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Existing Data Summary Report
for
Lower Subase Remedial Investigation

Naval Submarine Base New London
Groton, Connecticut

Volume I - Text

Northern Division
Naval Facilities Engineering Command
Contract Number N62472-90-D-1298
Contract Task Order 0260

March 1997

Brown & Root Environmental
A Division of Halliburton NUS Corporation

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MEMORANDUM

DISTRIBUTION: Ms. Kymberlee Keckler, USEPA - Region I (2 copies Volume I only)
Dr. Ken Finklestein, NOAA (1 copy Volumes I and II)
Mr. Mark Lewis, CTDEP (1 copy Volume I only)
Ms. Jennifer Hayes, Gannett Fleming (1 copy Volume I only)

FROM: Corey Rich, Project Manager

DATE: March 26, 1997

REFERENCE: CLEAN Contract Number N62472-90-D-1298
Contract Task Order Number 0260

SUBJECT: Final Existing Data Summary Report
Lower Subase Remedial Investigation (RI)
NSB-NLON, Groton, Connecticut

On behalf of the United States Navy, Northern Division Naval Facilities Engineering Command and the Naval Submarine Base - New London, please find enclosed Volume I of the final *Existing Data Summary Report*. This document will serve as the basis for development of the Work Plan/Sampling Analysis Plan for the Lower Subase RI and the Lower Subase RI Report.

Based on an agreement between the NORTHDIV and the USEPA Region I RPMs, only Volume I (i.e., the text) of the report is being reissued. This agreement was reached because there were no corrections required for Volume II, the Appendices. New report covers and signature pages are enclosed for Volume II. Please replace the existing cover page and signature page on your copy of Volume II with the enclosed pages. The exception to this approach is for individuals who are receiving this report for the first time. Volume II of the report is enclosed for those individuals who did not receive the draft version of this report.

The Navy's responses to comments on the draft report, received from the USEPA Region I in their February 5, 1997 letter, are included as an attachment to this letter. The final report was prepared in accordance with the responses provided in the attachment. The draft version of this report was entitled *Background Review Report*. The change in title for the report was requested by USEPA Region I.

No formal comments on the draft report were received from the CTDEP and no extension was requested for more review time. The CTDEP indicated verbally that they would not provide

comments on the report. Therefore, the report was finalized without receiving comments from the CTDEP.

If you would have any questions regarding the report, please contact me at (412) 921-8244 or Mr. Mark Evans at (610) 595-0567 (x162).

Very truly yours,

Corey A. Rich, P.E.
Project Manager

Attachment

c: Mr. Roger Boucher, NORTHDIV (letter only)
Mr. Mark Evans, NORTHDIV (2 copies Volume I only)
Mr. Andy Stackpole, NSB-NLON (3 copies Volume I, 2 copies Volume II)
Mr. John Trepanowski, B&RE (1 copy Volume I only)
Mr. Daryl Hutson, B&RE (letter only)
File: CTO 0260 (1 copy Volume I only)

RESPONSES TO USEPA's FEBRUARY 5, 1997 COMMENT LETTER ON THE DRAFT BACKGROUND REVIEW REPORT NAVAL SUBMARINE BASE - NEW LONDON, GROTON, CONNECTICUT CONTRACT TASK ORDER 260

General Comment 1:

I have reviewed the *Background Review Report for Lower Subase Remedial Investigation, Naval Submarine Base New London, Groton, Connecticut* dated January 1997. EPA's review focused on identifying data gaps needed for remedy selection and adequate characterization of the nature and extent of contamination. As discussed, I trust that the issues raised herein will be resolved by subsequent investigations as described in the forthcoming work plan. Detailed comments are provided in Attachment A.

Response to General Comment 1:

The Navy has prepared this Response to Comment letter to address the United States Environmental Protection Agency's (USEPA) comments on the *draft Background Review Report*. The title for the final version of this report will be changed to *Existing Data Summary Report* as per the USEPA's request. This Response to Comment letter will be included in the *final Existing Data Summary Report*. In addition, any corrections which are required to the report will be implemented in the *final Existing Data Summary Report*.

Many of the issues raised by the USEPA in their February 5, 1997 letter are addressed in the *draft Lower Subase Remedial Investigation (RI) Work Plan and Sampling and Analysis Plan (WP/SAP)* submitted on March 4, 1997. If the comment refers to an issue that will be addressed in the WP/SAP, the corresponding response will reference the WP/SAP.

General Comment 2:

Numerous data gaps exist. The sources of contamination for most of the zones, including Zone 1, have not been identified. Video inspection of pipelines and integrity testing will need to be performed to assist in identifying sources of TPH contamination. The extent and volume of free product needs to be evaluated. In order to assess options to prevent future migration of contaminants to the Thames River, preferential flow pathways should be further characterized.

Response to General Comment 2:

It is agreed that there are numerous data gaps that exist in the overall database for the Lower Subase. The goals of the Lower Subase RI are the following: to fill any existing data gaps, to determine the major source(s) of contamination, to determine the nature (i.e., historical or active) of the major source(s) of contamination, to determine the extent and volume of free product in each Zone, and to assess the potential for future migration of contaminants to the Thames River. These goals are described in the *draft Lower Subase RI WP/SAP* submitted to the USEPA on March 4, 1997.

The Navy conducted integrity testing in 1996 on some of the fuel lines at the Lower Subase. The test results will be included and evaluated in the Lower Subase RI. No additional testing or video inspection of pipelines is proposed in the *draft Lower Subase RI WP/SAP*. The Navy is however planning additional testing of the pipelines under the Connecticut Department of Environmental Protection (CTDEP)-regulated Underground Storage Tank (UST) program. The active diesel fuel lines between the Aboveground Storage Tanks (ASTs) at the Ballfields and the piers will be tested under the program. The results of these tests will also be included in the Lower Subase RI when they are available.

The Navy believes that it will not be technically feasible to investigate and evaluate all potential source areas and preferential flow pathways at the Lower Subase during the RI. It is quite possible that minor source areas (i.e., historical, undetected spill areas, small line leaks, etc.) and minor preferential flow pathways (i.e., abandoned utility lines) could be masked by contamination resulting from more significant sources (i.e., known source areas) and preferential flow pathways (i.e., known sewer lines discharging to the Thames River). These minor source areas and preferential flow pathways may have contributed a small amount of contamination detected at the site compared to the other sources. For this reason, it is recommended that a zone wide evaluation approach, focusing on known, significant, source areas and detected contamination which has the potential to impact the receptor endpoint (Thames River), be conducted. Remedial actions could then proceed to address these major sources and preferential flow pathways. Subsequent activities that are planned by the Navy under their routine maintenance programs at NSB-NLON (i.e., replacement of USTs, integrity testing programs, removal of abandoned fuel lines and replacement of old fuel lines) will address those less significant source and contaminant pathways.

General Comment 3:

The Lower Subase is an area of concern from an ecological risk perspective as a potential source of contamination to the Thames River. Sampling of soil and groundwater exhibited contamination with metals, primarily lead, and various petroleum components. Evidence of contamination was also found in the drainage systems. Sources of this contamination appear to be fuel storage and transport systems

associated with the Lower Subase operations. This report also confirms that the Lower Subase is likely to be a source of contamination to the Thames River. Because of the high level of contamination found in soils at the site, further action recommendations are offered to prevent possible future migration of contaminants to the Thames River. Elimination of source areas will limit contaminant transport to the Thames River.

Response to General Comment 3:

The *draft Lower Subase RI WP/SAP* submitted to the USEPA on March 4, 1997 provides the details of the sampling program proposed by the Navy for the Lower Subase. The information collected during the investigation will be used to evaluate current conditions and it will be presented in the Lower Subase RI Report.

The information that is collected will also be used in the Lower Subase Feasibility Study (FS) to develop appropriate remedial actions for each zone of the Lower Subase. Remedial actions will likely include free product and hot spot removal as well as in-situ treatment. In-situ treatment options will most likely be more feasible than complete elimination (i.e., removal) of all primary and secondary source areas due to the industrial nature of the area and the activities that occur at the Lower Subase. The USEPA will be able to provide input on the selection of appropriate remedial alternatives during the review process for the Lower Subase FS.

General Comment 4:

The report recommends further study for areas not fully characterized, including the storm water drainage system, to identify sources of contamination. Consistent with the findings of the Phase II Remedial Investigation ecological risk assessment, EPA concurs with the need for additional sediment and surface water sampling for SVOCs. Because of the high concentrations of lead, sediment and surface water analyses should include lead as well. Further characterization of any impacts to shellfish should be included in the work plan for the Lower Subase RI.

Response to General Comment 4:

The *draft Lower Subase RI WP/SAP* submitted to the USEPA on March 4, 1997 provides the details of the sampling program proposed by the Navy for the Lower Subase. Extensive sediment sampling is proposed in the WP/SAP to evaluate the nature and extent of Semivolatile Organic Compounds (SVOCs) and metals in the Thames River adjacent to the Lower Subase. The samples will also be evaluated for geotechnical parameters and parameters used to interpret toxicity. Both types of parameters will be used to evaluate risks to ecological receptors. The sediment sampling stations were selected to be adjacent to highly contaminated areas of the Lower Subase and at the discharge points of potential contaminant migration pathways (i.e., storm sewer outfalls).

The Navy proposes to postpone surface water sampling and further characterization of impacts to shellfish (i.e., cage studies) until the sediment sampling activities are completed and the results have been evaluated. The new sediment data will be used in conjunction with historical data to determine if there are any increased risks to ecological receptors along the Lower Subase. If the data warrants, the next phase of investigation will include the appropriate surface water and ecological sampling/studies (i.e., cage studies) to complete characterization of nature and extent of contamination and risks to ecological receptors (i.e., shellfish).

It is believed that additional surface water sampling in the Thames River would not provide conclusive evidence of contaminant migration from the Lower Subase during the RI for the following reasons:

- Historically, there have been limited, discrete discharges of petroleum from the Lower Subase groundwater to the Thames River and these have occurred only during warm weather, a low groundwater table and low tide.

- A single round of surface water measurements (i.e., a "snap shot") is unlikely to detect a discrete release of contaminants.

- The Navy has limited migration of the petroleum released to the Thames River using buoys and collected it using adsorbent material. In addition, preferential flow pathways were blocked to eliminate further migration of the petroleum to the Thames River.

- Surface water sampling results would be inconclusive due to the dilution and tidal flushing of the Thames River.

General Comment 5:

In Section 2.0 tables pertaining to COPC screening contain metals values that were detected during the simultaneously extracted metals ("SEM") evaluation. Comparison of these values to bulk sediment concentration criteria for the purpose of COPC screening is less effective than their comparison to corresponding acid volatile sulfide ("AVS") concentrations. Identification of these metals as COPCs would best be performed through the use of SEM/AVS ratio data. If SEM/AVS ratios for these metals at specific sediment locations are less than one, EPA recommends that they be eliminated from the tables. Additionally, if inorganics are shown to be greater than background - but less than conservative benchmark values - such contaminants should be dropped from the list of COPCs for ecological concern.

Response to General Comment 5:

Agreed. The main purpose for measuring SEM is to use the results with the measured AVS concentrations to determine the bioavailability of specific metals. The SEM results will be eliminated from the COPC screening tables in Section 2.0. The SEM and AVS results will be maintained in the database presented in Appendix A and a limited discussion of the AVS/SEM results will be inserted into Section 2.5.3, Ecological Risk Assessment, of the report.

General Comment 6:

To assess potential data gaps in the river, sediment sample locations need to be correlated with preferential flow pathways to the Thames River. Also, source area related contaminants need to be cross referenced with Thames River contaminants of potential concern. All additional sediment samples collected should be analyzed for SEM/AVS, TOC, and grain size in addition to chemical analytical parameters.

Response to General Comment 6:

All of the issues raised by the USEPA in General Comment 6 are addressed in the *draft Lower Subase RI WP/SAP* submitted to the USEPA on March 4, 1997.

General Comment 7:

Sanitary, utility, fuel, and storm sewer lines leaving primary or secondary source areas need to be identified as preferential flow pathways and correlated with existing sampling locations. For example in Zone 5, the former UST location could be given an identifier such as Source Area 5-A. Media contamination (soil and groundwater) would be depicted on the figure. All preferential flow pathways from Source Area 5-A and areas of detected contamination would also be shown on the figure. Sampling locations could then be correlated with preferential flow pathways from each source. The current Figure 7-1 does not depict the location of the former UST and the scale of Figure 7-1 is not conducive to evaluate whether the storm sewer line or sanitary line could act as a preferential flow pathway.

Response to General Comment 7:

The main focus of General Comment No. 7 is on potential sample locations for the RI. The purpose of the *Existing Data Summary Report*, formerly the *Background Review Report*, was to summarize the existing data that has been collected and evaluated at each of the Lower Subase zones by various Navy contractors; to determine if any data gaps exist that would impede completion of an RI/FS for each zone and to make recommendations on the methods which should be used to address the data gaps and

potential remedial actions that could be used to remediate each zone. Selection of potential sampling locations are addressed in the *draft Lower Subase RI WP/SAP* submitted to the USEPA on March 4, 1997. The drawings provided in the *final Existing Data Summary Report* will not be revised for the final version of the report, however changes will be made to the drawings to address USEPA's comment in the *final Lower Subase RI WP/SAP* and the subsequent RI Report.

The following actions will be taken to address the comment in the final WP/SAP and the subsequent RI Report:

- The line types used for the utilities will be changed to make each more distinguishable.

- The scale of the drawings will be increased so that it is easier to determine the source(s) of contamination and the preferential flow paths.

- Flow directions will be provide on each utility line.

- The former 1000-gallon UST was located in the same location as the existing 1000-gallon UST. Figure 7-1 does depict the location of the existing UST. The drawing is too cluttered in that area to depict both the former and existing USTs locations. Therefore, the text will be revised to indicate that both the former and existing USTs occupied the same location.

- The analytical results from the samples collected during the RI will be used to revise the isoconcentration contour maps provided in the *final Existing Data Summary Report*. These maps will provide a good indication of the source(s) of contamination. Therefore, source identifiers will not be used for each source located within a zone.

Please refer to the Response to General Comment 2 regarding the Navy's position on further delineation of source areas.

General Comment 8:

The Report gives the following recommendation within several of the zone specific recommendation sections, "focused effort toward the evaluation of potential remedial options to prevent possible migration of petroleum products and oily substances to the Thames River is required/determined to be necessary." A compilation of data parameters (*e.g.*, soil permeability, soil texture, free product thickness) needed to evaluate remedial options could be compared with existing data to identify data gaps.

Response to General Comment 8:

Most of the information requested by the USEPA is discussed in the text of the report. It is agreed that a summary table of appropriate parameters would make identification of data gaps easier. A table will be created for each zone that includes all existing parameters (e.g., soil permeability, soil texture and free product thickness) needed to evaluate remedial options and will be included in the Lower Subase RI.

General Comment 9:

Although Drawings 1-7 well illustrate hot spots in the Lower Subase, a legend providing the number of samples in each zone should be included.

Response to General Comment 9:

The number of samples collected in each zone is well documented in the text, the COPC screening tables provided in Sections 2 through 9 and the analytical database provided in Appendix A of the report. A legend providing the number of samples per zone will not be added to the isoconcentration maps.

Revised isoconcentration maps will be prepared for the Lower Subase RI Report. The revised maps will be at a larger scale and will be zone specific. In addition, summary tables will be provided in the RI which list all samples collected per zone and the analyses that were performed on the samples.

General Comment 10:

All screening tables in this document should explain how contaminants were screened. Analytes with no screening criteria should be retained.

Response to General Comment 10:

Section 1.4.2 of the report explains how contaminants were screened to identify COPCs. The section provides information on COPC screening per media. In addition, a footnote is provided at the bottom of each table which defines a COPC.

It is agreed that COPCs with no screening criteria should be retained. The tables will be revised appropriately.

General Comment 11:

Soils in all Zones should be analyzed for semivolatile compounds and these results should be integrated into a human health risk assessment.

Response to General Comment 11:

The analyses which will be performed on the samples to be collected for the RI are provided in the *draft Lower Subase RI WP/SAP* submitted to the USEPA on March 4, 1997. It is proposed in the WP/SAP that all soil and sediment samples collected for the RI will be analyzed for SVOCs. This approach is in agreement with USEPA's comment.

General Comment 12:

Typically, three or fewer soil samples from an area are not sufficient to determine contamination levels accurately, or to be sure that no contaminants of concern have been missed. As described in EPA guidance, at least 10 samples per exposure area are preferable to characterize an area. At a minimum, additional soil samples from the following areas are needed for the following zones. All samples should be analyzed for full TCL/TAL analytes. Zones needing additional sampling include: *Zone 1*- Shallow soils and Deep soils (no SVOCs analyses have been performed on deep soils); *Zone 2* - Shallow and Deep soils; *Zone 3*- Shallow and Deep soils; *Zone 4*- Shallow and Deep soils; *Zone 5*- hot spots require further investigation; *Zone 6*- Shallow and Deep soils; *Zone 7*- hot spots require further investigation.

Response to General Comment 12:

Further clarification is necessary from the USEPA on this comment. The Navy requests that the USEPA provide a reference to the document cited that indicates that, "at least 10 samples per exposure area are preferable to characterize an area." It is also unclear if the USEPA is requesting 10 samples per media or per site. The Navy will contact the USEPA on this issue and it will be resolved during completion of the *Lower Subase RI WP/SAP*.

Additional soil samples will be collected in each zone of the Lower Subase during the RI. The total number of samples and types of analyses to be performed on the samples is provided in the *draft Lower Subase RI WP/SAP* submitted to the USEPA on March 4, 1997. The Data Quality Objectives (DQOs) process and geostatistical methods were used to determine the appropriate number of samples to be collected in each zone during the Lower Subase RI. Generally, after the Lower Subase RI is completed there will have been 10 or more soil and groundwater samples collected from each zone.

Revisions to the number of samples to be collected and the type of analyses to be performed will be made once all comments are received on the *draft Lower Subase RI WP/SAP* from the USEPA and CTDEP.

General Comment 13:

The resolution of EPA General Comment 34 on the Phase II RI specified that the Navy would provide recommendations in the *Background Review Report for the Lower Subase Remedial Investigation* on viable remedial alternatives. The recommendations provided within the report appear to be too general. The same list of potential remedial alternatives is provided for each zone. Source areas need to be identified and provided in the report. Evaluation of viable remedial alternatives per source area is better suited for a feasibility study. The focus should be on the sources of contamination and the extent of migration from these sources not on previously identified zones.

Response to General Comment 13:

It is agreed that evaluation of viable remedial alternatives per source area is better suited for a feasibility study, therefore the general recommendations provided in the *draft Background Review Report* are sufficient and will be retained in the *final Existing Data Summary Report*. A Feasibility Study will be conducted once the Lower Subase RI is finalized.

