 45°	
101.0			.4			

CLARENCE WELTI ASSOC., INC. P.O. BOX 397 GLASTONBURY, CONN 06033	CLIENT MORRISON GEOTECHNICAL	PROJECT NAME SUBMARINE BASE LOCATION GROTON, CT

DRILLING PROCEDURES: 2 & 4 1., 2., 3., 4., (Select one or more)

1. HOLLOW STEM AUGER, Diameter
2. DRIVEN CASING, Diameter 4" HW
3. DRILLED CASING, Diameter
4. ROCK CORING, Diameter 2.980 & type NX

HOLE NO. B-34 Surface Elevation

GROUND WATER OBSERVATIONS
AT 4.9' FT. AFTER 0 HOURS
AT FT AFTER HOURS

START DATE 9/11/89
FINISH DATE 9/13/89

DEPTH	SAMPLE NO.	BLOWS/6"	DEPTH	A	STRATUM DESCRIPTION + DEPTH	REMARKS
	1	10-10-12	1.0'-2.5'	12"	** 1.0'	
5	2	6-60	5.0'-6.0'	6"	DRK/BR.FINE-CRS.SAND & FINE-CRS.GRAVEL,LITTLE WOOD, FUEL OIL 4.0'-6.0' 6.0'	
10	3	60/6"	10.0'-10.5'	8"	DRK/BR.& BLK.WOOD,CREOSOTE, & GR.FINE-MED.SAND 11.0'	
15	4	7-10-10	15.0'-16.5'	6"		
20	5	8-12-11	20.0'-21.5'	3"	GR.FINE-CRS.SAND & GRAVEL, LITTLE CONCRETE & BRICKS	
25	6	7-4-7	25.0'-26.5'	2"		
30	7	6-9-9	30.0'-31.5'	6"	30.0'	
35	8	27-65-30	35.0'-36.5'	8"	GR.FINE-MED.SAND,SOME FINE-CRS.GRAVEL,TR.SILT	
40	9	10-8-7	40.0'-41.5'	6"	40.0'	

LEGEND: Col. A SAMPLE RECOVERY &/OR CORING TIME MINUTES/FT

140lb Wt. x 30" fall on 2" O.D. Sampler

Sample Type	Proportions Used		Cohesionless Density	Cohesive Consistency
D = Dry C = Cored W = Washed	trace	0 to 10%	0-10 Loose	0-4 Soft
UP = Undisturbed Piston	little	10 to 20%	10-30 Med.Dense	4-8 M/Stiff
TP = Test Pit A = Auger V = Vane Test	some	20 to 35%	30-50 Dense	8-15 Stiff
UT = Undisturbed Thinwall	and	35 to 50%	50 + VeryDense	15-30 V-Stiff

Driller: BROMLEY
Helper:
Inspector CHURCHILL
Sheet 1 of 3

1. Unless otherwise agreed, *samples* will be held by Welti Associates a maximum of 60 days after boring completion.
2. *Water readings* represent driller observations — not interpretations.

CLARENCE WELTI ASSOC., INC. P.O. BOX 397 GLASTONBURY, CONN 06033	CLIENT MORRISON GEOTECHNICAL	PROJECT NAME SUBMARINE BASE LOCATION GROTON, CT

DRILLING PROCEDURES: 2 & 4 1., 2., 3., 4., (Select one or more)

1. HOLLOW STEM AUGER. Diameter
2. DRIVEN CASING. Diameter 4" HW
3. DRILLED CASING. Diameter
4. ROCK CORING. Diameter 2.980 & type NX

HOLE NO. B-34 Surface Elevation

GROUND WATER OBSERVATIONS
AT 4.9' FT. AFTER 0 HOURS
AT FT. AFTER HOURS

START DATE 9/11/89
FINISH DATE 9/13/89

DEPTH	SAMPLE NO.	BLOWS/6"	DEPTH	A	STRATUM DESCRIPTION + DEPTH	REMARKS
45	10	9-9-9'	45.0'-46.5'	6"		
					GR.FINE-CRS.SAND & FINE-MED.GRAVEL,TR.WOOD	
50	11	6-6-7	50.0'-51.5'	6"		
55	12	12-4-4	55.0'-56.5'	8"		
					56.0'	
					GR.ORGANIC SILT, WITH SHELLS,TR.CLAY	
60		7-8-8	60.0'-61.5'	0"		
65		7-7-8	65.0'-66.5'	0"		
70	13	6-7-7	70.0'-71.5'	18"		
					70.0'	
					GR.ORGANIC SILT,LITTLE WOOD, FINE SAND,CLAY & PEAT FIBERS	
75	14	1-0--0	75.0'-76.5'	18"		
					77.0'	
					GR.FINE-CRS.SAND,SOME FINE-MED.GRAVEL,TR.SILT	
80	15	41-20-19	80.0'-81.5'	12"		

LEGEND: Col A SAMPLE RECOVERY &/OR CORING TIME MINUTES/FT

Sample Type
D = Dry C = Cored W = Washed
UP = Undisturbed Piston
TP = Test Pit A = Auger V = Vane Test
UT = Undisturbed Thinwall

Proportions Used		Cohesionless Density	Cohesive Consistency
trace	0 to 10%	0-10 Loose	0-4 Soft
little	10 to 20%	10-30 Med.Dense	4-8 M/Stiff
some	20 to 35%	30-50 Dense	8-15 Stiff
and	35 to 50%	50 + VeryDense	15-30 V-Stiff

140lb Wt. x 30" fall on 2" O.D. Sampler

Driller: BROMLEY
Helper:
Inspector: CHURCHILL
Sheet 2 of 3

1 Unless otherwise agreed, *samples* will be held by Welti Associates a maximum of 60 days after boring completion.
2 *Water readings* represent driller observations – not interpretations.

CLARENCE WELTI ASSOC., INC. P.O. BOX 397 GLASTONBURY, CONN 06033	CLIENT MORRISON GEOTECHNICAL	PROJECT NAME SUBMARINE BASE LOCATION GROTON, CT

DRILLING PROCEDURES: 2 & 4 1., 2., 3., 4., (Select one or more)

1. HOLLOW STEM AUGER. Diameter
2. DRIVEN CASING. Diameter 4" HW
3. DRILLED CASING. Diameter
4. ROCK CORING. Diameter 2.980 & type NX

HOLE NO. B-34 Surface Elevation

GROUND WATER OBSERVATIONS
AT 4.9' FT AFTER 0 HOURS
AT FT AFTER HOURS

START DATE 9/11/89
FINISH DATE 9/13/89

DEPTH	SAMPLE NO.	BLOWS/6"	DEPTH	A	STRATUM DESCRIPTION + DEPTH	REMARKS
					GR.FINE-CRS.SAND,SOME FINE-MED.GRAVEL,TR.SILT	
85	16	21-20-35	85.0'-86.5'	18"	85.0'	
					GR.FINE-MED.SAND, LITTLE CRS.SAND	
90					90.0'	
				5	CORED: GR.GRANITE GNEISS	
				5		
				6	RUN #1 90.0'-95.0' REC.60'	
				7	(SOLID)	
95				7		
				7	RUN #2 95.0'-101.0' REC.72"	
				7	(SOLID)	
				7		
				7		
100				7		
				7	101.0'	
					BOTTOM OF BORING 101.0'	
105					**ASPHALT & CONCRETE	
110						
115						
120						

LEGEND: Col A SAMPLE RECOVERY &/OR CORING TIME MINUTES/FT 140lb Wt. x 30" fall on 2" O.D. Sampler

Sample Type	Proportions Used		Cohesionless Density	Cohesive Consistency
D = Dry C = Cored W = Washed	trace	0 to 10%	0-10 Loose	0-4 Soft
UP = Undisturbed Piston	little	10 to 20%	10-30 Med.Dense	4-8 M/Stiff
TP = Test Pit A = Auger V = Vane Test	some	20 to 35%	30-50 Dense	8-15 Stiff
UT = Undisturbed Thinwall	and	35 to 50%	50 + VeryDense	15-30 V-Stiff

Driller: BROMLEY
Helper:
Inspector CHURCHILL
Sheet 3 of 3

1 Unless otherwise agreed, samples will be held by Welti Associates a maximum of 60 days after boring completion.
2 *Water readings* represent driller observations — not interpretations.

LABORATORY TEST RESULTS

Boring 34, Sample 2

Water Content (ASTM D2216):

Water Content: 6.0

Specific Gravity (ASTM D-854):

Specific Gravity of Soil: 2.663

Dry Unit Weight (See Note 1):

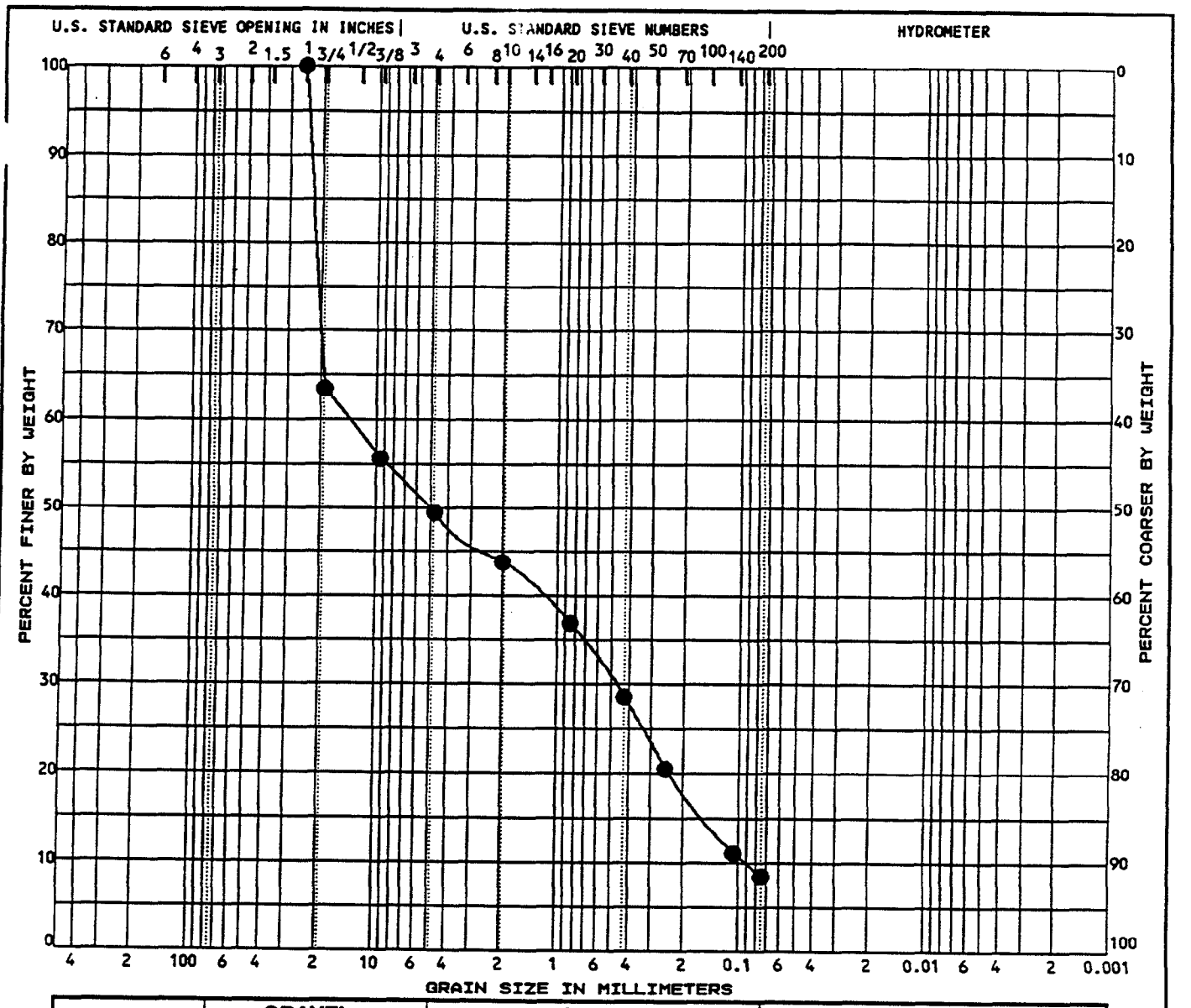
Dry Unit Weight Of Soil: 129.4

Void Ratio (See Note 2):

Void Ratio Of Soil: 0.28

Gradation (ASTM D-422):

	Percent Passing Sieve By Weight	
Sieve Size	Sample	Specification
1"	100	
3/4"	63.4	
3/8"	55.6	
No. 4	49.4	
No. 10	43.8	
No. 20	36.9	
No. 40	28.6	
No. 60	20.5	
No. 140	11.1	
No. 200	8.5	



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
●	B-34,S2	5.0	Poorly Graded Gravel with Silt and Sand GP-GM	6	NP	NP	NP	0.18	153.4

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-34,S2	5.0	25.00	14.05	0.478	0.0916	50.6	40.9	8.5	

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date October 1989	GRADATION CURVES

LABORATORY TEST RESULTS

Boring 34, Sample 2A

Water Content (ASTM D2216):

Water Content:	17.7

Organic Content (ASTM D-2974):

Percent Organic Matter:	4.05

ORGANIC CONTENT

Project Oakpoint Associates Groton, CT, Submarine Base

Source B-34 S-2A Project Number 3131

Date Tested 11-12-89 Tested By TJG

Moisture:

Tare Number	B
A. Weight of Wet Soil + Tare	149.91
B. Weight of Dry Soil + Tare	140.90
C. Weight of Water, Ww = (A-B)	9.01
D. Weight of Tare	89.98
E. Weight of Dry Soil, Ws = (B-D)	50.92
F. Water Content, W = (C/E X 100)	17.7

Ash:

Tare Number	
A. Weight of Dry Soil + Tare	106.16
B. Weight of Tare	55.24
C. Weight of Dry Soil, (A-B)	50.92
D. Weight of Ash + Tare	104.10
E. Weight of Tare	55.24
F. Weight of Ash, (D-E)	48.86
G. Percent Ash, (F/C + 100)	95.95

Organic Matter:

Percent Organic Matter, (100-G)	4.05

Remarks:

LABORATORY TEST RESULTS

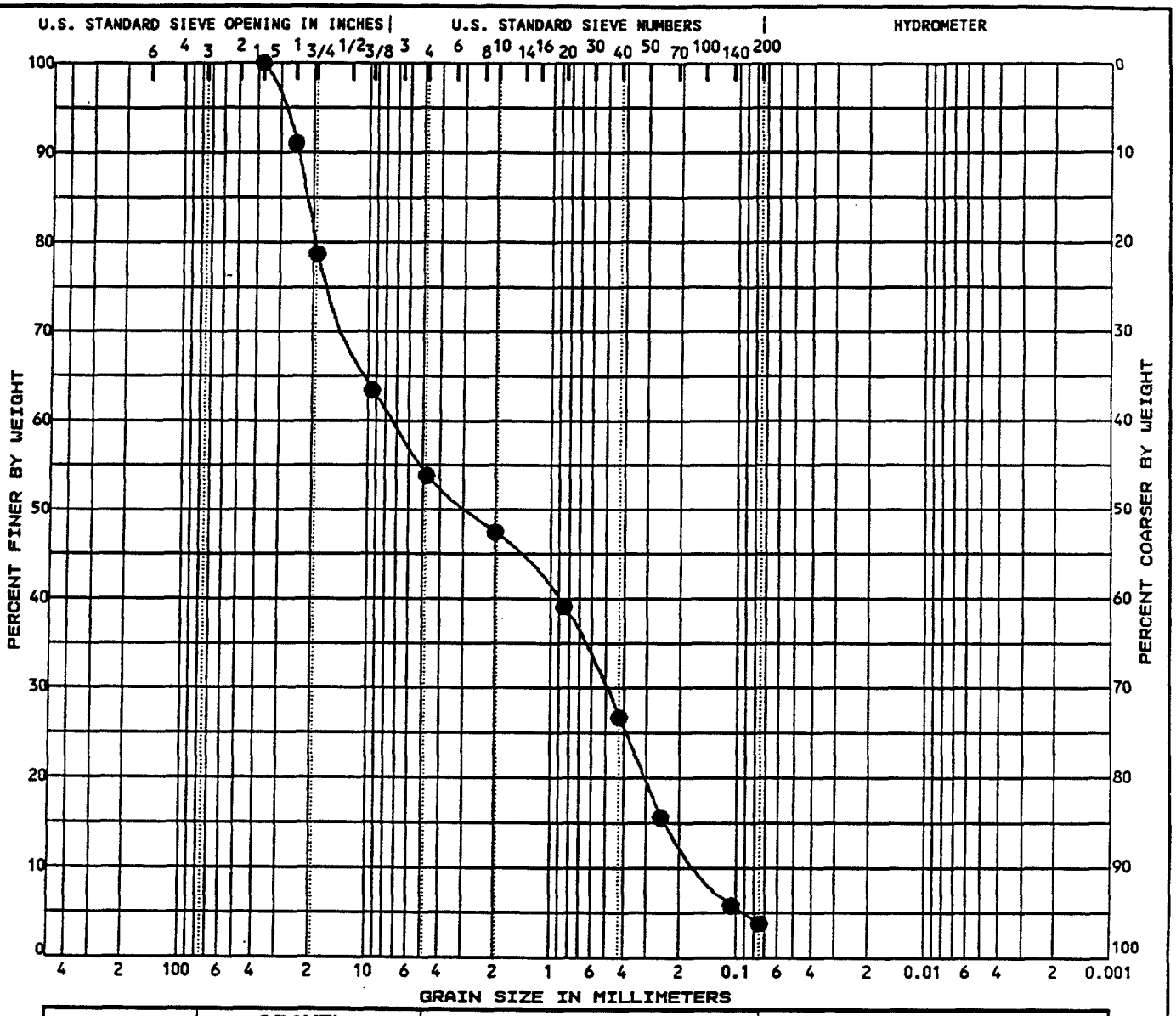
Boring 34, Sample 4

Water Content (ASTM D2216):

Water Content: 9.2

Gradation (ASTM D-422):

Sieve Size	Percent Passing Sieve By Weight: Sample	Specification
1 1/2"	100	
1"	91.0	
3/4"	78.7	
3/8"	63.4	
No. 4	53.8	
No. 10	47.4	
No. 20	39.2	
No. 40	26.8	
No. 60	15.6	
No. 140	5.8	
No. 200	3.8	



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
●	B-34,S4	15.0	Poorly Graded Sand with Gravel SP					0.23	48.5

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-34,S4	15.0	37.50	7.43	0.508	0.1531	46.2	50.0	3.8	

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date November 1989	GRADATION CURVES

LABORATORY TEST RESULTS

Boring 34, Sample 7

Water Content (ASTM D2216):

Water Content: 42.6

Organic Content (ASTM D-2974):

Percent Organic Matter: 0.58

Gradation (ASTM D-422):

	Percent Passing Sieve By Weight	
Sieve Size	Sample	Specification
1 1/2"	100	
1"	68.5	
3/4"	68.5	
3/8"	62.1	
No. 4	52.2	
No. 10	45.3	
No. 20	36.5	
No. 40	24.5	
No. 60	15.1	
No. 140	6.6	
No. 200	4.8	

ORGANIC CONTENT

Project Oakpoint Associates Groton, CT, Submarine Base

Source B-34 S-7 Project Number 3131

Date Tested 11-14-89 Tested By CEM

Moisture:

Tare Number	
A. Weight of Wet Soil + Tare	
B. Weight of Dry Soil + Tare	
C. Weight of Water, Ww = (A-B)	
D. Weight of Tare	
E. Weight of Dry Soil, Ws = (B-D)	
F. Water Content, W = (C/E X 100)	

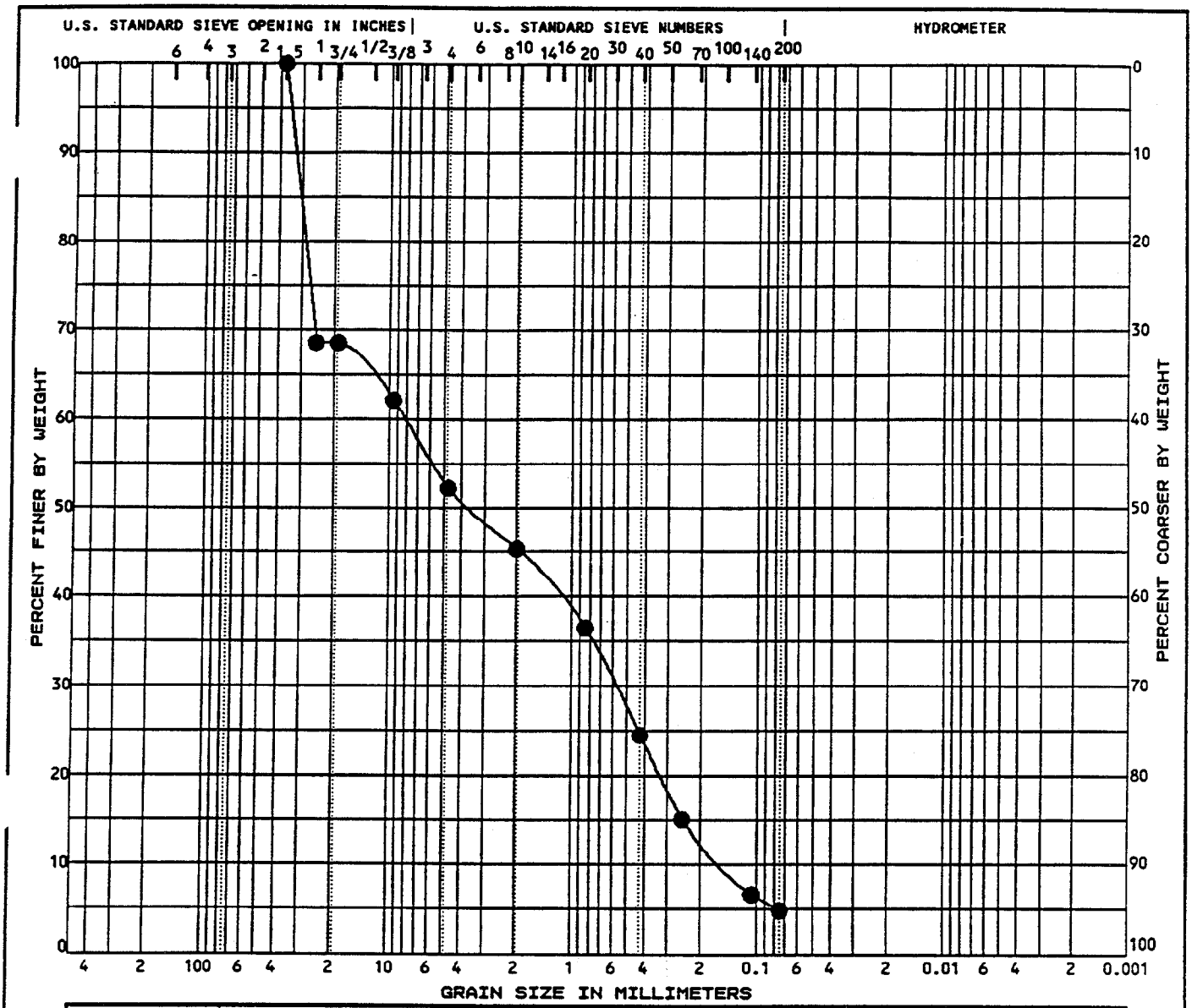
Ash:

Tare Number	E
A. Weight of Dry Soil + Tare	121.68
B. Weight of Tare	58.12
C. Weight of Dry Soil, (A-B)	63.56
D. Weight of Ash + Tare	121.30
E. Weight of Tare	58.11
F. Weight of Ash, (D-E)	63.19
G. Percent Ash, (F/C + 100)	99.42

Organic Matter:

Percent Organic Matter, (100-G)	0.58

Remarks:



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
●	B-34,S7	30.0						0.28	54.9

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-34,S7	30.0	37.50	8.20	0.584	0.1494	47.8	47.4	4.8	

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date November 1989	GRADATION CURVES

LABORATORY TEST RESULTS

Boring 34, Sample 8

Water Content (ASTM D2216):

Water Content: 10.0

Specific Gravity (ASTM D-854):

Specific Gravity of Soil: 2.717

Dry Unit Weight (See Note 1):

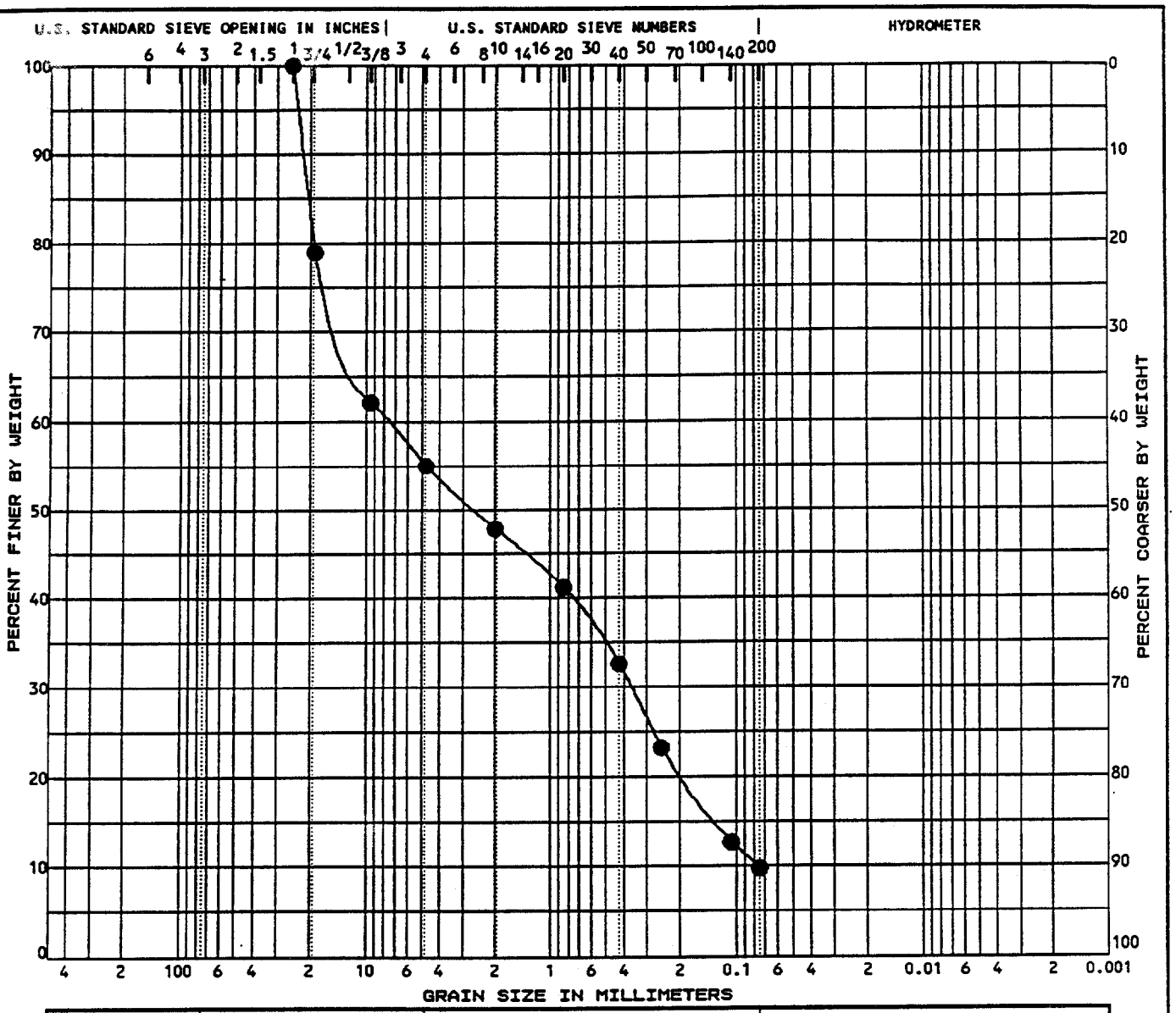
Dry Unit Weight Of Soil: 139.7

Void Ratio (See Note 2):

Void Ratio Of Soil: 0.21

Gradation (ASTM D-422):

	Percent Passing Sieve By Weight	
Sieve Size	Sample	Specification
1"	100	
3/4"	78.9	
3/8"	62.1	
No. 4	55.0	
No. 10	47.8	
No. 20	41.2	
No. 40	32.6	
No. 60	23.2	
No. 140	12.7	
No. 200	9.7	



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● B-34,S8 35.0						0.22	99.7

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-34,S8 35.0	25.00	7.74	0.367	0.0776	45.0	45.3	9.7	

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date November 1989	GRADATION CURVES

LABORATORY TEST RESULTS

Boring 34, Sample 12

Water Content (ASTM D2216):

Water Content:	52.5

Organic Content (ASTM D-2974):

Percent Organic Matter:	6.74

ORGANIC CONTENT

Project Oakpoint Associates Groton, CT, Submarine Base

Source B-34 S-12 Project Number 3131

Date Tested _____ Tested By _____

Moisture:

Tare Number	A
A. Weight of Wet Soil + Tare	141.86
B. Weight of Dry Soil + Tare	124.26
C. Weight of Water, Ww = (A-B)	17.60
D. Weight of Tare	90.75
E. Weight of Dry Soil, Ws = (B-D)	33.51
F. Water Content, W = (C/E X 100)	52.52

Ash:

Tare Number	
A. Weight of Dry Soil + Tare	88.76
B. Weight of Tare	55.24
C. Weight of Dry Soil, (A-B)	33.52
D. Weight of Ash + Tare	86.51
E. Weight of Tare	55.25
F. Weight of Ash, (D-E)	31.26
G. Percent Ash, (F/C + 100)	93.26

Organic Matter:

Percent Organic Matter, (100-G)	6.74

Remarks: _____

LABORATORY TEST RESULTS

Boring 34, Sample 13

Water Content (ASTM D2216):

Water Content:	60.8

Specific Gravity (ASTM D-854):

Specific Gravity of Soil:	2.646

Dry Unit Weight (See Note 1):

Dry Unit Weight Of Soil:	98.8

Void Ratio (See Note 2):

Void Ratio Of Soil:	0.67

Organic Content (ASTM D-2974):

Percent Organic Matter:	10.35

Atterberg Limit (ASTM D-4318):

Liquid Limit:	66.0
Plastic Limit:	42.8
Plasticity Index:	23.2

LABORATORY TEST RESULTS

Boring 34, Sample 13 (Con't)

Grain-Size Analysis (ASTM D422 With Hydrometer):

- Gravel, passing 3 inch and retained on No. 4 sieve		0.0%
- Sand, passing No. 4 and retained on No. 200 sieve		12.1%
- Coarse sand, passing No. 4 and retained on No. 10 sieve	0.0%	
- Medium sand, passing No. 10 and retained on No. 40 sieve	2.0%	
- Fine sand, passing No. 40 and retained on No. 200 sieve	10.1%	
- Silt, 0.074 mm (No. 200) to 0.005 mm		61.9%
- Clay, smaller than 0.005 mm		26.0%

ORGANIC CONTENT

Project Oakpoint Associates Groton, CT, Submarine Base

Source B-34 S-13 Project Number 3131

Date Tested 10-15-89 Tested By TJT

Moisture:

Tare Number	
A. Weight of Wet Soil + Tare	
B. Weight of Dry Soil + Tare	
C. Weight of Water, Ww = (A-B)	
D. Weight of Tare	
E. Weight of Dry Soil, Ws = (B-D)	
F. Water Content, W = (C/E X 100)	

Ash:

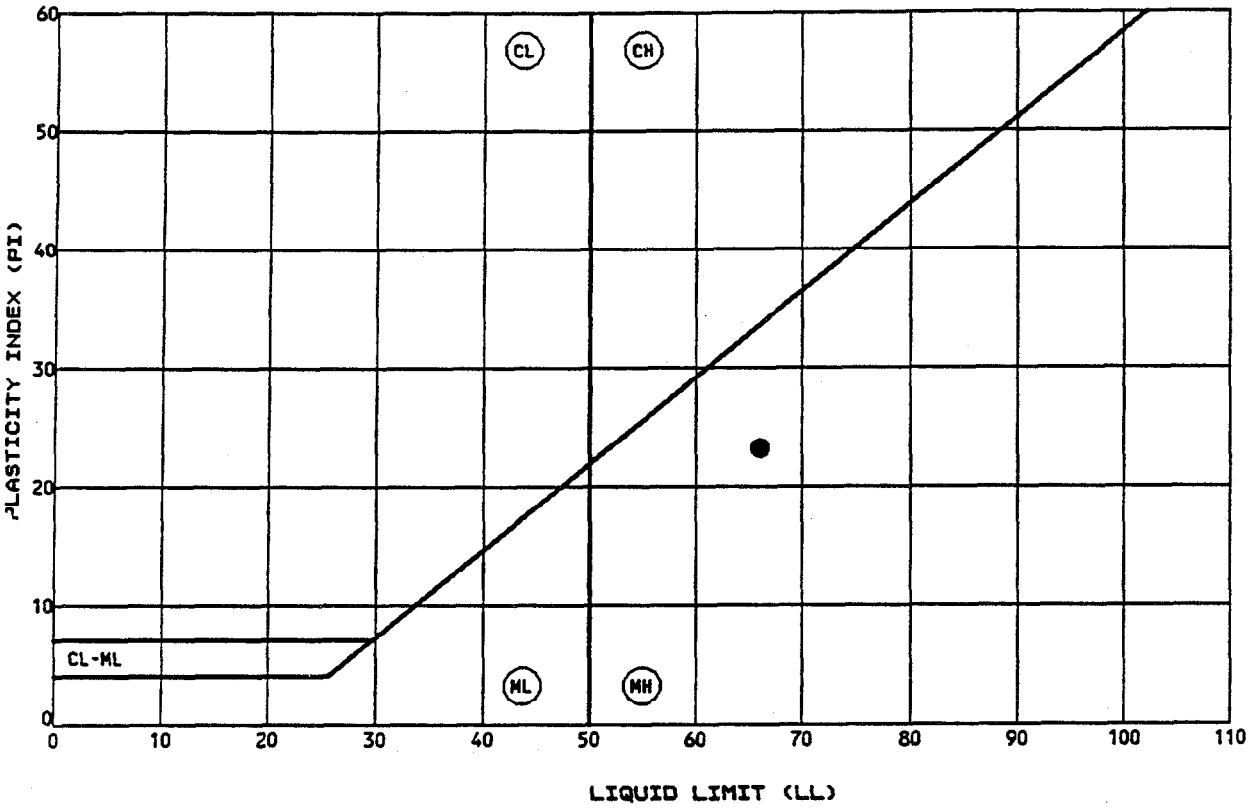
Tare Number	G
A. Weight of Dry Soil + Tare	85.46
B. Weight of Tare	57.93
C. Weight of Dry Soil, (A-B)	27.53
D. Weight of Ash + Tare	82.61
E. Weight of Tare	57.93
F. Weight of Ash, (D-E)	24.68
G. Percent Ash, (F/C + 100)	89.65

Organic Matter:

Percent Organic Matter, (100-G)	10.35

Remarks:

ATTERBERG LIMITS' RESULTS



	BORING	DEPTH	LL	PL	PI	FINES	CLASSIFICATION
●	B34,S13	70.0	66	43	23		

MGE

MORRISON GEOTECHNICAL ENGINEERING

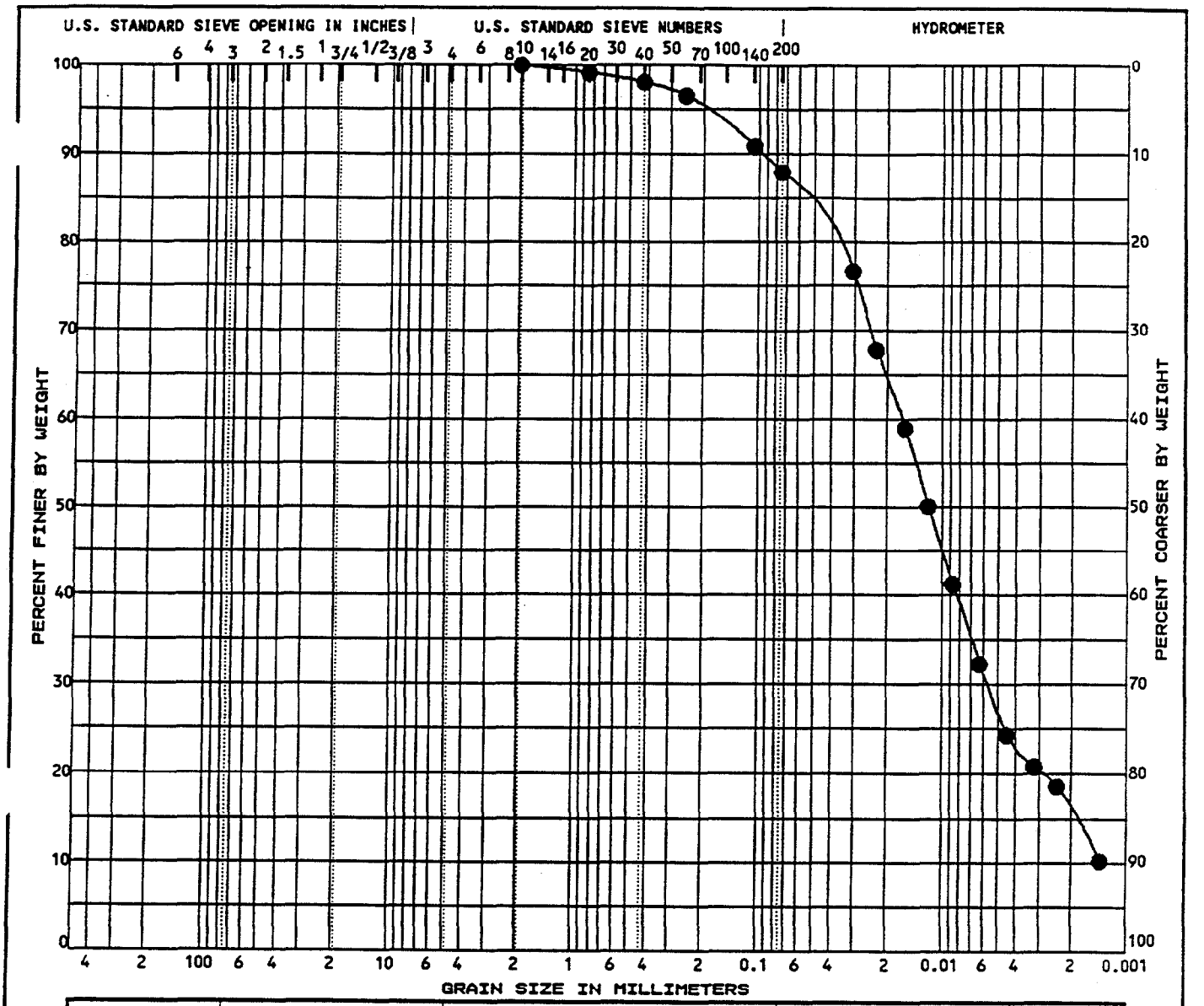
PROJECT NAME:

Oakpoint Associates

JOB NO.: 3131

BORING: B34,S13

DEPTH: 70.0



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
● B34,S13	70.0	Elastic Silt MH		66	43	23		

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B34,S13	70.0	2.00	0.02	0.006		0.0	12.1	61.0	26.8

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date November 1989	GRADATION CURVES

LABORATORY TEST RESULTS

Boring 34, Sample 14

Water Content (ASTM D2216):

Water Content:	57.2

Specific Gravity (ASTM D-854):

Specific Gravity of Soil:	2.537

Dry Unit Weight (See Note 1):

Dry Unit Weight Of Soil:	87.3

Void Ratio (See Note 2):

Void Ratio Of Soil:	0.81

Organic Content (ASTM D-2974):

Percent Organic Matter:	12.42

Atterberg Limit (ASTM D-4318):

Liquid Limit:	86.2
Plastic Limit:	59.0
Plasticity Index:	27.2

LABORATORY TEST RESULTS

Boring 34, Sample 14 (Con't)

Grain-Size Analysis (ASTM D422 With Hydrometer):

- Gravel, passing 3 inch and retained on No. 4 sieve		0.2%
- Sand, passing No. 4 and retained on No. 200 sieve		9.6%
- Coarse sand, passing No. 4 and retained on No. 10 sieve	1.1%	
- Medium sand, passing No. 10 and retained on No. 40 sieve	2.0%	
- Fine sand, passing No. 40 and retained on No. 200 sieve	6.5%	
- Silt, 0.074 mm (No. 200) to 0.005 mm		51.7%
- Clay, smaller than 0.005 mm		38.5%

ORGANIC CONTENT

Project Oakpoint Associates Groton, CT, Submarine Base

Source B-34 S-14 Project Number 3131

Date Tested 11-16-89 Tested By TJG

Moisture:

Tare Number	
A. Weight of Wet Soil + Tare	
B. Weight of Dry Soil + Tare	
C. Weight of Water, Ww = (A-B)	
D. Weight of Tare	
E. Weight of Dry Soil, Ws = (B-D)	
F. Water Content, W = (C/E X 100)	

Ash:

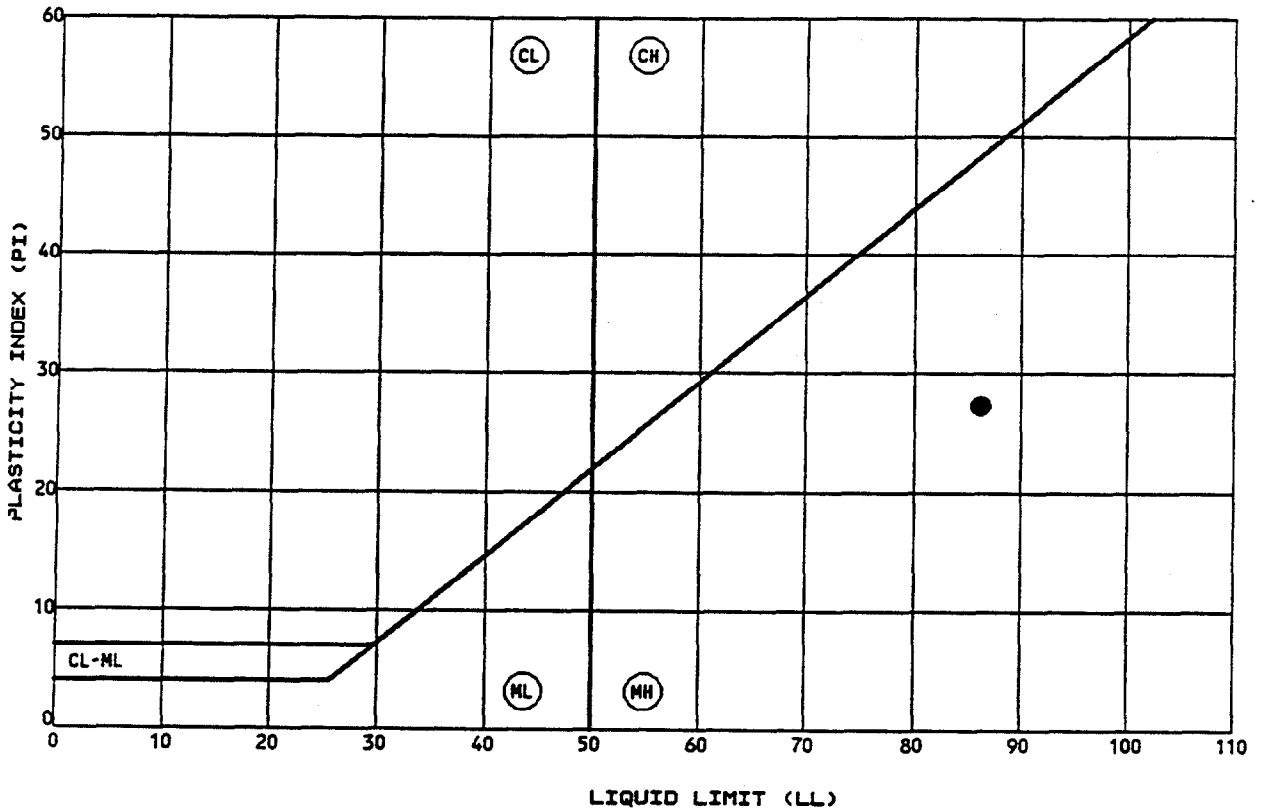
Tare Number	B
A. Weight of Dry Soil + Tare	89.69
B. Weight of Tare	58.12
C. Weight of Dry Soil, (A-B)	31.57
D. Weight of Ash + Tare	85.77
E. Weight of Tare	58.12
F. Weight of Ash, (D-E)	27.65
G. Percent Ash, (F/C + 100)	87.58

Organic Matter:

Percent Organic Matter, (100-G)	12.42

Remarks:

ATTERBERG LIMITS' RESULTS



	BORING	DEPTH	LL	PL	PI	FINES	CLASSIFICATION
●	B34,S14	75.0	86	59	27		

MGE

MORRISON GEOTECHNICAL ENGINEERING

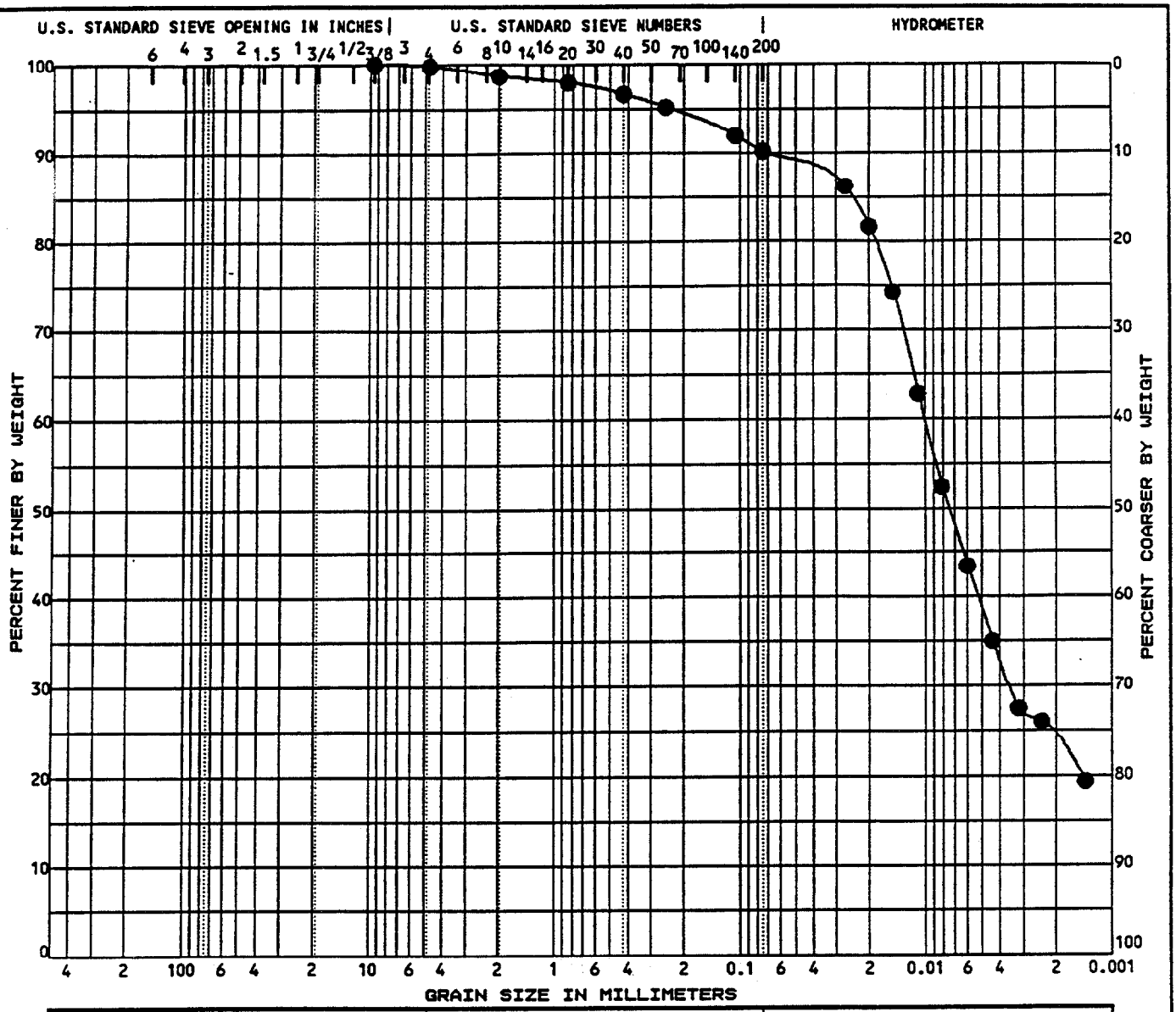
PROJECT NAME:

Oakpoint Associates

JOB NO.: 3131

BORING: B34,S14

DEPTH: 75.0



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
● B34,S14	75.0	Elastic Silt MH		86	59	27		

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B34,S14	75.0	9.50	0.01	0.004		0.2	9.6	51.7	38.4

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date November 1989	GRADATION CURVES

LABORATORY TEST RESULTS

Boring 34, Sample 16

Water Content (ASTM D2216):

Water Content: 15.9

Specific Gravity (ASTM D-854):

Specific Gravity of Soil: 2.661

Dry Unit Weight (See Note 1):

Dry Unit Weight Of Soil: 87.3

Void Ratio (See Note 2):

Void Ratio Of Soil: 0.81

Organic Content (ASTM D-2974):

Percent Organic Matter: 0.44

Gradation (ASTM D-422):

	Percent Passing Sieve By Weight	
Sieve Size	Sample	Specification
3/4"	100	
3/8"	96.0	
No. 4	93.1	
No. 10	87.9	
No. 20	76.2	
No. 40	48.8	
No. 60	18.8	
No. 140	6.5	
No. 200	4.8	

LABORATORY TEST RESULTS

Boring 34, Sample 16 (Con't)

Direct Shear (ASTM D-3080):

Trial No.	Initial Moisture Content,%	Initial Thickness inches	Initial Unit Weight Dry, pcf	Normal Stress, psf	Maximum Shear Stress, psf
1	16.7	0.81	101.3	390.29	476.47
2	20.6	0.82	103.9	779.71	864.71
3	20.1	0.79	117.1	1169.71	1191.18

friction angle = 43
cohesion = 129

ORGANIC CONTENT

Project Oakpoint Associates Groton, CT, Submarine Base

Source B-34 S-16 Project Number 3131

Date Tested 10-12-89 Tested By BH

Moisture:

Tare Number	D
A. Weight of Wet Soil + Tare	169.65
B. Weight of Dry Soil + Tare	158.82
C. Weight of Water, Ww = (A-B)	10.83
D. Weight of Tare	90.60
E. Weight of Dry Soil, Ws = (B-D)	68.22
F. Water Content, W = (C/E X 100)	15.9

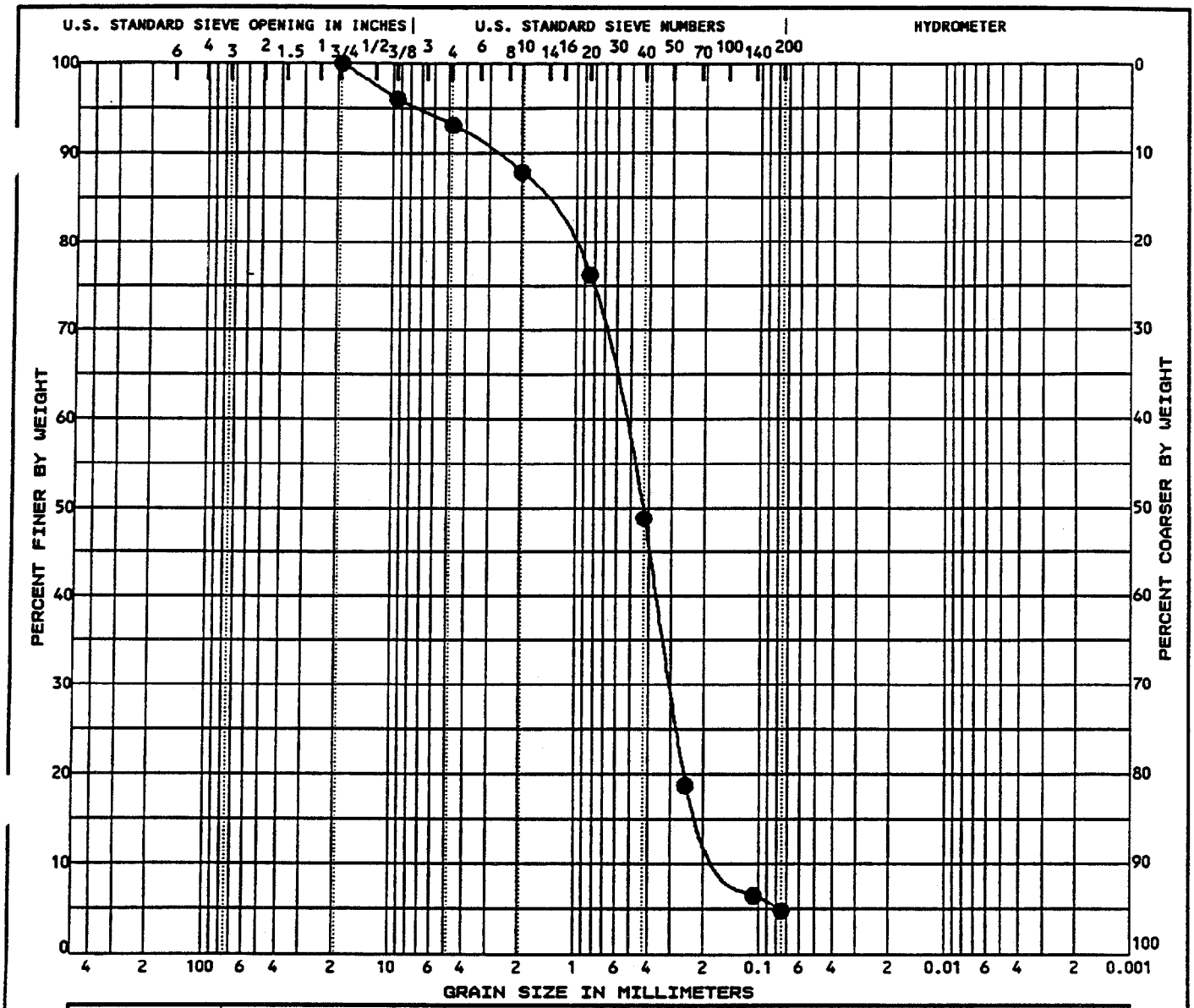
Ash:

Tare Number	
A. Weight of Dry Soil + Tare	125.58
B. Weight of Tare	57.36
C. Weight of Dry Soil, (A-B)	68.22
D. Weight of Ash + Tare	125.28
E. Weight of Tare	57.36
F. Weight of Ash, (D-E)	67.92
G. Percent Ash, (F/C + 100)	99.56

Organic Matter:

Percent Organic Matter, (100-G)	0.44

Remarks:



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

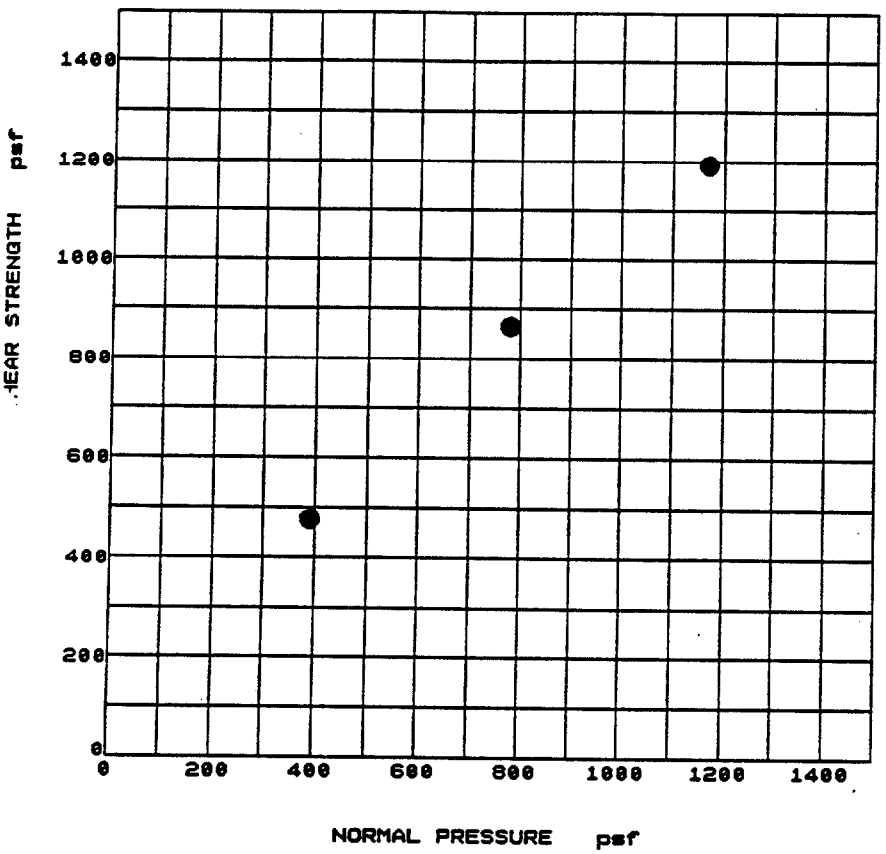
	Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
●	B34,S16	85.0						1.22	4.2

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B34,S16	85.0	19.00	0.56	0.305	0.1353	6.9	88.3	4.8	

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date November 1989	GRADATION CURVES

DIRECT SHEAR RESULTS



FRICTION ANGLE: 43

COHESION: 129

MORRISON GEOTECHNICAL ENGINEERING

PROJECT NAME:

Oakpoint Associates

JOB NO.: 3131

BORING: B34,S16

DEPTH: 85.0

MGE

LOG OF EXPLORATIONS

Hole No. **B-35**

Contractor: Clarence Weitl Associates
Driller: Dave Bromley
Type of Drill: Truck Mounted
Size & Type of Casing: 4"
Drilling Fluid: none
Other:

Project: Oakpoint Associates
No. 3131 Observer: Julie M. Churchill
Location:
Elevation: 8.14
Date Start: 9/8/89 Complete: 9/8/89
Weather:

FIELD DATA									LAB DATA	
DEPTH	ELEV	PROFILE	SAMPLE EQ TEST	SAMPLE TYPE & #	SAMPLE LENGTH	PENE-TRATION RESIST-TANCE PER 6"	RECOVERY FT. OR %	Field Description	Engineering Description	Test Data
1.0	7.1							Concrete and asphalt		
				S-1	1.5	16/14/10	53	Sand, f-c, little silt, little gravel, saturated, brown-gray, loose-dense, SM	SP:Poorly graded sand	
				S-2	1.5	2/3/4	67		SM:Silty sand, subrounded, subangular, hard, and durable,0.60% organics	W, G, D, e, OC, GS W/HYDRO, DS
11.0	-2.9			S-3	1.5	6/7/9	40		SW-SM:Well graded snad with silt and gravel, subangular, hard,and durable	
				S-4	1.5	10/11/19	40	Sand, f-m, trace silt, trace gravel, saturated, gray, medium dense to dense, SP	SP:Poorly graded sand with gravel, subangular, hard, and durable	W, G, D, e, GS, DS
					1.5	2/1/1	0			
25.5	-17.4							End of boring, refusal at 25.5'		

Remarks:

GROUNDWATER DATA

Date	Time	Depth
9/11/89	8:30 am	5.1'

MGE

Sheet 1 of 1

Hole No **B-35**

CLARENCE WELTI ASSOC., INC. P.O. BOX 397 GLASTONBURY, CONN 06033	CLIENT MORRISON GEOTECHNICAL	PROJECT NAME SUBMARINE BASE LOCATION GROTON, CT

DRILLING PROCEDURES: 2 1., 2., 3., 4., (Select one or more)

1. HOLLOW STEM AUGER. Diameter
2. DRIVEN CASING. Diameter 4" HW
3. DRILLED CASING. Diameter
4. ROCK CORING. Diameter & type

HOLE NO. B-35 Surface Elevation

GROUND WATER OBSERVATIONS
AT FT. AFTER 0 HOURS
AT FT. AFTER HOURS

START DATE 9/8/89
FINISH DATE 9/8/89

DEPTH	SAMPLE NO.	BLOWS/6"	DEPTH	A	STRATUM DESCRIPTION	+ DEPTH	REMARKS
	1	16-14-10	1.0'-2.5'	9"	**	0.5'	
					BR.FINE-CRS.SAND,SOME FINE-CRS.GRAVEL		
5	2	3-3-4	5.0'-6.5'	12"		5.0'	
10	3	6-7-9	10.0'-11.5'	8"	GR.FINE-CRS.SAND,SOME FINE-MED.GRAVEL		
15	4	10-11-14	15.0'-16.5'	6"			
20		2-1-1	20.0'-21.5'	0"			
25		60/0"	25.0'	0"		25.0'	
					***	25.5'	
30					ROLLER BIT REFUSAL AT 25.5' BOTTOM OF BORING 25.5' **GR.GRANITE GNEISS		
35							
40							

LEGEND: Col. A SAMPLE RECOVERY &/OR CORING TIME MINUTES/FT 140lb Wt. x 30" fall on 2" O.D. Sampler

Sample Type	Proportions Used		Cohesionless Density	Cohesive Consistency
D = Dry C = Cored W = Washed	trace	0 to 10%	0-10 Loose	0-4 Soft
UP = Undisturbed Piston	little	10 to 20%	10-30 Med.Dense	4-8 M/Stiff
TP = Test Pit A = Auger V = Vane Test	some	20 to 35%	30-50 Dense	8-15 Stiff
UT = Undisturbed Thinwall	and	35 to 50%	50 + VeryDense	15-30 V-Stiff

Driller: BROMLEY
Helper:
Inspector: CHURCHILL
Sheet 1 of 1

1. Unless otherwise agreed, samples will be held by Welti Associates a maximum of 60 days after boring completion.
2. *Water readings* represent driller observations — not interpretations.

