WORK PLAN INTERIM DESIGN

DEFENSE REUTILIZATION AND MARKETING OFFICE

Prepared For:

Northern Division
Naval Facilities Engineering Command
10 Industrial Highway
Lester, PA 19113-2090

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DRMO INTERIM DESIGN

1.0 INTRODUCTION

1.1 Purpose and Scope

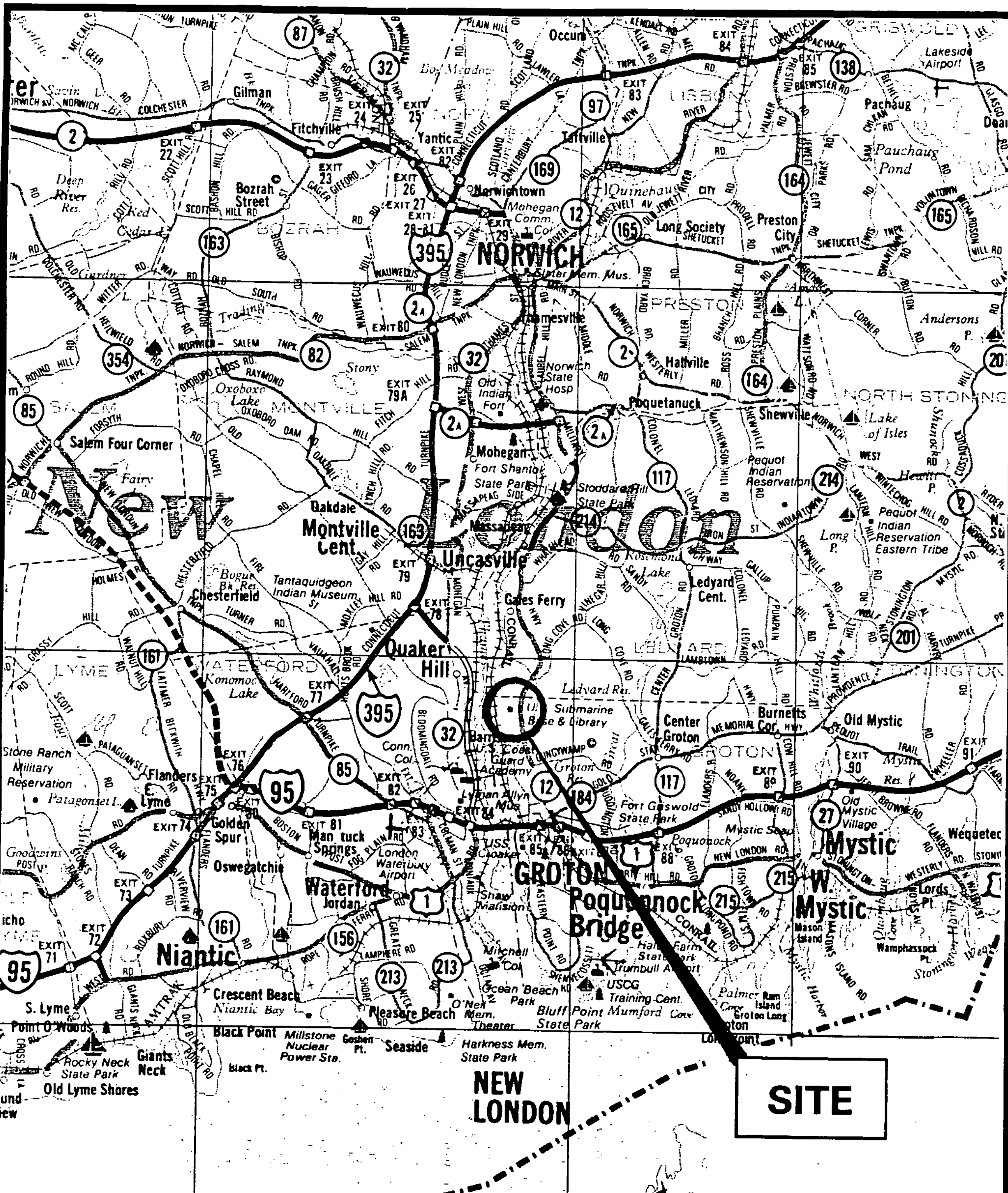
The Naval Submarine Base in New London (NSB-NLON) consists of approximately 547 acres of land and associated buildings in southeastern Connecticut in the towns of Ledyard and Groton. NSB-NLON is on the east bank of the Thames River, approximately 6.0 miles north of Long Island Sound. Figures 1-1 and 1-2 show the site vicinity and location, respectively. NSB-NLON was placed on the National Priorities List (NPL) on August 28, 1991 by the U.S. Environmental Protection Agency (U.S. EPA) pursuant to the comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980.

The purpose of this design work plan is to discuss proposed interim remedial designs for the Defense Reutilization and Marketing Office (DRMO) at NSB-NLON in Groton, Connecticut. These interim remedial designs are source excavation and containment (capping) actions. In addition to the interim remedial actions which are the subject of this document, the following interim actions will also be implemented, as discussed in separate documents.

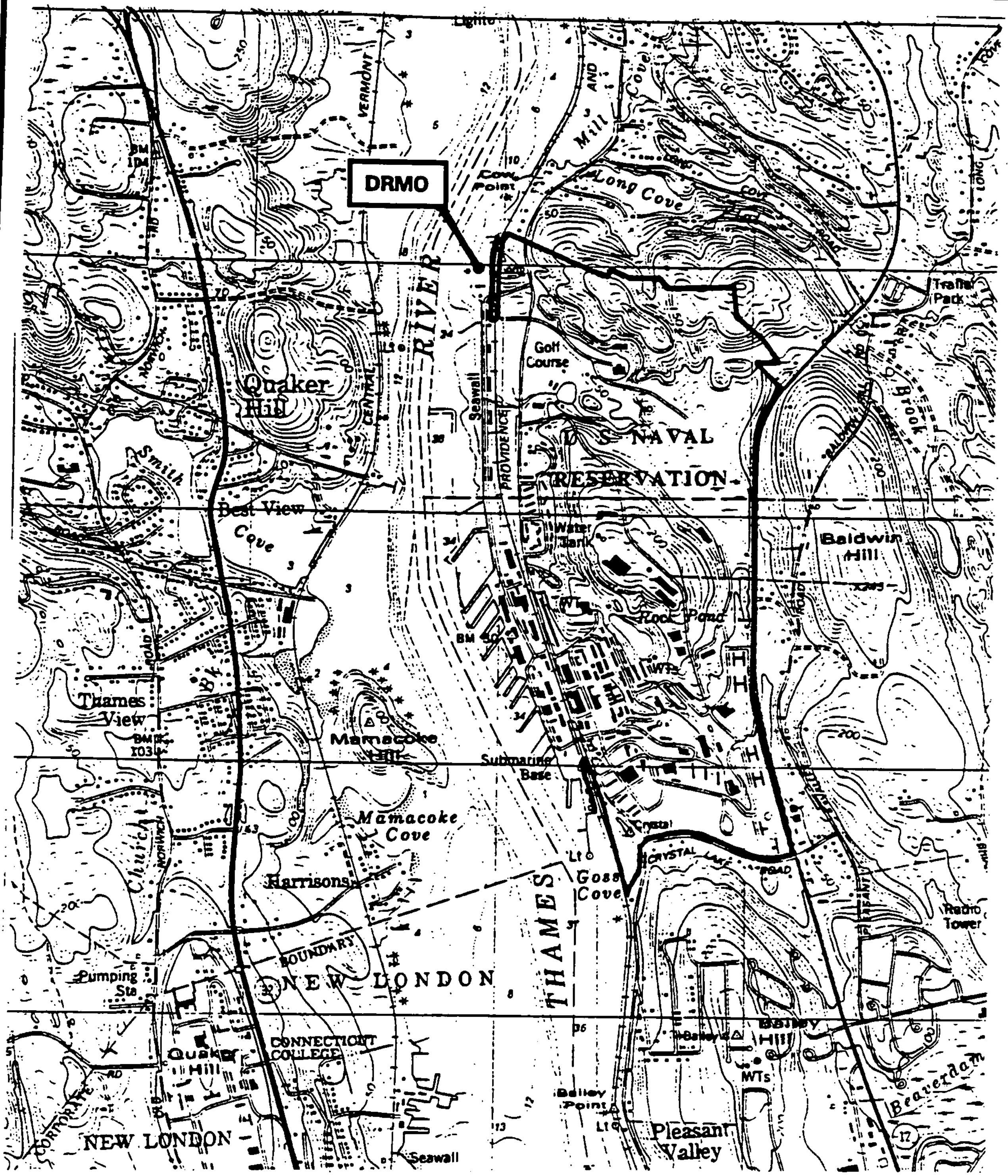
- Spent Acid Storage and Disposal Area
- Area A Landfill/Concrete Pad Area
- Area A Downstream/Over Bank Disposal Area (OBDA) - Sediment Remediation
- Area A Landfill - Final Capping

The draft design work plan for the Spent Acid Storage and Disposal Area and the Area A Landfill/Concrete Pad Area was submitted to the Navy for review on October 19, 1993.

These items represent the actions necessary to prevent the release of contaminants into the environment and prevent human exposure to the contaminants. The Navy's goal is to begin interim remedial actions at NSB-NLON as quickly as possible to protect human health and the



INSTALLATION RESTORATION STUDY NAVAL SUBMARINE BASE - NEW LONDON GROTON, CT	SOURCE: Marshall Penn-York Co. Inc. Miles 0 1 2 3 APPROXIMATE SCALE	FIGURE 1-1 SITE VICINITY ATLANTIC ENVIRONMENTAL SERVICES, INC.



INSTALLATION RESTORATION STUDY NAVAL SUBMARINE BASE - NEW LONDON GROTON, CT	SOURCE: Uncasville, CT U.S.G.S. Topographic Map 1984 N	FIGURE 1-2 SITE LOCATION ATLANTIC ENVIRONMENTAL SERVICES, INC.

environment and to comply with applicable or relevant and appropriate requirements (ARARs). Pursuant to this goal, this design work plan has been prepared concurrently with conducting portions of the Phase II Remedial Investigation (RI) Work Plan (Atlantic, May 1993) that collect design data required to finalize these interim remedial designs.