The focus of the report is on summarizing existing data and identifying data gaps for all zones that should be answered during the RI. Potential source areas are summarized for each zone in the text of the report and are generally depicted by the isoconcentration maps provided in the report. Sources of contamination and the extent of migration from the source areas for Zones 5 and 7 are also defined in the text and maps of the report . No additional information is available for Zone 6. No further action is required in response to this comment.

Specific Comment 1: p. 1-5 *et seq.*, §1.2.4.1

Please explain how the zones were delineated.

Response to Specific Comment 1:

Zones 1 through 4 were delineated in the Phase II RI and were accepted by the USEPA for the development of the Phase II RI Report. These same zones were carried through into the *Background Review Report* for the Lower Subase RI.

The Lower Subase includes numerous buildings and potential sources of contamination. The zones were delineated to encompass specific potential sources

and to focus the preparation of the Phase II RI report. The Navy and USEPA previously identified potential source areas at NSB-NLON that require investigation under the Navy's Installation Restoration Program (IRP) and CERCLA. Each of the potential source areas was given a unique site number and specific sites fall within each zone. The subdivision of the Lower Subase into zones also made report preparation easier, focused the nature and extent of contamination discussions and allowed the human health risk assessment to be linked to specific sources.

Site-specific hydrogeology and surface water hydrology information was also used to delineate the zones. The information was used to determine potential contaminant migration pathways from these potential source areas and zone boundaries were generally chosen so that contamination from one zone would not migrate into another.

The same approach used to delineate Zones 1 through 4 was also used for Zones 5 through 7. The information described above will be incorporated into the *final Existing Data Summary Report*.

Specific Comment 2. p. 1-5, §1.2.4.1

Please expand the description of Zone 2. Describe historical and present activities, and the portion of the river in Zone 2. Identify the number of buildings and the piers within the zones and activities conducted at the piers.

In Zone 5, include the stormwater culvert draining streams 1, 2, and 6. Potential impacts to the Thames river from this culvert draining Area A Downstream Watercourses should be assessed in this Lower Base Background review.

Response to Specific Comment 2:

The description of Zone 2 provided on p. 1-5 will be expanded with the limited information available for Zone 2 to provide a more thorough description of historical and present activities within the zone, and in the adjacent portion of the Thames River. The number of buildings and the piers within the zone will also be identified in the text.

The boundary of Zone 5 will be extended to include the stormwater culvert draining Streams 1, 2, and 6 from the Area A Downstream. The appropriate figures will be revised.

The effects of the culvert on the Thames River were previously evaluated in the Phase II RI ecological risk assessment. The potential impacts to the Thames River from this culvert will be further assessed during the Lower Subase RI field effort and the subsequent ecological risk assessment. The details of the proposed field effort and the approach to the ecological risk assessment are summarized in the *draft Lower Subase RI WP/SAP* submitted to the USEPA on March 4, 1997. No further changes will be

made in response to this comment during preparation of the *final Existing Data Summary Report.*

Specific Comment 3. p. 1-18, §1.4.3.2

Please provide a figure that shows wells that have free product and the thickness of the free product. Such a figure would assist in assessing the extent of contamination.

Response to Specific Comment 3:

Free product has been detected in Lower Subase monitoring wells and manholes during previous investigations. However, no actual measurements of free product thickness were taken during the investigations. A comprehensive round of free product thickness measurements is proposed in the *draft Lower Subase RI WP/SAP* submitted to the USEPA on March 4, 1997. Zone-specific figures that show wells that have free product in them and the associated thickness of the free product will be created and included in the forthcoming Lower Subase RI.

Specific Comment 4. p. 1-19, §1.4.4

Expand the discussion of the decision process. Analytical data are compared to criteria to identify COPCs. After COPCs are identified, how is it determined that there are sufficient data for identifying nature and extent of contamination, assessing human health risks, and, assessing ecological risks? How will the additional Thames River sediment data be evaluated? What analysis is being performed per source area to decide whether remedial action is necessary?

Response to Specific Comment 4:

The *Existing Data Summary Report* was not intended to be a RI. The interim report was prepared by the Navy to summarize the existing information that has been collected and evaluated at each of the Lower Subase zones by various Navy contractors. The recommendations made in the report in regards to sufficient data are generally the same recommendations that were made in the reports being summarized. Professional judgment was also used to make some of the decisions.

The details of future sampling and analyses that are planned for the Lower Subase RI are summarized in the *draft Lower Subase RI WP/SAP* submitted to the USEPA on March 4, 1997. The method used to determine if sufficient data is available to complete the Lower Subase RI is also explained in the WP/SAP.

Section 1.4.4 will be expanded to summarized the information discussed above and a reference will be included to the *draft Lower Subase RI WP/SAP.*

Specific Comment 5. p. 1-26, Table 1-1

According to Table 1-1 the analytical data for the quay wall (Report entitled *Removal Site Evaluation for Quay Wall for Naval Submarine Base New London* - Halliburton NUS Corporation May 1995) were not included in this reports database. However, in Appendix 1, pages 77 through 84 (sample numbers QW-1 through QW-5), it appears that these data have been included in the database.

Response to Specific Comment 5:

Table 1-1 is incorrect. The analytical data from the *Removal Site Evaluation for Quay Wall Report* (HNUS, 1995) was included in this report's database. Table 1-1 will be revised to indicate that it was included.

Specific Comment 6: p. 1-32, Figure 1-3

This figure is not consistent with the CERCLA process. For example, ARARs and remedial alternatives should be identified in a feasibility study and a risk assessment should be prepared as part of a remedial investigation. Such a risk assessment should be used to determine whether an imminent threat to human health or the environment exists. Removal actions may be taken at any point to address imminent and substantial endangerment or to minimize the toxicity, mobility, or volume of contaminants.

Secondly, as outlined in EPA's letter dated November 4, 1996, No Further Action Decision Documents are not appropriate for sites that have completed a remedial investigation. Such decisions must be embodied in a No Action ROD. The feasibility study may be excluded only if an actionable risk has not been demonstrated.

Revise this figure to incorporate specific decision points relevant to Lower Subase.

Response to Specific Comment 6:

Agreed. Figure 1-3 is too broad and is generally not consistent with the CERCLA process. The figure was intended to summarize the logic to be used for evaluating the existing data from the Lower Subase to determine data gaps that need to be addressed in the Lower Subase RI. The figure will be revised to incorporate specific decision points relevant to the Lower Subase RI.

Specific Comment 7: p. 2-5, §2.2.4

Please indicate whether chronic and acute benchmark values were exceeded.

Response to Specific Comment 7:

The benchmark values used for screening ecological data from the Thames River are summarized in Section 3.4 Ecological Risk Assessment Procedures and Section 17.7 Ecological Risk Assessment of the draft final Phase II RI (Brown & Root Environmental, March 1996). Generally, the benchmark values used are media- and receptor-specific chronic values. In some cases, chronic benchmark values had to be developed using acute benchmark values and a conversion factor. A reference to the draft final Phase II RI will be added to Section 2.2.4 of the *Existing Data Summary Report*.

In addition to the chronic benchmark values, it has been proposed that acute benchmark values will also be used for the ecological risk assessment to be prepared and included in the final Phase II RI. The results of this evaluation were not available at the time of preparation of this *final Existing Data Summary Report*. Therefore, the appropriate chronic and acute benchmark values from the final Phase II RI will be used for the ecological risk assessment to be included in the forthcoming Lower Subase RI Report.

Specific Comment 8: p. 2-7, §2.3.2

Stormwater runoff pathways (*e.g.*, sheet flow, culverts, point source discharges) should be described. A description of culverted streams passing through Lower Subase, including those draining other areas of NSB, should be included in this section. The description should include potential contaminant migration from sites in and outside of Lower Subase.

Response to Specific Comment 8:

Section 2.3.2 of the report was only intended to include information regarding surface water features of the Thames River. Each section of the report includes a subsection on Physical Features for each zone (Sections 3.3 through 9.3) that provides a description of the topography and surface water features of each zone and a subsection on Contaminant Fate and Transport for each zone (Sections 3.5.1 through 9.5.1). The text of these subsections will be expanded to more thoroughly describe potential contaminant migration pathways.

In addition, each of these subsections reference drawings that show underground utilities such as storm sewers, sanitary sewers, water lines and electric lines. Please refer to the response to General Comment 7 for the changes that are proposed for the drawings. The changes will be implemented in the *final Lower Subase WP/SAP* and Lower Subase RI Report, but not in the *final Existing Data Summary Report*.

Specific Comment 9: p. 2-10 *et seq.*, §2.4

The Thames River has been divided into zones that correspond to adjacent land zones. This has resulted in some zones with limited (3 or fewer) samples. COPCs have been determined for each river zone. Additional sediment and surface water samples should be collected for each zone to improve the statistical accuracy of the COPC screening process. Samples from additional locations will also contribute to determining where contaminants from Lower Subase are migrating into the Thames River.

Response to Specific Comment 9:

Agreed. Additional sediment sampling in the Thames River is proposed in the *draft Lower Subase RI WP/SAP* submitted to the USEPA for review on March 4, 1997. The proposed sampling locations are located in close proximity to the Lower Subase to determine if contamination from the Lower Subase is migrating and impacting the Thames River.

Specific Comment 10: p. 2-10, §2.4.1

Only one surface water sample from the Thames River was collected in the vicinity of the Lower Subase. This is not sufficient to characterize the surface water of the River. In addition, surface water sampling should be performed near storm water outfalls during a storm event to evaluate contaminant loading to the Thames from upgradient sources.

Response to Specific Comment 10:

Please refer to the response regarding additional surface water sampling provided for General Comment 4.

Sampling activities that are proposed in the Thames River for the Lower Subase RI are discussed the *draft Lower Subase RI WP/SAP* submitted to the USEPA on March 4, 1997. The rationale for specific activities is also provided in the WP/SAP.

Specific Comment 11: pp. 2-17 & 2-18, §2.5.1

Dispersion of contaminants from sediments to the water column through biotic movement could also be a transport pathway.

Response to Specific Comment 11:

Agreed. It is possible for contaminants adsorbed to sediments to be resuspended into the water column by the mechanical process of biotic movement. Biotic movement will

be added to the list of processes affecting contaminant transport in the river. However, it will also be noted that the magnitude of contaminant migration by this method is likely to be much less than that caused by the physical processes related to the flow of water in the tidally influenced river.

It will also be noted that biotic movement can include movement of contaminants from the sediments through the food chain to predatory fish. This type of movement can result in tissue concentrations in predatory fish being orders of magnitude greater than the sediment concentrations. A typical contaminant which would move through the food chain by biotic movement would be mercury. Mercury will biomagnify in the tissue of fish.

Specific Comment 12: pp. 2-18 & 2-19, §2.5.3

This section summarizes the results of the ecological risk assessment for the Lower Subase of NSBNL. Sections 3 through 9 of this report cite Section 2.5.3 and state that based on the results presented, Lower Subase has minimal impact on the Thames River. However, the summary of the ecological risk assessment of the Thames River presented in Section 2.5.3 is too vague to confirm this claim. The following changes would strengthen this section:

- Ecological receptors and exposure pathways should be summarized.
- The HQs that have the greatest contribution to ecological risks should be quantified. Stating that an HI exceeds unity does not provide sufficient information on the magnitude of specific ecological risk.
- The claim that actual risks to waterfowl from consuming prey are "...likely to be much less than those predicted..." should be further substantiated or eliminated. It is inappropriate to disregard calculated risk values because conservative assumptions were used in the risk assessment.
- This section states that the results of the ecological risk analyses indicate that the Thames River near NSB poses a minimal risk to ecological receptors. This does not appear to be consistent with the 1) impacts to benthic macroinvertebrates that were measured from several locations, 2) HIs in excess of 100 that were obtained for double-crested cormorants and herring gulls from eating on shellfish, and 3) COPC screening of sediment concentrations that indicate the presence of many chemicals at concentrations exceeding screening levels. The ecological risk analyses indicate that several ecological receptors associated with the Thames River adjacent to the Lower Subase could be impacted from site-related sources. However, impacts appear to be limited to macroinvertebrates in localized areas adjacent to the Lower Subase, and to the double-crested cormorants and herring gulls from prey ingestion.

Please revise the last sentence of Section 2.5.3 to provide a more balanced summary of the ecological risk assessment.

Response to Specific Comment 12:

Agreed. Section 2.5.3 is somewhat vague and does not provide sufficient information about the Thames River ecological risk assessment completed for the draft final Phase II RI (Brown & Root Environmental, March 1996) to substantiate the claim of minimal impacts on the Thames River. The section will be revised to provide a limited, but more comprehensive summary of the ecological risk assessment completed for the draft final Phase II RI. The topics discussed above in Specific Comment 13 will be addressed in the revised section.

Specific Comment 13: p. 2-37, Table 2-8

Only one sediment sample was collected for Zone 6 in the Thames River. This is not sufficient to characterize a zone.

Response to Specific Comment 13:

Agreed. Additional sediment sampling in the Thames River is proposed for each zone in the *draft Lower Subase RI WP/SAP* submitted to the USEPA for review on March 4, 1997.

Specific Comment 14: p. 2-40, Table 2-9

The data for Zone 7 of the Thames river were based on one sample that was analyzed for a subset of all relevant analytes. This sample was not analyzed for VOAs and was analyzed for only a limited numbers of semivolatiles, pesticides, and metals. The sediments in Zone 7 have not been adequately characterized.

In performing screening of sediments, analytes lacking a benchmark value were eliminated as COPCs. This resulted in the elimination of the analytes Aroclor-1248, Aroclor-1260, beta-BHC, endosulfan sulfate, and heptachlor epoxide. These analytes all have surrogates for which criteria are available. The screening should take surrogates into account when establishing benchmark values for screening (*e.g.*, screen beta-BHC on gamma-BHC values, endosulfan sulfate on endosulfan, heptachlor epoxide on heptachlor).

Response to Specific Comment 14:

Agreed. The sediment of the Thames River adjacent to Zone 7 has not been adequately characterized. However, it should be noted that additional sediment

samples were collected in the river adjacent to Zone 7, but the sampling locations were subsequently removed during dredging activities. The analytical results for the sample locations that were dredged were not considered during the COPC screening.

One sediment sample (EC-SDTR04-02), which was collected during the Phase II RI and was subsequently dredged, was analyzed for a full suite of contaminants including Target Compound List (TCL) Volatile Organic Compounds (VOCs), TCL SVOCs, TCL Pesticides/PCBs and Target Analyte List (TAL) Metals. The analytical results for this sample indicated that only SVOCs and metals were contaminants of concern. Only one VOC (i.e., acetone which is a common laboratory contaminant) and no pesticides or PCBs were detected in the sample.

Additional sediment sampling is proposed for Zone 7 in the *draft Lower Subase RI WP/SAP* submitted to the USEPA for review on March 4, 1997. However, it is proposed in the WP/SAP that the sediment samples only be analyzed for TCL SVOCs and TAL metals because of the analytical results for EC-SDTR04-02 and the Phase II RI ecological risk assessment for the Thames River.

Contaminants without screening criteria will be retained as COPCs in the *final Existing Data Summary Report*. Surrogates will be taken into account when establishing benchmark values for screening in the ecological risk assessment prepared for the Lower Subase RI.

Specific Comment 15: p. 2-42, Table 2-10

Only one sediment sample was collected for Zone 1 of the Thames river. This is not sufficient to characterize a zone.

Response to Specific Comment 15:

Agreed. Additional sediment sampling in the Thames River is proposed for each zone in the *draft Lower Subase RI WP/SAP* submitted to the USEPA for review on March 4, 1997.

Specific Comment 16: p. 2-48, Table 2-12

Sediment samples were collected from only one location for Zone 4 of the Thames River. This is not sufficient to characterize a zone.

Response to Specific Comment 16:

Agreed. Additional sediment sampling in the Thames River is proposed for each zone in the *draft Lower Subase RI WP/SAP* submitted to the USEPA for review on March 4, 1997.

Specific Comment 17: Figures 3-1, 4-1, 5-1, 6-1, 7-1, 8-1, & 9-1

Though storm sewer lines are depicted on these figures, outfalls or point source discharges are not clearly shown. Each point source discharge should be described in light of potential contamination within the discharge, including the drainage area, discharges from buildings, and connections to underground drains.

Response to Specific Comment 17:

Please refer to the responses to General Comment 7 and Specific Comment 8.

Specific Comment 18: p. 3-6, §3.2.7, ¶2

Were integrity inspections performed? If so, what were the results?

Response to Specific Comment 18:

The Navy conducted integrity testing in 1996 on some of the fuel lines at the Lower Subase. The testing was not done as part of the Site Investigation for the Tank Farm. The test results were not available until after preparation of the *draft Background Review Report* was complete. The test results will be included and evaluated in the Lower Subase RI.

No additional testing or video inspection of pipelines is proposed in the WP/SAP for the Lower Subase RI. The Navy is however planning additional testing under the CTDEP-regulated UST program. The active diesel fuel lines between the ASTs at the Ballfields and the piers will be tested under the program. The results of these tests will also be included in the Lower Subase RI when they are available.

Specific Comment 19: pp. 3-11 to 3-13, §3.4.2

Please specify when and where free product was identified. The last paragraph on page 3-12 states, "...No. 2 fuel oil was detected in groundwater in the vicinity of Tank 54-H during a previous investigation....Additionally, a mixture of diesel fuel and heavy residual fuel oil...was identified...." Was this free product?

Response to Specific Comment 19:

The information provided in the last paragraph on p. 3-12 was taken from the Phase I RI Report completed by Atlantic Environmental Services, Inc. (August, 1992). The groundwater samples collected during the Phase I RI were analyzed by fluorescence spectroscopy to determine the type of product that was present in the groundwater. No actual free product measurements were taken during the Phase I RI or the subsequent Phase II RI.

Based on the information that is available for this zone, it is likely that free product exists in the groundwater of this zone, but it was never confirmed. A comprehensive round of free product thickness measurements is proposed in the *draft Lower Subase RI WP/SAP* for this zone. The measurements will be provided in the forthcoming Lower Subase RI.

Specific Comment 20: p. 3-16, §3.5.5, 2nd bullet

TPH was detected at 51,600 mg/kg in deep soil in a tidally influenced water table, and free petroleum product and oily substances have entered the Thames River. It is therefore unclear why the report concludes that no imminent threat to the environment was identified. The report also states that no significant risks to ecological receptors exist. Considering the current data gaps (no SVOA data), it is premature to conclude that no significant risks to ecological receptors exist.

Response to Specific Comment 20:

An evaluation of potential PAH concentrations was performed during the Phase I RI human health risk assessment, as stated in the Phase II RI. Potential PAH concentrations in soil were estimated using TPH data, fluorescence spectroscopy data, and known percentages of No. 2 and 6 fuel oils (i.e., petroleum products known to be used at the Lower Subase). No significant human health effects were noted based on this analysis (i.e., HIs were <1 and ICRs were < $1x10^{-6}$).