LABORATORY TEST RESULTS

Boring 35, Sample 2

Water Content (ASTM D2216):

Water Content:	13.6

Specific Gravity (ASTM D-854):

Specific Gravity of Soil:	2.672

Dry Unit Weight (See Note 1):

Dry Unit Weight Of Soil:	89.8

Void Ratio (See Note 2):

Void Ratio Of Soil:	0.86

Organic Content (ASTM D-2974):

Percent Organic Matter:	0.60

Grain-Size Analysis (ASTM D422 With Hydrometer):

- Gravel, passing 3 inch and retained on No. 4 sieve 8.5%
- Sand, passing No. 4 and retained on No. 200 sieve 78.0%
  - Coarse sand, passing No. 4 and retained on No. 10 sieve 11.0%
  - Medium sand, passing No. 10 and retained on No. 40 sieve 35.1%
  - Fine sand, passing No. 40 and retained on No. 200 sieve 31.9%
- Silt, 0.074 mm (No. 200) to 0.005 mm 12.5%
- Clay, smaller than 0.005 mm 1.0%

LABORATORY TEST RESULTS

Boring 35, Sample 2 (Con't)

Direct Shear (ASTM D-3080):

Trial No.	Initial Moisture Content,%	Initial Thickness inches	Initial Unit Weight Dry, pcf	Normal Stress, psf	Maximum Shear Stress, psf
1	14.4	0.87	114.5	390.29	511.76
2	14.9	0.85	111.7	779.71	838.23
3	13.8	0.91	117.2	1169.71	1235.29

friction angle = 43
cohesion = 138

ORGANIC CONTENT

Project Oakpoint Associates Groton, CT, Submarine Base

Source B-35 S-2 Project Number 3131

Date Tested 10-17-89 Tested By TJG

Moisture:

Tare Number	
A. Weight of Wet Soil + Tare	
B. Weight of Dry Soil + Tare	
C. Weight of Water, Ww = (A-B)	
D. Weight of Tare	
E. Weight of Dry Soil, Ws = (B-D)	
F. Water Content, W = (C/E X 100)	

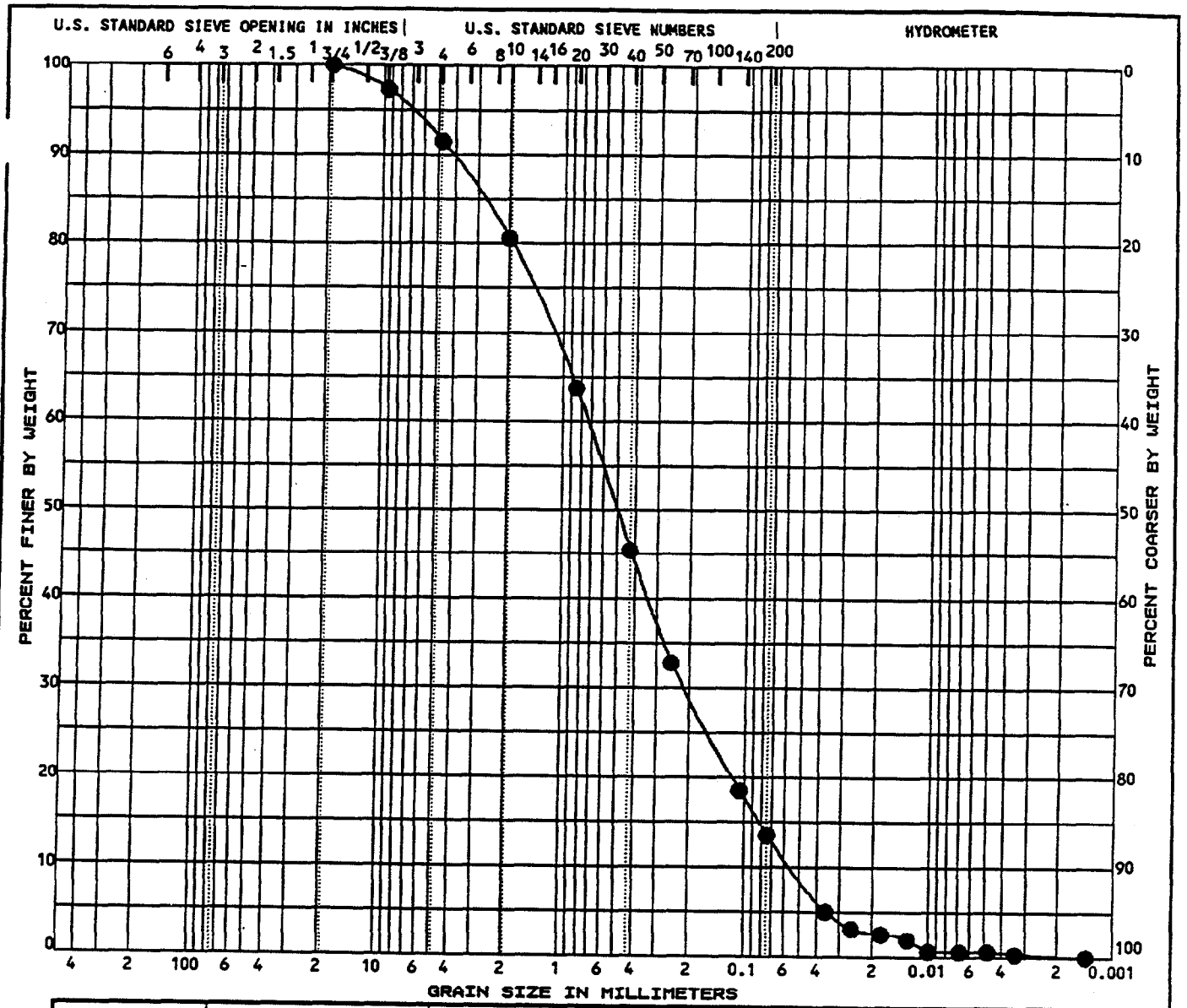
Ash:

Tare Number	
A. Weight of Dry Soil + Tare	99.84
B. Weight of Tare	58.12
C. Weight of Dry Soil, (A-B)	41.72
D. Weight of Ash + Tare	99.59
E. Weight of Tare	58.12
F. Weight of Ash, (D-E)	41.47
G. Percent Ash, (F/C + 100)	99.40

Organic Matter:

Percent Organic Matter, (100-G)	0.60

Remarks:



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

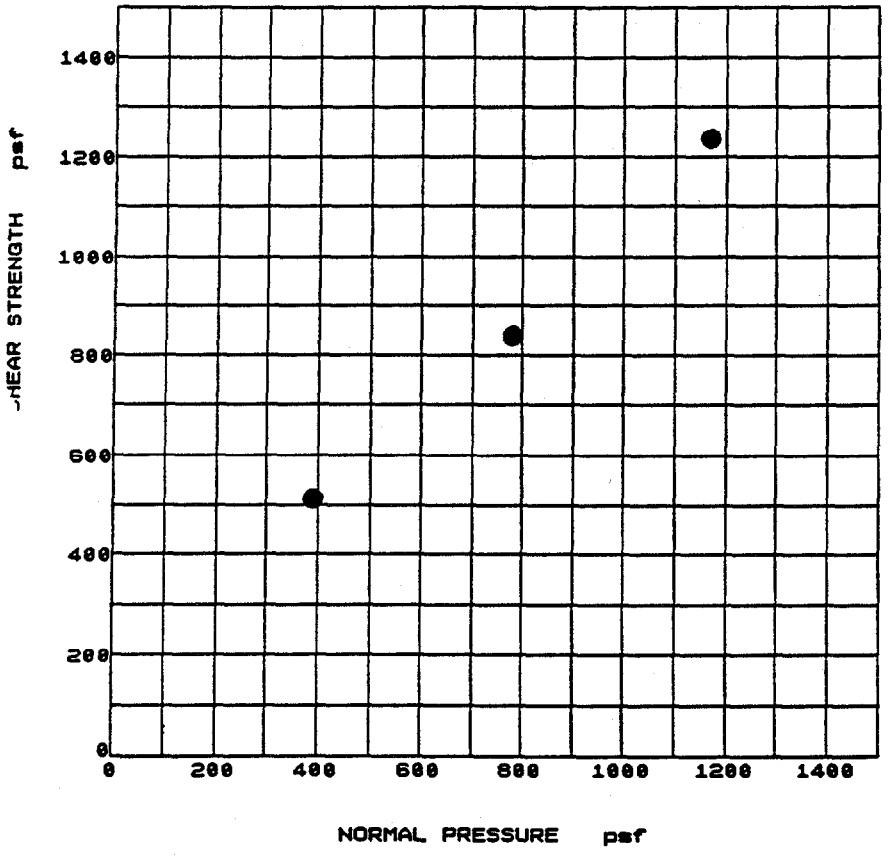
	Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
●	B-35,S2	5.0	Silty Sand SM	14	NP	NP	NP		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-35,S2	5.0	19.00	0.74	0.211	0.0554	8.5	78.0	12.9	0.6

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date October 1989	GRADATION CURVES

DIRECT SHEAR RESULTS



FRICTION ANGLE: 43

COHESION: 138

MORRISON GEOTECHNICAL ENGINEERING

PROJECT NAME:

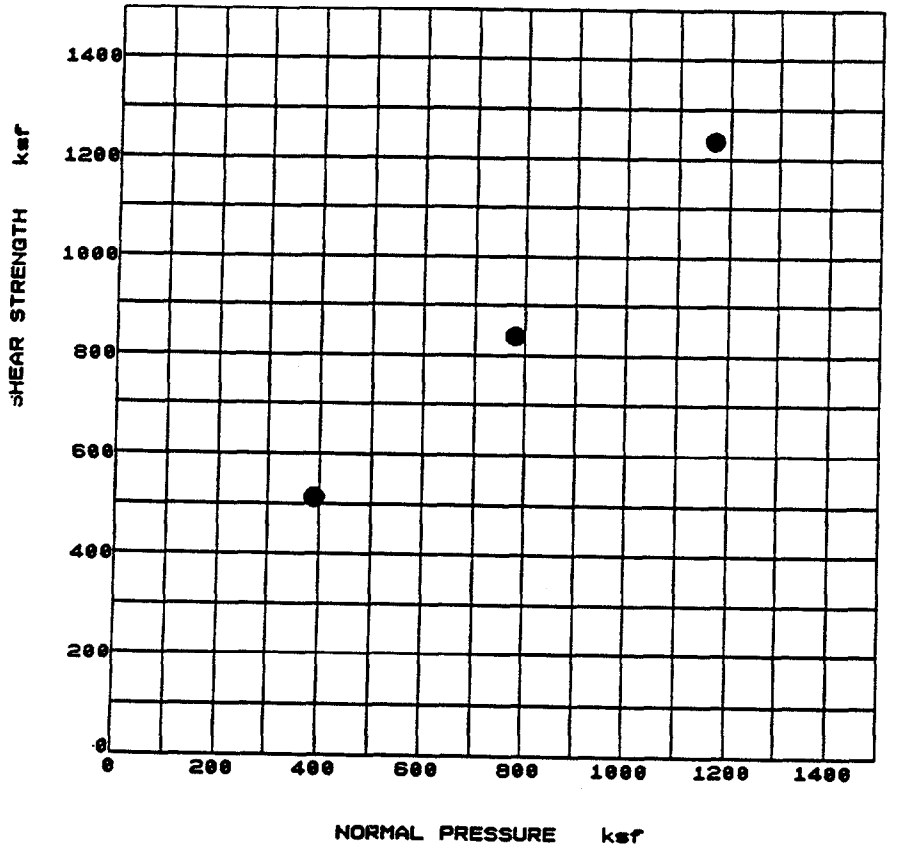
Oakpoint Associates

JOB NO.: 3131

BORING: B-35,S2

DEPTH: 5.0

DIRECT SHEAR RESULTS



FRICTION ANGLE: 43

COHESION: 138

MGE

MORRISON GEOTECHNICAL ENGINEERING

PROJECT NAME:

Oakpoint Associates

JOB NO.: 3131

BORING: B-35,S2

DEPTH: 5.0

LABORATORY TEST RESULTS

Boring 35, Sample 4

Water Content (ASTM D2216):

Water Content: 9.7

Specific Gravity (ASTM D-854):

Specific Gravity of Soil: 2.658

Dry Unit Weight (See Note 1):

Dry Unit Weight Of Soil: 106.4

Void Ratio (See Note 2):

Void Ratio Of Soil: 0.56

Gradation (ASTM D-422):

	Percent Passing Sieve By Weight	
Sieve Size	Sample	Specification
	100	
3/4"	92.9	
3/8"	75.8	
No. 4	63.1	
No. 10	53.3	
No. 20	44.1	
No. 40	32.7	
No. 60	20.4	
No. 140	6.6	
No. 200	3.6	

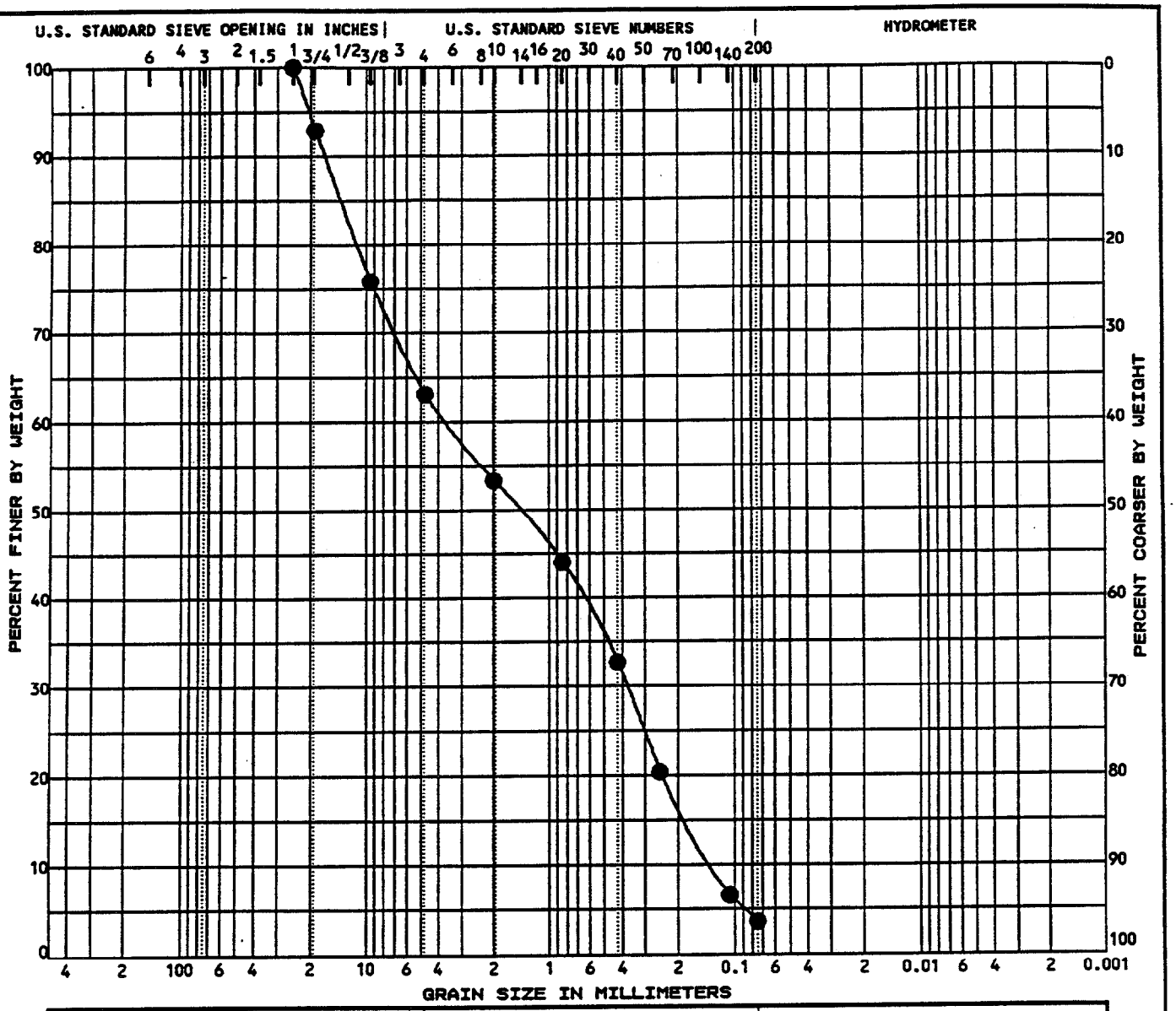
LABORATORY TEST RESULTS

Boring 35, Sample 4 (Con't)

Direct Shear (ASTM D-3080):

Trial No.	Initial Moisture Content,%	Initial Thickness inches	Initial Unit Weight Dry, pcf	Normal Stress, psf	Maximum Shear Stress, psf
1	12.0	0.80	105.6	390.29	441.18
2	14.7	0.82	107.9	779.71	873.53
3	16.5	0.88	110.4	1169.71	1152.94

friction angle = 42
cohesion = 110



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

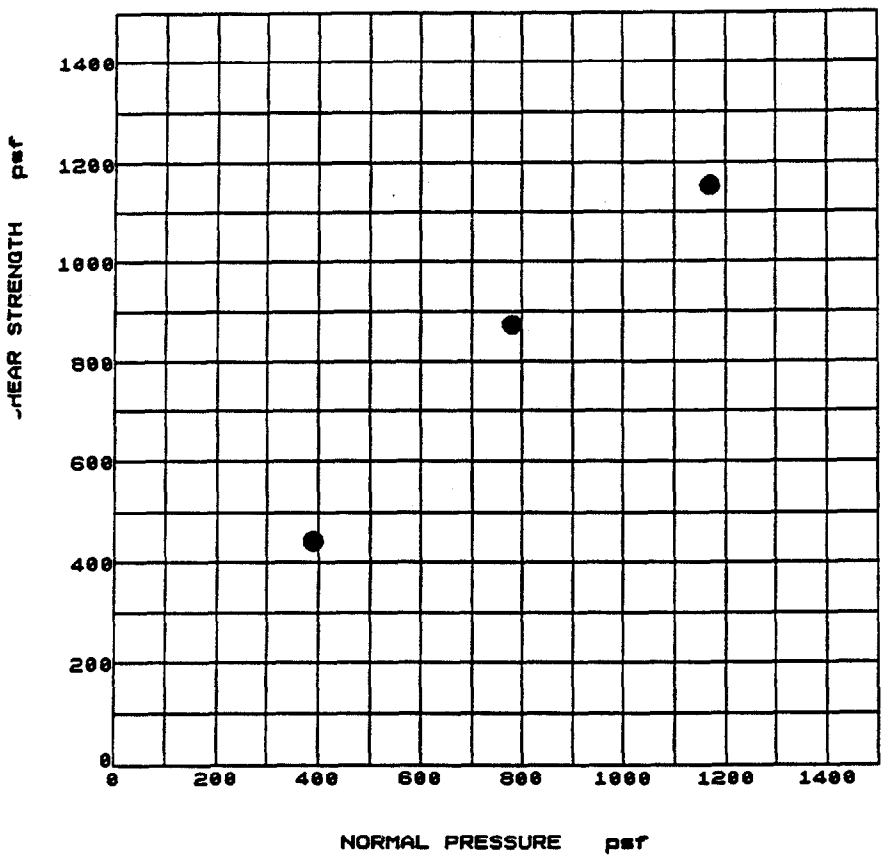
Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
● B-35,S4	15.0	Poorly Graded Sand with Gravel SP	10				0.30	27.6

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-35,S4	15.0	25.00	3.61	0.378	0.1310	36.9	59.5	3.6	

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date October 1989	GRADATION CURVES

DIRECT SHEAR RESULTS



FRICTION ANGLE: 42

COHESION: 110

MORRISON GEOTECHNICAL ENGINEERING

PROJECT NAME:

Oakpoint Associates

JOB NO.: 3131

BORING: B-35,S4

DEPTH: 15.0

MGE

LOG OF EXPLORATIONS

Hole No. **B-36**

Contractor: Clarence Welti Associates
Driller: Dave Bromley
Type of Drill: Truck Mounted
Size & Type of Casing: 4"
Drilling Fluid: none
Other:

Project: Oakpoint Associates
No. 3131 Observer: Julie M. Churchill
Location:
Elevation: 7.65
Date Start: 9/20/89 Complete: 9/20/89
Weather:

FIELD DATA										LAB DATA	
DEPTH	ELEV	PROFILE	SAMPLE EQ TEST	SAMPLE TYPE & #	SAMPLE LENGTH	PENE-TRATION RESIST-TANCE PER 6"	RECOVERY FT. OR %	Field Description		Engineering Description	Test Data
1.0	6.7			S-1	1.5	16/4/5	67	Concrete and asphalt		SP-SM:Poorly graded sand with silt	
				S-2	1.5	4/6/7	60	Sand, f-c, little gravel, little silt, brown, moist-saturated, loose-medium dense, SM		SP-SM:Poorly graded sand with silt and gravel, subangular,mostly hard, and durable	GS, DS
					1.5	11/4/1	0				
14.0	-6.4			S-3	1.5	4/3/2	7	Gravel and sand, f-c, trace silt, brown-gray, saturated, loose-dense, GP-SP		SP:Poorly graded sand, subangurlar, hard, and durable	
				S-4	1.5	8/6/2	40			SP:Poorly graded sand, subangular, angular, hard, and durable,0.23% organics	W, G, D, e, OC, GS W/HYDRO
				S-5	1.5	29/20/17	20			GP:Poorly graded gravel, subrounded, subangular, hard, anddurable	
				S-6	1.5	42/31/48	47			SP-SM:Poorly graded sand with silt and gravel, hard, and durable	
				S-7	1.5	8/6/5	20			GP:Poorly graded gravel, subrounded, subangular, hard, anddurable	
				S-8	1.5	67/22/17	13			SP-SM:Poorly graded sand with silt, subangular, hard, anddurable	
				S-9	1.5	4/4/4	33			SP:Poorly graded sand	
				S-10	1.5	7/7/11	33			GP:Poorly graded gravel with sand, subangular, hard, and durable	W, GS, DS
55.0	-47.4				0.0	60		End of boring, refusal at 55.0'			

Remarks:

GROUNDWATER DATA

Date	Time	Depth
9/20/89	3:40 pm	4.6'
9/21/89	8:30 am	3.7'

MGE

Hole No B-36

CLARENCE WELTI ASSOC., INC. P.O. BOX 397 GLASTONBURY, CONN 06033	CLIENT MORRISON GEOTECHNICAL	PROJECT NAME SUBMARINE BASE LOCATION GROTON, CT

DRILLING PROCEDURES: 2 1., 2., 3., 4., (Select one or more)

1. HOLLOW STEM AUGER. Diameter
2. DRIVEN CASING. Diameter 4" HW
3. DRILLED CASING. Diameter
4. ROCK CORING. Diameter & type

HOLE NO. B-36 Surface Elevation

GROUND WATER OBSERVATIONS
AT 4.7' FT. AFTER 0 HOURS
AT 3.7' FT. AFTER 18 HOURS

START DATE 9/20/89
FINISH DATE 9/21/89

DEPTH	SAMPLE NO.	BLOWS/6"	DEPTH	A	STRATUM DESCRIPTION + DEPTH	REMARKS
	1	16-4-5	1.0'-2.5'	12"	** 1.0'	
					BR.FINE-MED.SAND,SOME	
					FINE-CRS.GRAVEL,LITTLE SILT,	
					ASHES & CINDERS,TR.BRICKS,(FILL)	
5	2	4-6-7	5.0'-6.5'	12"		
					6.0'	
10		11-4-1	10.0'-11.5'	0"	GR.FINE-MED.SAND,SLIGHT FUEL OIL	
					ODOR,SOME FINE-MED.GRAVEL	
					14.0'	
15	3	4-3-2	15.0'-16.5'	2"		
					BR.CRS-FINE SAND,SOME	
					FINE-MED.GRAVEL	
20	4	8-6-2	20.0'-21.5'	6"		
25	5	29-20-17	25.0'-26.5'	2"	25.0'	
30	6	42-31-48	30.0'-31.5'	8"		
					GR.FINE-MED.SAND,SOME	
					FINE-CRS.GRAVEL & ROCK FRAGS.,	
					LITTLE SILT	
35	7	8-6-5	35.0'-36.5'	4"		
40	8	3-2-2	40.0'-41.5'	6"		

LEGEND: Col. A SAMPLE RECOVERY &/OR CORING TIME MINUTES/FT

140lb Wt. x 30" fall on 2" O.D. Sampler

Sample Type	Proportions Used		Cohesionless Density	Cohesive Consistency
D = Dry C = Cored W = Washed	trace	0 to 10%	0-10 Loose	0-4 Soft
UP = Undisturbed Piston	little	10 to 20%	10-30 Med.Dense	4-8 M/Stiff
TP = Test Pit A = Auger V = Vane Test	some	20 to 35%	30-50 Dense	8-15 Stiff
UT = Undisturbed Thinwall	and	35 to 50%	50 + VeryDense	15-30 V-Stiff

Driller: BROMLEY
Helper:
Inspector: CHURCHILL
Sheet 1 of 2

1. Unless otherwise agreed, ***samples*** will be held by Welti Associates a maximum of 60 days after boring completion.
2. ***Water readings*** represent driller observations — not interpretations.

CLARENCE WELTI ASSOC., INC. P.O. BOX 397 GLASTONBURY, CONN 06033	CLIENT MORRISON GEOTECHNICAL	PROJECT NAME SUBMARINE BASE LOCATION GROTON, CT

DRILLING PROCEDURES: 2 1., 2., 3., 4., (Select one or more)

1. HOLLOW STEM AUGER. Diameter
2. DRIVEN CASING. Diameter 4" HW
3. DRILLED CASING. Diameter
4. ROCK CORING. Diameter & type

HOLE NO. B-36 Surface Elevation

GROUND WATER OBSERVATIONS
AT 4.7' FT. AFTER 0 HOURS
AT 3.7' FT. AFTER 18 HOURS

START DATE 9/20/89
FINISH DATE 9/21/89

DEPTH	SAMPLE NO.	BLOWS/6"	DEPTH	A	STRATUM DESCRIPTION + DEPTH	REMARKS
45	9	4-4-4	45.0'-46.5'	7"	GR.FINE-MED.SAND,SOME FINE-CRS.GRAVEL & ROCK FRAGS., LITTLE SILT	
50	10	8-11-9	50.0'-51.5'	6"	50.0'	
					GR.FINE-MED.SAND,SOME FINE-MED. GRAVEL & ROCK FRAGS.,LITTLE SILT	
55		60/0"	55.0'	0"	55.0'	
					REFUSAL AT 55.0'	
					**ASPHALT & CONCRETE	
60						
65						
70						
75						
80						

LEGEND: Col A SAMPLE RECOVERY &/OR CORING TIME MINUTES/FT

Sample Type
D = Dry C = Cored W = Washed
UP = Undisturbed Piston
TP = Test Pit A = Auger V = Vane Test
UT = Undisturbed Thinwall

Proportions Used		Cohesionless Density	Cohesive Consistency
trace	0 to 10%	0-10 Loose	0-4 Soft
little	10 to 20%	10-30 Med.Dense	4-8 M/Stiff
some	20 to 35%	30-50 Dense	8-15 Stiff
and	35 to 50%	50 + VeryDense	15-30 V-Stiff

140lb Wt. x 30" fall on 2" O.D. Sampler

Driller: BROMLEY
Helper:
Inspector: CHURCHILL
Sheet 2 of 2

1 Unless otherwise agreed, *samples* will be held by Welti Associates a maximum of 60 days after boring completion.
2 *Water readings* represent driller observations — not interpretations.

LABORATORY TEST RESULTS

Boring 36, Sample 2

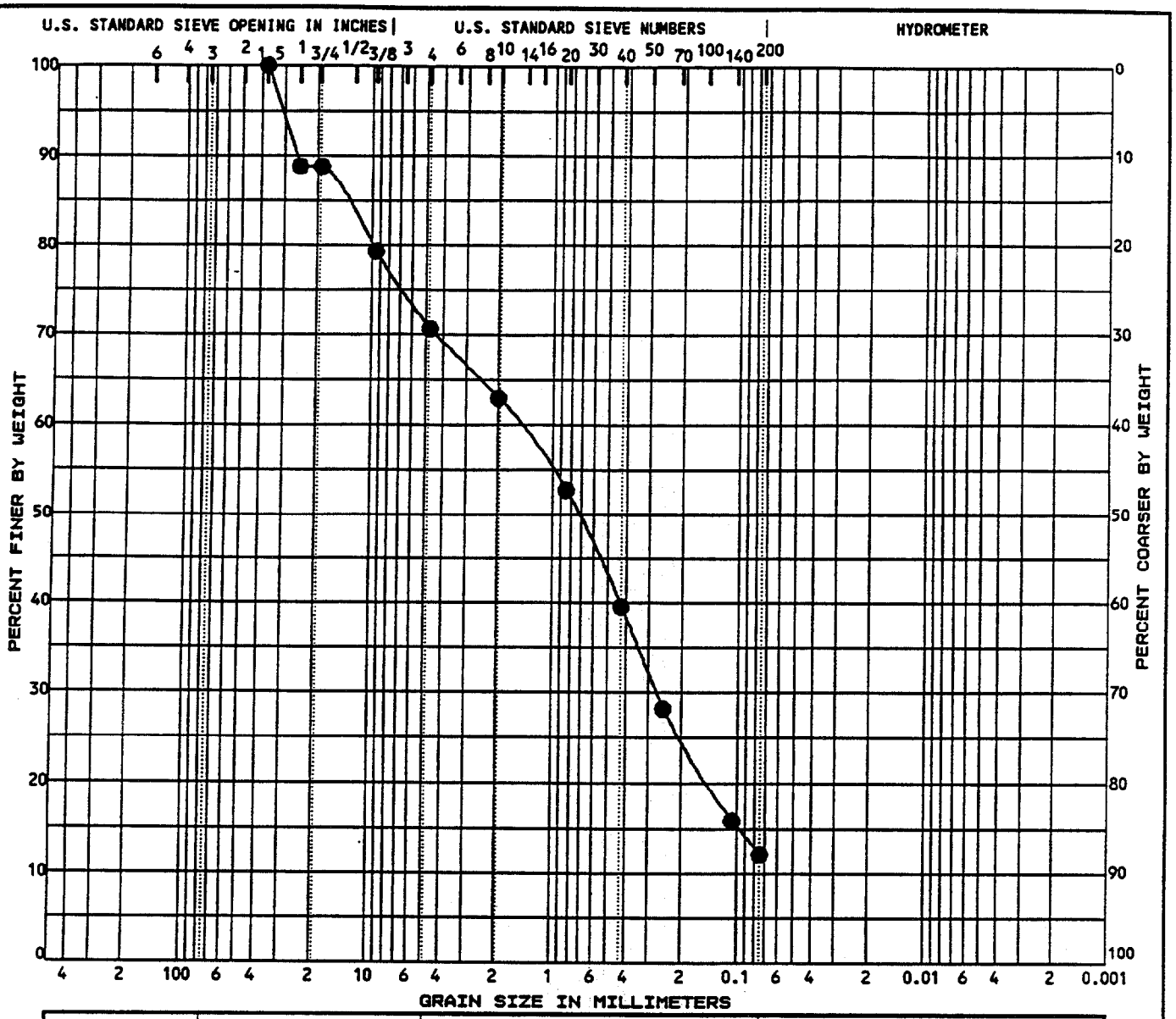
Gradation (ASTM D-422):

Sieve Size	Percent Passing Sieve By Weight: Sample	Specification
1 1/2"	100	
1"	88.8	
3/4"	88.8	
3/8"	79.3	
No. 4	70.6	
No. 10	62.9	
No. 20	52.7	
No. 40	39.6	
No. 60	28.2	
No. 140	15.9	
No. 200	12.1	

Direct Shear (ASTM D-3080):

Trial No.	Initial Moisture Content,%	Initial Thickness inches	Initial Unit Weight Dry, pcf	Normal Stress, psf	Maximum Shear Stress, psf
1	14.7	.82	105.0	390.29	467.65
2	16.5	.84	113.2	779.71	820.59
3	16.1	.82	109.7	1169.71	1147.06

friction angle = 41
cohesion = 132



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
● B-36,S2	5.0	Poorly Graded Sand with Silt and Gravel SP-SM		NP	NP	NP	0.67	22.4

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-36,S2	5.0	37.50	1.57	0.272		29.4	58.5	12.1	

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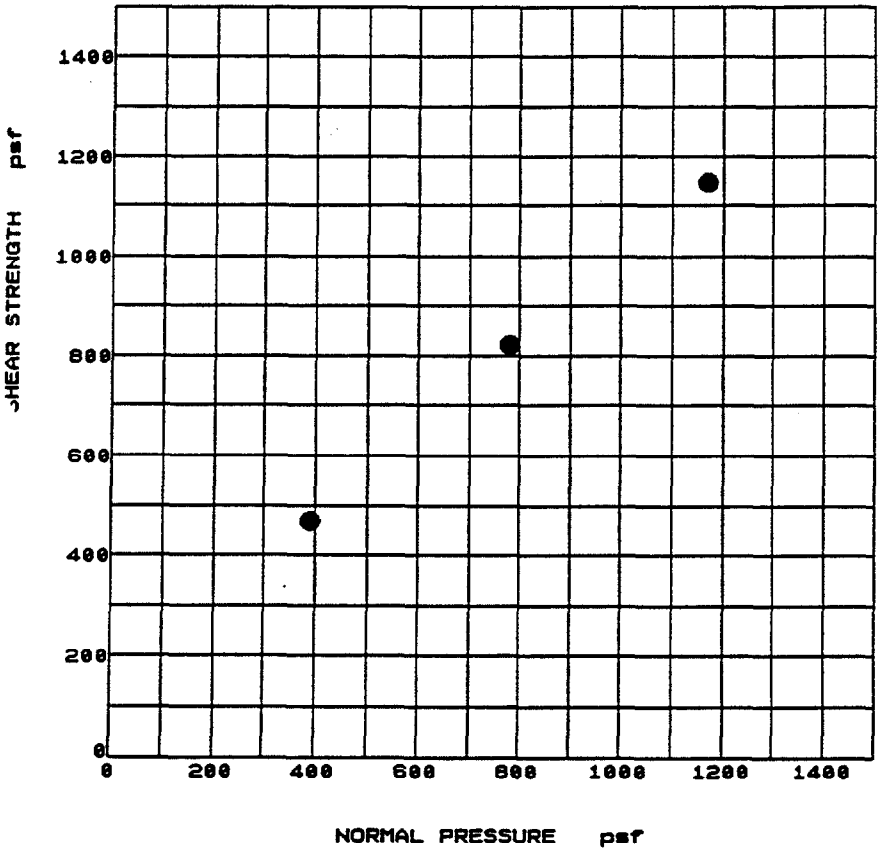
Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date October 1989	GRADATION CURVES

DIRECT SHEAR RESULTS



FRICTION ANGLE: 41

COHESION: 132

MORRISON GEOTECHNICAL ENGINEERING

PROJECT NAME:

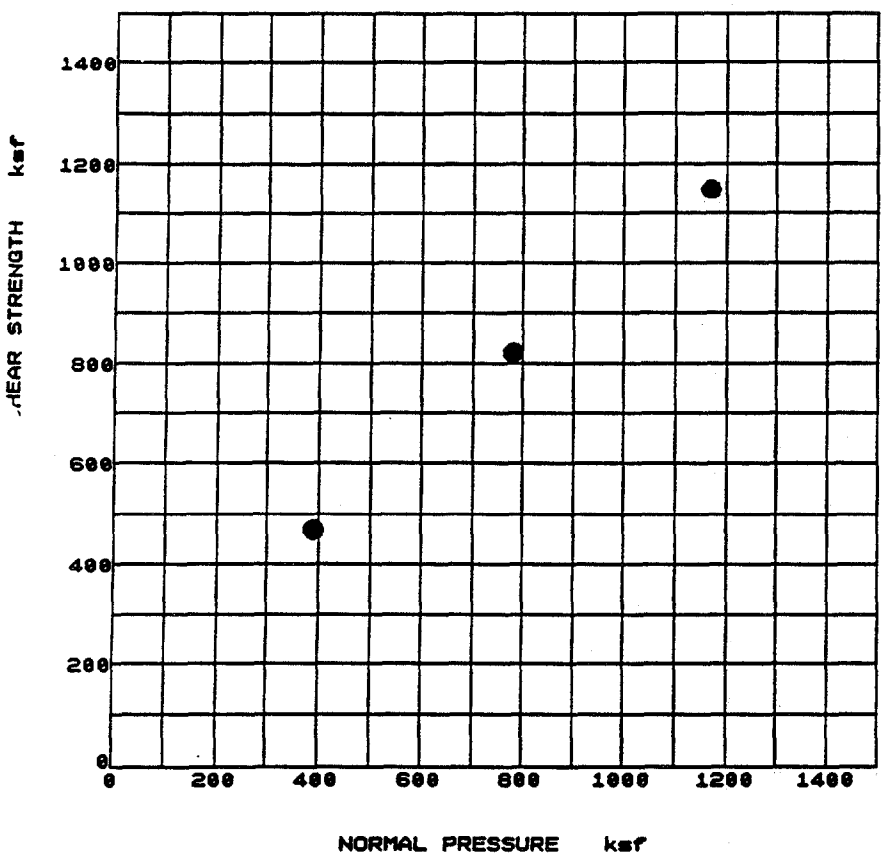
Oakpoint Associates

JOB NO.: 3131

BORING: B-36,S2

DEPTH: 5.0

DIRECT SHEAR RESULTS



FRICTION ANGLE: 41

COHESION: 132

MORRISON GEOTECHNICAL ENGINEERING

PROJECT NAME:

Oakpoint Associates

JOB NO.: 3131

BORING: B-36,S2

DEPTH: 5.0

LABORATORY TEST RESULTS

Boring 36, Sample 4

Water Content (ASTM D2216):

Water Content:	19.2

Specific Gravity (ASTM D-854):

Specific Gravity of Soil:	2.663

Dry Unit Weight (See Note 1):

Dry Unit Weight Of Soil:	96.5

Void Ratio (See Note 2):

Void Ratio Of Soil:	0.72

Organic Content (ASTM D-2974):

Percent Organic Matter:	0.23

Grain-Size Analysis (ASTM D422 With Hydrometer):

- Gravel, passing 3 inch and retained on No. 4 sieve 6.4%
- Sand, passing No. 4 and retained on No. 200 sieve 91.4%
  - Coarse sand, passing No. 4 and retained on No. 10 sieve 12.8%
  - Medium sand, passing No. 10 and retained on No. 40 sieve 48.1%
  - Fine sand, passing No. 40 and retained on No. 200 sieve 30.5%
- Silt, 0.074 mm (No. 200) to 0.005 mm 2.2%
- Clay, smaller than 0.005 mm 0.0%

ORGANIC CONTENT

Project Oakpoint Associates Groton, CT, Submarine Base

Source B-36 S-4 Project Number 3131

Date Tested 10-12-89 Tested By TJG

Moisture:

Tare Number	E
A. Weight of Wet Soil + Tare	168.56
B. Weight of Dry Soil + Tare	156.05
C. Weight of Water, Ww = (A-B)	12.51
D. Weight of Tare	90.83
E. Weight of Dry Soil, Ws = (B-D)	65.22
F. Water Content, W = (C/E X 100)	19.2

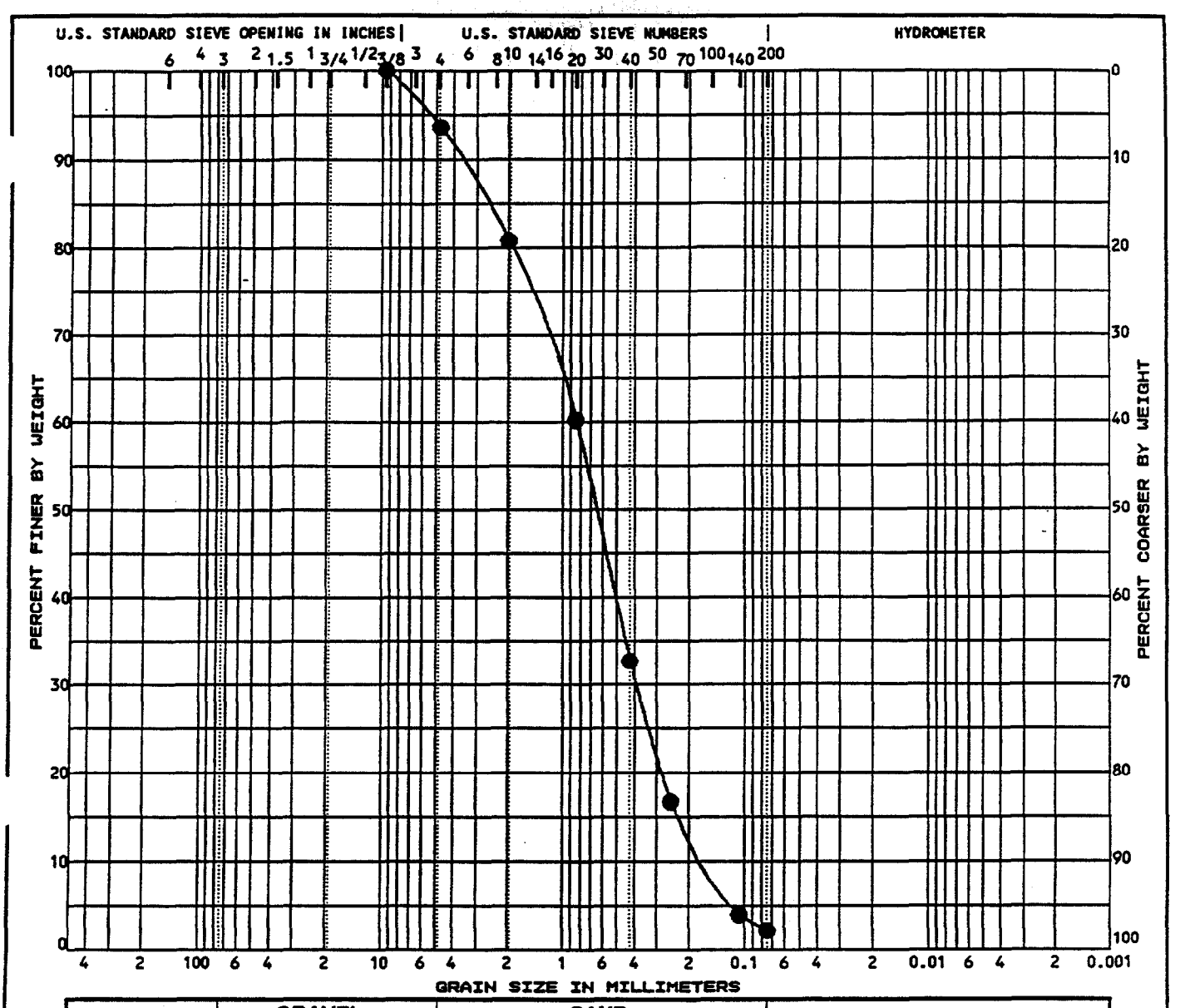
Ash:

Tare Number	
A. Weight of Dry Soil + Tare	123.34
B. Weight of Tare	58.12
C. Weight of Dry Soil, (A-B)	65.22
D. Weight of Ash + Tare	123.19
E. Weight of Tare	58.12
F. Weight of Ash, (D-E)	65.07
G. Percent Ash, (F/C + 100)	99.77

Organic Matter:

Percent Organic Matter, (100-G)	0.23

Remarks:



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
●	B-36,S4	20.0	Poorly Graded Sand SP	19	NP	NP	NP	1.12	5.3

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-36,S4	20.0	9.50	0.85	0.389	0.1590	6.4	91.4	2.2	

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date October 1989	GRADATION CURVES

LABORATORY TEST RESULTS

Boring 36, Sample 10

Water Content (ASTM D2216):

Water Content: 5.5

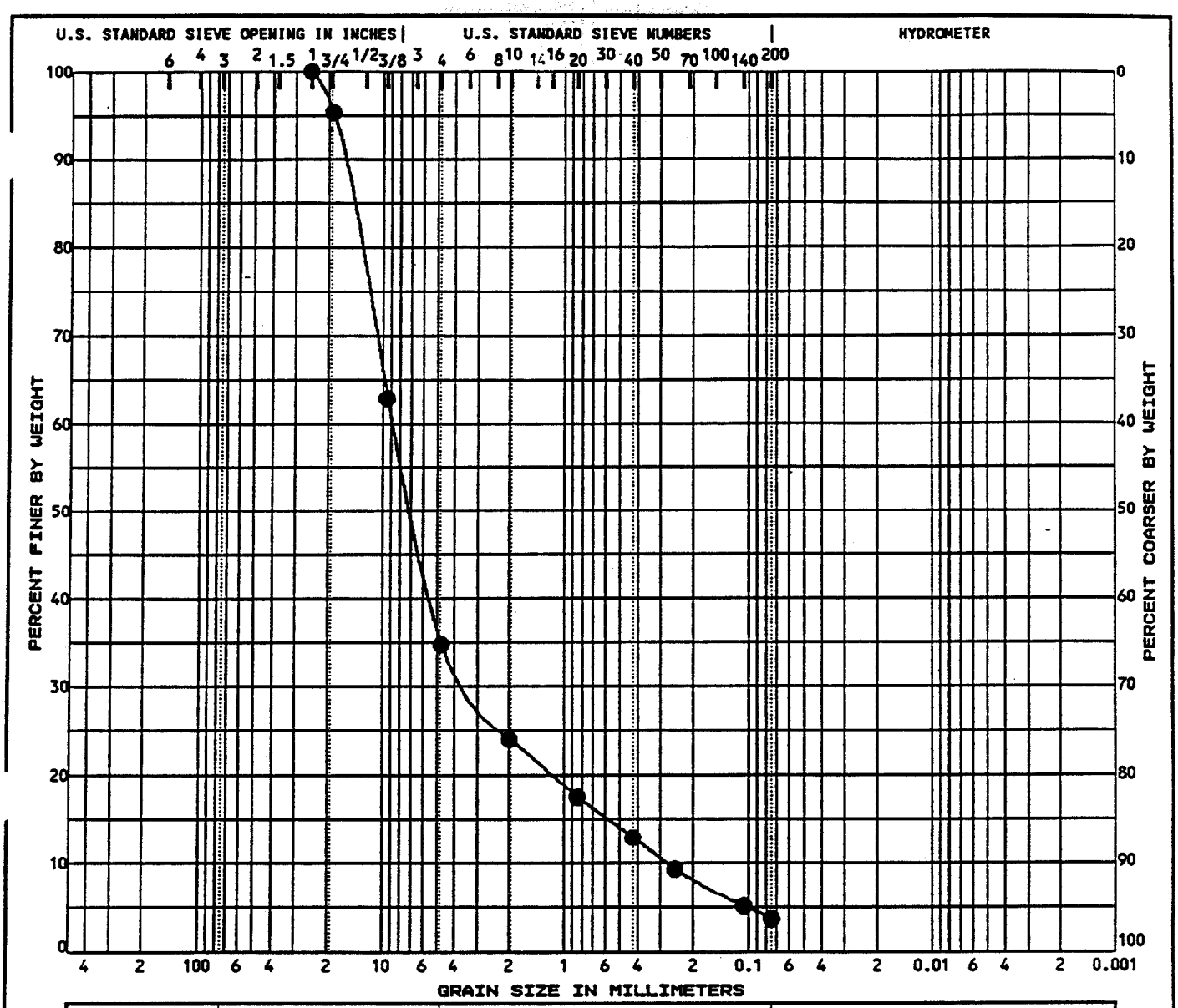
Gradation (ASTM D-422):

Sieve Size	Percent Passing Sieve By Weight: Sample	Specification
1"	100	
3/4"	95.3	
3/8"	62.9	
No. 4	34.8	
No. 10	24.0	
No. 20	17.5	
No. 40	12.9	
No. 60	9.3	
No. 140	5.1	
No. 200	3.7	

Direct Shear (ASTM D-3080):

Trial No.	Initial Moisture Content,%	Initial Thickness inches	Initial Unit Weight Dry, pcf	Normal Stress, psf	Maximum Shear Stress, psf
1	7.8	.91	100.4	390.29	502.94
2	12.8	.91	97.8	779.71	970.59
3	12.1	.89	104.0	1169.71	1544.12

friction angle = 53
cohesion = 0



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

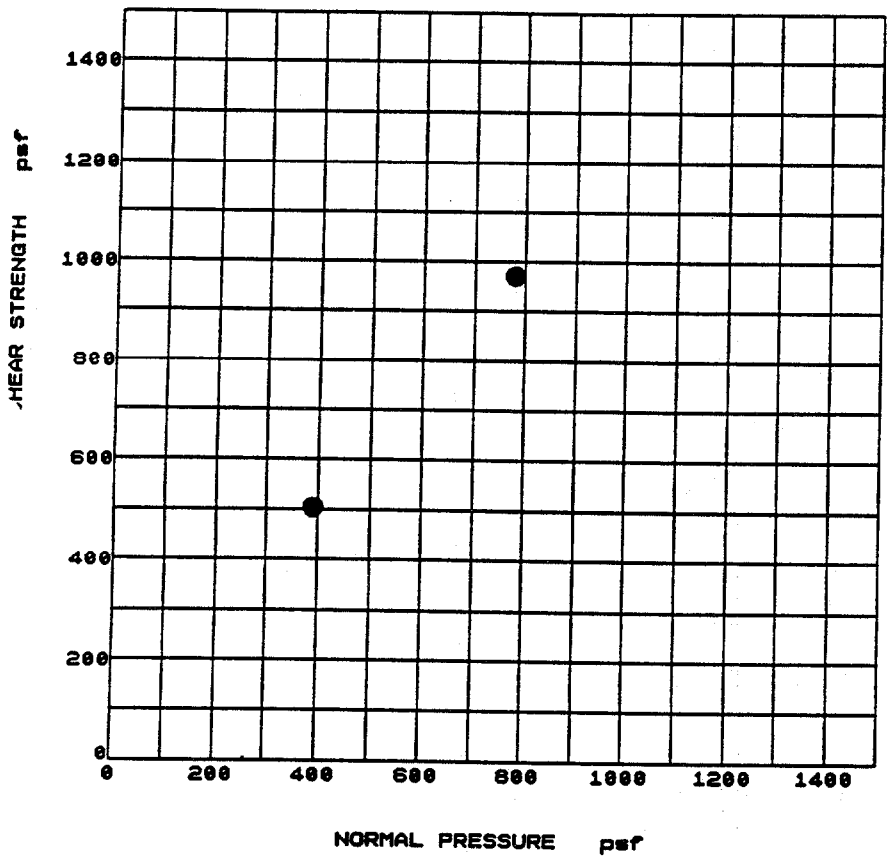
	Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
●	B36,S10	50.0	Poorly Graded Gravel with Sand GP	5	NP	NP	NP	4.27	31.9

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B36,S10	50.0	25.00	8.84	3.234	0.2772	65.2	31.1	3.7	

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date October 1989	GRADATION CURVES

DIRECT SHEAR RESULTS



FRICTION ANGLE: 53

COHESION: 0

MORRISON GEOTECHNICAL ENGINEERING

PROJECT NAME:

Oakpoint Associates

JOB NO.: 3131

BORING: B36,S10

DEPTH: 50.0

MGE

LOG OF EXPLORATIONS

Hole No. **B-37**

Contractor: Clarence Welti Associates
Driller: Dave Bromley
Type of Drill: Truck Mounted
Size & Type of Casing: 4"
Drilling Fluid: none
Other:

Project: Oakpoint Associates
No. 3131 Observer: Julie M. Churchill
Location:
Elevation: 7.03
Date Start: 9/7/89 Complete: 9/8/89
Weather:

FIELD DATA										LAB DATA	
DEPTH	ELEV	PROFILE	SAMPLE EQ TEST	SAMPLE TYPE & #	SAMPLE LENGTH	PENE-TRATION RESIST-TANCE PER 6"	RECOVERY FT. OR %	Field Description		Engineering Description	Test Data
1.0	6.0							Concrete and asphalt			
				S-1	1.6	66	31	Sand, f-c, little-some gravel, little silt, saturated with petroleum, dark gray, medium dense-very dense, SM		SW-SM:Well graded sand with silt, subangular, hard, and durable,0.54% organics	W, G, D, e, OC, GS W/HYDRO
9.5	-2.5										
12.0	-5.0							Concrete			
				S-2	1.5	7/11/8	93			SW-SM:Well graded sand with silt and gravel, subrounded,hard, and durable	
				S-3	1.5	6/17/22	47			SP-SM:Poorly graded sand with silt and gravel, subrounded,hard, and durable, 0.35% organics	W, OC, GS
28.5	-21.5							End of boring, refusal at 28.5'			

Remarks:

GROUNDWATER DATA

Date	Time	Depth
9/8/89	3:20 pm	4.7'
9/11/89	1:20 pm	4.9'

MGE

Hole No **B-37**

CLARENCE WELTI ASSOC., INC. P.O. BOX 397 GLASTONBURY, CONN 06033	CLIENT MORRISON GEOTECHNICAL	PROJECT NAME SUBMARINE BASE LOCATION GROTON, CT

DRILLING PROCEDURES: 2 1., 2., 3., 4., (Select one or more)

1. HOLLOW STEM AUGER, Diameter
2. DRIVEN CASING, Diameter 4" HW
3. DRILLED CASING, Diameter
4. ROCK CORING, Diameter & type

HOLE NO. B-37 Surface Elevation

GROUND WATER OBSERVATIONS
AT 5.3' FT. AFTER 0 HOURS
AT FT AFTER HOURS

START DATE 9/8/89
FINISH DATE 9/8/89

DEPTH	SAMPLE NO.	BLOWS/6"	DEPTH	A	STRATUM DESCRIPTION + DEPTH	REMARKS
		60/0"	1.0'-1.3'		** 0.5'	
5	1	70/6"	5.0'-5.5'	6"	BR.& BLK.FINE-CRS.SAND & GRAVEL, FUEL OIL VISIBLE 5.0'-9.5'	
10	2	60/0"	10.0'	0"	9.5' CONCRETE 12.0'	
15	3	60/0"	15.0'-15.1'	0"	BLK.SILT & HEAVY CREOSOTE & WOOD 19.0'	
20	4	7-11-89	20.0'-21.5'	12"		
25	5	6-17-22	25.0'-26.5'	10"	GR.FINE-CRS.SAND,SOME FINE-MED. GRAVEL (CREOSOTE ODOR) 28.5'	
30					REFUSAL AT 28.5'	
					**ASPHALT	
35						
40						

LEGEND: Col. A SAMPLE RECOVERY &/OR CORING TIME MINUTES/FT 140lb Wt. x 30" fall on 2" O.D. Sampler

Sample Type	Proportions Used		Cohesionless Density	Cohesive Consistency
D = Dry C = Cored W = Washed	trace	0 to 10%	0-10 Loose	0-4 Soft
UP = Undisturbed Piston	little	10 to 20%	10-30 Med.Dense	4-8 M/Stiff
TP = Test Pit A = Auger V = Vane Test	some	20 to 35%	30-50 Dense	8-15 Stiff
UT = Undisturbed Thinwall	and	35 to 50%	50 + VeryDense	15-30 V-Stiff

Driller: BROMLEY
Helper:
Inspector:
Sheet 1 of 1

1. Unless otherwise agreed, ***samples*** will be held by Welti Associates a maximum of 60 days after boring completion.
2. ***Water readings*** represent driller observations — not interpretations.

LABORATORY TEST RESULTS

Boring 37, Sample 1

Water Content (ASTM D2216):

Water Content:	12.7

Specific Gravity (ASTM D-854):

Specific Gravity of Soil:	2.669

Dry Unit Weight (See Note 1):

Dry Unit Weight Of Soil:	132.4

Void Ratio (See Note 2):

Void Ratio Of Soil:	0.26

Organic Content (ASTM D-2974):

Percent Organic Matter:	0.54

Grain-Size Analysis (ASTM D422 With Hydrometer):

- Gravel, passing 3 inch and retained on No. 4 sieve		13.8%
- Sand, passing No. 4 and retained on No. 200 sieve		75.3%
- Coarse sand, passing No. 4 and retained on No. 10 sieve	8.8%	
- Medium sand, passing No. 10 and retained on No. 40 sieve	29.0%	
- Fine sand, passing No. 40 and retained on No. 200 sieve	37.5%	
- Silt, 0.074 mm (No. 200) to 0.005 mm		10.9%
- Clay, smaller than 0.005 mm		0.0%

ORGANIC CONTENT

Project Oakpoint Associates Groton, CT, Submarine Base

Source B-37 S-1 Project Number 3131

Date Tested 10-11-89 Tested By TJG

Moisture:

Tare Number	C
A. Weight of Wet Soil + Tare	195.66
B. Weight of Dry Soil + Tare	183.81
C. Weight of Water, Ww = (A-B)	11.85
D. Weight of Tare	90.73
E. Weight of Dry Soil, Ws = (B-D)	93.08
F. Water Content, W = (C/E X 100)	12.7

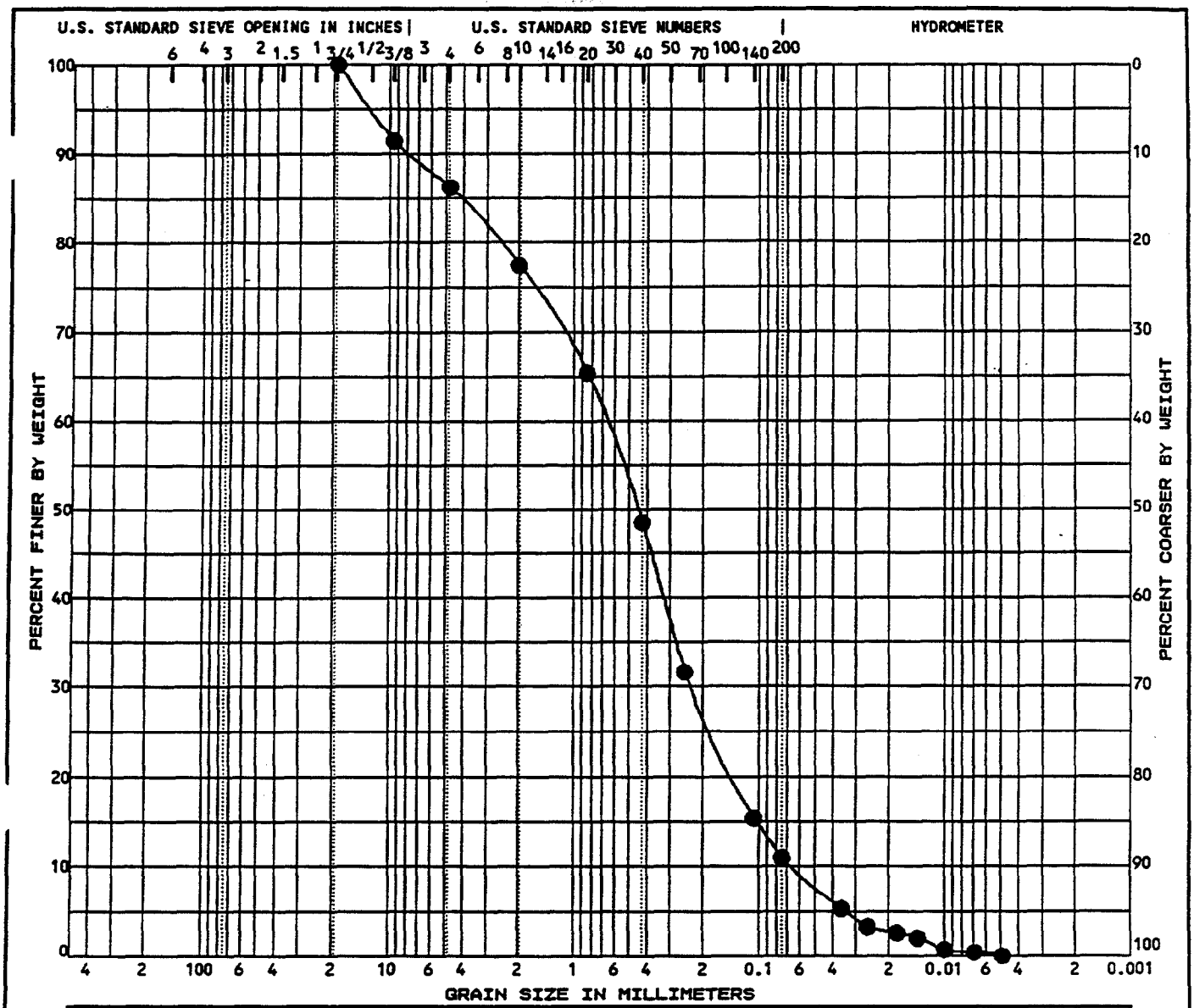
Ash:

Tare Number	
A. Weight of Dry Soil + Tare	151.01
B. Weight of Tare	57.93
C. Weight of Dry Soil, (A-B)	93.08
D. Weight of Ash + Tare	150.51
E. Weight of Tare	57.93
F. Weight of Ash, (D-E)	92.58
G. Percent Ash, (F/C + 100)	99.46

Organic Matter:

Percent Organic Matter, (100-G)	0.54

Remarks:



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
● B-37,S1	5.0	Well Graded Sand with Silt SW-SM	13	NP	NP	NP	1.11	9.7

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-37,S1	5.0	19.00	0.68	0.230	0.0667	13.8	75.3	10.8	0.0

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date October 1989	GRADATION CURVES

LABORATORY TEST RESULTS

Boring 37, Sample 3

Water Content (ASTM D2216):

Water Content: 9.7

Organic Content (ASTM D-2974):

Percent Organic Matter: 0.35

Gradation (ASTM D-422):

	Percent Passing Sieve By Weight	
Sieve Size	Sample	Specification
1"	100	
3/4"	94.0	
3/8"	68.4	
No. 4	56.7	
No. 10	47.8	
No. 20	32.4	
No. 40	22.8	
No. 60	15.2	
No. 140	7.2	
No. 200	5.1	

ORGANIC CONTENT

Project Oakpoint Associates Groton, CT, Submarine Base

Source B-37 S-3 Project Number 3131

Date Tested 10-11-89 Tested By BH

Moisture:

Tare Number	
A. Weight of Wet Soil + Tare	
B. Weight of Dry Soil + Tare	
C. Weight of Water, Ww = (A-B)	
D. Weight of Tare	
E. Weight of Dry Soil, Ws = (B-D)	
F. Water Content, W = (C/E X 100)	

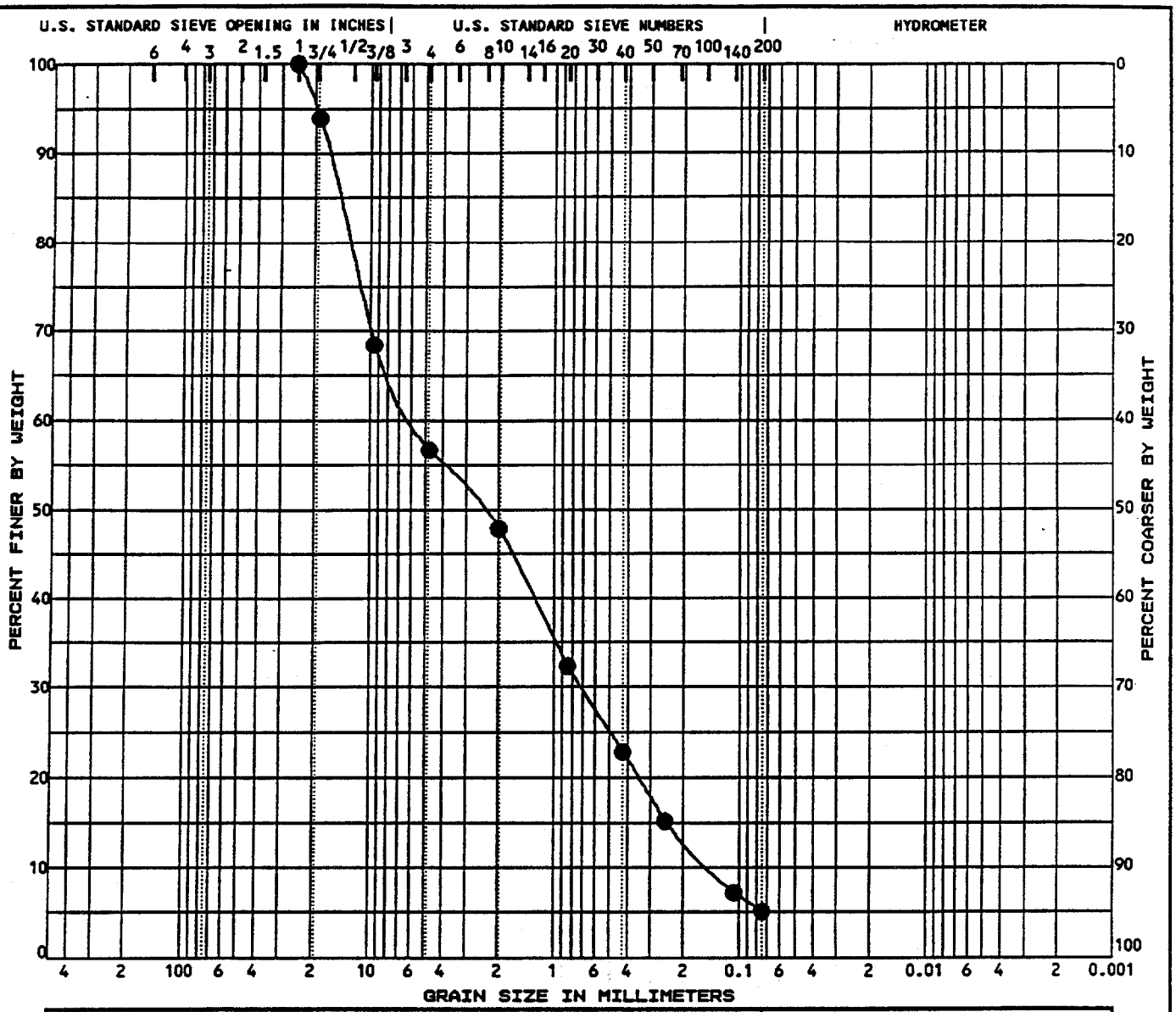
Ash:

Tare Number	G
A. Weight of Dry Soil + Tare	116.72
B. Weight of Tare	57.36
C. Weight of Dry Soil, (A-B)	59.36
D. Weight of Ash + Tare	116.51
E. Weight of Tare	57.36
F. Weight of Ash, (D-E)	59.15
G. Percent Ash, (F/C + 100)	99.65

Organic Matter:

Percent Organic Matter, (100-G)	0.35

Remarks:



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
●	B-37,S3	25.0	Poorly Graded Sand with Silt and Gravel SP-SM	10	NP	NP	NP	0.62	40.4

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-37,S3	25.0	25.00	5.78	0.715	0.1431	43.3	51.6	5.1	

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date October 1989	GRADATION CURVES

LOG OF EXPLORATIONS

Hole No. **B-39**

Contractor: Clarence Welti Associates
Driller: Dave Bromley
Type of Drill: Truck Mounted
Size & Type of Casing: 4"
Drilling Fluid: none
Other:

Project: Oakpoint Associates
No. 3131 Observer: Julie M. Churchill
Location:
Elevation: 7.35
Date Start: 9/8/89 Complete: 9/19/89
Weather:

FIELD DATA									LAB DATA	
DEPTH	ELEV	PROFILE	SAMPLE EQ TEST	SAMPLE TYPE & #	SAMPLE LENGTH	PENE-TRATION RESIST-TANCE PER 6"	RECOVERY FT. OR %	Field Description	Engineering Description	Test Data
1.0	6.4			S-1	1.5	8/4/4	53	Concrete and asphalt	SP-SM:Poorly graded sand with silt and gravel, subangularhard, and durable	
6.0	1.4			S-2	1.5	4/5/4	100	Sand, f-c, some silt, little gravel, brown-black, saturated with petroleum, loose, mottled, SM	SP-SM:Poorly graded sand with silt	
								Wood dock platform		
								Water		
22.0	-14.7			S-3	1.5	1/0/0	27	Organic silt, some sand, f-m, saturated with creosote, black, very soft, OL/OH	SM:Silty sand with gravel, 6.52% organics	W, G, D, e, OC, GS W/HYDRO
27.0	-19.7							Boulder		
31.0	-23.7			S-4	1.5	4/10/15	33	Gravel, some sand, little-some silt, gray-black, saturated, medium dense-very dense, mottled, GM	GW-GM:Well graded gravel with silt and sand, subrounded, hard,and durable, 0.71% organics	W, G, D, e, OC, GS
				S-5	1.5	17/24/25	33		GP-GM:Poorly graded gravel with silt and sand, subangular, hard,and durable, 0.87% organics	W, OC, GS
				S-6	1.5	67/20/17	13		SP-SM:Poorly graded sand with silt and gravel, subrounded,subangular, hard, and durable	
				S-7	1.5	9/13/27	33		SM:Silty sand with gravel, subangular, hard, and durable	
50.0	-42.7			S-8	1.5	22/12/10	0	End of boring, refusal at 52.0'		

Remarks:

GROUNDWATER DATA

Date	Time	Depth
9/23/89	2:30 pm	4.2'

MGE

Hole No **B-39**

CLARENCE WELTI ASSOC., INC. P.O. BOX 397 GLASTONBURY, CONN 06033	CLIENT MORRISON GEOTECHNICAL	PROJECT NAME SUBMARINE BASE LOCATION GROTON, CT

DRILLING PROCEDURES: 2 1., 2., 3., 4., (Select one or more)

1. HOLLOW STEM AUGER. Diameter
2. DRIVEN CASING. Diameter 4"HW&3"NW
3. DRILLED CASING. Diameter
4. ROCK CORING. Diameter & type

HOLE NO. B-39 Surface Elevation

GROUND WATER OBSERVATIONS
AT FT. AFTER 0 HOURS
AT FT. AFTER HOURS

START DATE 9/18/89
FINISH DATE 9/20/89

DEPTH	SAMPLE NO.	BLOWS/6"	DEPTH	A	STRATUM DESCRIPTION	+ DEPTH	REMARKS
	1	8-4-4	1.0'-2.5'		**	1.0'	
					DRK/BR.FINE-MED.SAND,SOME FINE-MED.GRAVEL,LITTLE SILT		
						4.0'	
5	2	4-5-4	5.0'-6.5'		BLK.OIL SOAKED FINE-MED.SAND & GRAVEL,LITTLE SILT		
						7.0'	
					***	7.5'	
10							
					WATER		
15							
20							
	3	1-0-0	22.0'-23.5'	4"		22.0'	
					BLK.SILT WITH CREOSOTE, SOME FINE-MED.SAND		
25		60/0"	25.0'	0"			
						27.5'	
					BOULDERS OR CONCRETE CUTTINGS, POSSIBLE BOULDER OR GRANITE		
30							
	4	4-10-15	31.0'-32.5'	9"		31.0'	
					GR.FINE-CRS.SAND,SOME FINE-MED. GRAVEL,LAYERS BLK.CRESOTE SOAKED FINE-CRS/SAND,SOME FINE-MED.GRAVEL		
35	5	17-25-23	35.0'-36.5'	10"			
40	6	67-22-17	40.0'-41.5'	2"			

LEGEND: Col. A SAMPLE RECOVERY &/OR CORING TIME MINUTES/FT 140lb Wt. x 30" fall on 2" O.D. Sampler

Sample Type	Proportions Used		Cohesionless Density	Cohesive Consistency
D = Dry C = Cored W = Washed	trace	0 to 10%	0-10 Loose	0-4 Soft
UP = Undisturbed Piston	little	10 to 20%	10-30 Med.Dense	4-8 M/Stiff
TP = Test Pit A = Auger V = Vane Test	some	20 to 35%	30-50 Dense	8-15 Stiff
UT = Undisturbed Thinwall	and	35 to 50%	50 + VeryDense	15-30 V-Stiff

Driller: BROMLEY
Helper:
Inspector: CHURCHILL
Sheet 1 of 2

1. Unless otherwise agreed, ***samples*** will be held by Welti Associates a maximum of 60 days after boring completion
2. ***Water readings*** represent driller observations — not interpretations.

CLARENCE WELTI ASSOC., INC. P.O. BOX 397 GLASTONBURY, CONN 06033	CLIENT MORRISON GEOTECHNICAL	PROJECT NAME SUBMARINE BASE LOCATION GROTON, CT

DRILLING PROCEDURES: 2 1., 2., 3., 4., (Select one or more)

1. HOLLOW STEM AUGER, Diameter
2. DRIVEN CASING, Diameter 4"HW/3HW
3. DRILLED CASING, Diameter
4. ROCK CORING, Diameter & type

HOLE NO. B-39 | Surface Elevation

GROUND WATER OBSERVATIONS
AT FT. AFTER 0 HOURS
AT FT. AFTER HOURS

START DATE 9/18/89
FINISH DATE 9/20/89

DEPTH	SAMPLE NO.	BLOWS/6"	DEPTH	A	STRATUM DESCRIPTION + DEPTH	REMARKS
					44.0'	
45	7	9-13-17	45.0'-46.5'	7"		
					GR.FINE-MED.SAND,SOME	
50	8	22-12-13	50.0'-51.5'		ROCK FRAGS.,LITTLE SILT	
					52.0'	
					REFUSAL AT 52.0'	
55					**ASPHALT & CONCRETE	
					***WOOD DECK WITH CREOSOTE	
60					NOTE: NO WATER READING @ COMPLETION OF BORINGS	
65					INSTALLED WOODEN PLUG IN DECK @ 7.0' 2' BENTONITE PELLETS ON TOP	
70						
75						
80						

LEGEND: Col. A SAMPLE RECOVERY &/OR CORING TIME MINUTES/FT 140lb Wt. x 30" fall on 2" O.D. Sampler

Sample Type	Proportions Used		Cohesionless Density	Cohesive Consistency
D = Dry C = Cored W = Washed	trace	0 to 10%	0-10 Loose	0-4 Soft
UP = Undisturbed Piston	little	10 to 20%	10-30 Med.Dense	4-8 M/Stiff
TP = Test Pit A = Auger V = Vane Test	some	20 to 35%	30-50 Dense	8-15 Stiff
UT = Undisturbed Thinwall	and	35 to 50%	50 + VeryDense	15-30 V-Stiff

Driller: BROMLEY
Helper:
Inspector: CHURCHILL
Sheet 2 of 2

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LABORATORY TEST RESULTS

Boring 39, Sample 3

Water Content (ASTM D2216):

Water Content:	72.6

Specific Gravity (ASTM D-854):

Specific Gravity of Soil:	2.564

Dry Unit Weight (See Note 1):

Dry Unit Weight Of Soil:	87.3

Void Ratio (See Note 2):

Void Ratio Of Soil:	0.83

Organic Content (ASTM D-2974):

Percent Organic Matter:	6.52

Grain-Size Analysis (ASTM D422 With Hydrometer):

- Gravel, passing 3 inch and retained on No. 4 sieve		26.9%
- Sand, passing No. 4 and retained on No. 200 sieve		44.5%
- Coarse sand, passing No. 4 and retained on No. 10 sieve	7.2%	
- Medium sand, passing No. 10 and retained on No. 40 sieve	16.3%	
- Fine sand, passing No. 40 and retained on No. 200 sieve	21.0%	
- Silt, 0.074 mm (No. 200) to 0.005 mm		25.6%
- Clay, smaller than 0.005 mm		3.0%

ORGANIC CONTENT

Project Oakpoint Associates Groton, CT, Submarine Base

Source B-39 S-3 Project Number 3131

Date Tested 10-12-89 Tested By RLB

Moisture:

Tare Number	F
A. Weight of Wet Soil + Tare	161.99
B. Weight of Dry Soil + Tare	131.74
C. Weight of Water, Ww = (A-B)	30.25
D. Weight of Tare	90.09
E. Weight of Dry Soil, Ws = (B-D)	41.65
F. Water Content, W = (C/E X 100)	72.6

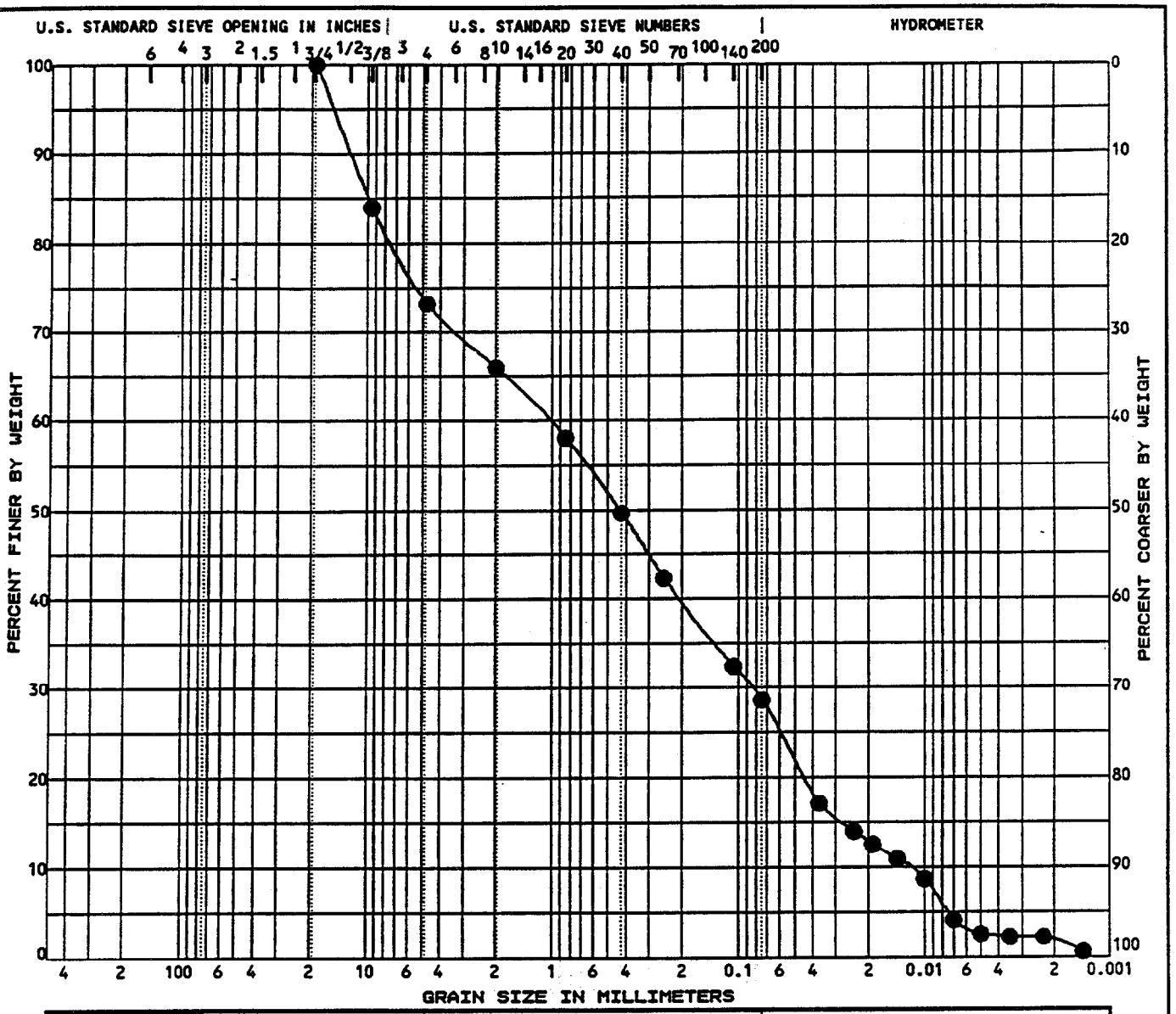
Ash:

Tare Number	
A. Weight of Dry Soil + Tare	99.77
B. Weight of Tare	57.93
C. Weight of Dry Soil, (A-B)	41.84
D. Weight of Ash + Tare	97.04
E. Weight of Tare	57.93
F. Weight of Ash, (D-E)	39.11
G. Percent Ash, (F/C + 100)	93.48

Organic Matter:

Percent Organic Matter, (100-G)	6.52

Remarks:



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
●	B-39,S3	22.0	Silty Sand with Gravel SM	73	NP	NP	NP		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-39,S3	22.0	19.00	1.06	0.085	0.0122	26.9	44.5	26.1	2.5

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date October 1989	GRADATION CURVES

LABORATORY TEST RESULTS

Boring 39, Sample 4

Water Content (ASTM D2216):

Water Content: 7.7

Specific Gravity (ASTM D-854):

Specific Gravity of Soil: 2.717

Dry Unit Weight (See Note 1):

Dry Unit Weight Of Soil: 112.2

Void Ratio (See Note 2):

Void Ratio Of Soil: 0.51

Organic Content (ASTM D-2974):

Percent Organic Matter: 0.71

Gradation (ASTM D-422):

	Percent Passing Sieve By Weight	
Sieve Size	Sample	Specification
1"	100	
3/4"	84.9	
3/8"	56.1	
No. 4	43.8	
No. 10	32.6	
No. 20	25.1	
No. 40	18.8	
No. 60	13.4	
No. 140	7.1	
No. 200	5.3	

ORGANIC CONTENT

Project Oakpoint Associates Groton, CT, Submarine Base

Source B-39 S-4 Project Number 3131

Date Tested 11-13-89 Tested By EBM

Moisture:

Tare Number	
A. Weight of Wet Soil + Tare	
B. Weight of Dry Soil + Tare	
C. Weight of Water, Ww = (A-B)	
D. Weight of Tare	
E. Weight of Dry Soil, Ws = (B-D)	
F. Water Content, W = (C/E X 100)	

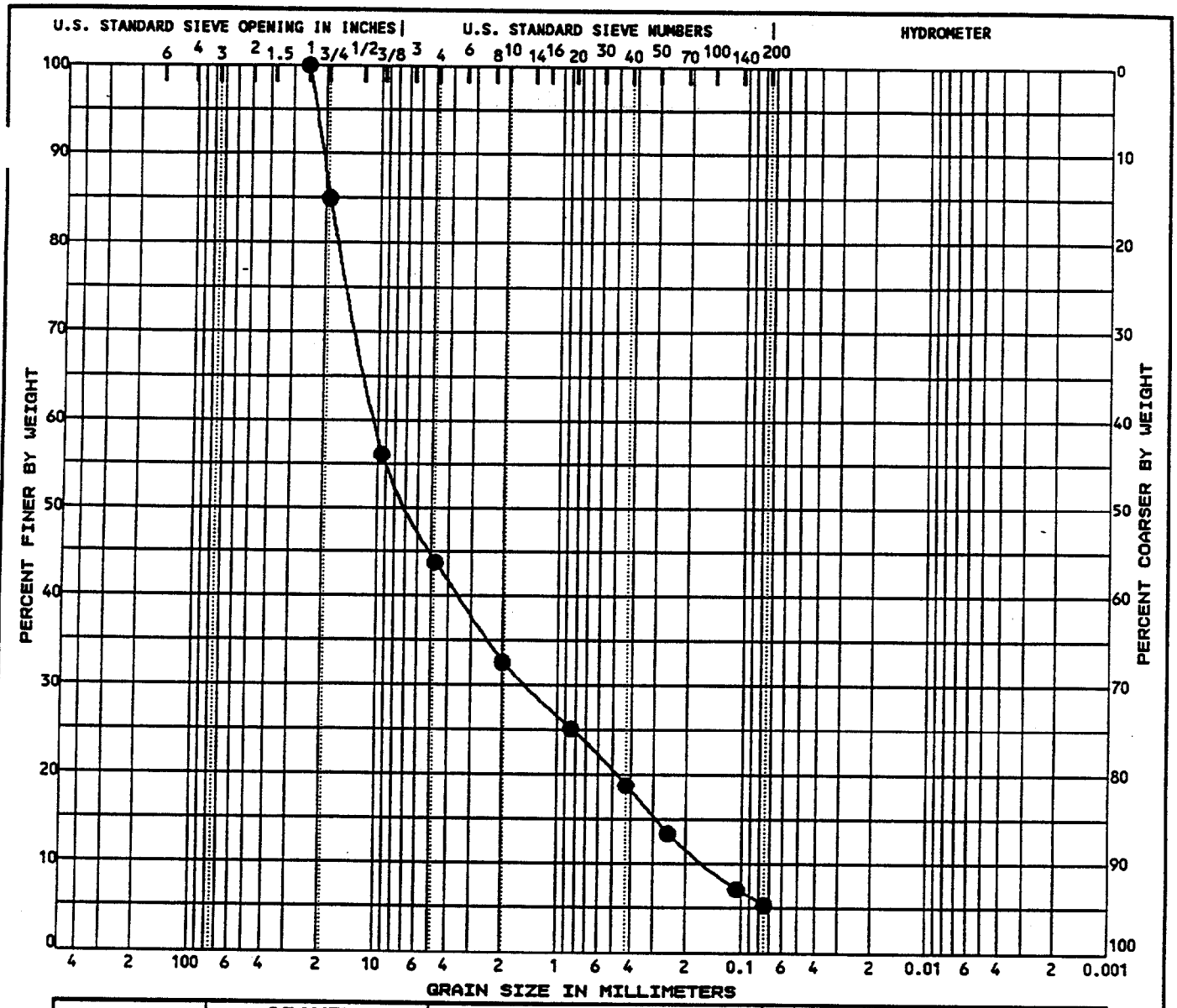
Ash:

Tare Number	B
A. Weight of Dry Soil + Tare	119.73
B. Weight of Tare	57.93
C. Weight of Dry Soil, (A-B)	61.80
D. Weight of Ash + Tare	119.29
E. Weight of Tare	57.93
F. Weight of Ash, (D-E)	61.36
G. Percent Ash, (F/C + 100)	99.29

Organic Matter:

Percent Organic Matter, (100-G)	0.71

Remarks:



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	WC%	L.L.	P.L.	PI	Cc	Cu
● B-39,S4	31.0	Well Graded Gravel with Silt and Sand GW-GM	8	NP	NP	NP	1.35	66.3

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-39,S4	31.0	25.00	10.43	1.487	0.1573	56.2	38.5	5.3	

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date October 1989	GRADATION CURVES

LABORATORY TEST RESULTS

Boring 39, Sample 5

Water Content (ASTM D2216):

Water Content: 7.4

Organic Content (ASTM D-2974):

Percent Organic Matter: 0.98

Gradation (ASTM D-422):

	Percent Passing Sieve By Weight	
Sieve Size	Sample	Specification
1"	100	
3/4"	76.7	
3/8"	66.2	
No. 4	52.7	
No. 10	41.8	
No. 20	33.3	
No. 40	25.8	
No. 60	19.5	
No. 140	12.2	
No. 200	9.8	

ORGANIC CONTENT

Project Oakpoint Associates Groton, CT, Submarine Base

Source B-39 S-5 Project Number 3131

Date Tested 11-13-89 Tested By CEM

Moisture:

Tare Number	E
A. Weight of Wet Soil + Tare	142.54
B. Weight of Dry Soil + Tare	138.97
C. Weight of Water, Ww = (A-B)	3.57
D. Weight of Tare	90.83
E. Weight of Dry Soil, Ws = (B-D)	48.14
F. Water Content, W = (C/E X 100)	7.42

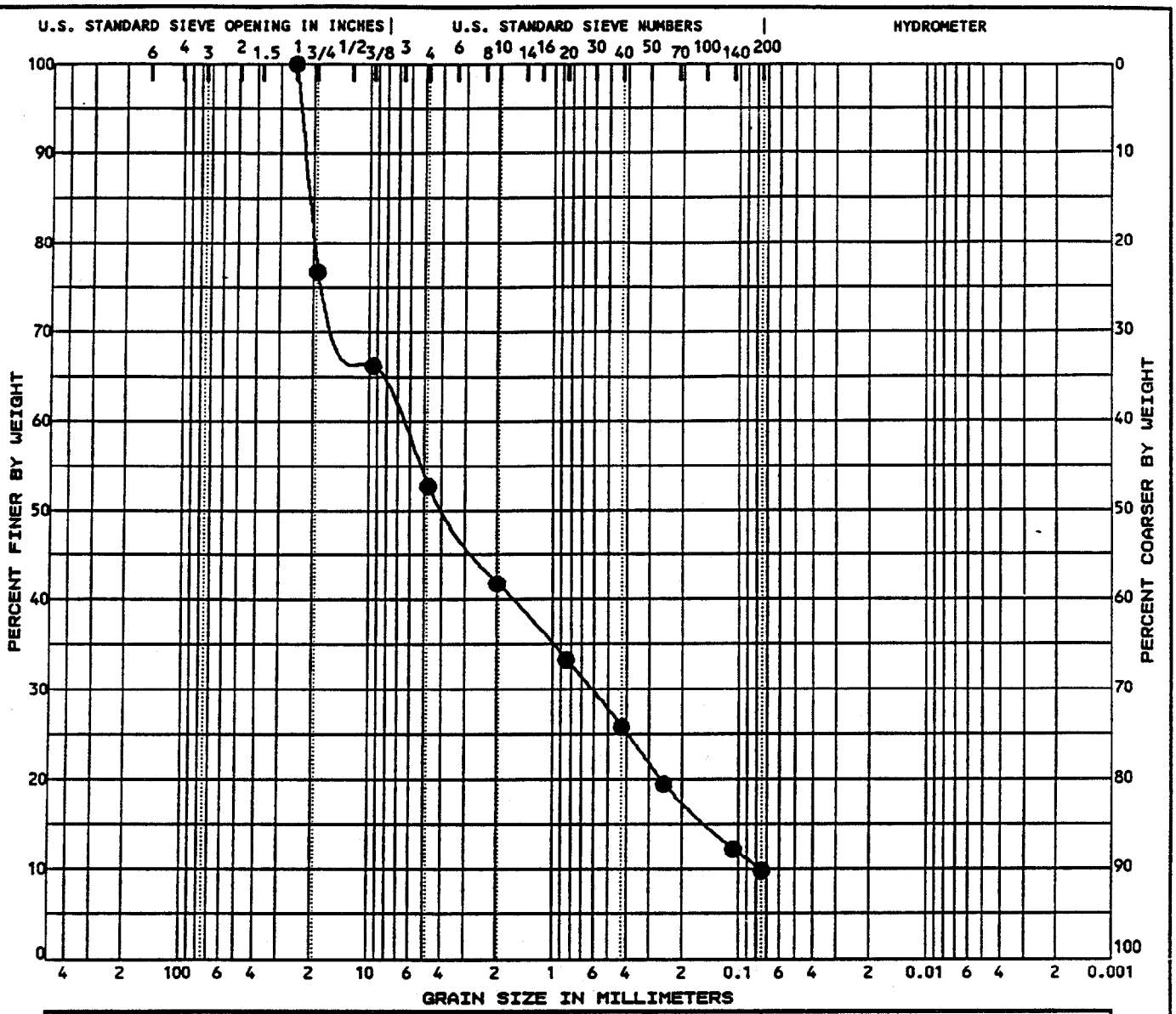
Ash:

Tare Number	
A. Weight of Dry Soil + Tare	106.12
B. Weight of Tare	57.93
C. Weight of Dry Soil, (A-B)	48.19
D. Weight of Ash + Tare	105.64
E. Weight of Tare	57.92
F. Weight of Ash, (D-E)	47.72
G. Percent Ash, (F/C + 100)	99.02

Organic Matter:

Percent Organic Matter, (100-G)	0.98

Remarks:



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
● B-39,S5	35.0	Poorly Graded Gravel with Silt and Sand GP-GM	7	NP	NP	NP	0.74	89.5

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-39,S5	35.0	25.00	6.91	0.627	0.0772	47.3	42.9	9.8	

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date October 1989	GRADATION CURVES

LOG OF EXPLORATIONS

Hole No. **B–40**

Contractor: Clarence Welti Associates
Driller: Dave Bromley
Type of Drill: Truck Mounted
Size & Type of Casing: 4"
Drilling Fluid: none
Other:

Project: Oakpoint Associates
No.: 3131 Observer: Julie M. Churchill
Location:
Elevation: 7.30
Date Start: 9/14/89 Complete: 9/18/89
Weather:

FIELD DATA									LAB DATA	
DEPTH	ELEV	PROFILE	SAMPLE EQ TEST	SAMPLE TYPE & #	SAMPLE LENGTH	PENE-TRATION RESIST-TANCE PER 6"	RECOVERY FT. OR %	Field Description	Engineering Description	Test Data
1.0	6.3							Concrete and asphalt		
				S-1	1.5	4/3/2	33	Sand, f–c, little silt, trace gravel, saturated with petroleum, brown–black mottling, loose, SM	SP–SM:Poorly graded sand with silt and gravel, subrounded,subangular, hard, and durable	
				S-2	1.5	4/3/6	67		SP–SM:Poorly graded sand with silt and gravel, subangular,hard, and durable, with asphalt and wood, 0.89% organics	W, G, D, e, OC, GS, DS
10.0	-2.7							Wood dock platform		
								Water		
23.0	-15.7							Sand, f–c, and gravel, trace silt, gray–black, saturated with petroleum and creosote, loose–very dense, SP–GP		
				S-3	1.5	2/2/4	33		SM:Silty sand	
				S-4	1.5	8/9/20	33		SP–SM:Poorly graded sand with silt and gravel, angular,subangular, hard, and durable	
				S-5	1.5	22/13/8	33		SP–SM:Poorly graded sand with silt	
					1.5	10/18/17	0			
				S-6	1.5	8/12/8	26		No Sample	
				S-8	1.5	12/29/50	13		SP–SM:Poorly graded sand with silt	
				S-9	1.5	13/8/6	27		GW:Well graded gravel, angular, hard, and durable	
60.0	-52.7							Organic silt, little sand, little shells, wet, stiff gray–green, OL/OH		
				S-10	1.5	8/4/4	73		SP–SM:Poorly graded sand with silt, subrounded, subangular,hard, and durable	W, G, D, e, OC, AL, GS W/HYDRO
					2.0		0			
				S-11	1.5	3/3/3	67		ML:Silt with sand and shells, 7.81% organics	W, G, D, e, OC, GS W/HYDRO
					2.0		100		ML:Gravelly silt with sand, subangular, hard, and durable,with shells, 4.72% organics	W, US, VS, DV
74.0	-66.7			S-12	1.5	5/6/6	0		MH:Elastic silt	W, AL
				S-13	1.5	11/13/17	33	Gravel and sand, f–c, trace silt, saturated, brown–gray, dense, GP/SP	SP–SM:Poorly graded sand with silt and gravel, subangular	W, G, D, e, GS W/HYDRO, DS

Remarks:

GROUNDWATER DATA

Date	Time	Depth
9/19/89	3:20 pm	5.3'

MGE

Hole No **B–40**

LOG OF EXPLORATIONS

Hole No. **B–40**

FIELD DATA									LAB DATA	
DEPTH	ELEV	PROFILE	SAMPLE EQ TEST	SAMPLE TYPE & #	SAMPLE LENGTH	PENE-TRATION RESIST-TANCE PER 6"	RECOVERY FT. OR %	Field Description	Engineering Description	Test Data
					1.5	13/15/16	0		and durable, with shells	
				S-14	1.5	10/13/14	47		No Sample	
92.0	-84.7			S-15	1.5	18/17/19	33			
					10.0		82	End of boring at 92.0' Light gray biotite granite gneiss		UR
102.0	-94.7							End of rock core at 102.0'		

Project Abbrev. Submarine Base, Groton
Project No. 3131

Date 9/28/89
Logged by JMC

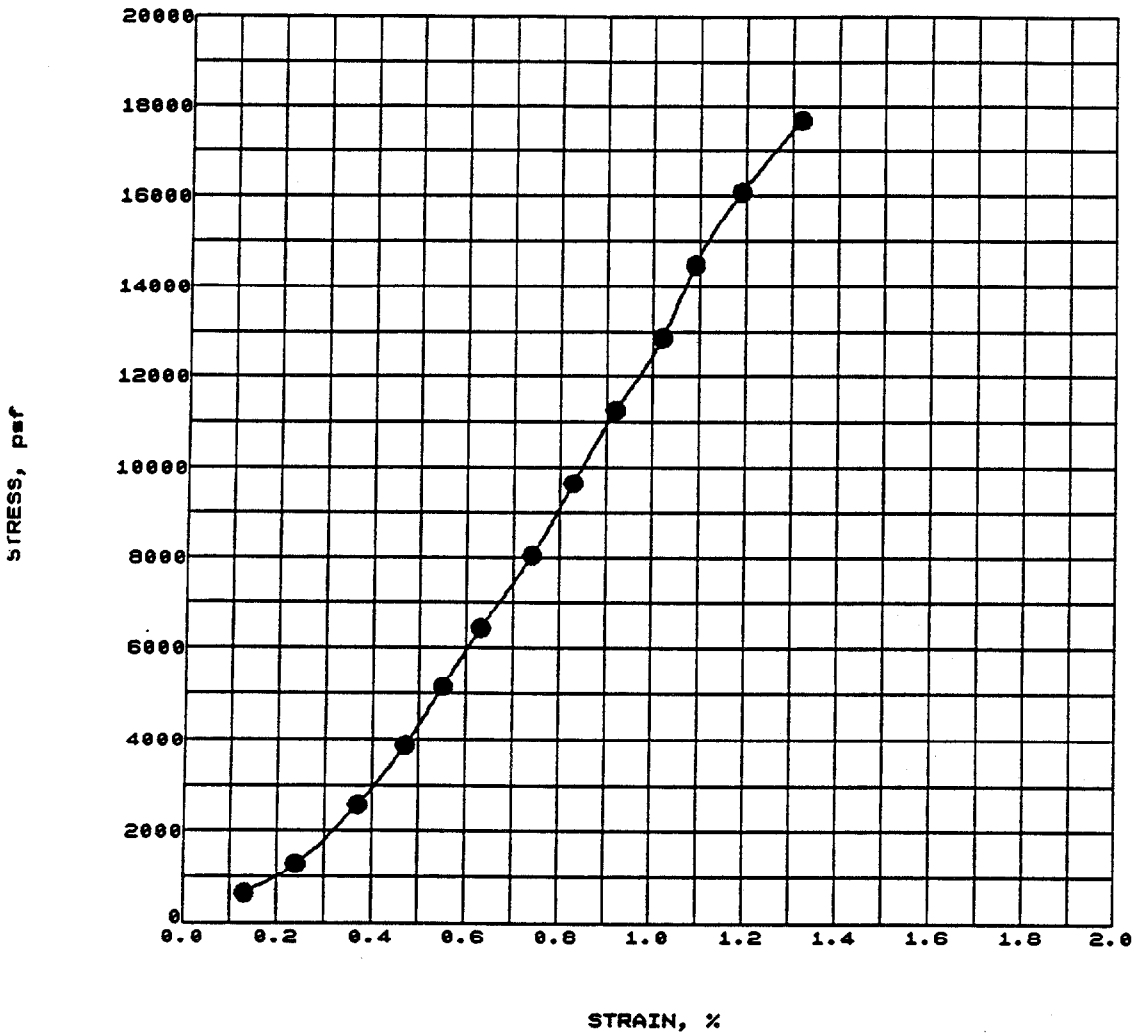
LOG OF ROCK CORE

Boring No. B-40
Depth of Boring 92.0
Size of Core 2.1"
Type of Core Barrel NX

Location Area C
Boring Elev. 7.30
Elev. Top of Bedrock -84.7
Elev. Groundwater

Depth	Run No.	Recovery 82 %	RQD %	Graphic Log	Fractures	Lithology
92					Weathered surface	Light gray biotite granite gneiss
					Mechanical break	
93	Run 1	41/60			Fracture 70°	
					Mechanical break	
94			.85			
			.45			
95						
			.7			
96					Unrecovered rock	
97					Mechanical	
			.5		Mechanical	
98			.6		Mechanical	
	Run 2	57/60	.45		Mechanical	
99			.4		Mechanical	
			.8		Mechanical	
100					Mechanical	
			.6		Mechanical/foliation	Biotitic
101						
			.75		Mechanical	
102					Mechanical Mechanical	Average drilling time 6 min/ft at 300 psi

Unconfined Compression on Rock



Strength, psi: 17,680

MORRISON GEOTECHNICAL ENGINEERING

Project Name:

Oakpoint Associates

Job No. : 3131

Boring : B-40

Depth : 95.0'

MGE

CLARENCE WELTI ASSOC., INC. P.O. BOX 397 GLASTONBURY, CONN 06033	CLIENT MORRISON GEOTECHNICAL	PROJECT NAME SUBMARINE BASE LOCATION GROTON, CT

DRILLING PROCEDURES: 2 1., 2., 3., 4., (Select one or more)

1. HOLLOW STEM AUGER, Diameter
2. DRIVEN CASING, Diameter 4" HW
3. DRILLED CASING, Diameter
4. ROCK CORING, Diameter 2.980 & type NX

HOLE NO. B-40 | Surface Elevation

GROUND WATER OBSERVATIONS
AT ___ FT. AFTER 0 HOURS
AT ___ FT. AFTER ___ HOURS

START DATE 9/14/89
FINISH DATE 9/18/89

DEPTH	SAMPLE NO.	BLOWS/6"	DEPTH	A	STRATUM DESCRIPTION + DEPTH	REMARKS
	1	4-3-2	1.0'-2.5'	14"	** 1.0'	
					DRK/BR.FINE-MED.SAND & GRAVEL,LITTLE SILT,	
5	2	4-3-6	5.0'-6.5'	12"	FUEL OIL & CREOSOTE 5.0'-7.0'	
					7.0'	
					*** 7.4'	
10						
					WATER	
15						
20						
					23.0'	
					BLK.FINE SAND & SILT	
25	3	2-2-4	25.0'-26.5'	6"	25.0'	
					**** 27.0'	
					BOULDER OR CONCRETE, (WATER WENT INTO BORING)	
30	4	8-9-20	30.0'-31.5'	8"	30.0'	
					GR.FINE-MED.SAND,SOME FINE-MED.GRAVEL,TR.SILT	
35	5	22-13-8	35.0'-36.5'	7"		
40		10-18-17	40.0'-41.5'	0"		

LEGEND: Col. A SAMPLE RECOVERY &/OR CORING TIME MINUTES/FT

140lb Wt. x 30" fall on 2" O.D. Sampler

Sample Type	Proportions Used		Cohesionless Density	Cohesive Consistency
D = Dry C = Cored W = Washed	trace	0 to 10%	0-10 Loose	0-4 Soft
UP = Undisturbed Piston	little	10 to 20%	10-30 Med.Dense	4-8 M/Stiff
TP = Test Pit A = Auger V = Vane Test	some	20 to 35%	30-50 Dense	8-15 Stiff
UT = Undisturbed Thinwall	and	35 to 50%	50 + VeryDense	15-30 V-Stiff

Driller: BROMLEY
Helper:
Inspector: CHURCHILL
Sheet 1 of 3

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2. ***Water readings*** represent driller observations — not interpretations.

CLARENCE WELTI ASSOC., INC. P.O. BOX 397 GLASTONBURY, CONN 06033	CLIENT MORRISON GEOTECHNICAL	PROJECT NAME SUBMARINE BASE LOCATION GROTON, CT

DRILLING PROCEDURES: 2 & 4 1., 2., 3., 4., (Select one or more)

1. HOLLOW STEM AUGER. Diameter
2. DRIVEN CASING. Diameter 4" HW
3. DRILLED CASING. Diameter
4. ROCK CORING. Diameter 2.980 & type NX

HOLE NO. B-40 Surface Elevation

GROUND WATER OBSERVATIONS
AT FT. AFTER 0 HOURS
AT FT AFTER HOURS

START DATE 9/14/89
FINISH DATE 9/18/89

DEPTH	SAMPLE NO.	BLOWS/6"	DEPTH	A	STRATUM DESCRIPTION	+ DEPTH	REMARKS
45	6	8-12-8	45.0'-46.5'	4"	GR.FINE-MED.SAND,SOME FINE-MED.GRAVEL,TR.SILT		
50	7	12-29-50	50.0'-51.5'	2"		50.0'	
55	8	13-8-6	55-56.5'	3"	GR.FINE-CRS.SAND & FINE GRAVEL, TR.PEAT FIBERS		
	9	18-4-4	60.0'-61.5'	18"		60.0'	
65	A	PRESSED-TUBE#1	65.0'-67.0'	0"	GR.ORGANIC SILT WITH SHELLS,LITTLE CLAY		
	10	3-3-3	67.0'-68.5'	12"			
70	B	PRESSED-TUBE#2	70.0'-72.0'	24"			
	11	5-6-6	72.0'-73.5'	10"			
75	13	11-13-17	75.0'-76.5'	11"		74.0'	
80		15-15-16	80.0'-81.5'	0"	GR.FINE-MED.SND,SOME FINE GRAVEL,LITTLE SILT		

LEGEND: Col A SAMPLE RECOVERY &/OR CORING TIME MINUTES/FT

140lb Wt. x 30" fall on 2" O.D. Sampler

Sample Type	Proportions Used		Cohesionless Density	Cohesive Consistency
D = Dry C = Cored W = Washed	trace	0 to 10%	0-10 Loose	0-4 Soft
UP = Undisturbed Piston	little	10 to 20%	10-30 Med.Dense	4-8 M/Stiff
TP = Test Pit A = Auger V = Vane Test	some	20 to 35%	30-50 Dense	8-15 Stiff
UT = Undisturbed Thinwall	and	35 to 50%	50 + VeryDense	15-30 V-Stiff

Driller: BROMLEY
Helper:
Inspector: CHURCHILL
Sheet 2 of 3

1 Unless otherwise agreed, *samples* will be held by Welti Associates a maximum of 60 days after boring completion.
2 *Water readings* represent driller observations — not interpretations.

CLARENCE WELTI ASSOC., INC. P.O. BOX 397 GLASTONBURY, CONN 06033	CLIENT MORRISON GEOTECHNICAL	PROJECT NAME SUBMARINE BASE LOCATION GROTON, CT

DRILLING PROCEDURES: 2 & 4 1., 2., 3., 4., (Select one or more)

1. HOLLOW STEM AUGER. Diameter
2. DRIVEN CASING. Diameter 4" HW
3. DRILLED CASING. Diameter
4. ROCK CORING. Diameter 2.980 & type NX

HOLE NO. B-40 Surface Elevation

GROUND WATER OBSERVATIONS
AT FT AFTER 0 HOURS
AT FT AFTER HOURS

START DATE 9/14/89
FINISH DATE 9/18/89

DEPTH	SAMPLE NO.	BLOWS/6"	DEPTH	A	STRATUM DESCRIPTION + DEPTH	REMARKS
					GR.FINE-MED.SAND,SOME FINE GRAVEL,LITTLE SILT	
85	14	10-13-14	85.0'-86.7'	8"	85.0'	
					GR.FINE SAND,SOME ROCK FRAGS., & FINE GRAVEL,LAYERS FINE SAND, SOME SILT	
90	15	18-17-19	90.0'-91.5'	8"	92.0'	
				6	CORED: GR.GRANITE GNEISS	
				4	MODERATELY FRACTURED	
95				4		
				6	RUN #1 92.0'-97.0' REC.41"	
				4		
				6	RUN #2 97.0'-102.0' REC.57"	
				6		
100				6		
				6		
				6	102.0'	
					BOTTOM OF BORING 102.0'	
105						
					**ASPHALT & CONCRETE	
					***WOODEN DECK	
110					****GR.& BLK.FINE-CRS.SAND,SOME FINE GRAVEL & CREOSOTE	
					NOTE: NO WATER READING @ COMPLETION OF BORING	
115					PLUGGED BORING W/8" TAPERED WOODEN PLUG; BENTONITE BALLS 2' ABOVE PLUG 5.0'-7.0'	
120						

LEGEND: Col A SAMPLE RECOVERY &/OR CORING TIME MINUTES/FT 140lb Wt. x 30" fall on 2" O.D. Sampler

Sample Type	Proportions Used		Cohesionless Density	Cohesive Consistency
D = Dry C = Cored W = Washed	trace	0 to 10%	0-10 Loose	0-4 Soft
UP = Undisturbed Piston	little	10 to 20%	10-30 Med.Dense	4-8 M/Stiff
TP = Test Pit A = Auger V = Vane Test	some	20 to 35%	30-50 Dense	8-15 Stiff
UT = Undisturbed Thinwall	and	35 to 50%	50 + VeryDense	15-30 V-Stiff

Driller: BROMLEY
Helper:
Inspector: CHURCHILL
Sheet 3 of 3

1 Unless otherwise agreed, *samples* will be held by Welti Associates a maximum of 60 days after boring completion.
2 ***Water readings*** represent driller observations — not interpretations.

LABORATORY TEST RESULTS

Boring 40, Sample 2

Water Content (ASTM D2216):

Water Content: 13.4

Specific Gravity (ASTM D-854):

Specific Gravity of Soil: 2.688

Dry Unit Weight (See Note 1):

Dry Unit Weight Of Soil: 97.4

Void Ratio (See Note 2):

Void Ratio Of Soil: 0.72

Organic Content (ASTM D-2974):

Percent Organic Matter: 0.91

Gradation (ASTM D-422):

	Percent Passing Sieve By Weight	
Sieve Size	Sample	Specification
3/4"	100	
3/8"	86.2	
No. 4	79.3	
No. 10	72.9	
No. 20	64.3	
No. 40	51.4	
No. 60	39.8	
No. 140	17.7	
No. 200	11.3	

LABORATORY TEST RESULTS

Boring 40, Sample 2 (Con't)

Direct Shear (ASTM D-3080):

Trial No.	Initial Moisture Content,%	Initial Thickness inches	Initial Unit Weight Dry, pcf	Normal Stress, psf	Maximum Shear Stress, psf
1	14.7	.89	104.7	390.29	458.82
2	14.9	.83	104.0	779.71	697.06
3	16.0	.82	104.4	1169.71	1067.65

friction angle = 38
cohesion = 132

ORGANIC CONTENT

Project Oakpoint Associates Groton, CT, Submarine Base

Source B-40 S-2 Project Number 3131

Date Tested 11-13-89 Tested By EBM

Moisture:

Tare Number	C
A. Weight of Wet Soil + Tare	149.51
B. Weight of Dry Soil + Tare	142.56
C. Weight of Water, Ww = (A-B)	6.95
D. Weight of Tare	90.73
E. Weight of Dry Soil, Ws = (B-D)	51.83
F. Water Content, W = (C/E X 100)	13.41

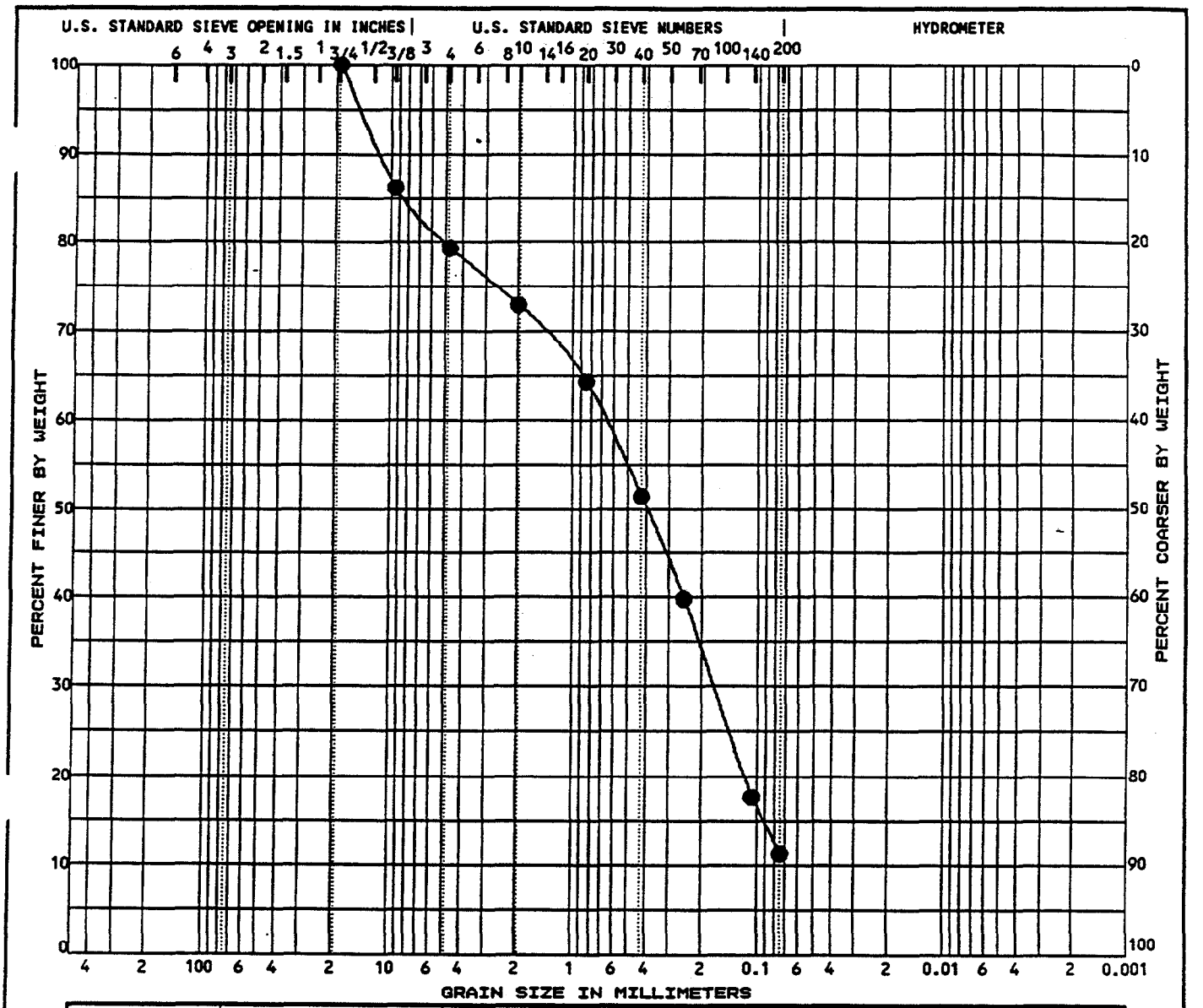
Ash:

Tare Number	
A. Weight of Dry Soil + Tare	109.95
B. Weight of Tare	58.11
C. Weight of Dry Soil, (A-B)	51.84
D. Weight of Ash + Tare	109.48
E. Weight of Tare	58.11
F. Weight of Ash, (D-E)	51.37
G. Percent Ash, (F/C + 100)	99.09

Organic Matter:

Percent Organic Matter, (100-G)	0.91

Remarks:



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

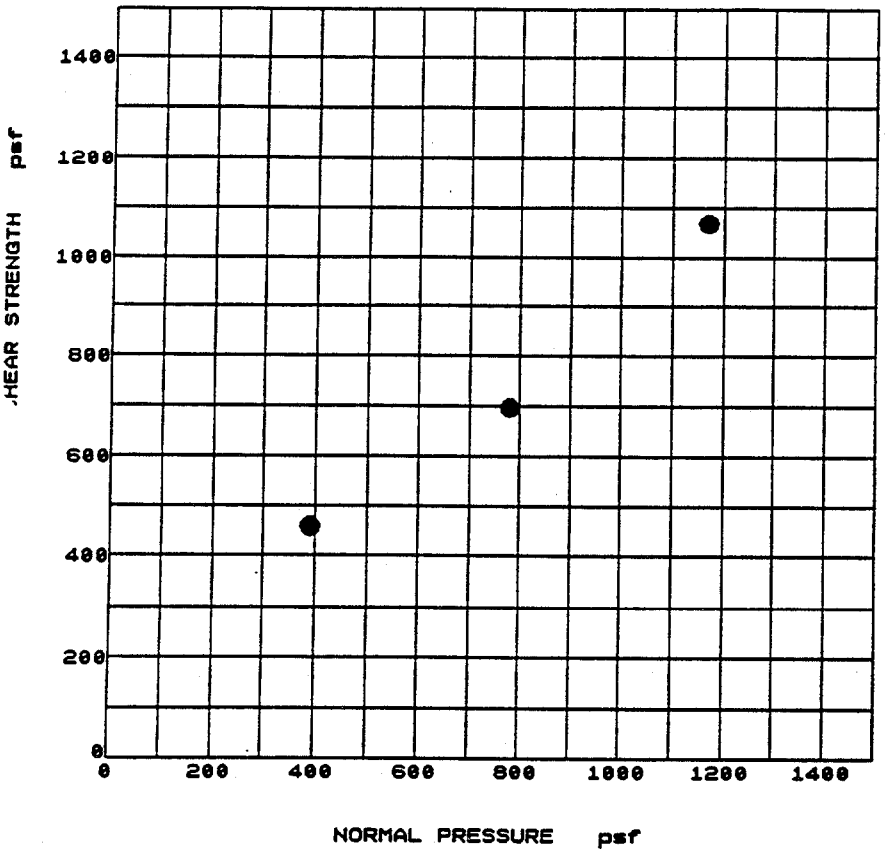
	Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
●	B-40,S2	5.0	Poorly Graded Sand with Silt and Gravel SP-SM	13	NP	NP	NP	0.62	9.6

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-40,S2	5.0	19.00	0.67	0.171		20.7	68.0	11.3	

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date October 1989	GRADATION CURVES

DIRECT SHEAR RESULTS



FRICTION ANGLE: 38

COHESION: 132

MORRISON GEOTECHNICAL ENGINEERING

PROJECT NAME:

Oakpoint Associates

JOB NO.: 3131

BORING: B-40,S2

DEPTH: 5.0

LABORATORY TEST RESULTS

Boring 40, Sample 10

Water Content (ASTM D2216):

Water Content:	28.2

Specific Gravity (ASTM D-854):

Specific Gravity of Soil:	2.663

Dry Unit Weight (See Note 1):

Dry Unit Weight Of Soil:	90.1

Void Ratio (See Note 2):

Void Ratio Of Soil:	0.84

Organic Content (ASTM D-2974):

Percent Organic Matter:	7.81

Atterberg Limit (ASTM D-4318):

Liquid Limit:	90.3
Plastic Limit:	47.7
Plasticity Index:	42.7

LABORATORY TEST RESULTS

Boring 40, Sample 10 (Con't)

Grain-Size Analysis (ASTM D422 With Hydrometer):

- Gravel, passing 3 inch and retained on No. 4 sieve		3.1%
- Sand, passing No. 4 and retained on No. 200 sieve		13.0%
- Coarse sand, passing No. 4 and retained on No. 10 sieve	1.3%	
- Medium sand, passing No. 10 and retained on No. 40 sieve	3.6%	
- Fine sand, passing No. 40 and retained on No. 200 sieve	8.1%	
- Silt, 0.074 mm (No. 200) to 0.005 mm		49.4%
- Clay, smaller than 0.005 mm		34.5%

ORGANIC CONTENT

Project Oakpoint Associates Groton, CT, Submarine Base

Source B-40 S-10 Project Number 3131

Date Tested 11-16-89 Tested By TJG

Moisture:

Tare Number	
A. Weight of Wet Soil + Tare	
B. Weight of Dry Soil + Tare	
C. Weight of Water, Ww = (A-B)	
D. Weight of Tare	
E. Weight of Dry Soil, Ws = (B-D)	
F. Water Content, W = (C/E X 100)	

Ash:

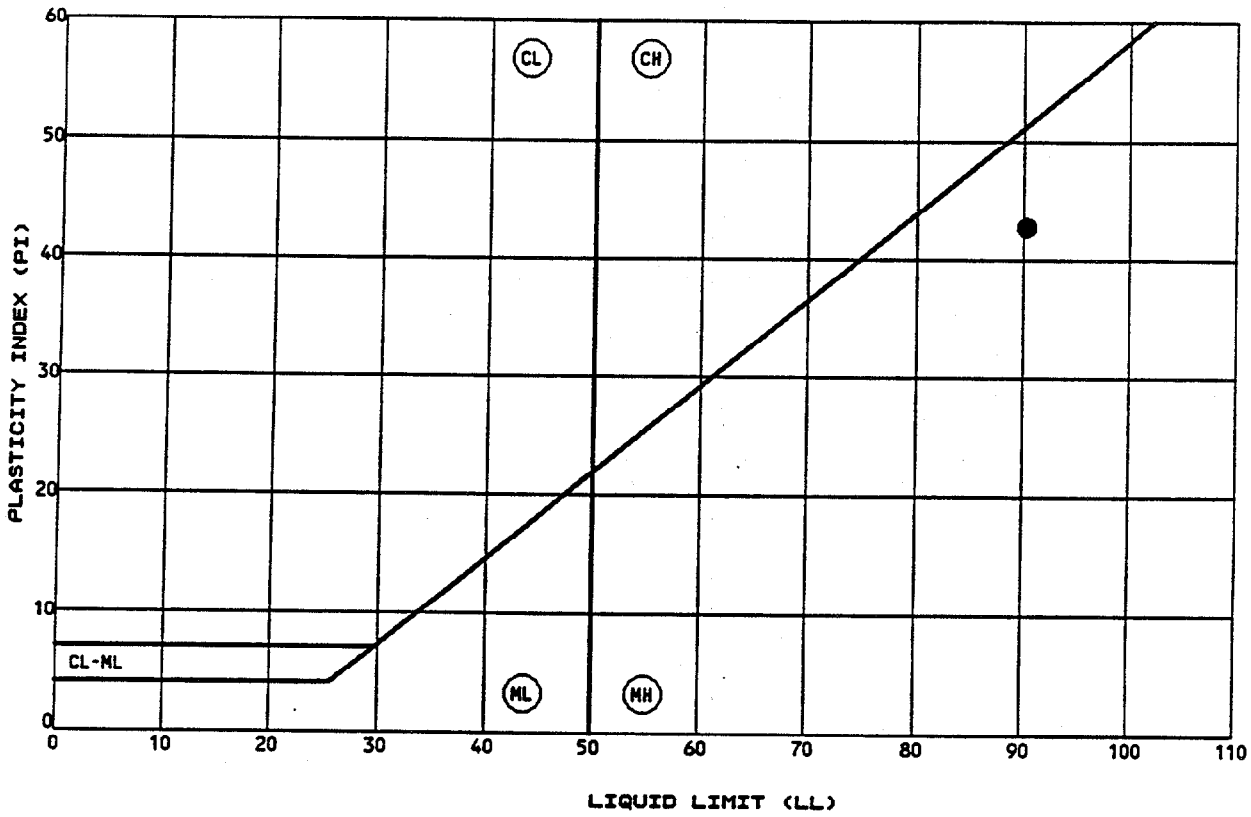
Tare Number	H
A. Weight of Dry Soil + Tare	94.69
B. Weight of Tare	57.93
C. Weight of Dry Soil, (A-B)	36.76
D. Weight of Ash + Tare	91.82
E. Weight of Tare	57.93
F. Weight of Ash, (D-E)	33.89
G. Percent Ash, (F/C + 100)	92.19

Organic Matter:

Percent Organic Matter, (100-G)	7.81

Remarks:

ATTERBERG LIMITS' RESULTS



	BORING	DEPTH	LL	PL	PI	FINES	CLASSIFICATION
●	B40S10	67.0	90	48	43		

MGE

MORRISON GEOTECHNICAL ENGINEERING

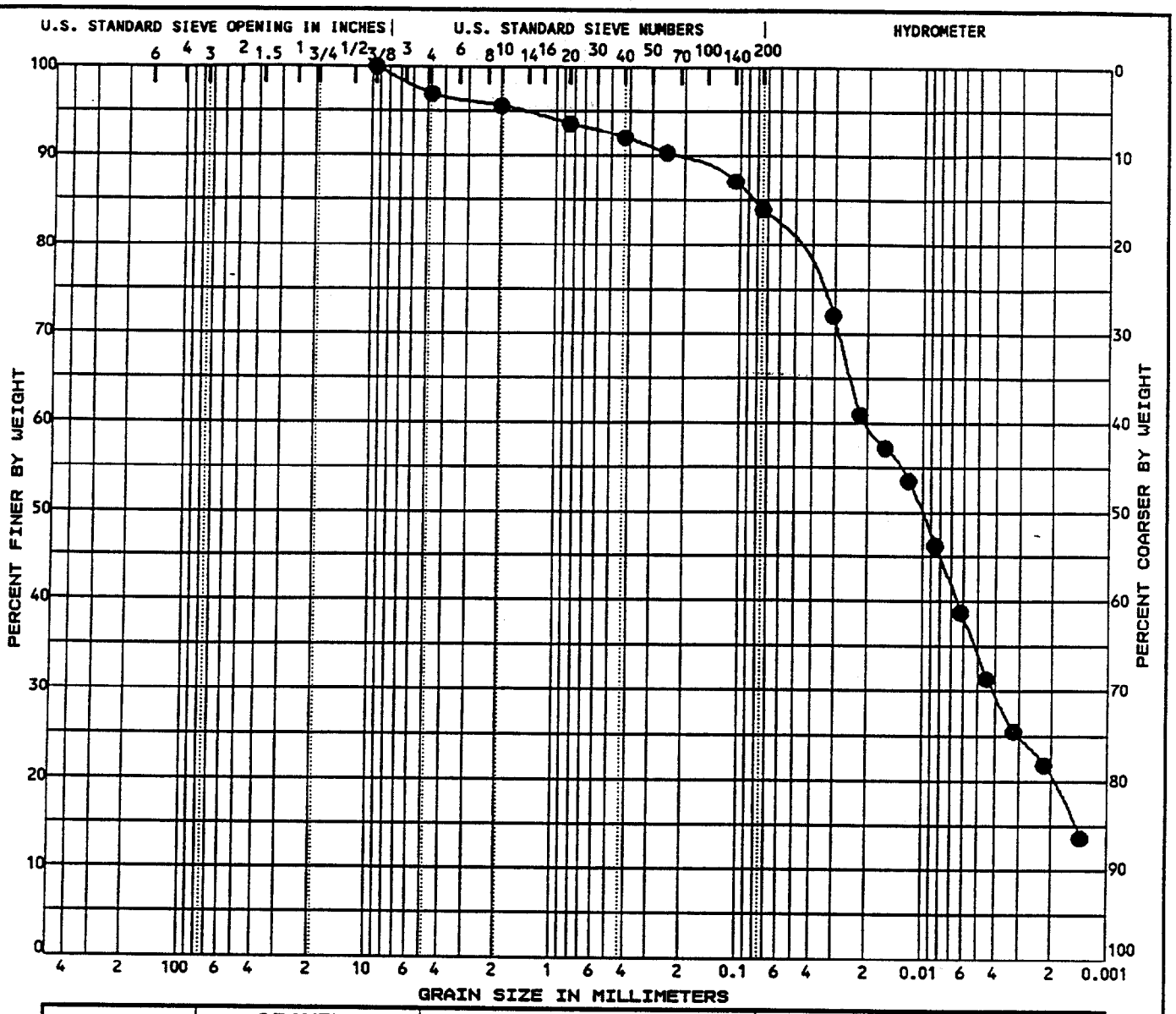
PROJECT NAME:

Oakpoint Associates

JOB NO.: 3131

BORING: B40S10

DEPTH: 67.0



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
●	B40,S10	67.0							

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B40,S10	67.0	9.50	0.02	0.004		3.1	13.0	50.0	33.8

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date November 1989	GRADATION CURVES

LABORATORY TEST RESULTS

Boring 40, Sample 11

Water Content (ASTM D2216):

Water Content:	41.4

Specific Gravity (ASTM D-854):

Specific Gravity of Soil:	2.678

Organic Content (ASTM D-2974):

Percent Organic Matter:	4.72

Dry Unit Weight (See Note 1):

Dry Unit Weight Of Soil:	90.1

Void Ratio (See Note 2):

Void Ratio Of Soil:	0.84

Grain-Size Analysis (ASTM D422 With Hydrometer):

- Gravel, passing 3 inch and retained on No. 4 sieve		29.2%
- Sand, passing No. 4 and retained on No. 200 sieve		17.0%
- Coarse sand, passing No. 4 and retained on No. 10 sieve	5.8%	
- Medium sand, passing No. 10 and retained on No. 40 sieve	5.6%	
- Fine sand, passing No. 40 and retained on No. 200 sieve	5.6%	
- Silt, 0.074 mm (No. 200) to 0.005 mm		32.8%
- Clay, smaller than 0.005 mm		21.0%

ORGANIC CONTENT

Project Oakpoint Associates Groton, CT, Submarine Base

Source B-40 S-11 Project Number 3131

Date Tested 11-16-89 Tested By TJG

Moisture:

Tare Number	H
A. Weight of Wet Soil + Tare	161.56
B. Weight of Dry Soil + Tare	140.82
C. Weight of Water, Ww = (A-B)	20.74
D. Weight of Tare	90.74
E. Weight of Dry Soil, Ws = (B-D)	50.08
F. Water Content, W = (C/E X 100)	41.4

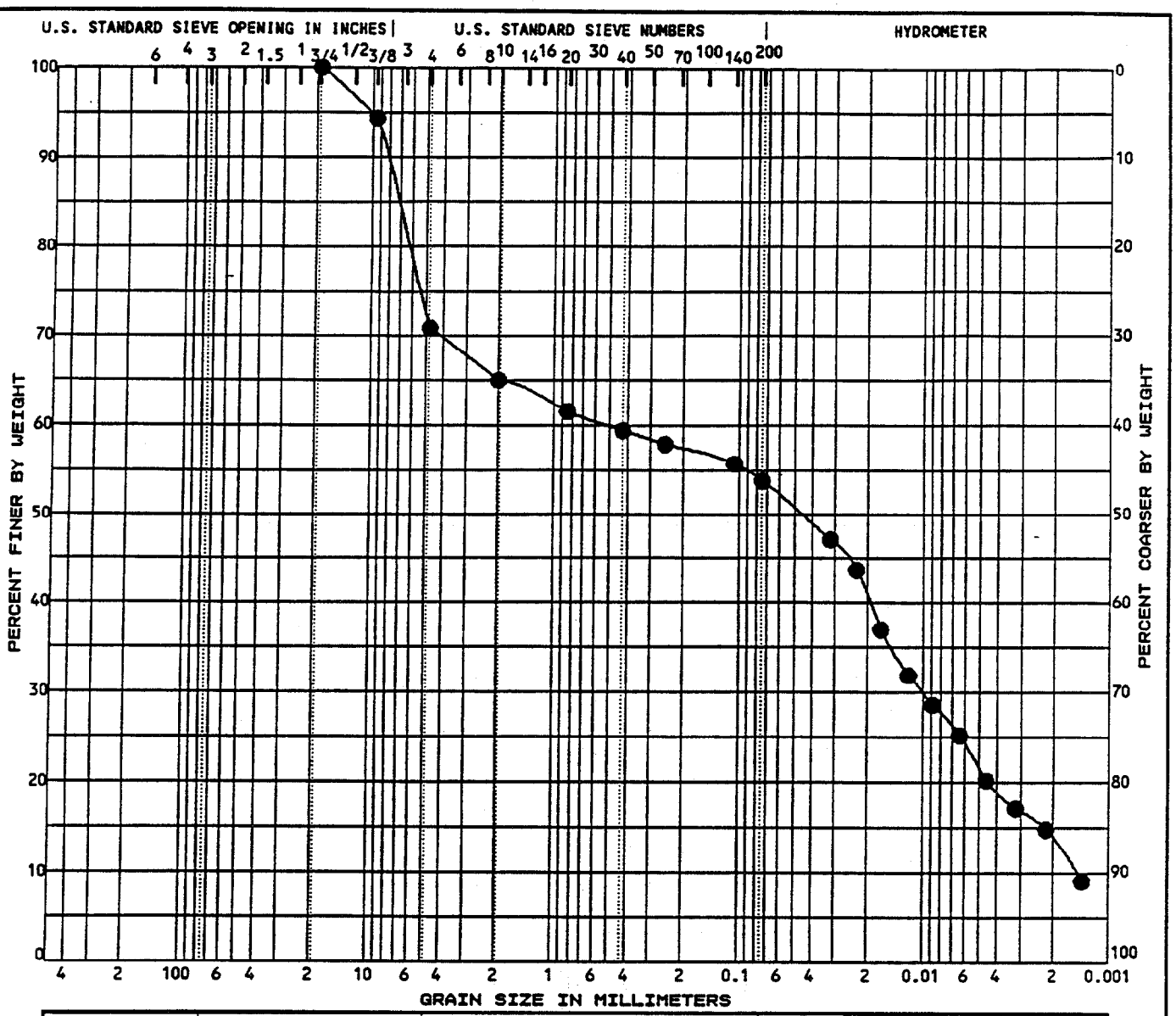
Ash:

Tare Number	
A. Weight of Dry Soil + Tare	108.38
B. Weight of Tare	58.12
C. Weight of Dry Soil, (A-B)	50.26
D. Weight of Ash + Tare	106.01
E. Weight of Tare	58.12
F. Weight of Ash, (D-E)	47.89
G. Percent Ash, (F/C + 100)	95.28

Organic Matter:

Percent Organic Matter, (100-G)	4.72

Remarks:



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
●	B40,S11	70.0							

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B40,S11	70.0	19.00	0.52	0.010	0.0015	29.2	17.0	32.3	21.4

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date November 1989	GRADATION CURVES

LABORATORY TEST RESULTS

Boring 40, 70.0'

Tube Opening

Tube Opening:

The sample was opened, and the following tests performed:

Sample Depth Below Ground Surface	Test	Results	Test Method
70' 3"	Torvane	0.28 tsf	ASTM D-2573
70' 4"	Moisture Content	45.6 %	ASTM D-2216
70' 6"	Dry Unit Weight*	81.8	Volumeter Method
70' 9"	Dry Unit Weight*	63.2	Volumeter Method
70' 10"	Unconfined	- See Below -	
71' 0"	Moisture Content	44.9 %	ASTM D-2216
71' 1"	Torvane	0.45 tsf	ASTM D-2573
71' 2"	Dry Unit Weight**	55.27 pcf	Volumeter Method
71' 7"	Torvane	0.45 tsf	ASTM D-2573
71' 8"	Moisture Content	63.8 %	ASTM D-2216

*These samples may have contained wood fibers
**This sample contained wood fibers

LABORATORY TEST RESULTS

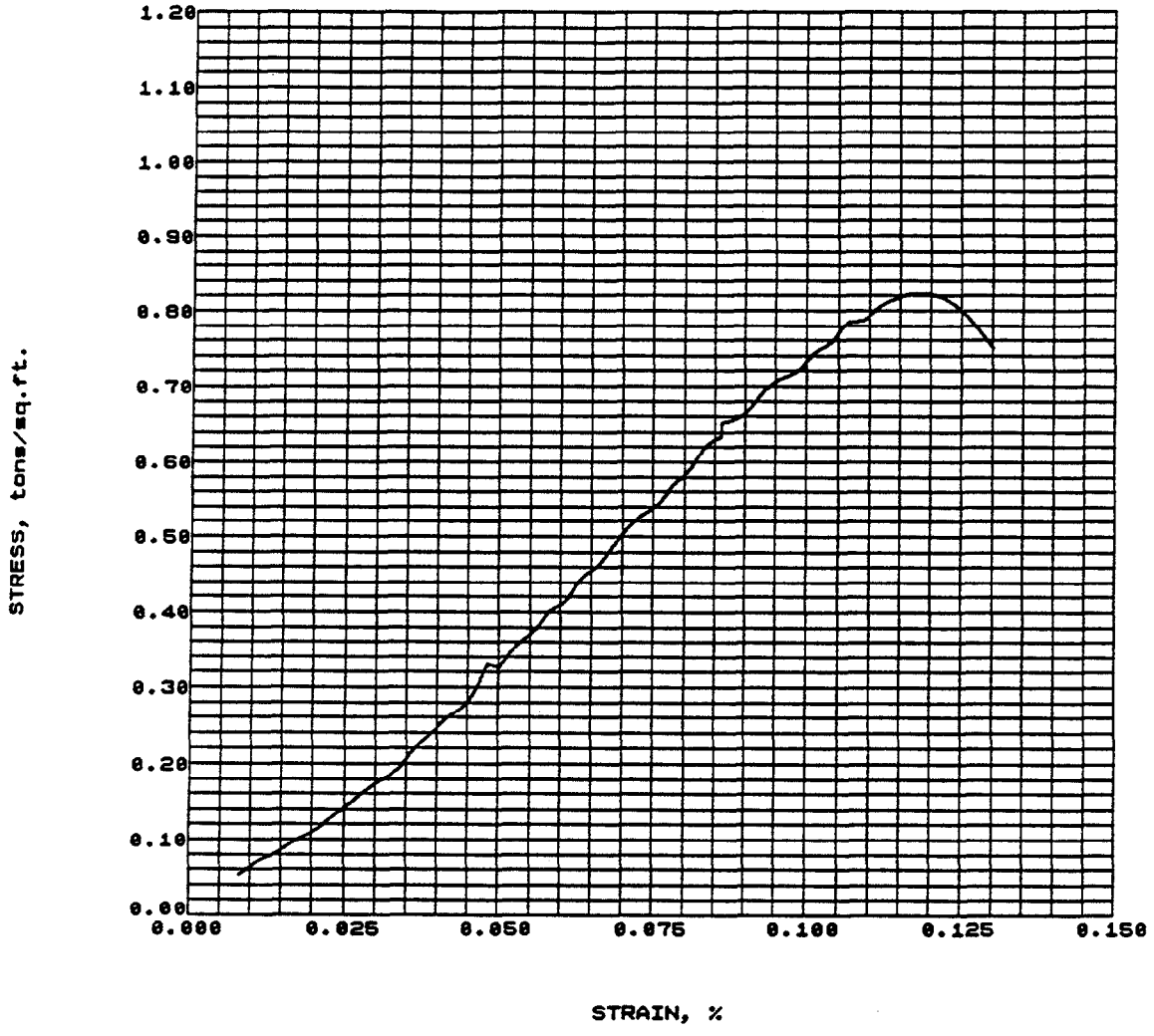
Boring 40, 70.0'

Tube Opening

Unconfined Compression On Soil, ASTM D-2166:

Strength, tsf	0.822
Strain at Failure, %	0.118
Height/Diameter Ratio	1.95
Density, pcf	74.2
Moisture, %	44.9

Unconfined Compression on Soil



MORRISON GEOTECHNICAL ENGINEERING

Project Name:

Oakpoint Associates

Job No. : 3131

Boring : B-40

Depth : 70.0'

LABORATORY TEST RESULTS

Boring 40, Sample 12

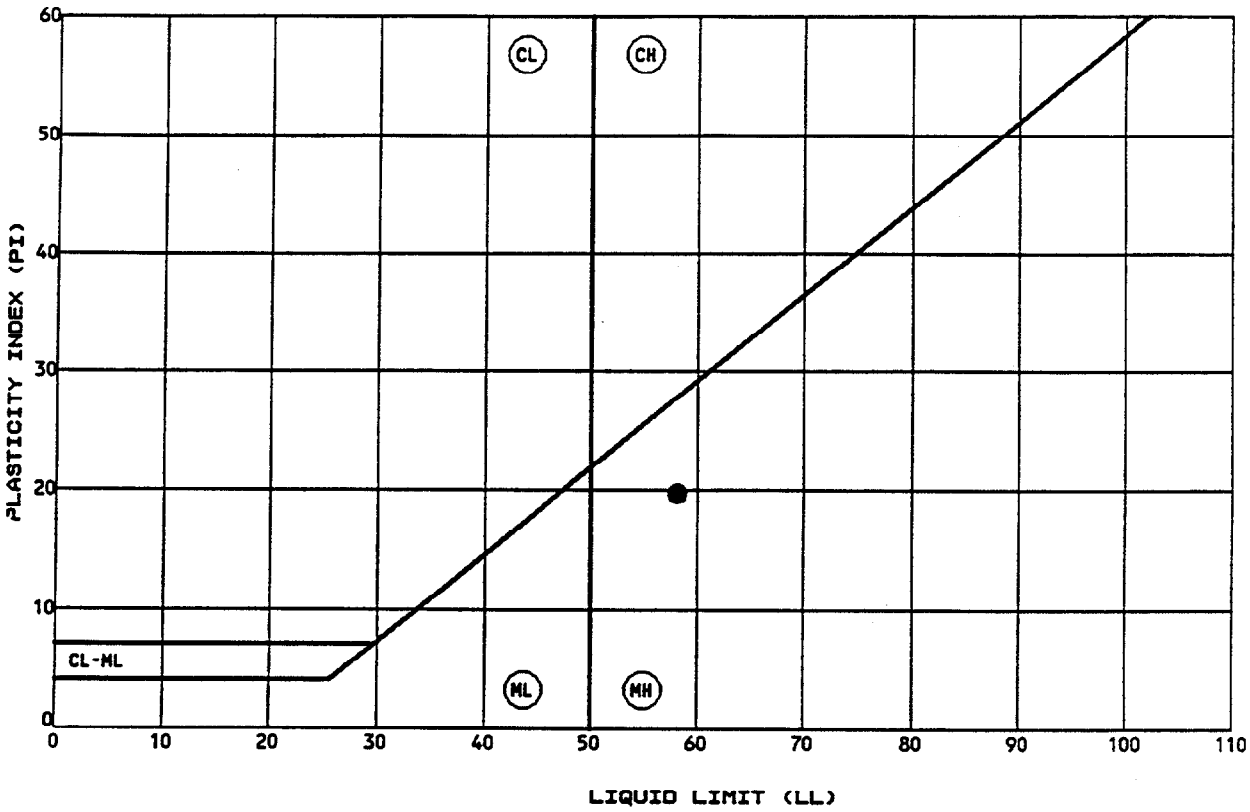
Water Content (ASTM D2216):

Water Content:	48.8

Atterberg Limit (ASTM D-4318):

Liquid Limit:	58.1
Plastic Limit:	38.4
Plasticity Index:	19.7

ATTERBERG LIMITS' RESULTS



	BORING	DEPTH	LL	PL	PI	FINES	CLASSIFICATION
●	B40,S12	72.0	58	38	20		

MGE

MORRISON GEOTECHNICAL ENGINEERING

PROJECT NAME:

Oakpoint Associates

JOB NO.: 3131

BORING: B40,S12

DEPTH: 72.0

LABORATORY TEST RESULTS

Boring 40, Samples 13 & 15

Water Content (ASTM D2216):

Water Content:	12.1

Specific Gravity (ASTM D-854):

Specific Gravity of Soil:	2.697

Dry Unit Weight (See Note 1):

Dry Unit Weight Of Soil:	114.5

Void Ratio (See Note 2):

Void Ratio Of Soil:	0.47

Grain-Size Analysis (ASTM D422 With Hydrometer):

- Gravel, passing 3 inch and retained on No. 4 sieve		30.5%
- Sand, passing No. 4 and retained on No. 200 sieve		57.1%
- Coarse sand, passing No. 4 and retained on No. 10 sieve	14.4%	
- Medium sand, passing No. 10 and retained on No. 40 sieve	18.8%	
- Fine sand, passing No. 40 and retained on No. 200 sieve	23.9%	
- Silt, 0.074 mm (No. 200) to 0.005 mm		10.4%
- Clay, smaller than 0.005 mm		2.0%

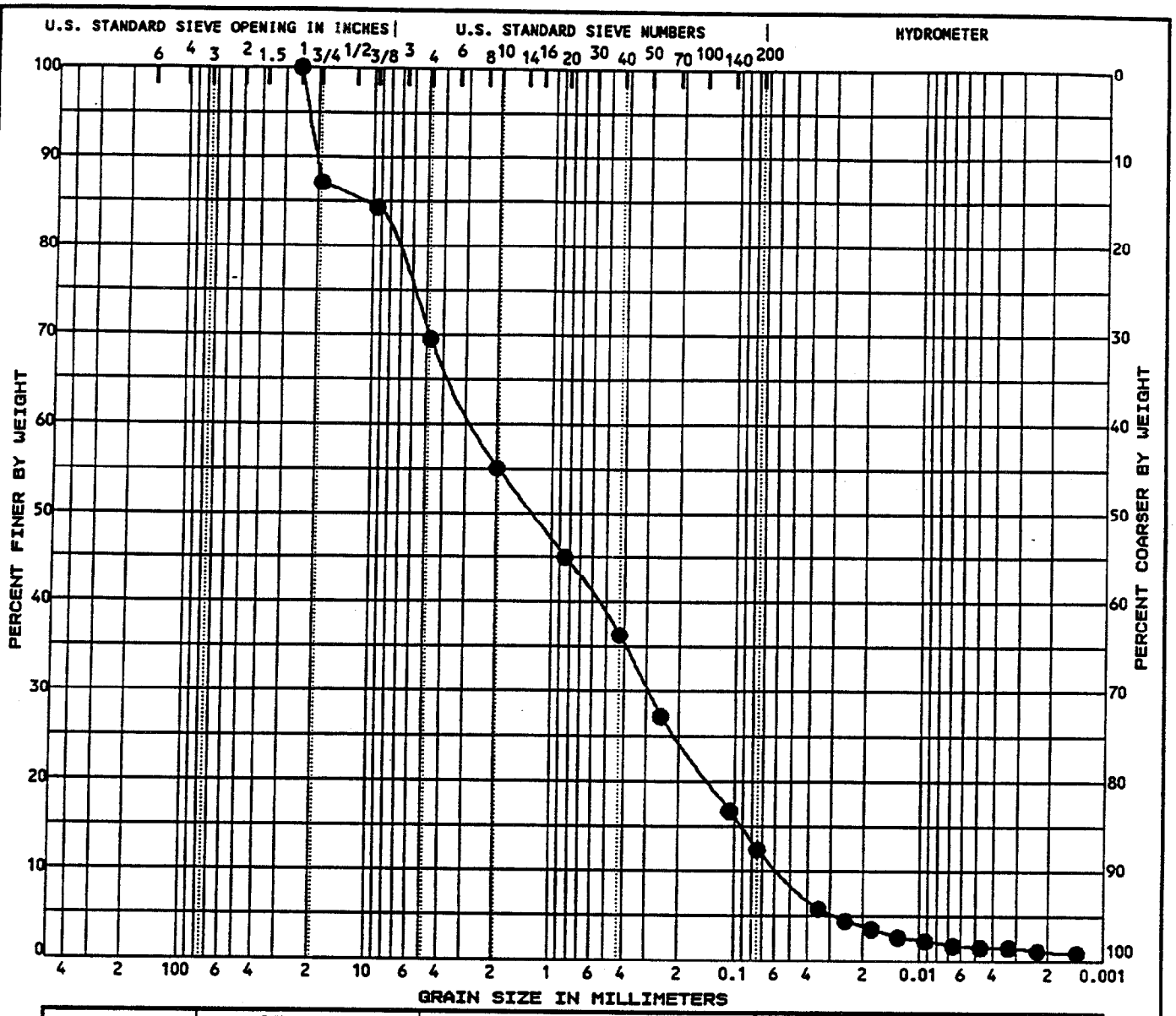
LABORATORY TEST RESULTS

Boring 40, Samples 13 & 15 (Con't)

Direct Shear (ASTM D-3080):

Trial No.	Initial Moisture Content,%	Initial Thickness inches	Initial Unit Weight Dry, pcf	Normal Stress, psf	Maximum Shear Stress, psf
1	11.9	.79	111.2	390.29	476.47
2	13.4	.86	120.1	779.71	882.35
3	10.9	.83	121.3	1169.71	1217.65

friction angle = 44
cohession = 117



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

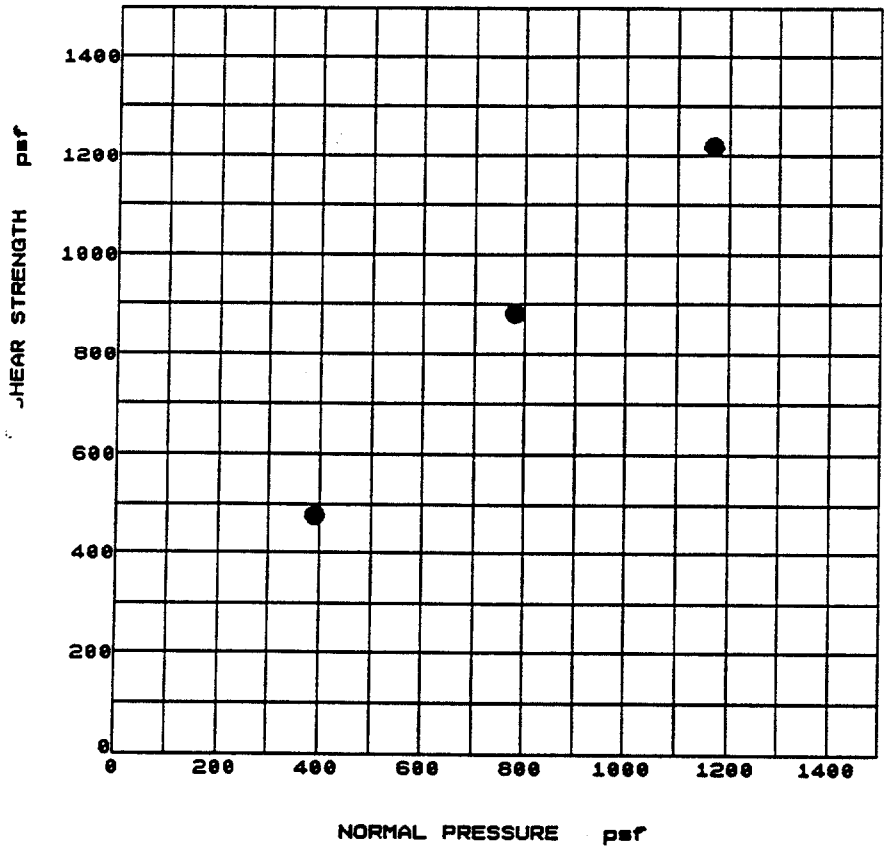
	Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
●	B40,S13	75.0	Poorly Graded Sand with Silt and Gravel SP-SM	12	NP	NP	NP	0.46	38.3

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B40,S13	75.0	25.00	2.68	0.294	0.0568	30.5	57.1	10.8	1.5

MGE

Project Oakpoint Associates	Location Groton, Connecticut
Area	Notes
Date October 1989	GRADATION CURVES

DIRECT SHEAR RESULTS



FRICTION ANGLE: 44

COHESION: 117

MORRISON GEOTECHNICAL ENGINEERING

PROJECT NAME:

Oakpoint Associates

JOB NO.: 3131

BORING: B40,S13, S15

DEPTH: 75.0

MGE

APPENDIX D

ATLANTIC TECHNICAL PROCEDURES

ATLANTIC PROCEDURE NO. 1020

FIELD PROCEDURES FOR COLLECTION OF SURFACE SOIL SAMPLES

Prepared By: John A. Ripp — Principal
JOHN A. RIPP — TITLE

Reviewed By: Edmund J. Burke — QA. Manager
EDMUND J. BURKE, P.E. — TITLE

Approved By: Paul Burgess — Chief Engineer
PAUL BURGESS, P.E. — TITLE

REVISIONS

NO.	DATE	PREPARED BY	REVIEWED BY	APPROVED BY
1.				
2.				
3.				
4.				

ATLANTIC ENVIRONMENTAL SERVICES, INC.
COLCHESTER, CONNECTICUT

TABLE OF CONTENTS

SECTION		PAGE
1.0	PURPOSE	2
2.0	SCOPE	2
3.0	RESPONSIBILITY	2
4.0	SUPPORTING PROCEDURES	2
5.0	REQUIRED FORMS	2
6.0	PROCEDURE	3

SECTION 1.0: PURPOSE

To insure a standard procedure for collection of surface soil samples for the identification of chemical parameters.

SECTION 2.0: SCOPE

The following procedure describes the logistics, chain-of-events, collection techniques and documentation requirements for collecting surface soil samples designated for chemical analysis.

SECTION 3.0: RESPONSIBILITY

Project Manager - First

Field Chemist, Geologist or Engineer - Second

SECTION 4.0: SUPPORTING PROCEDURES

Atlantic Procedure No. 1041 Sample Chain-of-Custody Procedure

SECTION 5.0: REQUIRED FORMS

Field Notebook No. 351, published by J.L. Darling Corp., Tacoma, Washington

SECTION 6.0: PROCEDURE

6.1 Selection of Sampling Locations

The selection of sampling locations in and around a project site will be based on a review of existing site data, the site topography and surface features, results of preliminary site surveys using portable geophysical and air monitoring equipment and the initial estimates as to the extent of and migration pathways of the waste present. At the start of the investigation, a number of surface soil samples are usually allocated. Only after initial field reconnaissance are the final locations selected. At a minimum, the following should be included as sampling points:

- Upgradient soil surfaces to determine background levels.
- Soil surfaces within the immediate area of contamination.
- Downgradient soil surfaces to determine any spread of contamination resulting from storm water runoff.

Sampling locations may be selected in the following areas at the site:

- Areas where chemicals may have been stored, handled or disposed.
- Areas where motor vehicles hauling chemicals may have traveled on the site.
- Areas where water may have ponded during storm events.

6.2 Equipment List

The following is to be considered a minimum listing of required field equipment for collecting soil samples. Other tools required for accessing soils beneath paved area, etc. should be included when necessary.

- Boots, latex gloves, chemical resistant gloves, appropriate level of protection.
- Sample container - 1 each 1 liter glass jar with a teflon lined cap.
- Teflon coated or stainless steel sample spoons.
- Wooden stakes and spray paint (highly visible)
- Field notebook
- Sample bottle labels
- Chain-of-custody forms

6.3 Order of Samples

Surface soil samples should be taken in all locations prior to all other site sampling events. This is to prevent the possibility of cross-contamination between sampling points by site personnel or equipment (backhoe, drill rigs, equipment vehicles, etc. . .). For consistency with other sampling programs, the upgradient samples should be collected first.

6.4 Location and Collection of Samples

Surface soils, depending upon the contaminants of interest, can be either individual or composite samples. Composites represent samples taken from a number of individual locations which are equally blended to form a sample representing a larger area. Certain state agencies are discouraging the use of composite samples when looking for aromatic volatile and halogenated volatile organic compounds because of dilution and the difficulty of forming a "true" composite. Therefore prior to sampling, the use of composites should be checked with the agency which will have final approval of actions regarding a site in which surface soil samples are used in developing certain actions regarding clean up.

If statistical techniques are to be employed in collecting surface soil samples using a random grid, the procedure provided in Chapter 5 of Methods of Soil Analysis, Part I by C.A. Black et al, American Society of Agronomy, Academic Press, N.Y. 1965 and Section I of EPA-SW 846 Test Methods for Evaluating Solid Waste. Physical Chemical/Methods are suggested protocols.

Once the general locations have been chosen, sampling can begin. Normally a sample representing the top 3 to 6 inches of soil is taken. Samples are collected using a dedicated, precleaned stainless steel or Teflon spoon and immediately stored in the glass jar. Organic debris (ie.

leaves, twigs, bark) along with large pieces of gravel should be avoided. The sample should be representative of the area soil; it is best represented by the finer grains of the topsoil. The jars must be filled completely so as to avoid creating a head space where volatiles may escape. After each jar is filled the threads should be wiped clean so that the cap can be threaded on without creating an air gap.

Latex or rubber gloves should be worn to protect the sampling person and to avoid cross contamination through handling.

All filled jars must be labelled with the following as a minimum:

- project number
- sampling time and date
- sample number
- analysis
- collector's initials

The sample chain-of-custody form is then immediately filled out and kept with the sample. The sample is then stored in a refrigerated container until delivery to the analytical lab.

The location, depth of sample, sample type, time of sample, and other associated data (ie. organic vapor readings, color of the ground, odors, texture, etc.) will be documented in the field notebook when the sample is taken. If sampling is performed under a paved area or in fill, a description of these unique areas will also be included.

6.5 Sample Verification

After each sample of soil is taken, an indicator should be used to mark the location in the event it will be surveyed at a later time. Once all the surface soil samples are collected, the sample numbers and locations should be reviewed before leaving the site or progressing to other tasks in a program. All used sampling devices will be kept together, separate from clean tools, so that they can be cleaned according to appropriate decontamination and cleaning procedure. In no event will a used sampling device be used for two or more samples without full cleaning between samples.

ATLANTIC PROCEDURE NO. 1021

FIELD PROCEDURES FOR COLLECTION OF SUBSURFACE SOILS

Prepared By: John A. Ripp — JOHN A. RIPP — Principal — TITLE

Reviewed By: Edmund J. Burke — EDMUND J. BURKE, P.E. — Q.A. Manager — TITLE

Approved By: Paul Burgess — PAUL BURGESS, P.E. — Chief Engineer — TITLE

REVISIONS

NO.	DATE	PREPARED BY	REVIEWED BY	APPROVED BY
1.				
2.				
3.				
4.				