This preliminary design document provides the following information for the DRMO:

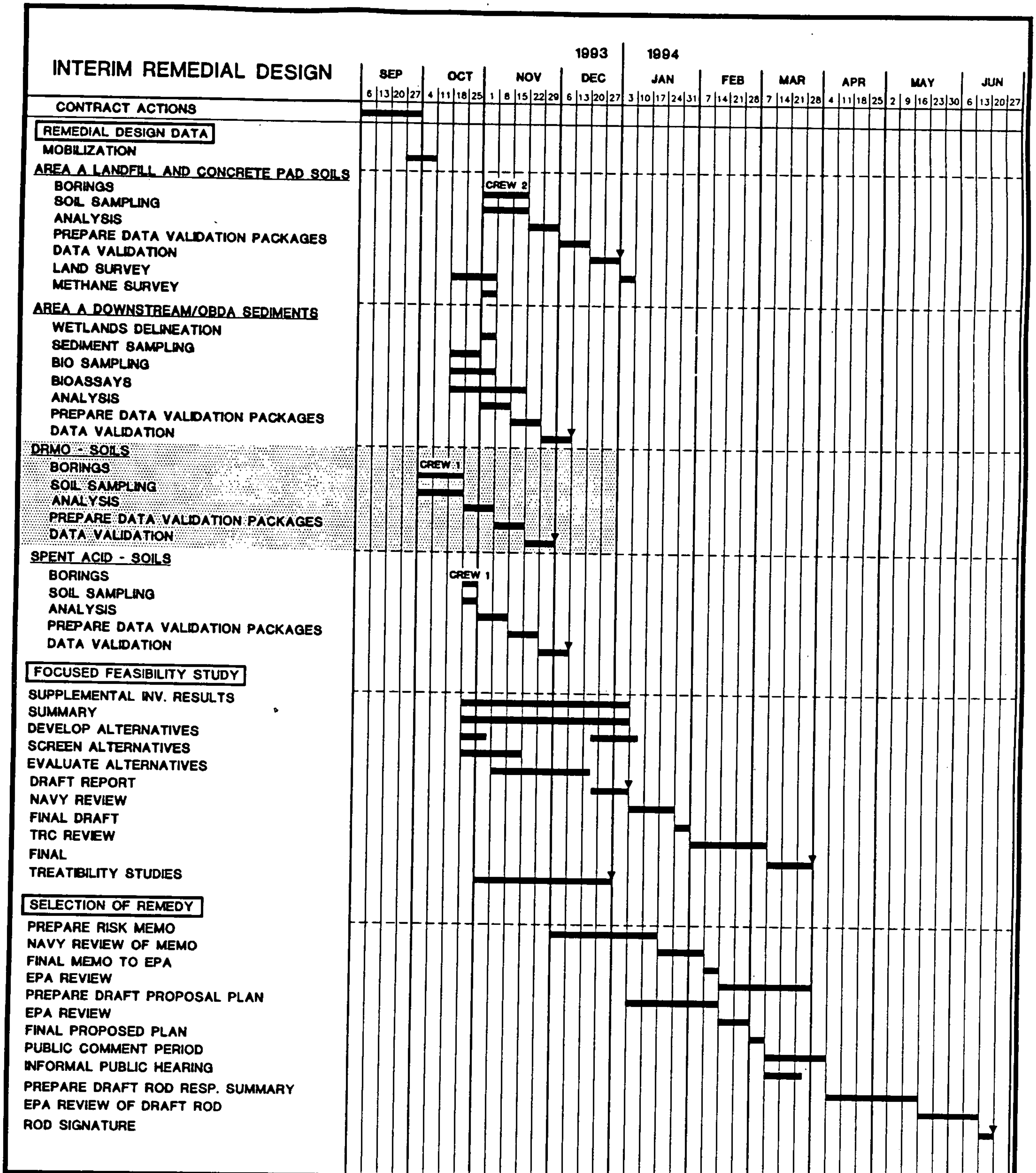
- Site Characteristics
- Interim Remedial Action Objectives
- Proposed Cleanup Levels
- Final Remediation Action
- Evaluation of Interim Remedial Design Alternatives
- Description of Work Items Required to Support the Remedial Action

The overall process of proceeding with the interim remedial actions is as follows:

- initiate remedial design and collection of supplemental data (laboratory analysis and engineering);
- complete focused feasibility study, including evaluation of collected data and remedial alternatives;
- develop proposed plan and record of decision (ROD);
- participate in ongoing public relations activities;
- complete design; and
- implement approved, interim remedial actions.

This document is the first phase of remedial design. Supplemental design data are currently being collected. Generalized schedules, showing all of the tasks to complete interim remedial actions for this project and the other interim remedial actions currently being implemented, are included in Tables 1-1 and 1-2.

Input from the Technical Review Committee (TRC) and regulatory agencies regarding the proposed interim remediation designs is requested at this time.

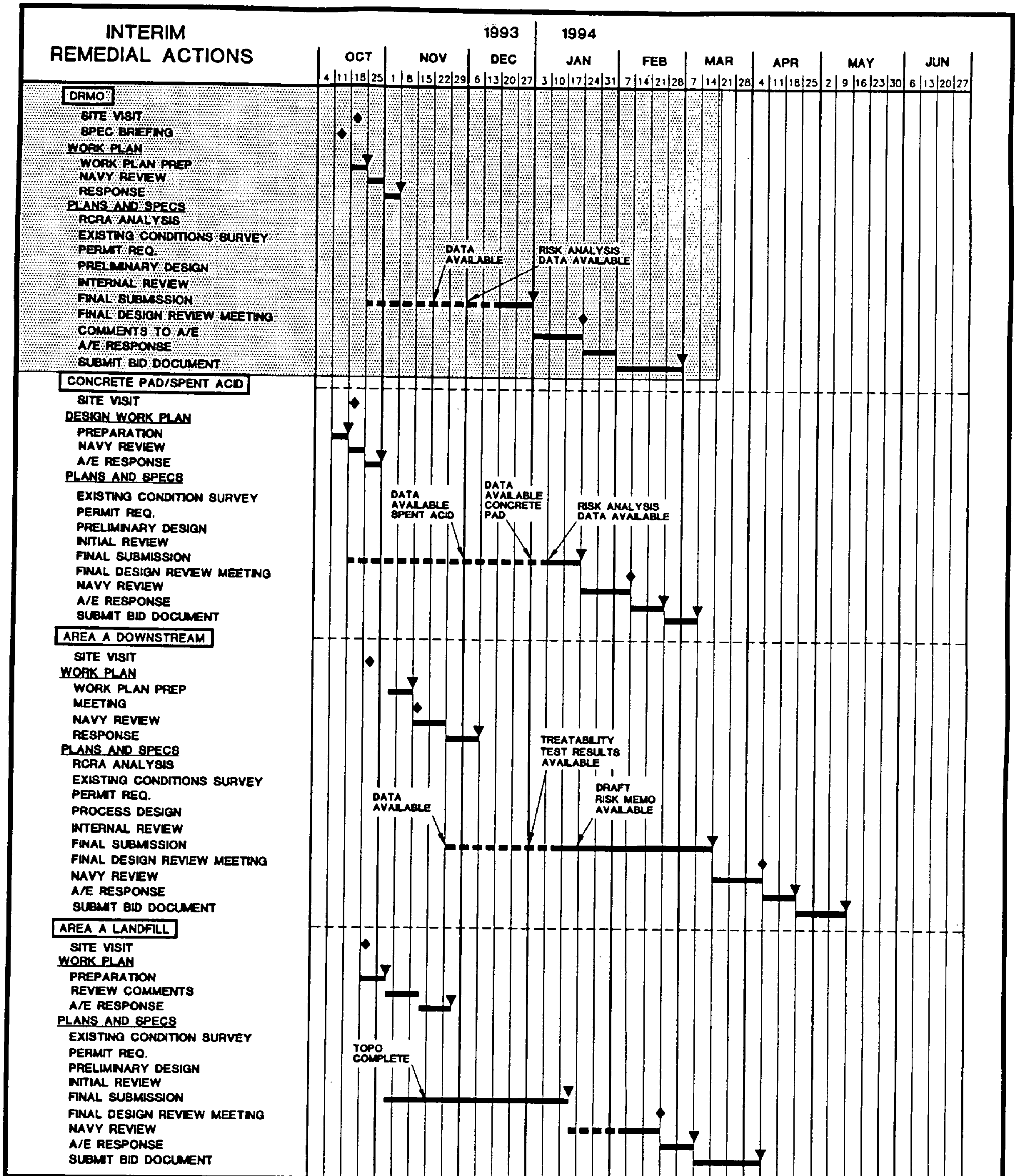


INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE - NEW LONDON
GROTON, CT

LEGEND
TASK TIME LINE
▼ ENDING MILESTONE

TABLE 1-1
SUPPLEMENTAL DESIGN DATA/
FOCUSED FEASIBILITY STUDY/
PROPOSED PLANS/RODS
INTERIM REMEDIAL ACTIONS

ATLANTIC ENVIRONMENTAL SERVICES, INC.



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

LEGEND

- TASK TIME LINE
- PART TIME TASK TIME LINE
- ▼ MILESTONE/DELIVERABLE
- ◆ MEETING

TABLE 1-2
SCHEDULE
DESIGN INTERIM REMEDIAL ACTIONS

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2.0 SITE CHARACTERISTICS AND REMEDIATION GOALS

Regional geology and hydrology are described in the Phase I Remedial Investigation (August 1992, Atlantic) along with detailed, site background information and a description of the nature and extent of contamination. Presented herein is a summary of background-specific geology and hydrology for the DRMO site, and the nature and extent of contamination.

2.1 Site Background

The DRMO site is adjacent to the Thames River in the northwest section of NSB-NLON. The DRMO is the storage and collection facility for items to be sold at auction sales held periodically throughout the year. Scrap metal is also temporarily stored before being transported off this site. Figure 2-1 illustrates previous sample locations and the locations of soil borings and monitoring well installations currently being performed.

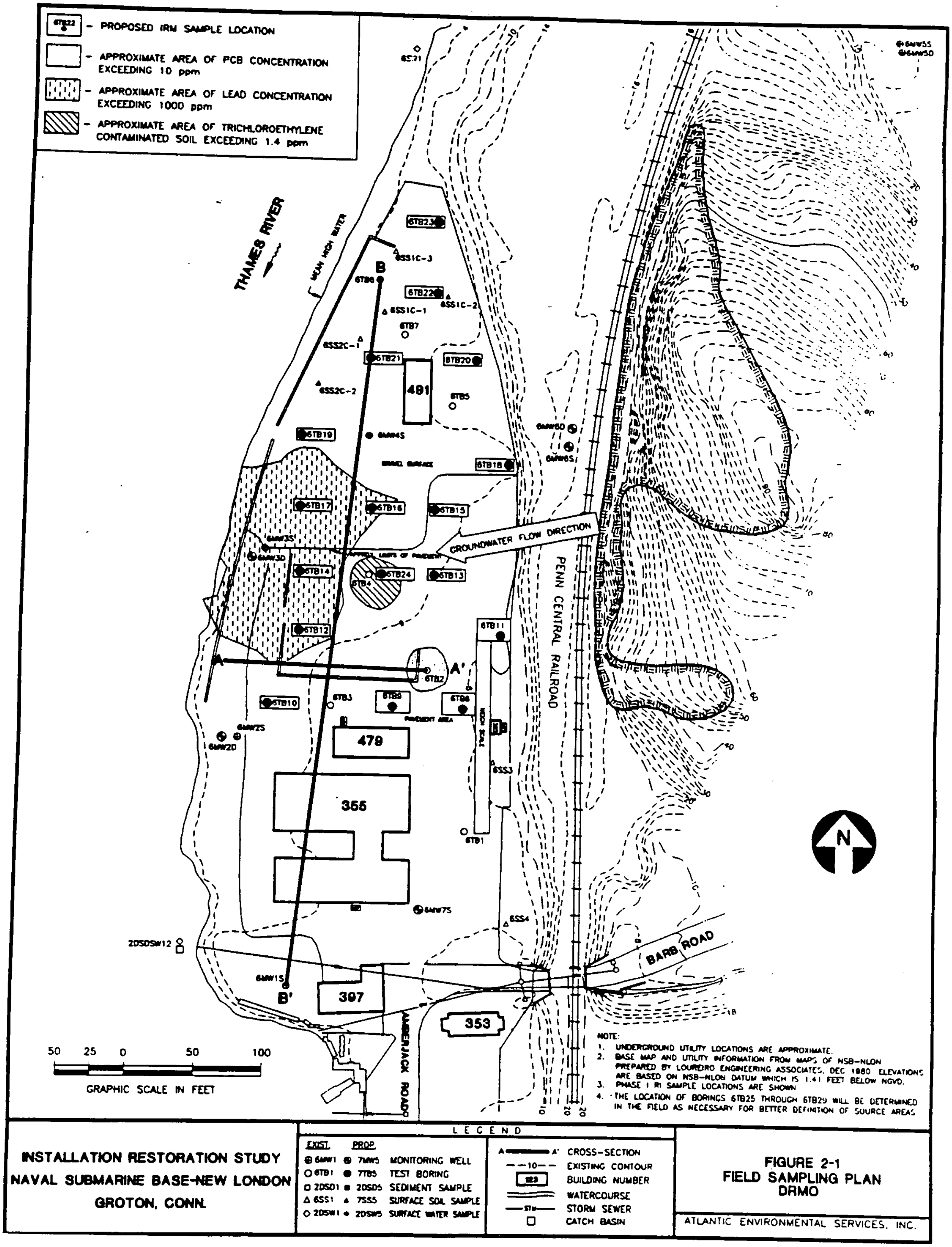
The DRMO site was used as a major base landfill and burning ground from 1950 to 1969. The materials burned and landfilled included construction materials, combustible scrap, and other nonsalvageable waste items. These materials were reportedly burned on the shoreline and then disposed over the riverbank and partially covered. Also, a former battery-acid handling facility was located near Building 491. An inground, rubber-lined tank and associated pumping facilities were present, similar to the spent acid storage and disposal area site.