The human health and ecological risk assessments that were completed for the Lower Subase and the Thames River in the Phase II RI showed some risks in excess of USEPA acceptable limits. Based on the magnitude of the calculated risks, site conditions, exposure potential and professional judgment, it was concluded that there was no imminent threat to the environment that warranted a time-critical removal action.

This recommendation was also made with the understanding that another RI was planned for the Lower Subase. It is anticipated that the RI will answer any of the remaining data gaps identified in the *draft Background Review Report* and that it will provide an updated human health and ecological risk assessment based on the new,

comprehensive database. A Feasibility Study will also be completed for the Lower Subase to determine the appropriate remedial action.

An oily sheen has been detected on the surface of the Thames River adjacent to the Lower Subase on a limited number of occasions. When free product has been detected in the Thames River the Navy has used buoys to contain and adsorb the product before it can migrate.

Specific Comment 21: p. 5-15, §5.6; p. 6-16, §6.6; & p. 9-14, §9.6

The recommendations for Zones 3, 4, and 7 for lead are limited to further evaluations on the nature and extent of lead in soils and continued groundwater sampling and analysis to monitor contamination levels. In addition to these efforts, it is important to quantify the amount of lead entering the Thames River. Cumulative ecological impacts should also be evaluated.

Response to Specific Comment 21:

Text will be added to the recommendations for Zones 3, 4 and 7 to indicate that additional sampling and analysis is necessary to determine the nature and extent of lead in soils, to monitor lead levels in groundwater, to quantify the amount of lead entering the Thames River and to evaluate the cumulative ecological impacts.

Specific Comment 22: p. 7-1, §7.1.1

The description of possible sources of TPH contamination in Zone 5 should be enhanced. The sixth sentence in the first paragraph, states, "...There are no known or reported spills from the storage tanks or transfer system...." While true, it is important to note that TPH was detected in deep soil samples in concentrations exceeding 6000 ppm and shallow soil samples exceeding 2000 ppm in the vicinity of the former UST adjacent to the western side of Building 175.

Response to Specific Comment 22:

It will be noted in Section 7.1.1 that TPH was detected in shallow and deep soil samples at concentrations in excess of state and Federal standards. It will also be noted that the samples were collected in the vicinity of the former UST adjacent to the western side of Building 175 which would indicate that this former UST was the source of the TPH contamination.

Specific Comment 23: Drawing 1

It is misleading to color contour the datum point on Drawing 1 since only one shallow soil sample was analyzed for Zone 5. Please only show the pink color corresponding to the 6800 ppm detected in the one sample.

Response to Specific Comment 23:

The colored isoconcentration contours shown for the data point at Zone 5 are based upon geostatistics. The geostatistical approach was used to develop a variogram which was then used to predict a trend from more distant data points. The processing results produced a grid that encompassed the entire site. This grid was composed of predicted data trends at 25 foot centers that are based upon near and distant known data points. A Boolean operation was then used to mask all predicted data that had an error that exceeded 4.471 mg/kg (the mean predicted grid error for this figure). Any predicted grid data that exceeded this level of error had an associated confidence limit of less than 68 percent. Only data trends that have a level of confidence that exceeds 68 percent are shown on all maps for this report. The data trend displayed in Figure 1 at Zone 5 represents a trend that has a confidence limit of between 68 percent and 95 percent. This range of confidence limits indicates that the estimation is correct to within $\pm$ 1 to $\pm$ 2 standard deviations.

The grid for Zone 5 appears as a quarter circle for the following reasons. The default area that the computer program considers for processing the grid is determined by the distribution of data locations. The default grid settings equal the minimum and maximum northing and easting coordinates of the data points. Because this single well in Zone 5 represented the maximum northing coordinate and a near minimum easting coordinate, the computer program stopped gridding at this location. This default will be overridden so that predictions of data trends can be extended beyond this well. However, the same data trend confidence limits of between 68 and 95 percent will be shown on the drawing because these limits are considered to be standards for data presentation. This will result in multiple colored isoconcentration contours being shown on the drawing which is in disagreement with USEPA's comment.

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March 1997
059606/P

EXISTING DATA SUMMARY REPORT
FOR
LOWER SUBASE REMEDIAL INVESTIGATION

NAVAL SUBMARINE BASE - NEW LONDON
GROTON, CONNECTICUT

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Northern Division
Environmental Branch Code 18
Naval Facilities Engineering Command
10 Industrial Highway, Mail Stop #82
Lester, Pennsylvania 19113-2090

Submitted by:
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CONTRACT NUMBER N62472-90-D-1298
CONTRACT TASK ORDER 0260

Volume I

MARCH 1997

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ACRONYMS, INITIALISMS, AND ABBREVIATIONS

4,4'-DDT	1,1,1-Trichloro-2,2-bis(4-chlorophenyl)ethane
4,4'-DDD	1,1-Dichloro-2,2-bis(4-chlorophenyl)ethane
4,4'-DDE	1,1-Dichloro-2,2-bis(4-chlorophenyl)ethene
AWQC	Ambient Water Quality Criteria
B&R	Brown & Root
BEHP	Bis(2-Ethylhexyl)Phthalate
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
CERCLA	Comprehensive Response, Compensation and Liability Act
CFR	Code of Federal Register
CLEAN	Comprehensive Long-term Environmental Action Navy
COC	Chemical of Concern
COPC	Chemical of Potential Concern
CRQL	Contract Required Quantitation Limit
CTDEP	Connecticut Department of Environmental Protection
CTE	Central Tendency Exposure
CTO	Contract Task Order
DCA	Dichloroethane
DCE	Dichloroethene
DEIS	Draft Environmental Impact Statement
DOD	United States Department of Defense
DRMO	Defense Reutilization and Marketing Office
EA	Environmental Assessment
ERA	Ecological Risk Assessment
FFA	Federal Facilities Agreement
FID	Flame Ionization Detector
FOL	Field Operations Leader
GPM	Gallons Per Minute
HASP	Health and Safety Plan
HHRA	Human Health Risk Assessment
HNUS	Halliburton NUS
HQ	Hazard Quotient
HSWA	Hazardous and Solid Waste Amendment of 1984

IAS	Initial Assessment Study
IDW	Investigation Derived Waste
IEUBK	Integrated Exposure Uptake Biokinetic
IWPT	Industrial Waste Treatment Plan
MCL	Maximum Contaminant Level
MSL	Mean Sea Level
NAD	North American Datum
NACIP	Navy Assessments and Control of Installation Pollutants
NAVFAC	Naval Facilities Engineering Command
NCP	National Contingency Plan
NEESA	Naval Energy and Environmental Support Activity
NESO	Naval Environmental Support Office
NLDS	New London Disposal Site
NSB-NLON	Naval Submarine Base - New London
OSWER	Office of Solid Waste and Emergency Response
OVA	Organic Vapor Analyzer
PAHs	Polynuclear Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PID	Photo Ionization Detector
POC	Point of Contact
ppm	parts per million
ppt	parts per thousand
PVC	Polyvinyl Chloride
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RAB	Restoration Advisory Board
RBC	Risk-Based Concentrations
RCRA	Resource Conservation and Recovery Act
RME	Reasonable Maximum Exposure
RI	Remedial Investigation
RPM	Remediation Project Manager
SARA	Superfund Amendments and Reauthorization Act
SCS	Soil Conservation Service
SEM/AVS	Simultaneously Extracted Metals/Acid Volatile Sulfide
SI	Site Investigation
SOP	Standard Operating Procedure

SPLP	Synthetic Precipitation Leaching Procedure
SVE	Soil Vapor Extraction
SVOCs	Semivolatile Organic Compounds
TAL	Target Analyte List
TCE	Trichloroethene
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TPH	Total Petroleum Hydrocarbons
TOC	Total Organic Carbon
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
USGS	United States Geologic Survey
UST	Underground Storage Tank
VOCs	Volatile Organic Compounds

1.0 INTRODUCTION

This Existing Data Summary Report for the planned Lower Subase Remedial Investigation (RI) at Naval Submarine Base - New London (NSB-NLON), Groton, Connecticut, was prepared for the U.S. Department of the Navy (Navy) by Brown & Root Environmental (B&R Environmental), a division of Halliburton NUS Corporation, under the Comprehensive Long-term Environmental Action Navy (CLEAN), Contract Number N62472-90-D-1298, Contract Task Order (CTO) 0260.

1.1 PURPOSE OF THE REPORT

The Existing Data Summary Report was prepared to summarize relevant background information and to document the scoping process for the planned Lower Subase RI at NSB-NLON. The purpose of the scoping process is to collect and analyze existing data, to establish physical characteristics of the site, and to determine the need for additional data and the appropriate additional studies to collect the data. After preparation of the Existing Data Summary Report, the next step for the Lower Subase RI is the preparation of a Work Plan/Sampling and Analysis Plan (WP/SAP). A draft version of the WP/SAP was prepared and submitted to the regulators for review on March 4, 1997.

1.2 BASE BACKGROUND

This section provides a description of base operations, a brief history of NSB-NLON and the Lower Subase, a summary of previous investigations at the Lower Subase, and a discussion of the contaminated areas and potential sources of contamination within the Lower Subase.

1.2.1 Base Description

NSB-NLON is located in southeastern Connecticut in the Towns of Ledyard and Groton. Figure 1-1 illustrates the location of the Base. NSB-NLON is situated on the east bank of the Thames River, approximately 6 miles north of Long Island Sound. It is bounded to the east by Connecticut Route 12, to the south by Crystal Lake Road, and to the west by the Thames River. The northern border is a low ridge that trends approximately east-southeast from the Thames River to Baldwin Hill.

NSB-NLON currently provides base command for naval submarine activities in the Atlantic Ocean. It also provides housing for Navy personnel and their families and supports submarine training facilities, military offices, medical facilities, and facilities for submarine maintenance, repair, and overhaul.

The Lower Subase is bounded on the west by the Thames River and on the east by the Providence and Worcester Railroad tracks. The quay wall runs along the Thames River for the entire length of the NSB-NLON. The Lower Subase contains piers and berths for submarine docking, as well as facilities for the submarine maintenance, repair, and overhaul.

For the purposes of this report, the Lower Subase extends to and includes Pier 2 to the south and Pier 33 to the north as shown on Figure 1-1. Building 175, located just north of Pier 33, is included within the Lower Subase. The Lower Subase is a secure, access-restricted portion of NSB-NLON. A more detailed depiction of the general configuration of the area is shown on Figure 1-2. As shown in Figure 1-2, the study area has been divided into seven zones. These zones are further discussed in Section 1.2.4.

1.2.2 Base History

In 1867, the State of Connecticut donated a 112-acre parcel of land on the east bank of the Thames River to the Navy. The Navy did not use the property until 1868, when it officially designated the property a Navy Yard. The site was used to moor small craft and obsolete warships and served as a coaling station for the Atlantic fleet. The Navy designated the site a Submarine Base in 1916. During World War I, facilities at the base were extensively expanded; 6 piers and 81 buildings were added. In 1917, a submarine school was established, and in 1918 the Submarine Medical Center was founded.

NSB-NLON underwent another period of growth during World War II. Between 1935 and 1945 the Navy built in excess of 180 buildings and acquired land adjacent to NSB-NLON. The base expanded from 112 acres to 497 acres. The growth of NSB-NLON continued after World War II. In 1946 the Medical Research Laboratory was established.

In 1968, the Submarine School was changed from the status of an activity to a command and became the largest tenant on the base. The Naval Submarine Support Facility was established in 1974, and the Naval Undersea Medical Institute was established the following year. Currently, NSB-NLON consists of more than 300 buildings on 576 acres of land.

On August 28, 1991, NSB-NLON was placed on the National Priorities List (NPL) by the United States Environmental Protection Agency (USEPA) pursuant to Comprehensive Environmental Response,

Compensation and Liability Act of 1980 (CERCLA) and the Superfund Amendments and Reauthorization Act (SARA) of 1986. The NPL is a list of uncontrolled or abandoned hazardous waste sites identified by USEPA requiring priority remedial actions.

In January 1995, the Navy, USEPA, and the State of Connecticut signed the USEPA Federal Facilities Agreement (FFA) for NSB-NLON. The agreement will be used to ensure that environmental impacts associated with past and present activities at NSB-NLON are thoroughly investigated and that the appropriate remedial action is pursued to protect human health and the environment. In addition, the FFA establishes a procedural framework and timetable for developing, implementing, and monitoring appropriate responses at NSB-NLON, in accordance with CERCLA (and SARA amendment of 1986), the National Contingency Plan (NCP), Resource Conservation and Recovery Act (RCRA) and Hazardous and Solid Waste Amendment (HSWA) of 1984, Executive Order 12580, and applicable state laws.

The Lower Subase is the original submarine base and, therefore, its use dates back to 1868. Most of the construction at the Lower Subase from approximately Pier 15 south took place in the early 1900s with a major expansion from 1935 to 1940. In 1946, the waterfront north of Pier 15 was developed extensively to accommodate berthing of the reserve fleet. The area was dredged, filled and bulkheads, piers, support buildings, and utilities were constructed.

Recently, dredging activities have occurred in the Thames River adjacent to the Lower Subase. The activities were conducted during 1995 and 1996 as part of the Pier 17 Replacement and Seawolf Class Submarine Homeporting projects. Dredged material was disposed of at the designated open-water disposal site in Long Island Sound.

1.2.3 Previous and Ongoing Investigations and Related Documentation

Brief summaries of previous and ongoing investigations and activities associated with the areas to be addressed by the RI are presented in Table 1-1. The following investigations are included:

- Oil Contamination of the Groundwater at Subase New London (Naval Environmental Support Office [NESO], 1979)
- Final Initial Assessment Study (Envirodyne, 1983)
- Final Site Investigation - Subsurface Oil Contamination (Wehran, 1987)
- Hydrogeologic Investigation UST OT-4, OT-7, OT-8, OT-9, and Tank 54-H (Fuss & O'Neill, 1989)
- Multimedia Inspection (USEPA Region I, 1991)
- Phase I Remedial Investigation (Atlantic, 1992)

- Action Memorandum for Building 31 (HNUS, 1993a)
- Remedial Design for Building 31 (HNUS, 1993b)
- Environmental Assessment for Pier 17 Replacement (Maguire, 1994)
- Post-removal Action Report for Building 31 (HNUS, 1995a)
- Final Site Inspection Report, Pier 33 and Berth 16/Former Incinerator (Atlantic, 1995a)
- Site Characterization Report for OT-10, Building 325 and Building 89 (HNUS, 1995b)
- Background Soil Investigation (Atlantic, 1995b)
- Preliminary Assessment/Supplement to Initial Assessment Study (Naval Facilities Engineering Service Center, 1995)
- Removal Site Evaluation for Quay Wall (HNUS, 1995c)
- Site Investigation Report for Tank Farm Investigation (B&R Environmental, 1996a)
- Phase II Remedial Investigation (B&R Environmental, 1996b)

Analytical data from previous investigations applicable to the study area were evaluated and included in a database generated for this Existing Data Summary Report to aid in the determination of nature and extent of contamination and data evaluation. The previous investigations selected for inclusion in the database are indicated in Table 1-1. Further discussion of the database is provided in Section 1.4.

Additional data contained in the following reports will be evaluated in the forthcoming Lower Subase RI; however, it was not evaluated within this report because it was outside of the scope of this task.

- Environmental Assessment for Pier 17 Replacement (Maguire, 1994)

- Final Environmental Impact Statement for Seawolf Class Submarine Homeporting on the East Coast of the United States (Maguire, 1995)

1.2.4 Contaminated Areas and Sources of Contamination within Lower Subase

Within the Lower Subase, several potential contaminated areas and sources of contamination have been identified and include Zones 1 through 7; the Thames River; the fuel oil distribution system; and steam, condensate, and electrical ducts. These areas and sources are discussed in the following subsections. Note that previous investigations have identified the Lower Subase as the area occupied by Zones 1 through 4. For the purposes of the RI, the Lower Subase is the area occupied by Zones 1 through 7 (See Figure 1-2). The investigation area was increased to include Zones 5 through 7 (from Pier 33 to Berth 16) at the request of the regulators to provide a cohesive and thorough evaluation of all potential Lower Subase source areas along the Thames River.

1.2.4.1 Zone Boundaries

Seven separate areas or zones of contamination have been identified in the Lower Subase, and the discussion in this report centers on these particular zones. Zones 1 through 4 were delineated in the Phase II RI and were accepted by the regulators for the development of the Phase II RI Report. These same zones were carried through into this Existing Data Summary Report for the Lower Subase RI.

The Lower Subase includes numerous buildings and potential sources of contamination. The zones were delineated to encompass specific, potential sources and to focus the preparation of the Phase II RI Report. The Navy and regulators previously identified potential source areas at NSB-NLON that require investigation under the Navy's IRP and CERCLA. Each of the potential source areas was given a unique site number and specific sites fall within each zone. Portions of the fuel oil distribution lines and steam, condensate, and electrical ducts may also be included in each of the zones. The distribution lines and ducts are discussed in Sections 1.2.4.3 and 1.2.4.4, respectively. The subdivision of the Lower Subase into zones also made the Phase II RI report preparation easier, focused the nature and extent of contamination discussions and allowed the human health risk assessment to be linked to specific sources.

Site-specific hydrogeology and surface water hydrology information was also used to delineate the zones. The information was used to determine potential contaminant migration pathways from these potential source areas and zone boundaries were generally chosen so that contamination from one zone would not migrate into another. The same approach used to delineate Zones 1 through 4 was also used for Zones 5 through 7. The seven zones are shown on Figure 1-2.

Zone 1 extends from Darter Road (just south of Building 89) to the south side of Corvina Road and includes the following sites:

- Site 10 - Fuel Storage Tanks and Tank 54-H
- Site 11 - Power Plant Oil Tanks
- Building 89 UST.

Zone 2 extends from the southern boundary of Zone 1 (i.e., Corvina Road which is north of Pier 8) to Capelin Road (just north of Building 31 and Pier 6). No IRP sites have been identified within Zone 2. Approximately 10 buildings are located with Zone 2. Most of the buildings within this zone (i.e., Buildings 1,2,16,17, 18, 20 and 76) have historically and are currently used for administrative activities. Other buildings within the zone, such as Buildings 38, 75 and 328, are currently used to house a carpenter's

shop, a sanitary sewer pump station/emergency generator, and utilities, respectively. A portion of the fuel pipeline is also located within this zone. The pipeline runs north from the southern end of the zone along Argonaut Road, then west along Cisco Road, and finally north along Albacore Road.