ATLANTIC ENVIRONMENTAL SERVICES, INC.
COLCHESTER, CONNECTICUT

TABLE OF CONTENTS

SECTION		PAGE
1.0	PURPOSE	2
2.0	SCOPE	2
3.0	RESPONSIBILITY	2
4.0	SUPPORTING PROCEDURES	2
5.0	REQUIRED FORMS	2
6.0	PROCEDURE	3

SECTION 1.0: PURPOSE

To insure a standard procedure for collection of subsurface soil samples during site contamination studies for the determination of chemical parameters.

SECTION 2.0: SCOPE

The following procedure describes the method, materials and documentation requirements for collection of subsurface soils from test pits and split spoon samplers for eventual analysis by a chemical laboratory.

SECTION 3.0: RESPONSIBILITY

Project Manager - First

Field Operations Manager - Second

Field Staff - Third

SECTION 4.0: SUPPORTING PROCEDURES

Atlantic Procedure No. 1041 Sample Chain-of-Custody Procedure

SECTION 5.0: REQUIRED FORMS

Field Notebook No. 351, published by J.L. Darling Corp., Tacoma, Washington

SECTION 6.0: PROCEDURE

6.1 Introduction

During a site investigation where test pits, exploratory borings, monitoring wells, test trenches and other forms of excavation are performed it is often planned that soils or buried waste materials are to be collected. For most drilling operations split spoon samples are used to collect discrete samples from known depths using samplers ranging in length from 2 feet to 5 feet. Usually not all samples from these split spoons are designated for analysis, therefore the containerization and handling of samples from split spoons may be different depending on their ultimate purpose.

Samples from test pits and test trenches may also be collected for chemical analysis. These samples can only be taken using a remote sampler from the side walls of each pit. Samples taken from the bucket of the backhoe are harder to identify especially regarding their actual vertical position beneath the ground surface.

The following is to be used as a general guide in collecting samples from either test pits or split spoons.

6.2 Split Spoon Sampling

After logging a split spoon sample following Atlantic Procedure No. 1030 the sample is then identified for either analysis by a laboratory or storage until further decisions are made. If the sample is to be stored, a clean glass jar, preferably new one liter size, will be used to store the sample. In many cases the driller will provide these to the field team. However in no case shall used or dirty soils jars be used to hold samples. If the driller does not have the proper jars, new clean "Mason type" jars may be used. A label must be affixed to these storage jars identifying the boring number, sample depth, date of sample and project number on it for future reference. If soil samples are to be sent for analysis then only properly cleaned or laboratory supplied sample containers are to be used.

The collector must take the following steps when preparing the samples:

1. Always follow designated safety precautions in terms of level of protection. At a minimum samples must always be handled using latex or chemical resistant gloves. This protects the collector and prevents cross-contamination between samples.

2. Do not use the top one to two inches of recovered sample in the split spoon. This usually consists of washings and cave-in soils from higher in the boring that fell into the bottom of the augers.
3. Use a properly cleaned stainless steel spoon (tablespoon size) to remove the soils from the split spoon.
4. When possible, try to fill each sample container so that no air space is allowed. This will prevent volatiles from escaping. If a number of containers are to be used then evenly divide the sample between containers.
5. Avoid getting soils on the threads of the soils containers. Use a clean paper towel to wipe off the threads to insure a good seal.
6. Fill out the sample labels on each jar including the following:

   - sample number
   - sample depth
   - date and time of sample
   - analysis
   - preservation
   - initials of the sample collector

7. Fill in the chain-of-custody form (Atlantic Form No. 1041) for each sample. If a confining layer is to be sampled to determine whether contamination from a shallower zone is migrating down, care should be exercised in collecting these samples. In many instances ground water will fill the auger and the split spoon will travel through the water before being pushed into a deeper zone, there is no guarantee that soils in the split spoon haven't been contaminated with standing water in the auger. To insure a "pure" sample, the drilling procedure may have to be modified to seal off the upper zone from the lower zone using casing and washing the interior of the casing clean. These operations must be detailed in the site sampling plan.

After each spilt spoon sample is collected Atlantic personnel will maintain custody and keep it refrigerated (when necessary) until shipment to the laboratory. The stainless steel sampling spoon is then decontaminated in accordance with Atlantic Procedure No. 1060 before the next sample is taken.

6.3 Sampling Soils from Test Pits

As mentioned before, soils designated for analysis must be collected directly from the side walls of the test pits. A remote sampler is basically a stainless steel scoop that can swivel so that it can be pushed against the side wall and hold soils in a trap at its base. The

scoop is attached to a light weight telescoping aluminum rod which will have a maximum 10 foot reach.

The depth of sample must be noted in the field notebook. The sample is then handled the same as the split spoon samples following the same safety precautions. After the sample is taken, the remote sampling tool will be decontaminated before obtaining the next sample.

ATLANTIC PROCEDURE NO. 1023

FIELD PROCEDURES FOR COLLECTION OF GROUND WATER SAMPLES FOR HAZARDOUS WASTE DETERMINATION

Prepared By: John A. Ripp — JOHN A. RIPP — Principal — TITLE

Reviewed By: Edmund J. Burke — EDMUND J. BURKE, P.E. — Q.A. Manager — TITLE

Approved By: Paul Burgess — PAUL BURGESS, P.E. — Chief Engineer — TITLE

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TABLE OF CONTENTS

SECTION		PAGE
1.0	PURPOSE	2
2.0	SCOPE	2
3.0	RESPONSIBILITY	2
4.0	SUPPORTING PROCEDURES	2
5.0	REQUIRED FORMS	2
6.0	PROCEDURE	3

SECTION 1.0: PURPOSE

To insure a standard procedure for collection of ground water samples for the identification of chemical constituents.

SECTION 2.0: SCOPE

The following procedure describes the logistics, chain of events, collection techniques and documentation requirements for collecting ground water samples designated for chemical analysis.

SECTION 3.0: RESPONSIBILITY

Project Manager - First

Field Supervisor - Second

Field Sampling Technicians - Third

SECTION 4.0: SUPPORTING PROCEDURES

Atlantic Procedure No. 1041 Sample Chain-of-Custody Procedure.

SECTION 5.0: REQUIRED FORMS

Field Notebook No. 351 published by J.L. Darling Corp., Tacoma, Washington

SECTION 6.0: PROCEDURE

6.1 Selection of Sampling Locations

Ground water sampling locations in and around a project site are typically obtained from existing domestic, production and monitoring wells, and newly installed ground water monitoring wells which were part of the site hydro-geological investigation. The location of new ground water monitoring wells will be based upon the review of existing site hydrogeological data, the results of preliminary site surveys, and the initial estimates of the extent of the waste. The ground water sampling locations will be chosen by the project manager. At a minimum one upgradient and three downgradient water samples from the uppermost aquifer will be taken.

6.2 Equipment List

The following is to be considered a guide for groundwater sampling preparation.

1. Latex gloves, and any other personal safety equipment specified in the site health and safety plan.

2. Sample containers (depending on sample requirements of the analytical laboratory) may include for each location:

   - 4 each 1 liter glass jars with Teflon lined caps
   - 8 each 40 ml. glass vials with Teflon lined septas
   - 1 each 500 ml. plastic containers for metals analysis
   - 1 each 500 ml. plastic containers for mercury analysis

3. Device to measure water levels in wells to within .01 feet. Typically a cloth tape with a "plopper" or an electronic water level indicator is used.

4. Field Notebook No. 351

5. Sample bottle labels

6. Chain-of-custody forms

7. A large volume bailer or pump to evacuate the wells.

8. Dedicated Teflon bailer with stainless steel cable, or a peristaltic pump with dedicated Teflon tubing.

6.3 Sample Collection

Prior to the extraction of any ground water, the depth to water shall be measured to the nearest .01 feet. A cloth tape with a "plopper", or an electronic water sensing device (i.e. Slope Indicator Water Mark) shall be used for this purpose. The device used must be clean to avoid contamination of the well. The depth to water is typically measured from a reference point established on the top of the well casing. This value is recorded in the field notebook along with the length of casing stick-up above the ground surface. If both an inner and outer casing are present, the one used as the measurement reference point shall be identified (normally the inner), and any distance between the two, measured and recorded. If the depth of the well is unknown the bottom shall be sounded and the depth recorded.

Ground water samples are to be collected in a manner to be representative of the formation from which the samples were taken. To insure against sampling stagnant water in a well, a minimum of four well volumes must be evacuated from the well prior to sampling. In the case of monitoring wells that will not yield water at a rate adequate to be effectively flushed, one of the two following procedures must be followed. The first procedure includes purging water to the top of the screened interval at a sufficiently slow rate to prevent the exposure of the gravel pack or formation to atmospheric conditions. The sample is then taken at a rate that would not cause rapid drawdown. The second procedure would be to pump the well dry and allowed it to recover. The samples should be collected as soon as a volume of water sufficient for the intended analytical scheme reenters the well. Exposure of water entering the well for periods longer than 2 to 3 hours may render samples unsuitable and unrepresentative of water contained within the aquifer system. In these cases, it may be desirable to collect small volumes of water over a period of time, each time pumping the well dry and allowing it to recover. Whenever full recovery exceeds 3 hours, samples should be collected in order of their volatility as soon as sufficient volume is available for a sample for each analytical parameter or compatible set of parameters. Parameters that are not pH-sensitive or subject to loss through volatilization should be collected last.

Evacuation is accomplished by bailing with a large volume (1.5 liter) bailer, or by pumping. Whichever method is used, it must be assured that any materials (hose, bailer, tubing, pumps, rope, etc.) entering the well must be clean. If the same device is being used to evacuate a number of wells, the device must be cleaned with the appropriate cleaners between each well to prevent cross-contamination.

For pre-preserved sample containers the following procedure will be followed:

1. Prior to collecting any water samples, place a waterproof sample label on each container which specifies the following:

   Sample Number
   Date
   Time
   Preservative
   Project Number
   Initials of the Collector

   Fill in the information with a waterproof ink pen. This will prevent difficulty in filling out labels on a wet jar after it is filled.

2. Extract the ground water sample using either a dedicated Teflon bailer or a peristaltic pump with dedicated Teflon tubing. Latex gloves shall be worn during this procedure.

3. When using the peristaltic pump or bailer first fill the 40 ml. vials making sure no air is trapped in the vials. This sample is normally taken for volatile analysis and therefore should be sampled prior to further disturbance of water in the well.
4. Fill all the remaining jars directly from the pump discharge or bailer. With the containers containing preservative, avoid overflow since this will dilute the preservative.
5. If dissolved metals analysis are required an extra bottle (no preservative) will be filled and the metals container (pre-preserved with nitric acid) will remain empty. Only after the water sample is field filtered will it be poured into the pre-preserved metals container. This will constitute a sample for dissolved metals.
6. Place all sample containers into a sample shipping container, cool with ice packs and fill out the chain-of-custody form.
7. Detail in the field notebook the following:

- sample identification number
- location of the sample
- time and date of sampling
- personnel performing task
- depth to water table, reference mark, casing(s) stick-up, and horizontal distance between inner and outer casing
- Amount evacuated from well and device used for evacuation
- Visual or sensory description of the sample (color, odor, turbidity, etc.)
- Weather conditions both present and previous to sampling
- Other pertinent observations

8. Make sure the well is secured after sampling.

Note:

1. It is understood that all sample containers and collection devices will be cleaned prior to field use following the appropriate cleaning procedures.
2. If sampling devices are to be dedicated to a particular sample location, they will be placed in a plastic bag after its use and marked or tagged

"DEDICATED TO PROJECT NO. _____

SAMPLE LOCATION NO. _____

ATLANTIC PROCEDURE NO. 1024

FIELD PROCEDURES FOR COLLECTION OF TCDD SAMPLES

Prepared By:	Curtis A. Kraemer CURTIS A. KRAEMER	Senior Hydrogeologist TITLE
Reviewed By:	John A. Ripp JOHN A. RIPP	Principal TITLE
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TABLE OF CONTENTS

SECTION		PAGE
1.0	PURPOSE	2
2.0	SCOPE	2
3.0	RESPONSIBILITY	2
4.0	SUPPORTING PROCEDURES	3
5.0	REQUIRED FORMS	3
6.0	PROCEDURE	3
7.0	REFERENCES	5

SECTION 1.0: PURPOSE

To insure the proper blending of soil samples for TCDD analysis. Proper blending assures that the laboratory results will be representative of the whole soil sample.

SECTION 2.0: SCOPE

The following procedure describes the collection of samples for TCDD (dioxin) analysis. TCDD is usually sampled as a contaminant in soil or sediment. Because it binds tightly with soil particles, it is often found in near-surface soils. The USEPA "A Compendium of Superfund Field Operations Methods"[1], dated December 1987, indicates that TCDD contamination might be found at greater depths if the contaminated material was used as fill or consists of transported sediments.

Atlantic personnel should be aware that the procedures for use in sampling TCDD are often revised by the USEPA. If there is any question, the USEPA Regional Sample Control Center should be contacted about any new sampling procedures.

SECTION 3.0: RESPONSIBILITY

Project Manager - First

Field Operations Manager - Second

Field Staff - Third

SECTION 4.0: SUPPORTING PROCEDURES

Atlantic Procedure No. 1020 Field Procedures for Collection of Surface Soil Samples

Atlantic Procedure No. 1041 Sample Chain-Of-Custody Procedure

SECTION 5.0: REQUIRED FORMS

Field Notebook No. 351, published by J.L. Darling Corp., Tacoma, Washington (or equivalent)

SECTION 6.0: PROCEDURE

As noted above, TCDD is usually sampled as a contaminant in near-surface soils or sediments. Sampling for TCDD in soils is similar to sampling for surface soil samples except that a thorough blending of the sample is of greater importance and that the sampling equipment must be rigorously cleaned. Because the "action levels" associated with TCDD contamination are very low, the Field Operations Manager should consider using sampling equipment that has been cleaned in a contract laboratory using CLP procedures. The sampling tools should not be used again until they have been decontaminated in a contract laboratory using CLP procedures.

The following procedure requires the use of a one quart stainless steel blender cup. The blender cup should not be filled more than 3/4 full. No gravel or stones should be placed into the cup and large clumps of soil should be broken

up as much as possible. The blending cup is then brought back to the blending station where the blender is placed on a plastic sample drop sheet. The blending procedure is as follows:

* Pulse blender five times.
* Invert blender cup several times and shake.
* Repeat this procedure six times for a total of 30 pulses.
* Allow the blender to sit for two to five minutes to allow all dust to settle. The blended sample is then dispersed into an amber jar that has been placed in a plastic bag or "baggie" with a rubber band closure at the neck to reduce the possibility of contamination outside of the sample jar.

The sample is removed from the blender cup by using scoopulas. The baggie and rubber band are removed and properly disposed. The sample jar may be spray rinsed with 1,1,1-trichloroethane to further reduce the possibility of contamination. The jar is rebagged in a clean baggie, tagged, and processed for shipping. Any material remaining in the blender cup should be properly disposed.

The blender is cleansed by filling it (1/4 to 1/2 full) with soapy water, agitate (blend) it for 30 seconds, and, if necessary, scrubbed with a brush. The cup is then rinsed with distilled water, alcohol, and 1,1,1-trichloroethane and allowed to drip dry.

Field personnel should note that the samples should be kept away from light and that field samples are not to be composited.

In the event a stainless steel blender is not available for use in the field, an undisturbed soil sample should be collected and sent to a contract laboratory for homogenization. The Field Operations Manager should make a special note to the laboratory that the sample requires homogenization in accordance with CLP protocol.

SECTION 7.0 REFERENCES

[1] United States Environmental Protection Agency, A Compendium of Superfund Field Operations Methods, OSWER Directive 9355.0-14, Washington, D.C., December, 1987.

ATLANTIC PROCEDURE NO. 1030

FIELD PROCEDURE FOR LOGGING SUB-SURFACE CONDITIONS DURING TEST BORINGS AND WELL LOGGING

Prepared By: John A. Ripp — JOHN A. RIPP — PRINCIPAL (TITLE)

Reviewed By: Edmund J. Burke — EDMUND J. BURKE, P.E. — QA MANAGER (TITLE)

Approved By: Paul Burgess — PAUL BURGESS, P.E. — CHIEF ENGINEER (TITLE)

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4.				

ATLANTIC ENVIRONMENTAL SERVICES, INC.
COLCHESTER, CONNECTICUT

TABLE OF CONTENTS

SECTION		PAGE
1.0	PURPOSE	2
2.0	SCOPE	2
3.0	RESPONSIBILITY	2
4.0	SUPPORTING PROCEDURES	2
5.0	REQUIRED FORMS	2
6.0	PROCEDURE	3
FIGURE		
6-1	Example Boring Log	8
6-2	Unified Soils Classification	9

SECTION 1.0: PURPOSE

To insure a standard procedure for the documentation of sub-surface conditions encountered during test borings and well drilling.

SECTION 2.0: SCOPE

The following procedure details a method for recording sub-surface conditions in test borings and well drill holes during site contamination, hydrogeological, and geotechnical investigations. An optional procedure for photographing samples is included.

SECTION 3.0: RESPONSIBILITY

Project Manager - First

Supervising Field Geologist/Engineer - Second

SECTION 4.0: SUPPORTING PROCEDURES

ASTM Designation D 1586 - Standard method for Penetration Test and Split-Barrel Sampling of Soils.

ASTM Designation D 2488 - Standard practice for Description and Identification of Soils (Visual-Manual Procedure)

SECTION 5.0: REQUIRED FORMS

Field Notebook No. 351 (published by J.L. Darling Corp., Tacoma, Wash.)

Atlantic Boring Log Form

SECTION 6.0: PROCEDURE

6.1 Predrilling Requirements

When conducting borings at any location, local or on-site buried utilities must be cleared through the appropriate engineering departments of each utility serving the area. At least a 48 hour notification shall be made to the utilities prior to drilling. The ticket number or call number given by the utility must be logged in the field notebook. This will protect the drilling supervisor from any liability associated with damaging a public utility.

The supervising geologist/engineer shall record the name of the drilling firm and the names of the driller and his assistant. The date, project location, project number, and weather conditions shall also be recorded.

An accurate time log of drilling activities shall be kept. This log shall be kept in the field notebook and shall include, at least the following:

- Time driller and rig on-site
- Time drilling begins
- Any delays in the drilling activities, and the cause of such delays.
- Time drillers leave the site.

6.2 Test Borings and Well Drilling Subsurface Sampling Methods

Test borings and monitoring well drilling can be conducted by a variety of drilling methods. The drilling method is not as critical to the documentation of the subsurface conditions as the soil and rock sampling techniques. However, the drilling method and type of drill rig shall be documented.

Where details of subsurface conditions are necessary, soil sampling shall be conducted using a split spoon penetration sampler driven with a 140 pound hammer at a height of 30 inches. The standard method of soil sampling as described in ASTM Designation D 1586 shall be used as a guide.

The supervising geologist/engineer shall record, at a minimum, the weight of the hammer, the length of the split spoon sampler, and the number of hammer blows on the spoon per 6 inches of penetration. Upon removal of the sampler the earth materials shall be logged in accordance with Section 6.3 of this document.

Rock sampling will be conducted using a double barrel core sampler. The supervising geologist/engineer shall record the length of the core barrel, the diameter of the barrel, the rate of penetration, and the down pressure torque and rotation of the sampler.

6.3 Logging of Unconsolidated Deposits

Vertical measurements in a boring shall be made from the original ground surface. Split spoon samples are typically taken in 2-foot intervals, or at changes in lithology through unconsolidated materials. The supervising geologist/engineer shall monitor drill cuttings and maintain communication with the driller (Re: down pressures, drilling rates, resistance, etc.) to determine where changes in lithology occur.

During the sampling, the hammer blows per 6 inches of sampler penetration, and the depth at which the sample was taken shall be recorded. Blow counts over 50 per 6 inches of penetration shall constitute sampler refusal. Upon extraction of the sampler moisture conditions on the drill rods shall be noted. Upon opening the sampler the percent recovery shall be recorded as the length of sample retained over the length of sampler penetration. Changes in lithology, color, or moisture conditions in the spoon are measured and recorded prior to emptying the spoon. If the sample is to be retained, a sample number is assigned and recorded in the field log and on the sample container. The sample container will also include the project name, boring number, location, depth, date, and person collecting the sample.

The supervising geologist/engineer will log the soil sample in the field notebook. The soil description shall include, at a minimum, the following information:

- o Color
- o Mineral or rock content
- o Grain size, in order from most predominant to least predominate using the proportions;

- Trace = 0 to 10%
- Little = 10 to 20%
- Some = 20 to 35%
- And = 35 to 50%

- o Density, descriptions based upon blow counts as follows:

- Cohesionless Soils (primarily sand and gravel)

0 - 10 blows = Loose
10 - 30 blows = Medium Compact
30 - 50 blows = Dense
50 plus blows = Very Dense

- Cohesive Soils (primarily silt and clay)

0 - 2 blows = Very soft
2 - 4 blows = Soft
4 - 8 blows = Medium
8 - 15 blows = Stiff
15 - 30 blows - Very stiff
30 plus blows = Hard

- o Moisture Content
- o Structure
- o Other (mottling, odor, instrument readings, etc.)

A sample soil log is shown in Figure 6-1.

When the technical specifications of a soil sampling program require soil descriptions to conform to the "Unified Soils Classification" the soils shall also be classified according to ASTM Standard Designation D 2488. Figure 6-2 shows this classification.

6.4 Logging Bedrock Cores

The supervising geologist/engineer on a drilling program is responsible for logging and recording geologic and geotechnical information from rock cores. The following information shall be included in a rock core run log:

- The depth and length of the core run.
- The coring rate, down pressure, torque and rotation speed. This information can be obtained from the driller.
- The color of the core wash water. Any changes or loss of return water will be noted.
- The recovery of the core run recorded as length of rock recovered over the length of the core run.
- The Rock Quality Designation (RQD) of the run. RQD is reported as the sum of inches of all rock core pieces larger than four inches over the total number of inches in the run.
- The rock type(s) and their location in the core run, rotating color, minerology, texture, fossil content, effervescence in HCL and any other data of geologic significance.
- Any structure in the core, including fractures, clay seams, vuggs, bedding, fissility and any other data of geologic or geotechnical significance.

Tuesday 2/14/84
General Power Corp, 1243-01-01
Middletown, U.S.A. Power
Weather: Cold (~35°F) light rain
ATLANTIC Personnel on-site 0700
T. Brooks & J. Ryan
Drillers (Penn Borings) on-site 0650
Joe Smith and Bob Jones

Boring B-1 -
20' so. of pumphouse started 0730
using Mobile B-61
and 6 3/4" ID H.S.A.

Sample B-1-A 0-2'
Blows: 1, 1, 3, 7
Recovery 1'9" / 2'
0-6" Dark br. top soil and roots
6-12" Light br. fine-med.
sand with some silt,
little organic loam
very loose, dry, slight rust
mottles at 1' 10"
OVA - < 1 ppm benzene

Figure 6-1
Example Boring Log

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COARSE-GRAINED SOILS More than 50% retained on No. 200 sieve*	GRAVELS 50% or more of coarse fraction retained on No. 4 sieve	CLEAN GRAVELS	GW	Well-graded gravels and gravel-sand mixtures, little or no fines
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines
		GRAVELS WITH FINES	GM	Silty gravels, gravel-sand-silt mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	SANDS More than 50% of coarse fraction passes No. 4 sieve	CLEAN SANDS	SW	Well-graded sands and gravelly sands, little or no fines
			SP	Poorly graded sands and gravelly sands, little or no fines
		SANDS WITH FINES	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures
FINE-GRAINED SOILS 50% or more passes No. 200 sieve*	SILTS AND CLAYS Liquid limit 50% or less		ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
			OL	Organic silts and organic silty clays of low plasticity
	SILTS AND CLAYS Liquid limit greater than 50%		MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts
			CH	Inorganic clays of high plasticity, fat clays
			OH	Organic clays of medium to high plasticity
Highly Organic Soils			PT	Peat, muck and other highly organic soils

* Based on the material passing the 3-in. (75-mm) sieve.

Figure 6-2
Unified Soils Classification

Rock cores shall be stored in a core box in the exact sequence they were removed from the ground. Core runs will be separated by wooden blocks clearly marked with the depth of the run. The core box shall be marked with the project name, location, project number, boring number, data and the depths of the core runs in that box.

6.5 Photographing Rock and Soil Samples from Borings

Soil samples should be photographed while still in the split spoon sampler. If smearing of the sample has occurred a fresh exposure can be made by scrapping with a pen knife or other similar object. The spoon and sample should be placed in a good light preferable against a solid colored background. A ruler for scale, and a tag identifying the sample number, depth and project name or number written so as to be legible in the photograph. Any photographs taken must be recorded in the field notebook.

Rock core samples are photographed in the wooden core box. The rock should be wetted to enhance the color and textual changes in the rock. Due to the relatively large size of most core boxes the photographer (when possible) should stand up on a chair, tail gate, car bumper or other perch in order to photograph the box from directly above, and get the entire box in the camera's field view. Somewhere in the photograph must be an identifier tag indicating the project name or number, the boring number, the date, and the depths of the various core runs.

ATLANTIC PROCEDURE NO. 1041

SAMPLE CHAIN-OF-CUSTODY PROCEDURE

Prepared By: John A. Ripp — JOHN A. RIPP — Principal — TITLE

Reviewed By: Edmund J. Burke — EDMUND J. BURKE, P.E. — QA Manager — TITLE

Approved By: Paul Burgess — PAUL BURGESS, P.E. — Chief Engineer — TITLE

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TABLE OF CONTENTS

SECTION		PAGE
1.0	PURPOSE	2
2.0	SCOPE	2
3.0	RESPONSIBILITY	2
4.0	SUPPORTING PROCEDURES	2
5.0	REQUIRED FORMS	3
6.0	PROCEDURE	3
FIGURE		
1041	Atlantic's Chain-Of-Custody Form	5

SECTION 1.0: PURPOSE

To provide the project manager with a record of the custody of any environmental field sample from time of collection to final analysis. Once a sample has been submitted to the laboratory, internal laboratory chain-of-custody will take over in the form of "Request for Analysis" forms, analytical notebooks, and "Reports of Analysis" forms.

SECTION 2.0: SCOPE

This procedure details how a sample is traced through the Chain-of-Custody-Form.

SECTION 3.0: RESPONSIBILITY

Project Manager - First

Field Supervisor - Second

Field Technician - Third

SECTION 4.0: SUPPORTING PROCEDURES

None

SECTION 5.0: REQUIRED FORMS

Atlantic Chain-of-Custody Form No. 1041

SECTION 6.0: PROCEDURE

This procedure describes the use of a Chain-of-Custody Form to accompany all sample containers from the time of collection to submission to the analytical laboratory.

For sampling programs where a large number of samples are to collected or where various laboratories will be receiving the samples, a Chain-of-Custody Form is to accompany each group of samples (see attached form). This form presents general sample information in tabular form listing sample number, date and time of sampling, whether the sample was a composite or grab and information regarding the number of containers, size of container and preservative used for each. If for instance a sample consisted of two 40 ml. vials with no preservation and one 500 ml vial preserved with nitric acid, the number of containers box would designate three while the first diagonal box would list 40 ml vial/PRSV.-NONE and the box beneath listing two and the second diagonal box listing 500 ml glass jar/PRSV.-HNO_3 and the box beneath listing one.

The bottom of the form is the chain-of-custody with dates and times of transfer indicated with the appropriate signatures. The sample collector is always the first signature while the analytical laboratory is the final. Theoretically all individuals handling the samples between collection and laboratory should sign the form. However if a common carrier (ie. Federal Express, Purolator) are used for shipping only one signature is required.

This form can be used as a legal document to guarantee samples were not mishandled and that they were delivered to the laboratory within the time frame necessary to start analysis.

On occasion, the analytical laboratory will provide their own Chain-of-Custody form. Usually the same information is included but in a different format from the Atlantic form. Chain-of-Custody forms from the analytical laboratories are acceptable documentation.

Since these forms are basically sample transmittal documents a copy of the form should remain with the sampling personnel. Upon completion of the analysis the laboratory will provide a complete set of all Chain-of-Custody forms for inclusion with analytical reports.

ATLANTIC
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FORM NO. 1041

CHAIN OF CUSTODY FORM

PROJECT NO.:	PROJECT NAME:												
SAMPLERS (SIGNATURE):													
SAMPLE NO.*	DATE	TIME	COMP	GRAB	NO. OF CON-TAINERS	PRSV.	PRSV.	PRSV.	PRSV.	PRSV.	PRSV.	REMARKS	

*SOURCE CODES: Test Pit Soil...(TP) Boring Hole Soil...(BH) Surface Soil...(SS) Waste...(W) Ground Water...(GW) Surface Water...(SW) Sediment...(SD) Waste Water...(WW)

RELINQUISHED BY (SIGNATURE):	DATE/TIME:	RECEIVED BY (SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE/TIME:	RECEIVED BY (SIGNATURE):
RELINQUISHED BY (SIGNATURE):	DATE/TIME:	RECEIVED BY (SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE/TIME:	RECEIVED BY (SIGNATURE):
RELINQUISHED BY (SIGNATURE):	DATE/TIME:	RECEIVED FOR LABORATORY BY (SIGNATURE):	DATE/TIME:	REMARKS:	

Distribution Original accompanies shipment, copy to coordinator field files.

ATLANTIC PROCEDURE NO. 1042

SHIPPING PROCEDURES FOR ENVIRONMENTAL FIELD SAMPLES

Prepared By: John A. Ripp — JOHN A. RIPP — Principal — TITLE

Reviewed By: Edmund J. Burke — EDMUND J. BURKE, P.E. — Q.A. Manager — TITLE

Approved By: Paul Burgess — PAUL BURGESS, P.E. — Chief Engineer — TITLE

REVISIONS

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TABLE OF CONTENTS

SECTION		PAGE
1.0	PURPOSE	2
2.0	SCOPE	2
3.0	RESPONSIBILITY	2
4.0	SUPPORTING PROCEDURES	2
5.0	REQUIRED FORMS	2
6.0	PROCEDURE	3

SECTION 1.0: PURPOSE

To insure a standard procedure for shipment of water, soil and other environmental samples that are controlled by chain-of-custody and strict analytical starting times.

SECTION 2.0: SCOPE

The following procedure is established to avoid mishandling, delays and mislabeling of samples normally collected and shipped from a field site to a designated analytical laboratory.

SECTION 3.0: RESPONSIBILITY

Project Manager - First

Field Supervisor - Second

Field Technicians - Third

SECTION 4.0: SUPPORTING PROCEDURES

Atlantic Procedure No. 1040 Sample Preservation for Solid and Liquid Matrices

Atlantic Procedure No. 1041 Sample Chain-Of-Custody Procedure

SECTION 5.0: REQUIRED FORMS

Receipt of Airweigh Bill or Weighbill Forms

Chain-of-Custody Form Standard Form No. 1041

SECTION 6.0: PROCEDURE

6.1 Prior to mobilization to a field site, the field operations manager or his designee will select a shipper based on proximity to the site and ability to ship overnight.

6.2 Upon selection of a shipper the following information will be gathered before any samples are shipped. This can be done over the phone or by correspondence.

1. Location of the shipping depot or local pickup office in case samples are to be delivered directly to the depot by the field team.
2. Name and phone number of a contact at the shipper.
3. Rates of shipping per package size and weight
4. Special instructions as to container sizes and weights.
5. A set of weighbills for the field team.
6. A copy of the shipper's brochure which will provide information on the format for the various types of weigh bills.
7. Times for calling in a pickup from the job site and normal pickup times.

6.3 The Atlantic field manager will give the shipper a street address where samples can be picked up by the courier near the job site.

6.4 Once all samples have been collected, preserved and containerized for shipment, the field supervisor will call the shipper to arrange for pick up.

6.5 All samples, unless so designated for ground transportation, will be shipped by air express for overnight delivery. This is the standard method since samples collected for Method 625 organics have only a 72-hour holding time between collection and the start of analysis.

6.6 The following steps will be followed in the field to prepare the sample shipping containers for pick up.

1. A standard chain-of-custody form will be filled-out, signed by the courier as a custodian, and placed inside each shipping container before final sealing.
2. The Atlantic field supervisor or his designee will insure that all weighbills have been filled-in properly for air express. If the contract laboratory is within ground transportation distance for overnight delivery, then the weighbills should reflect guaranteed overnight delivery.
3. A copy of all weighbills must be kept by the field supervisor and the weighbill number associated with each group of samples logged into the Master Sample Log. The name of courier must be written in this log also in case there is a problem in tracing samples.
4. If possible, to save shipping fees, the sample shipping containers can be strapped together.

5. An estimated time of delivery for the samples will be logged in the Master Sample Log, (e.g., ETA 12 noon 3/14/83).

6.7 Once the samples have been shipped, the field supervisor will call the analytical laboratory and provide a listing of samples to be delivered, the shipping company's name, and the weighbill numbers. As soon as the samples are delivered, the contract laboratory will inform Atlantic of their arrival and report, any damage associated with the samples or whether any sample containers are missing.

ATLANTIC PROCEDURE NO. 1051

OPERATION AND CALIBRATION OF THE HNu SYSTEMS PHOTOIONIZER MODEL PI-101

Prepared By: John A. Ripp — JOHN A. RIPP — Principal — TITLE

Reviewed By: Edmund J. Burke — EDMUND J. BURKE, P.E. — Q.A. Manager — TITLE

Approved By: Paul Burgess — PAUL BURGESS, P.E. — Chief Engineer — TITLE

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ATLANTIC ENVIRONMENTAL SERVICES, INC.
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TABLE OF CONTENTS

SECTION		PAGE
1.0	PURPOSE	2
2.0	SCOPE	2
3.0	RESPONSIBILITY	2
4.0	SUPPORTING PROCEDURES	2
5.0	REQUIRED FORMS	2
6.0	PROCEDURE	3

SECTION 1.0: PURPOSE

To insure a standard procedure for the calibration and operation of the HNu Systems Photoionizer Model PI-101.

SECTION 2.0: SCOPE

The following procedure details those steps necessary for the collection and operation in the survey mode of the HNu Photoionizer. A listing of calibration data needed for proper documentation is supplied at the end of this procedure.

SECTION 3.0: RESPONSIBILITY

Project Manager - First

Field Operations Manager - Second

Field Staff - Third

SECTION 4.0: SUPPORTING PROCEDURES

None

SECTION 5.0: REQUIRED FORMS

Field Notebook No. 351, published by J.L. Darling Corp., Tacoma, Washington (or equivalent), or a conventional paper, bound laboratory notebook (Nalge 6301 or equivalent).

SECTION 6.0: PROCEDURE

6.1 General Description

The HNu Photoionizer is a survey tool for determining general levels of organic vapors in air. The instrument is comprised of a readout module which contains all controls and the battery power supply and a photoionizer probe which contains the photo-cell. The readout module also contains terminals for connection to a recorder. This module is carried by a strap held across the shoulder while the probe is held by hand.

6.2 Instrument Startup

First connect the probe unit to the readout module by attaching and turning the connector terminal. Note this fitting is "keyed" and must be attached in only one orientation.

Second turn the main switch to battery. The needle should deflect to the upper end of the green scale. If it doesn't deflect into the green area or is at the low end of the scale, the instrument needs to be charged. A battery charger is located in the instrument cover and it plugs into the side of the readout module. For a full day's operation the battery should be charged overnight.

Third turn on the main switch to any range (ie. 0-2,000 ppm, 0-200 ppm or 0-20 ppm). Look into the probe through the sample tube and observe the violet light of the photo cell. If the light is not on, check the following:

1. Make sure the probe is attached properly to the readout module.
2. An etch mark should be scribed on the probe where it can be unscrewed to replace the photo cell. This mark shows the exact position that the top of the probe takes so that the air inlet ports are lined up. If not lined up,unscrew the probe and assemble it properly.
3. Check the photo cell lamp and replace it if necessary.

Once the battery and photo cell are operating, perform a calibration.

6.3 Calibration

The PI 101 Analyzer is designed for trace gas analysis in ambient air and is calibrated at HNu with certified standards of benzene, vinyl chloride and isobutylene.

Some general points to consider when calibrating the PI 101 are that the analyzer is designed for operation at ambient conditions and therefore the gas standards used for calibration should be delivered to

the analyzer at ambient temperatures and pressure and at the proper flow rates. The PI 101 is a non-destructive analyzer; calibrations using toxic or hazardous gases must be done in a well ventilated area.

The frequency of calibration should be twice daily as a minimum. The instrument should be calibrated at the beginning of the day (or when the instrument is first turned on) and at the end of the day (or when use of the instrument is completed). If the instrument is turned off during the day for any significant length of time, it should be calibrated when turned on. An accurate and reliable method of calibration check is to use analyzed gas cylinders of "hydrocarbon-free" air and isobutylene (prepared by HNu).

Step 1. Zero set - Turn the function switch to STANDBY. In this position the lamp is OFF and no signal is generated. Set the zero point with the ZERO set control. The zero can also be set with the function switch on the X1 position and using a "Hydrocarbon-free" air. In this case "negative" readings are possible if the analyzer measures a cleaner sample when in service.

Step 2. 0-20 or 0-200 range - For calibrating on the 0-20 or 0-200 range only one gas standard is required. Turn the function switch to the range position and note the meter reading. Adjust the SPAN control setting as required to read the ppm concentration of the standard. Recheck the zero setting (Step 1). If readjustment is needed, repeat Step 2. This gives a two-point calibration; zero and the gas standard point.

6.4 Documentation

In the field notebook, or in the bound laboratory notebook, at the start of the project (or if there is a change in instruments), record the following:

1. Site name
2. Instrument model and serial number S/N
3. Types of calibration gases
4. Note the size of the photo cell lamp used in the particular probe. This is useful to know which organic compounds the HNu is sensitive toward.

In the field notebook, or in the bound laboratory notebook, at the start of each calibration, record the following:

1. Date
2. Time
3. Name of person performing the calibration
4. Span setting before beginning calibration
5. That the instrument was zeroed, and whether the instrument was on standby or if "hydrocarbon-free" air was used.
6. The new span setting, if necessary, to calibrate instrument reading
7. Repeat Step 5 if span was adjusted during Step 6
8. Note that the second calibration reading was correct

ATLANTIC PROCEDURE NO. 1052

OPERATION OF THE PHOTOVAC 10S50 PORTABLE GAS CHROMATOGRAPH

Prepared By:	FRANCIS DUMONT	Chemist TITLE
Reviewed By:	DENNIS F. UNITES, P.G.	TITLE
Approved By:	JOHN A. RIPP	TITLE

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TABLE OF CONTENTS

SECTION		PAGE
1.0	PURPOSE	2
2.0	SCOPE	2
3.0	RESPONSIBILITY	2
4.0	SUPPORTING PROCEDURES	2
5.0	PROCEDURE	2
5.1	Introduction	2
5.2	Equipment Required	3
5.3	Instrument Set-Up	3
5.4	Sampling Introduction	5
6.0	STORAGE	5
7.0	REFERENCES	6

SECTION 1.0: PURPOSE

To establish a standard procedure for the operation of the Photovac 10S50 Portable Gas Chromatograph.

SECTION 2.0: SCOPE

This procedure details the steps necessary for the operation of the Photovac 10S50 in regard to performing soil gas surveys.

SECTION 3.0: RESPONSIBILITY

First - Project Manager

Second - Field Team Leader

Third - Photovac Operator

SECTION 4.0: SUPPORTING PROCEDURES

Atlantic Procedure No. 1053 *Soil Gas Screening for Volatile Organics*

SECTION 5.0: PROCEDURE

5.1 Introduction

The Photovac 10S50 is a portable gas chromatograph (GC) which can be used in the performance of soil gas surveys. This procedure describes the necessary equipment needed for GC operation, the method for setting up the GC, and the method for introducing samples into the GC system.

5.2 Equipment Required

Equipment needed for GC operation includes:

- Photovac 10S50 portable gas chromatograph with CPSIL5 capillary column and isothermal oven;
- cylinder of zero or ultra-zero grade air with regulator;
- glass gas-tight syringes;
- sample standards;
- gas standard of 1 or 10 ppm benzene in air;
- AC power supply;
- AC/DC converter;
- flowmeter (two channel); and
- Photovac owner's manual.

5.3 Instrument Set-Up

The GC requires that certain "running" parameters be inputted into its computer memory prior to operation. Parameters which should be entered include:

- electronic gain - 50;
- slope sensitivity - 18, 14, 6 mV/second;
- chart speed - 0.5 cm/minute;
- window +/- 10 percent;
- minimum area - 100 mV seconds
- timer delay - 10.0 seconds;
- cycle time - 0 minutes;

- analysis time - dependent on compounds of interest but should be at least three times greater than Event 3 (backflush);
- Event 1 (sample pump) on at 8.0 seconds, off at 10.0 seconds;
- Event 3 (backflush) on at 0.0 seconds, off at 160.0 seconds;

Once set, the GC computer memory should retain these running parameters.

The "use" function is utilized to set the date and time. The "info" function is utilized to input information the operator wishes to have printed out with each chromatogram (i.e., site name, location, etc.).

Once the parameters are set up, the carrier gas reservoir is filled with air (zero or ultra-zero grade). The flow meter is attached to the detector "out" and auxiliary "out" fittings. The detector outflow should be adjusted to approximately 10 ml/minute using the column flow adjustment knob. The auxiliary outflow should be adjusted to approximately 12 ml/minute using the auxiliary out valve knob. The oven is then turned on to 40° C. The instrument is then allowed to warm up and stabilize for 30 to 45 minutes.

After allowing for warm up, the "Start/Stop" and "Enter" keys should be pressed. This causes the GC to perform a run without the injection of a sample. This is done to ensure that a stable electronic baseline is being drawn. An unsteady baseline can be due to insufficient warm up or a leak in the GC system. A baseline with peaks can be due to a contaminated GC column. If a stable baseline is not obtained after sufficient warm up, refer to the Operation's Manual for probable causes and repair procedures.

While the baseline sample is running, the "chart" mode is set to "on with set-up". This setting activates the chart recorder to print set-up information at the end of the run, including the offset.

The offset is a measure of how much the instrument must adjust the baseline to compensate for background noise and is checked after each run. The offset should not exceed 50 mV. A high offset is usually the result of a contaminated column or the use of an unsuitable carrier gas. Refer to the Operation's Manual if the offset is greater than 50 mV.

5.4 Sampling Introduction

Analysis of standards and samples can be performed once the machine is properly set up. Standards (refer to Procedure 1053) and samples can be introduced into the GC by the following steps:

- push "Start/Stop" followed by "Enter" keys
- allow pump to buzz on for two seconds and shut off
- immediately inject the standard or sample utilizing a gas tight syringe

SECTION 6.0: STORAGE

While the GC is not in use, a low flow rate (approximately 1 ml/minute) should be maintained through the column. This is done by allowing the carrier gas reservoir to run out or by hooking up the external carrier gas fitting to an outside tank regulated to 40 psi. This is done in order to prevent the buildup of contamination in the column during downtime.

Long-term storage of the GC can cause low battery power. Low battery power can result in the loss of the GC's memory and would necessitate re-inputting running parameters. Sufficient battery charge to ensure memory retention can be maintained by occasionally plugging the GC in and turning it on overnight.

SECTION 7.0: REFERENCES

Photovac 10S Operations Manual

ATLANTIC PROCEDURE NO. 1053

SOIL GAS SCREENING FOR VOLATILE ORGANICS

Prepared By:	FRANCIS DUMONT	Chemist TITLE
Reviewed By:	DENNIS F. UNITES, P.G.	TITLE
Approved By:	JOHN A. RIPP	TITLE

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TABLE OF CONTENTS

SECTION		PAGE
1.0	PURPOSE	2
2.0	SCOPE	2
3.0	RESPONSIBILITY	2
4.0	SUPPORTING PROCEDURES	2
5.0	PROCEDURE	2
5.1	Introduction	2
5.2	Equipment Required	3
5.3	Instrument Start-Up and Calibration	4
5.4	Sampling Grid Layout	5
5.5	Soil Gas Collection	6
5.6	Analysis and Data Collection	6
5.7	QA/QC Protocol	7
5.8	Interpretation	8
6.0	DOCUMENTATION	9
7.0	REFERENCES	10

SECTION 1.0: PURPOSE

To establish standard procedures for screening study sites for volatile organic compound (VOC) contaminants using soil gas sampling, and subsequent analysis using Photovac 10S50 gas chromatograph (GC).

SECTION 2.0: SCOPE

This procedure details steps necessary for the collection and interpretation of soil gas data.

SECTION 3.0: RESPONSIBILITY

First - Project Manager

Second - Field Team Leader

Third - Photovac Operator

SECTION 4.0: SUPPORTING PROCEDURES

Atlantic Procedure No. 1052 *Operation of the Photovac 10S50 Portable Gas Chromatograph*

SECTION 5.0: PROCEDURE

5.1 Introduction

The objective of this field procedure is to provide a method for screening sites for VOC contamination prior to any subsurface investigation. This procedure can be used to estimate the lateral extent and relative concentration of VOCs in soil or ground water (shallow, unconfined, first

water bearing zone only) across a site. This is accomplished by collecting and analyzing soil vapors for selected constituents that are produced by the volatilization of VOCs from in-situ product, waste, contaminated soils, or ground water.

The primary objective of soil gas surveying is to provide cursory information on locations and relative concentrations of site contamination. These data permit more effective planning of the quantitative sampling and analytical phases of the investigation. Soil gas procedures are not intended for evaluating contamination located beneath the water table. These procedures cannot be used to quantify contamination. Subsurface soil/water sampling and analysis by standard laboratory procedures are required to verify soil gas survey results.

5.2 Equipment Required

The following is a list of equipment and supplies that would be required to implement the soil gas procedure:

- Photovac 10S50 portable gas chromatograph with CPS1L5 capillary column and isothermal oven;
- 1/4" ID stainless steel tubing (5 feet long);
- plastic line which fits snugly in tubing (5-1/2 feet long);
- various Swagelok fittings;
- flow meter (two channel);
- cylinder of Zero or Ultra Zero gas with regulator;
- glass gas-tight syringes (10, 100, 500 and 1000 ul);
- sample standards (i.e., benzene in air, BTX headspace, chlorinated solvents headspace, etc.);

- AC power supply (i.e., generator, access to power outlet, etc.);
- modeling clay sufficient to cover soil gas sample hole once stainless steel tube is inserted; and
- gas transfer line (Photovac internal tank).

5.3 Instrument Start-Up and Calibration

The following is a list of suggested initial instrument settings:

- carrier gas flow - 10 ml/min;
- electronic gain - 50;
- oven temperature - 40°C;
- backflush - 160 seconds;
- run time - 1000 seconds;
- data management parameters - see Atlantic Procedure No. 1052;
- sample event times - see Atlantic Procedure No. 1052.

The Photovac GC requires a 30-45 minute warm-up period for the oven temperature and gain settings to stabilize. The electronic baseline should be checked by initiating the GC run without injecting sample.

Next, the Photovac is calibrated by injecting qualitative and quantitative standard mixtures. Stock standards ranging from 25 to 500 ml/l of the target analytes are prepared by diluting the neat (pure) compound in pesticide-grade methanol. Headspace standards are prepared daily by adding a measured (3 - 100 ul) volume of stock standard to 30 ml of distilled water in a 40 ml volatile organic analysis (VOA) vial. The vial is shaken by hand for two minutes and then allowed to

equilibrate for an additional three minutes. Between 10 and 100 ul of the headspace vapor is injected into the GC for analysis. The headspace standard provides the relative retention times (time required to elute through the column) of the target analytes.

A standard of 1 part per million (ppm) benzene in air is used to evaluate chromatogram peak variation resulting from fluctuation in instrument sensitivity and as a quality control check on the headspace standards.

Finally, a sample of ambient air (system blank) is collected through the sampling apparatus (see Section 5.5 and 5.7) to ensure that the system is free from contamination.

5.4 Sampling Grid Layout

Soil gas sampling should be performed on a grid at sites where little or no history and/or geologic information is available. The grid spacing may range from 25 to 100 foot centers, depending on the size of the area to be screened and the time and cost constraints of the investigation.

If sources of soil contamination are better known and documented, then the choice of sampling locations can be tailored to that information. The approach for those better documented sites would be to sample in and around areas of known/suspected contamination first to ensure that the subsurface contaminants can be detected at those locations. Areas where no contamination is expected are sampled next. If nothing is detected at these background locations, then subsequent sampling points can be located approximately one-half the distance to the known source. This procedure is followed until soil contamination is defined to the degree that is consistent with project objectives.

5.5 Soil Gas Collection

Soil gas samples are obtained by the following procedure.

- A plunger bar is used to drive a 1/2 inch diameter hole in the ground to a desired depth*. If the sample location is covered by hard pavement or cement, then a hammer drill is used to break through this material.

- A pre-purged, 4 foot long, 1/4 inch O.D. stainless steel tube is used to collect the sample. To prevent soil from plugging the tube as it is lowered into the cavity, a section of plastic line is inserted into the tube and held in place. After the tube is placed in the ground, the line is pulled out. Clay is placed around the tube at the soil surface creating a seal that prevents surface air from mixing with the gas from the soil.

- A 3-way Swagelok fitting is placed on the open end of the steel tube at the ground surface. One end of the fitting is connected to a teflon tube leading to a small personal sampler air pump. A small teflon-coated septum is secured over the remaining opening of the fitting. The pump is switched on and allowed to run for 3 minutes at a flow rate of 100 to 150 milliliters per minute (ml/min). The soil gas sample is collected by inserting a pre-rinsed 500 ul syringe through the septum and withdrawing 300 ul of air.

- The sampling apparatus is removed from the hole and flushed with high flows of ambient air to remove any soil gas contaminants.

Flow rates and purge volumes may have to be adjusted depending on subsurface conditions. Tightly packed soils may necessitate the use of smaller purge volumes and slower flow rates. Sample volumes injected into the GC may need refinement based on the chromatographic responses obtained.

5.6 Analysis and Data Collection

The gas sample obtained is injected directly into the Photovac instrument. The chromatogram that is generated contains peaks that represent constituents in the sample. The retention times of

* Depth is generally four feet but may be changed based on site conditions such as depth of contamination or depth to ground water.

these peaks are compared to the headspace standard to qualitatively identify the compound. Relative concentrations can be calculated by comparing the integrated peak areas that are generated. Any major unknown peaks that cannot be immediately identified should be noted in the event further evaluation is necessary.

5.7 QA/QC Protocol

Standards are run at the beginning, middle and end of each sampling day, and to document, when necessary, any retention time shifts.

System blanks are run at the beginning and end of each day, and when possible cross-contamination between samples is suspected. A system blank is obtained by allowing the sample collecting system to draw in ambient air for 3 to 5 minutes, drawing 300 ul of sample, and injecting it into the GC. If the GC demonstrates contamination in the system, the soil gas sampling tube should be decontaminated in the following way:

- flush stainless steel tube with methanol;
- purge stainless steel tube with high pressure zero air until dry; and
- purge syringe and septa fitting with high pressure zero air.

If contamination persists after this treatment, a different sampling tube and syringe should be used.

A syringe blank is run when it is suspected that the syringe has become contaminated. This is done by drawing 300 ul of ambient air into the syringe and injecting it into the GC. The syringe should be purged with zero air if it is found to be contaminated. If contamination persists after this treatment, a different syringe should be used. Contaminated syringes can be cleaned in the

laboratory by flushing with methanol and drying under a UV lamp.

5.8 Interpretation

Integrated area counts can be obtained for individual peaks produced on the chromatograms. This information can be used to outline generalized areas of contamination and locate specific "hot spots" of high soil gas concentrations. It is possible to relatively quantitate soil gas concentrations at a particular site by establishing varied ranges of peak area.

In addition to identifying single peaks, the chromatographic patterns or "signatures" can be evaluated. For example, coal tar exhibits a different chromatographic signature from that of gasoline. The interpretation of these signatures is to a large extent dependent upon the experience and knowledge of the GC operator.

One method that may be useful for interpreting soil gas results involves collecting a known sample of onsite contamination from a sludge pit or boring, and producing a chromatographic "signature" of the headspace vapor to compare to soil gas chromatograms from samples taken elsewhere on the site.

Other methods of distinguishing between contamination sources using chromatographic signatures are presented in a recent topical report available through the Gas Research Institute (see references). Examples of coal tar related data are compared and contrasted with data derived from petroleum related products.

A number of factors can significantly influence the correlation between the soil gas results and the actual conditions present at a particular site. These include soil porosity and composition, soil heterogeneities, and local climatic conditions such as temperature and humidity. Thus, a soil gas

sample result should only be compared to results of other soil gas samples from the same site (assuming similar geology) taken under similar climatic conditions.

SECTION 6.0: DOCUMENTATION

The following information is recorded in a laboratory notebook during the implementation of this procedure:

- project title and date of investigation;
- personnel involved;
- instrument parameters used;
- sketch of all soil gas locations (along with measurements necessary to accurately position later on a scale drawing);
- description of collection parameters (e.g., depth, purge rate and volume, etc.);
- meteorological parameters and site geological information; and
- any variation or adjustment of the above procedure that is used.

In addition to the laboratory notebook documentation, each soil gas chromatogram is pasted on an Atlantic soil gas point description sheet which includes the following information:

- project number;
- sample number;
- date of sample collection;
- weather conditions;

- depth to sample;
- comments associated with sample;
- contaminant identification;
- retention time; and
- peak area.

Original chromatograms are saved in the project file and a set of copies are saved in a separate Photovac/Soil Gas file.

SECTION 7.0: REFERENCES

Gas Research Institute (GRI) Topical Report #GRI-89/0166. *Soil Gas Investigations at MGP Sites: An Evaluation of Alternative Compounds*. Chicago, Illinois. 1989.

ATLANTIC PROCEDURE NO. 1060

CLEANING PROCEDURE FOR SAMPLING DEVICES USED IN ENVIRONMENTAL SITE INVESTIGATIONS

Prepared By: John A. Ripp — JOHN A. RIPP — Principal — TITLE

Reviewed By: James E. Gould — JAMES E. GOULD — Engineer — TITLE

Approved By: Paul Burgess — PAUL BURGESS, P.E. — Principal — TITLE

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TABLE OF CONTENTS

SECTION		PAGE
1.0	PURPOSE	2
2.0	SCOPE	2
3.0	RESPONSIBILITY	2
4.0	SUPPORTING PROCEDURES	2
5.0	REQUIRED FORMS	2
6.0	PROCEDURE	3

REVISIONS

1. Revision 1 was incorporated to delete the use of acetone from field cleaning operations.

SECTION 1.0: PURPOSE

To insure a standard procedure for cleaning sampling devices for use on site investigations.

SECTION 2.0: SCOPE

This procedure is to be used during site investigations for the cleaning of split spoons, sampling spoons, well bailers, remote samplers, sampling dredges and all devices used to collect a sample or transfer a sample of soil or liquid into its shipping container. Following this general procedure will prevent the likelihood of cross-contamination between samples.

SECTION 3.0: RESPONSIBILITY

Project Manager - First

Field Operations Manager - Second

Field Staff - Third

SECTION 4.0: SUPPORTING PROCEDURES

None

SECTION 5.0: REQUIRED FORMS

None

SECTION 6.0: PROCEDURE

6.1 Materials Selection

All field sampling equipment that contacts the solid or liquid media being collected for eventual chemical analysis should be made of stainless steel or teflon. These materials are easily cleaned and relatively inert when containing the sample. Materials such as neoprene fittings, tygon tubing, silicon rubber bladders, PVC, polyethylene and viton are not acceptable. Also, stainless steel aircraft cable should be used for raising and lowering bailers into monitoring wells. Sampling equipment should be cleaned beforehand and dedicated to individual samples taken in the field. If this is not possible, a cleaning procedure must be followed between each sample. The following presents the procedures for the sampling of organic and inorganic constituents:

6.2 Procedure for Materials in Contact with Media to be Analyzed for Organics

1. Scrub the device with nonphosphate/low sudsing detergent in a stainless steel basin. This type of basin is easily cleaned and thus prevents the buildup of organic contaminants.
2. Rinse it thoroughly with tap water to remove all suds.
3. Rinse it three times with distilled water using a plastic squeeze bottle.

4. Finally rinse it three times with chromatograph grade methanol using a teflon squeeze bottle to remove nonpolar compounds. Allow to air dry and wrap in aluminum foil until use. 1

Note: Solvent resistant gloves should be worn when rinsing with organic solvents to prevent contamination of the equipment and for personal safety. Use aluminum foil to provide a clean surface if the equipment is set down during the cleaning procedure.

6.3 Procedure for Materials in Contact with Media to be Analyzed for Inorganics

1. Scrub the device with nonphosphate/low sudsing detergent in a HDPE (high density polyethylene) basin using a plastic brush.
2. Rinse it thoroughly with tap water to remove all suds.
3. Rinse it with dilute (0.1N) HCl and/or HNO3 using prerinsed plastic squeeze bottles.
4. Rinse three times with deionized distilled water. Air dry and wrap in plastic. Note: Any acid resistant disposable gloves can be used in this cleaning procedure. Plastic sheeting should be available to provide a clean surface if the equipment is set down during the cleaning procedure.

ATLANTIC PROCEDURE NO. 1070

WELL DEVELOPMENT PROCEDURES FOR SMALL DIAMETER MONITORING WELLS

Prepared By:	Curtis A. Kraemer CURTIS A. KRAEMER	Senior Hydrogeologist TITLE
Reviewed By:	John A. Ripp JOHN A. RIPP	Principal TITLE
Approved By:	Paul Burgess PAUL BURGESS, P.E.	Principal TITLE

REVISIONS

NO.	DATE	PREPARED BY	REVIEWED BY	APPROVED BY
1.				
2.				
3.				
4.				

ATLANTIC ENVIRONMENTAL SERVICES, INC.
COLCHESTER, CONNECTICUT

TABLE OF CONTENTS

SECTION		PAGE
1.0	PURPOSE	2
2.0	SCOPE	2
3.0	RESPONSIBILITY	2
4.0	SUPPORTING PROCEDURES	2
5.0	REQUIRED FORMS	3
6.0	PROCEDURE	3

SECTION 1.0: PURPOSE

To insure the natural hydraulic conductivity of the subsurface materials have been restored and all foreign sediment removed to ensure turbid-free ground water samples.

SECTION 2.0: SCOPE

The following procedure describes the methods for monitoring well development and the conditions for which the methods are best suited. The procedure also includes a method for determining whether the development is sufficient for monitoring wells used for RCRA ground water monitoring programs.

SECTION 3.0: RESPONSIBILITY

Project Manager - First

Field Operations Manager - Second

Field Staff - Third

SECTION 4.0: SUPPORTING PROCEDURES

Atlantic Procedure No. 1030 Field Procedures for Logging Subsurface Conditions During Test Boring and Well Logging

Atlantic Procedure No. 1060 Cleaning Procedure for Sampling Devices used in Environmental Site Investigations

Atlantic Procedure No. 1071 Field Procedures for Determination of In-Situ Hydraulic Conductivity with Single Well Hydraulic Tests

SECTION 5.0: REQUIRED FORMS

Field Notebook No. 351, published by J.L. Darling Corp., Tacoma, Washington (or equivalent)

SECTION 6.0: PROCEDURE

Well development is a means to restore the natural hydraulic conductivity of the subsurface materials surrounding a monitoring well and ensure a turbid-free ground water sample. There are a variety of well development techniques, all of which require reversals or surges in flow to avoid bridging by particles, which is common when flow is continuous in one direction. The in-situ ground water should be used for surging the well. If the well yields an insufficient quantity of water to use, an outside source of water (preferably tap water) may be used. If the source of the outside water is unknown (not tap water), a sample should be chemically analyzed to determine whether the water may have an impact on the in-situ water quality.

The following applies to all methods described below:

* All materials including submersible pumps, suction lines, surge blocks, and lines used to pump water or compressed air into a well should be decontaminated in accordance with Atlantic Procedure No. 1060.

* Field notes should be kept to record the following information;

initial static water level

method of well development

average discharge rate and corresponding drawdown

any measureable recovery or information regarding yield of monitoring well

any noticeable changes in ground water quality resulting from well development

* The well development should continue until the discharge runs sediment free after 20 strokes of the surge block. A clear glass jar of distilled water should be used as a reference. Discharge from the pump should be checked periodically by collecting some of the discharge in a clear glass jar and comparing to the distilled water reference.

6.1 Surge Block Method

This method is best suited for monitoring wells that will yield at least 1/2 gallons per minute (gpm) while being pump with a vacuum lift pump (centrifugal pump). It can be used on wells with yields of less than 1/2 gpm, but may require the introduction of water from an outside source.

A surge block is a piston-like device with an outside diameter that is just smaller than the inside diameter of the well and used with by stroking the block up and down in the well. On the downstroke water is forced outward into the subsurface materials, and on the upstroke water, silt and fine sand are pulled in through the screen. This results in sediment filling in the well screen, which must be periodically removed.

The surge block for 2-inch wells consists of two rubber stoppers with a 1/2-inch pipe passing through the rubber stoppers. The stoppers are held in place with washers and nuts; the nuts can be tightened or loosened to expand the stoppers to get a good fit inside the well. The surge block is attached to either 3/4-inch or 1-inch rigid polypropylene tubing. This tubing is rigid enough that it can be used to stroke the surge block. This tubing is then attached to a centrifugal pump with a valve on the discharge side to control the pumping rate from the well.

The surge block should be kept above the screen if sufficient water is above the well screen. If necessary, the block may be stroked in the well screen, however, care should be exercised so not to damage the well screen and the slot sizing. Periodically the surge block should be lowered to the bottom of the well to remove the sediment that has accumulated at the bottom.

The same methodology applies to wells with yields less than 1/2 gpm except that water may have to be introduced occasionally because the well may dewater. The discharged water from the well should be used if at all possible, if not, tap water is the next choice of an outside source of water. When developing the low yielding wells, keep the discharge rate to a minimum, and if necessary, stop pumping for a short period of time while stroking the surge block.

6.2 Overpumping/Backwashing Development Method

This method can be used for wells that yield either less than or more than 1/2 gpm. Any number of pieces of equipment can be used to develop wells with this method. In general, the method involves overpumping a well so that it dewaters the well and then introducing a slug of water back into the well. As

mentioned at the beginning of the procedure, it is preferred to use the discharge water when backfilling into the well. If that is not available, tap water is the next preferred source of water.

Any means of pumping water quickly out of a well may be used to overpump the well, however, there should be some means of removing the sediment that has flowed into the well. To this end a centrifugal pump will both pump quickly (will lift water up to about 25 feet of head) and remove the sediment from the bottom of a well. Most forms of submersible pumps are not designed to pump solids and will quickly become inoperative.

Backwashing the well is performed either by pumping the water back into the well quickly or pouring the water back into the well.

6.3 Air Development Method

The air development method consists of lowering a line (usually solid pvc pipe) down into a well and, using compressed air, blowing air into the well that literally lifts the water up and out of the well. This method is not well suited for low yielding wells since one has to wait for the well to recover before purging more water. The one major disadvantage to this method is that most air compressors have trace amounts of petroleum mixed in the air to keep the equipment lubricated. These trace amounts of petroleum can easily compromise the quality of the water in the well. There are some compressors which filter the air so there is no petroleum mixed in, however, these are not commonly available.

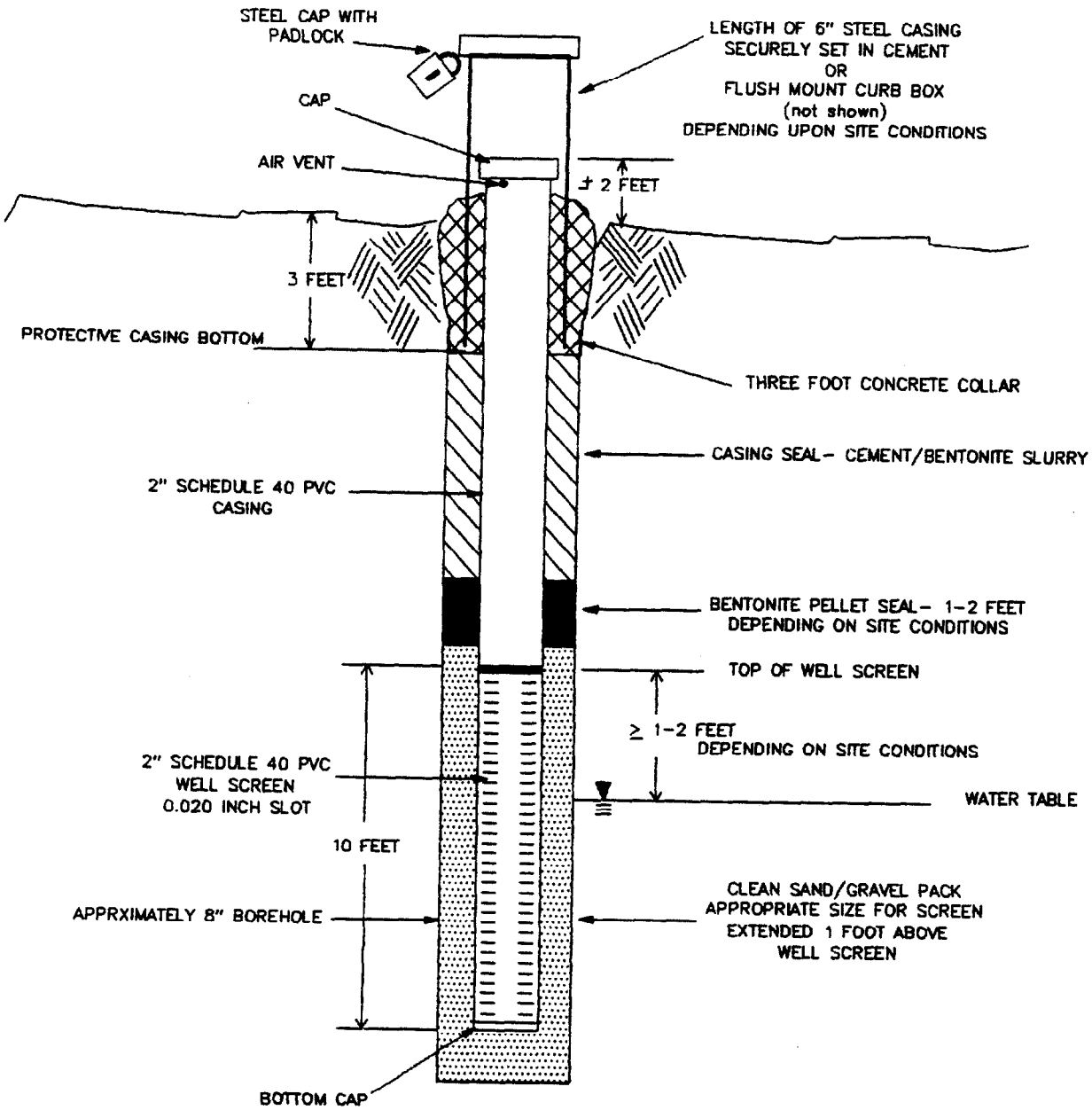
There should be a "U" shaped fitting at the bottom of the line placed in the well. This will direct the air in an upward direction, rather than blowing the air down and, subsequently, out into the subsurface materials. Without this U-shaped fitting, fine-grained materials may be pushed into the well screen producing the opposite of the desired affect. It is important that the air compressor be adequately sized so that it will produce sufficient pressure to lift the column of water out of the well (the longer the column, the more pressure that is required).

6.4 Jetting Development Method

This method can be used for both high and low yielding wells. It involves the pumping of water into the well through "jetting" nozzles (pointed directly at the well screen) and simultaneously pumping the well. The pumping pulls water into the well, and the jetting pushes water out through a small length of screen at a high velocity. This provides both a reversal and surge of water through the well screen. This may require the use of an outside source of water, particularly in low yielding wells. If an outside source is required, it preferably should be tap water.

APPENDIX E

OVERBURDEN MONITORING WELL DETAIL



OVERBURDEN MONITORING WELL CONSTRUCTION

QUALITY ASSURANCE/QUALITY CONTROL PLAN

ADDENDUM NO. 1

QUALITY ASSURANCE/QUALITY CONTROL AND DATA MANAGEMENT PLAN

PIER 33 AND BERTH 16

INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE - NEW LONDON
GROTON, CONNECTICUT

PREPARED FOR:

NORTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
PHILADELPHIA, PENNSYLVANIA

FEBRUARY 1993

ATLANTIC PROJECT NO.: 1256-15-01
NAVY CONTRACT NO. N62472-88-C-1294

ATLANTIC
ENVIRONMENTAL SERVICES, INC. 188 NORWICH AVENUE COLCHESTER, CONNECTICUT 06415 (203) 537-0751

TABLE OF CONTENTS

SECTION		PAGE
1.0	PROJECT DESCRIPTION	1
1.1	Data Quality Objective (DQO)	1
1.2	Site Description and History	1
1.3	Previous Data	2
1.4	Project Scope	2
2.0	PROJECT ORGANIZATION AND RESPONSIBILITIES	3
2.1	Project Manager's Responsibility	3
2.2	QA Officer's Responsibility	3
2.3	Field QC Coordinator - QA/QC Manager's Responsibilities	5
2.4	Laboratory QC Coordinator	5
3.0	SAMPLING PROCEDURES	6
3.1	Introduction	6
3.2	Selection of Sampling Locations	6
3.3	Sample Collection, Handling and Shipping	6
3.4	Field Quality Control (QC) Samples	8
	3.4.1 Trip Blanks	8
	3.4.2 Equipment Rinsates	8
	3.4.3 Field Blanks	9
	3.4.4 Field Duplicates/Splits	9
	3.4.5 Reference Duplicates	9
3.5	Field Decontamination Procedures	9
4.0	CHAIN-OF-CUSTODY	11
5.0	ANALYTICAL PROCEDURES	12
5.1	CLP TCL and TAL	12
5.2	Analytical Methodologies	12
6.0	DATA VALIDATION	17

TABLE OF CONTENTS

SECTION		PAGE
7.0	DATA QUALITY OBJECTIVES	18
7.1	Precision	18
7.2	Accuracy	18
7.3	Completeness	19
8.0	CORRECTIVE ACTION	20
8.1	Immediate Corrective Action	20
8.2	Long-Term Corrective Action	20
8.3	Out-of-Control Events and Corrective Action	21
9.0	DATA MANAGEMENT PLAN	23
9.1	Laboratory Data Management	23
9.2	Field Data Management	23
9.3	Project Files	24
9.4	Technical Calculation Review	24

TABLES:

Table 3-1:	Field QC Samples Per Sampling Event	7
Table 5-1:	Target Compound List (TCL) Volatile Compounds	13
Table 5-2:	Target Compound List (TCL) Semi-Volatile Compounds	14
Table 5-3:	Target Compound List (TCL) Pesticides, PCBs	15
Table 5-4:	Target Analyte List (TAL) Inorganics	16

FIGURES:

Figure 2-1:	Project Organization	4
Figure 8-1:	Corrective Action Request Form	22

APPENDICES:

Appendix A: Laboratory QA/QC Plan
Appendix B: Atlantic's QA Procedures
Appendix C: Summary of Samples to Be Collected at Each Site
Appendix D: NSB-NLON Project Files
Appendix E: Total Petroleum Hydrocarbons Test Method

1.0 PROJECT DESCRIPTION

This Addendum No. 1 to the Quality Assurance/Quality Control and Data Management Plan (QA/QC) has been developed for use in conjunction with the Addendum No. 1 Field Sampling Plan for the Naval Submarine Base-New London in Groton, Connecticut (NSB-NLON). This QA/QC Plan was developed specifically for activities planned for the Pier 33 and Berth 16 Step I sites at NSB-NLON and is based on guidance provided in "Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program", NEESA 20.2-047B.

This plan is a modification of the original QA/QC plan prepared for investigation of seven Step I and four Step II sites. The modifications make this plan specific to the two sites being investigated under this contract addendum, incorporate previous comments from the USEPA and CTDEP, and change the level of quality control from Level C to Level D.

1.1 Data Quality Objective (DQO)

The program to be implemented for the Berth 16 and Pier 33 sites will be performed under NEESA Level D quality control. Level D is equivalent to Level IV quality control as defined in the Superfund Manual *"Data Quality Objectives for Remedial Response Activities"* (EPA 540/G-87/003). The laboratory must successfully analyze a performance sample, undergo an audit, correct deficiencies found during the audit, and provide monthly progress reports on QA. The laboratory that performs Level D QC must have passed the performance sample furnished by the Superfund CLP in the past year.

Audits will be administered and evaluated by NEESA Contract Representative (NCR). The Navy audit and performance samples are required in addition to any specified by the EPA Superfund Program.