DRMO operations at this site, after the closing of the landfill, include storage of various items, including submarine batteries, white goods, and empty drums.

Other routine grading and minor excavation occurs in the northern portion of the site.

2.2 Site-Specific Geology and Hydrology

Site-specific geology has been determined by using the Phase I RI and interpretation of



PROPOSED IRM SAMPLE LOCATION
APPROXIMATE AREA OF PCB CONCENTRATION EXCEEDING 10 ppm
APPROXIMATE AREA OF LEAD CONCENTRATION EXCEEDING 1000 ppm
APPROXIMATE AREA OF TRICHLOROETHYLENE CONTAMINATED SOIL EXCEEDING 1.4 ppm
THAMES RIVER
MEAN HIGH WATER
GROUNDWATER FLOW DIRECTION
PENN CENTRAL RAILROAD
BARB ROAD
AMBERJACK ROAD
491
479
355
397
353
B
B'
A'
N
50 25 0 50 100
GRAPHIC SCALE IN FEET
NOTE:
1. UNDERGROUND UTILITY LOCATIONS ARE APPROXIMATE.
2. BASE MAP AND UTILITY INFORMATION FROM MAPS OF NSB-NLON PREPARED BY LOUREIRO ENGINEERING ASSOCIATES, DEC 1980. ELEVATIONS ARE BASED ON NSB-NLON DATUM WHICH IS 1.41 FEET BELOW NGVD.
3. PHASE I RI SAMPLE LOCATIONS ARE SHOWN
4. THE LOCATION OF BORINGS 6TB25 THROUGH 6TB29 WILL BE DETERMINED IN THE FIELD AS NECESSARY FOR BETTER DEFINITION OF SOURCE AREAS
INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE-NEW LONDON
GROTON, CONN.
LEGEND
EXIST. PROP.
6MW1 7MW5 MONITORING WELL
6TB1 7TB5 TEST BORING
2DSD1 2DSD5 SEDIMENT SAMPLE
6SS1 7SS5 SURFACE SOIL SAMPLE
2DSW1 2DSW5 SURFACE WATER SAMPLE
CROSS-SECTION
EXISTING CONTOUR
BUILDING NUMBER
WATERCOURSE
STORM SEWER
CATCH BASIN
FIGURE 2-1
FIELD SAMPLING PLAN
DRMO
ATLANTIC ENVIRONMENTAL SERVICES, INC.

the 1967 United States Geological Survey (USGS) Bedrock Geology Map, the 1983 (Soil Conservation Service (SCS) Soils Map, and the 1960 USGS Surficial Geology Map.

The 1967 USGS Bedrock Geologic Map shows the DRMO site as artificial fill underlain by a biotite-quartz-feldspar gneiss of the Mamacoke Formation. The northernmost portion of the DRMO is mapped as a gneissic biotite granite known as the Potter Hill Granitic Gneiss. An outcrop of the Westerly Granite is also mapped on the east side of the DRMO site. Field observations of fill material and bedrock outcrops are generally consistent with mapped classifications, although the Westerly Granite was not positively identified in the field. Bedrock was encountered northeast of the DRMO site (6MW5D) at a depth of 25 feet below grade. Twenty feet of bedrock was cored at this location. The mineralogy and texture of the core sample is consistent with that described as the Potter Hill Granitic Gneiss. Weathered and partially covered bedrock outcrops were present on the east side of the DRMO site adjacent to the railroad tracks. In addition, a prominent bedrock cliff exists east of both the DRMO site and railroad tracks.

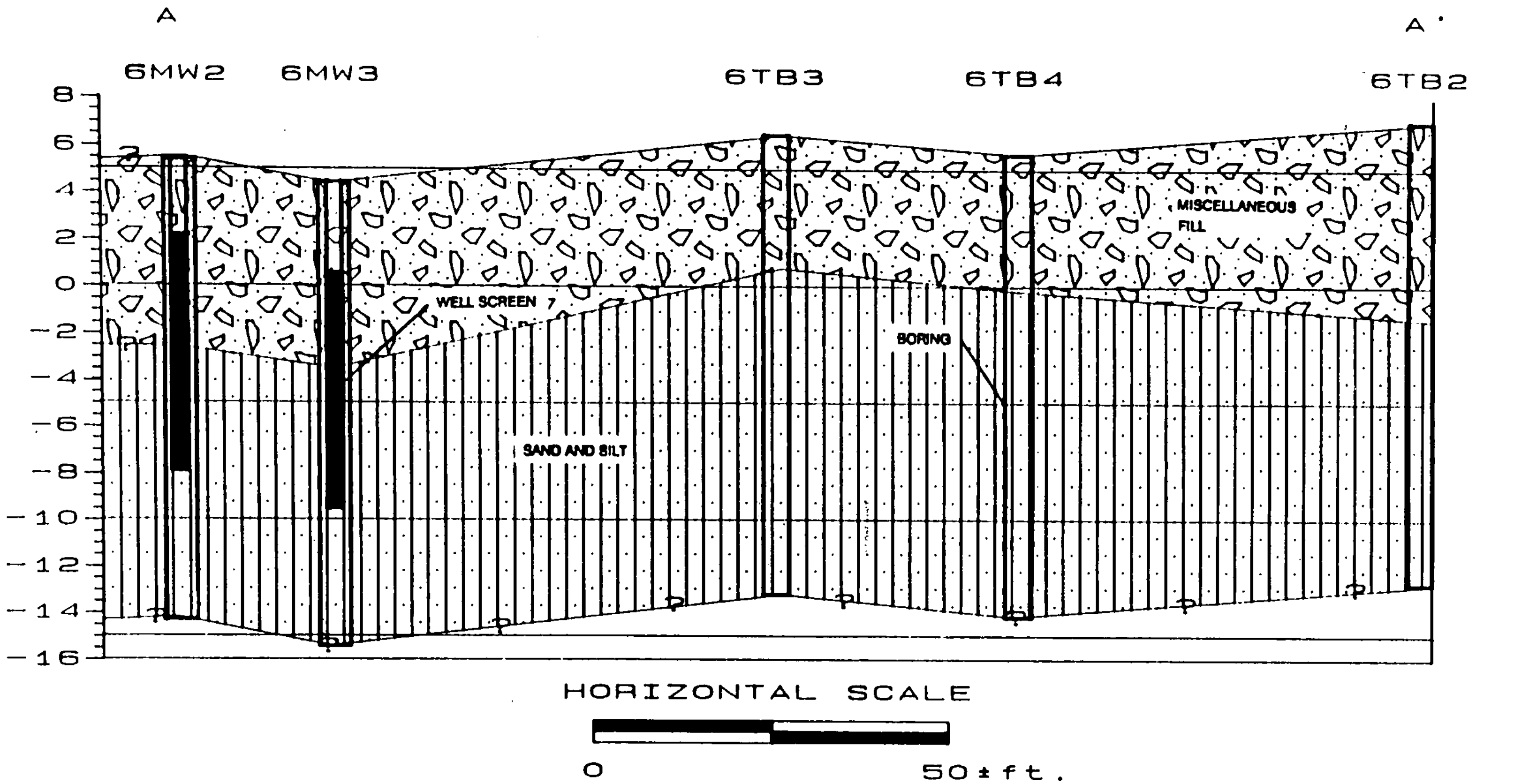
The 1983 SCS Soils Map depicts the DRMO site as udorthents-urban land on the portion of the site that is near the Thames River and Hinckley Sandy Loam on the northernmost portion of the site. The 1960 USGS Surficial Geology Map shows artificial fill in the portion of the DRMO that is adjacent to the Thames River and terrace deposits of the Thames River in the northern portion of the DRMO. The classifications of udorthents-urban land and artificial fill are consistent with the past and present conditions on the southern portion of the DRMO site. Subsurface soil sampling data from the northern portion of the DRMO site is consistent with the description of Hinckley Sandy Loam provided by the SCS. Soils observed at the northern portion of the DRMO site are consistent with a coarse fraction of the terrace deposits.

Subsurface investigations show that DRMO is underlain by between 5 and 20 feet of miscellaneous fill material (predominantly sand and gravel). Fill material is thickest in the northern portion of the site near Building 491, measuring up to 15 feet thick (at 6MW4). The sand and gravel are underlain by sand and silt that contain shell fragments.

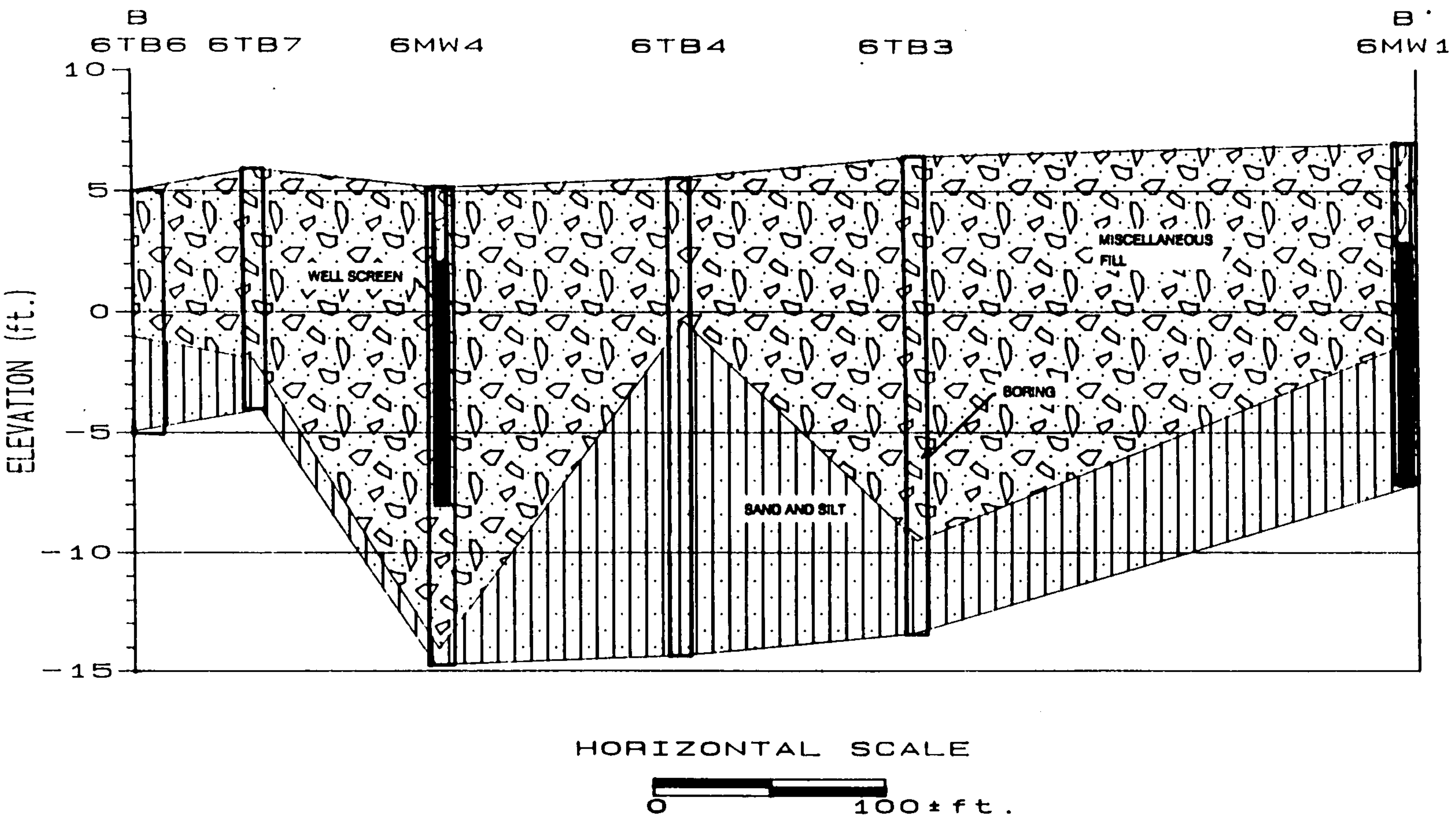
In the southern portion of the site, fill material overlies sand, silt, and clay. Shell fragments were observed in all borings in the southern portion, except 6MW1. Shell fragments in fine-grained soils probably represent the original river bed. The depth to fine-grained soils ranges from 10 feet in the central portion of the site to 20 feet in the northern portion. Figures 2-2 and 2-3 are geologic cross sections of the DRMO site, which illustrate the subsurface geology, landfill material (miscellaneous fill), and the water table.