Zone 3 extends from the southern end of Zone 2 (Capelin Road) to the south side of Bullhead Road and includes the following site:

- Site 17 - Hazardous Materials/Solvent Storage Area (Building 31)

Zone 4 extends from the south side of Bullhead Road to the southern boundary of the Lower Subase and includes the following sites:

- Site 13 - Building 79 Waste Oil Pit
- Site 19 - Solvent Storage Area (Building 316)
- Quay Wall

Zone 5 consists of Pier 33, Building 175, approximately 800 feet of additional property adjacent to these two structures and the storm sewer conveying Stream 6 from the Area A Downstream. Zone 5 includes the following site:

- Site 22 - Pier 33

Zone 6 consists of Building 174, which is identified as the following site:

- Site 24 - Central Paint Accumulation Area (Building 174)

Zone 7 extends from just north of Building 478 to the southern side of Dorado Road and includes the following sites:

- Site 21 - Berth 16
- Site 25 - Classified Materials Incinerator
- Transformers at Building 157 Vault 31

1.2.4.2 Thames River

The Thames River forms the western boundary of the Lower Subase. All of the zones and sites being evaluated as part of the RI are within several hundred feet of the river. In addition, both groundwater and surface water runoff from the Lower Subase discharge to the Thames River. Therefore, the Thames River may have been adversely impacted by activities at the Lower Subase.

1.2.4.3 Fuel Oil Distribution System

Distribution systems for No. 6 fuel oil and No. 2 diesel fuel have existed within the Lower Subase. The pipelines were historically used to convey fuel to the power house, to the underground storage tanks (USTs) at the fuel farm, and to fuel ships at the piers (see zone-specific figures in Sections 3.0 through 9.0). Recent changes have significantly modified the distribution systems at the Lower Subase. Historical and current information on the distribution systems is provided below.

The No. 6 fuel oil distribution system is no longer in use and has been decommissioned. The system previously included 3 USTs (OT-1, OT-2 and OT-3) at the Tank Farm, 2 USTs (54 A and B) near the Power Plant in the Lower Subase, and approximately 3700 linear feet of 12-inch line. The No. 6 fuel oil line along Argonaut Road from the valve house at the gate of the Lower Subase to the Power Plant (Building 29) was replaced in the late 1980s. Fuel lines along Corvina Road to the piers were also replaced. The No. 6 fuel oil line was contained in concrete-lined trenches shared with other utilities, including steam and condensate lines.

USTs OT-1, OT-2 and OT-3 were removed from service in the summer of 1991 and have subsequently been demolished and closed in place. Tanks 54A and B were emptied, cleaned, and repaired and are now used as containment structures for new, 150,000-gallon, steel tanks. Fuel oil for the Power House, which is stored in these new steel tanks, is brought in by tanker trucks.

The No. 2 diesel fuel oil distribution system included 5 USTs at the Tank Farm (OT-5, OT-6, OT-7, OT-8, and OT-9) and 5 USTs (C, D, E, F and G) at the Lower Subase. The system also included approximately 11,000 linear feet of 6-inch pipeline. Portions of the distribution system are still active. The active and inactive underground transfer lines are contained in concrete tunnels that are generally located adjacent to the concrete utility trenches. The concrete tunnels can be accessed through several manholes located throughout the Lower Subase.

A reduced demand for diesel in the mid-1970s lead to the modification of Tank OT-5 for waste oil storage purpose and the decommissioning and demolition of Tank OT-6. Tank OT-5 was later decommissioned in 1990. Tanks OT-7, OT-8, and OT-9 were decommissioned in the summer of 1990. Tanks C and D were emptied, cleaned, and repaired and are now used as containment structures for steel tanks. Tanks 54E, F and G have also been decommissioned by filling them with sand.

Both of the fuel distribution systems may be a source of petroleum contamination within the Lower Subase. An investigation along the active and inactive fuel lines located in the Lower Subase was conducted as part of the Phase II RI (B&R Environmental, 1996a). Soil sampling and analysis for total petroleum hydrocarbons (TPH) was conducted along new and old diesel underground pipelines in Zones 1 through 4. Soil samples were collected at intervals of approximately 100 feet along the underground lines. Elevated TPH concentrations [greater than the Connecticut Department of Environmental Protection's (CTDEP's) remediation industrial soil standard of 2500 mg/kg] were found in several soil sample locations. Based on the results of the investigation, new integrity inspections and review of previously performed integrity inspections were recommended for the fuel lines to identify current and previous sources of petroleum contamination present in the Lower Subase.

1.2.4.4 Steam, Condensate, and Electrical Ducts

The Power Plant, Building 29, is the producer of steam on the base. Three distribution systems, including the north, east, and pier systems, distribute steam to various portions of the NSB-NLON (see zone-specific figures in Sections 3 through 9). The north steam distribution system serves the zones located north of the power plant, the east steam distribution system serves buildings up to the gate valve house (Building 318), and the pier steam distribution system serves all the piers south of Pier 15. Generally, the steam is used for building heating and for domestic hot water supply. Steam supplied to the piers is used for the various valve stations and for protecting pier water lines against freezing. All steam condensate is returned to the power plant condensate receiver tank with the exception of that supplied to the piers and oil tank heating coils, which is not recovered. Generally, the condensate return piping parallels the steam distribution piping. The steam distribution and condensate return piping are installed mainly in concrete tunnels, trenches, or above grade. A small portion of the piping systems is buried. The tunnels have manholes for access, and the trenches have removable concrete covers at grade level. Electrical lines are also present in the trenches. The subgrade utility ducts may act as preferential flow pathways for contamination in the area. Previous investigations have identified petroleum contamination in the ducts.

1.3 PHYSICAL CHARACTERISTICS

General physical characteristics of the Lower Subase as provided in the IAS (Envirodyne, 1983), Phase II RI Report (B&R Environmental, 1996a) and the Site Inspection Report for Pier 33 and Berth 16/Former Incinerator (Atlantic, 1995a) are summarized below.

1.3.1 Topography and Surface Features

The topography of the Lower Subase slopes gradually to the west toward the piers and the Thames River. The ground elevation ranges from approximately 22 feet above mean sea level (msl) along the eastern edge of the Lower Subase to 8 feet above msl along the piers. There is a high density of buildings at the Lower Subase. Except for a few isolated grassy areas, the Lower Subase is completely paved or covered with buildings, which promotes surface water runoff. Numerous catch basins and storm sewers collect runoff from around the buildings and convey it to the Thames River. Based on the topography of the site, runoff not collected by the storm sewers will also ultimately reach the Thames River.

1.3.2 Water Classifications and Water Quality

The CTDEP previously classified the groundwater beneath the central and southern portions of NSB-NLON, which includes the Lower Subase, as GB/GA. A classification of GB/GA indicated that the groundwater may not be suitable for direct human consumption without treatment because of waste discharges, spills, chemical leaks, or land-use impacts. GB/GA waters may be used as industrial process waters or cooling waters. Groundwater beneath the northern portion of NSB-NLON is classified by CTDEP as GA (drinking water quality). The CTDEP's goal was to restore and maintain all groundwater beneath NSB-NLON to drinking water quality (GA).

However, it was unlikely that groundwater at the Lower Subase would be used for drinking because of the proximity of the site to the Thames River and the potential for salt water intrusion. The Navy applied to the CTDEP to get all groundwater beneath NSB-NLON reclassified to GB. The GB classification indicates that the area has been used for long-term intense industrial or commercial development and the groundwater is not used as a drinking water source. Remediation standards for GB areas are typically lower than those for GA areas. A reclassification application was submitted by the Navy to the CTDEP on August 12, 1996. The CTDEP initially indicated that the probability of reclassification was high in a letter to the Navy dated October 21, 1996. A public hearing was conducted on the issue on December 13, 1996, and formal notification from the CTDEP regarding successful reclassification was received on March 5, 1997. The groundwater for all of NSB-NLON, except for a small northern portion of the site, is

now classified as GB. The small northern portion, which is the portion north of Perimeter Road, will remain classified as GA. Therefore, all of the Lower Subase groundwater is now classified as GB.

The Thames River forms the western boundary of the Lower Subase and its waters are classified as SC/SB water. This classification designates the water for marine fish, shellfish, and wildlife habitat; certain aquaculture operations; recreational uses; and industrial and other legitimate uses. The classification also indicates that, because of pollution, the waters currently do not meet water quality criteria or support one or more designated uses. The Thames River is a salt wedge estuary. Depending on the time of year and climatology, the river can be highly stratified with freshwater on the surface and denser saline water on the bottom. Groundwater at locations adjacent to the river (i.e., Lower Subase) is also brackish.

The Groton Water Department supplies potable water to NSB-NLON. The primary source of the Groton water supply is surface water reservoirs, which are supplemented with wells. The water supplies are located within the Poquonock River Watershed, located east of NSB-NLON, which is not within the NSB-NLON watershed. Groundwater and surface water at NSB-NLON are not used for drinking water. There are several irrigation wells on site at the golf course located east of Zone 5 which have not been used for several years. Several active, private groundwater supply wells are located north (near Sleepy Hollow) and northeast (along Route 12 near the trailer park) of NSB-NLON.

1.3.3 Soil Characteristics

The Soil Conservation Service (SCS) soils map classifies the soil at the Lower Subase as Udorthents-Urban Land (in the northern portion of the Lower Subase) or as Urban land. Udorthents-Urban Land consists of excessively drained to moderately well drained soils that have been disturbed by cutting and filling along with areas that are covered by buildings or pavement. About 60 percent of the complex is Udorthents, 25 percent is Urban Land, and 15 percent is other soils. Urban Land is defined by areas where more than 85 percent of the surface is covered by streets, parking lots, and buildings. Most of the underlying soils have been altered by excavating or have been covered with fill material (Atlantic, 1995a).

1.3.4 Geology

In general, the Lower Subase is underlain by fill material that ranges in thickness from 5 feet on the east edge of the Lower Subase to at least 20 feet in the western portion of the Lower Subase. The fill material primarily consists of sand and gravel; however, wood, flyash, brick fragments, and concrete fragments have been detected in several locations. A silty layer underlies the sand and gravel fill along the western portion of the Lower Subase near the Thames River. In some cases, this silty layer contains sand and in

other cases it contains clay. This layer also contains shell and wood fragments and is mapped as stratified drift of former glacial meltwater stream deposits. A medium, coarse sand layer underlies the sand and gravel fill in the central and eastern portions of the Lower Subase. Underneath Building 31, there was a very significant quantity (up to 30 percent by volume) of cobbles (up to 3-inches in diameter) mixed in with the sand and silt.

Most of the soil borings completed in the Lower Subase did not exceed 30 feet and many were 20 feet in depth or less. Therefore, the bottom of the silt and sand layer was not always encountered. However, borings at Zone 5 extended to greater depths. According to geologic information provided during investigations at Zone 5, the sand and silt layers are underlain by approximately 10 feet of gravel, which overlies bedrock (Atlantic, 1995a).

Boring information confirms information provided on United States Geological Survey (USGS) surficial geology maps. According to the maps, most of the Lower Subase is artificial fill with stratified drift shown as terrace deposit of the Thames River mapped in the northern and eastern part of the Lower Subase. USGS bedrock geology maps indicate that bedrock at the Lower Subase is the Mamacoke Formation south of Berth 16. North of Berth 16, the maps indicate bedrock is Alaskite gneiss or Granite gneiss. Bedrock is mapped as Pre-Pennsylvania age rock, which consists of igneous intrusives that have been metamorphosed to granitic gneisses.

1.3.5 Hydrogeology

At the Lower Subase, the groundwater table is within the overburden (fill material) at approximate depths of between 4 and 10 feet below the ground surface. The shallowest depths to groundwater occur near the Thames River. Fluctuations in the groundwater table closely correspond to the measured tidal variations in the Thames River of 2.2 feet.

During low tide conditions, groundwater flow is toward the river throughout the Lower Subase. During high tide, localized flow gradient reversals occur, with surface water from the river recharging groundwater. Tidal studies performed within the Lower Subase as part of Action Memorandum for Building 31 (HNUS, 1993a) indicate that the reversal of flow gradient does not extend more than about 300 feet inland from the river. Overall, the daily groundwater discharge rate into the Thames River exceeds the recharge rate from the river to the aquifer.

An average hydraulic conductivity of 59 feet per day was calculated for the aquifer located in the shallow fill materials of the Lower Subase with measured hydraulic conductivities (by slug test) ranging from 1.7

feet per day to 576 feet per day (B&R Environmental, 1996a). An average hydraulic gradient of 0.0053 was calculated using groundwater and surface water measurements.

The bedrock at the Lower Subase consists of fractured metamorphic rock covered by glacial material that is thick in the low lands and thinner in the uplands. In the bedrock aquifer, groundwater movement is along joint planes rather than through intergranular openings. Well records indicate that bedrock wells in the vicinity yield from 1 to 65 gallons per minute (gpm). Potential well yields in bedrock wells are dependent on the degree of fracturing, topography, and type and thickness of overburden. In general, the greatest well yields occur in valleys where bedrock is highly fractured and overlain by more than 50 feet of stratified drift (Atlantic, 1995a).

1.3.6 Climatology

NSB-NLON is in an area that has a variable climate which is a result of both continental and maritime air masses and modified by the region's proximity to the Atlantic Ocean. The region lies in the path of prevailing westerly winds and cyclonic disturbances that cross the country from the west or southwest toward the east and northeast. In the summer, prevailing winds are southwesterly while in the winter are northwesterly. The average wind speed is about 10 miles per hour. The region is exposed to occasional storms that travel up the Atlantic coast. Storms in the region are laden with moisture from the ocean; in addition, some storms are tropical and occasional storms are of hurricane intensity.

Average annual temperature for New London, Connecticut, is approximately 50°F. Average monthly temperatures vary from 58 to 72°F in July and August, and from 23 to 30°F in January and February.

Precipitation averages approximately 44 inches per year, as measured at New London over an 81-year interval. Precipitation ranges from 32 to 65 inches per year. The greatest amount of precipitation occurs in the months of March and August; the least amount occurs in June and September. Evaporation averages approximately 23 inches per year (NSB-NLON Master Plan; Naval Facilities Engineering Command 1988).

1.3.7 Ecological Habitat

The Lower Subase is located in a highly industrialized portion of NSB-NLON and is characterized by large industrial buildings, a substantial amount of paved area, and very little maintained lawn. The area is characterized by heavy human activity and does not provide suitable habitat for wildlife. The only potential ecological habitat near the Lower Subase is the Thames River (described in Section 2.0), which

represents the Lower Subase's western border. This portion of the Thames River is dominated by piers and serves as a docking and repair facility. Based on previous investigations, contamination resulting from activities at the Lower Subase has potentially impacted the Thames River sediments.

1.4 DATA EVALUATION

Evaluation of existing analytical data for the Lower Subase (Thames River and Zones 1 through 7) is completed within this report to determine the need for further investigations in the Thames River and/or each of the Lower Subase zones. The approach to data evaluation is similar to that used in the draft final Phase II RI (B&R Environmental, 1996a). The data evaluation steps used for the Thames River and each zone include:

- Determination of Nature and Extent of Contamination
- Chemical of Potential Concern (COPC) Screening
- Contaminant Fate and Transport Evaluation
- Human Health Risk Assessment
- Ecological Risk Assessment

The results of these data evaluation steps are then summarized and logically evaluated using a decision-tree flow chart (See Figure 1-3) to determine the need for further investigations at each site.

Further discussion is provided below on the subtasks which required completion to facilitate the discussion of the Nature and Extent of Contamination and which are unique to this document. These subtasks include preparation of the analytical database, COPC screening tables and isoconcentration drawings. In addition, the decision-making process outlined in Figure 1-3 is also summarized below in Section 1.4.4.

The Contaminant Fate and Transport, Human Health Risk Assessment (HHRA), and Ecological Risk Assessment (ERA) information provided in this document is a summary of the information provided in the draft final Phase II RI (B&R Environmental, 1996a). The methodology used for completing the HHRA and ERA was presented in the draft final Phase II RI and is not reiterated in this document. The HHRA and ERA will be revised using analytical results from additional field efforts, and the revised risk assessments will be included in the forthcoming Lower Subase RI Report.

1.4.1 Analytical Database

Media-specific analytical data from multiple investigations at the Lower Subase are summarized in this report. The analytical data for the Lower Subase was collected for the Navy by various contractors. In some cases different sampling protocols were used to collect the samples. The samples were also analyzed using different laboratory methods. A database of much of the available analytical data was created and used during the preparation of the draft final Phase II RI Report (B&R Environmental, 1996a), which included an evaluation of a portion of the Lower Subase (Zones 1 through 4). Data from other investigations were entered into the database as part of this Lower Subase RI project. A complete list of investigations included in this Lower Subase Existing Data Summary Report was summarized in Section 1.2.3 and Table 1-1. The complete analytical database is included as Appendix A.

A complete summary of all analytical results (detections and nondetections) for each medium, including soil [analytical and Toxicity Characteristic Leaching Procedure (TCLP)], sediment (Thames River and storm sewer), groundwater, surface water (Thames River) and biological, is provided in the database. Information provided for each sample in the database includes sample number, sample depth, sample location, sample date, investigation during which the sample was collected, sample type, sample status (i.e., location intact or excavated), zone, and sample duplicates. The analytical results for each medium are sorted per zone.

Processing of the data contained in the database was necessary to provided frequency of detection and range of detection information for the COPC screening tables and to create chemical isoconcentration drawings. Data evaluation/processing techniques similar to those used in the Phase II RI were also used for this report. A summary of the media-specific data evaluation/processing techniques used for this report are provided below. The screening tables and isoconcentration figures are presented in subsequent sections of this report.

1.4.2 COPC Screening

Additional data, incorporated into the database as part of this preliminary Lower Subase RI project, are evaluated in this report but were not previously evaluated in the Phase II RI Report. The new data was not previously screened against applicable Federal or state criteria to determine whether there are concentrations present which pose a potential risk; therefore, the new data was incorporated into the Lower Subase database and the complete analytical data set was screened against appropriate criteria.

Screening tables were created for each medium including soil (analytical and TCLP), sediment, groundwater, surface water, and biological. Generally, the information provided in each screening table includes: frequency of detections, range of detections, range of nondetections, arithmetic average concentration, location of the maximum, applicable Federal and state criteria, and a column indicating whether the maximum chemical concentration exceeds any of the criteria. Details of each medium-specific screening table are provided below.

The results of the COPC screening provide an initial indication of which chemicals pose a potential human health and/or ecological risk. The potential for exposure to COPCs is discussed in the Contaminant Fate and Transport sections. Further quantification of the risk that each of the COPCs contributes to a receptor is provided in the HHRA and ERA evaluations. For two zones (i.e., Zones 5 and 7), further quantification of risks was not available, and the screening tables were the only means available to evaluate whether a chemical posed a potential risk or not.

1.4.2.1 Soil

To complete the soil COPC screening, soil analytical results were separated into two categories, shallow and deep, for each zone. Generally, shallow indicates a sample depth of less than 4 feet and deep indicates a sample depth of greater than 4 feet. Because of the range of sample depths at each zone, several zones used slightly different depths for shallow and deep categories (e.g., at Zone 1, shallow is less than 5 feet and deep is greater than 5 feet).