Level D requires use of CLP procedures as defined in USEPA Contract Laboratory Program *Statement of Work for Inorganics Analysis* (7/88), and *Statement of Work for Organics* (2/88). Data validation procedures under Level D must be conducted in accordance with USEPA Region I Laboratory Data Validation Functional Guidelines dated February 1, 1988 for organic analyses, and June 13, 1988 for inorganic analyses.

The purpose of this document is to specify the requirements for the control of the accuracy, precision, and completeness of the samples, and data from the point of collection through reporting. The QA/QC Plan outlines the organization, objectives, and all QA/QC activities which will ensure achievement of desired data quality goals.

1.2 Site Description and History

The Subase was established as an official Navy yard in July 1886. The site initially moored small craft and obsolete warships and was used as a coaling station for the Atlantic Fleet. The property was officially established as a permanent submarine base in 1916. The overall base facilities were expanded and a Submarine School training facility was established in 1917, and the Submarine Medical Center was established in 1918. During World Wars I and II, the Subase expanded greatly in size and in the number of buildings to support the Submarine fleet.

The Subase currently provides a base command for naval submarine fleet activities in the Atlantic Ocean. Additionally, the Subase consists of naval housing, submarine training facilities, military offices, medical facilities, and facilities designed for the maintenance, repair, and overhaul of submarines.

1.3 Previous Data

Under the IR program (formerly NACIP), an Initial Assessment Study (IAS) for the Subase sites was completed in 1982. The IAS identified sites where contamination from past waste disposal or handling practices may pose health or environmental risks. The IAS recommended further investigation of three sites at the Subase. The Verification Step of a Confirmation Study was performed from 1985-1988 on the three sites. Additionally, an investigation of petroleum contamination at the Lower Base was performed in 1985.

Atlantic under the IR program has recently completed Step I investigations at seven sites and Step II investigation at four sites.

1.4 Project Scope

The objectives of the Step I Site Inspection program is to conduct a screening level sampling program to determine the presence or absence, as well as the order of magnitude, of specific toxic or hazardous contaminants identified which may be present in concentrations considered to have health or environmental effects.

The objectives of the Step II RI/FS program involves comprehensive onsite investigations in order to determine the extent and concentrations of contamination, assess health and environmental risks and evaluate remediation alternatives.

The field activities, sample matrices, and analyses for the two new Step I sites to be investigated at NSB-NLON are presented in the Addendum No. 1 Field Sampling Plan.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

This project will be managed by Atlantic Environmental Services, Inc. (Atlantic). The names and addresses of Navy contact personnel appear below.

Specific Atlantic personnel have been identified who are responsible for implementing the quality aspects of the project. Primary responsibility rests with the Project Manager. Figure 2-1 presents the organizational structure for the IR Study for the Berth 16 and Pier 33 sites at NSB-NLON. The names of the primary contacts with the Navy are given below.

Engineer-in-Charge

Deborah Stockdale
c/o Commanding Officer
Northern Division, Naval Facilities Engineering Command
Building 77-L, U.S. Naval Base
Philadelphia, PA 19112-5094
Attn: Code 1421/APT
Telephone: (215) 897-6431

Point-of-Contact

William Mansfield
c/o Commanding Officer
Naval Submarine Base New London
Groton, CT
Attn: Code 803
Telephone: (203) 449-4481

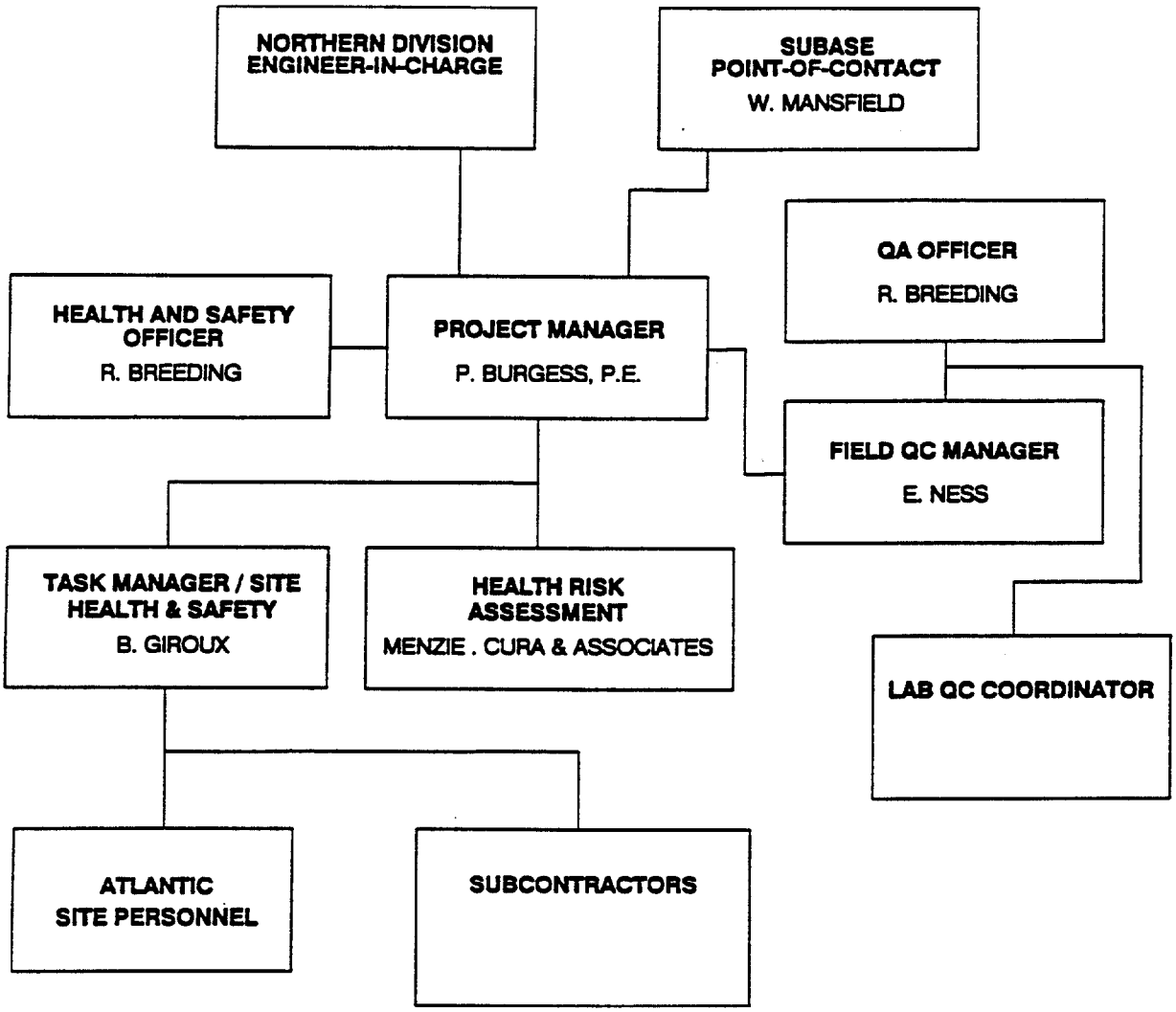
Responsibilities of Atlantic's Project Manager and QA/QC staff are presented below.

2.1 Project Manager's Responsibility

The Project Manager will provide overall direction to the project team and will be held responsible for overall technical, financial and scheduling matters. The Project Manager will be the primary contact for the Northern Division's Engineer-in-Charge (EIC) and NSB-NLON Point-Of-Contact (POC).

2.2 QA Officer's Responsibility

The QA Officer reports independently to Atlantic's President and has full authority to act independently from the technical management of the IR program. He will serve as Atlantic's primary contact with the Northern Division's QA staff, if so requested by the EIC. He will monitor compliance of the project with the QA/QC Plan and perform any necessary audits, initiate and report corrective actions, and he will assist in preparing QA/QC project summaries for the Final Report.



INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE - NEW LONDON
GROTON, CT

FIGURE 2-1
PROJECT ORGANIZATION

ATLANTIC ENVIRONMENTAL SERVICES, INC.

Three field audits are planned for this project, one for each of the following activities:

- drilling and soil sampling;
- well development;
- ground water sampling;

A laboratory audit is also included in the program.

2.3 Field QC Coordinator - QA/QC Manager's Responsibilities

The Field QC Coordinator will work with the field team during preparations for the sampling events, and also during conduct of field work. He/she will be onsite to ensure all required QC procedures are followed; will initiate informal and/or formal corrective actions, as necessary; and will maintain and report QC records and results to the Atlantic Project Manager and QA Officer. This person will be responsible for ensuring all analytical deliverables have been received and subsequently validated according to NEESA Level D Guidelines.

2.4 Laboratory QC Coordinator

The laboratory selected for this project is Pace Incorporated of Hampton, New Hampshire (PACE), who will also designate a QC Coordinator. PACE's Quality Assurance Project Plan is included as Appendix A to this plan. The Laboratory QC Coordinator will perform the following, in accordance with the NEESA-approved QA/QC plan.

1. Assist the Project/Task Manager in specifying QA/QC procedures to be used during the study.

2. Implement QC procedures and techniques to assure that the laboratory achieves established standards of quality.

3. Evaluate data quality and maintain records on related QC charts and other pertinent information.

4. Monitor laboratory activities to determine conformance with authorized QA policy.

5. Coordinate internal audits.

6. Review performance evaluation results.

7. Administer intralaboratory and interlaboratory QA efforts.

8. Prepare QA reports to management.

3.0 SAMPLING PROCEDURES

3.1 Introduction

The following matrices may be collected during this field investigation study: soil and ground water. All sample collection and monitoring procedures are discussed in the Addendum No. 1 Field Sampling Plan and a list of procedures for this project is found in Appendix B of this document (the actual procedures, along with site-specific modifications or clarifications, are in Appendix A of the Field Sampling Plan). All media samples collected will be handled in accordance with this Quality Assurance/Quality Control Project Plan, and Atlantic's Procedures.

3.2 Selection of Sampling Locations

The locations of samples for each of the two sites at NSB-NLON appear in the Field Sampling Plan. A summary of samples to be collected at each site appears in Section 4.0 of the Addendum No. 1 Field Sampling Plan and are presented in Appendix C of this document, along with the required QA/QC samples.

3.3 Sample Collection, Handling and Shipping

Sample bottles will be prepared and shipped to the field by the laboratory Sample Coordinator. Where possible, preservatives will be placed in the appropriate containers by the laboratory to minimize chemical handling in the field.

Sample containers, preservatives and holding times are listed in Table 5-1 of the Laboratory Quality Assurance Project Plan (Appendix A). The only modification to Table 5-1 is that aqueous VOC samples will be preserved with HCL, and 60 ml bottles with teflon-lined septums will be used to hold soil samples for VOC analyses.

The general listing of field QC samples to be included in each sampling event is provided in Table 3-1.

A sequentially numbered sample label will be filled out at the time of sampling by Atlantic's field personnel according to the proper procedures. It will be attached to each container with the following information:

1. Site number/project number
2. Field identification or sample station number
3. Date and time of collection
4. Designation as grab or composite
5. Matrix
6. Signature of samples
7. Preservation used
8. General type of analysis to be conducted

After samples have been collected, they will be placed in a shipping cooler and kept cool with frozen blue ice packs. Each sample container will be wrapped in bubble packing for shipment to the laboratory by an overnight carrier service or courier. Sample containers will be secured using nylon strapping tape and custody seals.

TABLE 3-1

FIELD QC SAMPLES PER SAMPLING EVENT

TYPE OF SAMPLE	METAL	ORGANIC
Trip Blank (for volatile organics only)	NA[1]	1/cooler
Equipment Rinsate[2]	1/day	1/day
Field Blank	1/source/event for all analytes	
Field Duplicates[3]	10%	10%
Referee Duplicate[3]	Collect at direction of USEPA Project Manager	

1. NA - Not Applicable
2. Samples are collected daily; however, only samples from every other day are analyzed. Other samples are held and analyzed only if evidence of contamination exists.
3. The duplicate must be taken from the same sample which will become the laboratory matrix/spike duplicate for organics or for the sample used as a duplicate in inorganic analysis.

The chain-of-custody (COC) record will accompany all samples to provide documentation of all samples collected and to trace sample possession. Chain-of-custody procedures are discussed in detail in Section 4.0 of this document.

After all the sample containers have been filled and properly stored, field testing will be performed. **Four** parameters will be measured in the field for all aqueous samples: pH, temperature, conductivity **and turbidity**. These measurements will be taken from a separate container which will not be submitted to the laboratory for analysis. Temperature will be measured immediately upon collection of all ground water and surface water samples, as it is subject to the most rapid change. Conductivity and pH will be measured with electronic probes, which will be cleaned with organic-free distilled water in between each usage. Atlantic will use a YS1 Model 33 SCT Meter for temperature and conductivity measurements and an ORION 407A specification meter for pH measurements.

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

3.4 Field Quality Control (QC) Samples

Trip blanks, equipment rinsates, field blanks, field duplicates and potentially referee duplicates will be collected as part of each sampling event, in order to ascertain a measure of quality control during each sampling round. The following sections described the purpose behind each of these types of samples, and Table 3-1 specifies the frequency of each type of QC sample.

3.4.1 Trip Blanks

Trip blanks are defined as samples which originate from analyte-free water taken from the laboratory to the sampling site and returned to the laboratory with the volatile organic analyte (VOA) samples. One trip blank will accompany each cooler containing VOAs, will be stored at the laboratory with the samples, and analyzed by the laboratory. Trip blanks are only analyzed for VOAs.

3.4.2 Equipment Rinsates

Equipment rinsates are the final analyte-free water rinse from equipment cleaning collected daily during a sampling event (e.g., split spoons, bailers). Initially, samples from every other day will be analyzed. If analytes pertinent to the project are found in the rinsate at such levels to cause estimation or rejection during data validation, the remaining samples will be analyzed. The results from the blanks will be used to flag or assess the levels of analytes in the samples. This comparison is made during data validation. The rinsates are analyzed for the same parameters as the related samples.

3.4.3 Field Blanks

Field blanks consist of the source water used in decontamination and steam cleaning. At a minimum, one field blank from each event and each source of water will be collected and analyzed for the same parameters as the related samples.

3.4.4 Field Duplicates/Splits

Duplicates or splits for soil samples are collected, homogenized, and split. All samples except VOAs are homogenized and split. Volatiles are not mixed, but select segments of soil are taken from the length of the split-spoon and placed in 60-ml glass vials. The duplicates for water samples will be collected simultaneously. Field duplicates will be collected at a frequency of 10% per sample matrix for Level D QC. All the duplicates will be sent to the laboratory. The samples used for field duplicates will be split by the laboratory and be used as the laboratory duplicate or matrix spike. This means that for the duplicate sample, there will be analyses of the normal sample, the field duplicate, and the laboratory matrix spike/duplicate.

3.4.5 Referee Duplicates

Duplicates/splits will be provided to a designated referee QA laboratory as directed by the USEPA or CTDEP. These duplicates/splits are collected and analyzed in addition to the field duplicates mentioned in the previous paragraph.

3.5 Field Decontamination Procedures

Drill rigs will be steam cleaned prior to entering the Subase and drilling equipment will be decontaminated prior to moving to individual sites. Drilling equipment used for multiple boreholes will be decontaminated prior to each boring at the site. All major decontamination will be conducted at the central decontamination area near Atlantic's base of operation. Minor decontamination such as cleaning of split-spoons and other sampling equipment will be performed at each site. Split-spoons along with stainless steel or teflon spatulas, and stainless steel mixing pans will be decontaminated using the following procedures:

1. wash and scrub with alconox detergent in tap water;
2. rinse with tap water;
3. rinse with 10% nitric acid or 1% nitric acid if carbon steel is being decontaminated (only if metals are being analyzed);
4. rinse with distilled/deionized water;
5. rinse with methanol;
6. rinse with hexane;
7. rinse with distilled/deionized water (demonstrated to be analyte-free); and

8. air dry - on clean polyethylene sheeting.

NOTE: Steps 3 and 4 may be omitted if sampling devices are not used for inorganic sample collection.

In order to minimize logistical difficulties and the spread of contaminated cleaning fluids, a procedure has been established for well to well decontamination. All drilling will be done over tarps and, once the boreholes or wells are complete, the tarp, cuttings and development water may be drummed onsite for possible offsite disposal as specified in the Field Sampling Plan. All contaminated drilling tools will be wrapped in plastic and moved to the central decontamination area for cleaning prior to moving to the next location.

4.0 CHAIN-OF-CUSTODY

Along with the sample labelling requirements presented in Section 3.3, a chain-of-custody record will be completed at the time of sampling and accompany samples between the field and the laboratory. The following information will be provided on the chain-of-custody form:

1. Project name/number
2. Signature of sampling personnel
3. Sample site number/sample number
4. Date and time of collection
5. Grab or composite
6. Signatures and dates and times of individuals involved in transferring samples
7. Sample matrix (included in the sample number)

The field chain-of-custody is complete when samples are transferred to overnight carriers or a courier. EPA does not require overnight carriers to continue COC within their organization to complete the COC. When samples are received at the laboratory, the receiver will sign the chain-of-custody form.

The sample analysis request section of the COC serves as official communication to the laboratory of the particular analysis required for each sample and provide further evidence that the COC is complete.

COC records initiated in the field shall be placed in a plastic cover and taped to the inside of the shipping container used for transport.

5.0 ANALYTICAL PROCEDURES

USEPA-approved methods will be used for all chemical and physical analyses undertaken during this Installation Restoration Study. Target Compound List (TCL) and Target Analyte List (TAL) parameters will be analyzed by CLP protocols for both organic and inorganic analyses. Approved methods for non-CLP parameters are contained in SW 846, ASTM or Federal Register.

A QA/QC Project Management Plan from the analytical laboratory is submitted together with this document. Presented below is a list of the chemical parameters planned for analysis during the Step 1 investigation. The TCL and TAL are the suites of parameters to be determined on all samples of soil, sediment, surface water, and ground water. In addition, selected soil samples will be analyzed for TCLP metals, total petroleum hydrocarbons, and oil type identification.

Atlantic will use procedures developed from attending USEPA seminars on the use of portable gas chromatographs for field screening. Atlantic will not, however, use the results of field GC analysis for reporting soil or water contamination. It is the intent to use soil gas analysis as a tool for the identification of elevated volatile organics areas for the final design of the drilling program.

5.1 CLP TCL and TAL

All organic compounds analyses will be conducted according to the U.S. EPA CLP, Statement of Work **(SOW ILM01.8)**, dated February 1988, or the latest version at the time of analysis. The organic compounds contained in the TCL will be determined using proven instruments and techniques to identify and quantify volatile, semi-volatile and PCB/pesticide compounds. The TCL compounds are shown in Tables 5-1 through 5-3, respectively.

All inorganic analyte analyses will be conducted according to the USEPA CLP, Statements of Work **(SOW ILM01.8)**, dated July 1988, or the latest version at the time of analysis. The inorganic compounds contained in the TAL will be determined using proven instruments and techniques. The TAL compounds are shown in Table 5-4.

Soil extraction for organic and inorganic leaching behavior will be performed using the Toxicity Characteristic Leaching Procedure (TCLP) analysis described in 40 CFR §261 Appendix II. **Metals analysis of the TCLP extract will be performed by the following methods from the USEPA SW-846 test methods manual: Arsenic-7060; Barium - 7088; Cadmium - 7131; Chromium -7191; Lead - 7421; Mercury - 7471; Selenium - 7740; and Silver - 7761.**

Total petroleum hydrocarbons will be performed in accordance with the method provided in Appendix E.

Fluorescence analysis to identify or "fingerprint" soils will be performed in accordance with methods described in *Petroleum Hydrocarbons by Fluorescent Spectroscopic Techniques*, ASTM D3650.

5.2 Analytical Methodologies

The analytical procedures to be used in this project are contained in the EPA Manuals *Methods for Chemical Analysis of Water and Wastes, Methods for Organic Analysis of Municipal and Instrial Wastewater, Test Methods for Evaluating Solid Wastes* (SW-846), *Contract Laboratory Program Statement of Work for Inorganic Analysis, Multi-Media, Multi-Concentration, Revision No. 7/88,* and *Contract Laboratory Program Statement of Work for Organic Analysis, Multi-Media, Multi-Concentration, Revision No. 2/88.* Other methods

may be taken from APHA - *Standard Methods for the Examination of Water and Wastewater* and ASTM - *The Annual Book of ASTM Standards.*

These methods are summarized in Table 7.1, located in the Laboratory Quality Assurance Project Manual (Appendix A).

These tables include all constituents in the TAL, TCL and other parameters that PACE routinely analyzes, including all parameters specified in the Field Sampling Plan.

TABLE 5-1

TARGET COMPOUND LIST (TCL)
VOLATILE COMPOUNDS

VOLATILES	
Chloromethane	Bromomethane
Vinyl chloride	Chloroethane
Methylene chloride	Acetone
Carbon disulfide	1,1-Dichloroethene
1,1-Dichloroethane	1,2-Dichloroethene (cis and trans)
Chloroform	1,2-Dichloroethane
2-Butanone	1,1,1-Trichloroethane
Carbon tetrachloride	Vinyl acetate
Bromodichloromethane	1,1,2,2-Tetrachloroethane
1,2-Dichloropropane	trans-1,3-Dichloropropene
Trichloroethene	Dibromochloromethane
1,1,2-Trichloroethane	Benzene
cis-1,3-Dichloropropene	2-Hexanone
Bromoform	Tetrachloroethene
4-Methyl-2-pentanone	Chlorobenzene
Toluene	Styrene
Ethyl benzene	
Total xylenes	

TABLE 5-2

TARGET COMPOUND LIST (TCL)
SEMI-VOLATILE COMPOUNDS

SEMI-VOLATILES	
Phenol	Bis(2-chloroethyl) ether
2-Chlorophenol	1,3-Dichlorobenzene
1,4-Dichlorobenzene	Benzyl alcohol
1,2-Dichlorobenzene	2-Methylphenol
Bis(2-chloroisopropyl)ether	4-Methylphenol
N-Nitroso-dipropylamine	Hexachloroethane
Nitrobenzene	Isophorone
2-Nitrophenol	2,4-Dimethylphenol
Benzoic acid	Bis(2-chloroethoxy) methane
2,4-Dichlorophenol	1,2,4-Trichlorobenzene
Naphthalene	4-Chloroaniline
Hexachlorobutadiene	4-Chloro-3-methylphenol (para-chloro-meta-cresol)
2-Methylnaphthalene	Hexachlorocyclopentadiene
2,4,6-Trichlorophenol	2,4,5-Trichlorophenol
2-Chloronaphthalene	2-Nitroaniline
Dimethyl phthalate	Acenaphthylene
3-Nitroaniline	Acenaphthene
2,4-Dinitrophenol	4-Nitrophenol
Dibenzofuran	2,4-Dinitrotoluene
2,6-Dinitrotoluene	Diethylphthalate
4-Chlorophenyl phenyl ether	Fluorene
4-Nitroaniline	4,6-Dinitro-2-methylphenol
N-nitrosodiphenylamine	4-Bromophenyl phenyl ether
Hexachlorobenzene	Pentachlorophenol
Phenanthrene	Anthracene
Di-n-butylphthalate	Fluoranthene
Pyrene	Butyl benzyl phthalate
3,3'-Dichlorobenzidine	Benzo(a)anthracene
Bis(2-ethylhexyl)phthalate	Chrysene
Di-n-octyl phthalate	Benzo(b)fluoranthene
Benzo(k)fluoranthene	Benzo(a)pyrene
Indeno(1,2,3-cd)pyrene	Dibenzo(a,h)anthracene
Benzo(g,h,i)perylene	

TABLE 5-3

TARGET COMPOUND LIST (TCL)
PESTICIDES, PCBs

PESTIDICES	
alpha-BHC	beta-BHC
delta-BHC	gamma-BHC (Lindane)
Heptachlor	Aldrin
Heptachlor epoxide	Endosulfan I
Dieldrin	4,4'-DDE
Endrin	Endosulfan II
4,4'-DDD	4,4'-DDT
Endosulfan sulfate	Methoxychlor
Endrin ketone	Toxaphene
Chlordane (alpha and gamma isomers)	Arochlor 1221
Arochlor 1016	Arochlor 1242
Arochlor 1232	Arochlor 1254
Arochlor 1248	
Arochlor 1260	

TABLE 5-4

TARGET ANALYTE LIST (TAL)
INORGANICS

ELEMENTS	
Aluminum	Antimony
Arsenic	Barium
Beryllium	Calcium
Cadmium	Cobalt
Chromium	Iron
Copper	Magnesium
Lead	Mercury
Manganese	Potassium
Nickel	Silver
Selenium	Thallium
Sodium	Zinc
Vanadium	Boron
Cyanide	

6.0 DATA VALIDATION

Data validation will be done under NEESA Level D requirements (DQO4) as presented in *Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program,* (NEESA 20.2-047B). Level D requires full CLP data validation. USEPA CLP data validation procedures are contained in the *Region I Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses,* February 1, 1988, and *the Region I Laboratory Data Validation Function Guidelines for Evaluating Inorganic Analyses,* June 13, 1988.

7.0 DATA QUALITY OBJECTIVES

The data quality objectives for all measurements (field and laboratory) include considerations of precision, accuracy, and completeness as described below in general terms. Detailed quality control objectives can be found in Table 5.2 in the Laboratory Quality Assurance Project Manual (Appendix A).

7.1 Precision

The precision of a measurement is an expression of mutual agreement of multiple measurement values of the same property conducted under prescribed similar conditions. Precision reflects the repeatability of the measurement. Precision is evaluated most directly by recording and comparing multiple measurements of the same parameter on the same sample under the same conditions. Precision is usually expressed in terms of standard deviation. The precision objectives for TCL parameters are specified in the CLP protocols. Except as otherwise specified by the method, the QC objective for precision under this project will be ± 20 percent (relative percent difference) as determined by duplicate analyses. The relative percent difference (RPD) is calculated as:

$$RPD = \frac{1}{2} \times \frac{V1 - V2}{V1 + V2} \times 100$$

Where: V1 V2 = two values obtained by analyzing duplicates

7.2 Accuracy

The degree of accuracy of a measurement is based on a comparison of the measured value with an accepted reference or true value, or is a measure of system bias. Accuracy of an analytical procedure is best determined based on analysis of a known or "spiked" sample quantity. The degree of accuracy and the recovery of analyte to be expected for the analysis of QA samples and spiked samples is dependent upon the matrix, method of analysis, and compound or element being determined in the analysis. The concentration of the analyte relative to the detection limit is also a major factor in determining the accuracy of the measurement. Except as otherwise specified by a method, the QC objective for accuracy under this project will be 75 to 125 percent (percent recovery), as determined by sample spike recoveries. Alternatively, accuracy may be assessed through the analysis of appropriate standard reference materials, certified standards, or other samples, as available. The percent recovery is calculated as:

$$\%\ recovery = \frac{Ss - So}{S} \times 100$$

Where: Ss = Value obtained by analyzing the sample with the spike added.
So = Background value, i.e., the value obtained by analyzing the sample without a spike.
S = Concentration of the spike added to Ss.

7.3 Completeness

Completeness is a measure of the amount of valid data obtained from the measurement system relative to the amount anticipated under ideal conditions. This project's QC objective for completeness, as determined by the percentage of valid data generated, will be $\geq$ 90 percent. The formula to be used to estimate completeness is:

$$C = 100 \frac{V}{T}$$

Where:
C = Percent Completeness
V = Number of judgements determined valid
T = Total number of measurements

8.0 CORRECTIVE ACTION

Atlantic and PACE recognize and have established methods to control nonconforming field and analytical procedures. The PACE QA/QC Plan documents their corrective action plan. Corrective actions can be of three forms: immediate, long-term and those applied to out-of-control events. Each is discussed in light of the activities planned in the Installation Restoration Study at the Subase.

8.1 Immediate Corrective Action

Immediate action applies to field and analytical procedures that can be instituted as normal operating procedures that would prevent the generation of poor quality data. These types of actions are considered informal and only require noting problems and corrections
in the field notebooks or laboratory notebooks. The use of trained field and laboratory personnel will increase the awareness of problems requiring immediate corrective action.

Types of situations which would require immediate corrective action in the field include:

1. drill rig breaks a throw-out bearing;

2. HNu meter will not zero;

3. sampling pumps do not operate; and

4. grout enters a well screen possibly contaminating a well.

If immediate corrective actions are not performed then Atlantic will apply formalized long-term corrective action.

8.2 Long-Term Corrective Action

A long-term corrective action may be identified by problems with standard operating procedures, the use of control charts, or the result of performance or system audits. Any quality problem which cannot be solved by immediate corrective action falls into the long-term category. The Atlantic QA system ensures that the quality problem is reported to a person responsible for correcting it, and who is part of a closed-loop action and follow-up plan.

The essential steps in the closed-loop corrective action system are listed below:

- identify and define the problem;

- assign responsibility for investigating the problem;

- investigate and determine the cause of the problem;

- determine a corrective action to eliminate the problem;

- assign and accept responsibility for implementing the corrective action;

- establish effectiveness of the corrective action and implement it; and

- verify that the corrective action has eliminated the problem.

Documentation of the problem is important to the system. A Corrective Action Request and Reporting Form (Figure 8-1) is provided. This form identified the problem, possible causes, and the person responsible for action on the problem. If no person is identified as responsible for action, the QA Officer investigates the situation and determines who is responsible in each case.

The Corrective Action Request and Reporting Form also includes a description of the corrective action planned and the date it was taken, and space for follow-up. The QA Officer checks to be sure that initial action has been taken and appears effective and, at an appropriate later date, checks again to see if the problem has been fully solved. The QA Officer receives a copy of all Corrective Action Forms and enters them in the Corrective Action Log. This log is maintained as part of the QA records for the project.

8.3 Out-of-Control Events and Corrective Action

Out-Of-Control events are usually associated with the analytical portion of an IR Study. PACE provides a statement for the resolution of Out-Of-Control events in their QA/QC Plan.

FIGURE 8-1
INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE - NEW LONDON
GROTON, CONNECTICUT

CORRECTIVE ACTION REQUEST FORM

CORRECTIVE ACTION REQUEST NO. _____

Originator:	Date:
Person Responsible for Replying:	Contract Involved:
Description of problem and when identified:	
State cause of problem, if known or suspected:	
Sequence of Corrective Action: (If no responsible person is identified, notify QA Officer immediately. Submit all CA forms to QA Officer for initial approval of CA.)	
State Date, Person, and Action Planned:	
CA Initially Approved by:	Date:
Follow-up Dates:	
Final CA Approval by:	Date:

Information copies to:

RESPONSIBLE PERSON/QC COORDINATOR: _____

QA OFFICER: _____

PROJECT MANAGER: _____

9.0 DATA MANAGEMENT PLAN

The purpose of the Data Management Plan is to document and track investigation data and results.

9.1 Laboratory Data Management

All laboratory data will be managed by the Field QC Coordinator, who will be responsible for all chain-of-custody records and the master sample log notebook. All samples will be recorded in the master sample log notebook for future reference. This will include sample site, sample number, data, time, sampling personnel, sample media, containers, parameters for analysis, date/method of shipment, and sample preservation. The notebook will also be used to document the receipt of laboratory analysis data from the laboratory.

The chain-of-custody and master sample log notebook will be kept in the files for the IR Study under the custody of the Project Manager. The removal of the documents from the file will require a signature.

Laboratory data used for the generation of figures, maps, etc. must be reviewed by another Atlantic employee. All laboratory data tables will be initialed by both the preparer and the reviewer, and kept in the files.

9.2 Field Data Management

The data collected during the field investigation and sampling will be documented in field notebooks. Field notebook entries will include the following information:

- name and title of author, date and time of entry, and weather conditions;
- site name and location;
- field investigation observations;
- description of sample location;
- sample collection method;
- sample media, sample I.D. number;
- sample preservation;
- field measurements (pH, temperature, conductivity);
- location (distance measurement from known field locations); and
- **sample description (e.g., color).**

All field entries will be made in waterproof ink. The field team leader will conduct periodic checks of field entries to insure their accuracy and completeness.

Atlantic's Project Manager will control all field notebooks. Each field notebook will receive a serialized number and be issued to the field team leader. Field notebooks when complete will be returned to the project files.

Field data used for the generation of subsequent information (e.g., boring logs, reports, ground water elevation, monitoring well logs, etc.) must be reviewed by another Atlantic technical employee and both initial provided on the information.

9.3 Project Files

A summary of the project files being used for this project is provided as Appendix D.

All file information will be placed chronologically in each file. Files removed from the file cabinets must be recorded on a signature sheet. All files must be returned to the cabinet at the conclusion of each day.

9.4 Technical Calculation Review

Technical calculations performed for this project will include, permeability, ground water flow directions and velocity, health risk calculations, material volumes, engineering calculations for remediation, etc. All calculations will be performed on Atlantic calculation paper with the project number, date, and person recorded. All technical assumptions, references will be fully documented. All calculations will be reviewed and initialed by a technical person with required expertise in the subject matter.

APPENDIX A

LABORATORY QA/QC PLAN

Quality Assurance Project Plan
Navy Pier 33/Berth 16
Residential Wells and Background Soil Investigation

PACE New England, Incorporated

March 24, 1993
Revision 2

Approved by/Date

Stephanie Beck Date 3-24-93
Quality Assurance Officer, PACE NE

Stuart Brown Date 3-24-93
Project Manager, PACE NE

Table of Contents

1.0 PROJECT DESCRIPTION 4

2.0 PROJECT ORGANIZATION AND RESPONSIBILITY 4

3.0 QUALITY ASSURANCE OBJECTIVES 7
3.1 Data Quality Parameters 7

4.0 SAMPLING PROCEDURES 25

5.0 SAMPLE CUSTODY 25
5.1 Chain-of-Custody 25
5.2 Sampling Kits 26

6.0 CALIBRATION PROCEDURES AND FREQUENCY 29
6.1 General 29
6.2 Specific Procedures 30

7.0 ANALYTICAL PROCEDURES 30
7.1 Sample Analysis 30
7.1.1 Volatile Organic Compounds 30
7.1.2 Semi-Volatile Organic Compounds 39
7.1.3 TCLP Metals 40
7.1.4 Chloride 41
7.1.5 Total Petroleum Hydrocarbons - Infra Red 42
7.1.6 Grain Size 43
7.1.7 TAL Metals 43
7.1.8 Pesticides/PCBs 45
7.1.9 Total Cyanide 46

8.0 DATA REDUCTION, VALIDATION AND REPORTING 46
8.1 Data Validation 46
8.1.1 External Data Validation 47
8.1.2 Internal Laboratory Data Reduction and Validation 47
8.2 Reporting 50
8.3 Documentation 50

9.0 INTERNAL QUALITY CONTROL CHECKS 51
9.1 Laboratory Method Blanks 51
9.2 Laboratory Control Samples 51
9.3 Laboratory Duplicates 51
9.4 Matrix Spikes 51
9.5 Matrix Spike Duplicates 52

10.0 PERFORMANCE AND SYSTEMS AUDITS 52
10.1 Interlaboratory Performance Surveys 52
10.2 Periodic Internal Audits 53
10.2.1 Performance Audits 54
10.2.2 Systems Audits 54
10.3 QA Reporting and Corrective Action 55

11.0 PREVENTIVE MAINTENANCE 56
11.1 GC\MS 56
11.2 ICP 56
11.3 AA Graphite Furnace 57
11.4 Mercury Analyzer 57
11.5 Laboratory - General 57

12.0 SPECIFIC PROCEDURES TO ASSESS PRECISION, ACCURACY , AND COMPLETENESS 58
12.1 Precision 58
12.2 Accuracy 58
12.3 Completeness 59
12.4 Background Contamination 59

13.0 CORRECTIVE ACTION 59

14.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT 63

1.0 PROJECT DESCRIPTION

PACE New England, Inc. (PACE NE) will provide analytical services to Atlantic Environmental Services, Inc. in support of the Navy Pier 33/Berth 16 project and the Wells and Background Soil Investigation at the Naval Submarine Base in Groton Connecticut (Atlantic project number 1256-15-O2P and 1256-22-04P). All analytical services will be performed at PACE NE's laboratories in Hampton, New Hampshire with the exception of Dioxin analyses which will be subcontracted to Triangle Laboratories in Houston, Texas. This will include organic and inorganic analyses on both soil and water samples. It is estimated that samples will arrive in March and continue for a period of approximately two months.

PACE NE has a staff of 70 employees and over 24,000 square feet available for the efficient management, preparation and analysis of a wide variety of sample types, and for the administration of the associated data. The facility has a large area where samples can be stored according to protocol and under custody. A 2400 square foot organic preparation lab and 1400 square foot metals preparation lab support separate 3400 square foot organics and 1200 square foot metals instrumentation labs respectively. Shipping, receiving, and warehousing are separate from the laboratories.

In addition to routine annual state inspections, PACE NE routinely undergoes audits from USEPA as part of the Contract Laboratory Program.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITY

PACE NE will utilize its normal organizational structure (Figure 1) to perform analytical services associated with this program. Special assignments for this project are described as follows:

Liaison with Atlantic Environmental, Inc. will be handled by Mr. Stuart Bronson as Project Manager. Field activities will coordinate with the lab through Mr. Bronson and questions or problems arising in the lab will be conveyed to Atlantic Environmental, Inc. personnel through him.

Ms. Heather Gilley will serve as Sample Management Director and will inspect all samples for appropriateness, sufficient volume, labelling and condition, and will notify Mr. Bronson of any problems immediately upon arrival.

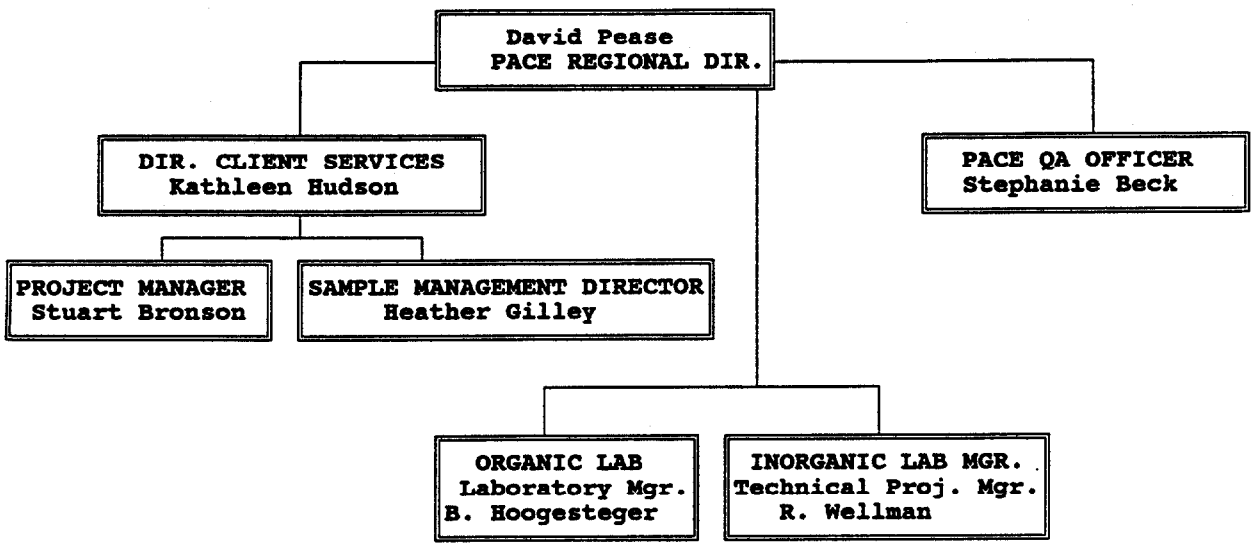
Mr. Bruce Hoogesteger will serve as Organic Laboratory Director. Mr. Hoogesteger will have technical oversight of the analysis of samples for volatile organic compounds and the analysis of samples for extractable organic compounds.

Monitoring of internal lab scheduling and work oversight for this project will be performed by Mr. Richard Wellman who, in addition to serving as Inorganics Lab Director will also serve as Technical Project Coordinator and will monitor all phases of the analytical work. Mr. Wellman will also have technical oversight of the preparation and analysis of samples for metals and wet

chemical parameters.

Ms. Stephanie Beck will oversee the Laboratory Quality Assurance Program. The Quality Assurance Unit (QAU) functions independently from that of lab operations, sales and marketing, finance and other administrative functions. QA's functions include: state and federal regulatory compliance issues, laboratory accreditation and approval, data auditing, systems inspections, documentation and records archiving. PACE NE's Standard Quality Assurance Practices are outlined and described in the PACE NE Quality Assurance Operations Manual. The QAU will perform an audit of the QA program during the project and be available for additional analytical system audits as required.

Figure 1. Lab Organizational Chart



3.0 QUALITY ASSURANCE OBJECTIVES

Quality assurance is defined as the ability to assure that all of the activities are performed correctly and the data can be confidently used to make decisions.

In order to achieve the data requirements that are consistent with the objectives of each task, there must be an assessment of the performance of five data quality parameters. These data quality parameters are precision, accuracy, representativeness, completeness, and comparability. Definitions of these data quality parameters are presented below:

Precision - A measure of the reproducibility of measurements under a given set of conditions.

Accuracy - A measure of how close a result is to the true value.

Representativeness - The degree to which a single measurement is indicative of the characteristics of a larger sample or area or the degree to which the data gathered by the project represents the field conditions.

Completeness - A measure of the amount of valid data obtained from the measurement system compared to the amount that is planned, e.g.,

$$\% \text{ Completeness} = \frac{\text{\# of Valid Results}}{\text{Total \# of Results}} \times 100$$

Valid results will be defined for each task by addressing accuracy, precision, and representativeness parameters quantitatively.

Comparability - A measure of the confidence with which one data set can be described as similar to another.

3.1 Data Quality Parameters

Target compound list volatiles (waters)

1. Accuracy

- All blanks must be less than the reporting limits.

- The Laboratory Control Sample percent recoveries must be and Matrix Spike recovery advisory limits are:

	water
1,1-Dichloroethane	61-145%
Trichloroethene	71-120%

Benzene	76-127%
Toluene	76-125%
Chlorobenzene	75-100%

- The Relative Response Factor (RRF) for initial calibration must be greater than 0.300 for the five System Performance Check Compounds (0.250 for Bromoform). The System Performance Check Compounds are: chloromethane; 1,1-dichloroethane; bromoform; 1,1,2,2-tetrachloroethane; and chlorobenzene.

- The Percent Relative Standard Deviation (%RSD) for the initial calibration must be less than 30% for Calibration Check Compounds (CCCs) 1,1-Dichloroethene, Chloroform, 1,2-Dichloropropane, Toluene, Ethylbenzene, and Vinyl chloride.

- The percent difference (%D) for the continuing calibration (CCCs) must be less than 25%.

- The detection limit must be equal to or less than the reporting limits listed below.

Water
μg/l

Chloromethane	2
Bromomethane	2
Vinyl Chloride	2
Chloroethane	2
Methylene Chloride	2
Acetone	5
Carbon Disulfide	1
1,1-Dichloroethene	1
1,2-Dichloroethene (total)	1
Chloroform	1
1,2-Dichloroethane	1
2-Butanone	5
1,1,1-Trichloroethane	1
Carbon Tetrachloride	1
Bromodichloromethane	1
1,2-Dichloropropane	1
cis-1,3-Dichloropropene	1
Trichloroethene	1
Dibromochloromethane	1
1,1,2-Trichloroethane	1
Benzene	1
trans-1,3-Dichloropropene	1
Bromoform	1

4-Methyl-2-pentanone	5
2-Hexanone	5
Tetrachloroethene	1
Toluene	1
1,1,2,2-Tetrachloroethane	1
Chlorobenzene	1
Ethyl Benzene	1
Styrene	1
Xylenes (Total)	1

2. Precision

- All laboratory duplicates and matrix spike duplicates should have a relative percent difference (RPD) as follows:

	water
1,1 Dichloroethene	14%
Trichloroethane	14%
Benzene	11%
Toluene	13%
Chlorobenzene	13%

If the results for the duplicate pair are positive and greater than five (5) times the PQL then the %D criteria are used. However, if the results for the duplicate pair are less than 5 times the PQL then the acceptance criteria will be +/- PQL or the %D criteria, whichever is greater. This criteria will be used for duplicate results that have a "ND" and a positive value. Of course, a duplicate that gives two ND values does not give any precision information and thus precision will not be used to judge the date's validity.

3. Representativeness

To insure that analyses reflect actual field conditions the laboratory will strive to maintain the integrity of the samples prior to and during analysis and to minimize the effects of the laboratory environment on the samples. To monitor effects of the laboratory environment, two types of blanks are used.

The first type is a trip blank which will consist of a volatile organic analysis vial filled by Pace with deionized, analyte-free water that will remain capped and accompany the sample VOA vials at all times. A trip blank may accompany all water VOA samples shipped to the laboratory. The trip blank indicates the effects of sample bottle preparation, shipment to the site, site storage and handling, return shipment, and sample holding at the laboratory on sample integrity.

The second type is a laboratory holding blank which consists of a volatile organics sample vial filled with analyte-free water and randomly placed with samples as received for storage prior to analysis. The holding blank serves to monitor the effects of sample bottle preparation and sample storage at the lab prior to and during analysis.

The laboratory will make every reasonable effort to assure that the samples are adequately mixed prior to taking aliquots for analysis, to insure that the reported results are representative of the sample received. It must be recognized that any means of mixing that exposes the sample to significant risk of contamination or analyte loss through volatilization should be avoided. Soil samples for volatile organics are particularly vulnerable will not be mixed. A sub sample will be quickly withdrawn for analysis. Water samples will be taken from separate volatile organics vials for GC screening and subsequent GC/MS analysis. Water samples for extractable organics will be decanted from their containers so as to exclude settleable solids that would interfere with liquid/liquid extraction. Other samples will be mixed in a clean laboratory environment with non-contaminating spatulas or other suitable instruments.

Field preservation will be checked and documented upon sample analysis at the laboratory by the analytical staff.

Pace will analyze all samples within the holding times specified by the method.

4. Completeness

- The objective of this project can be addressed with a 90% completeness for the analysis of VOC in water.

5. Comparability

- In general, the results are expected to be reasonably similar to any VOC data collected from the same locations. To ensure this, the analytical methodology for this task will adhere to EPA SW-846 3rd edition and updates, method 8260.

Target Compound List Volatiles (soil)

1. Accuracy

- The presence of any analyte in the method blank is undesirable, although trace amounts of methylene chloride periodically occur, because of their use in other parts of the lab. Up to 5 times the reporting limit is allowed for this analyte. For all others, no compounds shall be present above the reporting limit.

- The Matrix Spike percent recoveries must be:

Compound Name	soil % recv
1,1-Dichloroethene	59-172
Trichloroethene	62-137
Benzene	66-142

Toluene	59-139
Chlorobenzene	60-133

- This method requires an initial 5 point calibration at 10, 20, 50, 100, and 200μg/L. Calibration criteria are outlined in the SOW. Two failures are allowed with the initial calibration providing that the minimum RF >0.01 and % RSD <40%. The 5 point calibration is performed when compliance cannot be met on a daily calibration or when a new internal or surrogate standard is made.

- The instrument calibration must be checked every 12 hours during which samples are being run. As with the initial calibration, the continuing calibration should be checked for compliance with criteria listed in the SOW. Two compounds may fail to meet minimum RF/maximum %D as long as RF >0.01 and %D <40%.

- The detection limit must be equal to or less than the reporting limits defined below.

	Soil Low (μg/Kg)	Soil Medium (μg/Kg)
Chloromethane	10	1200
Bromomethane	10	1200
Vinyl chloride	10	1200
Chloroethane	10	1200
Methylene chloride	10	1200
Benzene	10	1200
Toluene	10	1200
1,1-Dichloroethene	10	1200
Cholorbenzene	10	1200
Ethylbenzene	10	1200
Xylene (total)	10	1200
Chloroform	10	1200
Styrene	10	1200
1,1,1-Trichloroethane	10	1200
Carbon Tetrachloride	10	1200
Bromodichloromethane	10	1200
1,2-Dichloropropane	10	1200
cis-1,3-Dichloropropene	10	1200
trans-1,3-Dichloropropene	10	1200
Trichloroethene	10	1200
1,1,2-Trichloroethane	10	1200
Bromoform	10	1200
Acetone	10	1200
Carbon Disulfide	10	1200
2-Butanone	10	1200
4-Methyl-2-pentanone	10	1200
2-Hexanone	10	1200

1,2-Dichloroethane	10	1200
Dibromochloromethane	10	1200
Tetrachloroethene	10	1200
1,1,2,2-Tetrachloroethane	10	1200
1,1-Dichloroethane	10	1200
1,2-Dichloroethene	10	1200

2. Precision

- All matrix spike duplicates should have a relative percent difference (RPD) as listed below.

1,1-Dichloroethene	22
Trichloroethene	24
Benzene	21
Toluene	21
Chlorobenzene	21

The RPD for samples is advisory. If the results for a sample duplicate pair are positive and greater than five (5) times the PQL then the %D criteria are used. However, if the results for the duplicate pair are less than 5 times the PQL then the acceptance criteria will be +/- PQL or the %D criteria, whichever is greater. This criteria will be used for duplicate results that have a "ND" and a positive value. Of course, a duplicate that gives two ND values does not give any precision information and thus precision will not be used to judge the data's validity. Sample duplicates not meeting these criteria will be so qualified.

3. Representativeness

To insure that analyses reflect actual field conditions the laboratory will strive to maintain the integrity of the samples prior to and during analysis and to minimize the effects of the laboratory environment on the samples. To monitor effects of the laboratory environment, two types of blanks are used.

The first type is a trip blank which will consist of a volatile organic analysis vial filled by Pace with deionized, analyte-free water that will remain capped and accompany the sample VOA vials at all times. A trip blank may accompany all water VOA samples shipped to the laboratory. The trip blank indicates the effects of sample bottle preparation, shipment to the site, site storage and handling, return shipment, and sample holding at the laboratory on sample integrity.

The second type is a laboratory holding blank which consists of a volatile organics sample vial filled with analyte-free water and randomly placed with samples as received for storage prior to analysis. The holding blank serves to monitor the effects of sample bottle preparation and sample storage at the lab prior to and during analysis.

The laboratory will make every reasonable effort to assure that the samples are adequately mixed prior to taking aliquots for analysis, to insure that the reported results are representative of the sample received. It must be recognized that any means of mixing that exposes the sample to significant risk

of contamination or analyte loss through volatilization should be avoided. Soil samples for volatile organics are particularly vulnerable and will not be mixed. A sub sample will be quickly withdrawn for analysis.

Pace will analyze all samples as soon as possible and within the holding times specified by the analytical method.

4. Completeness

- The objective of this project can be addressed with a 90% completeness for the analysis of VOC in soil.

5. Comparability

- In general, the results are expected to be reasonably similar to any VOC data collected from the same locations. To ensure this, the analytical methodology for this task will adhere to USEPA SOW OLMO1.8.

Target Compound List Semivolatiles

1. Accuracy

- All blanks must be less than the CRQL (less than 5 Xs the CRQL for phthalate esters)

- The matrix spike percent recoveries should be:

	% water	%soil
Phenol	12-110%	26-90%
2-Chlorophenol	27-123%	25-102%
1,4-Dichlorobenzene	36-97%	28-104%
N-Nitroso-di-n-propyl Amine	41-116%	41-126%
1,2,4-Trichlorobenzene	39-98%	38-107%
4-Chloro-3-methylphenol	23-97%	26-103%
Acenaphthene	46-118%	31-137%
4-Nitrophenol	10-80%	11-114%
2,4-Dinitrotoluene	24-96%	28-89%
Pentachlorophenol	9-103%	17-109%
Pyrene	26-127%	35-142%

These limits are advisory. Corrective action is not required if the criteria is not met.

- The RRf values for both initial and continuing calibrations must be met as described in OLMO1.8.

- The maximum RSD must be less than 20.5% with allowances up to four BNA and surrogate compounds. The %RSD for the four compounds must be less than 40%. If this criteria is not met, then the calibration curve should be reanalyzed.

- For continuing calibration checks to be valid, the relative response factor for each compound must be less than 25% difference with the initial calibration. Up to four compounds may fail but they must be within 40%.

- The detection limit must be equal to or less than the OLMO1.8 contract required quantitation limits(CRQL). It should be noted that the detection limits for samples may be considerably higher depending on the sample matrix.

	Water (µg/L) CLP	Low soil (µg/Kg) CLP	Med soil (µg/Kg) CLP
Phenol	10	330	10000
bis(2-Chloroethyl)ether	10	330	10000
2-Chlorophenol	10	330	10000
1,3-Dichlorobenzene	10	330	10000
1,4-Dichlorobenzene	10	330	10000
1,2-Dichlorobenzene	10	330	10000
2-Methylphenol	10	330	10000
bis(2-Chloroisopropyl)ether	10	330	10000
4-Methylphenol	10	330	10000
N-Nitroso-di-n-dipropylamine	10	330	10000
Hexachloroethane	10	330	10000
Nitrobenzene	10	330	10000
Isophorone	10	330	10000
2-Nitrophenol	10	330	10000
2,4-Dimethylphenol	10	330	10000
bis(2-Chloroethoxy)methane	10	330	10000
2,4-Dichlorophenol	10	330	10000
1,2,4-Trichlorobenzene	10	330	10000
Naphthalene	10	330	10000
4-Chloroaniline	10	330	10000
Hexachlorobutadiene	10	330	10000
4-Chloro-3-methylphenol (para-chloro-meta-cresol)	10	330	10000
2-Methylnaphthalene	10	330	10000
Hexachlorocyclopentadiene	10	330	10000
2,4,6-Trichlorophenol	10	330	10000

2,4,5-Trichlorophenol	25	800	25000
2-Chloronaphthalene	10	330	10000
2-Nitroaniline	25	800	25000
Dimethylphthalate	10	330	10000
Acenaphthylene	10	330	10000
2,6-Dinitrotoluene	10	330	10000
3-Nitroaniline	25	800	25000
Acenaphthene	10	330	10000
2,4-Dinitrophenol	25	800	25000
4-Nitrophenol	25	800	25000
Dibenzofuran	10	330	10000
2,4-Dinitrotoluene	10	330	10000
Diethylphthalate	10	330	10000
4-Chlorophenyl-phenylether	10	330	10000
Fluorene	10	330	10000
4-Nitroaniline	25	800	25000
4,6-Dinitro-2-methylphenol	25	800	25000
N-nitrosodiphenylamine	10	330	10000
4-Bromophenyl-phenylether	10	330	10000
Hexachlorobenzene	10	330	10000
Pentachlorophenol	25	800	25000
Phenanthrene	10	330	10000
Anthracene	10	330	10000
Di-n-butylphthalate	10	330	10000
Fluoranthene	10	330	10000
Pyrene	10	330	10000
Butylbenzylphthalate	10	330	10000
3,3'-Dichlorobenzidine	10	330	10000
Benzo(a)anthracene	10	330	10000
Chrysene	10	330	10000
bis(2-Ethylhexyl)phthalate	10	330	10000
Di-n-octylphthalate	10	330	10000
Benzo(b)fluoranthene	10	330	10000
Benzo(k)fluoranthene	10	330	10000
Benzo(a)pyrene	10	330	10000
Indeno(1,2,3-cd)pyrene	10	330	10000
Dibenz(a,h)anthracene	10	330	10000
Benzo(g,h,i)perylene	10	330	10000

2. Precision

- All matrix spike and matrix spike duplicates should have a relative percent difference as listed below:

Compound	RPD water	RPD soil

Phenol	42%	35%
2-Chlorophenol	40%	50%
1,4-Dichlorobenzene	28%	27%
N-Nitroso-di-n-proyl Amine	38%	38%
1,2,4-Trichlorobenzene	28%	23%
4-Chloro-3-methylphenol	42%	33%
Acenaphthalene	31%	19%
2,4-Dinitrotoluene	38%	47%
Pyrene	31%	36%
Pentachlorophenol	50%	47%
4-Nitrophenol	50%	50%

The limits for matrix spike compound RPD are advisory. Corrective action investigation is warranted only when the limits consistently fail to be met.

3. Representativeness

To insure that analyses reflect actual field conditions the laboratory will strive to maintain the integrity of the samples prior to and during analysis and to minimize the effects of the laboratory environment on the samples.

The laboratory will make every reasonable effort to assure that the samples are adequately mixed prior to taking aliquots for analysis, to insure that the reported results are representative of the sample received. Water samples for extractable organics will be decanted from their containers so as to exclude settleable solids that would interfere with liquid/liquid extraction. Other samples will be mixed in a clean laboratory environment with non-contaminating spatulas or other suitable instruments.

Field preservation will be checked and documented upon sample receipt at the laboratory by the sample management staff.

Pace will analyze all samples as soon as possible and within the holding times specified by the analytical SOP.

The representativeness of the sampling technique is measured by the variability of values from the same sampling site.

4. Completeness

- The goal for completeness for this task is 90%.

5. Comparability

- The results are expected to be reasonably similar to any Semi Volatile data collected from the same locations. To ensure this, the analytical methodology for this task will adhere to USEPA CLP SOW

OLMO1.8.

Target Analyte List Metals and Boron

1. Accuracy

- Initial and continuing calibration verification results must be within 90-110% of the true value with the exception of mercury. The control limit for mercury is 80-120%.

- All blanks must give values not above the EPA CLP CRQL. Sample values >10 times the blank value or less than the detection limit will be reported without qualification.

- The ICP interference check sample must give results between 80-120% of the true value.

- The LCS results must give percent recoveries between 80-120%.

- Matrix Spike recoveries should be 75-125%. Data associated with matrix spiked recoveries out side of these limits will be flagged.

- AA post digestion spikes and Method of Standard Additions will be performed in compliance with ILMO2.0 including revision ILMO2.1.
- ICP serial dilution (5 fold) must be equal to or less than a 10% difference from the initial (undiluted) value if the diluted value is greater than the CRDL. The criteria does not apply to elements diluted to concentrations below their respective CRDL. If the dilution analysis for one or more analytes is not at or within 10%, a chemical or physical interference effect must be suspected, and the data for all affected analytes in the samples received associated with that serial dilution will be qualified.

- Reporting limits will be as follows.

Analyte	ug/L
Aluminum	200
Antimony	60
Arsenic	10
Barium	200
Beryllium	5
Cadmium	5
Calcium	5000
Chromium	10
Colbalt	50
Copper	25
Lead	3
Magnesium	5000
Manganese	15

Mercury	0.2
Nickel	40
Potassium	5000
Selenium	5
Silver	10
Sodium	5000
Thallium	10
Vanadium	50
Zinc	20
Boron	500

2. Precision

- Sample duplicate results should have a % difference of 20% or less. Data associated with sample duplicates with a greater than 20% difference when the results are greater than 10 times the CRDL will be flagged. When there are duplicate results less than 10 times the CRDL then the control limit is +/- CRDL.

3. Representativeness

To insure that analyses reflect actual field conditions the laboratory will strive to maintain the integrity of the samples prior to and during analysis and to minimize the effects of the laboratory environment on the samples.

The laboratory will make every reasonable effort to assure that the samples are adequately mixed prior to taking aliquots for analysis, to insure that the reported results are representative of the sample received. Prior to subsample removal for analysis samples will be homogenized for the analytical value to best represent the content of the sample as a whole.

4. Completeness

- The objective of this project can be addressed with 90% completeness for the analyses of Metals in water and soil.

5. Comparability

- The results are expected to be reasonably similar to any Metals data collected from the same locations. To ensure this, the analytical methodology for this task will adhere to ILMO2.0 including ILM02.1.

Target Compound List Pesticide/PCBs

1. Accuracy

- Target compounds must not be detected in the method blank above the contract required quantitation

limit and the surrogate retention times cannot be outside of the retention time windows calculated from the initial calibration for tetrachloro-m-xylene and decachlorobiphenyl.

- For an initial calibration sequence to be valid,the following criteria apply: Resolution between peak valley depths must be greater than or equal to 60% of the shorter peak in the resolution check standard.

- The breakdown of DDT and Endrin must be less than 20.0% and the combined breakdown must be less than 30.0% in the PEM standards.

- Chromatograms must meet scaling, baseline, and resolution requirements.
The % RSD of the calibration factors for each single component target compound must be less than or equal to 20.0%. Surrogates and two target compounds may be as great as 30.0%.

- The limits for matrix spike compound recovery are advisory.

The limits for matrix spike and matrix spike duplicate recovery are the following:

Compound	% Recovery Water	% Recovery Soil
gama-BHC	56-123	46-127
Heptachlor	40-131	35-130
Aldrin	40-120	34-132
Dieldrin	52-126	31-134
Endrin	56-121	42-139
4,4-DDT	38-127	23-134

- The detection limit must be equal to or less than the OLMO1.8 contract required quantitation limits(CRQL). It should be noted that the detection limits for samples may be considerably higher depending on the sample matrix. The CRQLs are as follows:

	water µg/L	soil µg/kg
alpha-BHC	0.05	1.7
beta-BHC	0.05	1.7
delta-BHC	0.05	1.7
gamma-BHC	0.05	1.7
Heptachlor	0.05	1.7
Aldrin	0.05	1.7
Heptachlor epoxide	0.05	1.7
Endosulfan I	0.05	1.7
Dieldrin	0.10	3.3
4,4'-DDE	0.10	3.3
Endrin	0.10	3.3
Endosulfan II	0.10	3.3
4,4'-DDD	0.10	3.3

Endosulfan sulfate	0.10	3.3
4,4'-DDT	0.10	3.3
Methoxychlor	0.50	17.0
Endrin ketone	0.10	3.3
Endrin aldehyde	0.10	3.3
alpha-Chlordane	0.05	1.7
gamma-Chlordane	0.05	1.7
Toxaphene	5.0	170.0
Aroclor-1016	1.0	33.0
Aroclor-1221	2.0	67.0
Aroclor-1232	1.0	33.0
Aroclor-1242	1.0	33.0
Aroclor-1248	1.0	33.0
Aroclor-1254	1.0	33.0
Aroclor-1260	1.0	33.0

2. Precision

- The limits for matrix spike and matrix spike duplicate compound RPD are advisory. Corrective action investigation is warranted only when the limits consistently fail to be met.

The limits for matrix spike and matrix spike duplicate precision are the following:

Compound	RPD water	RPD soil
gama-BHC	15	50
Heptachlor	20	31
Aldrin	22	43
Dieldrin	18	38
Endrin	21	45
4,4-DDT	27	50

3. Representativeness

To insure that analyses reflect actual field conditions the laboratory will strive to maintain the integrity of the samples prior to and during analysis and to minimize the effects of the laboratory environment on the samples.

The laboratory will make every reasonable effort to assure that the samples are adequately mixed prior to taking aliquots for analysis, to insure that the reported results are representative of the sample received. Water samples for extractable organics will be decanted from their containers so as to exclude settleable solids that would interfere with liquid/liquid extraction. Other samples will be mixed in a clean laboratory environment with non-contaminating spatulas or other suitable instruments.

Field preservation will be checked and documented upon sample receipt at the laboratory by the sample management staff.

Pace will analyze all samples within the holding times specified by the analytical SOP.

The representativeness of the sampling technique is measured by the variability of values from the same sampling site.

4. Completeness

The goal for completeness of this task is 90%.

5. Comparability

- The results are expected to be reasonably similar to any Pesticide PCB data collected from the same locations. To ensure this, the analytical methodology for this task will adhere to OLMO1.8.

TCLP Metals

1. Accuracy

- Elements of interest shall not be present above the detection limit in the method blank.

- Initial and continuing calibration verification results must be within 90-110% of the true value with the exception of mercury. The control limit for mercury is 80-120%.

- The ICP interference check sample must give results between 80-120% of the true value.

- The LCS results must give percent recoveries between 80-120%.

- Matrix Spike recoveries should be 75-125%. Data associated with matrix spiked recoveries out side of these limits will be flagged.

- Following are the method detection limit goals for TCLP metals. It should be noted that the detection limits for samples may be considerably higher depending on the sample matrix. Dilutions of at least a factor of 10 are expected for all potential furnace analyses. (Pb, As, Se, Ag, Cd, Cr)

Element	Concentration (mg/l)
Arsenic	0.05
Barium	2
Cadmium	0.005
Chromium	0.1
Lead	0.015
Selenium	0.05

Silver	0.1
Mercury	0.002

2. Precision

- Sample duplicate results should have a % difference of 20% or less. Data associated with sample duplicates with a greater than 20% difference when the results are greater than 10 times the detection limit will be flagged. When there are duplicate results less than 10 times the detection limit then the control limit is +/- detection limit.

3. Representativeness

- To insure that analyses reflect actual field conditions the laboratory will strive to maintain the integrity of the samples prior to and during analysis and to minimize the effects of the laboratory environment on the samples. The laboratory will make every reasonable effort to assure that the samples are adequately mixed prior to taking aliquots for analysis, to insure that the reported results are representative of the sample received. Prior to subsample removal for analysis samples will be homogenized for the analytical value to best represent the content of the sample as a whole.

4. Completeness

- The goal of completeness for this task is 90%.

5. Comparability

- The results are expected to be reasonably similar to any TCLP metals data collected from the same locations. To ensure this, the sample extraction methodology for this task will adhere to SW-846 Method 1311 as amended in the November 24, 1992 Federal Register (57 FR 55114). Extract analysis will adhere to SW846 3rd edition and updates. ICP or Furnace methods may be employed with the end goal being to meet the detection limit goals of the project.

Total Petroleum Hydrocarbons

1. Accuracy

- If the result does not fall below the minimum detection limit for this procedure, blank and associated samples must be re-extracted and re-analyzed.

- Calibration verification must agree within 20%. A new calibration curve is prepared if the check sample does not agree within 20%.

- Acceptable recoveries for matrix spike, matrix spike duplicates and Laboratory Control Samples are 50 - 150% of true value. LCSs falling outside of these limits, and associated samples, must be re-extracted.

- The method detection limit for Petroleum hydrocarbons is 60μg/g.

2. Precision

- Matrix spike and matrix spike duplicates should agree within 50 - 150%. If values do not agree, it is determined whether there is a matrix effect.

3. Representativeness

- To insure that analyses reflect actual field conditions the laboratory will strive to maintain the integrity of the samples prior to and during analysis and to minimize the effects of the laboratory environment on the samples. The laboratory will make every reasonable effort to assure that the samples are adequately mixed prior to taking aliquots for analysis, to insure that the reported results are representative of the sample received. Prior to subsample removal for analysis samples will be homogenized for the analytical value to best represent the content of the sample as a whole.

4. Completeness

- The goal for completeness for this project is 90%.

5. Comparability

- The results are expected to be reasonably similar to any TPH data collected from the same locations. To insure this analysis will adhere to EPA 600 method 418.1 (1978) with a soxhelet extraction.

Grain Size

1. Accuracy

- Not Applicable

2. Precision

A duplicate sample is analyzed at the rate of one (1) every 20 samples or every three months, whichever is more frequent. An acceptable relative range for each sieve is 30% if the sieve percentage is above 5% of wet weight. If the sieve percentage is below 5% of wet weight, this relative range convention is not acceptable.

3. Representativeness

- To insure that analyses reflect actual field conditions the laboratory will strive to maintain the integrity of the samples prior to and during analysis and to minimize the effects of the laboratory environment on the samples. The laboratory will make every reasonable effort to assure that the samples are adequately mixed prior to taking aliquots for analysis, to insure that the reported results are representative of the sample received. Prior to subsample removal for analysis samples will be

homogenized for the analytical value to best represent the content of the sample as a whole.

4. Completeness

- The goal of completeness for this task is 90%.

5. Comparability

- The results are expected to be reasonably similar to any grainsize data collected from the same locations. To insure this analysis will adhere to USEPA Procedures for Handling and Chemical Analysis of Sediment and Water Samples (Plumb 1981)

Chloride

1. Accuracy

- The instrument is calibrated with a ten point curve using the calibration standards above plus a DI water blank. Calibration is evaluated by 4 factors. These are slope, intercept, minimum valid absorbance, and the correlation coefficient.

- Matrix spikes are performed using the same sample as the duplicate. The sample is spiked with a known concentration of chloride. A recovery of 75-125% is expected from a sample with no matrix interferences.

- Laboratory Control Samples must yield a recovery of 80-120%

- Blanks should be less than the method detection limit for the method to be considered under control. They are run at a frequency of 1 per batch of samples. Samples with values less than 5Xs the value of the associated blank are rerun.

- The method detection limit for chloride is 1.0 mg/l.

2. Precision

Sample duplicates are run at a frequency of 5%. Duplicate values should agree within 20%.

3. Representativeness

- To insure that analyses reflect actual field conditions the laboratory will strive to maintain the integrity of the samples prior to and during analysis and to minimize the effects of the laboratory environment on the samples. The laboratory will make every reasonable effort to assure that the samples are adequately mixed prior to taking aliquots for analysis, to insure that the reported results are representative of the sample received. Prior to subsample removal for analysis samples will be homogenized for the analytical value to best represent the content of the sample as a whole.

4. Completeness

- The goal of completeness for this task is 90%.

5. Comparability

- The results are expected to be reasonably similar to any chloride data collected from the same locations. To insure this chloride will by analyzed by Flow injection analysis, LACHAT 10-117-07-1-A, EPA 600 method 325.1.

4.0 SAMPLING PROCEDURES

Field sampling will not be performed by PACE New England, Incorporated.

5.0 SAMPLE CUSTODY

Chain-of-Custody encompasses three major elements: the field sampling, the laboratory analysis and the final data file. This section will cover quality related activities from the receipt of samples at the laboratory through the issuance of final analytical data and the storage of data in its final data file.

5.1 Chain-of-Custody

The National Enforcement Investigations Center (NEIC) of EPA defines custody of evidence in the following manner:

1. It is in your actual possession, or

2. It is in your view, after being in your physical possession, or

3. It was in your possession and then you locked or sealed it up to prevent tampering, or

4. It is in a secure area.

Samples may be physical evidence and should be handled according to certain procedural safeguards.

Field personnel or Client representatives complete the Chain-of-Custody Forms. Samples are received by the laboratory accompanied by these forms. The Chain-of-Custody (COC) may be the means by which the courts, in some types of legal proceedings, require proof of custody of samples from time of receipt to completion of analysis.

The sampler should provide the following information:

- Client project name

- Project location

- Field sample number/identification
- Date and time sampled
- Sample type
- Preservative
- Analysis requested
- Sampler signature
- Signature of person relinquishing samples
- Date and time relinquished
- Sampler remarks
- Custody Seal Number

The record is filled out completely and legibly. Correction of errors is made by drawing a single line through and initialing and dating the error. The correct information is then recorded with indelible ink. All transfers of samples except to and from commercial couriers must be recorded on the Chain-of-Custody via the "relinquished" and "received by" sections. All information except signatures may be printed.

When samples are received into the laboratory the Sample Management Personnel will sign the Chain-of-Custody, verify their integrity as they are unpacked and will explicitly state in the receipt records whether the Chain-of-Custody seal is intact, whether the sample is received intact or broken, and whether the sample is appropriately identified. This information is documented on the Sample Receipt Condition Report. If the integrity requirements are met or when any discrepancies are resolved, the sample is assigned a laboratory identification number, the sample is stored in the appropriate refrigerator and the pertinent information is entered into the Laboratory Information Management System (LIMS). Once samples are in the laboratory, an Internal Custody Record is generated to track the transport and status of each sample within the laboratory. After sample log-in, the Chain-of-Custody record and all sample receipt documentation will be sent to the Reporting Department. Further detail on internal laboratory custody procedures is provided in subsequent subsections.

5.2 Sampling Kits

In general, sampling kits comprise the following:

- Sampling containers
- Preservatives (upon request)
- Chain-of-Custody forms

- Custody Seals (upon request)
- Sample labels
- Packing Material
- Shipping containers
- Ice Packs

Sample kit requests are received by the laboratory personnel (generally the Sample Custodian) from Client Services or sampling team members via telephone request, memo, or facsimile.

Based upon the specific request, the Sample Custodian determines the appropriate containers, preservatives and the necessary volume/quantity to specify for the analysis. This information is outlined in Tables 5-1.

On arrival at the laboratory, all samples will be inspected thoroughly to confirm that the integrity of the samples and containers have not been compromised. The temperature of the cooler will be recorded on the chain of custody accompanying the cooler. The cooler custody seals will be inspected to verify that they are still intact and were properly signed and dated by the sampler. The individual sample containers will also be inspected to verify that each has a sample tag or label. The condition of the samples will be noted on the sample receipt condition report.

The sample containers will be checked against the accompanying chain-of-custody to verify that the cooler contents are identical to the samples described on the chain-of-custody documents. If discrepancies exist, the sample custodian will immediately contact Mr. Bronson who will notify the Atlantic Project Manager of the problem.

The samples will be placed in refrigerated (4°C) storage until they are taken for preparation or analyses.

Internal chains of custody (ICOC's) will be initiated by the laboratory sample custodian to account for each sample and to track its progress through the analytical process. As samples are taken from the sample custodian, the sample technician will sign the ICOC. On return of unused sample to the sample custodian for storage, the ICOC will again be annotated to indicate the transfer of custody. When the sample is exhausted, the ICOC will be noted as such.