Four overburden monitoring wells and one bedrock monitoring well were installed at DRMO. Groundwater elevations in the overburden aquifer were approximately 4 to 6 feet below grade in the southern portion of DRMO and approximately 12 feet below grade in the north portion of DRMO. Water level measurements taken at the five overburden monitoring wells show that groundwater flow is toward the west. As with other sites next to the Thames River, groundwater flow at DRMO is influenced by tidal fluctuations.

Slug displacement tests were done in two overburden wells. Single well pumping tests were conducted in one overburden well and one bedrock well. The average hydraulic conductivity was estimated to be 50.0 feet per day, and the hydraulic upgradient was 0.005. Using data from these tests, the volume of water discharged from the overburden to the Thames River is estimated to be approximately 23,100 cubic feet per day (172,800 gpd), based on a flow velocity of 0.7 feet per day, a saturated thickness of 50 feet, and a 660-foot section



INSTALLATION RESTORATION STUDY NAVAL SUBMARINE BASE - NEW LONDON GROTON, CT		**FIGURE 2-2** GEOLOGIC CROSS SECTION A - A' DRMO ATLANTIC ENVIRONMENTAL SERVICES, INC.



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

FIGURE 2-3
GEOLOGIC CROSS SECTION B - B'
DRMO

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perpendicular to the flow path. Flow to the river is probably greater during low tide.

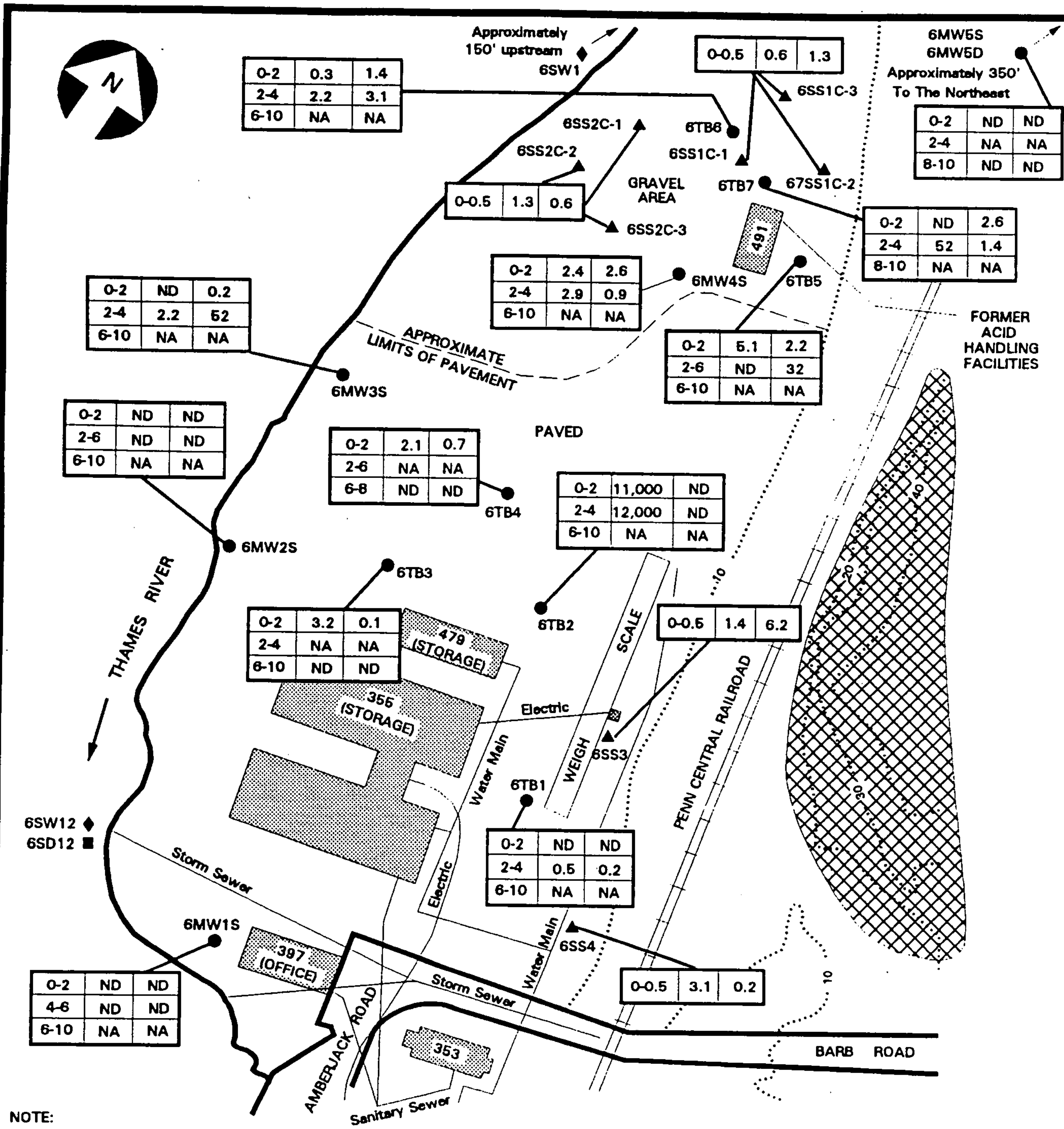
Data analyses indicate that the transmissivity of the bedrock in the vicinity of this well is 1,670 square feet per day, assuming a porous aquifer thickness of 150 feet.

2.3 Nature and Extent of Contamination

Documented soil contaminants at this site include: low concentrations of volatile organic compounds (VOCs) with one isolated hot spot; moderate levels of semivolatile compounds (SVOCs) comprised predominantly of polycyclic aromatic hydrocarbons (PAHs); polychlorinated biphenyls (PCBs) in low-to-moderate concentrations; moderate-to-high concentrations of DDT, DDD, and DDE (DDTR) at one sample point; and metal concentrations above background. The most significant metals (relative to health or ecological risk) detected above background levels include cadmium, lead, and mercury. In groundwater, VOCs were present in low levels, and the following inorganics were present above to-be-considered (TBC) or applicable or relevant and appropriate requirements (ARARs) values: boron, sodium, iron, manganese, and selenium. The apparent source of contamination at the site is the fill material deposited at the site and spillage from site activities. This subsection details the nature and extent of contamination determined in the Phase I RI.

Radiation, geophysical, and soil gas surveys were conducted. No radiation above background levels was detected. The geophysical survey identified several, suspectedly buried, metal objects, which were avoided during drilling operations. The soil gas survey assisted in defining VOCs in several areas. Figure 2-4 illustrates the concentrations of PCBs and TCLP (Toxicity Characteristic Leachate Procedure) lead detected in surface and sediment samples.

Twenty-four soil samples were collected from 12 test boring/monitoring well locations. Four surface soil samples and six groundwater samples were collected. These samples were



NOTE:

1. Underground utility locations are approximate.
2. Base map and utility information from maps of NSB-NLON prepared by Loureiro Engineering Associates, Dec 1980. Elevations are based on NSB-NLON datum which is 1.41 feet below NGVD.
3. Refer to analytical tables for specific sample depth interval.

INSTALLATION RESTORATION STUDY

NAVAL SUBMARINE BASE - NEW LONDON

GROTON, CT

LEGEND

■ SD1-Sediment Sample
▲ SS1-Surface Soil Sample
♦ SW1-Surface Water Sample

Sample Depth (ft)	PCB (ppb)	TCLP LEAD (ppm)

NA - Not Analyzed
ND - Not Detected

● MW1- Monitoring Well
● TB1- Test Boring
···95··· - Existing Grade
- Building
- Exposed Bedrock

Approximate Scale
0 20 40'

FIGURE 2-4
SUMMARY OF PCB AND TCLP LEAD IN SOILS DRMO

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analyzed to define the nature and extent of contamination at the former landfill site.

VOC concentrations in soil at DRMO were generally low. However, elevated VOCs were detected at 6TB4 (6-8 feet), where the following chemicals were found: vinyl chloride (1,300 ppb), trichloroethene (20,000 ppb), and tetrachloroethene (210 ppb). The contamination appears to be generally isolated at the site, based on results of the soil gas survey and other soil samples collected in this area.

SVOCs were present in most samples collected in the former landfill area. The SVOCs predominantly consisted of PAH compounds, many of which were at elevated levels. The spatial density of the sample locations indicates that PAHs are likely present throughout the limits of the DRMO site. Based on the former use of the site as a landfill, and an area where material was burned, the PAHs are probably a result of incomplete combustion and, perhaps to a lesser degree, petroleum releases.

PCB Aroclor 1260 is present at almost all sample locations except 6MW5S (background), 6MW1S, and 6MW2S (rear of office and storage building). Concentrations range from 52 ppb to 12,000 ppb. This contaminant is generally present in both the 0-2 foot and 2-6 foot depths. The presence of PCBs at this site is most likely associated with scrap metal storage (e.g., white goods), associated capacitor leaks, and past storage of transformers. The PCBs do not necessarily come from landfill disposal. PCB Aroclor 1260 was also detected at sediment sample location 2DSD12, which is at the outfall of the storm drainage system from Area A to the rear of Building 397 at DRMO. It was not present in other upgradient sample points along the Area A downstream and may be a result of surface soil transport via surface water run-off from DRMO.

Pesticides at elevated concentrations were detected at one sample location; pesticides were detected at no other sample locations. Total pesticide concentrations were 57,800 ppb, consisting of DDT, DDD, and DDE. The DDT concentration was above the TBC value. Because pesticides were detected at only one sample location and at a depth of 2-6 feet, the DDT probably came from past landfilling rather than surficial application.

Out of 24 samples analyzed for TCLP metals, 21 contained one or more metals exceeding to-be-considered (TBC) values. Metals exceeding TBC values included barium, cadmium, chromium, lead, mercury, and silver. The TCLP hazardous waste characteristic value for lead is 5 ppm. This value was exceeded at 6MW3S (2-4 feet) (52 ppm); at 6TB5 (2-6 feet) (32 ppm); and at 6SS3 (0-0.5 feet) (6.2 ppm). Lead levels were generally elevated around Building 491 (from former battery-acid handling), indicating that battery acid releases occurred in this area. Many inorganic constituents exceeded established background levels, based on mass analysis. These inorganics included antimony, beryllium, cadmium, cobalt, copper, lead, mercury, nickel, zinc, and boron. The majority of these elevated levels probably are related to a combination of past landfill disposal and scrap metal storage.

No petroleum hydrocarbons were detected in the groundwater samples. Trichloroethene (TCE) and 1,2 dichloroethene were present in three downgradient wells (6MW2S, 6MW3S, and 6MW4S). TCE exceeded the ARAR value (5 ppb) with a concentration of 8 ppb at well 6MW4S. The primary source of the solvents in the groundwater, based on the soil analytical results and the soil gas data, is projected to be in the area of 6TB4, 6MW4S, 6TB6, and 6TB7.