Six criteria were used to screen the soil analytical results. Three of the criteria are Federal criteria including USEPA Risk-Based Concentrations (RBCs) Region III for Residential Soil Ingestion (USEPA Region III, May 10, 1996) and USEPA Soil Screening Levels for Inhalation and Migration to Groundwater (USEPA, May 1996). The other three criteria used for screening are CTDEP remediation criteria. They include Residential and Industrial Direct Exposure criteria and Pollutant Mobility criteria for GB-classified groundwater (CTDEP, 1995). Use of residential soil criteria (i.e., Federal or state) for screening is conservative because the Lower Subase is highly industrialized and will remain so in the foreseeable future.

Two criteria were used to screen the TCLP results for soil. The criteria are CTDEP Pollutant Mobility remediation standards for GB-classified groundwater (CTDEP, 1995) and the Federal Toxicity Characteristic Regulatory Levels (58 FR 46049).

For soil COPC screening, analytical results for original and duplicate pairs were considered as independent samples. This approach was used in the Phase II RI for Chemical of Concern (COC) screening at USEPA Region I's request. The approach accounts for the heterogeneity of the soil medium and eliminates the potential for the masking of high detections.

The average chemical concentrations presented in the screening tables are arithmetic averages of all detections and nondetections. One-half of the detection limit is used for in the average calculation for nondetections. This approach assumes that the chemical may be present at some concentration below the detection limit (i.e., approximately one-half of the detection limit).

1.4.2.2 Sediment

Sediment samples were collected from the Thames River and from storm sewers in Zones 5 and 7 of the Lower Subase. The sediment samples from the river and the storm sewer were screened differently because of the different receptors which could come into contact with each type of sediment. The main receptor for the Thames River sediment was an ecological receptor. Humans were not considered appropriate receptors for Thames River Sediment because of the depth of the river. For the storm sewer sediment, a human receptor was considered the most appropriate receptor.

For the Thames River sediment, background concentrations and ecological benchmarks presented in the draft final Phase II RI were used to screen the sediment concentrations. In contrast, the storm sewer sediment concentrations were screened against COC screening levels developed from USEPA Region III RBCs for Residential Soil Ingestion (USEPA Region III, May 10, 1996) and two CTDEP remediation criteria, the Residential and Industrial Direct Exposure criteria (CTDEP, 1995). As discussed above, use of residential criteria to evaluate Lower Subase media is conservative because of the industrialized nature of the area.

Original and duplicate pairs of sediment analytical results for both the Thames River and storm sewers were considered as independent samples for sediment COPC screening. This approach is similar to the approach used for soil. In addition, the average chemical concentrations presented in the screening tables are arithmetic averages of all detections and nondetections, which is the same approach used for the soil. One-half of the detection limit is used in the average calculation for nondetections.

1.4.2.3 Groundwater

Multiple rounds of analytical data are available for many monitoring wells at the Lower Subase. For screening purposes, the maximum concentration of all sampling rounds was used to represent the chemical concentration in a monitoring well. Duplicates were considered as discrete samples.

The criteria used to screen the groundwater results included COC screening levels developed from USEPA Region III RBC's for residential ingestion of tap water, Federal Maximum Contaminant Levels (MCLs), Connecticut MCLs, and the CTDEP remediation standards for groundwater and surface water protection. Use of the COC screening levels for residential ingestion of tap water, the Federal MCLs, and the Connecticut MCLs for screening is a conservative approach because the groundwater at the Lower Subase is not used for human consumption. It was assumed for this report that the screening should be conservative and that a more realistic evaluation of the risk associated with the chemical concentrations would be presented in the draft final Phase II RI HHRA.

The CTDEP's remediation standards for surface water protection that are used in this report for COPC screening of chemical concentrations measured in the Lower Subase groundwater are groundwater remediation standards which are protective of surface water. The standards are calculated using the lower of the human health criteria or the freshwater aquatic life criteria for a chemical and dilution factors. Unfortunately, the groundwater from the Lower Subase discharges to the Thames River which is a marine ecosystem and not a freshwater ecosystem. Therefore, some of the CTDEP's surface water remediation standards (i.e., those based on freshwater aquatic life criteria) that were used for COPC screening are not directly applicable for COPC screening at the Lower Subase. No alternative standards were developed for this report, but development of others will be considered for the Lower Subase RI.

Average chemical concentrations in groundwater were calculated and are presented in the groundwater screening tables. The average concentration for a particular chemical is the arithmetic average for all analytical results (detections and one-half nondetections) for the zone. The average chemical concentration represents a good estimate of the average plume concentration per zone.

1.4.2.4 Surface Water

Both shallow and bottom surface water samples were collected from the Thames River. The analytical results for filtered and unfiltered surface and bottom surface water samples were screened independently to account for both the stratified flow conditions in the river and suspended sediments. Analytical results

for duplicate surface water samples were considered as discrete samples, and the maximum concentration of each sample was used for COPC screening.

Each data set was screened against the same human health and ecological criteria. The human health criteria used for screening included the COC screening values developed from USEPA Region III RBCs for Residential Ingestion of Tap Water and the Connecticut and Federal Ambient Water Quality Criteria (AWQC) for consumption of water and organisms. The ecological criteria used for the COPC screening included background surface water concentrations and ecological benchmark values from the draft final Phase II RI Report.

Use of the COC screening values developed from RBCs for residential ingestion of tap water for human health screening is conservative because the surface water in the Thames River is not used for human consumption. It was assumed for this report, similar to the groundwater screening, that the surface water COPC screening should be conservative and that a more realistic evaluation of the risk associated with the chemical concentrations would be presented in the draft final Phase II RI HHRA and ERA.

1.4.2.5 Biota

Tissue samples of ribbed and blue mussels, oysters, and clams were collected and analyzed for the Phase II RI. The data were used to develop ingestion intakes for the HHRA and to determine the potential doses to aquatic birds for the ERA. The COPC screening that was completed for this document was specifically concerned with human health concerns.

Only the analytical results for oysters and clams were screened against the USEPA Region III criteria for human ingestion of fish (USEPA Region III, May 10, 1996). Analytical data for the ribbed and blue mussel tissue samples were not screened because these biota are not commercially harvested for human consumption (B&R Environmental, 1996a).

Duplicate biological tissue samples were considered as discrete samples, and the maximum concentration of each sample was used for screening. An average concentration was calculated and is presented in the biota screening tables in Section 2.0. This average is the arithmetic average for all analytical results (detections and one-half nondetections).

1.4.3 Preparation of Isoconcentration Drawings

Isoconcentration drawings of primary COPCs were created to help evaluate the nature and extent of contamination at the Lower Subase. Isoconcentration drawings of soil and groundwater concentrations were created. The approach for creation of the drawings is discussed below.

1.4.3.1 Soil

Isoconcentration drawings were created for both shallow and deep soils to show the variation in the distribution of contamination in soil with depth. Sediment analytical results for Thames River sampling locations are also presented on both the shallow and deep soil isoconcentration drawings. These concentrations are presented to show which source of contamination in the soil may be contributing to contamination in the Thames River. Because of the limited number of locations, the analytical data for the sediment was not contoured.

Analytical results for original and duplicate pairs were considered as independent samples for isoconcentration drawing preparation. This approach was used in the Phase II RI for Chemical of Concern (COC) screening at EPA Region I's request. The approach accounts for the heterogeneity of the soil medium and eliminates the potential for the masking of high detections.

Maximum detections of chemical concentrations in soil were used to create isoconcentration contours. The detection limits for nondetections were not considered for creation of the isoconcentration contours. Kriging techniques were used to create these contours. A discussion of the kriging routine used for processing the analytical data is provided in Appendix B.

1.4.3.2 Groundwater

Groundwater analytical results were considered differently for screening and for preparation of isoconcentration drawings. The different approaches are used because they serve different purposes. For creation of an isoconcentration drawing, the arithmetic average of all rounds of data for each well was used to create the drawing. Detections and nondetections were considered in the average concentration at each well. One-half of the detection limit was used for nondetections for averaging. The average well concentrations were considered more representative of the long-term concentrations at a monitoring well than one single measurement. This approach is also consistent with the development of the Central Tendency Exposure concentrations for the Phase II RI HHRA.

The kriging routine discussed in Appendix B was also used for development of the groundwater isoconcentration drawings. If there were no detections at a monitoring location, one-half of the detection limit is presented on the drawing, but the value was not used for kriging. This approach allows one to see locations where there were no detections but high detection limits which potentially exceed criteria. These locations have high uncertainty in regards to the actual contaminant level which may be present there.

1.4.4 Decision-Making Process

The results of several investigations that have been conducted at the Lower Subase (Thames River and Zones 1 through 7) are summarized and evaluated within this report to determine the need for further action in the Thames River and/or each of the Lower Subase zones. The data evaluation steps used in this report are described above in Section 1.4. The results of these data evaluation steps are then summarized, using the portion of the decision-tree flow chart labeled as Existing Data Summary Report in Figure 1-3, to determine the direction of further actions.

The decision framework provided in Figure 1-3 is generally consistent with the RI/FS process under CERCLA. The flow chart shows the key steps required to complete investigation and remediation of the Lower Subase. The flow chart also shows the logical progression from this Existing Data Summary Report to the final remedial action. The 3 potential conclusions that can be reached in this report for each zone and the Thames River using the decision framework include: (1) an imminent threat to human health or the environment exists and a time-critical removal action is necessary, (2) no imminent threat exists, but data gaps exist and further investigation is required during the Lower Subase RI, and (3) no data gaps exist and therefore no further investigation is required to complete the Lower Subase RI Report. The decisions reached for each zone and the Thames River are provided in the following sections of the report.

1.5 REPORT ORGANIZATION

Section 1.0 consists of this introduction. Sections 2.0 through 9.0 discuss the Thames River and the 7 zones within the Lower Subase, respectively. Each section includes a site description, discussion of site investigations, site-specific physical characteristics, nature and extent of contamination, data evaluation, and recommendations. Section 10.0 of this report provides a summary of conclusions and recommendations for the Thames River and each zone.

TABLE 1-1

SUMMARY OF PREVIOUS AND ONGOING INVESTIGATIONS AT THE LOWER SUBASE AND RELATED DOCUMENTATION NSB-NLON, GROTON, CONNECTICUT

Report	Area Investigated	Associated NSB-NLON Site	Media Investigated	Number of Analytical Samples	Analytical parameters	Summary of Findings	Historical Recommendations	Analytical Data Included in the Database
NESO 1-026 "Oil Contamination of the Groundwater At Subase New London, CT" Naval Environmental Support Office February 11, 1979	Building 29 (Power Plant Oil Tanks, Area 1)	Lower Subase, Site 11	Soil Groundwater	38 16	Oil/Grease	Source of contamination at Site 11 is the heated day storage tanks and the reclamation tank behind the power plant	Inspection of tanks and storm sewers and repair as necessary	No
	Building 107/345 (Oil Storage Tanks, Area 2)	Lower Subase, Site 10				Site 10 poses no environmental threat	Monitor adjacent well regularly	
	Building 79 (Waste Oil Pit, Area 3)	Lower Subase, Site 13				Site 13 contaminated with oil originating from abandoned exfiltration well or basin	Install well system to remove oil from the soil	
Final Initial Assessment Study of Naval Submarine Base New London, CT NEESA 13-025 Envirodyne Engineers, Inc. March, 1983	Building 79 (Waste Oil Pit, Site 13)	Lower Subase, Site 13	Visual investigation and research of site history	None	NA(1)	Low potential for contributing contaminants to the environment because source of contamination has been filled with concrete and closed to all drainage	No further action	NA
	Building 107/345 (Oil Storage Tanks, Site 10)	Lower Subase, Site 10						
	Building 29 (Power Plant Oil Tanks, Site 11)	Lower Subase, Site 11						

TABLE 1-1

SUMMARY OF PREVIOUS AND ONGOING INVESTIGATIONS AT THE LOWER SUBASE AND RELATED DOCUMENTATION
NSB-NLON, GROTON, CONNECTICUT
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Report	Area Investigated	Associated NSB-NLON Site	Media Investigated	Number of Analytical Samples	Analytical parameters	Summary of Findings	Historical Recommendations	Analytical Data Included in the Database
Final Site Investigation Subsurface Oil Contamination - Lower Subase Naval Submarine Base - New London, Groton, Connecticut Wehran Engineering Corporation November 1987	Building 29 (Power Plant Oil Tanks, Area 1)	Lower Subase, Site 11	Soil Oil Groundwater	10 9 7	Oil/PCBs	Soluble constituents of oil are present throughout the study area: • Manholes and groundwater in the vicinity of Building 29 and 345 contaminated with #6 and #5 fuel oil	Additional study of oil distribution in Building 29 and of electrical conduits/ manholes along Corvina Road	Yes
	Building 107/345 (Oil Storage Tanks, Area 2)	Lower Subase, Site 10				• Manholes, soils, and groundwater in the vicinity of Building 79 contaminated with #6 fuel oil. Likely caused by old undocumented spills	Mopping sludge oil or excavation of oil-laden soils	
	Building 79 (Waste Oil Pit, Area 3)	Lower Subase, Site 13				• Utility trench from Building #85 to #78 contaminated with #6 fuel oil. Leak suspected in #6 fuel line within trench	Inspection of the #6 fuel oil line and cleaning of trench	
Hydrogeologic Investigation Underground Storage Tanks OT-4, OT-7, OT-8, OT-9, and 54-H U.S. Naval Submarine Base New London Groton, Connecticut Fuss & O'Neill, Inc. September 1989	Lower Subase, Tank 54-H	Lower Subase, Site 10	Groundwater	4	Volatile organics, Petroleum Scan (Coast Guard Method)	• Impacts have occurred as a result of petroleum handling at the site • No. 2 fuel oil found in groundwater monitoring wells • Volatile organics found in groundwater monitoring wells	With data available cannot determine if tanks or the associated piping and appurtenances are leaking	Yes

TABLE 1-1

SUMMARY OF PREVIOUS AND ONGOING INVESTIGATIONS AT THE LOWER SUBASE AND RELATED DOCUMENTATION
NSB-NLON, GROTON, CONNECTICUT
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Report	Area Investigated	Associated NSB-NLON Site	Media Investigated	Number of Analytical Samples	Analytical parameters	Summary of Findings	Historical Recommendations	Analytical Data Included in the Database
Multi-media Inspection, Naval Submarine Base-New London, Groton, Connecticut USEPA, Region I, August 8, 1991	Various locations for Clean Water Action inspection	DRMO, Site 6, Lower Subase	Sediment Surface Water Industrial/ Sanitary Discharge	3 1 3	Unknown Oil/Grease VOC, Metals	Certain accessible sampling locations and flow measurement devices will be necessary to comply with future self monitoring requirements	To be provided	No
	Various locations for TSCA inspection	Lower Subase	None	NA	NA	Various PCB spills and storage problems	Correct problems	NA
	Various locations for RCRA inspection	Torpedo shops, Site 7, Lower Subase	None	NA	NA	Various deficiencies in container storage area, inspections, documentation, waste manifests, contingency plan, and spill prevention, control, and counter measures	Correct problems	NA

TABLE 1-1

SUMMARY OF PREVIOUS AND ONGOING INVESTIGATIONS AT THE LOWER SUBASE AND RELATED DOCUMENTATION NSB-NLON, GROTON, CONNECTICUT

Report	Area Investigated	Associated NSB-NLON Site	Media Investigated	Number of Analytical Samples	Analytical parameters	Summary of Findings	Historical Recommendations	Analytical Data Included in the Database
Phase I Remedial Investigation Naval Submarine Base New London Atlantic Environmental Services, Inc. August 1992	Lower Subase, Site 13	Lower Subase, Site 13	Soil Groundwater	17 24	TCL VOC TAL Metals/CN[9] TCLP Metals TPH[3] Fluorescence TCL VOC TAL Metals/CN[9] TPH[3] Fluorescence pH	Nature and Extent of Contamination • Groundwater slightly exceeds drinking water standards • No oil releases along Thames River • Groundwater near Building 29 had high pH • Former onsite oil pit in Building 79 is source of subsurface soil contamination • Elevated lead levels detected in soil but not in groundwater • Subsurface free product detected in previous studies is no longer present • Low levels of Thallium detected in two monitoring wells Human Health Risk Assessment • Negligible risks calculated for several exposure pathways	Proceed to a Feasibility Study with additional data requirements	Yes
Action Memorandum for Building 31 Naval Submarine Base - New London Groton, Connecticut Halliburton NUS Corporation May, 1993	Building 31	Lower Subase, Site 17	Subsurface Soil Surface Soil Groundwater	101 28 9 5 4 20	pH, Lead TCLP Lead Metals Organics Lead Metals	• Soil at the site contaminated primarily with metals • Other contaminants include PAHs, phthalate esters, chlorinated phenolics and pesticides	Excavation, onsite solidification, and offsite solidification of soil contaminated with lead	Yes

TABLE 1-1

SUMMARY OF PREVIOUS AND ONGOING INVESTIGATIONS AT THE LOWER SUBASE AND RELATED DOCUMENTATION
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Report	Area Investigated	Associated NSB-NLON Site	Media Investigated	Number of Analytical Samples	Analytical parameters	Summary of Findings	Historical Recommendations	Analytical Data Included in the Database
Remedial Design for Building 31 Naval Submarine Base - New London Groton, Connecticut Halliburton NUS Corporation May, 1993	Building 31	Lower Subase, Site 17	Design Report			Design for removal actions documented.	Proceed to removal action	NA
Environmental Assessment for Pier 17 Replacement, Naval Submarine Base New London, Groton Connecticut, Prepared for: Department of the Navy, Commander-In-Chief, U.S. Atlantic Fleet, Norfolk, Virginia, Prepared by: Maguire Group Inc. September 1994	Pier 15 Pier 17	Thames River	Sediment Surface Water Fish and Benthic Species	24 3 5	Metals, PAHs Elutriate Test Toxicity test and Taxonomy study	• Higher concentrations of metals and PAHs in upper sediment strata than lower strata • Pesticides and PCBs detected in low levels in upper sediment strata • Mercury and nickel exceeded marine USEPA water quality criteria	The proposed action will have short-term effects on Thames River water quality, no effects on navigation, and minimal effects on fish and benthic species	Yes
Post-Removal Action Report for Building 31 Lead Remediation Naval Submarine Base - New London Groton, Connecticut Halliburton NUS Corporation January, 1995	Building 31	Lower Subase, Site 17	Excavated Soil Solidified Soil Wipe Samples	57 54 27	Total Lead TCLP Lead Total Lead	The final sample results showed that the walls of the excavation were no longer contaminated or the excavation reached the mean low tide elevation (maximum excavation depth). Albacore Road could not be completely excavated due to operational concerns of the Base. The sampled concrete surfaces were either not contaminated or were adequately decontaminated	No further excavation was required for most areas of site. Navy to defer continued remediation at Albacore Road	Yes