TABLE 5-1
PRESERVATION AND HOLDING TIME REQUIREMENTS

Parameter	Required Volume & Containers	Preservation	Holding[1] Time (in days)
Organics:			
Volatile Organic Compounds	3 40ml VOA vial(water) 1 125ml glass (soil)	4°C (±2°C) HCl; pH <2	10 days
Semi Volatile Organic Compounds	1 125ml glass (soil)	2 L (water)	4°C (±2°C)5 days to extract (waters) 10 to extract (soils) 40 from start of extraction to analysis
Pesticides/Arochlors	2 L (water) 125 ml glass (soil)	4°C (±2°C)	5 to extract (waters) 10 to extract (soils) 40 from start of extraction to analysis
TAL Metals plus Boron Hg	50 ml glass (water) 10 g	HNO_3 pH<2 4°C	180 days 26 days
Total Cyanide	1000ml glass (water) 40 g	NaOH pH>12 4°C	12 days
Grainsize	100g	4°C	N/A
Chloride	10ml 20g	4°C	26 days
Total Petroleum Hydrocarbons	1000ml amber glass 30g	H_2SO_4 pH<2 4°C	26 days

PLEASE NOTE: ALL SAMPLE CONTAINERS SHOULD BE FILLED TO MAXIMUM CAPACITY
[1]Holding time begins at time of receipt at laboratory.

6.0 CALIBRATION PROCEDURES AND FREQUENCY

6.1 General

Calibration standards for each parameter are chosen to bracket the expected concentrations of those parameters in the sample, and to operate within the linear response range of the instrument. Samples that fall outside of the calibration range are diluted until bracketed by the calibration standards. Calibration standards are prepared typically at a minimum of three concentration levels, usually chosen at two times, three to five times, and five to ten times the estimated method detection limit plus a calibration blank. Either an internal standard or external standard quantification technique can be utilized.

Calibration standards are prepared from materials of the highest available purity. To establish instrument calibration, working standards are prepared from more concentrated working stock solutions. All organic standards are refrigerated or frozen. Inorganic standards are refrigerated as necessary. Data regarding their preparation is recorded in the each laboratory sections' Standards Notebook.

Instrumental responses to calibration standards for each parameter are subjected to an appropriate statistical test of fitness (least squares linear regression, quadratic equation, or relative standard deviation of response factors). The calibration must reflect an acceptable correlation of data points (correlation coefficient of at least 0.99), or linearity (<35% RSD) to be acceptable. In cases where the calibration data are outside of these criteria, the analyst must rerun the calibration standards (meeting the same criteria), changing instrumental conditions as necessary.

For analyses which are performed frequently and for which substantial calibration data is available, a complete recalibration is not required each time an analysis is performed providing that the following criterion is met: one calibration standard is analyzed at the beginning of the analysis which may vary from the expected response (based on the initial, most recent calibration curve) by no more than $\pm 25\%$ or as specified by the method or QAPP. If this criterion is not met, a complete recalibration is necessary.

During the course of analysis, calibration standards are routinely analyzed to ensure that the instrumental response has not changed. Again the criterion stipulated in each method for expected response is used by the analyst to determine whether the instrument must be recalibrated or the instrument conditions further optimized.

The accuracy of prepared standards is periodically checked by comparison with a standard from an independent source.

Certain pieces of equipment such as balances, pH meters, and turbidity meters are normally calibrated with NIST traceable standard reference material.

6.2 Specific Procedures

Calibration procedures and frequencies for analytical instrumentation are discussed in Section 7 and in the methods referenced in Table 7-1.

7.0 ANALYTICAL PROCEDURES

Analytical procedures shall conform to USEPA CLP SOW OLMO1.8 and ILMO2.0(including revision ILMO2.1), USEPA SW-846 Third Edition and updates, EPA 600/4-79-020, and ASTM.

Methods for volatile soil analyses, semivolatiles, pesticides, PCBs, metals (including boron) and cyanide are taken from USEPA CLP SOW (OLM01.8 and ILM02.0(including ILMO2.1)). Methods for volatiles (water) and TCLP metals are taken from SW-846 Third edition and updates. Methods for TPH-IR will be from EPA 600/4-79-020 418.1 with a soxhlet extraction procedure. Methods for grain size will be from Plumb 1981. Dioxins will be performed using USEPA CLP SOW DFLM01.0 as modified by SAS-Dioxin-002 August, 1992 by Triangle Laboratories in Houston Texas.

The following is a description of the overall quality control samples and checks which will be incorporated into the methods utilized for the analyses of soil and water samples associated with the site. General laboratory quality control procedures, such as balance calibration and maintenance and glassware cleaning are described in the PACE Quality Assurance Plan.

7.1 Sample Analysis

Selection of the analytical parameters of interest for each sampling site has been done by Atlantic Environmental Services.

7.1.1 Volatile Organic Compounds

Volatile Organic Compounds in water will be analyzed following U.S. EPA SW-846 "Test Methods for Evaluating Solid Waste - Physical/Chemical Methods" Third edition and updates method 8260. Volatile Organic Compounds in soil will be analyzed following U.S. EPA SOW OLMO1.8. Samples for VOC's will be analyzed within ten (10) days of verified time of sample receipt (VTSR). Further details and additional procedures are described in the analytical methods cited in Table 7-1. Target analytes will include the EPA Contract Laboratory Program Target Compound List VOCs. Detection limits will be as defined in section 3.0.

- Tuning - The GC/MS System will be tuned to meet the EPA acceptance criteria for BFB (bromofluorobenzene), as required by the method, each day prior to instrument calibration or every twelve hours of analysis time.

- Calibration for 8260 - The GC/MS System will be calibrated at a minimum of five concentrations of each parameter to be analyzed in the samples. One of the concentrations of each compound will be slightly above the method detection limit. The

other four concentrations will correspond to the linear range of the instrument or the expected range of concentrations in the samples, but also within the linear range. Daily calibration is not necessary if the daily check standard validates the initial calibration curve, as per the method.

- Calibration Check for 8260 - Each day of sample analysis, after the GC/MS performance tests have been conducted, calibration check standards will be analyzed to confirm the validity of the original calibration. If the response to a calibration check standard differs from the initial calibration by more than $\pm$ 25%, then investigation and corrective action will be performed, including a complete recalibration, if necessary. Sample analyses will not be resumed until this criterion is met. The calibration check compounds are described in the method.

- Calibration for OLMO1.8 - This method requires an initial 5 point calibration at 10, 20, 50, 100, and 200μg/L. Calibration criteria are outlined in the SOW. Two failures are allowed with the initial calibration providing that the minimum RF $>$0.01 and % RSD $<$40%. The 5 point calibration is performed when compliance cannot be met on a daily calibration or when a new internal or surrogate standard is made.

- Continuing Calibration for OLMO1.8 - The instrument calibration must be checked every 12 hours during which samples are being run. As with the initial calibration, the continuing calibration should be checked for compliance with criteria listed in the SOW. Again, two compounds may fail to meet minimum RF/maximum %D as long as RF $>$0.01 and %D $<$40%.

- Internal Standards - Prior to injection, representative compounds, similar to, but not those being analyzed for, are injected into each GC/MS extract. These standards are also injected into the calibration standards. They are used to more accurately determine analyte concentration by normalizing the response to the amount of internal standard injected to 100 percent. The internal standards to be used and the spiking level for each standard are specified in the EPA method.

- Surrogates - Surrogate compounds representing the classes of compounds of interest but different than those being analyzed will be spiked into every sample prior to extraction. The recovery of the surrogates will be used to assess each sample's matrix effects. Specific compounds and acceptable recovery limits are listed in Table 7.2.

- Soil Blanks - A medium soil blank is made up of 4.0g VOA free sand + 9ml MeOh + 1ml surrogate. Its purpose is to identify any contamination in the methanol used to prepare a soil sample for purging, or anything in the sample preparation process. Allowable contamination levels are the same as those for reagent water blanks.

  A low soil blank functions much the same way as a water blank in that it serves as an indicator of contamination of the analytical apparatus, of the water used in the procedure (to disperse the soil). Ideally, a purified solid would also be used in the blank to mimic

the behavior of a 5 gram soil sample. As of yet, no purified solid has been identified which does not introduce its own matrix effects. Therefore 5 mls of water are used for low soil blanks. A low soil blank must be free of contamination above the CRQL, except acetone, methylene chloride and 2-butanone, which may be present up to 5X the CRQL.

- Method Blanks - At least one method blank for every twenty samples will be analyzed to detect possible interferences introduced in the laboratory. For volatiles analyses, a method blank will be analyzed prior to sample analyses each day. An acceptable method blank will not contain any target compounds above the detection limit (above 5 time the detection limit for methylene chloride, acetone, toluene, and 2-butanone).

- Trip Blanks - Each package or cooler containing VOA vials sent to the site from the laboratory will contain a trip blank consisting of two VOA vials filled with organic-free water. The blanks will remain in the cooler during sample collection and will accompany the samples back to the laboratory. The blanks will then be logged-in and stored with the associated samples.

- Holding Blanks (OLMO1.8) - These blanks are designed to identify any blank contamination problems which have occurred during storage of the sample at the lab. A holding blank is simply reagent water which is put into a VOA vial, and then stored with a particular sample set in the VOA refrigerator. One holding blank is analyzed per SDG. If any analytes above the detection limit are found in a holding blank, all samples stored with that blank should be checked for that contaminant, and the data qualified as necessary.

- Matrix Spikes - At least one fortified sample for every twenty field samples will be prepared by spiking a sample aliquot with known quantities of the compounds being analyzed at concentrations within the range of concentrations expected in the samples. The fortified sample will be extracted and analyzed to assess the accuracy of the analytical method for that matrix. To ensure that adequate sample volume is available to the laboratory for the matrix spikes and matrix spike duplicates, replicate and triplicate sets of sample containers will be filled with sample for every twenty field samples. The additional sets of containers must be labeled with the field identification and "For Matrix Spike Samples". Compounds and acceptable recovery limits are listed in Table 7.2.

- Matrix Spike Duplicate - Another aliquot of the sample chosen as the matrix spike will be fortified with the same parameters and at the same concentration, carried through the full sample preparation and analysis procedure and together with the matrix spike results used to assess the precision of the analytical method performed. Acceptance criteria are listed on Table 7-2.

TABLE 7-1

ANALYTICAL METHOD REFERENCES

PARAMETER	METHOD NUMBER	REFERENCE
Volatile Organics	8260 USEPA SOW OLMO1.8	1 3
Semivolatiles, Pesticides/PCBs	USEPA CLP SOW OLM01.8	3
TAL Metals and Boron, Cyanide	USEPA CLP SOW ILM02.0	4
TCLP Metals	1311/6010	1
Total Petroleum Hydrocarbons, IR	418.1	2
Chloride	325.1	2
Grain Size	ASTM	5
Dioxins	USEPA CLP SOW DFLMO1.0	6

1 Test Methods for Evaluating Solid Waste Physical/Chemical Methods, SW-846, US EPA Office of Solid Waste and Emergency Response, 3rd edition, 1986 and updates.

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

3 USEPA Contract Laboratory Program Statement of Work for Organic Analysis, OLMO1.8

4 USEPA Contract Laboratory Program Statement of Work for Inorganic Analysis, ILMO2.0 including ILMO2.1 rev.

5 American Society for Testing Materials, D422

6 USEPA Contract laboratory Program Statement of Work for Dioxin Analysis, DFLMO1.0 as modified by SAS-Dioxins-002, August, 1992.

TABLE 7-2
QUALITY CONTROL CRITERIA FOR ORGANIC ANALYSES

Parameter	Type	Frequency	Compounds	Performance Criteria	
WATER					
Volatiles	Method blank	1/20 or 1/batch	---	± D.L.	
(8260)	Surrogate spike	every sample	$D_4$1,2-dichloroethane	76 to 114%	
			BFB	86 to 115%	
			D_8-toluene	88 to 110%	
				Recovery	RPD
	Matrix Spike/Matrix Spike duplicate	1/20 or 1/batch	Benzene	76 to 127%	11
			1,1-dichloroethene	61 to 145%	14
			Trichloroethene	71 to 120%	14
			Chlorobenzene	75 to 130%	13
			Toluene	76 to 125%	13
	Calibration check	every 12 hours		≤ 25% difference	
	Laboratory Control Sample	1/20 or 1/batch	See Matrix Spike	See Matrix Spike	
Base/neutral Acid compounds	Method blank	1/20 or 1/batch	---	± D.L.	
	Surrogate spike	every sample	D_5 -phenol	10 to 110%	
			2-fluorophenol	21 to 110%	
			2,4,6-tribromophenol	10 to 123%	
			D_5-nitrobenzene	35 to 114%	
			2-fluorobiphenyl	43 to 116%	
			D_{14}-terphenyl	33 to 141%	
			2-chlorophenol-d4 (advisory) 33 to 110%		
			1,2-dichlorobenzene-d4 (")	16 to 110%	
				Recovery	RPD
	Matrix Spike Matrix Spike Duplicate	1/20 or 1/batch	Phenol	12 to 110%	42
			2-chlorophenol	27 to 123%	40
			1,4-dichlorobenzene	36 to 97%	28
			N-nitrosodipropylamine	41 to 116%	38
			1,2,4-trichlorobenzene	39 to 98%	28
			4-chloro-3-methylphenol	23 to 97%	42
			Acenaphthene	46 to 118%	31
			2,4-dinitrotoluene	24 to 96%	38
			4-nitrophenol	10 to 80%	50
			Pentachlorophenol	9 to 103%	50
			Pyrene	26 to 127%	31
	Calibration check	every 12 hours		≤25% difference from	

				min. RRFs for majority of target analytes
Pesticides & Aroclors	Method blank	1/20 or 1/batch	---	± D.L.
	Instrument Blank	every 12 hours		
	Surrogate spike	every sample	TCX (advisory)	60 to 150%
			DCB (advisory)	60 to 150%
				Recovery RPD
	Matrix Spike	1/20 or 1/batch	Lindane	56 to 123% 15
	Matrix Spike Duplicate		Heptachlor	40 to 131% 20
			Aldrin	40 to 120% 22
			Dieldrin	52 to 126% 18
			Endrin	56 to 121% 21
			4,4-DDT	38 to 127% 27
	Calibration check	every 12 hours		PEMs - ≤25 %D ≤20% breakdown INDs - ≤25 %D
SOIL				
Volatiles	Method blank	1/20 or 1/batch	---	+ D.L.
	System monitoring compound spike recovery	every sample	$D_4$1,2-dichloroethane	70 to 121%
			BFB	59 to 113%
			D_8-toluene	84 to 138%
				Recovery RPD
	Matrix Spike Matrix spike duplicate Sample	1/20 or 1/batch	Benzene	66 to 142% 21
			1,1-dichloroethene	59 to 172% 22
			Trichloroethene	62 to 137% 24
			Chlorobenzene	60 to 133% 21
			Toluene	59 to 139% 21
	Calibration check	every 12 hours		< 25% difference from min. RRFs for the majority of target analytes
Base/Neutral Acid compounds	Method blank	1/20 or 1/batch	---	± D.L.
	Surrogate spike	every sample	D_5 -phenol	24 to 113%
			2-fluorophenol	25 to 121%
			2,4,6-tribromophenol	19 to 122%
			D_5-nitrobenzene	23 to 120%
			2-fluorobiphenyl	30 to 115%
			D_{14}-terphenyl	18 to 137%

			2-chlorophenol-d4 (advisory)	20 to 130%	
			1,2-dichlorobenzene (*)	20 to 130%	
				Recovery	RPD
	Matrix Spike				
	Matrix Spike Duplicate	1/20 or 1/batch	Phenol	26 to 90%	35
	Sample		2-chlorophenol	25 to 102%	50
			1,4-dichlorobenzene	28 to 104%	27
			N-nitrosodipropylamine	41 to 126%	38
			1,2,4-trichlorobenzene	38 to 107%	23
			4-chloro-3-methylphenol	26 to 103%	33
			Acenaphthene	31 to 137%	19
			2,4-dinitrotoluene	28 to 89%	47
			4-nitrophenol	11 to 114%	50
			Pentachlorophenol	17 to 109%	47
			Pyrene	35 to 142%	36
	Calibration check	every 12 hours		≤25% difference from min. RRFs for the majority of target analytes	
Pesticides & Aroclors	Method blank	1/20 or 1/batch	---	± D.L.	
	Instrument Blank	every 12 hours			
	Surrogate spike	every sample	TCX (advisory)	18 to 150%	
			DCB (advisory)	60 to 150 %	
				Recovery	RPD
	Matrix Spike	1/20 or 1/batch	Lindane	46 to 127%	50
	Matrix Spike Duplicate		Heptachlor	35 to 130%	31
			Aldrin	34 to 132%	43
			Dieldrin	31 to 134%	38
			Endrin	42 to 139%	45
			4,4-DDT	23 to 134%	50
	Calibration check	every 12 hours		PEMs - ≤25 %D; ≤20% breakdown INDs - ≤25 %D	

TABLE 7-3
QUALITY CONTROL CRITERIA FOR METALS AND GENERAL CHEMISTRY ANALYSES

Soil and Water

Parameter	Type	Frequency	Performance Criteria
ICP Metals	Calibration Blank	every calibration	± D.L.
	Calibration verification	every calibration	90 to 110%
	Continuing calibration verification	1/10 samples	90 to 110%
	Method blank	1/20 or 1/batch	± D.L.
	Matrix spike	1/20	75 to 125%
	Sample duplicate	1/20	follows protocol (± DL/20% RPD)
	Lab control sample	1/20 or 1/batch	80 to 120% or vendor specified for soil
	Continuing calibration blank	1/10 samples	± CRDL
Furnace AA	Calibration blank	every calibration	± D.L.
	Calibration verification	every calibration	90 to 110%
	Continuing calibration verification	1/10 samples	90 to 110%
	Method blank	1/20 or 1/batch	± D.L.
	Matrix spike	1/20	75 to 125%
	Analytical spike	every sample	85 to 115%
	Sample duplicate	1/20	follows protocol (±DL/20% RPD)
	Lab control sample	1/20 or 1/batch	80 to 120% or vendor specified for soil
	Continuing calibration blank	1/10 samples	± CRDL
	Duplicate injections	every sample and standard	± 20% RSD
Cold Vapor AA (mercury)	Calibration blank	every calibration	± D.L.
	Calibration verification	every calibration	80 to 120%
	Continuing calibration verification	1/10 samples	80 to 120%
	Continuing calibration blank	1/10 samples	± CRDL
	Method blank	1/20 or 1/batch	± D.L.
	Matrix spike	1/20	75 to 125%
	Sample duplicate	1/20	follows protocol (± DL/20% RPD)
	Lab control sample	1/20 or 1/batch	80 to 120% or vendor specified

TABLE 7-3 (continued)
QUALITY CONTROL CRITERIA FOR METALS AND GENERAL CHEMISTRY ANALYSES

Soil and Water

Parameter	Type	Frequency	Performance Criteria
Total Cyanide	Calibration blank	every calibration	± CRDL
	Calibration Verification (LCS)	every calibration	85 to 115%
	Continuing calibration verification	1/10 samples	85 to 115%
	Continuing calibration blank	1/10 samples	± CRDL
	Method blank	1/20 or 1/batch	± CRDL
	Sample duplicate	1/20 or 1/SDG	follows protocol (±20% RPD/± 10 ppb)
	Matrix Spike	1/20 or 1/SDG	75 to 125%
Chloride	Calibration blank	every calibration	± D.L.
	Calibration verification	every calibration	85 to 115%
	Continuing calibration verification	1/10 samples	85 to 115%
	Method blank	1/20 or 1/batch	± D.L.
	Sample duplicate	1/20 or 1/batch	± 30% RPD
	Matrix Spike	1/20 or 1/SDG	75 to 125%
Grain Size	Duplicate	1/20 or 1/SDG	N/A
TPH-IR	Calibration blank	every calibration	± D.L.
	Calibration verification	every calibration	85 to 115%
	Continuing calibration verification	1/10 samples	85 to 115%
	Method blank	1/20 or 1/batch	± D.L.
	Matrix Spike/Spike duplicate	1/20 or 1/SDG	75 to 125%/30% RPD

7.1.2 Semi-Volatile Organic Compounds

SVOCs will be analyzed in groundwater and soil following USEPA CLP SOW OLMO1.8. All soil samples will be extracted within 10 days of VTSR and analyzed within 40 days of extraction. Water samples will be extracted within 5 days of VTSR and analyzed within 40 days of extraction. Further details and additional procedures are described in the analytical methods cited in Table 7-1. Target analytes will include the EPA CLP Target Compound List. Detection limits will be as stated in the Section 3.

- Tuning - The GC/MS System will be tuned to meet the EPA acceptance criteria for DFTPP (decafluorotriphenylphosphine) as required by the method, each day prior to instrument calibration or every twelve hours of analysis time.

- Calibration - The GC/MS System will be calibrated at a minimum of five concentrations of each parameter to be analyzed in the samples. One of the concentrations of each compound will be slightly above the method detection limit. The other four concentrations will correspond to the linear range of the instrument or the expected range of concentrations in the samples, but also within the linear range. Daily calibration is not necessary if the daily check standard validates the initial calibration curve, as per the method.

- Calibration Check Standard - Each day of sample analysis, after the GC/MS performance tests have been conducted, calibration check standards will be analyzed to confirm the validity of the original calibration. If the response to a calibration check standard differs from the initial calibration by more than $\pm$ 25% then investigation and corrective action will be performed, including a complete recalibration, if necessary. Sample analyses will not be resumed until this criterion is met. The calibration check compounds are described in the method.

- Internal Standards - Prior to injection, representative compounds, similar to, but not those being analyzed for, are injected into each GC/MS extract. These standards are also injected into the calibration standards. They are used to more accurately determine analyte concentration by normalizing the response to the amount of internal standard injected to 100 percent. The compounds to be used as internal standards and the spiking level of each are specified in the method.

- Surrogates - Isotope-labeled surrogate compounds representing the classes of compounds of interest but different than those being analyzed will be spiked into every sample prior to extraction. The recovery of the surrogates will be used to assess each samples' matrix effects. Specific compounds, spiking levels, and acceptable recovery limits are listed on Table 7-2. If laboratory control sample surrogate recoveries are within acceptance criteria, samples with surrogate recoveries outside control limits will be considered to have a matrix problem. No reanalysis will be required, but the data will be qualified in the narrative.

- Method Blanks - At least one method blank for every twenty samples will be extracted and analyzed to detect possible interferences introduced in the laboratory. An acceptable method

blank must not contain any target compounds above the detection limit (above 5 times the detection limit for phthalate esters).

- Matrix Spikes - At least one fortified sample for every twenty field samples will be prepared by spiking an aliquot of the field sample with known quantities of the compounds being analyzed at concentrations within the range of concentrations expected in the samples. The fortified sample will be extracted and analyzed to assess the accuracy of the analytical method for that matrix. To ensure that adequate sample volume is available to the laboratory for the matrix spike sample in water, a second 1-liter must be collected once for every twenty field samples. The sample must be identified with the field ID and "For Matrix Spike Sample". Compounds and acceptable recovery limits are listed on Table 7-2.

- Matrix Spike Duplicate - Another aliquot of the sample chosen as the matrix spike will be fortified with the same parameters and at the same concentration, carried through the full sample preparation and analysis procedure and together with the matrix spike results used to assess the precision of the analytical method performed. A third 1-liter sample volume must be collected for the matrix spike duplicate in water once for every twenty field samples. It must also be identified with the field ID and "For Matrix Spike Duplicate Samples".

7.1.3 TCLP Metals

The analytical methods to be followed for the extraction and analyses of the 8 TCLP metals in soil are described in the US EPA SW-846 "Test Methods for Evaluating Solid Waste - Physical/Chemical Methods" Third edition and updates method 1311. ICP spectroscopy will be used for the determination of Barium, Cadmium, Chromium, silver, Lead, Arsenic and Selenium. Graphite furnace atomic absorption spectroscopy will be used for determination only in the event that project specific detection limits cannot be met by ICP. Mercury will be analyzed by cold vapor generation atomic absorption spectroscopy. All analyses will be performed in strict accordance with the methods. This includes:

- Calibration - The analytical system will be calibrated daily, or every time the instrument is set up. For GFAA analyses this will entail a 3 point calibration and a blank. The ICP will be calibrated using a single point calibration standard, a blank, and a linear range standard. Calibration for Mercury will consist of 4 standards and a blank. The concentrations will define the linear operating range of the instrument or analysis.

- Calibration Verification Standards - Immediately after each analytical system has been calibrated, the accuracy of the initial calibration will be verified by the analysis of an independently derived check standard for every analyte. To ensure calibration accuracy during the analytical run, a continuing calibration verification standard must be analyzed for every analyte at a frequency of 10% or every two hours, whichever is more frequent. If the initial or continuing calibration verification standard differs from the initial calibration by

more than +10% (+20% for mercury), then the system will be recalibrated.

- ICP Interference Check Sample - To verify interelement and background correction factors, an ICP interference check sample must be analyzed an reported at the beginning and end of each analysis run or a minimum of twice per every 8 hours. The elements and concentrations used in the sample are described in the method. The results for the ICP analyses of the sample must fall within ± 20% of the true value for the analytes included in the sample.

- Method Blank - At least one method blank for every twenty samples will be extracted, digested and analyzed to detect possible interferences introduced in the laboratory. An acceptable method blank should contain no elements of interest above the detection limit. Samples with concentrations less than 10Xs the value of a contaminated blank will be rerun.

- Matrix Spikes - At least one fortified sample for each waste type as defined by the client will be prepared by spiking an aliquot of TCLP extract with known quantities of the parameters being analyzed at concentrations within the range of concentrations expected in the samples. The fortified sample will be extracted and analyzed to assess the accuracy of the analytical method for that matrix. There are no acceptance criteria for TCLP Matrix Spikes. Digests will be spiked at a frequency of 1/20 samples analyzed.

- Laboratory Control Samples (LCS) - LCSs for TCLP metals samples consist of aliquots of de-ionized water spiked with analytes of interest. These LCSs are carried through the digestion and analysis phases and provide an estimate of bias based on recovery of the compounds from a clean, control matrix.
  If LCS recoveries are within acceptance criteria, samples with spike recoveries outside control limits will be considered to have a matrix problem, not a data quality problem.

- Analytical Spikes - For each sample matrix a known amount of standard will be added post digest and analyzed to verify that neither positive nor negative interferences are present.

7.1.4 Chloride

Chloride will be analyzed by flow injection analysis, method 325.1 from EPA Methods for the Chemical Analysis of Water and Wastes, EPA-600/4-79-020, revised 1983. Further details and additional procedures are described in the analytical method cited in Table 7-1. The method referenced provides a complete description of the procedures to be followed.

- Calibration - The Lachat Auto Analyzer will be calibrated daily, or every time the instrument is set up.

- Calibration Check Standards - Immediately after the analytical system has been calibrated, the accuracy of the initial calibration will be verified by the analysis of an independently derived check standard. To ensure calibration accuracy during the analytical run, a check standard must be analyzed at a frequency of 10% or every two hours, whichever is more frequent. If the initial or continuing calibration check standard differs from the initial calibration by more than $\pm$ 10%, then the system will be recalibrated.

- Method Blank - At least one method blank for every twenty samples analyzed to detect possible interferences introduced in the laboratory. If Chloride is detected in the method blank more than 5Xs the method detection limit (MDL), the source of the contamination will be investigated and corrected. Reanalysis of the method blank and the samples associated with the method blank will occur.

- Sample Duplicates - Duplicates are run at a rate of 1/20 or 1/SDG. Two aliquots of a field sample will be carried through the analysis procedure and together will be used to assess the precision of the analytical method performed. The relative percent difference between duplicates should be within $\pm$ 20%.

- Laboratory Control Sample - A QC check sample of known composition spiked with a known amount of chloride will be used to monitor method performance exclusive of matrix interferences. Recoveries for Laboratory Control Samples (LCS) should be within 80 - 120% of expected value.

- Matrix Spikes - At least one matrix spike will be performed at a rate of 1/20 or 1/SDG. Field samples will be fortified with spiking solution as assigned in the field with known quantities of chloride at a concentration within the linear range of concentrations expected in the samples. Matrix spike recoveries are anticipated to be 75-125%. Recoveries outside of this range will be investigated to determine whether the low or high recoveries are a result of matrix effect.

7.1.5 Total Petroleum Hydrocarbons - Infra Red

The analytical method to be followed for the analysis of TPH in water is described in EPA 600/4-88/039 method 418.1 including a 1 - 1 soxhlet extraction procedure. All samples will be analyzed within 26 days of VTSR. Further details and additional procedures are described in the analytical method cited in Table 7-1. The method referenced provides a complete description of the procedures to be followed but briefly, the following will be employed:

- Calibration Check Standards - Immediately after the analytical system has been calibrated, the accuracy of the initial calibration will be verified by the analysis of an independently

derived check standard. To ensure calibration accuracy during the analytical run, a check standard must be analyzed at a frequency of 10% or every two hours, whichever is more frequent. If the initial or continuing calibration check standard differs from the initial calibration by more than ±20%, then the system will be recalibrated.

- Method Blank - At least one method blank for batch samples will be extracted and analyzed to detect possible interferences introduced in the laboratory. If any contamination is detected in the method blank above the method detection limit (MDL), but less than 5 times the MDL, then the data will be flagged and the source of the problem investigated for future work. If contamination in the method blank exceeds 5 times the MDL, reanalysis the method blank and the samples associated with the method blank is required.

- Matrix Spike/Matrix Spike Dup - Field samples will be fortified with spiking solution as assigned in the field with known quantities of petroleum hydrocarbons at a concentration within the linear range of concentrations expected in the samples. Matrix spike recoveries are anticipated to be 50 - 150%. Recoveries outside of this range will be investigated to determine whether the low or high recoveries are a result of matrix effect.

7.1.6 Grain Size

The analytical method to be followed is described in ASTM method D422 and includes:

- Sample Duplicates - One duplicate analysis will be performed at a rate of 1/20 or 1/SDG. Control limits for each sieve is ± 30% if each sieve contains 5% or more of the total sample weight. If a sieve contains less than 5% of the total sample weight, the control limits do not apply. For samples that exceed the control limits, reanalysis of that sample is required.

7.1.7 TAL Metals plus Boron

The analytical methods to be followed for metals are described in USEPA SOW ILMO2.0 (including ILMO2.1). Target analytes will include the 23 TAL elements in the CLP statement of work ILMO2.0 plus boron. Furnace atomic absorption spectroscopy will be used as required to achieve the CRDL. Mercury will be analyzed by cold vapor generation atomic absorption spectroscopy. Reporting of boron will follow CLP SOW procedures and will be treated as an additional TAL metal. All remaining metals will be analyzed by ICP spectroscopy. All analyses will be performed in accordance with the methods. This includes:

- Calibration - The analytical system will be calibrated daily, or every time the instrument is set up. For GFAA analyses this will entail a 3 point calibration and a blank. The ICP will be calibrated using a single point calibration standard, a blank, and a linear range standard. Calibration for Mercury will consist of 4 standards and a blank. One of the concentrations of each parameter will be slightly above the method detection limit. The other

concentrations will define the linear operating range of the instrument or analysis.

- Calibration Verification Standards - Immediately after each analytical system has been calibrated, the accuracy of the initial calibration will be verified by the analysis of an independently derived check standard for every analyte. To ensure calibration accuracy during the analytical run, a continuing calibration verification standard must be analyzed for every analyte at a frequency of 10% or every two hours, whichever is more frequent. If the initial or continuing calibration verification standard differs from the initial calibration by more than +10% for target compound list metals or +20% for mercury , then the system will be recalibrated.

- ICP Interference Check Sample - To verify interelement and background correction factors, an ICP interference check sample must be analyzed an reported at the beginning and end of each analysis run or a minimum of twice per every 8 hours. The elements and concentrations used in the sample are described in the method. The results for the ICP analyses of the sample must fall within $\pm$ 20% of the true value for the analytes included in the sample.

- Method Blank - At least one method blank for every twenty samples will be digested and analyzed to detect possible interferences introduced in the laboratory. An acceptable method blank should contain no elements of interest above the detection limit. Samples associated with blanks greater than 10Xs the detection limit will be reanalyzed.

- Matrix Spikes - At least one fortified sample for every twenty field samples will be prepared by spiking a sample aliquot with known quantities of the parameters being analyzed at concentrations within the range of concentrations expected in the samples. The fortified sample will be extracted and analyzed to assess the accuracy of the analytical method for that matrix. The spiking acceptance criteria can be found in Table 7-3.

- Sample Duplicate - Another aliquot of a sample will be carried through the full sample preparation and analysis procedure and together with the original sample results used to assess the precision of the analytical method performed. The relative percent difference between spiked duplicates should be within $\pm$ 20%.

- Laboratory Control Samples (LCS) - consist of aliquots of ideal matrices (water, sand, etc.) spiked with analytes of interest. In the case of metals analysis, all analytes of interest must be included. Laboratory pure water is used to prepare most LCSs for methods for analysis of water. Highly characterized solids, where available, are used for LCSs for methods for analysis of solids. Where no such solid LCS is available, spiked laboratory pure water or spiked reagent blanks may be substituted. LCSs provide an estimate of bias based on recovery of the compounds from a clean, control matrix. If LCS recoveries are within acceptance criteria, samples with spike recoveries outside control limits will be considered to

have a matrix problem, not a data quality problem. No reanalysis will be required, but the data will be qualified in the narrative.

7.1.8 Pesticides/PCBs

Pesticides and PCBs will be analyzed in groundwater and soil following USEPA CLP SOW OLMO1.8. All soil samples will be extracted within 10 days of VTSR and analyzed within 40 days of extraction. Water samples will be extracted within 5 days of VTSR and analyzed within 40 days of extraction. Further details and additional procedures are described in the analytical methods cited in Table 7-1. Target analytes will include the EPA CLP Target Compound List. Detection limits will be as stated in the method.

- Calibration - For pesticides, the GC system will be calibrated at a minimum of three concentrations and a blank. One of the concentrations of each compound will be the method detection limit. For PCBs and toxaphene, a single point calibration procedure will be used. Daily calibration is not necessary if the daily check standard validates the initial calibration curve, as per the method.

- Surrogates - Surrogate compounds representing the classes of compounds of interest but different than those being analyzed will be spiked into every sample prior to extraction. The recovery of the surrogates will be used to assess each samples' matrix effects. Specific compounds and acceptable recovery limits are listed on Table 7-2. If laboratory control sample surrogate recoveries are within acceptance criteria, samples with surrogate recoveries outside control limits will be considered to have a matrix problem. No reanalysis will be required, but the data will be qualified in the narrative.

- Method Blanks - At least one method blank for every twenty samples will be extracted and analyzed to detect possible interferences introduced in the laboratory. An acceptable method blank must not contain any target compounds above the detection limit.

- Matrix Spikes - At least one fortified sample for every twenty field samples will be prepared by spiking an aliquot of the field sample with known quantities of the compounds being analyzed at concentrations within the range of concentrations expected in the samples. The fortified sample will be extracted and analyzed to assess the accuracy of the analytical method for that matrix. To ensure that adequate sample volume is available to the laboratory for the matrix spike sample in water, a second 1-liter must be collected once for every twenty field samples. The sample must be identified with the field ID and "For Matrix Spike Sample". Acceptable recovery limits are listed on Table 7-2. Samples associated with matrix spike data that is outside of the control limits will be flagged with no re-extraction or reanalysis required.

- Matrix Spike Duplicate - Another aliquot of the sample chosen as the matrix spike will be

fortified with the same parameters and at the same concentration, carried through the full sample preparation and analysis procedure and together with the matrix spike results used to assess the precision of the analytical method performed. A third 1-liter sample volume must be collected for the matrix spike duplicate in water once for every twenty field samples. It must also be identified with the field ID and "For Matrix Spike Duplicate Samples".

7.1.9 Total Cyanide

Total Cyanide will be analyzed following US EPA CLP SOW ILMO2.0. Samples for Cyanide will be analyzed within 12 days of VTSR. Further details and additional procedures are described in the analytical methods cited in Table 7.1. Detection limit will be as set forth in the method.

- Calibration - The auto-analyzer is calibrated using nine standards and a blank bracketing the range of expected concentrations. The correlation coefficient will be 0.990 or better.

- Calibration Check Standard - During each analysis calibration check standards will be analyzed at a rate of 1 per 10 injections to confirm the validity of the initial calibration. If the % recovery varies by more than 10 from the initial calibration the instrument will be recalibrated and samples run between failing calibration checks will be reanalyzed.

- Method Blanks - At least one DI blank will be analyzed with each batch of 20 samples digested. The method blank shall not show contamination above the detection limit.

- Laboratory Control Sample - LCSs are prepared following the requirements of ILMO2.0. They are from a source independent of the calibration standards and expected recovery is 80 - 120% or as specified by the vendor for solid LCS materials.

- Matrix Spike - Field samples will be fortified with spiking solution as assigned in the field with known quantities of cyanide at a concentration within the range of concentrations expected in the samples. Matrix spike recoveries are anticipated to be between 75 - 125%. Corrective action will be taken as necessary and as specified in ILMO2.0.

- Sample Duplicate - Sample duplicate results should have a % difference of 20% or less. Data associated with sample duplicates with a greater than 20% difference when the results are greater than 10 times the CRDL will be flagged. When there are duplicate results less than 10 times the CRDL then the control limit is +/- CRDL.

8.0 DATA REDUCTION, VALIDATION AND REPORTING

8.1 Data Validation

8.1.1 External Data Validation

External data validation will be as described in the Atlantic Environmental Quality Assurance Project Plan.

8.1.2 Internal Laboratory Data Reduction and Validation

GC/MS Analyses

The instrument performance test data will accompany the raw data to be reviewed. Mass Spectrometer tune and system performance check compound behavior are checked against acceptance criteria. Each sample report is inspected to verify that the following criteria were met for qualitative identification of each organic pollutant.

- Characteristic ions for each compound of interest must maximize in the same or within one scan of each other.

- Retention time must occur within ± 30 seconds of the retention time of the authentic compound.

- Relative peak heights of the three characteristic ions in the Extracted Ion Current Profile (EICP) must fall within ± 20 percent of the relative intensities of these ions in a reference mass spectrum. The reference mass spectrum can be obtained by a standard analyzed in the GC/MS system or from a reference library.

- The entire mass spectrum of the compound of interest is compared to the reference compound.

If requested the analyst performs additional library searches for identifying additional non-HSL compounds seen in the sample.

Structural isomers having similar mass spectra can be explicitly identified only if the resolution between authentic isomers in a standard mix is acceptable. Acceptable resolution is achieved if the base-to-valley height between the isomers is less than 25 percent of the sum of the two peak heights. Otherwise, structural isomers are identified as isomeric pairs.

When a compound has been identified, the quantitation of that compound is based on the integrated abundance from the EICP of the primary characteristic ion. The base peak ion for internal standards is used. If the sample produces an interference for the first listed ion, a secondary ion is used to quantitate. Quantitation is performed using internal standard techniques.

To ensure that reported data are accurate, all such resultant data are verified. Retention items and area counts are checked carefully for correct and accurate identification and quantification. The analyst verifies that calibration criteria have been met, that the LCS and LCS duplicate associated with the sample meet project acceptance criteria, that surrogate compound recoveries are acceptable, and that blank contamination as would affect sample results was not present. Sample exception reports are filed with any affected sample reports.

Metals Analyses

Each instrumental session produces an instrument data file or hardcopy printout. A hardcopy of the data file is made. The hardcopy is reviewed by the analyst. Each sample datum is evaluated for compliance with calibration and range specifications, and in the case of ICP data for sample instrument spike recovery compliance. Acceptable sample data are flagged by the analyst. Accepted data from QC samples are tabulated into QC Batch Reports which summarize the QC for each sample batch prepared. Accepted field sample data are entered into the laboratory information system computer. The computer uses initial sample weights and volumes together with instrument results and any dilution factors to calculate the sample concentrations corrected for moisture content:

$$\text{mg/L or } \mu\text{g/g } M = \frac{A \times B \times C}{D \times E}$$

where:

A = instrument value, ug/L in the distillate or dilution
B = dilution factor
C = distillate volume
D = sample volume or weight
E = dry weight fraction , if solid

A sample data summary report is generated by the computer listing all factors used in the calculation of the final sample result, the associated QC batch number(s), and the final sample results. A senior analyst or supervisor reviews the QA Batch Reports for acceptability and flags any affected samples with explanatory narrative. The analyst verifies that calibration criteria have been met, that the LCS and LCS duplicate associated with the sample meet project acceptance criteria, that surrogate compound recoveries are acceptable, and that blank contamination as would affect sample results was not present. Sample exception reports are filed with any affected sample reports.

Inorganic Analyses

The review and validation of total cyanide data is representative of the procedures applied to general wet chemical data. A method specific bench notebook is used to document the handling, preparation , and analysis of each sample. The initial volume or weight taken for analysis is recorded together with final distillate volume, dilutions made to the distillate, and spectrometric readings of the distillate.

The reviewer checks to verify that the spectrophotometer calibration verification and blank are within acceptance limits. Concentrations in the distillates or diluted distillates from field and QC samples are then calculated based on the initial instrument calibration.

The method blank and duplicate laboratory control samples are checked for acceptability and then sample values are calculated based on initial sample volumes or weights. Sample values are not corrected for method blank values. Any unusual sample behavior during the test procedure is noted in the lab notebook. Sample specific data are entered onto a sample data summary or into the lab information system computer for compiling into the final report. The analyst verifies that calibration criteria have been met, that the LCS and LCS duplicate associated with the sample meet project acceptance criteria, that surrogate compound recoveries are acceptable, and that blank contamination as would affect sample results was not present. Sample exception reports are filed with any affected sample reports.

Sample Custody Data Reduction and Validation

The sample manager or his designee generates a laboratory computer report listing all sample data entered into the computer at the time of sample receipt and log-in. This data is manually compared to the chain of custody and laboratory work order forms that accompanied the samples. Any errors are corrected at this time.

8.2 Reporting

Each of the analytical laboratories enter final report data to the laboratory information management system using file transfer utilities or manual data entry. Job control sheets are submitted to the data review and reporting department. There, data are printed in final report format and are reviewed for completeness, and for compliance with project specific acceptance criteria.

Sample exception reports from the laboratory and results of review for project compliance are integrated into a case narrative which is printed and submitted with the final report to the Technical Director or his designee for signature and authorization for release.

The type of laboratory report to be provided will be consistent with NEESA level D. Level D requires a CLP data package to be delivered. This shall include the summary package and the remainder of the package. In addition to the CLP data package, laboratory control charts will be included.

For methods which are not defined in the CLP SOWs the calibration information, method blanks, LCSs, chromatograms, MS/MSD, and sample duplicate information shall be reported.

If a diskette is required, USEPA Format A will be provided for CLP parameters, including volatile, semi-volatile, pesticide/PCB, and TAL metals.

8.3 Documentation

All analytical results will be thoroughly documented in ink and in reproduction quality. Duplicate records will be kept whenever practical. Records will be maintained in a secure area.

For each analytical result, including all blanks, spikes, calibration standards, and samples, supporting documentation will be maintained that includes at least the following:

- Complete chain-of-custody records for the sample.
- Records of traceability to Certified Reference Materials for all analytical standards, spikes, and balance calibration weights.
- Records of all sample preparation and analysis, including weights and volumes of samples, solvents, reagents, dilution ratios, standards, etc. These records should be in laboratory notebooks and/or formalized data sheets, and should undergo review by a supervisor or quality control officer.
- Documentation of all manual calculations in reproduction quality.

9.0 INTERNAL QUALITY CONTROL CHECKS

Each set of samples will be analyzed concurrently with laboratory blanks, laboratory control samples and replicates. Surrogate standards will be spiked and analyzed where appropriate.

9.1 Laboratory Method Blanks

Laboratory method blanks measure the amount of contamination arising from laboratory processing. A method blank consists of deionized laboratory water carried through the entire analytical scheme (extraction, concentration and analysis). The method blank volume must be approximately equal to the sample volumes being processed.

A method blank is prepared at a rate of one per batch of samples or every 20 samples of similar matrix, whichever is more frequent. Analysis of the blank verifies that method interferences caused by contaminants in solvents, reagents, glassware, and other sample processing hardware are known and minimized. Optimally, a method blank should contain no greater than five times (5X) the method detection limit for common laboratory solvents and phthalate esters; less than the detection limit for all other parameters

9.2 Laboratory Control Samples

Laboratory Control Samples (LCS), consist of aliquots of ideal matrices (water, sand, etc.) spiked with analytes of interest. LCS's for methods with extensive lists of analytes that may interfere with one another may include a limited number of analytes, but the analytes included must be representative of as many analytes as is practical. In the case of metals analysis, all analytes of interest must be included. Laboratory pure water is used to prepare most LCS's for methods for analysis of water. Highly characterized solids, where available, are used for LCS's for methods for analysis of solids. Where no such solid LCS is available, spiked laboratory pure water or spiked reagent blanks may be substituted. LCS's provide an estimate of bias based on recovery of the compounds from a clean, control matrix. They provide evidence that the laboratory is performing the method within accepted guidelines without potential non-matrix interferences. They are prepared in duplicate at a rate of one set per twenty samples or one set per 14 days whichever is more frequent.

9.3 Laboratory Duplicates

A Laboratory duplicate is a sample or laboratory control sample that has been homogenized and split into two equal portions before the method sample preparation process. It measures sample precision associated with the preparation through analysis and is prepared and analyzed at a rate of one per batch or one per twenty samples whichever is greater.

9.4 Matrix Spikes

Project bias or accuracy will be assessed by utilizing matrix spikes. Matrix spikes will be prepared by fortifying a sample aliquot with known quantities of the compounds being analyzed at concentrations within the range of concentrations expected in the sample. After analysis, by subtracting the unfortified aliquot from the fortified or matrix spike, percent recovery of each analyte within the representative sample matrix can be determined. Matrix spikes will be prepared in the laboratory and analyzed for at least one out of every twenty samples for each analyte measured. Additional sample volume will be required for matrix spikes. The volumes required will be the same as that for the original sample.

9.5 Matrix Spike Duplicates

Analytical precision and accuracy will be assessed by utilizing matrix spikes and matrix spike duplicates. Another aliquot of the same sample as the matrix spike will be fortified with the same parameters and at the same concentrations as the matrix spike.

If possible, enough sample should be collected in one container so that the matrix spikes can be prepared. However, if an additional sample is collected to accommodate these additional analyses, the sample containers from which a matrix spike is to be prepared must be identified on the sample label and chain-of-custody form. It is imperative that adequate sample volume be provided from the field, especially for water samples. Additional sample volume will be required for matrix spike duplicates. The volumes required will be the same as that for the original sample.

0.0 PERFORMANCE AND SYSTEMS AUDITS

PACE NE's Analytical Chemistry Laboratory participates in a variety of interlaboratory tests and intralaboratory and performance checks to provide periodic assessment of the effectiveness of the overall quality control program.

10.1 Interlaboratory Performance Surveys

Performance surveys conducted by the EPA and the New Hampshire Department of Environmental Services constitute the bulk of interlaboratory comparisons.

- EPA Performance Evaluations - Water Supply - Semiannual (May and November)
    - Trace Metals
    - Nitrate/Nitrite/Fluoride
    - Insecticides
    - Herbicides
    - PAH's
    - Adipate/Phthalates
    - Trihalomethanes (THMs)
    - Volatile Organic Compounds

- Residual Free Chlorine
- Turbidity
- Total Filterable Residue
- Calcium (as $CaCO_3$)
- pH
- Alkalinity
- Corrosivity
- Sodium
- Sulfate
- Total Cyanide

- EPA Performance Evaluations - Water Pollution - Semiannual (April and October)

  - Trace Metals
  - Minerals
  - Nutrients
  - Demand
  - PCB's
  - PCB's in Oil
  - Pesticides
  - Volatile Halocarbons
  - Volatile Aromatics
  - Total Cyanide
  - Non-Filterable Residue
  - Oil and Grease
  - Total Phenolics

PACE NE's performance is evaluated by the respective agency after each round of testing, and reported to the Laboratory Technical Director. The Laboratory Technical Director forwards the results to the QA Auditor in charge of certifications. The QA Auditor distributes copies of the results to section managers and the QA Officer.

In addition to the EPA WP/WS performance evaluation studies, PACE NE participates in a number of different state, federal and commercial studies such as the State of New York, US Navy NEESA, US Army COE, USEPA CLP Quarterly Blind samples, US EPA DMR PE studies, and Chemical Waste Management round robin studies.

10.2 Periodic Internal Audits

Internal auditing is conducted by the QA Auditors. These audits occur periodically and typically focus on either performance relative to an SOP or a specific project. Internal audits take two forms - performance audits and systems audits. Performance audits involve submittal of blind spikes to the laboratory by the Quality Assurance Department for assessment of analytical accuracy. Systems audits consist of a thorough

review of procedures and documentation to confirm that work was performed in accordance with this Manual, SOPs, and/or project QA Plan and that adequate documentation exists to satisfy the project requirements.

10.2.1 Performance Audits

Audit Standards

As required on specific projects, the Quality Assurance Department provides spikes for analysis as independent check samples (audit standards). The QA Department prepares any audit standards that can be prepared readily from relatively non-hazardous, pure materials or certified concentrated standards. In some cases, preparation of reliable audit standards requires special facilities and equipment due to the hazardous nature of the materials and/or the requirement for precise measurement of minute quantities. In such cases, audit standards are obtained from the USEPA, Environmental Monitoring and Support Laboratory (EMSL), Cincinnati, Ohio, or from an equivalent source. The nature of the audit standards and the frequency of performance audits are specified in the Quality Assurance Plan of each project for which performance auditing is required. When practical, audit standards are provided in matrices resembling real project sample matrices, and undergo the full sample preparation and analysis procedure. However in many cases this is impractical, and it is necessary to submit audit samples as extracts, for analysis only. All measurable constituents in the audit standards should be within the expected range of concentrations to be encountered in the real samples (or in the extracts).

10.2.2 Systems Audits

There are two different types of laboratory systems audits. Systems audits of laboratory operations are performed at a minimum frequency of once every month. Systems audits address general laboratory operations and conformance to the Laboratory Quality Assurance Manual.

Systems Audit Procedures

The systems audits are performed by the Quality Assurance Auditors. Audit checklists are used to ensure that all salient points are addressed and documented. The checklists are filled out legibly and reproducibly, in ink, by the auditor, and are signed and dated by the auditor when completed. The audit checklist is based on EPA laboratory evaluation criteria, the provisions of the Laboratory Quality Assurance Manual and PACE NE SOPs. Project audit checklists are drawn from the applicable QAPPs, as well as relevant provisions of the QA Manual.

Audit checklists will cover at least the following areas:

- Systems Audit
  - Personnel qualifications and training records

- Adequacy of laboratory facilities, including work space, lighting, ventilation, and supplies
- Maintenance and calibration recordkeeping for analytical equipment
- Safety (facility configuration and practices)
- General operations, including glassware cleaning, inventory and checking of reagents and standards, and storage procedures
- Recordkeeping, including sample log-in and tracking, traceability of standards, control charts, and raw data recording and tracking.

- Project Audit

  - Sample log-in and chain-of-custody records
  - Sample storage procedures and records
  - Sample preparation and analysis procedures
  - Method validation (where applicable)
  - Conformance to QAPP
  - Control charts
  - Precision and accuracy assessment
  - Method blanks, reagent blanks, duplicates, check samples, fortifications, surrogates, etc.
  - Calibration
  - Data packages
  - Analyst qualifications
  - Data validation and reporting

10.3 QA Reporting and Corrective Action

Each systems audit is immediately followed by a debriefing, in which the auditor discusses his/her findings with the laboratory representatives. The debriefing serves a two-fold purpose. First, laboratory management is afforded an early summary of findings, which allows them to begin formulating corrective strategies, and second, the auditor has a chance to test preliminary conclusions and to correct any misconceptions before drafting his report.

The systems audit report (which may or may not contain performance audit findings) is issued to the Laboratory Director and appropriate supervisors and personnel for corrective action. These responses are forwarded, in writing, to the auditor. The auditor then circulates the report to the QA Officer, laboratory management and to company management.

Results of interlaboratory performance surveys and in-house audits, along with unresolved corrective action items are summarized in a monthly report from the Quality Assurance Officer to the PACE NE Regional Director.

11.0 PREVENTIVE MAINTENANCE

To minimize downtime and interruption of analytical work, preventive maintenance is routinely performed on each analytical instrument. Designated laboratory personnel are trained in routine maintenance procedures for all major instrumentation. When repairs are necessary, they are performed by either trained staff or instrument manufacturer service personnel.

SOPs are written for each instrument that cover basic operation and maintenance procedures. Detailed logbooks documenting preventive maintenance, non-routine maintenance and repairs are also maintained for each instrument. The following are brief summaries of maintenance for each major instrument.

11.1 GC\MS

Regularly performed maintenance includes, but is not limited to the following for GC/MS instrumentation:

- hard tune with calibration gas (PFTBA)
- removal of 2-3 inches from the injection end of the capillary columns
- replacement of 2-3 inches of column packing from the injection end of packed columns
- injection port liner replacement
- replace injection port septum
- clean ion source as needed
- check vacuum pump oil level
- check carrier gas tanks
- replace or recondition vent traps

11.2 ICP

- check liquid argon tank level
- change pump tubing
- clean nebulizer and spray chamber as needed
- replace and realign plasma torch when required

- check cooling system water level
- empty waste reservoir when full

11.3 AA Graphite Furnace

- check and align source lamps
- clean and inspect graphite tube, replacing when surface appears excessively burnt or cracked
- clean and inspect contact ring, replacing when excessively worn
- clean mirrors for optical sensor and sample compartment windows
- check autosampler injector alignment and deposition

11.4 Mercury Analyzer

- Check and align source lamp
- remove and clean sample cell and connecting tubes
- check sparger for proper operation
- clean sample compartment windows

11.5 Laboratory - General

- clean and calibrate balances biannually
- check balance calibration each day of use
- clean balance pan prior to each use
- calibrate class "S" weights every two years
- calibrate automatic pipets
- calibrate thermometers yearly
- record refrigerator, freezer, and oven temperatures each weekday

- clean, check, calibrate to manufacturers specifications all pH, DO, conductivity and, turbidity meters, and spectrophotometers biannually

- general housekeeping: keep counter tops, hoods, and floors clean

12.0 SPECIFIC PROCEDURES TO ASSESS PRECISION, ACCURACY , AND COMPLETENESS

Project records, precision, accuracy, and background contamination will be assessed as they relate to project quality goals.

All project analytical data will be subjected to a three tier review process within the laboratory including review by the analyst, the Laboratory Manager, and the Technical Director prior to its release. The review process has been developed to minimize errors associated with sample processing, sample analysis and data reporting and to ensure that information pertaining to a given sample is well documented.

12.1 Precision

For each compound and each matrix, precision will be estimated by calculating the average relative percent difference (RPD) as follows:

1) calculate the relative percent difference (RPD) for <u>each</u> duplicate measurement

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

where X1 =the value obtained for one field duplicate, and
X2 =the value obtained for the field duplicate of that same sample

2) calculate the average RPD as $RPD = \underline{1}\ RPD_{i,n}$

where "i" denotes the consecutive duplicate, and "n" denotes the number of duplicates.

12.2 Accuracy

The results of the Laboratory Control Samples and matrix-fortified samples will be used to estimate the accuracy of the data. The estimated accuracy will be expressed as percent bias or relative percent difference for each compound in the fortified samples, as follows:

1) Let X = the analytical result for a given fortified compound in the fortified sample, and thus

$X = F\text{-}U$,

where F = the analytical result for the fortified aliquot, and
U = the analytical result for the unfortified aliquot.

2) Compute the percent bias of each fortified sample (B_i) as:

$B_i = 100\ (X)/T$

where T = the true concentration based on the amount of compound used in fortification.

3) Compute the percent bias (B) represented by all fortified sample results for a given parameter in a given medium as the average of B_i for that parameter and medium:

$B = B_i/n$,

where n = the number of fortified samples for that parameter and medium or matrix.

12.3 Completeness

Completeness is a measure of valid, usable data. Once all data review and assessment has taken place, the number of valid/usable points for each parameter is compared to the total number collected. Sample data may be invalidated due to sample collection problems, breakage or loss, or analyses that exceeded holding times or other performance criteria. Completeness is calculated as:

$$\% \text{ Completeness} = \frac{\text{Valid Data Points}}{\text{Total Data Points}} \times 100$$

12.4 Background Contamination

Background contamination will be reviewed by utilizing results from both field and trip blanks. High background levels of analytes or contaminants may render some results questionable or impose higher detection limits on some analyses.

An analytical result above the minimum detection limit for a given parameter necessitates the field blank testing for that parameter. If the field blank result is above the minimum detection limit for volatile organics analysis, the appropriate trip blank(s) are analyzed to pinpoint the contamination.

13.0 CORRECTIVE ACTION

The following procedures have been established to assure that conditions adverse to quality, such as malfunctions, deficiencies, deviations, and errors, are promptly investigated, documented, evaluated and corrected. When a significant condition adverse to quality is noted at the laboratory, the cause of the condition will be determined and corrective action taken to preclude repetition. Condition identification, cause, reference documents, and corrective action planned to be taken will be documented and reported to the laboratory directors, technical director, and QAU management. Serious deficiencies will be reported to the QAU within twenty-four hours of the time the respondent knew or should have known of the deficiency.

Implementation of corrective action is verified by documented follow-up action. All project personnel have the responsibility, as part of the normal work duties, to promptly identify, solicit approved correction, and report conditions adverse to quality.

Laboratory corrective actions may be initiated when the following situations occur:

- When predetermined acceptance standards are not attained
- When procedures or data are determined deficient
- When equipment or instrumentation is found faulty
- When samples and test results are questionably traceable
- When quality assurance requirements have been violated
- When designated approvals have been circumvented
- As a result of system and performance audits
- As a result of a management assessment
- As a result of laboratory comparison studies

Project management and staff monitor ongoing work performance in the normal course of daily responsibilities. Work is audited at the offices, sites, laboratories, and subcontractor locations by the QAU and/or designated lead auditors. Items, activities, or documents ascertained to be in noncompliance with quality assurance requirements will be documented and corrective actions mandated through audit finding sheets attached to the audit report. Audit findings are logged, maintained, and controlled by the QAU.

All project personnel can identify a noncompliance; however, it is the Technical Director's responsibility to ensure that all recommended corrective actions are produced, accepted, and received in a timely manner.

The Technical Director also approves all corrective actions issued by the staff.

The Corrective Action Report (Figure 13-1) identifies the adverse condition, reference document(s), and recommended corrective action(s) to be administered. The issued CAR is directed to the responsible Laboratory Manager in charge of the item or activity for action. The individual to whom the CAR is addressed returns the requested response promptly to the individual in charge, affixing his signature and date to the corrective action block, after stating the cause of the conditions and corrective action to be taken. The Laboratory Manager maintains the log for status control of CAR's responses, confirms the adequacy of the intended corrective action, and verifies its implementation. The Laboratory Manager will issue and distribute CAR's to specified personnel, including the originator, involved subcontractor, and the QAU as a minimum.

Figure 13-1
PACE NEW ENGLAND CORRECTIVE ACTION REPORT
Revision 1 - 12/92

Protocol_____

Date:_____ Reported By:_____
Sample ID Number(s) Involved and QC batch #:_____

Type of Event: ☐ Out-of Control Event ☐ Unusual Occurrence

Description of Event:_____

Discussion of Known or Suspected Cause:_____

Corrective Action(s) Taken (include date, person and action):_____

Signed_____

Signed_____
Group Supervisor

Signed_____
Technical Director

Follow Up:_____

Quality Assurance Review

_____ Date _____

Management Review

_____ Date _____

14.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

The QA Auditors perform data audits and system inspections which assess sample storage, chain of custody documentation, QC precision and accuracy activities, instrument operation and maintenance, recordkeeping and SOP maintenance. Any noncompliances with either the PACE NE QA Manual, PACE NE SOP ('s) or study-specific protocols are documented by the QA Auditor and reported to the Laboratory Director and the Regional Director. QA Auditors also periodically verify that corrective action has occurred.

APPENDIX B

ATLANTIC'S QA PROCEDURES

LIST OF ATLANTIC'S QA PROCEDURES	
NUMBER	TITLE
1020	Field Procedures for Collection of Surface Soil Samples
1022	Field Procedures for Collection of Surface Water and Sediment Samples for Hazardous Waste Determination
1023	Field Procedures for Collection of Ground Water Samples for Hazardous Waste Determination
1030	Field Procedures for Logging Subsurface Conditions During Test Boring and Well Logging
1031	Field Procedures for Logging Subsurface Conditions in Test Pit Excavations
1041	Sample Chain-of-Custody Procedure
1042	Shipping Procedures for Environmental Field Samples
1050	Operation and Calibration of the Century Organic Vapor Analyzer Model OVA-128
1051	Operation and Calibration of the HNu Systems Photoionizer Model PI-101
1052	Operation of the Photovac 10S50 Portable Gas Chromatograph
1053	Soil Gas Screening for Volatile Organics
1060	Cleaning Procedure for Sampling Devices Used in Environmental Site Investigations
1070	Well Development Procedures for Small Diameter Monitoring Wells

APPENDIX C

SUMMARY OF SAMPLES TO BE COLLECTED AT EACH SITE

APPENDIX C
SUMMARY OF SAMPLES TO BE COLLECTED AT EACH SITE

Media	Analyses	No. of Samples	Field Duplicate	Trip Blank[1]	Equipment Rinsate	Field Blank Source Water	Matrix Spike	Matrix Spike Duplicates
PIER 33								
Soil	VOC, SVOC, inorganics, pesticides, PCB, TCLP metals, TPH, pH, oil fingerprint	9	1	5	3	1	1	1
Soil	VOC, SVOC, inorganics, pesticides, PCB, pH[2]	9	1	4	2	—	1	1
Soil	Pb, pH	7[3]	1	—	—	—	1	1
Ground Water	VOC, SVOC, inorganics, pesticides, PCB, TPH, oil fingerprint, pH	4	1	2	1	—	1	1
BERTH 16/FORMER INCINERATOR								
Soil	VOC, SVOC, inorganics, pesticides, PCB, TCLP metals, TPH, pH, oil fingerprint	14	2	7	4	1	2	2
Soil	VOC, SVOC, inorganics, pesticides, PCP, pH[2]	15	2	7	3	—	2	2
Soil	Dioxins/dibenzofurans	6	1	—	2	—	1	1
Ground Water	VOC, SVOC, inorganics, pesticides, PCB, TPH, oil fingerprint, pH	7	1	3	2	—	1	1

Notes:
1. Trip blank for VOC analysis only
2. Samples 19SD1, 19SD2, 20SD1 and 20SD2 also to be analyzed for TPH and oil fingerprint
3. Number may vary based upon depth to bedrock

APPENDIX D

NSB-NLON PROJECT FILES

FILING REQUEST FORM
U.S. NAVAL BASE
GROTON, CT

UPDATED 12/28/92

CONTRACTS

____ CONTRACT
____ CONTRACT ADDENDUM #4/PIER 33 & BERTH 16 WORK PLANS
____ CONTRACT ADDENDUM #5/RES. WELL SAMPLING
____ CONTRACT ADDENDUM#6/WELL SAMPLING
____ AMEND. #7/COMMUNITY RELATIONS PLAN
____ CONTRACT #10/TRC MEETING
____ CONTRACT MOD #11/RES. WELL SAMPLING
____ CONTRACT MOD #12/H.W. STORAGE AREA SAMPLING
____ CONTRACT MOD#13 SUPPLEMENTAL & PHASE II WORK PLANS
____ CONTRACT AMENDMENT #14
____ CONTRACT AMENDMENT #15 SUPPLEMENTAL STEP I,MISC, GOSS COVE
____ CONTRACT AMENDMENT #16 PIER 33/BERTH 16
____ CONTRACT NEGOTIATION FILE (IR STUDY)
____ SUBCONTRACTOR CONTRACT CORRESPONDENCE
____ CONTRACT OFFSITE POND SAMPLING
____ CONTRACT MOD-FS STUDY
____ CONTRACT MOD-OFFSITE POND SAMPLING
____ PROPOSAL FEASIBLITY STUDY
____ TRC MEETING CONTRACT AMENDMENT
____ AMENDMENT #17 COST PROPOSAL

CORRESPONDENCE/MISC.

____ ATSDR
____ CORRESPONDENCE
____ CTDEP/EPA/NAVY COMMENTS
____ FINANCIAL (FILE MY MONTH)
____ INTERNAL MEMO'S
____ MISC. MEETING NOTES
____ FIELD SUPPLIES COST ESTIMATE BACKUP
____ NEWSPAPER ARTICLES
____ PROGRESS REPORTS
____ HOMEOWNER MEETING 3/12/1991
____ PUBLIC MEETING 7/26/90
____ PUBLIC MEETING 1/22/91
____ PUBLIC MEETING 3/12/91
____ PUBLIC MEETING TRC 4/11/91
____ PUBLIC MEETING TRC 9/19/91
____ PUBLIC MEETING TRC 12/2/92
____ PURCHASE ORDERS
____ SCHEDULE
____ TIME SHEETS
____ TRC COMMENTS
____ TRC MEETING MEETING NOTES
____ TRC MEETING NOTES 1/9/91
____ TRC MEETING 3/31/92
____ TRC MEETING CONTRACT AMENDMENTS
____ TRC MEMBER LIST

SUBCONTRACTORS

____ ASSOCIATED SURVEYS
____ MENZIE-CURA & ASSOCIATES
____ EMPIRE SOILS
____ META ENVIRONMENTAL
____ NET ATLANTIC
____ RADIATION SAFETY
____ WESTON GEOPHYSICAL

PROJECT FILES

____ HAZARDOUS WASTE STORAGE FIELD SAMPLING (TSDF)
____ PIER 16 & BERTH 33 WORK PLAN
____ OFF SITE POND SAMPLING FIELD
____ COMMUNITY RELATIONS
____ TSDF SAMPLING 1256-12-01
____ NAVY PROPOSAL FEASIBILITY STUDY
____ RESIDENTIAL WELL SAMPLING 1256-13
____ NAVY DESCRIPTION OF CURRENT SITUATION 1256-14-01
____ NAVY FS DEVELOPMENT OF

ALTERNATIVE REMEDIAL ACTION 1256-14-02
____ NAVY INITIAL SCREENING OF ALTERNATIVE 1256-14-03
____ NAVY EVALUATION OF ALTERNATIVES 1256-14-04
____ FS REPORT PREPARATION 1256-14-05
____ NAVY FS MENZIE 1256-14-06
____ NAVY/SUPPLEMENTAL WELL SAMPLING, ISTOPIC ANALYSIS 1256-17-01
____ COMUNIITY RELATIONS FACT SHEETS 1256-18-08
____ PHASE II WORK PLAN, FSP, QA/QC AND HASP 1256-18
____ BORON/BACKGROUND PLAN OF ACTION
____ BORON LITERATURE SEARCH

NAVY REMEDIAL INVESTIGATION (STEP I/II)

____ FS FINAL
____ FSP 1ST DRAFT
____ FSP 2ND DRAFT
____ HASP FINAL
____ HASP 1ST DRAFT
____ HASP 2ND DRAFT
____ QA/QC GENERAL
____ QA/QC FINAL
____ QA/QC 1ST DRAFT
____ QA/QC 2ND DRAFT
____ FEASIBILITY STUDY WORKING DRAFT 9/92
____ PHASE II WORK PLAN

NAVY PLANS & BACKGROUND INFORMATION

____ 200 SCALE UTILITIES
____ AREA A
____ AERIAL PHOTOS
____ BATTERY ACID AREA
____ DPDO AREA
____ GOSS COVE
____ FORMER GAS STATION
____ LOWER BASE BLD. #79
____ MAPS PLANS
____ SUBMARINE BASE
____ TECHNICAL REFERENCES/PAST REPORTS
____ TORPEDO SHOP
____ EXISTING CONDITIONS/PHOTO REDUCTION
____ RAW MATERIAL INFO.
____ AERIAL PHOTOS
____ NEW SITE INFORMATION
____ RADIOLOGICAL TEST RESULTS 12/91

____ DRAFT EIS THAMES RIVER DREDGING PROJECT
____ BORING LOGS PIER 33/ BERTH 16

NAVY FIELD & LAB DATA

____ BORING LOGS
____ MONITORING WELL CONSTRUCTION
____ GROUNDWATER ELEVATION DATA
____ GEOLOGIC INFORMATION
____ HYDROLOGIC INFORMATION
____ GEOPHYSICAL DATA
____ SOIL GAS DATA
____ FIELD NOTEBOOKS
____ MASTER SAMPLE LOG BOOKS
____ CHAIN OF CUSTODY
____ NET/ATLANTIC MONTHLY QA REPORTS
____ MONTHLY LAB DATA FOR PROGRESS REPORTS
____ LAB RESULTS SURFACE SOIL
____ LAB RESULTS GROUNDWATER
____ LAB RESULTS SURFACE WATER
____ LAB RESULTS SEDIMENT
____ LAB RESULTS BORING
____ LAB RESULTS RESIDENTIAL WELLS
____ QA/QC SURFACE SOIL DATA
____ QA/QC DATA VALIDATION
____ QA/QC GROUNDWATER DATA
____ QA/QC SEDIMENT DATA
____ QA/QC BORING DATA
____ QA/QC AUDITS
____ UTILITY MANHOLE INSPECTION
____ FIELD NOTES (PRELIMINARY SITE INSPECTION)
____ INTERNAL LAB
____ ANALYSIS TRACKING
____ PHOTOS/SLIDES/VIDEO

APPENDIX E

TOTAL PETROLEUM HYDROCARBONS TEST METHOD

ATTACHMENT I
(Special Technical Instructions)

Total Recoverable Petroleum Hydrocarbons in Soil/Sediment

1. Decant and discard any water layer covering a sediment sample.

2. The soil or sediment sample must be mixed thoroughly. Any foreign objects such as sticks, leaves and rocks are discarded.

3. A portion of the sample should be weighed out for moisture determination, to be carried out by drying overnight at 105°C. Method 3540, Part 7.2.1. If the sample contains more then 50% water (less than 50% solids) then more sample must be taken in order to reach the 20 gm of solid sample needed for analysis.

4. Blend 20g. of the solid soil sample with 20g. of anhydrous sodium sulfate and place in an extraction thimble. If the sediment sample is a sludge use the preparation described in Method 9071 7.2-7.6 using $Mg_2SO_4 \cdot 2H_2O$.

5. Extract samples according to Method 3540, Extraction of Nonvolatile and Semi-Volatile Organic Compounds from Solids.

6. Soxhlet extraction should be performed using 250 ml. of Freon 113. Extract the sample for four hours.

7. The 250 ml of Freon extract must be concentrated to 10.0 ml using a Kuderna Danish (K-D) concentrator equipped with a three ball Snyder Column. The freon is concentrated to approximately 10.0 ml or to a low volume capable of transfer to the silica gel column. To avoid loss of low molecular weight hydrocarbons, do not bring the concentrate to dryness.

8. A silica gel column as described in SW846 method 3630, Section 7.1.2, is prepared by loading activated silica gel onto the column using freon 113 solvent. The activated silica gel will remove polar compounds while allowing hydrocarbons to pass through.

9. The 10 ml of concentrated extract is loaded onto the column and allowed to elute at a rate of 2 ml/min. The rate can be measured using a volumetric cylinder and stop watch. When the level of sample solution reaches the upper surface of the sodium sulfate covering the silica gel, the 25 ml of freon 113 is loaded onto the column. The first 35 ml of freon is collected and should contain the petroleum hydrocarbons. The column must be eluted with only enough solvent to elute the petroleum distillates and not elute any polar or aromatic compounds. The 35 ml of solution is collected in a 50 ml volumetric flask. The eluate is then brought to mark with Freon 113.

10. The Standard reference oil is made as per Method 418.1 as follows:

15.0 ml Hexadecane
15.0 ml isooctane
10.0 ml Chlorobenzene
40 ml stored in a stopped bottle

1 ml of reference oil is weighed into a tared 200 ml volumetric flask, stoppered quickly and reweighed. The oil is diluted to 200 ml with Freon 113 and stoppered. This is the stock standard from which working standards are made. The concentration of this standard is calculated in mg/l.

11. A 1.0 gm solid sample of Lauramide (lauric acid amide) is weighed into a tared 200 ml volumetric flask and dissolved in 100 ml Freon 113. After dissolution the volumetric is brought to mark. This Lauramide solution will be mixed with the reference oil solution in a 0.5 mg/50 ml/0.5 mg/50 ml ratio to give a 0.25 mg/50 ml concentration of both. The equal mixture will be used to measure the separation efficiency of the silica gel column. Ten milliliters of the mixed reference and Lauramide solution will be passed through the silica gel column identically as a sample is passed through the column as in Paragraph 9.0. The concentration of the reference oil will be subsequently measured to determine the recovery. If the Lauramide remains in the solution after silica column separation, then the measurement of the reference oil at 2930 cm^{-1} will exceed the expected concentration of .25 mg/50 ml. The presence of Lauramide will create a high absorbance when the scan is started from 3200 cm^{-1} through 2700 cm^{-1}.