No SVOCs, PAHs, pesticides, or PCBs were detected in any wells at the DRMO site. Low levels of phthalates and benzoic acid were detected in the upgradient well 6MW5D. The inorganic groundwater analysis indicates that selenium exceeds the primary drinking water standards (ARARs) at wells 6MW2S, 6MW3S, and 6MW4S. The cause of the elevated levels is unclear but appears to be site-related.

No VOCs, SVOCs, pesticides, or PCBs were detected in the surface water sample.

The distribution of contaminants at this site has not been completely defined. Therefore, as part of the overall remediation design effort for this site soil sampling and analysis will be conducted to better define the extent of contamination. Future investigations for this site are specified in the Phase II RI Work Plan. Those portions of the work plan regarding the extent of contamination currently are being performed to allow for the timely incorporation of the data into the final interim remedial design. In general, these data collection requirements consist of the drilling of up to 22 borings (one of which will be completed as a monitoring well) and analysis at an off-site laboratory of up to 28 soil samples. The boring locations are illustrated in Figure 2-1.

3.0 INTERIM REMEDIAL DESIGN

3.1 Interim Remedial Action Objectives and Remediation Target Levels

Risks to human health at DRMO were identified with respect to specific chemicals and receptors. No acute risks or imminent hazards related to the chemicals were found. However, there is some risk for workers at the DRMO involved in sorting scrap metal and future construction workers and workers involved in servicing underground utilities due to the presence of PCBs in surface soils and lead in surface and subsurface soils. Also, a source area containing TCE-contaminated soil contributing to TCE contamination in groundwater was detected. The objectives of the interim remedial action are to reduce infiltration through the land fill, remove source areas that are contributing to TCE contamination in groundwater, prevent erosion of surface soils, and reduce exposure of workers to PCBs and lead in soils.

The preliminary remediation action target level for PCBs in soil at this site is 10 ppm. The Connecticut Department of Environmental Protection (CTDEP) guidance target value for PCBs in soil is 2 ppm, and the U.S. EPA regulatory guidance for PCBs in soil is 10 ppm. The remediation action target level for PCBs in soil was chosen at the higher value of 10 ppm because the area will be capped and there will be long-term maintenance and groundwater monitoring at this site. Also, the 2 ppm value is a CTDEP guidance value and not a regulatory standard or ARAR for PCBs in soil.

The preliminary remediation action target level for lead in surface and subsurface soils is 1,000 ppm. This target level is at the higher end of the range (500-1,000) recommended by the EPA. The higher remediation action target level was chosen for lead in soil at this site because the area will be capped and there will be long-term maintenance and groundwater monitoring at this site.

The preliminary remediation action target level for TCE is 1.4 ppm. This remediation action target level is based on computation of a contaminant level in source soils that is capable of causing values in groundwater above ambient water quality criteria (AWQC) based on the Summer's Model.

The final remediation action target levels will be determined from the results of supplemental field investigation and further risk analysis. The action levels will be finalized when the record of decision (ROD) is signed.

3.2 Final Remediation Actions

Interim remedial actions for the DRMO consist of the excavation of "hot spots" and the installation of an interim cap. Long-term maintenance and groundwater monitoring will be conducted at this site after the interim remediation. The remainder of the work in the Phase II RI work plan for the DRMO consists of the installation of groundwater monitoring wells and performing an ecological risk assessment regarding the Thames River. The monitoring wells will be sampled periodically to assess site groundwater quality and determine site groundwater hydrology. The results of the chemical analysis on groundwater samples and the ecological risk assessment will be used to evaluate the effect of groundwater discharges from the DRMO on the Thames River ecology after the interim remediation has been completed. Based on this evaluation, a determination will be made whether any further action is required to remediate groundwater at this site to protect the ecology of the Thames River. Further action, if required, would consist of a groundwater pump and treat system designed to control contaminants discharging to the Thames River.

Additional work may be performed on the interim cap to expand its limits or to decrease its permeability or increase its permanence by adding more layers after the interim remedial action has been evaluated. No further excavations are anticipated at this site after the interim remedial actions have been completed.

3.3 Evaluation of Alternatives

To further document the rationale for selecting the proposed interim remedial action, a focused feasibility study (FFS) will be performed. Additional remedial design data currently are being collected to support the FFS and remedial design efforts. The preliminary evaluation of alternatives presented herein are based on data currently available from the Phase I RI and preliminary work done in preparing a feasibility study based on the Phase I RI. Work on this feasibility study was put on hold, pending completion of the Phase II RI.

Based on the initial screening of technologies and a risk assessment, it was determined that the interim remedial action at this site would consist of the excavation of "hot spots" and capping of the portion of the site that is not currently paved, including the portions of the site where "hot spots" have been excavated. Soils containing concentrations of PCBs, lead, and TCE above the remediation action target levels previously discussed will be excavated and properly treated and/or disposed of. It was determined that these areas would be excavated because the currently defined areas are limited in size and therefore excavation and ex-situ treatment of the material is cost effective. Also, eliminating the "hot spots" will reduce the potential for groundwater contamination and the exposure of future construction or utility workers to contaminated soils.

Installation of the cap on the unpaved area of the site will reduce the exposure of workers involved in sorting scrap, future construction workers, and frequent visitors to the DRMO that participate in the auctions to the contaminants present in surface soils at the site. The cap will also reduce infiltration through the landfill and prevent erosion of landfill surface soils.

The evaluation of treatment options for the excavated materials and an evaluation of capping options are presented in the following subsections.

3.3.1 Evaluation of Treatment Alternatives - PCB-Contaminated Materials

Based on screening of technologies, several alternatives, as shown in Table 3-1, were selected for a screening evaluation. Three alternatives have been retained for further analysis, based on initial screening of the technologies during the feasibility study and the elimination of any alternatives that did not include available, cost-effective, and proven technologies. The three alternatives retained for further evaluation are indicated (as shaded) in Table 3-1. One of the three alternatives consists of containment of contaminated soil via a surface cap. This alternative as discussed above will be implemented in addition to excavation of the "hot spots." The capping alternatives are discussed in a following subsection. The following alternatives for disposal or treatment of the excavated soils have been evaluated:

- on-site treatment of the excavated PCB-contaminated soils via low-temperature thermal desorption; and
- off-site disposal of the excavated PCB-contaminated soils at a landfill permitted for the disposal of hazardous waste under RCRA (RCRA landfill).

On-site treatment of the excavated PCB-contaminated soils via low-temperature thermal desorption has been considered as an alternative to off-site disposal. Mobilization of a thermal desorber to the site would not be cost-effective for the limited amount of PCB-contaminated soils currently anticipated. The use of an on-site thermal desorber currently is being evaluated for the interim remediation of DDT-contaminated sediments at the Area A Downstream/OBDA sites at the NSB-NLON and if selected, this alternative conceptually could be used to treat the PCB-contaminated soils from DRMO. However, as this remediation is being performed as an

TABLE 3-1
DRMO - PCB-CONTAMINATED SOILS
DEVELOPMENT OF ALTERNATIVES

RETAINED PROCESS OPTIONS	ALTERNATIVES									
SOIL/SEDIMENT	LIMITED ACTION		CONTAINMENT	OFF-SITE ALTERNATIVES[3]		ON-SITE ALTERNATIVES				
	No Action	Access Restriction	Surface Cap	Incineration	RCRA Landfill	In situ Stabilization	Above-ground Stabilization	Incineration[1]	Low Temperature Thermal Desorption[1]	Solvent Extraction[1]
	6PCB-1	6PCB-2	6PCB-3	6PCB-4	6PCB-5	6PCB-6	6PCB-7	6PCB-8	6PCB-9	6PCB-10
No Action	•									
Access Restriction		•	•							
Horizontal Barrier - Cap			•							
Site Grading & Stormwater Management			•							
Excavation - Backhoe				•	•		•	•	•	•
In situ Stabilization						•				
Solvent Extraction										•
Stabilization							•			
On-site Incineration								•		
Off-site Incineration (residues)				•					•[2]	•[2]
On-site Low Temp. Thermal Desorption									•	
On-site Backfill							•	•	•	•
Off-site RCRA Chemical Landfill					•					

1. Feasibility of these alternatives is contingent upon specified alternative being selected for remediation of DDTR-contaminated sediments in Area A downstream.
2. The condensed/extracted PCB and spent carbon will be transported off-site for incineration.
3. Off-site low temperature thermal desorption or off-site reuse (asphalt or cement) will be reconsidered if a permitted off-site facility is located.
4. Shading indicates alternatives to be evaluated during the focused feasibility study.

11-Nov-93 PCBALT.WK3

interim remedial action separate from the remediation of the DDTR-contaminated soils in Area A Downstream/ODBA, it is not possible to coordinate the two activities to take advantage of the economies of size. Thermal treatment of PCB-contaminated soils potentially may form dioxins which in turn must be destroyed or removed from the air stream prior to exhausting to the atmosphere. The air pollution control equipment required for the thermal treatment of PCB-contaminated materials makes this alternative costly and unattractive. In addition, the very high contaminant destruction removal efficiency (99.9999%) required under the Toxic Substance Control Act (TSCA) also make this alternative difficult to implement.

The currently proposed interim remedial action consists of the excavation of soils contaminated with PCBs at concentrations greater than 10 ppm and contaminated soil disposal at a RCRA landfill. This evaluation is based on the available data, which indicate that the amount of PCB-contaminated soil to be excavated is limited in size. The final design will be based on the results of the supplemental field investigation currently being performed, which will define the actual extent of contamination. The interim remedial design is currently proceeding for the excavation and off-site disposal alternative.

3.3.2 Evaluation of Treatment Alternatives - Lead-Contaminated Material

Based on a screening of technologies, several alternatives, as shown in Table 3-2, were selected for a screening evaluation. Three alternatives have been retained for further analysis, based on initial screening of the technologies during the feasibility study and the elimination of any alternatives that did not include available, cost-effective, and proven technologies. The three alternatives retained for further evaluation are indicated (as shaded) in Table 3-2. One of the three alternatives consists of containment of lead-contaminated soil via a surface cap.

TABLE 3–2
DRMO – LEAD–CONTAMINATED SOILS
DEVELOPMENT OF ALTERNATIVES

RETAINED PROCESS OPTIONS	ALTERNATIVES						
	LIMITED ACTION		CONTAINMENT	OFF–SITE ALTERNATIVE	ON–SITE ALTERNATIVES		
SOIL/SEDIMENT	No Action	Access Restriction	Temporary Cap	RCRA Landfill	In situ Stabilization	Above–ground Stabilization	Soil Washing
	6LEAD–1	6LEAD–2	6LEAD–3	6LEAD–4	6LEAD–5	6LEAD–6	6LEAD–7
No Action	●						
Access Restriction		●	●				
Horizontal Barrier – Cap			●				
Surface Water Control			●				
Excavation – Backhoe				●		●	
In situ Stabilization					●		
Soil Washing							
Stabilization				●[1]		●	1
On–site Backfill						●	2
Off–site RCRA Chemical Landfill				●			2

1. Optional, depends on TCLP analysis. Off–site stabilization can be performed at the selected off–site RCRA landfill.
2. Fine–grained (contaminated) soils separated by the soil washing process will be landfilled, while the larger soil particles will be backfilled.
3. Shading indicates alternatives to be evaluated during the focused feasibility study.

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This alternative as discussed above will be implemented in addition to excavation of the "hot spots."

The capping alternatives are discussed in a following subsection. The following alternatives for disposal or treatment of the excavated soils have been evaluated:

- aboveground stabilization of the excavated material and disposal on site; and

- off-site disposal of the excavated material at a RCRA landfill.

Once the contaminated soil has been excavated, the soil can be shipped off site to be disposed of in a RCRA landfill, or it can be treated on site. Because lead is an inorganic element, few treatment technologies are available, and none result in the destruction of the lead. Aboveground stabilization of the excavated material would reduce the leachate generated from the lead-contaminated soils. However, disposal of the stabilized material on site would still present a hazard by direct contact. Because the amount of soil currently anticipated to be excavated is relatively small, disposal of the material at an off-site RCRA landfill is the more cost-effective alternative at this time. Pretreatment of the contaminated material may be required prior to disposal in a RCRA landfill. This pretreatment will most likely consist of stabilization and can be performed off site at the landfill.