TABLE 1-1

SUMMARY OF PREVIOUS AND ONGOING INVESTIGATIONS AT THE LOWER SUBASE AND RELATED DOCUMENTATION
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Report	Area Investigated	Associated NSB-NLON Site	Media Investigated	Number of Analytical Samples	Analytical parameters	Summary of Findings	Historical Recommendations	Analytical Data Included in the Database
Final Site Inspection Report Pier 33 and Berth 16/Former Incinerator Installation Restoration Study Naval Submarine Base - New London Groton, Connecticut Atlantic Environmental Services, Inc. February, 1995	Pier 33 and Berth 16/ Former Incinerator	Portions of the Pier 33 Study Areas are located near Lower Subase Site 22 Berth 16 is not located in the formal boundaries of the Lower Subase site used in the RI, however, Berth 16 is proximate to Site 13	Soil Sediment Groundwater	43 4 9	TAL/TCL Parameters TPH TCLP Metals Dioxin	• VOCs concentrations detected in the soils are not considered to be significant • Elevated concentrations of TPH were detected • No significant concentrations of pesticides or PCBs were detected • Groundwater quality at the site is generally good and does not exceed ARARs except for lead in one well • Dioxin was detected in one location	Remedial investigation is recommended for both Pier 33 and Berth 16	Yes
Background Soil Investigation Naval Submarine Base - New London Groton, Connecticut Atlantic Environmental Services, Inc. April, 1995	Undisturbed Areas of NSB-NLON	None	Soil	18	TCL VOC TCL SVOC TCL Pest/PCB TAL Metals Cyanide Boron	• All site-derived background levels are within the ranges published by the USGS for background levels for the eastern United States • Based on the organic compounds detected, it is concluded that all samples locations are representative of native background conditions	Background levels of inorganics were established to screen site analytical data to identify areas where releases of pollutants may have occurred	Yes

TABLE 1-1

SUMMARY OF PREVIOUS AND ONGOING INVESTIGATIONS AT THE LOWER SUBASE AND RELATED DOCUMENTATION
NSB-NLON, GROTON, CONNECTICUT
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Report	Area Investigated	Associated NSB-NLON Site	Media Investigated	Number of Analytical Samples	Analytical parameters	Summary of Findings	Historical Recommendations	Analytical Data Included in the Database
Site Characterization Report for OT-10, Building 325, and Building 89 Naval Submarine Base - New London Groton, Connecticut Halliburton NUS Corporation April 1995	Building 89, Tank Z01	Site is not located in the formal boundaries of the Lower Subase site used in the RI; however, Building 89 is proximate to the Lower Subase site	Soil	3 1	BTEX, TPH Lead, TPH, Volatile Aromatics	Analytical results indicate soils in the vicinity of tank Z01 have detected contaminants below state cleanup levels Groundwater has been impacted by a petroleum related source	Due to the possibility of the groundwater contamination originating from another source, and because the Lower Subase is being investigated as part of the RI, no further action is recommended	Yes
Preliminary Assessment, Draft Final PA-13-025A-ENV Supplement to Initial Assessment Study NEESA 13-025, Naval Facilities Engineering Service Center, Naval Submarine Base New London Groton, Connecticut April, 1995	Transformer at Building 157, Vault 31	Lower Subase, Zone 7	Visual Investigation and Research of Site History			Oil on concrete pad surface, potential for PCBs	No further action under the cleanup recommended under the spill cont. plan	NA
	Hazardous Waste Accumulation Areas	Various				No evidence of releases found	No further action	
Removal Site Evaluation for Quay Wall for Naval Submarine Base New London Halliburton NUS Corporation May 1995	Quay Wall	Lower Subase	Soil	5	BTEX TCLP Metals TCL VOC TCLP VOC TCL SVOC Total PCB TAL Metals Cyanide TPH	• Lead and arsenic detected above CTDEP regulatory standard • VOC, SVOC, and pesticides below regulatory CTDEP standards • No PCBs detected • TPH detected in all soils but not in exceedance of CTDEP standards	No further removal actions are recommended but further study needed	Yes

TABLE 1-1

SUMMARY OF PREVIOUS AND ONGOING INVESTIGATIONS AT THE LOWER SUBASE AND RELATED DOCUMENTATION
NSB-NLON, GROTON, CONNECTICUT
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Report	Area Investigated	Associated NSB-NLON Site	Media Investigated	Number of Analytical Samples	Analytical parameters	Summary of Findings	Historical Recommendations	Analytical Data Included in the Database
Site Investigation Report for Tank Farm Investigation Naval Submarine Base - New London Groton, Connecticut Brown & Root Environmental March, 1996	Tank Farm	The Investigation of the pipelines from the Tank Farm include a portion of the Lower Subase Site	Soil	29	TPH	Petroleum hydrocarbons found in soil along the fuel pipeline in the Lower Subase Area.	Further assess pipelines under the upcoming Lower Subase RI.	Yes
Phase II Remedial Investigation for Naval Submarine Base - New London Groton, Connecticut Brown & Root Environmental March, 1996	Lower Subase	Lower Subase	Soil Groundwater	22 23 2 52 2	Lead TPH, TCLP Metals TCLP VOC, SVOC TCLP Herb/Pest TCL VOC TCL SVOC TAL Metals TAL Metals (dis.) TPH Eng. Parameters	• It appears that the lower Subase may have impacted the Thames River due to elevated contamination in the sediment adjacent to the Lower Subase • Elevated human health risks for Construction Worker in Zones 1 and 2 (non-carcinogenic) • It is unlikely that the Lower Subase represents a risk to ecological receptors	Further characterization of the Lower Subase should be performed.	Yes

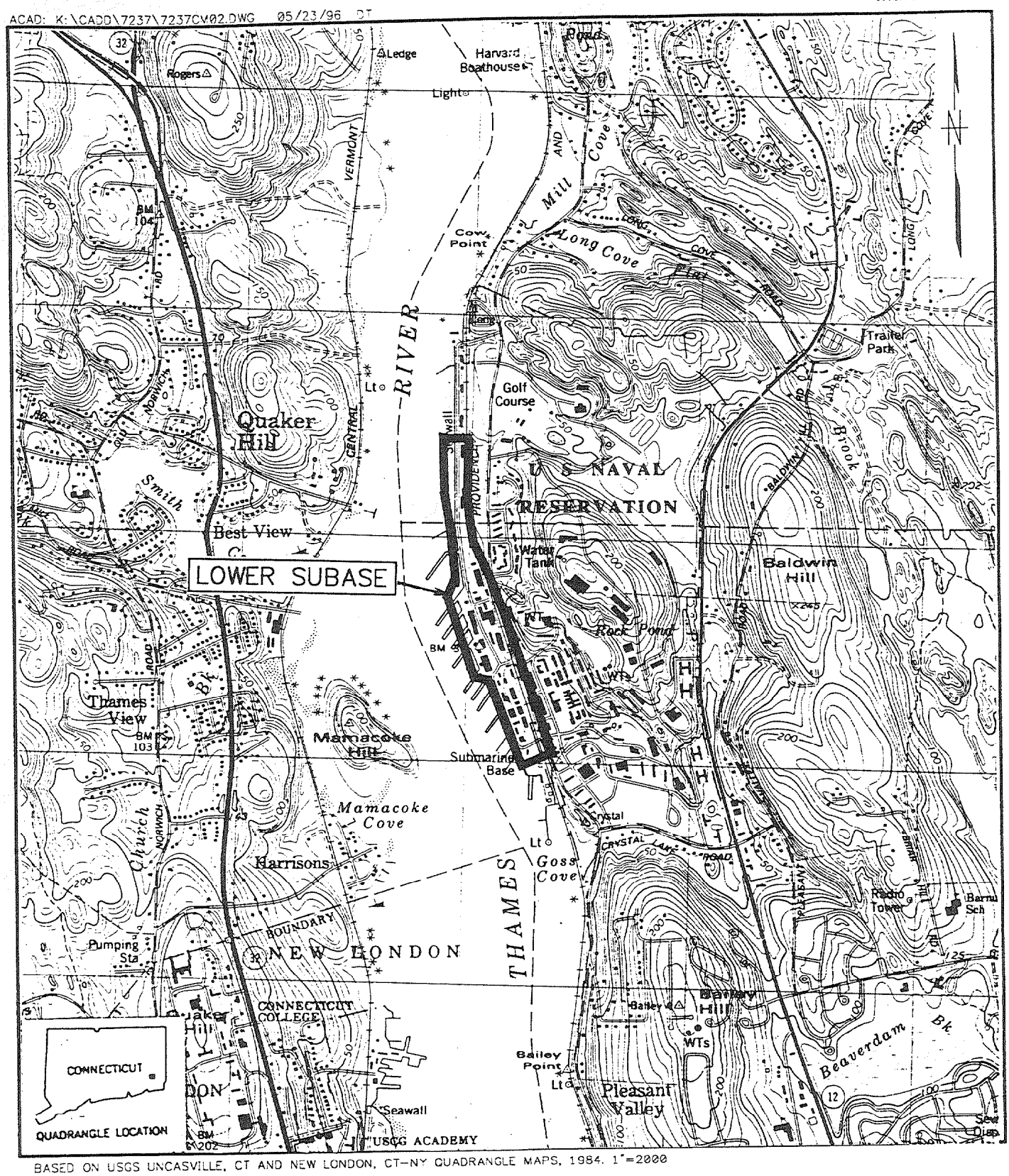
TABLE 1-1

SUMMARY OF PREVIOUS AND ONGOING INVESTIGATIONS AT THE LOWER SUBASE AND RELATED DOCUMENTATION
NSB-NLON, GROTON, CONNECTICUT
PAGE 9 OF 9

Report	Area Investigated	Associated NSB-NLON Site	Media Investigated	Number of Analytical Samples	Analytical parameters	Summary of Findings	Historical Recommendations	Analytical Data Included in the Database
Phase II Remedial Investigation (Continued)	Thames River	Thames River	Sediment Surface Water Biota	2 18 16 15 6 11 25	TCL VOC TCL SVOC TCL Pest TCL PCBs TAL Metals Taxonomy Engr. Char. TCL VOC TCL SVOC TCL Pest TCL PCBs TAL Metals TAL Metals (dis.) TCL VOC TCL SVOC TCL Pest TCL PCBs TAL Metals	• Nature and extent of contamination in surface water and sediment of Thames River is not indicative of releases from NSB-NLON except possibly the Lower Subase • Carcinogenic risks associated with ingestion of finfish/shellfish • Thames River presents minimal risks to potential ecological receptors	Perform additional characterization of the Thames River in the vicinity of the Lower Subase.	Yes

1 NA: Not Applicable
2 VOC: Volatile organic compounds
BNA: base/neutral acids
Pest/PCB: pesticides and polychlorobiphenols
3 TCLP: Toxicity Characteristic Leaching Procedure
TPH: Total Petroleum Hydrocarbons
4 TSS: Total suspended solids
5 SVOC: Semivolatile organic compounds
6 TCE: Trichloroethylene
7 1,2-DCA: 1,2-dichloroethene
8 TBC: To be considered
9 TAL: Target Analyte List
CN: Cyanide

ACAD: K:\CADD\7237\7237CV02.DWG 05/23/96 DT



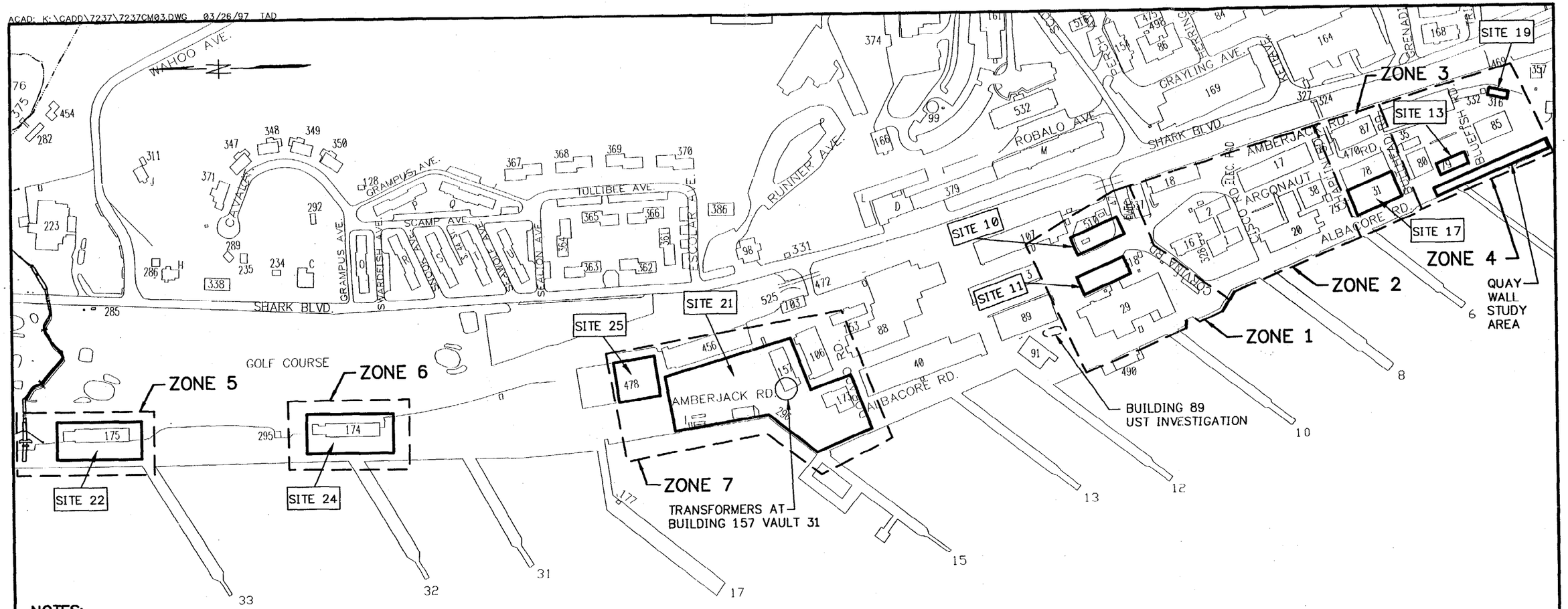
BASED ON USGS UNCASVILLE, CT AND NEW LONDON, CT-NY QUADRANGLE MAPS, 1984. 1"=2000

FIGURE 1-1

SITE LOCATION MAP
NSB-NLON, GROTON, CONNECTICUT

0 2000 4000
SCALE IN FEET

Brown & Root Environmental



NOTES:

1. SITE AND STUDY AREA LOCATIONS WERE TAKEN FROM DRAWING 1, DRAFT FINAL PHASE II REMEDIAL INVESTIGATION REPORT, BROWN AND ROOT ENVIRONMENTAL, MARCH 1996.
2. SITE AND STUDY AREA BOUNDRIES ARE APPROXIMATE.
   - SITE 10 – FUEL STORAGE TANKS AND TANK 54–H
   - SITE 11 – POWER PLANT OIL TANKS
   - SITE 13 – BUILDING 79 WASTE OIL PIT
   - SITE 17 – HAZARDOUS MATERIALS/SOLVENT STORAGE AREA (BUILDING 31)
   - SITE 19 – SOLVENT STORAGE AREA (BUILDING 316)
   - SITE 21 – BERTH 16
   - SITE 22 – PIER 33
   - SITE 24 – CENTRAL PAINT ACCUMULATION AREA (BUILDING 174)
   - SITE 25 – CLASSIFIED MATERIALS INCINERATOR

LEGEND:

— — — LOWER SUBASE REMEDIAL INVESTIGATION ZONE BOUNDARY

——— LOWER SUBASE REMEDIAL INVESTIGATION SITE OR STUDY AREA BOUNDARY

FIGURE 1–2

LOWER SUBASE
ZONE AND SITE LOCATION MAP
NSB–NLON, GROTON, CONNECTICUT

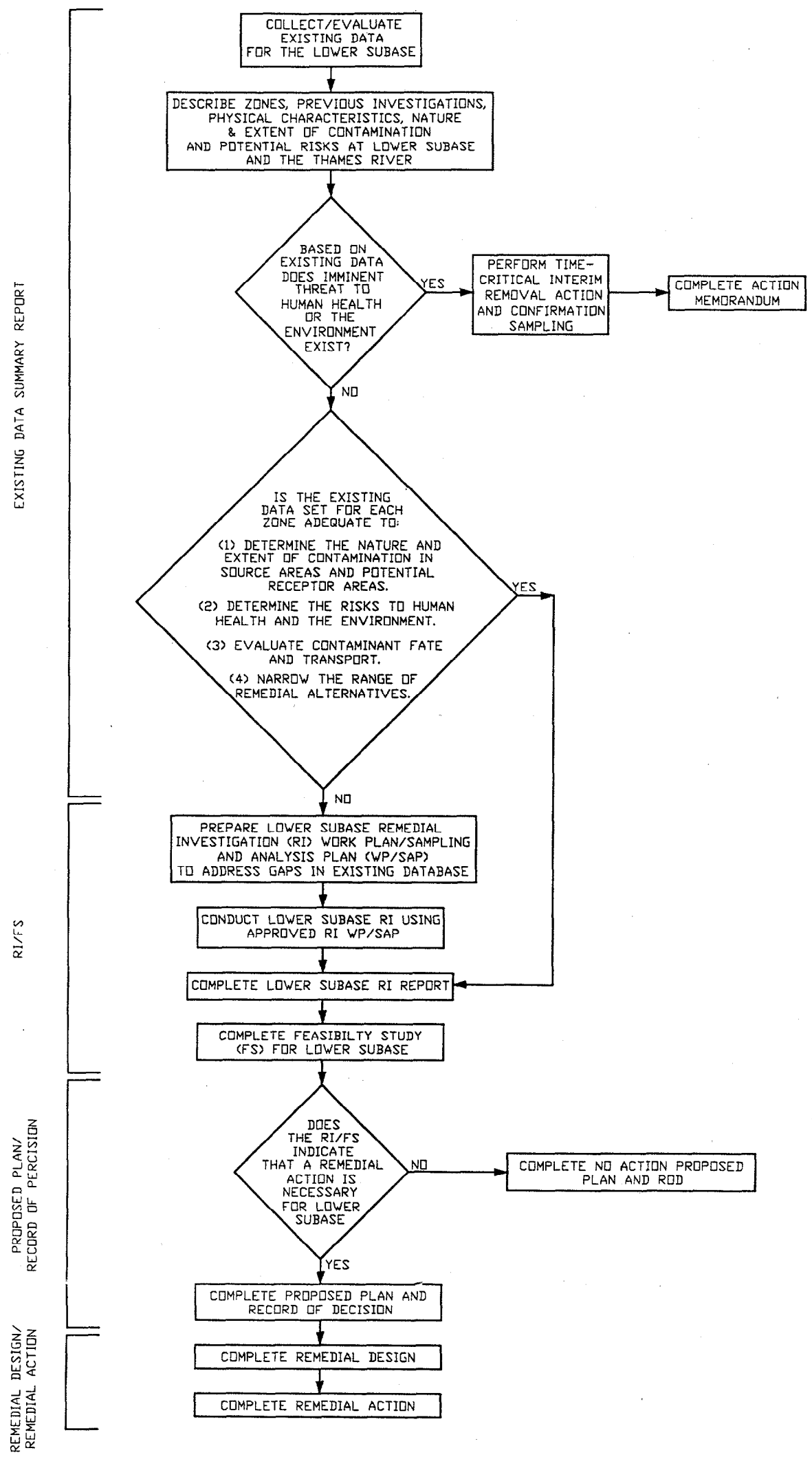
0 300 600
SCALE IN FEET

059606/P

Brown & Root Environmental

01097012

CTO 0260



DECISION TREE FOR
SCOPING LOWER SUBASE RI/FS
NSB-NLON, GROTON, CONNECTICUT

FIGURE 1-3

Brown & Root Environmental

2.0 THAMES RIVER

2.1 SITE DESCRIPTION

The Thames River, which forms the western boundary of NSB-NLON, is a tidal estuary formed at the confluence of the Shetucket and Yantic Rivers in Norwich, Connecticut (see Figure 1-1). The river flows south approximately 16 miles to Long Island Sound. NSB-NLON and the town of Groton are on the east bank of the river approximately 6 miles north of Long Island Sound. The City of New London is located on the west bank of the river. Land development along the southern portion of the river is primarily industrial. Chemical companies, oil terminals, power plants, and wastewater treatment plants occupy both banks of the river.