12. Calibrate the infrared spectrophotometer with the appropriate cell path using a series of five standards including a blank equivalent to .01 mg/50 ml to 1.0 mg/50 ml petroleum distillate. The standards are prepared as per Method 418.1 and Step 10.0. Prepare a calibration plot of absorbance vs. milligrams/50 ml petroleum hydrocarbons measured at 2930 cm^{-1}. Each sample and standard should be scanned from 3200 cm^{-1} to 2700 cm^{-1} and the maximum checked at 2930 cm^{-1}. Calculate the correlation coefficient for the plot using the least squares fit method. The correlation coefficient must be >0.995.

13. Fill the infrared cell from the 50 ml sample flask and scan the range from 3200 cm^{-1} to 2700 cm^{-1}. Measure the absorbance at 2930 cm^{-1} and record the reading.

14. The concentration of petroleum hydrocarbons in the samples should be calculated on a dry weight basis.

ATTACHMENT II
DELIVERABLES

1. Narrative explaining all anomalies and corrective actions taken. Included in the narrative should be a tabulation of the sample numbers with the corresponding laboratory sample numbers.

2. Daily instrument calibration plot of styrene thin film.

3. Tabulated sample results; positive results and detection limits for non-detects.

4. Laboratory analysis notebook pages or bench sheets; all sample raw data including sample weight, dilutions, and concentration factors.

5. Tabulated results of duplicate and matrix spike analyses; tabulations of standard results and calibration verification results.

6. Calibration curve raw data.

7. Examples of sample results calculations.

8. Sample preparation logs.

9. Copies of request, packing lists, chain-of-custody, sample tags and shipping airbills.

10. Raw data for percent solids determination must be included.

11. Scans of Lauramide/reference oil check plots from 3200 cm^{-1} to 2700 cm^{-1}.

ATTACHMENT III

QC Requirements

Audits Required	Frequency Audits	Limits	Corrective Actions
1. Calibrate Spectrophotometer (wavelength) using styrene film	Daily	Must meet manufacturer's specification for wavelength	Call for help from manufacturer's representative.
2. Prepare a calibration plot of absorbance vs. mg petroleum hydrocarbons per 50 ml solution (.01 mg/50 ml to 1.0 mg/50 ml	Daily	Correlation Coefficient >.995	Make new working standards and prepare new calibration plot.
3. Method Blank	1 per 10 analytical samples	≤2 times DL	If >2 times DL, determine source of contamination and reanalyze blank. Limits must be met prior to analysis.
4. Laboratory Duplicate (Separate preparation of sample)	1 per 10 analytical samples	±20%	If not ±20%, rerun duplicate. If out of limit, proceed.
5. Matrix spike 0.20 mg/50 ml reference oil solution	1 per 10 analytical samples	80%-120% recovery	If not within limits repeat if not again proceed
6. Continuing Check Standard 0.20 mg/ 50 ml std reference oil solution	1 per 10 samples and at the end of analysis	±10%	If outside limits, recalibrate and rerun all samples run since last acceptable calibration check.
7. Separation check sample (Lauramide/ Ref oil mixture)	1 per 20 samples	No ore than +10% of reference oil concentration	If outside limit reseparate all related samples with new SiO_2 column since last compliant check.

SAS - Dioxin-002
Revised August, 1992

U.S. Environmental Protection Age
CLP Sample Management Office
P.O. Box 818 - Alexandria, Virgin
Phone: 703/557-2490 - FTS/557-249

_____ _____
Region I, CLP-TPO, SAS Approval Date

SPECIAL ANALYTICAL SERVICES

Client Request

_____ Regional Transmittal _____ Telephone Request

A. EPA Region/Client: Region I/

B. RSCC Representative: Heidi Horahan

C. Telephone Number: (617) 573-5798

D. Date Of Request: _____

E. Site Name: _____

Please provide below description of your request for Special Analytical Services under the Contract Laboratory Program. In order to most efficiently obtain laboratory capability for your request, please address the following considerations, if applicable. Incomplete or erroneous information may result in a delay in the processing of your request. Please continue response on additional sheets, or attach supplementary information as needed.

1. General description of analytical services requested:

Analysis of water, soil, fly ash and/or chemical wastes (stillbottom, fuel oil and sludge matrices) using a modified version of the DFLM01.0 Statement Of Work (SOW) for analysis of Polychlorinated Dibenzo-P-Dioxins (PCDD) and Polychlorinated Dibenzofurans (PCDF). Modifications are as per Section 8 (Special Technical Instructions)

Note: High Resolution Mass Spectrometry (HRMS) may be utilized as long as all QC requirements stated in this analytical request are met or exceeded. M-COCL$^+$ ions need not be monitored when employing HRMS.

2. Definition and number of work units involved (specify whether whole samples or fraction; whether organics or inorganics; whether aqueous or soil and sediments; and whether low, medium or high concentration):

3. Purpose of analysis (specify whether Superfund (enforcement or remedial action), RCRA, NPDES, etc.):

4. Estimated date(s) of collection:

5. Estimated date(s) and method of shipment

6. Number of days analysis and data required after laboratory receipt of samples:

Analysis must be completed and data package must be received by the Region within 35 days of laboratory receipt of last sample in the SDG.

Deliver data to:

Overnight Delivery	US Mail
Heidi Horahan US EPA Region I 90 Canal Street Boston, MA 02114	Heidi Horahan US EPA Region I JFK Federal Building MPC-CAN 7 Boston, MA 02203-2211

7. Analytical protocol required (attach copy if other than a protocol currently used in this program):

DFLM01.0, Statement Of Work (SOW) for Analysis of Polychlorinated Dibenzo-P-Dioxins (PCDD) and Polychlorinated Dibenzofurans (PCDF), with SAS modifications. Any deviations from this request must be approved by Region I prior to bid award.

8. Special Technical Instructions (if outside protocol requirements, specify compound names, CAS numbers, detection limits, etc):

a) ALL EMPC values are to be included in the TEF calculations.

b) Second column confirmation is required for all samples which exceed the action level of 7 ppt for water, 0.7 ppb for solids (soil, sediment and fly ash; dry weight) or 7 ppb for chemical wastes.

c) Dry weights must be performed on all solid (soil, sediment and fly ash) samples. Immediately after weighing the sample for extraction, weigh 5-10 grams of the sample into a tared crucible. Determine the percent moisture by drying overnight at 105°C. Allow to cool in a desiccator before weighing. Concentrations of individual analytes in each sample must be reported relative to the dry weight of the sample.

d) The S/N ratio of the continuing calibration standard (CC3) must be greater than 10 to 1 for all unlabeled PCDD/PCDF ions and for all labeled internal, recovery and clean-up standards.

e) Window defining mix must be analyzed every day prior to the continuing calibration standard (CC3).

f) The laboratory must provide an example of an EDL and EMPC calculation.

9. Analytical results required (if known, specify format for data sheets, QA/QC reports, Chain-of-Custody documentation, etc.). If not completed, format of results will be left to program discretion.

As per deliverables stated in Exhibit B of the CLP DFLM01.0 SOW including the following clarification:

a) SICPs must be presented so the two molecular ions, M^+ and $(M+2)^+$, the $(M-COCL)^+$ ion, and any relevant internal/recovery standards or diphenyl ether interferents are to be presented on one page. The SICP must show the full time window scanned for each ion.

b) The complete data system report shall include all of the information listed below. For laboratories which do not use automated data system procedures, a laboratory "raw data sheet", containing the following information, must be included in the sample data package in addition to the chromatogram and SICPs:

- EPA sample number,
- Data and time of analysis,
- RT (and scan number if available) of identified compounds,
- Ions used for quantitation with measured area,
- Copy of area table from data system,
- GC/MS instrument ID,
- Lab file ID.

c) Report Form I values corrected for the dry weight.

10. Other (use additional sheets or attach supplementary information, as needed):

None

11. Name of sampling/shipping contact:

	Name	Phone
Primary		
Secondary		

12. Data Requirements

Parameter	Method Detection Limit

Refer to Section C in the CLP SOW DFLM01.0.

13. QC Requirements

Audits Required	Frequency of Audit	Limits	Corrective Action

As per the CLP SOW DFLM01.0.

Note: Blind QC samples must meet EPA's 99% Confidence Limits.

14. Action Required if Limits are Exceeded

If limits are exceeded, contact the Sample Management Office, then _____

_____

_____

Please return this request to the Sample Management Office as soon as possible to expedite processing of your request for Special Analytical Services. Should you have any questions or need any assistance, please contact your Regional representative at the Sample Management Office.

HEALTH AND SAFETY PLAN

FINAL

ADDENDUM NO. 1

HEALTH AND SAFETY PLAN

PIER 33 AND BERTH 16/FORMER INCINERATOR

INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE - NEW LONDON
GROTON, CONNECTICUT

PREPARED FOR:

NORTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
LESTER, PENNSYLVANIA

FEBRUARY 1993

ATLANTIC PROJECT NO.: 1256-15-01
NAVY CONTRACT NO. N62472-88-C-1294

ATLANTIC
ENVIRONMENTAL SERVICES, INC. 188 NORWICH AVENUE COLCHESTER, CONNECTICUT 06415 (203) 537-0751

TABLE OF CONTENTS

SECTION		PAGE
1.0	INTRODUCTION	1
2.0	MEDICAL SURVEILLANCE PROGRAM	4
3.0	EMERGENCY SUPPORT AND PROCEDURES	6
3.1	Communications	6
3.2	Local Emergency Support Units	6
3.3	Preparation for Medical Emergencies	6
3.4	First Aid for Injuries Incurred During Field Work	7
	3.4.1 First Aid Equipment List	7
	3.4.2 Other Emergency Equipment	8
3.5	Record of Injuries Incurred Onsite	8
	3.5.1 Occupational Injuries and Illnesses Form (OSHA 200)	8
	3.5.2 Employer's First Report of Injury	8
3.6	Emergency Site Evacuation Procedures	8
4.0	TRAINING PROGRAMS	11
4.1	Health and Safety Training	11
4.2	Onsite Training Program	12
5.0	SITE SAFETY PLAN	14
5.1	Introduction	14
	5.1.1 Pier 33 - Site Description	14
	5.1.2 Berth 16 - Site Description	16
5.2	Entry Objectives	18
5.3	Authorized Site Personnel and Their Responsibilities	18
5.4	Control of Site Access	19
5.5	Evaluation of Potential Hazards at the Associated Sites	20
5.6	Levels of Protection For Site Workers	21
	5.6.1 Levels of Protection for Specific Site Activities	22
	5.6.2 Radiological Monitoring	23
	5.6.3 Ambient Monitoring and Protection Limits	23

TABLE OF CONTENTS
(continued)

SECTION		PAGE
5.6.4	Heat Stress Monitoring	23
5.6.5	Precautions for Sampling or Contacting Medical Wastes	25
5.6.6	Precautions for Sampling or Contact with Buried Compressed Gas or Ordnance	25
5.6.7	Precautions for Confined Entry Work	25
5.7	Communication Procedures	26
5.8	Decontamination Procedures	26
5.8.1	Personnel Decontamination Station	26
5.8.2	Heavy Equipment Decontamination	27
5.9	Location of Buried Utilities	27
5.10	Engineering Controls and Work Practices	28
5.11	Handling Drums and Containers	28
5.12	Illumination	28
5.13	Sanitation for Temporary Work Sites	28
6.0	SIGNATURES OF FIELD TEAM MEMBERS AND OBSERVERS	29

TABLES:

Table 5-1: Signs and Symptoms of Heat Stress	24

FIGURES:

Figure 1-1: Subase Location	2
Figure 1-2: Installation Restoration Study Sites	3
Figure 3-1: Route to Lawrence and Memorial Hospital	10
Figure 5-1: Site Safety Plan - Pier 33	15
Figure 5-2: Site Safety Plan - Berth 16	17

APPENDICES:

Appendix A: Recommended Blood Tests
Appendix B: Sample Medical Data Sheet
Appendix C: Accident Report Form
Appendix D: OSHA Form 200
Appendix E: Employer's First Report of Injury Form
Appendix F: Record of Safety Meetings
Appendix G: Material Safety Data Sheets

1.0 INTRODUCTION

This Health and Safety Plan (HASP) addresses the health and safety practices that will be employed by all site workers participating in the Installation Restoration Study at the Pier 33 and Berth 16 sites at the Naval Submarine Base - New London, Groton, Connecticut (NSB-NLON). This HASP is a modification of the original HASP, dated April 1989, prepared for similar investigations of seven Step 1 sites and four Step II sites. Pier 33 and Berth 16 are Step I sites. Figure 1-1 shows the general location of NSB-NLON and Figure 1-2 shows the two newly identified sites and the original eleven investigation sites.

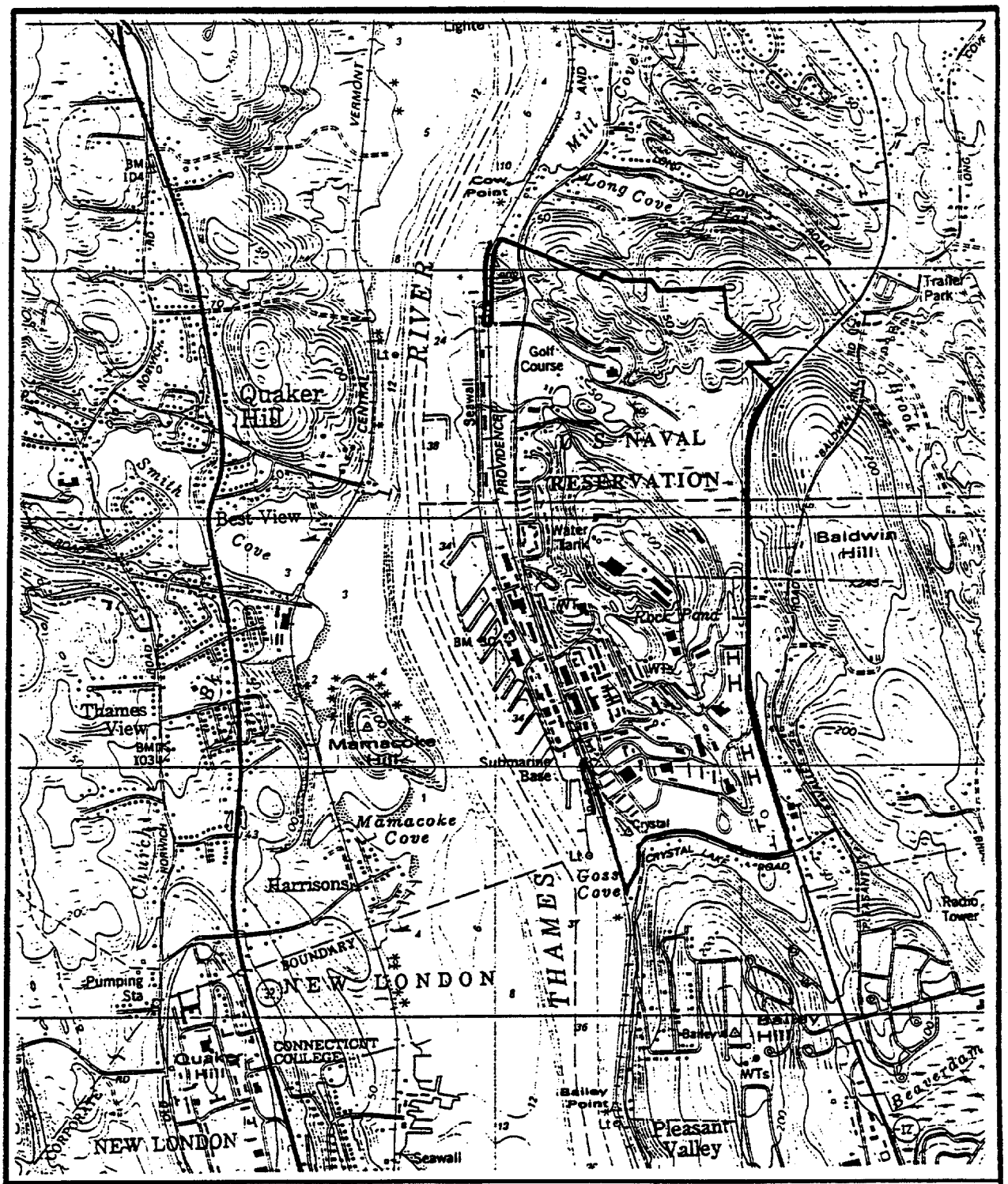
Step I involves a preliminary assessment of the site based on a screening level of field investigation in order to determine the presence of contamination and potential health and environmental risks. Step II involves a comprehensive field investigation in order to determine the extent of contamination, health and environmental risks, and evaluate remedial alternatives if appropriate. The HASP takes into account the specific hazards inherent to each site and presents detailed procedures to be followed by Atlantic Environmental Services, Inc. (Atlantic) and its subcontractors in order to avoid and, if necessary, deal with potential health and/or safety problems. All activities performed under this HASP will comply with OSHA Regulations 29 CFR Part 1910, 1925 and 1926 with amendments.

This plan is based on an initial assessment of health and safety risks associated with each site. The plan will be updated if additional information is obtained on the chemical nature of materials spilled, used or disposed at each site and their associated health and safety risks.

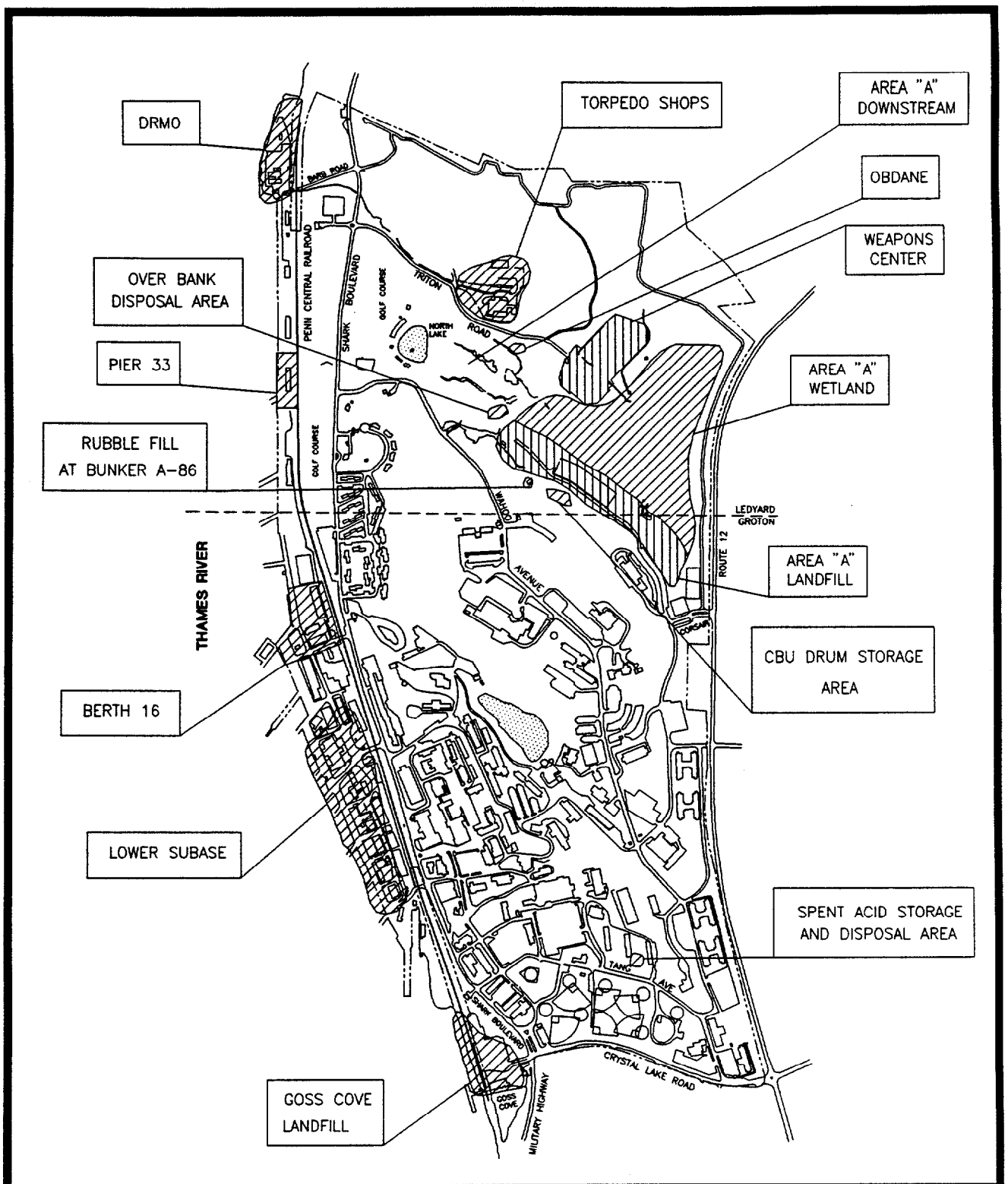
The HASP will be applicable to all of the field activities which are discussed in detail in the Field Sampling Plan. Elements of the field investigation include a soil gas survey, utility inspections, installation of monitoring wells, drilling of test borings, well development, ground water sampling, and soil sampling. The field sampling plan outlines which investigative measures are proposed for each site. Specific health and safety measures applicable to each activity will be discussed in the following sections of the HASP.

Included in this HASP are four general sections covering the Medical Surveillance Program, Emergency Procedures, Safety Training Programs, and the Site Safety Plan. The Site Safety Plan is written in a format such that it can be separated from this HASP and posted at the site field office for general use.

Robert Breeding is Atlantic's Corporate Health and Safety Officer and Barry Giroux is the designated Health and Safety Engineer for the investigation of the NSB-NLON site. When referred to in the following plan, site safety engineer refers to Mr. Giroux or his designee.



INSTALLATION RESTORATION STUDY **NAVAL SUBMARINE BASE** **NEW LONDON** **GROTON, CT**	SOURCE: Uncasville, CT U.S.G.S. Topographic Map 1984 N	**FIGURE 1-1** **SUBASE LOCATION** ATLANTIC ENVIRONMENTAL SERVICES, INC.



INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE - NEW LONDON
GROTON, CT

SOURCE: Naval Submarine Base
Existing Conditions
April 1985
Laureiro Engineering Associates

N

0 600 1200
GRAPHIC SCALE IN FEET

FIGURE 1-2
INSTALLATION RESTORATION STUDY SITES

ATLANTIC ENVIRONMENTAL SERVICES, INC.

2.0 MEDICAL SURVEILLANCE PROGRAM

Atlantic maintains a continuous in-house medical surveillance program designed specifically for field personnel engaged in work at sites where hazardous or toxic materials may be present. Atlantic employs the services of Lawrence & Memorial Occupational Health Center and Dr. Martin G. Cherniak, M.D., M.P.H. who are specialists in occupational health and conduct yearly comprehensive examinations of all field personnel on Atlantic staff. The medical results of the examinations aid in determining the overall fitness of employees participating in field activities.

Dr. Cherniak's address and telephone number are:

Office: Lawrence & Memorial Occupational Health Center

Suite 28, 404 Thames Street
Groton, Connecticut 06340

Telephone: (203) 445-4551

Under Dr. Cherniak's supervision, all field personnel undergo a complete physical examination including a detailed medical and occupational history before they participate in hazardous waste site investigations. The following tests are performed as part of the examination:

- Complete blood workup (38 analyses), including screens for particular toxicants anticipated at the NSB-NLON sites (see Appendix A for list of recommended blood tests).
- Urine analysis, including screens for metals and indicators of proper kidney and liver function.
- Pulmonary Function
- Electrocardiogram
- Chest x-ray
- Hearing and Eye exam

Upon completion of these tests, personnel are certified whether they are fit for field work, in general, and fit to use all levels of respiratory protection, in particular.

In the event that an employee of Atlantic is exposed to some form of hazardous substance or wishes to be rechecked because he/she shows symptoms of exposure, he/she will be sent to Dr. Cherniak immediately. Dr. Cherniak also acts as a consultant to the subcontractors participating in Atlantic's field teams providing information on health risks associated with various chemical substances.

All subcontractors or other personnel that will enter any active sampling area must certify that all of their personnel are in a medical surveillance program that complies with OSHA regulations for hazardous waste operations (29CFR 1910.120).

3.0 EMERGENCY SUPPORT AND PROCEDURES

3.1 Communications

A telephone will be located in the field office trailer located adjacent to Building 181. A mobile telephone will be provided with the field vehicles used at each sampling activity. Walkie-talkies may be used to communicate during field investigations.

3.2 Local Emergency Support Units

In order to be able to deal with any emergency that might occur during the site investigations, the following information has been obtained and will be posted prominently in the field office. Field teams working away from the site office will carry a copy of these emergency numbers:

1.	Local emergency medical team located at NSB-NLON (ambulance/fire dispatcher):	Dial 449-3333
2.	Nearest emergency room (NSB-NLON Hospital):	449-3666
	Emergency Room at Lawrence Memorial Hospital (New London):	442-0711
3.	Groton Police:	445-2451
4.	Groton Fire Department:	445-2456
5.	Toxicological Consultant: Dr. Cherniak:	445-4551
6.	Utility Emergencies (electric, gas, water and sewer) NSB-NLON Public Works:	449-3841
7.	Authorized Navy Site Personnel:	
	William Mansfield:	449-4481
	Adrienne Townsel:	449-3853
		After 11/91 (215) 877-6432
8.	NSB-NLON Security:	449-3224
9.	National Information Centers:	
	Chemtrec:	(800) 424-9300
	National Response Center:	(800) 424-8802

Before the field investigations begin, the NSB-NLON fire department will be notified of the field activities planned and the potential materials that are thought to exist at each site so that they will be able to respond in case of an emergency.

3.3 Preparation for Medical Emergencies

Atlantic will contact and meet with supervisory staff at the NSB-NLON fire department who will be the point of contact for all emergencies, i.e., chemical, fire, or injury, while working at NSB-NLON. The fire department will be able to provide ambulance and paramedic support to any incident, and they will make the critical decisions regarding where an injured person would be transported. In case of immediate threat to life, the Naval Hospital on NSB-NLON would be used, otherwise all cases would be directed to Lawrence and Memorial Hospital in New London.

Before field work on each site commences, personnel who will be working there or observing the operations will complete a brief medical history data sheet that includes the following information:

1. Name, address, home phone
2. Age, height, weight
3. Name of person to be notified in case of emergency
4. All prescription and non-prescription medications currently being used
5. Allergies
6. Particular sensitivities
7. Need for and type of corrective lenses
8. Short medical history including list of previous illnesses
9. Name of personal physician and phone

These data sheets will be filled out during an initial site safety training meeting before any field work begins. They will be filed in the field office, and their maintenance will be the responsibility of the designated site safety engineer or his designee (see Appendix B for sample medical data sheet).

In the event of an incident where a team member becomes exposed to or suffers from an acute symptom of exposure to site materials and has to be taken to a hospital, a copy of his/her medical data sheet will be presented to the attending physician.

3.4 First Aid for Injuries Incurred During Field Work

All injuries will be reported to the site safety engineer immediately. An accident report (Appendix C) will be completed by the safety engineer for all incidents.

A permanent first-aid station will be available at the field office trailer. A portable first aid station will accompany each field sampling team. During the site safety briefing, project personnel will be informed of the location of the first aid station(s).

When possible, site workers will refrain from administering first aid for serious injury or illness and await for the arrival of NSB-NLON professional paramedics at the site to take the appropriate action. Unless they are in immediate danger, injured persons will not be moved until paramedics can attend to them. Some injuries, such as severe cuts and lacerations or burns, may require immediate treatment. Any first aid instructions that can be obtained from doctors or paramedics, before an emergency-response squad arrives at the site or before the injured person can be transported to the hospital, will be followed closely.

3.4.1 First Aid Equipment List

The first aid kits that will be kept at the site will consist of a weatherproof container with individually sealed packages for each type of item. The kit will include at least the following items:

- Gauze roller bandages, 1 inch and 2 inch
- Gauze compress bandages, 4 inch
- Gauze pads, 2 inch

- Adhesive tape, 1 inch
- Band aids, 1 inch
- Butterfly bandages
- Triangular bandages, 40 inch
- Ampules of ammonia inhalants
- Antiseptic applicators or swabs
- Burn dressing and sterilized towels
- Surgical scissors
- Eye dressing
- Emergency eye wash
- Alcohol
- Hydrogen peroxide

3.4.2 Other Emergency Equipment

One portable fire extinguisher having a rating of 20ABC will be conspicuously and centrally located at the site office. In addition, extinguishers will be located at the drilling rig during subsurface sampling activities.

Portable extinguishers will be properly tagged indicating inspection dates and maintained in accordance with "Maintenance and Use of Portable Fire Extinguishers". As presented in the manual, field personnel will be trained in fire extinguisher use before field operations begin.

An emergency at any site, such as a fire or chemical release, might require that some appropriately trained site workers direct traffic on or near the site. Atlantic would be equipped to do this before NSB-NLON emergency support arrives. Reflective vests, flares, and flashlights to be used for traffic control will be kept readily available in the field office.

3.5 Record of Injuries Incurred Onsite

3.5.1 Occupational Injuries and Illnesses Form (OSHA 200)

All occupational injuries and illnesses that are required to be recorded under the Occupational Safety and Health Act will be registered on OSHA Form 200 (Appendix D). Occupational injuries and illnesses will be recorded by the site safety engineer within 48 hours of occurrence as is required by statute.

3.5.2 Employer's First Report of Injury

This form (Appendix E) will be completed by the site safety engineer for all accidents involving worker injury at the site. Follow-up procedures will include investigation of each accident or near-miss by the safety engineer to assure that no similar accidents that may lead to injuries occur.

3.6 Emergency Site Evacuation Procedures

In order to mobilize the manpower resources and equipment necessary to cope with a fire or other emergency, a clear chain of authority has been established. The site safety engineer will take charge of all emergency response activities and dictate the procedures that will be followed until

NSB-NLON personnel arrive. The safety engineer will report immediately to the scene of the emergency, assess the seriousness of the situation, and direct whatever efforts are necessary until the emergency response units arrive. At his/her discretion, the safety engineer also may order the closure of the site activity for an indefinite period.

All project personnel will be instructed on proper emergency response procedures and locations of emergency telephone numbers during the initial site safety meeting.

If an emergency occurs, including but not limited to fire, product spill, explosion, or significant release of gas into the atmosphere, an air horn will be sounded on the site. For those sites where only two or three people are working side by side, the air horn will not be necessary. For those operations where hearing is impaired or personnel are spread out, the horn will sound continuously for approximately 15 seconds, signaling that immediate evacuation of all personnel is necessary as a result of some immediate or impending danger. All heavy equipment will be shut down, and all personnel will evacuate the work areas and assemble at a predetermined area, where the site safety engineer will give directions for implementing whatever actions are necessary. The site safety engineer will attend a mobile telephone and call for backup assistance.

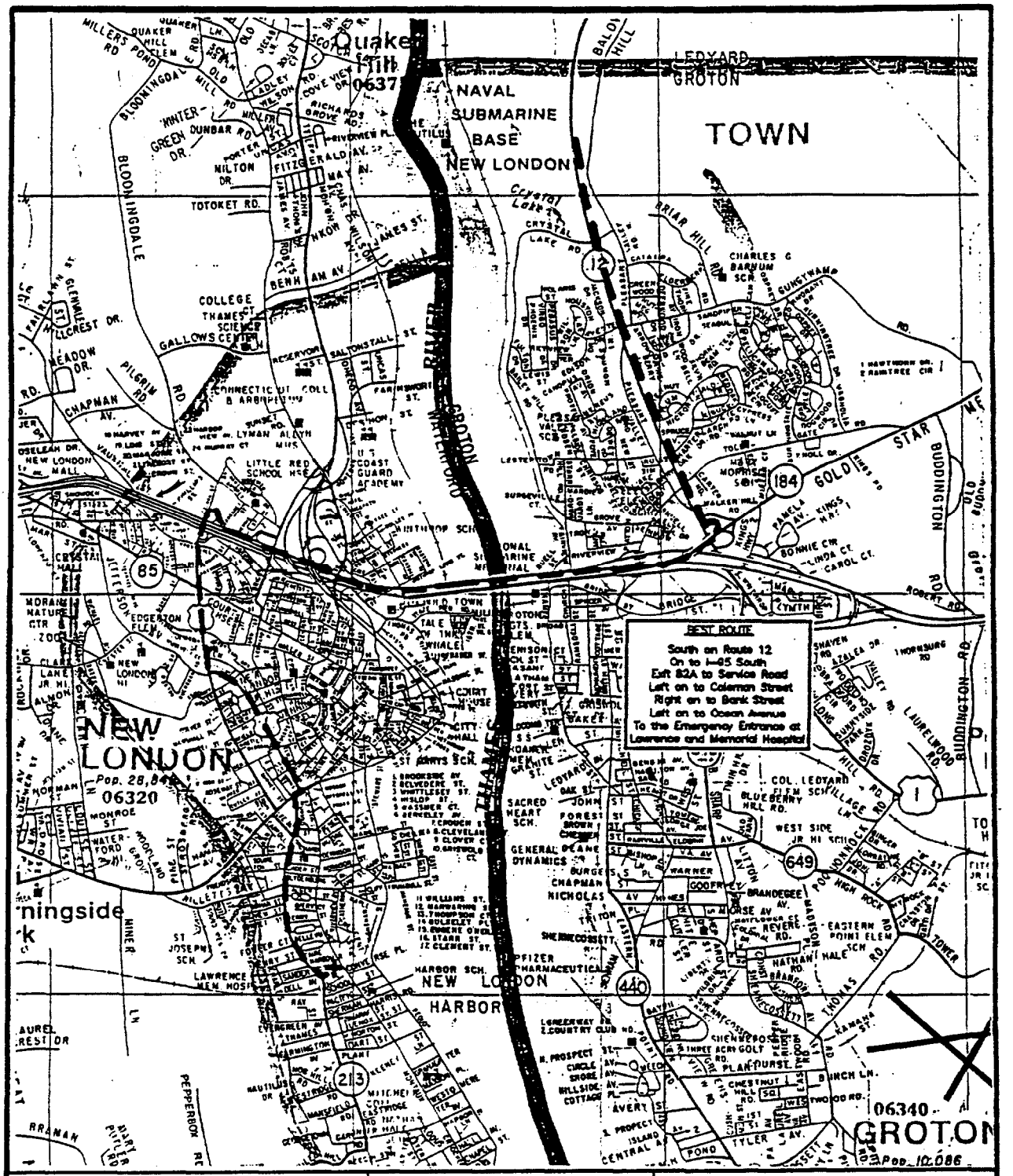
If a toxic-gas release has occurred, the safety engineer will determine whether it is upwind of the meeting place. If the gas poses a danger to the health and safety of those assembling, an alternative meeting location will be established. Under no circumstances will incoming visitors be allowed to enter a site while an emergency is occurring. Visitors or observers present in the area of the emergency will be instructed to evacuate the area immediately.

After sounding the alarm and initiating emergency response procedures, the site safety engineer will check and attempt to ensure that access roads are not obstructed. If traffic control is necessary, as in the event of a fire or explosion, one of Atlantic's personnel who has been trained in these procedures and designated at the site safety meeting will take over these duties until emergency units arrive. Appropriate reflective warning vests will be worn by personnel involved with traffic control.

The site safety engineer will remain on the site to provide any assistance requested by emergency-response squads as they arrive to deal with the situation.

The site safety engineer will have the authority to cease the field investigation after an emergency until he deems it safe to continue the investigation. He will dictate any changes in site safety practices which are made necessary by specific aspects of the emergency that has occurred or are required for preventing further emergencies.

The location of the NSB-NLON Naval Hospital is provided in Figure 1-2. The route to Lawrence and Memorial Hospital (New London) is shown on Figure 3-1.



INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE
NEW LONDON
GROTON, CT

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FIGURE 3-1
ROUTE TO LAWRENCE
AND MEMORIAL HOSPITAL

ATLANTIC ENVIRONMENTAL SERVICES, INC.

4.0 TRAINING PROGRAMS

4.1 Health and Safety Training

All of Atlantic's field personnel assigned to this project and its major subcontractors have attended at the minimum a 40 hour health and safety training course as required by OSHA standards. Also, a number of Atlantic's supervisory personnel have completed the required eight hour Supervisory Training Course required by OSHA. A list of Atlantic personnel identified to work at the NSB-NLON sites and titles and dates of the safety courses that they have attended are provided below.

Name	General Site Worker	Management and Supervisor
Paul Burgess	5/88	5/88
Barry Giroux	3/89	5/91
Erik Ness	3/90	5/91
Robert Breeding	7/90	5/91
John Bogdanski	6/91	----
Nicole Ruderman	8/90	----

These training courses have been comprised of classroom instruction, field demonstrations, use of respirators, use of appropriate protective clothing, and written and field tests. They cover the following topics:

1. Identification of hazardous substances
2. Properties of hazardous substances
3. Routes of exposure
4. Toxicity of different substances and their synergistic effects
5. Practical considerations in health and safety management
6. Physical properties of chemicals
7. References for threshold limit values (TLV), lower explosion limits (LEL), toxicity data, cross references
8. Technical assistance organizations
9. Air monitoring and survey instruments
10. Site entry and egress procedures
11. Heat stress monitoring
12. Levels of personnel protection
13. Controlling access to work zones and other contaminated areas
14. Personnel decontamination
15. Equipment decontamination
16. Site/area safety planning

Everyone attending the courses were tested for the fit of their personal respirator and were trained in using self contained breathing apparatus (SCBA) both with and without level A suits. The courses also emphasized the importance of, and discussed the procedures for, decontamination.

Health and safety training is an ongoing activity at Atlantic. Yearly refresher courses or site-specific training programs are presented as needed to keep field personnel up-to-date with proper health and safety practices.

All subcontractors or other personnel that will enter the active sampling area must certify that they have received the training specified in OSHA regulations for hazardous waste operations (29CFR1910.120).

4.2 Onsite Training Program

After the Atlantic field office has been set up and initial site mobilization has taken place, but before any drilling, surveying or sampling activities, the Atlantic site safety engineer will conduct an onsite training meeting for all personnel and observers who will be involved in the various site investigations. This program will cover specific practices and potential problems inherent to each site. No person will be allowed to work at the site unless he has attended this training meeting. During the meeting, the Site Safety Plan will be reviewed and copies given to all attending. Copies will be kept in the field office throughout the investigation. The major components of the onsite training are:

1. Review the scope of activities for each site.

2. Review of suspected chemical hazards for each site, their forms (e.g. vapor, gas, liquid), and the warning signs of their presence.

3. Review of potential hazards posed by drilling and sampling in the presence of underground utilities and other unidentified hazards.

4. Operational Procedures:

   - control of site activities
   - control of site access and perimeter
   - zones of hazard
   - levels of protection
   - detection equipment
   - decontamination procedures
   - specific precautions for drilling near buried tanks, utilities, and medical waste

5. Emergency Procedures:

   - first aid
   - emergency communications
   - local response groups and their phone numbers
   - evacuation procedures

6. Fit testing requirements for all personnel on their personal respirator prior to commencing work at the site.

7. Complete reading of the Site Safety Plan followed by initialing of the document to confirm the effort.

Any new personnel who join the field investigation team later in the study are required to go through a similar health and safety briefing before they may participate in any aspect of the field program.

Site-specific rules and regulations will be emphasized during the onsite safety meeting. The following rules will also be posted in the Atlantic office trailer:

1. No smoking, drinking, eating within restricted (contaminated) zones. Proper respiratory protection is required to be worn at all times within this zone, unless toxic vapor/gas levels are determined to be within recommended safe limits based on organic vapor meter readings near the subsurface work zones and thus do not pose a health hazard to workers.

2. All rest, refreshment, and sanitary facility use will take place in "clean areas" outside of restricted zones and decontamination zones.

3. Those in contact with contaminated soils or other materials that are thought to be contaminated must go through decontamination upon egress from the restricted area based on the level of contamination and before they may enter a "clean area" or non-restricted area. Decontamination procedures are detailed in Section 5.8.

4. The site safety engineer has full authority over start-up and shutdown of operations from a safety standpoint. He will determine whether conditions are too extreme for work, and he will establish the working hours at the site.

Additional meetings will be held if necessitated by changing site conditions, new operation procedures, or the entry of new personnel unfamiliar with important daily safety topics. A record will be kept of safety meeting dates and topics discussed (see Appendix F).

5.0 SITE SAFETY PLAN

The nature of contaminants present at NSB-NLON sites vary from site to site. This plan establishes policies and procedures to protect workers, base personnel, and other contractors and the public from the potential hazards posed by investigation activities at NSB-NLON. General NSB-NLON information is presented and specific site descriptions and potential hazards are given for each of the two investigation sites.

5.1 Introduction

Location: U.S. Naval Submarine Base (NSB-NLON) Groton and Ledyard, CT

Plan Prepared By: Barry Giroux, P.E.

Date Prepared: July 1991

Plan Use: 08/01/91 - 12/31/91

NSB-NLON consists of approximately 547 acres of land and is located off Route 12 in the Towns of Ledyard and Groton. The area surrounding NSB-NLON consists of primarily residential dwellings, undeveloped land, and some commercial establishments. The site is easily accessible to emergency response groups, both within NSB-NLON and from area municipalities. A Naval hospital is located on NSB-NLON, and the New London Hospital is located within four miles of the subject property.

Morrison Geotechnical Engineering during 1990 performed chemical analyses on subsurface soils in connection with the proposed dredging for the construction of new quaywalls near Pier 33 and Berth 16. Those analyses indicated a release of No. 2 fuel oil in both of these locations. As a result, the Navy decided a Step I environmental investigation was warranted. In addition, record searches showed a former underground distribution system for electrolyte (battery acid) and electrical transformers.

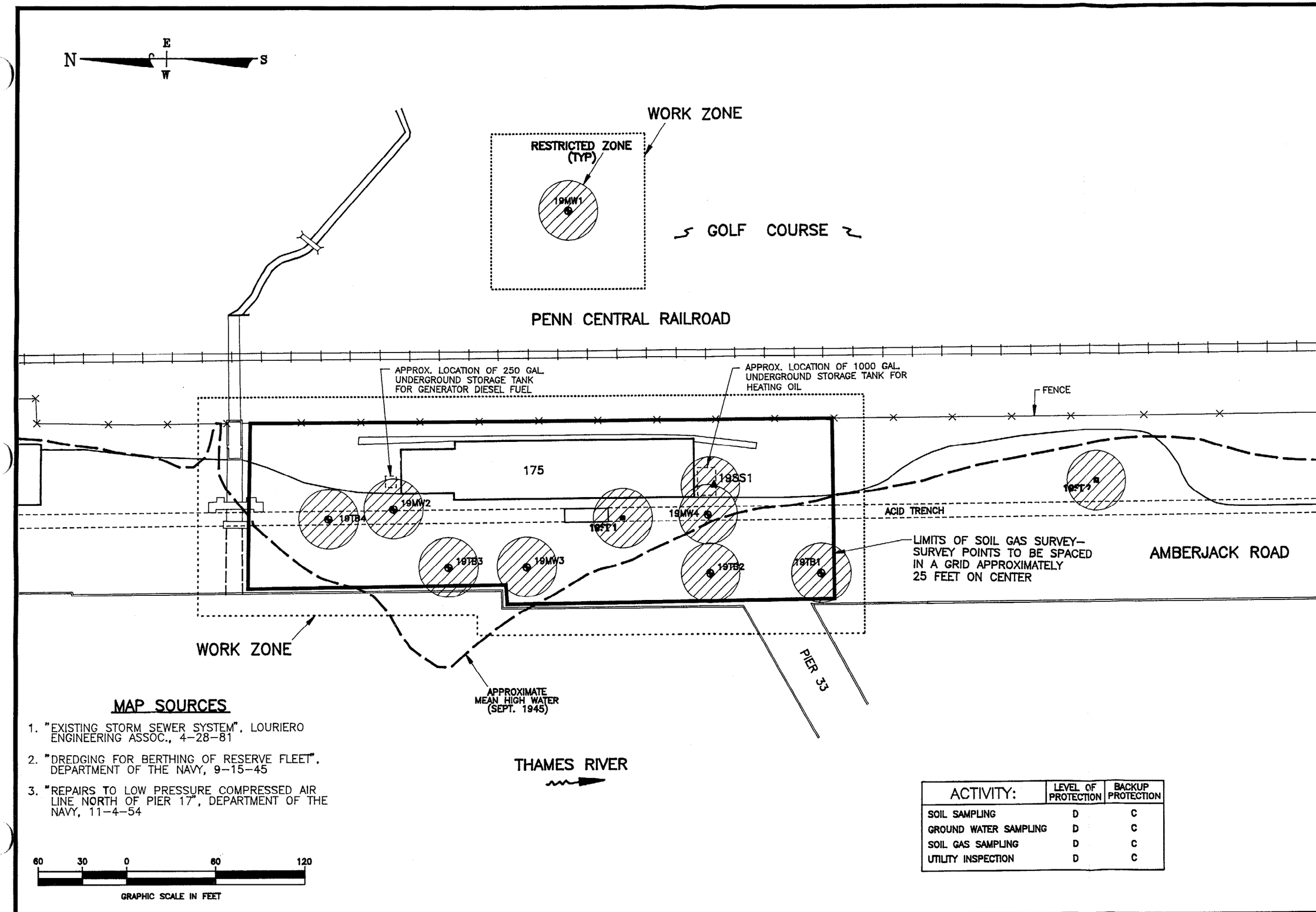
This HASP is developed in conjunction with the Field Sampling Plan which describes the field investigation program which will be performed by Atlantic Environmental Services, Inc. (Atlantic) as part of the Naval Installation Restoration Study at Pier 33 and Berth 16.

Specific descriptions of the two additional Step I sites to be investigated are discussed below.

5.1.1 Pier 33 - Site Description

1. Location and Access: The site is located in the northwestern portion of NSB-NLON and in the northern portion of the Lower Subase. Amberjack Road provides direct access to the site. The site is bounded on the east by the Penn Central Railroad and on the west by the Thames River. A site plan is shown in Figure 5-1.

2. Existing information for Site: Detailed _____
   Preliminary __X__ Sketchy _____ None _____



MAP SOURCES

1. "EXISTING STORM SEWER SYSTEM", LOURIERO ENGINEERING ASSOC., 4–28–81
2. "DREDGING FOR BERTHING OF RESERVE FLEET", DEPARTMENT OF THE NAVY, 9–15–45
3. "REPAIRS TO LOW PRESSURE COMPRESSED AIR LINE NORTH OF PIER 17", DEPARTMENT OF THE NAVY, 11–4–54

ACTIVITY:	LEVEL OF PROTECTION	BACKUP PROTECTION
SOIL SAMPLING	D	C
GROUND WATER SAMPLING	D	C
SOIL GAS SAMPLING	D	C
UTILITY INSPECTION	D	C

LEGEND

- 123 BUILDING NUMBER
- UNDERGROUND STORAGE TANK
- RAILROAD TRACKS
- DIESEL FUEL OIL
- 19TB1 PROPOSED TEST BORING
- 19MW1 PROPOSED MONITORING WELL
- 19SS1 PROPOSED SOIL SAMPLE
- 19SD1 PROPOSED SEDIMENT SAMPLE

FIGURE 5–1
SITE SAFETY PLAN
PIER 33

ATLANTIC ENVIRONMENTAL SERVICES, INC.

INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE–NEW LONDON
GROTON, CONN.

0652 12072

3. Site History/Status: The site was originally developed as a battery acid storage area to support berthing of the reserve fleet. The area is presently used for miscellaneous storage of non-hazardous materials.

4. Facilities Onsite: Potable water, electricity, communications, and sanitary facilities are available from many sources in this and adjacent areas.

5. Underground Utilities: This area is serviced by communications, electricity, sanitary sewer, compressed air, and storm sewers which are located underground. The available utility maps have been reviewed prior to selecting the locations for borings/monitoring wells. Prior to commencing any drilling, NSB-NLON Department of Public Works personnel will be contacted to approve drilling locations.

6. Topography: The site is relatively level from the Thames River to the buildings and is paved. The ground slopes steeply upward from the buildings to the Penn Central Railroad.

7. Additional Information: Based upon information provided by NSB-NLON personnel, there are two underground fuel oil tanks located at this site.

8. Potential Hazardous Chemicals Onsite: Hazardous materials identified onsite consist of No. 2 fuel oil and battery acid (formerly). Potential hazardous materials onsite include No. 6 fuel oil, PAH compounds, solvents, and lead.

5.1.2 Berth 16 - Site Description

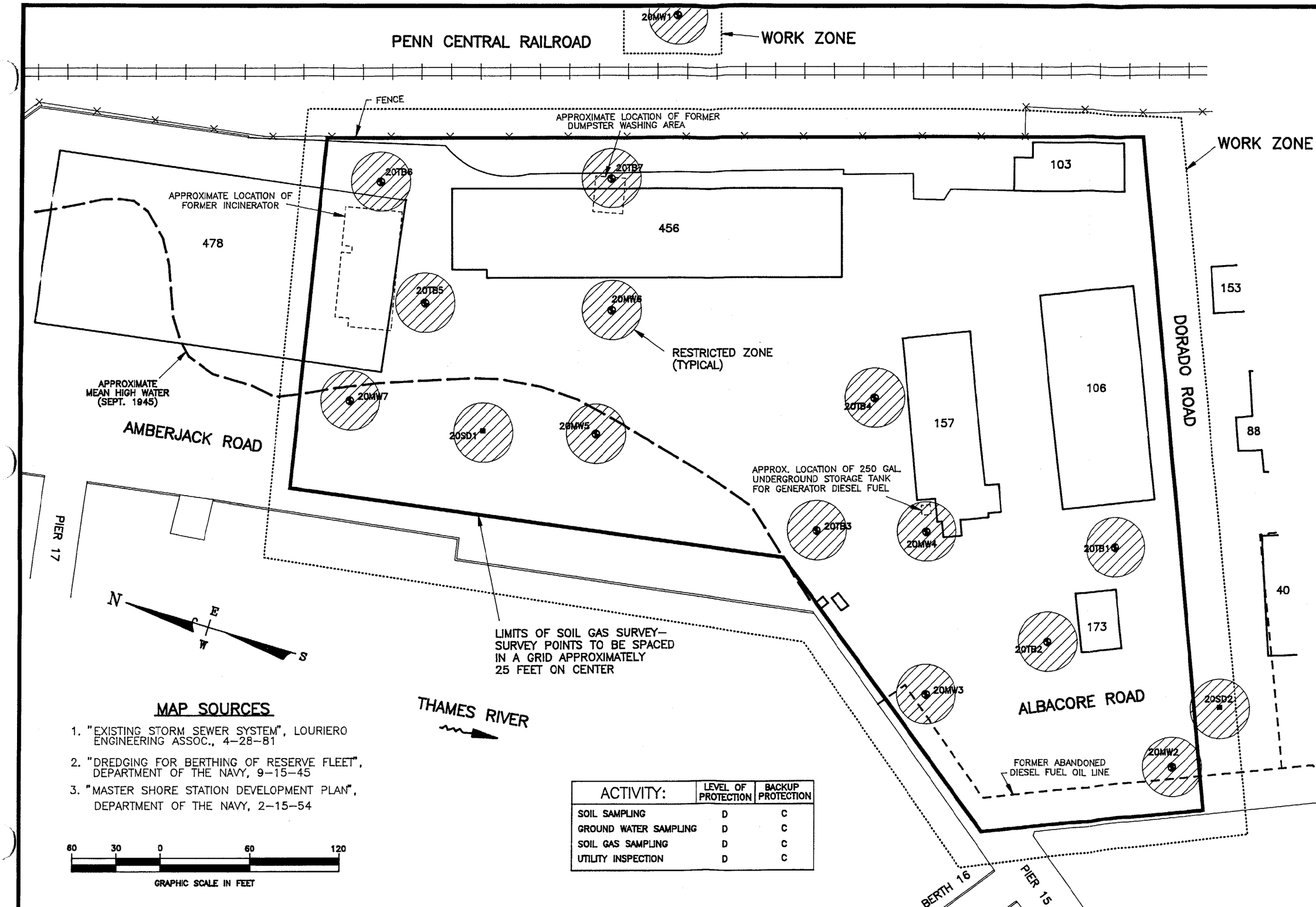
1. Location and access: The site is located in the northwestern portion of the property in the northern portion of the Lower Base. This site is south of Pier 33. Amberjack Road provides direct access to the site. The site is bounded on the west by the Thames River and on the east by the Penn Central Railroad. A site plan is shown in Figure 5-2.

2. Existing Information for Site: Detailed _____
Preliminary __X__ Sketchy _____ None _____

3. Site History/Status: This site originally contained a garbage incinerator in the northern section. The buildings to the south have been present since the early 1900s. Presently this area is used primarily for maintenance activities.

4. Facilities Onsite: Potable water, electricity, communications, and sanitary facilities are available from many sources in this and adjacent areas.

5. Underground Utilities: This area is serviced by steam, communications, electricity, sanitary sewer, compressed air, and storm sewers which are all located underground. The available utility maps have been reviewed prior to selecting the locations for borings/monitoring wells. Prior to commencing any drilling, NSB-NLON Department of Public Works personnel will be contacted to approve drilling locations.



MAP SOURCES

1. "EXISTING STORM SEWER SYSTEM", LOURIERO ENGINEERING ASSOC., 4–28–81
2. "DREDGING FOR BERTHING OF RESERVE FLEET", DEPARTMENT OF THE NAVY, 9–15–45
3. "MASTER SHORE STATION DEVELOPMENT PLAN", DEPARTMENT OF THE NAVY, 2–15–54

ACTIVITY:	LEVEL OF PROTECTION	BACKUP PROTECTION
SOIL SAMPLING	D	C
GROUND WATER SAMPLING	D	C
SOIL GAS SAMPLING	D	C
UTILITY INSPECTION	D	C

FIGURE 5–2
SITE SAFETY PLAN
BERTH 16

ATLANTIC ENVIRONMENTAL SERVICES, INC.

LEGEND

- 123 — BUILDING NUMBER
- UNDERGROUND STORAGE TANK
- RAILROAD TRACKS
- DIESEL FUEL OIL
- 20TB1 — PROPOSED TEST BORING
- 20MW1 — PROPOSED MONITORING WELL
- 20SD2 — PROPOSED SEDIMENT SAMPLE

INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE–NEW LONDON
GROTON, CONN.

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6. Topography: The site is relatively level from the Thames River to the rear of the buildings, and is paved. The ground slopes steeply upward from the rear of the buildings to the Penn Central Railroad. There is a large retaining wall behind some of the buildings.

7. Additional Information: Based upon information provided by NSB-NLON personnel, there is one underground diesel storage tank located at the generator adjacent to building 159. This area was formerly serviced by underground fuel lines and there was a dumpster washing facility to the south of the garbage incinerator. Transformers that might have contained PCB oils were formerly present at the electrical substation (Building 173).

8. Potential Hazardous Chemicals Onsite: Hazardous materials identified onsite consist of No. 2 fuel oil. Potential hazardous materials onsite include No. 6 fuel oil, PAH compounds, PBCs, solvents, and lead.

5.2 Entry Objectives

The HASP was developed to provide a predetermined level of safety with contingencies during non intrusive testing, drilling, well installation, well development, soil sampling, and ground water sampling activities at NSB-NLON. The purpose of the field investigation is to determine the extent and source of contamination onsite, assess environmental and public health risks, and evaluate remedial action plans.

5.3 Authorized Site Personnel and Their Responsibilities

The following responsibilities have been assigned to the personnel indicated below:

(Note: One person may be responsible for more than one job function:)

Project Manager:	Paul Burgess
Health and Safety Officer:	Robert Breeding
Site Safety Engineer:	Barry Giroux
Field Team Leader:	Barry Giroux
Field Team Members:	Erik Ness
	John Bogdanski

Authorized Navy Representatives:

William Mansfield (Point of Contact)
Suzanne Berkman
Deborah Stockdale, Engineer in Charge

State/Federal Agency Representatives:

Andrew Miniuks, USEPA
Paul Jameson, CTDEP

Contractors: To be selected.

5.4 Control of Site Access

1. The site safety engineer will be responsible for controlling access to all work areas and contaminated zones on the site.

2. The sites which are the subject of the restoration study have been identified according to restricted zones, decontamination zones, and the support zone(s) ("clean" areas, such as the field office or laboratory). These areas are indicated on the individual site maps and are described as follows:

   a. Restricted Zones:

      1) In areas of drilling including surface soil sampling, the work is defined as a circle around the sample point or drill rig with a radius of 20 feet. Only authorized site personnel will be able to enter this zone under the appropriate level of protection during sampling activities.

   b. Decontamination Zone(s):

      1) Personnel decontamination will also be conducted near the site office area. The office will be marked by a sign.

      2) All heavy equipment and drilling tools will be decontaminated at a centralized area in Area A. See Figure 5-3. All sediment and water from this operation will be contained and stored in drums prior to disposal.

   c. Support Zones (clean areas):

      1) The Site office will be located at a field trailer near Building 181.

      2) The heavy equipment (e.g., drilling) storage location will be situated in Area A.

Maps of the base of operations heavy equipment decontamination area and both of the sites delineating the various areas described above will be posted at the following locations:

<u>POC's Office</u>
<u>Atlantic's Site Office</u>
<u>NSB-NLON Security Office</u>
<u>NSB-NLON Fire Department</u>

If site conditions develop that require changes in the established zones, the Navy POC will be notified immediately. The zones will be revised, and a meeting will be held for site personnel to inform them of the changes, the reasons that caused them to be made, and any new health and safety practices that might be necessary as a result of the altered site conditions. The site maps will be revised to show the new configuration of controlled areas. The new maps will be posted at the locations listed above and attached to the copy of the HASP kept in the site office.

5.5 Evaluation of Potential Hazards at the Associated Sites

The major waste types expected at these sites, based on past operations, and the primary hazards of each are identified below.

WASTE SOURCES: FUEL OIL, WASTE OIL AND PETROLEUM PRODUCTS

Potential Locations: Pier 33 and Berth 16

Form: Gas ___ Liquid _X_ Sludge _X_ Solid _X_ (Adsorbed)

Characteristic: Corrosive ___ Ignitable _X_ Radioactive__
Volatile _X_ Toxic ___ Reactive __ Other ___
Unknown __

Containment: Drum _?_ Pit _?_ (Buried) Pond ___ Lagoon ___
Above ground tank __ Below ground tank _?__
Soils _X_ Debris ___ Other ___

WASTE SOURCES: SOLVENTS

Potential Locations: Pier 33 and Berth 16

Form: Gas ___ Liquid _X_ Sludge ___ Solid _X_ (Adsorbed)

Characteristic: Corrosive _X_ Ignitable _X_ Radioactive ____
Volatile _X_ Toxic _X_ Reactive ____ Other ___
Unknown ____

Containment: Drum _?_ Pit _?_ (Buried) Pond ___ Lagoon ___
Above ground tank ___ Below ground tank ____
Soils _X_ Debris ___ Other ___

WASTE SOURCES: BATTERY ACID STORAGE AND TRANSFER

Potential Locations: Pier 33

Form: Gas ___ Liquid _X_ Sludge __ Solid _X_ (Adsorbed)

Characteristic: Corrosive _X_ Ignitable ___ Radioactive__
Volatile __ Toxic _X_ Reactive _X_ Other ___
Unknown __

Containment: Drum _?_ Pit _?_ (Buried) Pond __ Lagoon __
Above ground tank __ Below ground tank _?__
Soils _X_ Debris __ Other __

NOTE: "?" indicates a feature or characteristic whose existence is determined on a site specific basis during the preliminary phase of the investigation; x indicates a characteristic usually associated with the specific waste type.

The specific chemicals expected to be found on the site are listed below and Materials Safety Data Sheets for these compounds are included in Appendix G.

Substances Involved	Primary Hazards
Petroleum product contaminated soils	Skin absorption, vapor inhalation, skin or eye contact
Solvents	Vapor inhalation, skin absorption, skin or eye contact
PAH compounds	Skin or eye contact
Lead compounds	Inhalation of fugitive dust, ingestion, direct contact
Battery Acid	Corrosive

The following additional hazards, not related to NSB-NLON disposal activities, also are expected to be found on site: Overhead power lines, vehicular traffic around site vicinity, and buried utilities.

5.6 Levels of Protection For Site Workers

Levels of protection specified by the EPA refer largely to requirements for respiratory protection. The lists below stipulate equipment for respiratory, clothing, and other types of protection that will be required for different tasks during the site investigation. The designated levels of protection are based on evaluation of potential hazards and risks associated with work at the NSB-NLON site.

Based on organic vapor readings using a HNu photoionization detector or OVA flame ionization detector in the work zone for each site activity, the criteria for maintaining or revising levels of protection taken in respiratory areas are as follows:

Background (ambient)	Level D
5-50 ppm above ambient	Level C
50-500 ppm above ambient	Level B
500-1000 ppm above ambient	Level A

5.6.1 Levels of Protection for Specific Site Activities

ACTIVITY	LEVEL OF PROTECTION	BACKUP PROTECTION
PIER 13		
Soil Gas Survey	D	C
Borings and Well Installation	D	C
Well Development and Ground Water Sampling	D	C
BERTH 16		
Soil Gas Survey	D	C
Borings and Well Installation	D	C
Well Development and Ground Water Sampling	D	C

Specific protective equipment for each level of protection is as follows:

LEVEL C	LEVEL D
half- or full-face respirators (MSA GMC-H or equivalent) depending on site conditions	hard hats with splash shields or goggles
tyvek splash resistant suit	tyvek suit or work overalls
hard hats with splash shields or goggles	steel-toe boots and over-boots
steel-toe boots and over-boots	disposable, latex, inner gloves
disposable, latex inner gloves	chemical-resistant outer gloves
chemical-resistant outer gloves	

LEVEL B	LEVEL A
pressure-demand, full face SCBA or pressure demand supplied air respirator with escape SCBA	pressure-demand, full face SCBA or pressure demand supplied air respirator with escape SCBA
chemical resistant clothing	fully encapsulating chemical resistant suit
inner and outer chemical resistant gloves	inner and outer chemical resistant gloves
chemical resistant safety boots or shoes	chemical resistant safety boots or shoes
hard hat	hard hat
two way radio	two way radio

The site safety engineer will closely monitor the work schedules listed in the Field Sampling Plan in order to be sure that all workers entering the site have had their safety briefing and the amount of safety equipment kept on site, such as the number of respirators available, is sufficient for all of the workers and observers present at any time.

5.6.2 Radiological Monitoring

An environmental radiation survey was conducted prior to investigations at the original eleven sites. The results of this investigation can be found in a separate report. Based upon the results of that investigation and the site history of the new study areas, no radiological monitoring is required.

5.6.3 Ambient Monitoring and Protection Limits

During drilling, excavation, and sampling, the air in work areas will be sampled periodically for the presence of contaminants as stipulated by the EPA Interim Standard Operation Guidelines. A HNu portable photoionizer will be utilized to periodically monitor the levels of organic vapors in the ambient air during the field work to ensure that appropriate levels of respiratory protection are employed at all times. HNu readings will be taken continuously during the advancement of drill holes or test pits. Measurements will be monitored from within the test pits or the top of the borings as an indicator of the worst case conditions, however, measurements will be monitored from the respiratory level (waist level and higher) for determining the actual safety conditions and whether there is a need to change to a higher level of safety (or whether the level of safety can be lowered). In addition, Atlantic will use an oxygen deficiency and lower explosive limit (LEL) meter to screen for potential gas or vapor leaks around drilling operations in unknown areas. The following gas specific Draeger tubes will be used as necessary:

- hydrogen sulfide
- natural gas
- benzene
- vinyl chloride
- mercury vapor
- cyanide

5.6.4 Heat Stress Monitoring

Wearing personal protective equipment puts site workers at risk of developing heat stress which may result in health effects ranging from fatigue to serious illness to death. Heat stress is caused by the interplay of a variety of factors, including ambient conditions, workload, clothing, and the physical characteristics of each worker. The major symptoms of heat stress are listed in Table 5-1. When the temperature in the work area is at or above 70 degrees F (21 degrees C), all workers, even those not wearing protective clothing, will be monitored for heat stress during rest periods according to the following procedures:

- Take pulse over a 30 second period as early as possible in the rest period. If the heart rate exceeds 110 beats per minute at the beginning of the rest period, shorten the next work cycle by one third and keep the rest time the same. If, at the next rest period, the heart rate still excees 110 beats per minute, shorten the following work period again by one third. Continue the process as necessary.

TABLE 5-1

SIGNS AND SYMPTOMS OF HEAT STRESS

Heat rash may result from continuous exposure to heat or humid air.
Heat cramps are caused by heavy sweating with inadequate electrolyte replacement. Signs and symptoms include: • muscle spasms • pain in the hands, feet and abdomen
Heat exhaustion occurs from increased stress on various body organs including inadequate blood circulation due to cardiovascular insufficiency or dehydration. Signs and symptoms include: • pale, cool, moist skin • heavy sweating • dizziness • nausea • fainting
Heat stroke is the most serious form of heat stress. Temperature regulation fails and the body temperature rises to critical levels. Immediate action must be taken to cool the body before serious injury and death occur. Competent medical help must be obtained. Signs and symptoms are: • red, hot, usually dry skin • lack of or reduced perspiration • nausea • dizziness and confusion • strong, rapid pulse • coma

- Take body temperature orally using a clinical thermometer kept under the tongue for three minutes. Take temperature at the end of each work cycle before drinking anything. If the temperature exceeds 99.6°F (37.6°C), shorten the next work period by one third without changing the rest period. If the temperature still exceeds 99.6°F at the beginning of the next rest period, shorten the following work cycle by one third. No worker will be permitted to wear a semi-permeable or impermeable garment if their temperature exceeds 100.6°F (38.1°C).

- If possible, it is also a good practice to monitor worker's body water loss. Body water loss is determined by weighing each worker, on a scale good to 0.25 pounds, at the beginning and end of each day.

  The difference in weights will indicate whether an individual is drinking enough fluids to prevent dehydration. The body weight loss should not exceed 1.5 percent of the total body weight in one work day.

ALTHOUGH THE FOLLOWING HAZARDS (MEDICAL WASTE, ORDINANCE, CONFINED SPACE) ARE NOT EXPECTED TO BE ENCOUNTERED DURING INVESTIGATION OF THESE TWO NEW SITES, THE FOLLOWING PRECAUTIONS FROM THE ORIGINAL HASP ARE INCLUDED JUST IN CASE UNEXPECTED CONDITIONS ARE ENCOUNTERED.

5.6.5 Precautions for Sampling or Contacting Medical Wastes

Due to the ambiguous nature of where historic medical waste were disposed and the potential for encountering it at NSB-NLON, Atlantic will take special precautions when working. If encountered, the site personnel will handle lab packs, syringes, medicinal vials, and/or soiled fabric by remote handling (pliers or other tool) practices. Level C respiratory protection plus a double layer of chemical resistant gloves will be worn while handling these wastes. Such wastes will be stored in plastic bags and documented in field logs and through chain-of-custody procedures. In no case will any site workers be allowed to breath or touch any form or sign of medical wastes. Medical wastes encountered will be placed under the control of the Navy for disposal with other hospital wastes generated at NSB-NLON.

5.6.6 Precautions for Sampling or Contact with Buried Compressed Gas or Ordnance

Atlantic will use a metal detector, organic vapor analyzers, and LEL (lower explosive limit) meters at the drilling operations to screen for potential releases of compressed gas. If a release is imminent, the site safety engineer and the activity POC will be notified and emergency procedures will be implemented.

5.6.7 Precautions for Confined Entry Work

The Field Sampling Plan does not call for performing any specific confined entry work, but the nature of site investigations is to find the unexpected. Therefore, if any confined entry work is required, it will be performed in accordance with NAVSEA S6470-AA-SAT-010 (NAVSEA Gas Free Engineering Program) and NIOSH Standards for Working in Confined Spaces (December 1979). Copies of both standards will be kept on file in Atlantic's main office. Confined entry work

will not be performed without first notifying and receiving approval from the site safety engineer at the POC.

5.7 Communication Procedures

Atlantic will utilize mobile telephones at the base of operations and for each field activity in order to have access to emergency support groups and between field team members.

5.8 Decontamination Procedures

Decontamination areas will be established for the following activities:

1) Personnel Decontamination
2) Equipment Decontamination

5.8.1 Personnel Decontamination Station

A personnel decontamination area will be set up **at the boundary of each exclusion zone and will consist of** benches where workers can sit, clean and remove protective clothing (e.g., boots and gloves) and other equipment, such as respirators. It will be equipped with basins for water, detergent, and other decontamination fluids. Once personnel have gone through decontamination at this station and taken off their protective gear, they will be able to proceed to a sink where they will wash themselves wherever they may have been exposed to any contaminants.

The following specific decontamination procedure will be used by site workers wearing protective clothing and equipment from Level D through Level B:

Step 1	Equipment drop
Step 2	Boot and glove wash and rinse, and tape removal and drop (wash with non-foaming detergent, rinse with fresh water spray, then dilute acetone, then fresh water spray)
Step 3	Hard hat and goggle removal (use same wash as in Step 2)
Step 4	Tyvek suit removal
Step 5	Respirator wash and rinse and drop (use same wash and rinse sequence as in Step 2 with a soft-bristle brush and a sponge)
Step 6	Inner glove removal
Step 7	Wash potentially exposed skin (use water and soap at indoor sink)

Wash water and used cleaning fluids will be stored in drums onsite as specified in the Field Sampling Plan.

5.8.2 Heavy Equipment Decontamination

The area designated for heavy equipment decontamination will be located at Area A. A shallow retainage structure will be built where the equipment will be parked during each cleaning operation. A steam generator and brushes will be used to clean drill rigs, backhoes, auger flytes, casing materials, and other tools. The drilling equipment will be cleaned after each borehole operation. No heavy equipment will be permitted to leave NSB-NLON unless it has been thoroughly decontaminated.

To prevent the spread of potentially contaminated soil at each drilling location at NSB-NLON, the following procedure will apply:

- Prior to any drilling, a 20 x 20 foot heavy duty tarp will be placed on the ground centered over the borehole.
- All drilling cuttings will be retained on the plastic and may be placed in a 55 gallon drum as specified in the Field Sampling Plan.
- At the conclusion of the boring or well installation, the tarp and all soils may be drummed as specified in the Field Sampling Plan.
- All drums with contaminated materials will be temporarily stored at the Area A decontamination area pending waste classification.
- All drilling tools will be held within the tarp at each borehole site and transported to the heavy equipment decontamination area after the boring is completed.

All soil, sediment and water from the heavy equipment decontamination area will be removed from the cleaning structure and stored in properly labelled drums as specified in the Field Sampling Plan.

5.9 Location of Buried Utilities

These two sites are underlain by shallow, buried utilities so that it will be necessary for the field team to exercise a high degree of caution in determining the exact location of each test boring done on the site. The NSB-NLON public works department will be contacted so that active lines in the site areas can be identified and marked out. Maps of known utilities at the site will be made during the preliminary investigation from maps of former Naval plant operations and information supplied by former and current site employees. No borings will be made without prior clearance from Navy Public Works personnel.

Site workers will use these data to choose apparently safe locations for borings. Atlantic will also use metal detectors and pipe locators for site screening. Excavation will proceed carefully at shallow depths to avoid rupturing a line that may be present but that was not detected.

5.10 Engineering Controls and Work Practices

Engineering controls and work practices specified by both OSHA and EPA are directed primarily toward limiting exposure through application of engineered barriers. These requirements apply to practices on Superfund sites.

5.11 Handling Drums and Containers

Regulations for handling drums and containers are specified by OSHA. Potential hazards associated with handling drums include vapor generation, fire, explosions, and possible physical injury.

Handling of drums/containers at the NSB-NLON site may involve the movement of unknown materials. Prior to handling of drums, they should be visually inspected to gain information regarding their content. The investigation team should look for:

- symbols or words which indicate that the contents are hazardous, radioactive, explosive, corrosive, toxic or flammable;
- signs of deterioration, for example: rust, corrosion or leaks;
- signs that drum is under pressure, such as bulging or swelling; and
- drum type.

Air quality monitoring should be conducted around drums using a portable organic vapor meter. Encountering buried drums or containers is anticipated, and a ground penetrating device, such as a metal detector should be used to estimate the location and depth of the drums.

5.12 Illumination

Illumination requirements identified by OSHA are directed to work efforts inside buildings and/or during non-daylight hours. All field activities planned for the NSB-NLON site will occur outside during daylight hours.