The final design will be based on the results of the supplemental field investigation currently being performed, which will define the actual extent of contamination. Based on the preliminary evaluation, excavation of the material with concentrations of lead above 1000 ppm and disposal of the material at an off-site RCRA landfill is the recommended interim remedial action at this time. The interim remedial design is currently proceeding for this alternative.

3.3.3 <u>Evaluation of Treatment Alternatives - TCE-Contaminated Materials</u>

Based on screening of technologies, several alternatives, as shown in Table 3-3, were

TABLE 3-3
DRMO – VOC (TCE)-CONTAMINATED SOILS
DEVELOPMENT OF ALTERNATIVES

RETAINED PROCESS OPTIONS	ALTERNATIVES										
	LIMITED ACTION		CONTAINMENT	OFF-SITE[4]		ON-SITE ALTERNATIVES					
SOIL/SEDIMENT	No Action	Access Restriction	Impermeable Cap	Incineration	RCRA Landfill	Above-ground Stabilization	Above-ground Landfarming	Incineration[1]	Low Temperature Thermal Desorption[1]	Air Stripping	Solvent Extraction[1]
	6VOC-1	6VOC-2	6VOC-3	6VOC-4	6VOC-5	6VOC-6	6VOC-7	6VOC-8	6VOC-9	6VOC-10	6VOC-11
No Action	•										
Access Restriction		•	•								
Horizontal Barrier – Cap			•								
Site Grading & Stormwater Management			•								
Excavation – Backhoe				•	•		•	•	•	•	•
In situ Stabilization						•					
Air Stripping (above-ground)					•					•	
Solvent Extraction											•
Stabilization							•	•[2]	•[2]	•[2]	•[2]
On-site Incineration								•			
Off-site Incineration (residues)				•					•[3]		•[3]
On-site Low Temperature Thermal Desorption									•		
On-site Backfill							•	•	•	•	•
Off-site RCRA Chemical Landfill					•						

1. Feasibility of this alternative is contingent upon specified alternative being selected for remediation of DDTR-contaminated sediments in Area A downstream.
2. Stabilization may be required due to high TCLP lead levels.
3. The condensed/extracted VOC's and spent carbon will be transported off-site for incineration.
4. Off-site low temperature thermal desorption or off-site reuse (asphalt or cement) will be reconsideered if a permitted off-site facility is located.
5. Shading indicates alternatives to be evaluated during the focused feasibility study.

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selected for a screening evaluation. Four alternatives have been retained for further analysis, based on initial screening of the technologies during the feasibility study and the elimination of any alternatives that did not include available, cost-effective, and proven technologies. The four alternatives retained for further evaluation are indicated (as shaded) in Table 3-3. One of the four alternatives consists of containment of TCE-contaminated soil via a surface cap. This alternative, as previously discussed, will be implemented in addition to excavation of the "hot spots." The capping alternatives are discussed in a following subsection. The following alternatives for disposal or treatment of the excavated soils have been evaluated:

- on-site treatment of the contaminated material via low-temperature thermal desorption;
- on-site treatment of the contaminated material via air stripping; and
- off-site disposal of the contaminated material in a RCRA landfill.

Thermal desorption of TCE-contaminated material would be effective for removing TCE from the soils. Mobilization of a thermal desorber to the site would not be cost effective for the limited amount of TCE-contaminated soils currently anticipated and for the reasons stated in Section 3.3.1 it is not possible to take advantage of the economies of size if a thermal desorber is selected to treat DDTR-contaminated sediments in Area A Downstream/OBDA. Also, the TCE source area soils may contain PCBs, and the problems discussed previously in subsection 3.3.1 make thermal desorption unattractive and costly.

Air stripping of TCE-contaminated materials would be effective for the removal of TCE from the soils. Mobilization of an air-stripper to the site may not be cost effective for the limited amount of TCE-contaminated soils currently anticipated. Also, the soils may also contain lead and PCBs. Process options capable of removing PCBs would be required in series with the air-stripping process if these semivolatile constituents are present in concentrations that would require their removal from the soil. The Phase II investigation will determine the amount of TCE-contaminated material that will need to be treated and the other contaminants present in the TCE source area.

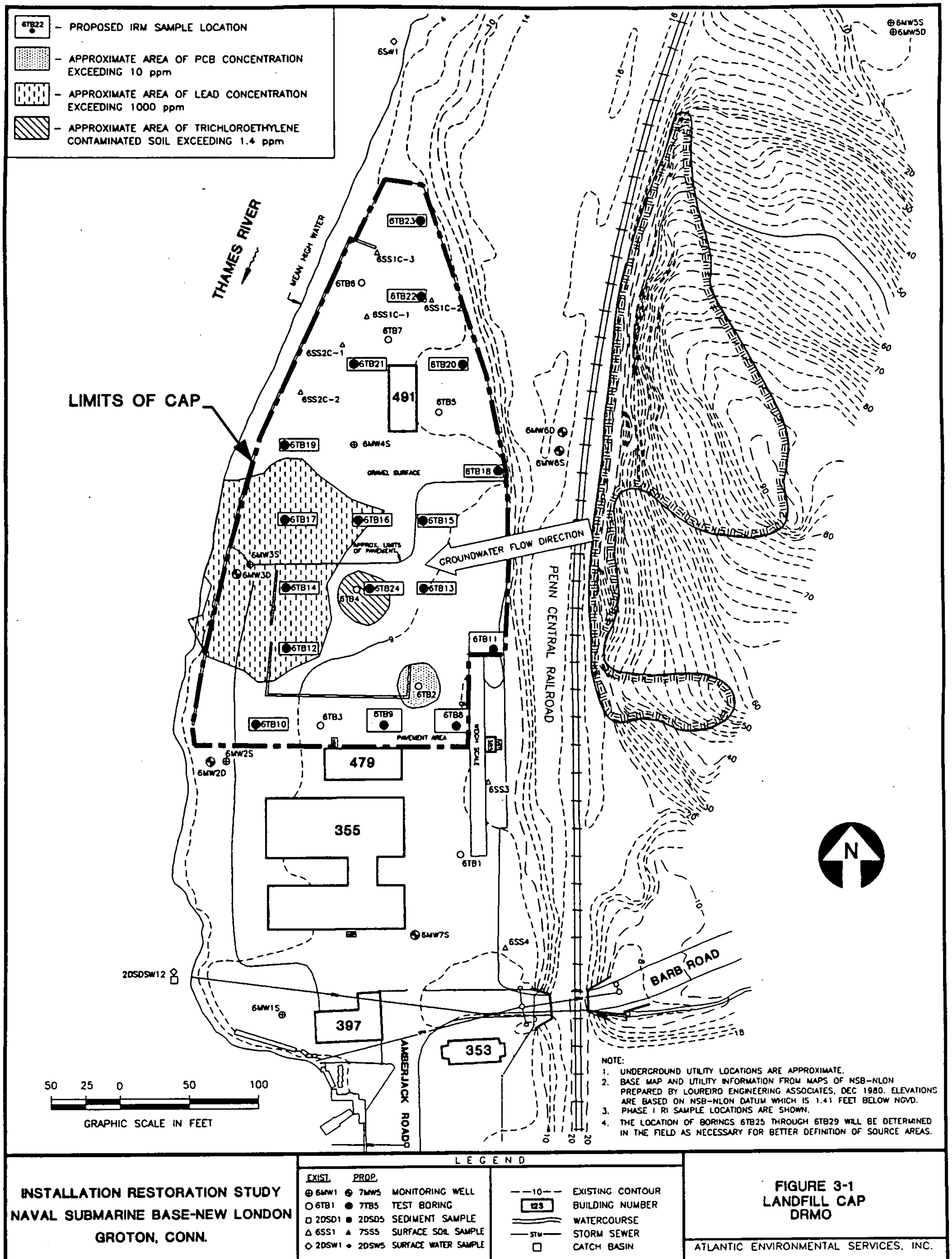
Disposal of TCE-contaminated soil at a RCRA landfill may be restricted, based on the land disposal restriction (LDR) requirements for TCE-contaminated soils. These requirements will be addressed in the final design. The final design will be based on the results of the supplemental field investigation currently being performed, which will define the actual extent of contamination. If it is determined that the soil can not be disposed of at a RCRA landfill, other off-site disposal/treatment options will be evaluated. If none of these off-site alternatives are cost-effective, the interim remedial action currently proposed for solvent-contaminated soils may have to be reevaluated.

3.3.4 Evaluation of Capping Alternatives

The proposed area to be capped on this site is illustrated in Figure 3-1. This area consists of the portion of the site currently not paved and extends to the extent of the excavations and to the top of the slope to the Thames River. The area is approximately 65,500 square feet in area. This area may be increased, pending the results of the Phase II RI and an evaluation of the integrity of the currently paved area. Four capping options were evaluated based the following parameters:

- cost;
- ability to maintain integrity under current work loads at the site;
- controlling surface water runoff;
- preventing surface erosion;
- preventing infiltration; and
- compliance with ARAR.

The cap design must be consistent with the future continued operation of the site as a scrap yard for the Submarine Base. The cap must be capable of supporting heavy equipment while maintaining its structural integrity. Therefore, all of the capping alternatives evaluated have a surface layer of 1.0 foot of compacted crushed stone "choked" with stone fines and cement dust. This composition provides a very hard durable surface for operating heavy equipment such as front end loaders and cranes. This type of surface was chosen as the minimum surface required to meet the continued operational needs of the site. The crushed stone surface also prevents direct contact with the contaminated soils and surface erosion will be minimal. The costs associated with this surface are relatively inexpensive and the surface is easily maintained. The purpose of the crushed stone surface is not to provide an impermeable barrier; however, it should possess a very low permeability once choked with fines and cement dust.



PROPOSED IRM SAMPLE LOCATION
APPROXIMATE AREA OF PCB CONCENTRATION EXCEEDING 10 ppm
APPROXIMATE AREA OF LEAD CONCENTRATION EXCEEDING 1000 ppm
APPROXIMATE AREA OF TRICHLOROETHYLENE CONTAMINATED SOIL EXCEEDING 1.4 ppm
THAMES RIVER
MEAN HIGH WATER
LIMITS OF CAP
GROUNDWATER FLOW DIRECTION
PENN CENTRAL RAILROAD
BARB ROAD
AMBERJACK ROAD
491
479
355
397
353
N
50 25 0 50 100
GRAPHIC SCALE IN FEET
NOTE:
1. UNDERGROUND UTILITY LOCATIONS ARE APPROXIMATE.
2. BASE MAP AND UTILITY INFORMATION FROM MAPS OF NSB-NLON PREPARED BY LOUREIRO ENGINEERING ASSOCIATES, DEC 1980. ELEVATIONS ARE BASED ON NSB-NLON DATUM WHICH IS 1.41 FEET BELOW NGVD.
3. PHASE I RI SAMPLE LOCATIONS ARE SHOWN.
4. THE LOCATION OF BORINGS 6TB25 THROUGH 6TB29 WILL BE DETERMINED IN THE FIELD AS NECESSARY FOR BETTER DEFINITION OF SOURCE AREAS.
INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE-NEW LONDON
GROTON, CONN.
LEGEND
EXIST. PROP.
6MW1 7MW5 MONITORING WELL
6TB1 7TB5 TEST BORING
2DSD1 2DSD5 SEDIMENT SAMPLE
6SS1 7SS5 SURFACE SOIL SAMPLE
2DSW1 2DSW5 SURFACE WATER SAMPLE
EXISTING CONTOUR
BUILDING NUMBER
WATERCOURSE
STORM SEWER
CATCH BASIN
FIGURE 3-1
LANDFILL CAP
DRMO
ATLANTIC ENVIRONMENTAL SERVICES, INC.