In general, no evidence of severe impacts to the Thames River have been reported near the Lower Subase. On a few occasions, petroleum compounds have been visible on the water surface along the shoreline of the Lower Subase. The compounds were visible only near the southern end of the Lower Subase (i.e., Quay Wall Investigation Area). Appropriate corrective measures were implemented each time petroleum compounds were sited to minimize the magnitude of the release and the migration of the compounds. Based on the nature and extent of contamination evaluation, the focused human health risk assessment, and the conservative ecological risk assessment performed in the Phase II RI, it was shown that the Thames River has potentially been impacted by activities and contamination at the Lower Subase.

2.2 SITE INVESTIGATIONS

Investigation of the Thames River was part of the following investigations:

- Environmental Assessment for Pier 17 Replacement (Maguire, 1994)
- Final Environmental Impact Statement for the Seawolf Class Submarine Homeporting on the East Coast of the United States (Maguire, 1995).
- Phase II Remedial Investigation (B&R Environmental, 1996a)
- Phase II RI Supplemental Ecological Investigation (B&R Environmental, 1996a)
- After Dredge Surveys for Pier 17 Replacement and Seawolf Homeporting Projects (Gahagen & Bryant, 1996)

2.2.1 Environmental Assessment for Pier 17 Replacement

In September 1994, Maguire Group, Inc. prepared an Environmental Assessment (EA) for the proposed replacement of Pier 17 and dredging alongside Pier 15 and Pier 17. The EA was conducted to determine whether the proposed pier replacement would affect the offshore environment. As part of the assessment, surface water, sediment, and fish and benthic species sampling at and in the vicinity of Piers 15 and 17 was conducted. The sediment sampling program was performed as part of the assessment to characterize the physical and chemical nature of sediments to be dredged around Piers 15 and 17. Sediment samples were collected from the proposed dredging area and analyzed for total organic carbon (TOC), metals, Semi-Volatile Organic Compounds (SVOCs), pesticides, and Polychlorinated Biphenyls (PCBs). Sediment sampling locations are discussed in more detail in Section 2.2.5. Three samples were collected at each location, one from the upper strata (0 to 3 feet) and two from the lower strata (approximately 3 to 6 feet and 6 to 10 feet). Benthic toxicity tests were conducted on composite samples from the top 3 feet of material from each pier. Three sediment grab samples were also collected in the vicinity of Pier 15 and 17 to provide a general description of the benthic communities associated with the sediments of the two piers and to provide an assessment of potential impacts to fauna in the area. Elutriate tests were conducted on three grab samples (one north and south of Pier 17 and one south of Pier 15) to determine whether chemical constituents in the sediment were likely to be released to the water column during dredging and/or disposal operations. The more highly contaminated sediments (in the upper strata) were used for the test.

Upper sediments (0 to 3 feet) contained higher concentrations of metals and Polynuclear Aromatic Hydrocarbons (PAHs) than lower sediment layers. Pesticides and PCBs were also detected at low levels in the upper sediment layer. Maximum concentrations were generally detected in the sample collected on the southern side of Pier 17. However, results of a 10-day benthic toxicity test on *Ampelisca abdita* showed that amphipod mortality using site-specific sediment was not statistically greater than mortality using reference sediment (i.e., site-specific results did not exceed reference test results by more than 20 percent).

Samples collected adjacent to Pier 17 to assess benthic communities contained a relatively low number of species and individuals. The EA Report suggested that the results are indicative of an area that was highly disturbed and/or is subjected to stressful environmental conditions. The sample collected from Pier 15 contained a high number of species and individuals. The fauna collected from Pier 15 was more characteristic of organisms (both numerically and in terms of species richness) associated with many area in the Thames River estuary.

Based on the results of the elutriate tests, release of contaminants to surface water during dredging was not likely to result in unacceptable concentrations in surface water.

The report concluded, based on the results of sampling in the vicinity of Piers 15 and 17, that the proposed action (replacement of Pier 17 and dredging at Piers 15 and 17) would have short-term effects on Thames River water quality and minimal effects on fish and benthic species. The Navy has completed the dredging activities associated with this replacement project.

2.2.2 Final Environmental Impact Statement for the Seawolf Class Submarine Homeporting on the East Coast of the United States

In 1991, a Draft Environmental Impact Statement (DEIS) was prepared by Maguire Group, Inc. for proposed dredging of the Thames River for transit of the lead ship of the SEAWOLF class submarine from its manufacturer, General Dynamics' Electric Boat Division, to Pier 33 at NSB-NLON for operational testing, known as sea trials. Approximately 2.7 million cubic yards of sediment were proposed to be dredged from the main river channel and from Piers 32 and 33. At that time, no decision had been made as to the homeport location for the SEAWOLF submarines. In 1994, President Clinton announced that the preferred homeporting alternative for the SEAWOLF submarines was NSB-NLON. This decision modified the proposed dredging action to the degree that the NEPA process had to be re-initiated.

A revised DEIS was prepared by Maguire Group, Inc. and was issued in February of 1995. The Final EIS (FEIS) was subsequently issued in July of 1995. The preferred action in the FEIS was to berth the SEAWOLF submarines at Piers 8 and 10. By changing the berthing location for the submarines from Piers 32 and 33 to Piers 8 and 10 and making changes to the required dredging depths, the amount of dredge spoils that required disposal was reduced from 2.7 million cubic yards to 1.1 million cubic yards. The final proposed dredged depths were -39 feet MLW in the navigation channel of the Thames River and -42 feet MLW in the berths. The dredged spoils are to be disposed of offbase at the New London Disposal Site (NLDS).

Sediment sampling programs were conducted in 1990, 1992, 1994, and 1995 in support of the proposed dredging projects. The sediment sampling locations for these four programs are discussed in more detail in Section 2.2.5. The purpose of the sampling programs was to characterize existing biological, physical, and chemical conditions of the sediment to be dredged from the Thames River. The analytical results for the sediment samples showed that the sediments to be dredged are very similar to sediments previously dredged from the Thames River and disposed of at the NLDS. The analytical results also showed that sediments from the channel tended to be less contaminated than sediments collected near the pier areas.

Benthic toxicity results on project sediments indicate that sediments to be dredged are not toxic to bottom-dwelling organisms. Bioaccumulation testing has revealed that channel sediments near the Subase piers could cause accumulation of organic contaminants in the tissues of benthic organism. Also, sediments at Piers 8 and 10 contain comparable contaminant levels and would likely cause similar bioaccumulation effects. These sediments would be capped at the disposal site with clean sediments from the channel.

The results of sampling conducted in the vicinity of the Lower Subase are discussed in the nature and extent of sediments in Section 2.4.2. The Navy has completed the dredging activities associated with this project.

2.2.3 Phase II Remedial Investigation

The field investigation conducted in the Thames River by B&R Environmental for the Phase II RI included surface water, sediment, and biota sampling. The investigation included portions of the Thames River upgradient of NSB-NLON; in the vicinity of the Defense Reutilization and Marketing Office (DRMO) which is located north of the Lower Subase; the Lower Subase; Goss Cove which is located south of the Lower Subase; and downgradient of NSB-NLON. Sediment samples were collected from portions of the Thames River at a point near the shoreline and at a point near the centerline of the river for each portion investigated. At the portions bounding NSB-NLON (i.e., DRMO, Lower Subase, and Goss Cove), additional samples were taken between the near shore and midstream stations. A quantitative benthic study was also performed using these sediments. The goal of the study was to characterize the structure of macroinvertebrate community. Sediment sampling stations are depicted on Figure 2-1.

Surface water samples were collected from 7 stations in the Thames River, covering the river from upstream of NSB-NLON to downstream. In between, samples were collected along the shoreline in the vicinity of the DRMO, from the vicinity of the Lower Subase, and from the area near Goss Cove. Except for one station, samples were collected from both the surface (S) and bottom (B) of the river. Surface water sampling stations are depicted on Figure 2-2.

Several species of native shellfish were collected from the Thames River for analysis. Oysters, blue mussels, and hardshell clams were collected to determine the concentrations of chemicals present in the tissues of these organisms. The native shellfish sampling locations are shown on Figure 2-3. In addition, a caged mussel study was performed, in which ribbed mussels were purchased and deployed in replicate at five different stations (with the exception of CMU3 for which only one set was deployed). Two sets of undeployed ribbed mussels were sent for chemical analysis as a control set. After 28 days the mussels

were retrieved, samples were collected and sent to the analytical laboratory for homogenization and analysis. The concentrations of chemicals detected in the deployed mussels were compared to the chemical concentrations present in the unexposed (control) samples. These comparisons provided an indication of the extent to which chemicals present in the Thames River were biologically available and could be concentrated in the tissues of these and other species of aquatic organisms. Locations of native and deployed shellfish samples are depicted on Figure 2-3.

The data and results of the Phase II RI are discussed as part of the nature and extent and data evaluation discussions in Sections 2.4 and 2.5, respectively.

2.2.4 Phase II RI Supplemental Ecological Investigation

The data collected during the initial sampling of the Phase II RI determined that several metals and organic compounds (i.e., PAHs) were present at concentrations in excess of benchmark values protective of aquatic biota, indicating that aquatic biota inhabiting this section of the river could be adversely impacted. The benchmark values used for screening ecological data from the Thames River are summarized in Section 3.4 Ecological Risk Assessment Procedures and Section 17.7 Ecological Risk Assessment of the draft final Phase II RI (B&R Environmental, 1996a). Generally, the benchmark values used were media- and receptor-specific chronic values. In some cases, chronic benchmark values were developed using acute benchmark values and a conversion factor.

In response to these results, additional sediment samples were collected from the Thames River in 1995. The intent of the Phase II RI Supplemental Ecological Investigation was to focus more closely on the potential impacts that these chemicals might have on aquatic biota and to determine whether the chemicals were biologically available in concentrations that could represent an actual risk to the aquatic community.

Stations sampled during the Phase II RI Supplemental Ecological Investigation were located closer to NSB-NLON because of concerns about contamination detected in the original Phase II RI upstream and downstream reference stations. Three of the ten stations sampled in the supplemental investigation were the same as those sampled in the original Phase II RI. Sediment sample locations are shown in Figure 2-1.

The data and results of the Phase II RI Supplemental Ecological Investigation are discussed as part of the nature and extent of contamination and data evaluation discussions in Sections 2.4 and 2.5, respectively.

2.2.5 "After Dredge" Surveys for Pier 17 Replacement and SEAWOLF Homeporting Projects

Dredging of the navigation channel of the Thames River and the appropriate berths at NSB-NLON for the Pier 17 Replacement and SEAWOLF Homeporting projects was conducted between November 1995 to February 1996. Hydrographic post-dredging surveys were completed by Gahagan & Bryant Associates, Inc., during the same time period as discrete portions of the dredging activities were completed. Survey data were obtained with a Trimble 4000 Differential Global Positioning System, Polarfix Range-Azimuth System, Deso 20 Fathometer and the survey vessel "SEA SCAN."

Figures 2-4 and 2-5 show the limits of dredging as determined by the "After Dredge" surveys. A complete set of sampling locations and limits of dredging for the Thames River is shown on Figure 2-4. The reach of the Thames River shown on the figure corresponds to the reach sampled for the Phase II RI. Additional sampling was conducted as part of the SEAWOLF Homeporting project south of the reach. However, these locations are not relevant to this project and are not shown on Figure 2-4. The sampling locations and the limits of dredging in the vicinity of Piers 15 and 17 are shown in more detail on Figure 2-5.

Only analytical data for surface sediment composite samples (C1 through C6), collected as part of Pier 17 Replacement project, have been included in the database for this project. Any data that fell within the limits of dredging have been marked as "excavated" in the database. Additional data from the two projects will be incorporated into the database and evaluated as part of the subsequent Lower Subase RI.

2.3 PHYSICAL CHARACTERISTICS

This section presents a summary of physical characteristics for the Thames River based on information provided in the Phase II RI Report (B&R Environmental, 1996a). Surrounding topography and surface features, surface water, soils, geology, and hydrogeology are discussed in the subsections that follow.

2.3.1 Surrounding Topography and Surface Features

NSB-NLON borders the Thames River for approximately 1.5 miles. The NSB-NLON facility is highly developed along the Thames River in the vicinity of the Lower Subase. There are 15 piers at NSB-NLON. The ground elevation along these piers and at the facility boundary is less than 10 feet. The 100-year flood level for NSB-NLON is 11.2 feet above msl. This elevation is higher than most of the western portion of NSB-NLON; therefore, this area is susceptible to flooding.

Adjacent to the northern boundary of NSB-NLON, the land is relatively undeveloped with scattered residences. Further north, the land is residential, commercial, recreational, and open-space. To the immediate south of NSB-NLON along the Thames River, the land is primarily residential with open spaces. Along the Thames River, tributary streams and wetlands are prevalent. Other high profile industries along the Thames River include General Dynamics' Electric Boat Division (south of NSB-NLON on east shore), Pfizer Chemical Company (south of NSB-NLON on east shore), and Dow Chemical Company (north of NSB-NLON on east shore).

2.3.2 Surface Water Features

The Thames River and its tributaries drain approximately 1,500 square miles of eastern Connecticut, western Rhode Island, and south central Massachusetts. The Thames River originates at the confluence of the Shetucket and Yantic Rivers in Norwich, Connecticut, and discharges into Long Island Sound approximately 6 miles south of NSB-NLON and the town of Groton. The total length of the Thames River is 16 miles. The Yantic River has a drainage basin of 88 square miles. Average, minimum, and maximum flows in the Yantic River have been reported at 170, 3.5, and 13,400 cubic feet per second (ft^3/s), respectively. The Shetucket River, which has a 1,390-square-mile drainage basin, has reported average, minimum, and maximum flows of 2,000, 14, and 52,300 ft^3/s, respectively. Other sources of inflow to the Thames River are reportedly minor in comparison to these flows and to the volume of tidal exchange. Other sources of inflow include wastewater treatment facilities in Norwich, Montville, New London, the City of Groton, and the Town of Groton, combined sewer overflows in Norwich, industrial discharges, and several small streams. Both surface water runoff and groundwater from NSB-NLON discharge to the Thames River.

Widths of the river vary from 1.5 miles at New London Harbor to approximately 500 feet at Norwich Harbor. A dredged channel runs north to south in the river. Depths in the dredged channel are approximately 40 feet below msl. At NSB-NLON, the width of the river ranges from approximately 1,300 to 3,000 feet, whereas the width of the dredged channel ranges from 600 to 900 feet (see Figure 2-4). Outside of the channel (near the west shore of the river), river depths are relatively shallow (2 to 10 feet). There are shallow coves upstream and downstream of NSB-NLON that empty into the river. Most of the coves are at least partially cut off from the river by a rail bed.

The Thames River is a salt wedge estuary that is highly stratified with fresher water on the surface and denser saline water on the bottom. At the NSB-NLON, the measured tidal range is about 2.2 feet. Estimated freshwater flushing time is 0.5 to 2 days from Norwich to Long Island Sound. In comparison, estimated flushing time for bottom water is greater than 19 days. The average freshwater flow discharging

to the Sound from the Thames River has been estimated at 222 million cubic feet per day. However, streamflow in the river is small in comparison to intertidal volume and exchange. Very little vertical mixing occurs in the Thames River. The north-south alignment, steep banks, and narrow channel do not permit much wind-induced mixing. Therefore, the freshwater outflows reach Long Island Sound in a well-defined surface layer.

Studies of the Thames River indicate that net flow in the upper layer of water is downstream at velocities of 0.06 to 0.3 feet per second. The current velocities in this area vary according to tide and freshwater flow from upstream. Velocities of up to 1.6 feet per second have been measured in the river during periods of storm runoff. The lower layer of water has a net up-estuary flow at velocities of 0.03 to 0.2 feet per second. The velocity of the lower layer is dominated by the tide and is reportedly relatively insensitive to stream flow.

As stated above, the Thames River estuary is stratified with relatively fresh water on the surface and saline water on the bottom. Historical records show that the salinity in the water at the bottom of the river is relatively constant at 30 parts per thousand (ppt). Salinity measurements taken in the Thames River adjacent to NSB-NLON in May of 1995 for the Supplemental Ecological Investigation (B&R Environmental, 1996a) confirmed the constant 30 ppt salinity level. Measurements taken near the bottom in the channel of the Thames River ranged from 29.4 to 30 ppt. The salinity of the water at the surface of the river is more variable, with the salinity ranging from 28 ppt at the mouth of the river to 2 ppt at the upstream end of the estuary at Norwich.

Surface water classification and water supply are discussed in Section 1.3.2.

2.3.3 Soil Characteristics

As discussed in Section 1.3.1, soil in the vicinity of the Lower Subase is either Udorthents-Urban Land or Urban Land. In addition, most of the land at NSB-NLON along the Thames River is also mapped as either Udorthents-Urban Land or Urban Land. Along the Thames River, Udorthents-Urban Land is identified in the northern portion of NSB-NLON, while Urban Land occurs in the southern portion of NSB-NLON. A small area of Hinkley loam has been identified in the vicinity of the northern most portion of the facility along the river. This soil is found on stream terraces and outwash plains and consists of a dark, gravely sand loam. Native materials along the Thames River were most likely of this type.

2.3.4 Geology and Hydrogeology

Geology and hydrogeology in the vicinity of the Lower Subase are discussed in Sections 1.3.3 and 1.3.4, respectively. Groundwater along the shore flows west from NSB-NLON, discharges into the Thames River and is tidally influenced. During low tide, groundwater flows toward the Thames River. During high tide, the hydraulic gradient along the Thames River reverses and estuarine water intrudes into NSB-NLON. The reversal in the hydraulic gradient occurs only near the river, generally within 300 feet of the Thames River. Groundwater flow in upgradient areas is not significantly altered.