5.13 Sanitation for Temporary Work Sites

Sanitary facilities at the NSB-NLON site will be available at adjacent facilities within existing Navy buildings.

6.0 SIGNATURES OF FIELD TEAM MEMBERS AND OBSERVERS

THIS SITE SAFETY PLAN HAS BEEN RECEIVED AND READ BY:

(Signatures of site investigation team members and observers who have been through site safety briefing and have read this health and safety plan.)

NAME	DATE	FIRM	TELEPHONE

APPENDIX A

RECOMMENDED BLOOD TESTS

MEDICAL SURVEILLANCE PROGRAM		
FUNCTION	**TEST**	**EXAMPLE**
Liver:	Blood Tests	Total protein, albumin globulin, total bilirubin (direct bilirubin if total is elevated).
Kidney:	Blood Tests	Blood urea nitrogen (BUN), creatinine, uric acid.
Blood-Forming Function:	Blood Tests	Complete blood count (CBC) with differential and platelet evaluation, including white cell count (WBC), red blood count (RBC), hemoglobin (HGB), hematocrit or packed cell volume (HCT), and desired erythrocyte indices. Reticulocyte count may be appropriate if there is a likelihood of exposure to hemolytic chemicals.

NOTE: From *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*; October 1985; DHHS (NIOSH) Publication No. 85-115.

APPENDIX B

SAMPLE MEDICAL DATA SHEET

MEDICAL DATA SHEET

CONFIDENTIAL

THE FOLLOWING INFORMATION IS REQUESTED
TO DETERMINE YOUR CURRENT MEDICAL STATUS

DATE

1. Name (Last, First, Middle Initial)			3. Social Security Number
2. Employee Address (Number & Street)		City - State Zip Code	4. Telephone Number
5. Sex* ☐M ☐F	6. Birth Date*	7. Name and Address of Person to Notify in an Emergency	8. Telephone Number
9. Personal Physician	Address	Telephone Number	11. Type of Examination ☐Pre-Placement ☐Periodic ☐Other(Specify)
10. Division or Facility		Position	12. Employee Number
13. Work Location			
14. Please Check if You Have Been Immunized for. ☐Tetanus ☐Don't Know ____ Last Date ☐Smallpox ☐Don't Know ____ Last Date ☐Polio ☐Don't Know ____ Last Date ☐ Others ☐Don't Know ____ Last Date			15. Are You: ☐Right Handed ☐Left Handed ☐Ambidextrous

16. Family History*				CHECK EACH BOX (If Answer is Yes, state blood relationship)			
Relation	Age	State of Health	If Dead, Cause and Age		Yes	No	Relation
Father				Cancer			
Mother				Diabetes			
Spouse				Stomach Trouble			
Grandparents				Kidney Trouble			
				Heart Trouble			
				Tuberculosis			
Brothers and Sisters				Mental Disorder			
				Convulsions			
				Arthritis			
				Allergies			
Children				Other			

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MEDICAL DATA SHEET (con't)

17. PERSONAL HISTORY*

DO YOU HAVE, OR HAVE YOU EVER HAD ANY OF THE FOLLOWING. (Check Each Box)

	YES	NO		YES	NO		YES	NO
Asthma			Foot Trouble			Malaria		
Cancer, Cyst, Tumor or Growth			Frequent Indigestion or Heartburn			Nervous Breakdown		
Chest Pain or Shortness of Breath			Frequent or Painful Urination			Nervous Trouble of any Sort		
Fever, Night Sweats			Frequent Trouble Sleeping			Numbness, Weakness		
Chronic Cough or Colds			Gall Bladder Trouble			Palpitation or Pounding Heart		
Convulsions, Fits			Goiter or Thyroid Problem			Prostate Trouble		
or Fall Sickness			Hayfever or Allergies			Reaction from Medicines		
or coughing up, spitting or			Headaches, Frequent or Severe			Recent Gain or Loss of Weight		
vomiting blood			Heart Trouble			Rheumatism or Arthritis		
Expression of Excessive Worry			Hemorrhoids or Rectal Trouble			Scarlet Fever or Rheumatic Fever		
Diabetes, or Sugar in Urine			Hernia or Rupture			Skin Rash or Hives		
Dizziness			High Blood Pressure			Stomach Trouble, Ulcers		
Ear, Nose, or Throat Trouble			Jaundice or Hepatitis			Swelling of Ankles or Feet		
Epilepsy			Kidney Trouble or Blood in Urine			Swollen or Painful Joints		
Eye Trouble			Liver Trouble			Tuberculosis or Pleurisy		
Fainting			"Locked" Knee or "Trick Joint"			Varicose Veins		
Fatigue, Chronic or Frequent			Loss of Appetite, Chronic			Other		
Female Disorders			Venereal Disease			Other		

MEDICAL DATA SHEET (con't)

18. Injuries: Please Check Any Injuries You Have Had

- ☐ Fractures/Broken Bones
- ☐ Back Injury
- ☐ Low Back Pain
- ☐ None
- ☐ Other Injury
- ☐ Severe Cuts
- ☐ severe Burns
- ☐ Lost Consciousness
- ☐ Dislocations
- ☐ Loss of Arm
- ☐ Loss of Leg
- ☐ Loss of Finger(s)
- ☐ Loss of Toe(s)

19. Check Yes or No. If Yes, Give Details in Blank Area	Yes	No	Details
a. Any Time Loss From Work Past Two years Due to Illness			
b. Any Brace or Support Worn			
c. Discharged or Disqualified From Armed Services for any Reason.			
d. Military Service - Dates and Locations			
e. Applied for, or Received Workmen's Compensation			
f. Been Exposed to Work With Dusts, Radiation, Excessive Noise. Chemicals.			
g. Have You Been Unable to Hold a Job Because of:			
1. Sensitivity to Chemicals, Dust, Sunlight, etc.			
2. Inability to Perform Certain Motions.			
3. Inability to Assume Certain Positions.			
4. Other Medical Reasons.			
h. Been a Patient in a Hospital or Sanitarium			
i. Had Surgery Recommended or Performed. Date and Type			
j. Are You Taking Medicines Now.			
k. Have You Been Turned Down on a Physical Examination or Been Informed of Any Abnormal Findings From a Physical Examination.			
l. Do You Smoke - If Yes, Quantity Per Day.			
m. Do You Use Alcoholic Beverages - If Yes, Quantity per Day			
n. Have You Lived or Traveled Outside the Continental U.S.A.			

APPENDIX C

ACCIDENT REPORT FORM

ACCIDENT REPORT FORM
ACCIDENT REPORT

Report No._____

SITE: _____ PROJECT NO. _____

Location: _____

Date of Report: _____ Preparers Name:_____

Name and Address of Injured: _____ SSN: ___-___-___ Age: _____

_____ Sex: _____

Years of Service: _____ Time on Present Job: _____ Title/Classification: _____

Division/Department _____ Date of Accident _____ Time: _____

Accident Category: ___ Motor Vehicle ___ Property Damage ___ Fire

___ Chemical Exposure ___ Near Miss ___ Other

Severity of Injury or Illinoiss: ___ Non-disabling ___ Disabling

___ Medical Treatment ___ Fatality

Amount of Damage: $_____ Property Damaged: _____

Estimated Number of Days Away from Job: _____

Nature of Injury or Illness: _____

CLASSIFICATION OF INJURY:

___ Fractures	___ Heat Burns	___ Cold Exposure
___ Dislocations	___ Chemical Burns	___ Frostbite
___ Sprains	___ Radiation Burns	___ Heat Stroke
___ Abrasions	___ Bruises	___ Heat Exhaustion
___ Lacerations	___ Blisters	___ Concussion
___ Punctures	___ Toxic Respiratory Exposure	___ Faint/Dizziness
___ Bites	___ Toxic Ingestions	___ Toxic Respiratory
___ Toxic Ingestions	___ Dermal Allergy	

Part of Body Affected: _____

Degree of Disability: _____

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ACCIDENT REPORT FORM
(Continued)

18. Injuries: Please Check Any Injuries You Have Had

- ☐ Fractures/Broken Bones
- ☐ BackInjury
- ☐ Low Back Pain
- ☐ None
- ☐ Severe Cuts
- ☐ Severe Burns
- ☐ Loss of Arm, Leg, Finger, Toe
- ☐ Loss of Consciousness
- ☐ Dislocations
- ☐ Other Injury

19. Check Yes or NO. If Yes, Give Details in Blank Area	Yes	No	
a. Any Time Loss From Work Past Two years Due to Illness			
b. Any Brace or Support Worn			
c. Discharged or Disqualified From Armed Services for any Reason.			
d. Military Service - Dates and Locations			
e. Applied for, or Received Workmen's Compensation			
f. Been Exposed to Work With Dusts, Radiation, Excessive Noise. Chemicals.			
g. Have You Been Unable to Hold a Job Because of:			
1. Sensitivity to Chemicals, Dust, Sunlight, etc.			
2. Inability to Perform Certain Motions.			
3. Inability to Assume Certain Positions.			
4. Other Medical Reasons.			
h. Been a Patient in a Hospital or Sanitarium			
i. Had Surgery Recommended or Performed. Date and Type			
j. Are You Taking Medicines Now.			
k. Have You Been Turned Down on a Physical Examination or Been Informed of Any Abnormal Findings From a Physical Examination.			
l. Do You Smoke - If Yes, Quantity Per Day.			
m. Do You Use Alcoholic Beverages - If Yes, Quantity per Day			
n. Have You Lived or Traveled Outside the Continental U.S.A.			
o. Allergies			

ACCIDENT REPORT FORM
(Continued)

Date Medical Care Was Received: _____

Where Medical Care was Received: _____

Address (if off-site): _____

ACCIDENT LOCATION:

Causative agent most directly related to accident (Object substance, material, machinery, equipment conditions):

_____

_____

_____

Was weather a factor? _____

Unsafe mechanical/physical/environmental condition at time of accident (Be specific):

_____

_____

_____

Unsafe act by injured and/or others contributing to the accident (Be specific, must be answered):

_____

_____

_____

Personal factors (Improper attitude, lack of knowledge of skill, slow reaction, fatigue):

_____

_____

_____

ACCIDENT REPORT FORM
(Continued)

Level of personal protection equipment required in Site Safety Plan: _____

_____

Modifications: _____

Was injured using required equipment _____

If not, how did actual equipment use differ from plan: _____

_____

What can be done to prevent a recurrence of this type of accident (Modification of machine; mechanical guards; correct environment training):

_____

_____

Detailed narrative description (How did accident occur, why; objects, equipment tools used, circumstance assigned duties) (Be specific):

_____

_____

_____

(Use back of sheet as required)

Witnesses to accident _____

_____

Signature of Preparer _____

Signature of Site Leader _____

APPENDIX D

OSHA FORM 200

Bureau of Labor Statistics
Log and Summary of Occupational
Injuries and Illnesses

U.S. Department of Labor

For Calendar Year 19 _____ Page ___ of ___

NOTE This form is required by Public Law 91-596 and must be kept in the establishment for 5 years. Failure to maintain and post can result in the issuance of citations and assessment of penalties. *(See posting requirements on the other side of form.)*

RECORDABLE CASES: You are required to record information about every occupational death, every nonfatal occupational illness, and those nonfatal occupational injuries which involve one or more of the following: loss of consciousness, restriction of work or motion, transfer to another job, or medical treatment (other than first aid). *(See definitions on the other side of form.)*

Company Name

Establishment Name

Establishment Address

Form Approved
O.M.B. No. 1220-0029
See OMB Disclosure Statement on reverse

Case or File Number	Date of Injury or Onset of Illness	Employee's Name	Occupation	Department	Description of Injury or Illness	Extent of and Outcome of INJURY: Fatalities	Nonfatal Injuries: Injuries With Lost Workdays				Injuries Without Lost Workdays	Type, Extent of, and Outcome of ILLNESS: Type of Illness							Fatalities	Nonfatal Illnesses: Illnesses With Lost Workdays				Illnesses Without Lost Workdays
Enter a nonduplicating number which will facilitate comparisons with supplementary records.	Enter Mo./day	Enter first name or initial, middle initial, last name.	Enter regular job title, not activity employee was performing when injured or at onset of illness. In the absence of a formal title, enter a brief description of the employee's duties.	Enter department in which the employee is regularly employed or a description of normal workplace to which employee is assigned, even though temporarily working in another department at the time of injury or illness.	Enter a brief description of the injury or illness and indicate the part or parts of body affected. Typical entries for this column might be Amputation of 1st joint right forefinger, Strain of lower back, Contact dermatitis on both hands, Electrocution—body	Enter DATE of death. Mo./day/yr.	Enter a CHECK if injury involves days away from work, or days of restricted work activity or both	Enter a CHECK if injury involves days away from work.	Enter number of DAYS away from work.	Enter number of DAYS of restricted work activity.	Enter a CHECK if no entry was made in columns 1 or 2 but the injury is recordable as defined above	CHECK Only One Column for Each Illness (See other side of form for combinations or permanent transfers.)							Illness Related: Enter DATE of death. Mo./day/yr.	Enter a CHECK if illness involves days away from work, or days of restricted work activity, or both.	Enter a CHECK if illness involves days away from work	Enter number of DAYS away from work.	Enter number of DAYS of restricted work activity.	Enter a CHECK if no entry was made in columns 8 or 9.
(A)	(B)	(C)	(D)	(E)	(F)	(1)	(2)	(3)	(4)	(5)	(6)	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(8)	(9)	(10)	(11)	(12)	(13)
					PREVIOUS PAGE TOTALS →																			
					TOTALS (instructions on other side of form) →																			

INJURIES

ILLNESS

Certification of Annual Summary Totals By _____ Title _____ Date _____

OSHA No. 200

POST ONLY THIS PORTION OF THE LAST PAGE NO LATER THAN FEBRUARY 1.

OSHA No. 200

OMB DISCLOSURE STATEMENT

We estimate that it will take from 4 minutes to 30 minutes to complete a line entry on this form, including time for reviewing instructions; searching, gathering and maintaining the data needed; and completing and reviewing the entry. If you have any comments regarding this estimate or any other aspect of this recordkeeping system, send them to the Bureau of Labor Statistics, Division of Management Systems (1220-0029), Washington, D.C. 20212 and to the Office of Management and Budget, Paperwork Reduction Project (1220-0029), Washington, D.C. 20503.

Instructions for OSHA No. 200

I. Log and Summary of Occupational Injuries and Illnesses

Each employer who is subject to the recordkeeping requirements of the Occupational Safety and Health Act of 1970 must maintain for each establishment a log of all recordable occupational injuries and illnesses. This form (OSHA No. 200) may be used for that purpose. A substitute for the OSHA No. 200 is acceptable if it is as detailed, easily readable, and understandable as the OSHA No. 200.

Enter each recordable case on the log within six (6) workdays after learning of its occurrence. Although other records must be maintained at the establishment to which they refer, it is possible to prepare and maintain the log at another location, using data processing equipment if desired. If the log is prepared elsewhere, a copy updated to within 45 calendar days must be present at all times in the establishment.

Logs must be maintained and retained for five (5) years following the end of the calendar year to which they relate. Logs must be available (normally at the establishment) for inspection and copying by representatives of the Department of Labor, or the Department of Health and Human Services, or States accorded jurisdiction under the Act. Access to the log is also provided to employees, former employees and their representatives.

II. Changes in Extent of or Outcome of Injury or Illness

If, during the 5 year period the log must be retained, there is a change in an extent and outcome of an injury or illness which affects entries in columns 1, 2, 6, 8, 9, or 13, the first entry should be lined out and a new entry made. For example, if an injured employee at first required only medical treatment but later lost workdays away from work, the check in column 6 should be lined out, and checks entered in columns 2 and 3 and the number of lost workdays entered in column 4.

In another example, if an employee with an occupational illness lost workdays, returned to work, and then died of the illness, any entries in columns 9 through 12 should be lined out and the date of death entered in column 8.

The entire entry for an injury or illness should be lined out if later found to be nonrecordable. For example, an injury which is later determined not to be work related, or which was initially thought to involve medical treatment but later was determined to have involved only first aid.

III. Posting Requirements

A copy of the totals and information following the fold line of the last page for the year must be posted at each establishment in the place or places where notices to employees are customarily posted. This copy must be posted no later than *February 1 and must remain in place until March 1.*

Even though there were no injuries or illnesses during the year, zeros must be entered on the totals line, and the form posted.

The person responsible for the *annual summary totals* shall certify that the totals are true and complete by signing at the bottom of the form.

IV. Instructions for Completing Log and Summary of Occupational Injuries and Illnesses

Column A – **CASE OR FILE NUMBER.** Self-explanatory.

Column B – **DATE OF INJURY OR ONSET OF ILLNESS.**
For occupational injuries, enter the date of the work accident which resulted in injury. For occupational illnesses, enter the date of initial diagnosis of illness, or, if absence from work occurred before diagnosis, enter the first day of the absence attributable to the illness which was later diagnosed or recognized.

Columns C through F – Self-explanatory.

Columns 1 and 8 – **INJURY OR ILLNESS-RELATED DEATHS.** Self-explanatory.

Columns 2 and 9 – **INJURIES OR ILLNESSES WITH LOST WORKDAYS.** Self-explanatory.

Any injury which involves days away from work, or days of restricted work activity, or both must be recorded since it always involves one or more of the criteria for recordability.

Columns 3 and 10 – **INJURIES OR ILLNESSES INVOLVING DAYS AWAY FROM WORK.** Self-explanatory.

Columns 4 and 11 – **LOST WORKDAYS--DAYS AWAY FROM WORK.**
Enter the number of workdays (consecutive or not) on which the employee would have worked but could not because of occupational injury or illness. The number of lost workdays should not include the day of injury or onset of illness or any days on which the employee would not have worked even though able to work.
NOTE: For employees not having a regularly scheduled shift, such as certain truck drivers, construction workers, farm labor, casual labor, part-time employees, etc., it may be necessary to estimate the number of lost workdays. Estimates of lost workdays shall be based on prior work history of the employee AND days worked by employees, not ill or injured, working in the department and/or occupation of the ill or injured employee.

Columns 5 and 12 – **LOST WORKDAYS--DAYS OF RESTRICTED WORK ACTIVITY.**
Enter the number of workdays (consecutive or not) on which because of injury or illness:
(1) the employee was assigned to another job on a temporary basis, or
(2) the employee worked at a permanent job less than full time, or
(3) the employee worked at a permanently assigned job but could not perform all duties normally connected with it.

The number of lost workdays should not include the day of injury or onset of illness or any days on which the employee would not have worked even though able to work.

Columns 6 and 13 – **INJURIES OR ILLNESSES WITHOUT LOST WORKDAYS.** Self-explanatory.

Columns 7a through 7g – **TYPE OF ILLNESS.**
Enter a check in only one column for each illness.

TERMINATION OR PERMANENT TRANSFER—Place an asterisk to the right of the entry in columns 7a through 7g (type of illness) which represented a termination of employment or permanent transfer.

V. Totals

Add number of entries in columns 1 and 8.
Add number of checks in columns 2, 3, 6, 7, 9, 10, and 13.
Add number of days in columns 4, 5, 11, and 12.
Yearly totals for each column (1-13) are required for posting. Running or page totals may be generated at the discretion of the employer.

If an employee's loss of workdays is continuing at the time the totals are summarized, estimate the number of future workdays the employee will lose and add that estimate to the workdays already lost and include this figure in the annual totals. No further entries are to be made with respect to such cases in the next year's log.

VI. Definitions

OCCUPATIONAL INJURY is any injury such as a cut, fracture, sprain, amputation, etc., which results from a work accident or from an exposure involving a single incident in the work environment.
NOTE: Conditions resulting from animal bites, such as insect or snake bites or from one time exposure to chemicals, are considered to be injuries.

OCCUPATIONAL ILLNESS of an employee is any abnormal condition or disorder, other than one resulting from an occupational injury, caused by exposure to environmental factors associated with employment. It includes acute and chronic illnesses or diseases which may be caused by inhalation, absorption, ingestion, or direct contact.

The following listing gives the categories of occupational illnesses and disorders that will be utilized for the purpose of classifying recordable illnesses. For purposes of information, examples of each category are given. These are typical examples, however, and are not to be considered the complete listing of the types of illnesses and disorders that are to be counted under each category.

7a. Occupational Skin Diseases or Disorders
Examples: Contact dermatitis, eczema, or rash caused by primary irritants and sensitizers or poisonous plants, oil acne, chrome ulcers, chemical burns or inflammations, etc.

7b. Dust Diseases of the Lungs (Pneumoconioses)
Examples: Silicosis, asbestosis and other asbestos-related diseases, coal worker's pneumoconiosis, byssinosis, siderosis, and other pneumoconioses.

7c. Respiratory Conditions Due to Toxic Agents
Examples: Pneumonitis, pharyngitis, rhinitis or acute congestion due to chemicals, dusts, gases, or fumes, farmer's lung, etc.

7d. Poisoning (Systemic Effect of Toxic Materials)
Examples: Poisoning by lead, mercury, cadmium, arsenic, or other metals, poisoning by carbon monoxide, hydrogen sulfide, or other gases, poisoning by benzol, carbon tetrachloride, or other organic solvents, poisoning by insecticide sprays such as parathion, lead arsenate, poisoning by other chemicals such as formaldehyde, plastics, and resins, etc.

7e. Disorders Due to Physical Agents (Other than Toxic Materials)
Examples: Heatstroke, sunstroke, heat exhaustion, and other effects of environmental heat, freezing, frostbite, and effects of exposure to low temperatures, caisson disease, effects of ionizing radiation (isotopes, X-rays, radium), effects of nonionizing radiation (welding flash, ultraviolet rays, microwaves, sunburn), etc.

7f. Disorders Associated With Repeated Trauma
Examples: Noise-induced hearing loss, synovitis, tenosynovitis, and bursitis, Raynaud's phenomena, and other conditions due to repeated motion, vibration, or pressure.

7g. All Other Occupational Illnesses
Examples: Anthrax, brucellosis, infectious hepatitis, malignant and benign tumors, food poisoning, histoplasmosis, coccidioidomycosis, etc.

MEDICAL TREATMENT includes treatment (other than first aid) administered by a physician or by registered professional personnel under the standing orders of a physician. Medical treatment does NOT include first-aid treatment (one-time treatment and subsequent observation of minor scratches, cuts, burns, splinters, and so forth, which do not ordinarily require medical care) even though provided by a physician or registered professional personnel.

ESTABLISHMENT: A single physical location where business is conducted or where services or industrial operations are performed (for example: a factory, mill, store, hotel, restaurant, movie theater, farm, ranch, bank, sales office, warehouse, or central administrative office). Where distinctly separate activities are performed at a single physical location, such as construction activities operated from the same physical location as a lumber yard, each activity shall be treated as a separate establishment.

For firms engaged in activities which may be physically dispersed, such as agriculture, construction, transportation, communications, and electric, gas, and sanitary services, records may be maintained at a place to which employees report each day.

Records for personnel who do not primarily report or work at a single establishment, such as traveling salesmen, technicians, engineers, etc., shall be maintained at the location from which they are paid or the base from which personnel operate to carry out their activities.

WORK ENVIRONMENT is comprised of the physical location, equipment, materials processed or used, and the kinds of operations performed in the course of an employee's work, whether on or off the employer's premises.

APPENDIX E

EMPLOYER'S FIRST REPORT OF INJURY FORM

EMPLOYER'S FIRST REPORT OF INJURY

STANDARD FORM FOR EMPLOYER'S FIRST REPORT OF INJURY

Please submit this report in TRIPLICATE

Employer

1. Name of Employer _____
2. Office address: No. & St._____City/town _____State_____
3. Insured by Name of Company _____
4. Give nature of business (or article manufactured) _____

Time and Place

5. (a) Location of plant or place where accident occurred _____
   (b) If injured in a mine, did accident occur on surface, under ground, shaft, drift or mill _____.
6. Date of injury _____19___ Day of week _____ Hour of day _____a.m. _____p.m._____
7. Date disability began _____19___ a.m.____ p.m._____
8. Was injured paid in full for this day _____
9. When did you or foreman first know of injury _____
10. Name of foreman _____

Injured Person

11. Name of Injured _____
    (First Name) (Middle Initial) (Last Name) (SS#)
12. Address: No. and St._____City/Town _____State __
13. Check (✓)Married__ Single___Widowed___ Widower___, Divorced___, Male ___, Female___;
14. Age _____ Did you have on file employment certificate or permit _____
15. (a) Occupation when injured_____
    (b) Was this his or her register occupation _____
    (If not, state in what department or branch of work regularly employed _____
16. (a) How long employed by your _____ (b) Wages per day $_____
17. (a) No. hours worked per day _____ (b) Wages per day $_____
    (c) No. days worked per week _____ (d) Average weekly earnings $_____
    (e) If board, lodging, fuel or other advantages were furnished in addition to wages, give estimated value per day, week or month _____

Cause of Injury

18. Machine, tool or thing causing injury _____
19. Kind of power (hand, foot, electrical, steam, etc.) _____
20. Part of machine on which accident occurred _____
21. (a) Was safety appliance or regulation provided _____ (b) Was it in use at time _____
22. Was accident caused by injured's failure to use or observe safety appliance or regulation _____
23. Describe fully how accident occurred, and state what employee was doing when injured _____
24. Names and addresses of witnesses _____

Nature of Injury

25. Nature and location of injury (describe fully exact location of amputations or fractures, right or left) _____
26. Probably length of disability _____
27. Has injured returned to work _____If so, date and hour _____At what wage $_____
28. At what occupation _____
29. (a) Name and address of physician _____
    (b) Name and address of hospital _____

Cases Fatal

30. Has injured died _____If so, give date of death _____

Date of this report _____Firm name _____

Signed by _____Official Title _____

ATLANTIC
ENVIRONMENTAL SERVICES, INC.

APPENDIX F

RECORD OF SAFETY MEETINGS

RECORD OF SAFETY MEETINGS

Company	Date/Time	Location	Attended By	Affiliation

ATLANTIC
ENVIRONMENTAL SERVICES, INC.

APPENDIX G

MATERIAL SAFETY DATA SHEETS

Material Safety Data Sheet

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 9
SULFURIC ACID, CONCENTRATED
Revision C
Issued: October 1980
Revised: February 1986

SECTION 1. MATERIAL IDENTIFICATION

19

MATERIAL NAME: SULFURIC ACID, CONCENTRATED

OTHER DESIGNATIONS: Oil of Vitriol, Hydrogen Sulfate; H_2SO_4; CAS #7664-93-9

MANUFACTURER/SUPPLIER: Available from many suppliers, including:
Allied Corporation, PO Box 2064R, Morristown, NJ 07960; Telephone: 800 631-8050

HMIS
H:3
F: 0
R: 2
PPE: *
* See Sect. 8

R 1
I 3
S 4
K 0

SECTION 2. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
Hydrogen Sulfate (H_2SO_4)	93-98	8-hr TWA: 1 mg/m^3
Water	Balance*	Human, Mist Inhalation, TCLo: 3 mg/m^3, 24 wk. (Toxic Mouth Effects)
		Rat, Oral, LD_{50}: 2140 mg/kg

* Material is obtained by the reaction of SO_3 and water. Can contain low impurity levels, such as 0.02% max of iron as Fe. Properties vary with H_2SO_4 content.

Current OSHA standard and ACGIH (1985-86) TLV. NIOSH has a 10-hr TWA, 40-hr. work week, of 1 mg/m^3.

SECTION 3. PHYSICAL DATA

	93.19% H_2SO_4	98.33% H_2SO_4	100% H_2SO_4
Boiling Point, 1 atm, deg C	ca 281	ca 338	ca 330 (dc)
Specific Gravity (60/60°F)	1.8354	1.84	1.84
Volatiles, % @ 340°C	ca 100	ca 100	ca 100
Melting Point, deg C	ca -34	ca 3	10.4

Water Solubility ... Complete Miscible
Vapor Pressure, mm Hg @ 100°F ... <1 (93.19% H_2SO_4); Deg. Baume ... 66 (93.19% H_2SO_4) - Density of H_2SO_4 is often reported in degrees Baume Be). Formula is Be=145 [145/sp gr for liquids heavier than water].

Appearance and odor: Clear, colorless, hygroscopic, oily liquid with no odor. Mists greater than 1 mg/m^3 are easily recognizable. Those at 5 mg/m^3 are distinctly objectionable.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air	LOWER	UPPER
None - Nonflammable	NA	NA	NA	NA

Sulfuric acid is nonflammable; however, it is a strong oxidizing agent and may cause ignition by contact with combustible materials. Small fires may be smothered with suitable dry chemical. Cool exterior of storage tanks of H_2SO_4 with water to avoid rupture if exposed to fire. Do not add water or other liquid to the acid! The acid, especially when diluted with water, can react with metals to liberate flammable hydrogen gas.
Sulfuric acid mists and vapors from a fire area are corrosive (see sect. 5).
Fire fighters must wear self-contained breathing equipment and fully protective clothing.

SECTION 5. REACTIVITY DATA

Sulfuric acid is stable under normal conditions of use and storage. It does not undergo hazardous polymerization. It is a strong mineral acid reacting with bases and metals. The concentrated acid is also a dehydrating agent, picking up moisture readily from the air or other materials. Hydrogen gas may be generated within a H_2SO_4 container. Vent drums cautiously.

This material reacts exothermically with water. (Acid should always be added slowly to water. Water added to acid can cause boiling and uncontrolled splashing of the acid.) Sulfur oxides can result from decomposition and from oxidizing reactions of sulfuric acid.

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SECTION 6. HEALTH HAZARD INFORMATION | TLV

Concentrated sulfuric acid is a strong mineral acid, an oxidizing agent, and a dehydrating agent that is rapidly damaging to all human tissue with which it comes in contact. Ingestion may cause severe injury or death. Eye contact produces severe or permanent injury. Inhalation of mists can damage both the upper respiratory tract and the lungs. Sulfuric acid is not listed as a carcinogen by the NTP, IARC, or OSHA.

FIRST AID: EYE CONTACT: Immediately flush eyes (including under eyelids) with plenty of running water for at least 15 minutes. Speed in diluting and rinsing out acid with water is extremely important if permanent eye damage is to be avoided. Obtain medical help as soon as possible.* SKIN CONTACT: Immediately flush affected areas with water, removing contaminated clothing while under the safety shower. Continue washing with water and get medical attention.*

INHALATION: Remove to fresh air. Restore breathing. Call a physician immediately. INGESTION: Dilute acid immediately with large amounts of milk or water, then give milk of magnesia to neutralize. Never give anything by mouth to an unconscious person. Do not induce vomiting; if it occurs spontaneously, continue to administer fluid. Obtain medical attention as soon as possible.*

Maintain observation of patient for possible delayed onset of pulmonary edema.

* GET MEDICAL HELP = In plant, paramedic, community.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Handle major spills by a predetermined plan. Contact supplier for assistance in this planning, in meeting local regulations, and for disposing of large amounts. Notify safety personnel. Provide optimum ventilation; vapors are extremely irritating. Stop leak if you can do so without risk.

Cleanup personnel need protection against inhalation or contact. Keep upwind. Contain spill. Minor leaks or spills can be diluted with much water and neutralized with soda ash or lime. If water is not available, cover contaminated area with sand, ashes, or gravel and neutralize cautiously with soda ash or lime.

DISPOSAL: Follow Federal, state, and local regulations. Runoff to sewer may create hydrogen gas, which is a fire or explosion hazard. EPA (CWA) RQ 1000 lbs. (40 CFR 117).

SECTION 8. SPECIAL PROTECTION INFORMATION

Provide general ventilation to meet current TLV requirements in the workplace. Where mists are up to 50 mg/m^3, a high-efficiency particulate respirator with full facepiece is warranted; a type-C supplier-air respirator with full facepiece operated in pressure-demand mode is used to 100 mg/m^3.

Avoid eye contact by use of chemical safety goggles or face shield where splashing may occur. Acid-resistant protective clothing, such as rubber gloves, aprons, boots, and suits, is recommended to avoid body contact.

Eyewash fountain and safety showers with deluge type of heads should be readily available where this material is handled or stored.

Contact lenses pose a special hazard; soft lenses may absorb and all lenses concentrate irritants.

Comprehensive preplacement and annual medical examinations with emphasis on dental erosion, cardiopulmonary system, and mucous membrane irritation and cough are indicated.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Sulfuric acid in carboys or drums should be stored in clean, ventilated storage areas having acid-resistant floors with good drainage. Keep out of direct sunlight, do not store above 89.6°F (32°C). Storage facilities are to be separate from organic materials, metallic powders, chromates, chlorates, nitrates, carbides, oxidizables, etc. Soda ash, sand, or lime should be kept in general storage or work areas for emergency use. Protect containers against physical damage. Glass bottles need extra protection. Sulfuric acid is highly corrosive to most metals, especially below 77% H_2SO_4. Avoid breathing mist or vapors. Avoid contact with skin or eyes. Do not ingest. Do not add water to concentrated acid. Drums may contain hydrogen gas, so open cautiously. Use nonsparking tools free of oil, dirt, and grit and vapor-proof electrical fixtures

DOT Classification: Corrosive Material. ID No.: UN1830 Label: Corrosive

Data Source(s) Code: 1-12, 19, 20, 24, 26, 31, 37-39, 42, 82. CK

Judgements as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corp. extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

Approvals [illegible] 6/86.

Indust. Hygiene/Safety [illegible] 6/86

Medical Review [illegible] 86

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(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 334
Mineral Spirits, Type I

Issued: 7/84 Revision: C, 11/89

Section 1. Material Identification 30

Mineral Spirits, Type I, Description: Used as a diluent in paints, coatings, and waxes; as a dry cleaning agent; as a degreaser and cleaner in mechanical shops; and as an herbicide.
Other Designations: Stoddard solvent; Texsolve S; Varsol 1; white spirits; CAS No. 8052-41-3.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide* (Genium ref. 73) for a suppliers list.
Comments: All mineral spirits are refined petroleum distillates Genium divides into types I, II, and III (*MSDS Collection*, Nos. 334, 334A, and 334B, respectively). Types I and II have a standard aromatic content and 100 and 140 °F (37.78 and 60 °C) minimum flash points, respectively; while type III has a high aliphatic content (low or reduced aromatic content), little odor, and a 100 °F minimum flash point. These different types have different applications. Consult your manufacturer or supplier to ascertain the exact information applicable to your purchased mineral spirits.

R	1
I	3
S	2
K	2

Genium

HMIS
H 1
F 2
R 0
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Mineral spirits, type I, ca 100%*

OSHA PEL	ACGIH TLV, 1989-90	NIOSH REL, 1987	Toxicity Data†
TWA-air: 500 ppm, 2900 mg/m³	TLV-TWA: 100 ppm, 525 mg/m³	10-hr TWA: 350 mg/m³	Cat, inhalation, LC_{Lo}: 10 g/m³/2.5 hr
		15-min Ceiling: 1800 mg/m³	Human, eye: 470 ppm/15 min

* All mineral spirits are mixtures that typically consist of both straight and branched hydrocarbons, paraffins, naphthenes (cycloparaffins), and aromatic hydrocarbons. However, their physical properties divide them into types I, II, and III. Since these parameters vary among suppliers, the purchaser must determine the mineral spirits' composition based on the supplier's information. Note that the mineral spirits' exact composition can affect disposal, shipping, approved uses, insurance policies, and regulatory liabilities.
† See NIOSH, *RTECS* (WJ8925000), for additional data with references to irritative effects.

Section 3. Physical Data

Boiling Point: 300 to 407 °F (149 to 208 °C)*
Vapor Density (Air = 1): ca 4.8
% Volatile by Volume: ca 100
Water Solubility: Insoluble
Molecular Weight: Not applicable (mixture)
Vapor Pressure: ca 5 torr at 77 °F (25 °C)
Specific Gravity (H_2O = 1 at 39 °F (4 °C)): ca 0.79

Appearance and Odor: A clear, colorless liquid; a kerosene-like odor usually perceptible to humans at about 1-ppm concentration.

* This 300 to 407 °F (149 to 208 °C) distillation range describes a specific cut of petroleum distillates, as well as defines and distinguishes these mineral spirits from many petroleum distillates (petroleum naphtha, petroleum ether, rubber solvent, kerosene, mineral seal oil, and others).

Section 4. Fire and Explosion Data

Flash Point: >100 °F (38 °C) min. TCC	Autoignition Temperature: >450 °F (232 °C)	LEL: ca 1% v/v	UEL: ca 6% v/v

Extinguishing Media: Use water fog, dry chemical, carbon dioxide (CO_2), or foams to put out fires involving this material. Never direct solid streams of water into burning pools of this liquid since this can scatter and spread the flames.
Unusual Fire or Explosion Hazards: During fires, or if heated or misted, this liquid is an explosive, flammable hazard. Finely dispersed mists are a dangerous explosion hazard.
Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

Section 5. Reactivity Data

Stability/Polymerization: Type I mineral spirits are stable at room temperature in closed containers. Hazardous polymerization cannot occur.
Chemical Incompatibilities: As a hydrocarbon mixture, type I can react dangerously with strong oxidizing agents like chlorine and oxygen, as well as with nitric, sulfuric, and phosphoric acids.
Conditions to Avoid: Prevent exposures to heat and ignition sources and incompatible chemicals. Perform processing operations that heat or mist type I in a careful, controlled manner that minimizes exposure of vapors or mists to possible heat or ignition sources such as lighted tobacco products, open flames, or uninsulated heating elements.
Hazardous Products of Decomposition: Thermal oxidative decomposition of type I mineral spirits can produce carbon dioxide and carbon monoxide (CO). Depending on your material's exact composition and its unreported contaminants (benzene, toluene, or other aromatics or aliphatics), degradation products could include unidentified aromatic compounds and organics. When heated to decomposition, this material may explode.

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Section 6. Health Hazard Data

Carcinogenicity: Neither the NTP, IARC, nor OSHA lists mineral spirits as a carcinogen.
Summary of Risks: Millions of industrial workers in chemical process and allied industries have been exposed to mineral spirits with minimal serious health effects, aside from the drying, defatting (stripping away of your skin's protective fats and emoilents), and irritant skin effects. However, overexposure can depress the central nervous system (CNS) with these symptoms: headache, dizziness, drowsiness, intoxication with euphoria, and possibly unconsciousness. Prolonged or repeated skin contact can cause dermatitis due to this mineral spirits' defatting effect.
Medical Conditions Aggravated by Long-Term Exposure: None reported. **Target Organs:** Skin, eyes, nose, throat, respiratory system, and CNS. **Primary Entry:** Skin or eye contact with the liquid or inhalation of vapors. **Acute Effects:** Irritation, redness of skin, eyes; narcotic effects like dizziness, slurred speech, or drunkeness. **Chronic Effects:** None reported in humans; animal testing indicates possible liver and kidney damage.
FIRST AID
Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for 15 min. **Skin:** Remove all contaminated clothing to prevent continued exposure. After rinsing affected area with flooding amounts of water, wash it with soap and water. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Treat as an emergency. Potentially fatal aspiration hazard exists. Keep victim's head down between his knees. Never give anything by mouth to an unconscious or convulsing person. Never induce vomiting unless directed by qualified medical personnel. Even if aspiration into the lungs does not occur, ingestion of 3 to 4 oz. can prove fatal in humans due to the CNS's depressed action.
After first aid, get appropriate in-plant, paramedic, or community medical attention and support.
Physician's Note: Aspiration of even a few milliliters of mineral spirits can be fatal! The resulting diffused chemical irritation of the lungs can progress to fatal pulmonary edema after aspiring (breathing in) liquid mineral spirits. Persons who swallow mineral spirits must be monitored very carefully to prevent aspiration of freshly vomited solvent.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: *Design and practice a mineral spirits spill control and countermeasure plan (SCCP).* When a spill occurs, notify safety personnel, eliminate heat and ignition sources, provide optimum explosion-proof ventilation, and implement the SCCP. Cleanup crews must use nonsparking tools and equipment and protective clothing to prevent vapor inhalation or skin contact. Absorb the spilled material with vermiculite or a similiar material and place in appropriate disposal containers.
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1)
EPA Designations
RCRA Hazardous Waste (40 CFR 261.33): Not listed
CERCLA Hazardous Substance (40 CFR 302.4): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Wear a NIOSH-approved respirator if necessary (see Genium ref. 28 for specific recommendations). Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. **Warning:** Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious rubber or polyvinyl gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. **Ventilation:** Provide general and local explosion-proof ventilation systems that maintain airborne concentrations below the OSHA PEL standard (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by eliminating it at its source (Genium ref. 103). **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Launder contaminated clothing before wearing. Remove this material from your shoes and equipment. **Other Equipment:** Use only nonsparking tools and equipment in handling operations in production and storage areas. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics. Never inhale its mists or vapors, especially when processing operations heat or mist this material.

Section 9. Special Precautions and Comments

Storage Requirements: Store this material in a cool, dry, well-ventilated, fireproof area away from heat and ignition sources and oxidizing agents. Protect these containers from physical damage. Store in properly labeled closed metal drums or safety cans.
Engineering Controls: To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations in production and storage areas.
Comments: Shipping regulations vary with your particular mineral spirits' physical properties (flash point, boiling point). The data below represent one of several ways to classify mineral spirits, per the actual entries in the table of regulations. Before shipping mineral spirits, ascertain how the pertinent shipping rules apply to your product.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Petroleum distillate	**IMO Shipping Name:** Petroleum distillates, n.o.s.
DOT Hazard Class: Combustible liquid *or* Flammable liquid	**IMO Hazard Class:** 3.1 *or* 3.2 *or* 3.3
ID No.: UN1268 (Both)	**IMO Label:** Flammable liquid
DOT Label: None *or* Flammable liquid	**IMDG Packaging Group:** II

***MSDS Collection* References:** 1, 6, 7, 84-94, 100, 116, 117, 119, 120, 122
Prepared by: PJ Igoe, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Hardies, MD M3

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Material Safety Data Sheets Collection:

Sheet No. 469
Fuel Oil No. 2

Issued: 10/81 Revision: A, 11/90

Section 1. Material Identification

33

Fuel Oil No. 2 Description: A mixture of petroleum hydrocarbons; a distillate of low sulfur content. Fuel oil no. 2 resembles kerosine. Used as a general-purpose domestic or commercial fuel in atomizing-type burners; as a fuel for trucks, ships and other automotive engines; as mosquito control (coating on breeding waters); and for drilling muds.
Other Designations: CAS No. 68476-30-2, diesel oil.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.

R	1
I	-
S	2
K	2

NFPA

HMIS
H 0
F 2
R 0
PPG*
* Sec. 8

Cautions: Fuel oil No. 2 is a skin irritant and central nervous system depressant with high mist concentrations. It is an environmental hazard and a dangerous fire hazard when exposed to heat, flame, or oxidizers.

Section 2. Ingredients and Occupational Exposure Limits

Fuel oil No. 2*

1989 OSHA PEL	1990-91 ACGIH TLV	1988 NIOSH REL	1985-86 Toxicity Data†
None established	None established	None established	Rat, oral, LD_{50}: 9 g/kg; produces gastrointestinal effects (hypermotility, diarrhea)

* A complex mixture (<95%) of paraffinic, olefinic, naphthenic, and aromatic hydrocarbons; sulfur content (<0.5%); and benzene (<100 ppm). [A low benzene level reduces carcinogenic risk. Fuel oils can be exempted under the benzene standard (29 CFR 1910.1028)].
† Monitor NIOSH, *RTECS* (HZ1800000), for future toxicity data.

Section 3. Physical Data

Boiling Point Range: 363 to 634 °F (184 to 334 °C)
Viscosity: 268 centistoke at 100 °F (37.8 °C)
Specific Gravity: 0.8654 at 59 °F (15 °C)
Appearance and Odor: Brown, slightly viscous liquid.
Water Solubility: Insoluble
Pour Point:* <21 °F (-6 °C)

*Pour point is the lowest temperature at which a liquid flows from an inverted test container.

Section 4. Fire and Explosion Data

Flash Point: 100 °F (38 °C) min.	Autoignition Temperature: 494 °F (257 °C)	LEL: 0.6% v/v	UEL: 7.5% v/v

Extinguishing Media: Use dry chemical, carbon dioxide, foam, water fog or spray. Do not use a forced water spray directly on burning oil since this scatters the fire. Use a smothering technique to extinguish fire.
Unusual Fire or Explosion Hazards: Vapors may travel to an ignition source and flash back. This fuel oil's volatility is similar to gasoline's.
Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode and full protective clothing. If feasible, remove containers from fire. Be aware of runoff from fire control methods. Do not release to sewers or waterways due to health and fire or explosion hazard.

Section 5. Reactivity Data

Stability/Polymerization: Fuel oil no. 2 is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Incompatible with strong oxidizing agents; heating greatly increases fire hazard.
Conditions to Avoid: Avoid heat and ignition sources.
Hazardous Products of Decomposition: Thermal oxidative decomposition of fuel oil no. 2 yields various hydrocarbons and hydrocarbon derivatives and partial oxidation products including carbon dioxide, carbon monoxide, and sulfur dioxide.

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Section 6. Health Hazard Data

Carcinogenicity: Although it has not assigned an overall evaluation to fuel oil No. 2, the IARC has evaluated distillate (light) fuel oils as not classifiable as human carcinogen (Group 3; animal evidence limited).
Summary of Risks: Excessive inhalation of aersol or mist can cause respiratory tract irritation, headache, dizziness, nausea, stupor, convulsions, or unconsciousness, depending on concentration and time of exposure. Since intestinal absorption of longer chain hydrocarbons is lower than absorption from lighter fuels, a lesser degree of systemic effects and more diarrhea may result. When removed from exposed area, affected persons usually experience complete recovery. Hemorrhaging and pulmonary edema, progressing to renal involvement and chemical pneumonitis, may result if oil is aspirated into the lungs. These results are more likely when vomiting after ingestion rather than upon ingestion, as is often the case with lower viscosity fuels. A comparative ratio of oral-to-aspirated lethal doses may be 1 pt vs. 5 ml. Prolonged or repeated skin contact may cause irritation of the hair follicles and may block the sebaceous glands, producing a rash of acne pimples and spots, usually on arms and legs.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Target Organs: Central nervous system (CNS), skin, and mucous membranes.
Primary Entry Routes: Inhalation, ingestion.
Acute Effects: Systemic effects from ingestion include gastrointestinal (GI) irritation, vomiting, diarrhea, and, in severe cases, CNS depression, progressing to coma and death. Inhalation of aerosol or mists may result in increased rate of respiration, tachycardia (excessively rapid heart beat), and cyanosis (dark purplish coloration of the skin and mucous membranes caused by deficient blood oxygenation).
Chronic Effects: Repeated contact with the skin causes dermatitis.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. If large areas of the body are exposed or if irritation persists, get medical help immediately. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, *do not induce vomiting* due to aspiration hazard. Contact a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Gastric lavage is contraindicated due to aspiration hazard. Preferred antidotes are charcoal and milk. In cases of severe aspiration pneumonitis, consider monitoring arterial blood gases to ensure adequate ventilation. Observe the patient for 6 hr. If vital signs become abnormal or symptoms develop, obtain a chest x-ray.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate area for large spills, remove all heat and ignition sources, and provide maximum explosion-proof ventilation. Cleanup personnel should protect against vapor inhalation and liquid contact. Clean up spills promptly to reduce fire or vapor hazards. Use noncombustible absorbent material to pick up small spills or residues. For large spills, dike far ahead to contain. Pick up liquid for reclamation or disposal. Do not release to sewers or waterways due to health and fire and/or explosion hazard. Follow applicable OSHA regulations (29 CFR 1910.120). Fuel oil no. 2 is an environmental hazard. Report large spills.
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.21): Ignitable waste
CERCLA Hazardous Substance (40 CFR 302.4): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed
OSHA Designations
Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, use a NIOSH-approved respirator with mist filter and organic vapor cartridge. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations that promote worker safety and productivity. Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Use and storage conditions should be suitable for an OSHA Class II combustible liquid. Store in closed containers in a well-ventilated area away from heat and ignition sources and strong oxidizing agents. Protect containers from physical damage. To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations. Use nonsparking tools and explosion-proof electrical equipment. No smoking in areas of storage or use.
Engineering Controls: Avoid prolonged skin contact and vapor or mist inhalation. Use only in a well-ventilated area with personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Practice good personal hygiene and housekeeping procedures. Do not wear oil contaminated clothing. Do not put oily rags in pockets. When working with this material, wear gloves or use barrier cream.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Fuel oil

DOT Hazard Class: Combustible liquid

ID No.: NA1993

DOT Label: None

DOT Packaging Exceptions: 173.118a

DOT Packaging Requirements: None

MSDS Collection References: 1, 6, 7, 12, 73, 84, 103, 126, 127, 132, 133, 136, 143
Prepared by: MJ Allison, BS; Industrial Hygiene Review: DJ Wilson, CIH; Medical Review: W Silverman, MD; Edited by: JR Stuart, MS

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Material Safety Data Sheets Collection:

Sheet No. 474
Fuel Oil No. 6

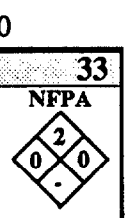
Issued: 10/81 Revision: A, 11/90

Section 1. Material Identification 33

Fuel Oil No. 6 Description: A high-viscosity residual oil. Used to power heavy units such as ships, trucks, and trains. A thick paste, fuel oil No. 6 is not usually used unless preheated to decrease its viscosity.
Other Designations: CAS No. 68553-00-4, bunker C.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.

R	1
I	-
S	2
K	2

NFPA



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* Sec. 8

Cautions: Fuel oil No. 6 is a respiratory irritant and central nervous system (CNS) depressant. It is a moderate fire hazard when exposed to heat or flame.

Section 2. Ingredients and Occupational Exposure Limits

Fuel oil No. 6*

1989 OSHA PEL	1990-91 ACGIH TLV	1988 NIOSH REL	1985-86 Toxicity Data†
None established	None established	None established	Rat, oral, LD_{50}: 9 g/kg

* A complex mixture of paraffinic, olefinic, naphthenic, and aromatic hydrocarbons, including polycyclic aromatic hydrocarbons. Sulfur content is <2.8%. A fuel oil No. 6 with low sulfur (0.2 and 1.2%) is commercially available.
† Monitor NIOSH, *RTECS* (HZ1800000), for future toxicity data.

Section 3. Physical Data

Boiling Point: 500 °F (>260 °C)
Vapor Pressure: 0.2 mm Hg at 70 °F (21 °C)
Viscosity: 36,000 centistoke at 100 °F (37.8 °C)
Specific Gravity: ~0.966
Water Solubility: Insoluble
Appearance and Odor: Black liquid to heavy paste with a petroleum odor.

Section 4. Fire and Explosion Data

Flash Point: 150 to 270 °F (66 to 132 °C)	Autoignition Temperature: 765 °F (407 °C)	LEL: 3.9% v/v	UEL: 20.1% v/v

Extinguishing Media: Use dry chemical, carbon dioxide, foam, water fog, or spray. Do not use a forced water spray directly on burning oil since this scatters the fire. Use a smothering technique to extinguish fire. Cool fire-exposed containers with water spray.
Unusual Fire or Explosion Hazards: Fuel oil No. 6 is an OSHA Class IIIA combustible liquid that exhibits "boil-over" characteristics.
Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode and full protective clothing. If feasible, remove containers from fire hazard area. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Fuel oil No. 6 is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Incompatible with strong oxidizing agents; heating greatly increases fire hazard.
Conditions to Avoid: Avoid heat and ignition sources.
Hazardous Products of Decomposition: Thermal oxidative decomposition of fuel oil No. 6 can produce various hydrocarbons and hydrocarbon derivatives and partial oxidation products including carbon dioxide, carbon monoxide, and sulfur dioxide.

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Section 6. Health Hazard Data

Carcinogenicity: The IARC lists fuel oils, residual (heavy) as possible human carcinogen (Group 2B); animal evidence-limited.
Summary of Risks: Residual oils are generally more viscous and less toxic than kerosene due to their low volatility and limited absorption through the intestinal tract. Inhalation of heated or misted fuel oil No. 6 can cause the same systemic and local pulmonary effects seen with lighter grade fuel oils, respiratory tract irritation, headache, dizziness, nausea, stupor, convulsions, or unconsciousness, depending on concentration and time of exposure. When removed from exposure area, affected persons usually experience complete recovery. The residual (heavy) oils have a lower aspiration hazard since heavy oils are more viscous. Aspiration is limited to inhalation from vomiting after ingestion and dilution with gastric contents. Significant ingestion is unlikely. In addition, intestinal absorption of long-chain hydrocarbons is low. Its primary toxicities, then, are its laxative effect, mild gastrointestinal (GI) irritation, and skin irritation. After prolonged skin contact, changes in rabbit bladder linings are reported. Prolonged or repeated skin contact may cause irritation and block the sebaceous glands, with a rash of acne-like pimples and spots, usually on the arms and legs. Repeated prolonged dermal contact may also have systemic effects. Heavy repeated application of fuel oil No. 6 to rabbit skin gave severe skin changes and systemic toxicity including an increased incidence of hyperplasia of the urinary bladder epithelium.*
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Target Organs: Central nervous system (CNS), skin, and mucous membranes.
Primary Entry Routes: Inhalation, ingestion.
Acute Effects: Systemic effects from ingestion include gastrointestinal (GI) irritation, vomiting, diarrhea, and in severe cases, CNS depression, progressing to coma and death. Inhalation of aerosol or mists may result in increased rate of respiration, tachycardia (excessively rapid heart beat), and cyanosis (dark purplish coloration of the skin and mucous membranes caused by deficient oxygentation of the blood).
Chronic Effects: Repeated skin contact causes dermatitis and possible systemic toxicity.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, *do not induce vomiting*. Consulting a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Gastric lavage is contraindicated due to aspiration hazard. Preferred antidotes are charcoal and milk.

* EPA (TOSCA) document 8EHQ-0181-0377, December, 1980.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate area for large spills, remove all heat and ignition sources, and provide maximum explosion-proof ventilation. Cleanup personnel should protect against vapor inhalation and liquid contact. Clean up spills promptly to reduce fire or vapor hazards. Use a noncombustible absorbent material to pick up small spills or residues. For large spills, dike far ahead to contain. Pick up liquid for reclaim or disposal. Do not release to sewers or waterways due to health and fire and/or explosion hazard. Follow applicable OSHA regulations (29 CFR 1910.120). Report large oil spills.
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
RCRA Hazardous Waste (40 CFR 261.33): Not listed
CERCLA Hazardous Substance (40 CFR 302.4): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed
OSHA Designations
Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, use a NIOSH-approved respirator with mist filter and organic vapor cartridge. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations that promote worker safety and productivity. Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Use and storage conditions should be suitable for an OSHA Class IIIA combustible liquid. Store in closed containers in a well-ventilated area away from heat and ignition sources and strong oxidizing agents. Protect containers from physical damage. To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations. Use nonsparking tools and explosion-proof electrical equipment. No smoking in area of storage or use.
Engineering Controls: Avoid prolonged skin contact and vapor or mist inhalation. Use only in a well-ventilated area with personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Practice good personal hygiene and housekeeping procedures. Do not wear oil-contaminated clothing. Do not put oily rags in pockets. When working with this material, wear gloves or use barrier cream.

Transportation Data (49 CFR 172.101)
DOT Shipping Name: Fuel oil
DOT Hazard Class: Combustible liquid
ID No.: NA1993
DOT Label: None
DOT Packaging Exceptions: 173.118a
DOT Packaging Requirements: None

MSDS Collection **References:** 1, 6, 7, 12, 73, 84, 103, 126, 131, 132, 133, 136, 143
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD; **Edited by:** JR Stuart, MS

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MATERIAL SAFETY DATA SHEET

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No. 1200

AROCLOR 1254

Date May 1980

SECTION I. MATERIAL IDENTIFICATION

MATERIAL NAME: AROCLOR 1254
DESCRIPTION: Distillation cut of polychlorinated biphenyl (or diphenyl), containing 54% Cl.
OTHER DESIGNATIONS: PCB, an Askarel, PYRANOL, GE Material A13B1, CAS # 027 323 188
MANUFACTURER: Material was a product of Monsanto Co., but dropped in 1977. Except for uses specifically exempted and regulated by EPA (for example power transformers), legal manufacture, distribution in commerce, and use of PCB's in USA ended in 1979 under TSCA.

SECTION II. INGREDIENTS AND HAZARDS

SECTION II. INGREDIENTS AND HAZARDS	%	HAZARD DATA
Mixture of Chlorinated Biphenyls, $C_{12}H_{10-x}Cl_x$:	ca 100	EPA exemption or authorization needed for any measurable exposure*
		Rat, Oral LD_{50} Adult 4-10 g/kg Weaning 1.2 g/kg
		Rat, Intravenous LD_{50} 358 mg/kg
		Rat, Oral, TDLo 1220 mg/kg/35 wk (neoplastic effect)

x	Approx. %
2	0.5
3	1
4	21
5	48
6	23
7	6

Includes 69 or more compounds with average of 4.98 Cl atom/molecule. Mixture may contain 0-2 ppm chlorinated dibenzofurans.

*Current ACGIH 8-hr TWA is 0.5 mg/m^3. NIOSH has proposed a 10-hr TWA of 1.0 µg/m^3. Materials with over 50 ppm PCB content are regulated for handling, storage, records, and waste disposal. EPA criterion in navigable waters is 0.001 µg/L. PCB's.

SECTION III. PHYSICAL DATA

Boiling range at 1 atm, deg C	ca 360-390	Specific gravity (65/15.5 C)	1.5
Vapor pressure at 150 C, mm Hg	<1	Pour point, deg C	10
Water solubility at 25 C, ppm	ca 0.01	Molecular weight (Av)	327
Viscosity at 100 F, cstk	ca 460	Partition Coef. (octanol/water)	$>10^4$

Appearance & Odor: A light yellow, viscous fluid.

SECTION IV. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air	LOWER	UPPER
None to boiling point				

Extinguishing Media: Use media appropriate to the surrounding fire conditions. This material has very low combustibility, but it can undergo thermal-oxidative degradation in a fire situation.

Firefighters should use full protective clothing and self-contained breathing equipment when fighting fire where any PCB's are involved.

SECTION V. REACTIVITY DATA

AROCLOR 1254 and other PCB's are nearly inert materials with very high chemical stability; the higher chlorine levels usually give the greater stability. At about 300 to 600 C some PCB's can oxidize to produce chlorinated dibenzofurans which are much greater in toxicity than the PCB's. For complete incineration of PCB's a 2-second dwell time above 2000 F (1090 C) with 3% excess oxygen in the stack is suitable (see Sect. VII).

AROCLOR 1254 shows very little degradation after 3 weeks exposure to direct sunlight.

PCB's are strongly absorbed on particulates or sediments in aquatic systems (streams, lakes, ocean, etc.).

Mixed in activated sludge, biodegradation occurs slowly, but only very slowly or almost not at all with compounds above Cl_4.

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SECTION VI. HEALTH HAZARD INFORMATION

TLV (See Sect. II)

PCBs show high levels of bioaccumulation in fatty tissue and very slow metabolism, especially for Cl_5 compounds and above. They have become widely dispersed in world-wide environment and in the food chain (much like DDT) since their introduction in 1929. Effective control of PCB discharge into the environment began after 1970.

AROCLOR 1254 has a low vapor pressure, but it can be irritating to the eyes, nose, and throat if misted or heated to produce vapors. Excessive acute and chronic exposures may cause liver damage. Chronic exposure to or ingestion of PCB's (especially when thermally oxidized) can result in chloracne after 1-6 months. There is some evidence of possible carcinogenic risk and adverse reproductive effects with this material. PCB's may appear in the breast milk of an exposed mother.

FIRST AID:

Skin Contact: Clean exposed skin with waterless cleaner, wipe with a disposable towel, then wash with soap and water. Promply remove contaminated clothing. (Control separate disposal of PCB-contaminated materials.)

Eye Contact: Flush promptly & thoroughly with lots of running water for 15 minutes.

Inhalation: Remove to fresh air. Get medical help if symptoms continue.

Ingestion: Get medical help. NIOSH has recommended that vomiting be induced.

Get medical help in all cases of severe exposure, repeated exposures, or persistent symptoms.

SECTION VII. SPILL, LEAK, AND DISPOSAL PROCEDURES

Notify safety personnel of all PCB spills or leaks. Promptly contain spilled material! Prevent its release into the environment! Restrict PCB spill area to trained clean-up personnel; use proper protective gear; follow an established emergency plan.

Stop leakage if possible. Pick up spill. Absorb small spills and residues using a powdered, dry clay. Place leaking containers, picked-up PCBs, and PCB-contaminated materials and refuse into approved, properly labeled, closed containers for storage under controlled, EPA regulated conditions prior to disposal. EPA allows approved storage to 1/1/84.(See Sect.IX.) Storage: 40CFR761.42; Annual report: 40CFR761.45

DISPOSAL: Destroy PCB-containing material by burning in an EPA approved facility. Liquid 50-500 ppm PCB material can be burned as above or landfilled if not ignitable. Non-flowing, PCB-contaminated debris can be disposed of in an EPA approved landfill. (See 40CFR 761; Federal Register, Vol. 44, 31551-4, 66989; Vol.45, 20473.)

SECTION VIII. SPECIAL PROTECTION INFORMATION

Provide highly effective local exhaust ventilation (trap for exhaust vapors) especially if this material is heated or misted. Unless authorized by EPA an isolated system must be used for PCBs.

For nonroutine and emergency conditions of exposure use an approved canister respirator or self-contained breathing equipment.

Prevent skin contact for those who work with PCBs. Use neoprene or polyethylene gloves and apron, safety glasses and/or face shield, and other protective clothing as determined by use conditions. An eyewash station and washing facilities should be available to the work area.

Provide for special handling and disposal of PCB-contaminated materials, including paper towels and clothing (see Sect. VII). Provide locker and shower facilities. Workers must be trained for PCB work, and they must follow good hygienic practice.

Provide pre-placement medical exams for workers with emphasis on liver function, skin condition, and reproductive history. Provide annual medical exams for exposed workers.

SECTION IX. SPECIAL PRECAUTIONS AND COMMENTS

PCB materials in containers and in equipment must have proper labeling including the date of storage. Short term (up to 30 days) storage of non-leaking PCBs can be done. Long term storage requires an EPA approved facility, including such criteria as roof and walls to shield from rain, impervious base and diking which will contain 25% of stored volume or twice the volume of the largest container, no drains or openings to allow flow loss, and the base must be located above the 100-year flood water elevation. Prevent physical damage to containers. Inspect storage frequently.

Prevent skin contact with PCBs, or with solid products contaminated with PCBs. Prevent inhalation of airborne PCBs. Properly contain PCBs until legally disposed of; do not allow them to escape into the environment!

PCBs, and especially used PCBs, can contain higher toxicity contaminants.

DATA SOURCE(S) CODE: 1-6,20,26,31,36

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APPROVALS: MIS CRD J.M. Nielsen

Industrial Hygiene and Safety DJW 5-29-80

MEDICAL REVIEW: June 1980

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Material Safety Data Sheets Collection:

Sheet No. 713
Lead (Inorganic)

Issued: 8/90

Section 1. Material Identification

32

Lead (Inorganic) (Pb) Description: Exists widely throughout the world in a number of ores. Its main commercial source is galena (lead sulphide). Lead mineral is separated from crude ores by blast-furnace smelting, drossing, or electrolytic refining. Lead is used mostly in manufacturing storage batteries. Other uses are in manufacturing tetraethyllead and both organic and inorganic lead compounds in ceramics, plastics, and electronic devices; in producing ammunition, solder, cable covering, sheet lead, and other metal products (brass, pipes, caulking); in metallurgy; in weights and as ballast; as a chemical intermediate for lead alkyls and pigments; as a constuction material for the tank linings, piping, and equipment used to handle the corrosive gases and liquids used in sulfuric acid manufacturing, petroleum refining, halogenation, sulfonation, extraction, and condensation; and for x-ray and atomic radiation protection.
Other Designations: CAS No. 7439-92-1, lead oxide; lead salts, inorganic; metallic lead; plumbum.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.

R	0
I	4
S	-
K	0

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* Sec. 8

Cautions: *Inorganic lead is a potent systemic poison.* Organic lead (for example, tetraethyl lead) has severe, but different, health effects. Occupational lead poisoning is due to inhalation of dust and fumes. Major affected organ systems are the nervous, blood, and reproductive systems, and kidneys. Health impairment or disease may result from a severe acute short- or long-term exposure.

Section 2. Ingredients and Occupational Exposure Limits

Lead (inorganic) fumes and dusts, as Pb, ca 100%

1989 OSHA PELs (Lead, inorganic compounds)
8-hr TWA: 50 μg/m³
Action Level TWA*: 30 μg/m³

29 CFR 1910.1025 Lead Standard
Blood Lead Level: 40 μg/100 g

1989-90 ACGIH TLV (Lead, inorganic, fumes and dusts)
TLV-TWA: 150 μg/m³

1988 NIOSH REL
10-hr TWA: <100 μg/m³

1985-86 Toxicity Data†
Human, inhalation, TC_{Lo}: 10 μg/m³ affects gastrointestinal tract and liver
Human, oral, TD_{Lo}: 450 mg/kg ingested over 6 yr affects peripheral and central nervous systems
Rat, oral, TD_{Lo}: 790 mg/kg affects multigeneration reproduction

* Action level applies to employee exposure without regard to respirator use.
† See NIOSH, *RTECS* (OF7525000), for additional mutative, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 3164 °F (1740 °C)
Melting Point: 621.3 °F (327.4 °C)
Vapor Pressure: 1.77 mm Hg at 1832 °F (1000 °C)
Viscosity: 3.2 cp at 621.3 °F (327.4 °C)
Molecular Weight: 207.20
Specific Gravity (20 °C/4 °C): 11.34
Water Solubility: Relatively insoluble in hot or cold water*
Appearance and Odor: Bluish-white, silvery, gray, very soft metal.

* Lead dissolves more easily at a low pH.

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: None reported	LEL: None reported	UEL: None reported

Extinguishing Media: Use dry chemical, carbon dioxide, water spray, or foam to extinguish fire.
Unusual Fire or Explosion Hazards: Flammable and moderately explosive in the form of dust when exposed to heat or flame.
Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective equipment. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Lead is stable at room temperature in closed containers under normal storage and handling conditions. It tarnishes on exposure to air. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Mixtures of hydrogen peroxide + trioxane explode on contact with lead. Lead is incompatible with sodium azide, zirconium, disodium acetylide, and oxidants. A violent reaction on ignition may occur with concentrated hydrogen peroxide, chlorine trifluoride, sodium acetylide (with powdered lead), ammonium nitrate (below 200 °C with powdered lead). Lead is attacked by pure water and weak organic acids in the presence of oxygen. Lead is resistant to tap water, hydrofluoric acid, brine, and solvents.
Conditions to Avoid: Rubber gloves containing lead may ignite in nitric acid.
Hazardous Products of Decomposition: Thermal oxidative decomposition of lead can produce highly toxic fumes of lead.

Section 6. Health Hazard Data

Carcinogenicity: Although the NTP and OSHA do not list lead as a carcinogen, the IARC lists it as probably carcinogenic to humans, but having (usually) no human evidence. However, the literature reports instances of lead-induced neoplasms, both benign and malignant, of the kidney and other organs in laboratory rodents. Excessive exposure to lead has resulted in neurologic disorders in infants. Experimental studies show lead has reproductive and teratogenic effects in laboratory animals. Human male and female reproductive effects are also documented.
Summary of Risks: Lead is a potent, systemic poison that affect a variety of organ systems, including the nervous system, kidneys, reproductive system, blood formation, and gastrointestinal (GI) system . The most important way lead enters the body is through inhalation, but it can also be ingested when lead dust or unwashed hands contaminate food, drink, or cigarettes. Much of ingested lead passes through feces without absorption into the body. Adults may absorb only 5 to 15% of ingested lead; children may absorb a much larger fraction. Once in the body, lead enters the bloodstream and circulates to various organs. Lead concentrates and remains in bone for many years. The amount of lead the body stores increases as exposure continues, with possibly cumulative effects. Depending on the dose entering the body, lead can be deadly within several days or affect health after many years. Very high doses can cause brain damage (encephalopathy).
Medical Conditions Aggravated by Exposure: Lead may aggravate nervous system disorders (e.g., epilepsy, neuropathies), kidney diseases, high blood pressure (hypertension), infertility, and anemia. Lead-induced anemia and its effect on blood presssure can aggravate cardiovascular disease.

Continue on next page

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Section 6. Health Hazard Data, *continued*

Target Organs: Blood, central and peripheral nervous systems, kidneys, and gastrointestinal (GI) tract.
Primary Entry Routes: Inhalation, ingestion.
Acute Effects: An acute, short-term dose of lead could cause acute encephalopathy with seizures, coma, and death. However, short-term exposures of this magnitude are rare. Reversible kidney damage can occur from acute exposure, as well as anemia.
Chronic Effects: Symptoms of chronic long-term overexposure include appetite loss, nausea, metallic taste in the mouth, lead line on gingival (gum) tissue, constipation, anxiety, anemia, pallor of the face and the eye grounds, excessive tiredness, weakness, insomnia, headache, nervous irritability, fine tremors, numbness, muscle and joint pain, and colic accompanied by severe abdominal pain. Paralysis of wrist and, less often, ankle extensor muscles may occur after years of increased lead absorption. Kidney disease may also result from chronic overexposure, but few, if any, symptoms appear until severe kidney damage has occurred. Reproductive damage is characterized by decreased sex drive, impotence, and sterility in men; and decreased fertility, abnormal menstrual cycles, and miscarriages in women. Unborn children may suffer neurologic damage or developmental problems due to excessive lead exposure in pregnant women. Lead poisoning's severest result is encephalopathy manifested by severe headache, convulsions, coma, delirium, and possibly death.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Consult a physician if any health complaints develop.
Inhalation: Remove exposed person to fresh air and support breathing as needed. Consult a physician.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If large amounts of lead were ingested, induce vomiting with Ipecac syrup. Consult a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: For diagnosis, obtain blood pressure, blood lead level (PbB), zinc protoporphyrin (ZPP), complete blood count for microcytic anemia and basophilic stippling, urinalysis, and blood urea nitrogen (BUN) of creatinine. Examine peripheral motor neuropathy, pallor, and gingival lead line. Use Ca-EDTA to treat poison, but *never* chelate prophylactically. Consult an occupational physician or toxicologist.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel and evacuate all unnecessary personnel immediately. Cleanup personnel should protect against inhalation of dusts or fume and contact with skin or eyes. Avoid creating dusty conditions. Water sprays may be used in large quantities to prevent the formation of dust. Cleanup methods such as vacuuming (with an appropriate filter) or wet mopping minimizes dust dispersion. Scoop the spilled material into closed containers for disposal or reclamation. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33, Appendix II—EP Toxicity Test Procedures)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [* per Clean Water Act, Sec. 307(a)]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact. Protective clothing made of man-made fibers and lacking turn-ups, pleats, or pockets retain less dust from lead.
Ventilation: Provide general and local ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[303]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially washing hands before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in tightly closed containers in a cool, dry, well-ventilated area away from all incompatible materials, direct sunlight, and heat and ignition sources.
Engineering Controls: Educate worker about lead's hazards. Follow and inform employees of the lead standard (29 CFR 1910.1025). Avoid inhalation of lead dust and fumes and ingestion of lead. Use only with appropriate personal protective gear and adequate ventilation. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Avoid creating dusty conditions. Segregate and launder contaminated clothing. Take precautions to protect laundry personnel. Practice good personal hygiene and housekeeping procedures. For a variety of reasons, the lead concentration in workroom air may not correlate with the blood lead levels in individuals.
Other Precautions: Provide preplacement and periodic medical examinations which emphasize blood, nervous system, gastrointestinal tract, and kidneys, including a complete blood count and urinalysis. Receive a complete history including previous surgeries and hospitalization, allergies, smoking history, alcohol consumption, proprietary drug intake, and occupational and nonoccupational lead exposure. Maintain records for medical surveillance, airborne exposure monitoring, employee complaints, and physician's written opinions for at least 40 years or duration of employment plus 20 years. Measurement of blood lead level (PbB) and zinc protoporphyrin (ZPP) are useful indicators of your body's lead absorption level. Maintain worker PbBs at or below 40 µg/100 g of whole blood. To minimize adverse reproductive health effects to parents and developing fetus, maintain the PbBs of workers intending to have children below 30 µg/100 g. Elevated PbBs increase your risk of disease, and the longer you have elevated PbBs, the greater your chance of substantial permanent damage.

Transportation Data (49 CFR 172.102)
IMO Shipping Name: Lead compounds, soluble, n.o.s.
IMO Hazard Class: 6.1
ID No.: UN2291
IMO Label: St. Andrews Cross (X, Stow away from foodstuffs)
IMDG Packaging Group: III

***MSDS Collection* References:** 26, 38, 73, 84, 85, 88, 89, 90, 100, 101, 103, 109, 124, 126, 132, 133, 134, 136, 138, 139, 142, 143
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