Based on an evaluation of applicable, relevant, and appropriate requirements (ARARs), it was determined that this site, based on its usage and detected contaminants, has been used as a solid waste disposal area. Therefore, any cap at this site should, at a minimum, meet the RCRA guidance regarding closure of solid waste disposal areas. It should be noted that two of the four alternatives cap designs also meet RCRA guidance regarding closure of hazardous waste disposal areas.

As an option, the crushed stone base can be covered with asphalt if a more permanent surface is desired. This option can be implemented during the installation of the cap or at a later date. The asphalt surface is more durable than the crushed stone surface; however, it is considerably more expensive. The crushed stone base with asphalt surface is approximately two times more expensive than the crushed stone base alone.

The following capping alternatives were evaluated and are illustrated in Figures 3-2 through 3-5. The advantages, disadvantages, and approximate unit costs for each alternative are also listed in Figures 3-2 through 3-5.

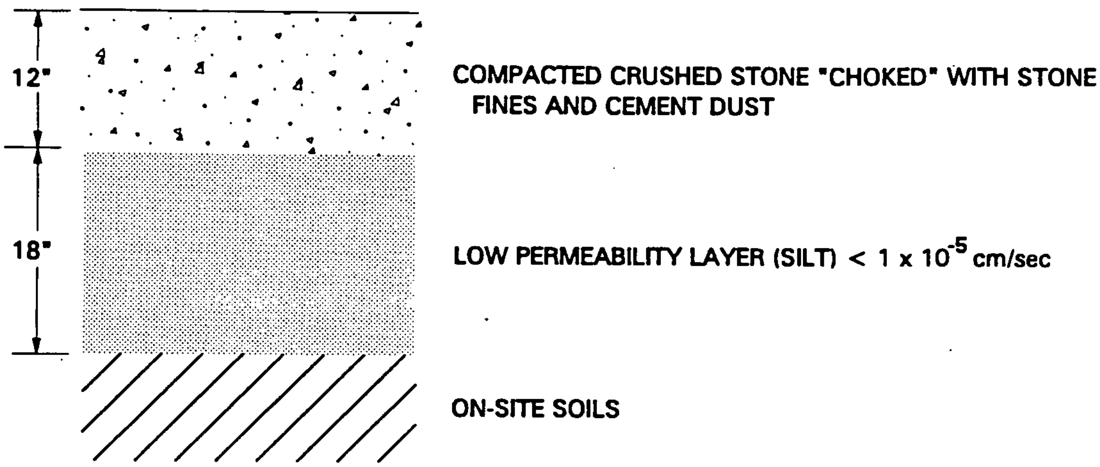
- Alternative #1 (Figure 3-2): RCRA Nonhazardous Waste Landfill Cap.
- Alternative #2 (Figure 3-3): RCRA Hazardous Waste Landfill Cap.
- Alternative #3 (Figure 3-4): Geo-Composite Clay Liner.
- Alternative #4 (Figure 3-5): Bentonite/Flexible Membrane Liner (FML) Composite Liner.

3.3.4.1 Recommended Capping Design Concept

Atlantic recommends that Alternative 4 be used for capping the DRMO site. Alternatives 3 and 4 are both applicable technologies for capping the DRMO site. Alternative 3 is slightly less expensive than Alternative 4; however, the bentonite/FML

FIGURE 3-2

Evaluation Of Capping Options - Alternative #1
RCRA Non-Hazardous Waste Landfill Cap



ADVANTAGES

- COST
- MEETS RCRA NON-HAZARDOUS WASTE LANDFILL CAPPING REQUIREMENTS

DISADVANTAGES

- ALLOWS INFILITRATION TO THE CONTAMINATED SOILS

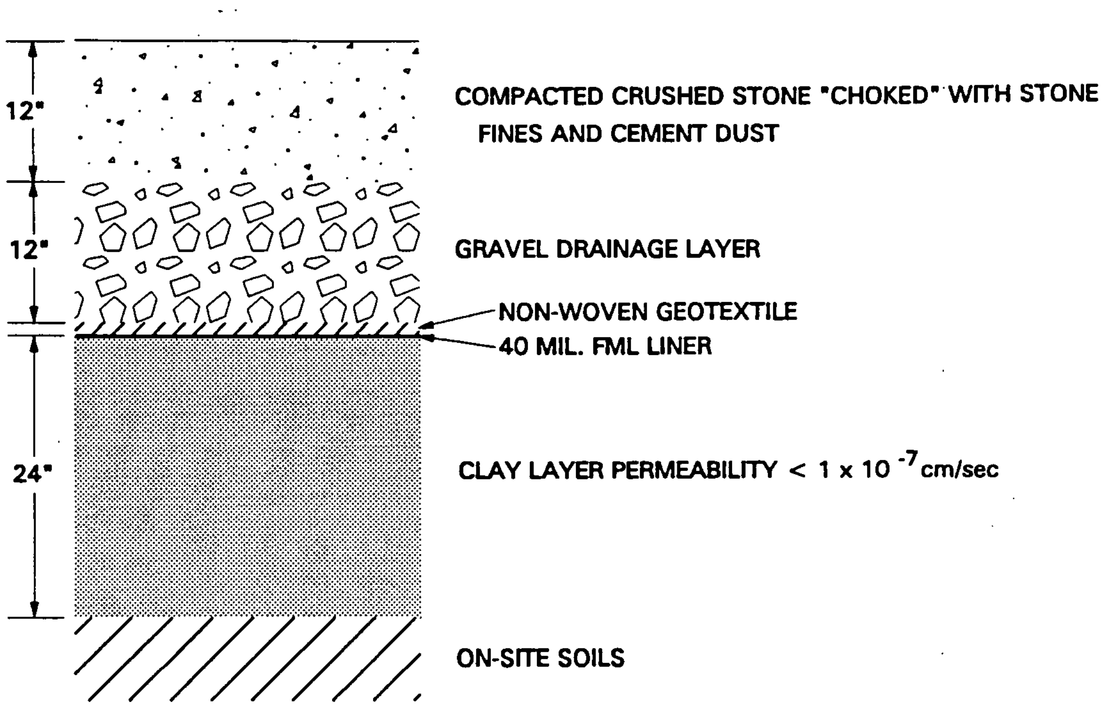
APPROXIMATE UNIT COST

- $1.70 / SQUARE FOOT
- WITH ASPHALT SURFACE: $2.70 / SQUARE FOOT

FIGURE 3-3

Evaluation Of Capping Options - Alternative #2

RCRA Hazardous Waste Landfill Cap



ADVANTAGES

- MEETS RCRA REQUIREMENTS FOR HAZARDOUS WASTE LANDFILL
- PROVIDES DOUBLE BARRIER FOR INFILTRATION

DISADVANTAGES

- COST
- CAP THICKNESS = 48"; REQUIRES SIGNIFICANT GRADING
  MAY NOT BE ABLE TO MEET CURRENT CONDITIONS AND GRADES
- AVAILABILITY OF CLAY IS LIMITED

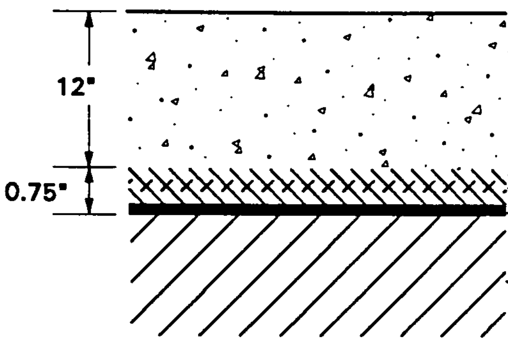
APPROXIMATE UNIT COST

- $15.00 / SQUARE FOOT
- WITH ASPHALT SURFACE: $16 / SQUARE FOOT

FIGURE 3-4

Evaluation Of Capping Options - Alternative #3

Geo-Composite Clay Liner



NOTE: Geo Composite - Clay liner consists of a 0.25 inches of sodium bentonite clay between woven polypropylene fabric.

ADVANTAGES

- CLAY LINER OFFERS AN IMPERMEABLE LAYER AND IS SELF SEALING FOR SMALL PUNCTURES. (PERMEABILITY = 2×10^{-10} cm/sec)
- EASE OF INSTALLATION - MINIMAL GRADING AND NO SEAMING REQUIRED
- COST

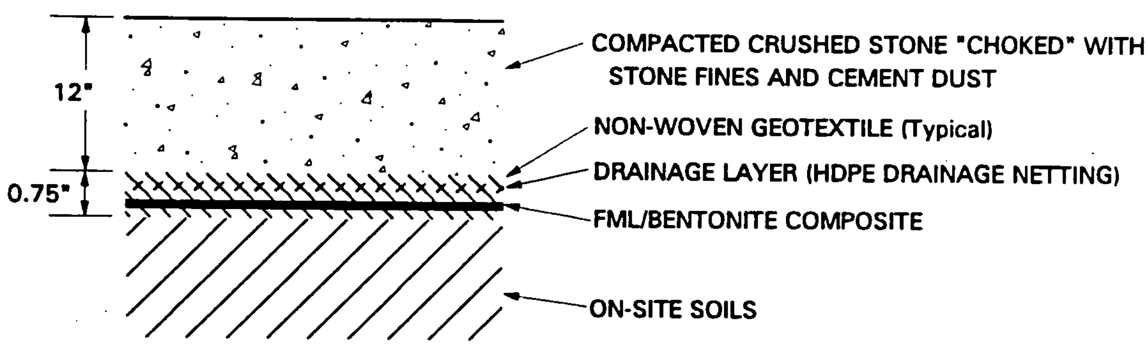
DISADVANTAGES

- DOES NOT CONTAIN DOUBLE BARRIER REQUIRED FOR RCRA HAZARDOUS WASTE LANDFILL
- MORE LIKELY TO BE DAMAGED DUE TO SETTLING THAN FML

APPROXIMATE UNIT COST

- \$2.00 / SQUARE FOOT
- WITH ASPHALT SURFACE: \$3 / SQUARE FOOT

FIGURE 3-5
Evaluation Of Capping Options - Alternate #4
Bentonite/FML Composite Liner



NOTE: FML / Bentonite Composite Liner consists of a layer of sodium bentonite attached to an Flexible Membrane liner with a non-toxic adhesive.

ADVANTAGES

- LINER OFFERS IMPERMEABLE LAYER PLUS PUNCTURE PROTECTION WITH BENTONITE LAYER
  (PERMEABILITY; HDPE: 2.7 x 10^{-13} cm/sec, BENTONITE: 3.7 x 10^{-10} cm/sec)
- EASE OF INSTALLATION - NO MAJOR REGRADING
- COST
- CONTAINS A DOUBLE BARRIER TO MEET RCRA REQUIREMENTS FOR A HAZARDOUS WASTE LANDFILL

DISADVANTAGES

- NOT MOST COST EFFECTIVE

APPROXIMATE UNIT COST

- $2.50 / SQUARE FOOT
- WITH ASPHALT SURFACE: $3.50 / SQUARE FOOT

composite liner used in Alternative 4 is less permeable than the clay liner in Alternative 3 and offers some of the self-sealing properties of a clay liner. Vendor specifications for the FML/Bentonite liner used in Alternative 4 are included as Appendix A.

4.0 INTERIM REMEDIATION WORK ITEMS

The interim remediation for this site consists of the excavation of lead, PCB, and TCE-contaminated soils followed by off-site disposal at a RCRA landfill. The following subsection summarized the work items required to completed this interim remedial action.

Based on Phase I RI soil analysis results, the estimated areas to be excavated for lead, PCB, and TCE-contaminated soils at the DRMO site are illustrated on Figure 3-1. The estimated depth of the excavation for the lead-contaminated soils is 3.0 to 6.0 feet. The estimated volume of lead-contaminated soils to be excavated is 1,000 to 2,000 cubic yards. The estimated depth of the excavation for the PCB-contaminated soils is 6.0 feet. The estimated volume of PCB-contaminated soils is 250 cubic yards. The estimated depth of the excavation for the TCE-contaminated soils is 8.0 feet. The estimated volume of TCE-contaminated soil to be excavated is 500 cubic yards. The results of the Phase II RI currently being conducted will define more completely the actual extent of the excavations. Therefore, the actual amount of soil to be excavated could increase or decrease for each area. It is not the intent of the interim remedial action to excavate soils below a depth of six feet. Excavating to six feet will attain the goal of eliminating future direct contact with contaminated soils.

Prior to the start of the excavations, underground utilities will be located to determine if any conflicts exist. The work at the site will be coordinated with the Navy to minimize any interferences with Sub Base operations.

The depth to groundwater at the site is between four to six feet. The excavations are currently to extend below this depth. Therefore, dewatering, water storage and water treatment will be required. The water pumped from the excavations will be stored on site in polyethylene tanks, tested, and disposed of properly.

The vertical extent of contamination will also be determined from the Phase II RI work discussed previously. If the surface soils are determined to be clean, these soils will be excavated, stockpiled separately, tested, and backfilled if suitable.

The contaminated soils will be excavated and either loaded and immediately shipped off site or temporarily stored on site in roll-off containers or in stockpiles. If the contaminated soils are stockpiled, on-site lined stockpile areas will have to be prepared. The stockpile area will be constructed to prevent leachate from the excavated soils stockpile from contacting surface soils. The excavation limits will be sampled to confirm that target cleanup levels have been met for all constituents of concern.

The excavation will be filled with clean gravel and/or fill as soon as possible after confirmatory samples verify that target cleanup standards have been met. The areas will then be graded and paved.

The area where the cap is to be installed shall be graded to allow proper drainage of surface runoff and to meet required final surface elevations. The FML liner seams must be sealed during liner installation.

The crushed stone surface layer shall be compacted in accordance with the specifications.

The following design work items will be completed for this interim remedial action.

- Topographical Survey of Existing Conditions
- Utility Locations
- Permit Requirements Investigation
- Soil Disposal Assessment and Determination of Acceptable Landfills
- Water Disposal Assessment
- Preliminary Design Plans

    - ▸ Existing Conditions
    - ▸ Final Grades
    - ▸ Boring Logs

- ▸ Cap Details
- ▸ Removal Profile

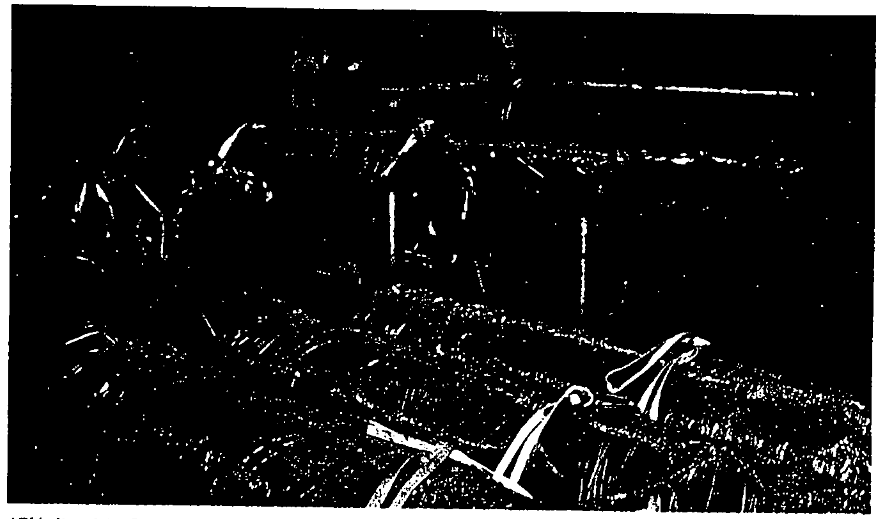
- Finalization of Limits of Excavation Based on Review of Supplemental Data
- Finalization of Limits of Cap
- Design of Pavement Replacement and Site Restoration
- Preparation of Contract Plans and Specifications for Bidding

APPENDIX A

VENDOR SPECIFICATIONS FOR FML/BENTONITE COMPOSITE LINER

Gundl Lining Syst ms Inc

An Added Barrier Of Protection From Gundle: High Performance HDPE/Bentonite Composite Landfill Liner



17½-ft. wide Gundseal rolls wrapped for shipment from our Spearfish, South Dakota plant.

As concern for our environment continues to grow worldwide, the demand for reliable synthetic landfill liners is escalating. More than ever, legislation mandates these lining systems, and often requires double lining solutions.

Responding to state-of-the-art engineering strategy of designing liner systems which combine synthetic and clay layers, Gundle offers GUNDSEAL. Gundseal is a bentonite clay/polyethylene composite liner for one step deployment (usually as an addition to a conventional single or double liner system). Gundseal is made by attaching the highest quality sodium bentonite to the highest quality synthetic liner using a patented nontoxic adhesive application system. This forms a single composite liner, which takes advantage of the complementary behavior of the synthetic liner together with the bentonite clay, and forms a complete barrier.

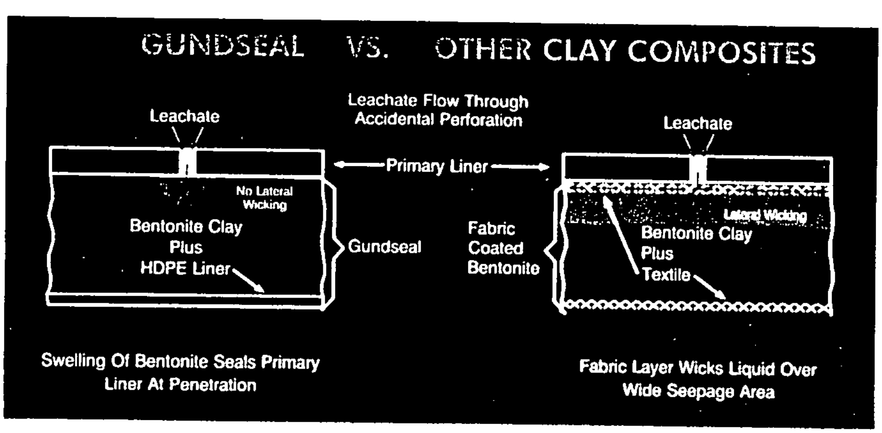
Swelling to several times its original volume when wet, the bentonite layer in Gundseal is able to seal potential leaks in a synthetic liner under confining pressures as low as 27 psf.

In a single composite liner application, the bentonite side is deployed face up. The primary liner is then installed on top and in direct contact with the bentonite. Any possible leakage becomes blocked by the bentonite layer with 10^{-10}cm/sec k-value followed by a polyethylene membrane with 10^{-12}cm/sec effective k-value. This means tremendous insurance is built into the liner system.

Using Gundseal, double composite liner systems can be constructed without having to compact soil on top of synthetic layers. The addition of a Gundseal blanket (bentonite face up) under a primary liner and above the drainage layer will add factors of safety in eliminating fluids in the leak detection zone. This is very attractive in light of EPA's new Response Action Plan (RAP) for leak detection systems.

Desiccation/weathering problems in standard clay caps can be solved by constructing a much less permeable, weathering- and settlement - resistant composite liner closure with Gundseal. In this case, the bentonite side of the Gundseal is deployed face down and dry against fine grained, compacted soils. The bentonite must be protected if the Gundseal is to be placed bentonite side down over coarse grained soils. These are but two of the potential applications for Gundseal.

Compared with fabric coated bentonite blankets, Gundseal will not shrink after getting wet because, unlike fabric, the membrane cannot be flexed by bentonite. And there is no fabric to transmit fluids laterally over a wide area when a Gundseal bentonite blanket is used. With Gundseal, moisture is confined to a point, not distributed over a broad area. In contrast to many fabric-coated bentonite blankets, Gundseal packs very fine mesh bentonite particles in a dense layer. There are few agglomerates or areas of loose particles.



Gundseal HDT

Textured Gundseal combines Gundline® HDT textured high density polyethylene sheet with the high quality fine mesh grade bentonite.

Textured Gundseal provides excellent slope stability due to the textured surface of Gundline HDT. Textured surface of Gundseal is therefore ideal for steeper slopes.

GUNDSEAL HDPE/BENTONITE COMPOSITE LINER

Standard Construction

Membrane Backing	Gundline HD Membrane	20 mil*
Coating	Sodium Bentonite	1 lb./ft.[2]*
Roll Width		17 ft. 6 in. (5.3 m)
Roll Length		200 ft. (60 m)
Roll Weight		3950 lbs.

* Other Gundle liner products and different coating weights available for special non-standard orders.

Typical Properties

Bentonite Loading	1lb./ft.[2]
Effective Hydraulic Conductivity (Gundseal)	No Measurable Leakage
Coefficient of Permeability (Membrane)[1], ASTM E96	2.7×10^{-13} cm/sec
Hydraulic Conductivity (Bentonite)[2]	3.7×10^{-10} cm/sec
Resistance to Hydrostatic Head[3] (Ft. of water), ASTM D751	Tested to 150 ft. Head No Failure
Resistance to Water Migration Through Overlap[4]	No Measurable Leakage
Resistance to Water Migration Under Membrane[5]	Tested to 150 ft. Head No Measurable Leakage
Wet/Dry Cycles, ASTM D559	No Effect
Freeze/Thaw Cycles, ASTM D559	No Effect
Pliability: 180° bend over 1" mandrel @ -25°F, ASTM D146	10,000 cyc. No Failure

TYPICAL PROPERTIES OF GUNDLINE HD 20 MIL

(Used As Membrane For Gundseal)

Puncture Resistance, FTMS 101, Method 2065	22 lbs.
Tear Resistance, ASTM D1004	15 lbs.
Dimensional Stability, ASTM D1204	±2%
Tensile Strength, ASTM D638	
yield	2300 psi
break	4000 psi
Tensile Elongation, ASTM D638	
yield	13%
break	700%
Resistance to Soil Burial, ASTM D3083	
Tensile strength @ yield and break	±10%
Elongation @ yield and break	±10%
Environmental Stress Crack, ASTM D1693	1500 hrs.

TYPICAL PROPERTIES OF HIGH SWELLING SODIUM BENTONITE

(Used As Coating For Gundseal)

Percent Montmorillonite	80-90%
Silicon Dioxide (SiO_2)	55-64%
Aluminum Oxide (Al_2O_3)	16-22%
Ferric Oxide (Fe_2O_3)	3-6%
Sodium Oxide (Na_2O)	1-3%
Magnesia (MgO)	2-4%
Lime (CaO)	1-3%
Miscellaneous	1-5%
Water Content	5-10%
Bulk Density	77 lb/ft.[3]
Dry Particle Size	20-50 mesh
Free Swell	20-28 ml/2 gm

1. Darcy's Law Coefficient of permeability for membrane calculated from moisture vapor transmission data (ASTM E96).
2. A 2-1/2" diameter sample was placed in a permeameter form 5 days water soaking. Permeability determined in a 15 hour time frame with a 15' falling head permeameter.
3. Membrane applied to porous stone and placed in permeameter. Pressure increased to equivalent of 150 ft. water head.
4. Two samples placed one against the other clamped between two half cyclinders of lucite and placed in a flexible wall permeameter for 25 days. Also, standing 2 ft. head of water over an 8 ft. long 3 in. overlap Gundseal seam for 5 months at U. of Texas, Austin, had no measurable leakage.
5. A 1" diameter hole was cut in the middle of a 3 1/2" diameter sample. Sample clamped in 3" diameter permeameter, 150 ft. of head applied.

GUNDSEAL is rolled on 6" I.D. hollow cores. Each roll is provided with 2 slings to aid handling on site. Dimensions and weights are approximate. Rolls are stretch-wrapped to keep dry. Each roll has an overall sheet thickness of 0.125" (3 mm). Gundseal adhesive is non-toxic and non-polluting.

Gundle Lining Systems Inc

Gundle®

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