2.3.5 Ecological Habitat

Various surveys have been conducted to identify the ecological habitat of the Thames River. Results of surveys on plankton, marine algae, benthic invertebrates, shellfish, finfish and birds are summarized below.

Little information exists on the phytoplankton community present for the Thames River. Results of surveys suggest that while densities are generally low, greater *chlorophyll a* concentrations were present in the upper surface water than in the river's deeper, more saline waters. Members of the class Bacillariophyceae tend to dominate samples collected from the river. Zooplankton samples are dominated by adult copepods, particularly *Acartia hudsonica* and *A. tonsa*. Other groups found in zooplankton samples collected from this portion of the river include barnacle and crab larval forms. Studies of ichthyoplankton conducted during the summer of 1988 reported the presence of bay anchovy, winter flounder eggs and larvae, tautog eggs, and rainbow smelt larvae.

Few species of macroalgae have been collected from this portion of the river and populations are generally low and sporadic in distribution. Results of a survey conducted in 1983 reported that the algal populations present in the nonindustrialized portions of the river were typical of those associated with northeastern rocky coastlines. Populations found in industrialized sections of the river tend to be sparse and dominated by relatively few species. The depth and lack of appropriate substrate in dredged portions of the river preclude algal growth. In fact, the general lack of suitable substrate accounts for the generally low algal species diversity and density throughout this section of the Thames River.

Results of macroninvertebrate surveys conducted in this portion of the Thames River have determined that the communities differ moving from north to south and between the channelized and nonchannelized portions of the river. The benthic community south of the I-95 bridge (2 miles south of NSB-NLON) is typical of that found in Long Island Sound. As with most estuarine rivers, benthic community abundance

and species richness increases toward the more saline waters of Long Island Sound. The benthic macroinvertebrate community is dominated by several taxonomic groups, including several species of bivalves and polychaetes.

Although shellfish beds are found throughout this portion of the river, recreational shellfishing has been closed due to fecal bacterial contamination. Shellfish found in these beds include hardshell clams and oysters. In addition to shellfish, both lobsters and blue crabs are harvested from the river.

The Thames River contains a relatively diverse fish community and includes year-round residents such as winter flounder, tomcod, and mummichogs as well as coastal (e.g., menhaden and bluefish) and seasonal (tautog and whiting) migrants. Anadromous species associated with the river include the American shad, alewife, blueback herring, and rainbow smelt. Stripped bass also overwinter in the estuarine portions of the river and form the basis of an important local recreational fishery.

Birds observed frequently along the Thames River in the vicinity of the NSB-NLON include herring gulls, cormorants, great-backed gulls, mute swans, and several species of ducks. Many duck species, in particular mallards, are observed on the river and overwinter in the coves around Mamacoke Island, opposite the river from NSB-NLON. During summer, 10 to 12 mallards and black ducks are normally present in this area; however, during the winter, up to 1,000 ducks have been observed. These include large numbers of canvasback, hooded merganser, mallard, black, gadwall, and redhead ducks. Greater scaup and common goldeneye ducks are occasionally observed in the area.

2.4 NATURE AND EXTENT OF CONTAMINATION

This section presents a summary of the nature and extent of contamination observed in surface water, sediment, and biota samples collected from the Thames River. In addition, the results of the medium-specific COPC screening are also summarized in this section.

2.4.1 Surface Water

Tables 2-1 through 2-4 summarize the analytical results of the surface water samples collected from the Thames River as well as the COPC screening results. The analytical data are grouped using sample depth and filtered status and are not segregated into zones. Analytical data for deep, filtered surface water samples are summarized in Table 2-1, while data for deep, unfiltered surface water samples are shown in Table 2-2. Tables 2-3 and 2-4 provide a summary of analytical results for shallow filtered and

unfiltered surface water samples, respectively. Only one sample station (T3SW2S/B) is located in the vicinity of the Lower Subase.

Organic contaminants were detected infrequently in the surface water of the Thames River. Trichloroethene (TCE) and butyl benzyl phthalate were detected in the shallow surface water at the upstream sampling station 6SW1S. The concentration of TCE at 6SW1S (3 µg/L) exceeded all of the available human health criteria. The concentration of butyl benzyl phthalate detected at the same location did not exceed any of the screening criteria. Di-n-butylphthalate (0.6 µg/L) was detected in the shallow surface water sample T3SW1S (near DRMO), and endrin aldehyde (0.14 µg/L) was detected in the deep surface water sample T3SW2B (Lower Subase). The concentration of endrin aldehyde at T3SW2B exceeded only the ecological benchmark value, while the concentration of di-n-butylphthalate did not exceed any of the available criteria..

Inorganics were detected frequently in the surface water samples at fairly consistent concentrations. Metals identified as COPCs in filtered, bottom surface water include boron, chromium, manganese, and potassium. For unfiltered bottom surface water, boron, iron, manganese, mercury, potassium, and vanadium were identified as COPCs. The analytical results for shallow surface water samples showed similar exceedances. COPCs for filtered, shallow surface water samples include aluminum, barium, boron, chromium, manganese and vanadium. For unfiltered samples, aluminum, barium, boron, cadmium, iron, lead, manganese, mercury and vanadium were identified as COPCs.

These results appear to indicate that the surface water in the Thames River is not being noticeably impacted by organic chemicals (i.e., few and infrequently detected), but is possibly being impacted by inorganics (i.e., numerous exceedances and frequent detections).

In the vicinity of the Lower Subase, only unfiltered shallow and bottom surface water samples were collected and analyzed at T3SW2S/B. The inorganic chemicals detected in the shallow sample in excess of criteria are aluminum, boron, iron, manganese, and mercury. In the bottom sample boron, iron, manganese, mercury, and potassium concentration exceeded criteria. The only criterion exceeded by the potassium concentration was the surface water background concentration.

2.4.2 Sediment

Tables 2-5 through 2-14 summarize analytical results for sediment samples collected in the Thames River as well as the COPC screening results by zone. The Thames River zones are depicted on Figure 2-1. The Thames River is zoned only for evaluation of the sediment data. The following sections are

segregated based on contaminant categories. Under each category, both a general summary of the nature and extent of contamination and a zone-specific COPC discussion are provided. Analytical results for sediment samples taken from locations that were subsequently dredged are not used for COPC screening.

Volatile Organic Compounds

Acetone (ranging from 0.018 mg/kg to 0.64 mg/kg) was detected in 10 of 11 samples analyzed for VOCs. These included samples from each location, with the lowest concentrations in the DRMO and upstream locations and the highest concentrations detected in the areas of Berth 16 and the Lower Subase. Although 2-butanone was not detected in samples collected from the upstream and DRMO areas, it was detected at concentrations ranging from 0.020 mg/kg to 0.19 mg/kg in all the remaining samples. The highest concentrations were detected in samples collected in the areas near Berth 16 and the Lower Subase. Carbon disulfide (0.007 mg/kg) was also detected in sample T3SD1 (from near Goss Cove).

Acetone was detected in sediment samples taken from 8 of the 10 zones; however, there was no criteria available to determine whether it is or is not a COPC. Therefore, it was retained and is considered a COPC for this report. 2-Butanone and carbon disulfide were detected in the sediment at concentrations below criteria in 6 of 10 zones and 1 of 10 zones, respectively. No volatile organic compounds were detected in Zone 7 or the Downstream Zone. Acetone and 2-butanone are common laboratory contaminants, which might substantiate why they were detected in most zones.

Semivolatile Organic Compounds

PAHs were by far the most prevalent organic sediment constituents. The concentrations of PAHs remained fairly constant from the upstream location to the downstream location, with slight increases in the areas of Pier 33 and Berth 16 and with a substantial increase in the vicinity of the Lower Subase. The samples collected from the pier line near the Lower Subase (i.e., T4SD2 and EC-T4SD2) contained the highest concentrations of PAHs, with a maximum detected concentration of fluoranthene and pyrene of 5.3 mg/kg in the sediment sample from location T4SD2 (Zone 2 and 3). The presence of PAHs in this area is most likely related to industrial activities. No additional impact was observed downstream. The samples collected from near Goss Cove and the downstream area contained PAH concentrations similar to those found in the upstream samples. 4-Methylphenol, carbazole, dibenzofuran, and four phthalate esters were also sporadically detected in sediment samples at concentrations ranging up to 0.42 mg/kg (butylbenzyl phthalate in the sediment sample from location EC-T3SD4).

Fluoranthene, fluorene, and phenanthrene were identified as sediment COPCs. Fluoranthene is a COPC in Zone 4 only, whereas fluorene is a COPC in both Zones 1 and 4. Phenanthrene is identified as a COPC in 7 of 10 zones and is therefore the most pervasive semivolatile COPC. Benzo(b)fluoranthene was detected in a sediment sample collected in Zone 7 and was retained as a COPC because there was no criteria available to determine whether this chemical is or is not a COPC. However, it is not believed that it is a COPC because the concentration is approximately the same as many of the other PAHs which were not identified as COPCs.

Pesticides/PCBs

Pesticides were detected in a majority of the Thames River zones, but the frequency of detection of pesticides in sediment samples was generally below 50 percent. Pesticides were detected in the Upstream, DRMO, 5, 7, 2 and 3, Goss Cove and Downstream Zones. The concentrations of pesticides ranged from 0.0031 mg/kg [alpha-chlordane (Upstream Zone) and 4,4'-DDD (Zone 5)] to 0.11 mg/kg [4,4'-DDD (DRMO Zone)].

A variety of pesticides were detected in the sediment samples, including 4,4'-DDT and related compounds, as well as aldrin, beta- and gamma-BHC, alpha- and gamma-chlordane, dieldrin, endrin, endrin aldehyde, endosulfan sulfate, heptachlor and heptachlor epoxide. 4,4'-DDT and related compounds were frequently found in sediment samples collected in Area A Downstream of NSB-NLON. Two streams, which originate in the Area A Downstream Site, discharge into the Thames River in the vicinity of the DRMO Zone and Zone 5. The contaminated sediments found in these zones may have originated from the Area A Downstream Site.

4,4'-DDD, 4,4'-DDE and heptachlor were identified as sediment COPCs in 5 of 10 zones, primarily in the zones north (Upstream, DRMO and Zone 5) and south (Goss Cove and Downstream) of the Lower Subase. Endrin aldehyde was detected at concentrations indicating that it is a COPC in the 3 northern zones (Upstream, DRMO and Zone 5). 4,4'-DDT was identified as a sediment COPC in 2 zones on either end of the Lower Subase (i.e., Upstream and Goss Cove). Gamma-chlordane, dieldrin, aldrin and gamma-BHC (Lindane) were detected only once in the Upstream, DRMO, Goss Cove and 2&3 Zones, respectively, but the concentrations were at levels in excess of the screening criteria indicating that they are COPCs.

Endosulfan sulfate and heptachlor epoxide were detected in one sediment sample from Zone 7. No criteria were available to determine whether the chemicals were COPCs, therefore they were retained as COPCs.

PCBs (aroclor-1248 and aroclor-1260) were detected at concentrations of 0.055 and 0.07 mg/kg, respectively, in only one zone, Zone 7. The PCBs were detected in the composite sediment sample C-1. This sample was collected as part of the Pier 17 Replacement project. No criteria were available to determine whether the detected concentrations of these two PCBs pose a potential risk to the environment, therefore they were retained as COPCs.

Metals

Concentrations of several metals (including aluminum, arsenic, iron, magnesium, manganese, potassium, sodium, and vanadium) were slightly higher near NSB-NLON, particularly in the vicinity of Pier 33 and Berth 16, but decreased to near upstream levels at the downstream location. Barium, beryllium, boron, calcium, copper, lead, nickel, and zinc showed slight overall increases from upstream to downstream. Maximum concentrations of several metals (including antimony, arsenic, cadmium, chromium, copper, lead, mercury, and zinc) exceeded background concentrations for all locations including upstream. Maximum concentrations of iron exceeded background for samples from DRMO, Pier 33, Berth 16, and Lower Subase locations; of nickel for Berth 16 and Lower Subase; of silver for Berth 16, Lower Subase, and downstream; and of selenium for downstream. These results may indicate that sediments have been locally affected by discharges from the NSB-NLON. However, since the brackish sublayer in the river flows upstream, this could also have been indicative of long-term loading from sources between NSB-NLON and Long Island Sound.

Metals identified as sediment COPCs in a majority or all of the zones include antimony, arsenic, chromium, copper, iron, lead, mercury, nickel and zinc. Boron and silver were identified as COPCs in less than one half of the zones. The remaining metals, although possibly pervasive in the sediment, were not identified as COPCs.

Pier 17 Replacement

Several PAHs, ranging in concentration from 0.16 mg/kg to 3.0 mg/kg (fluoranthene), were detected in composite surface (0 to 3 feet) samples collected during the ecological assessment for the Pier 17 replacement. Concentrations of PAHs were generally higher in the area of Pier 17 than in the area of Pier 15. The maximum concentrations of most PAHs, ranging up to 2,200 μg/kg (fluoranthene), were detected in one of the samples (C4) collected from the south side of Pier 17. Several pesticides, including aldrin, beta-BHC, gamma-BHC, 4,4'-DDD, 4,4'-DDE, endosulfan I, endrin, and heptachlor epoxide, were also detected at concentrations less than 20 μg/kg in sample C4. Aldrin, beta-BHC, endosulfan I, endosulfan

sulfate, and heptachlor epoxide were also each detected in at least one of the other samples at concentrations less than 10 μg/kg, with beta-BHC and endosulfan I detected most frequently. Aroclor-1248, -1254, and -1260 were also each detected in from four to six of the six sediment samples. Maximum concentrations of Aroclor-1254 and -1260 (81 μg/kg and 91 μg/kg, respectively) were also detected in sample C4. Arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc were also detected in these samples, with maximum concentrations of all metals once again found in sample C4 (south side of Pier 17).

All surface (0 to 3 feet) composite sediment samples collected around Piers 15 and 17 (Zone 7) were excavated during dredging activities except for C1. The analytical results for C1 were not able to be screened in this report because the appropriate screening criteria are not available.

2.4.3 Biota

Tables 2-15 through 2-18 summarize analytical results for biota samples and, if applicable, summarize the COPC screening results. Screening for COPCs only considered human receptors and those biota normally consumed by humans (oysters and clams). Table 2-15 summarizes the analytical results for the ribbed mussels used for the cage study. The analytical results for the blue mussels collected from the Thames River are shown in Table 2-16. COPC screening was not completed for either of these types of biota samples because they are not typically consumed by humans. Tables 2-17 and 2-18 summarize the analytical results and COPC screening results for the oyster and clam samples, respectively.

Caged Ribbed Mussels

The caged mussel deployment stations in the Thames River were selected to represent potential source locations at the NSB-NLON (DRMO, Lower Subase, and Goss Cove Landfill). Upstream and downstream locations were selected to characterize the biological availability of chemicals in areas outside the immediate influence of the NSB-NLON. Tissue concentrations were reported and are discussed in this section on a wet weight basis.

VOCs detected in deployed ribbed mussels included methylene chloride, carbon disulfide, 2-butanone, tetrachloroethene, styrene, benzene, ethylbenzene, toluene, and xylenes. With the exception of tetrachloroethene and styrene, these compounds were also detected in the control mussels not deployed in the Thames River. It is likely that low levels of VOCs are ubiquitous, or present in abundance, in bivalve shellfish. Concentrations of most of these compounds were similar in deployed and control mussels.

Few SVOCs were detected in the deployed ribbed mussel samples. PAHs were not detected in upstream and downstream samples, but were present in DRMO and Goss Cove samples at levels similar to the control samples. The exception to this pattern was the Lower Base, where concentrations of several PAHs as well as 2-methylphenol, dibenzofuran, benzyl alcohol, and benzoic acid were detected in the mussels at concentrations well above those detected in the control samples. The PAHs may be attributable to activities in that area. Benzoic acid was detected in each of the deployed ribbed mussel samples at concentrations above detected in the control samples. This compound can occur naturally.

Low concentrations of organochlorine pesticides were detected in deployed mussel samples including alpha-, beta-, and gamma-BHC, heptachlor, aldrin, 4,4'-DDE, endrin aldehyde, and gamma-chlordane. However, concentrations of most of these pesticides were equivalent to, or less than, concentrations of these pesticides measured in the non-deployed control mussels. PCBs were not detected in either the deployed or non-deployed mussels.

In general, concentrations of metals in deployed ribbed mussels were similar to those measured in the non-deployed control mussels. The exception was mercury, which was not detected in control mussels, but was detected in one of the two samples from the mussels deployed off Goss Cove at a concentration of 1.6 mg/kg wet weight. Concentrations of mercury were also elevated (up to 3.9 μg/L) in groundwater at the Goss Cove Landfill, a fact which indicates that groundwater discharging from this site may be adversely affecting the Thames River and resident shellfish.

Native Shellfish

Native blue mussels, oysters, and hardshell clams were collected from the river and analyzed for SVOCs, PCBs and pesticides, and metals. Results are on a wet weight basis. The oysters were collected from commercial shellfish beds in the river. The hardshell clams were collected from locations adjacent to the commercial shellfish beds. Blue mussels were collected from areas of the river where they are abundant and from pilings along the Lower Subase.

Few SVOCs were detected in native shellfish. Two PAHs, were detected in only one blue mussel sample from the Lower Subase. The detection of PAHs in this sample may be due to activities at the Lower Subase. Bis(2-ethylhexyl)phthalate and di-n-octylphthalate were detected in many of the shellfish samples at concentrations ranging from 18 to 160 μg/kg wet weight. These compounds are ubiquitous in the environment and are also common laboratory contaminants. Benzyl alcohol was detected in one hardshell clam sample from the Long Cove area upstream of NSB-NLON.

Relatively few pesticides were detected in the native Thames River mussels, oysters, and clams. Heptachlor was detected in most samples at concentrations ranging from 2 to 4.5 µg/kg wet weight. 4,4'-DDT and its metabolites and gamma-chlordane were detected in native blue mussel samples from adjacent to the Nautilus Museum, Lower Subase, and the channel off Mill Cove, upstream of NSB-NLON. Gamma-chlordane was also detected in a hardshell clam sample from Long Cove north of NSB-NLON. 4,4'-DDE and 4,4'-DDD concentrations ranged from 5 to 16 µg/kg wet weight. Gamma-chlordane concentrations ranged from 2.1 to 13 µg/kg wet weight. PCBs were not detected in the native shellfish samples.

Of the inorganics detected in Thames River native shellfish, arsenic, cadmium, chromium, and selenium were detected at low levels in most samples. The concentrations were similar among locations and shellfish species. Boron was only detected in two blue mussel samples, from the Lower Subase and the Nautilus Museum pilings at concentrations of 70.9 and 77.5 mg/kg wet weight, respectively. Concentrations of copper, silver, and zinc varied considerably among species. Silver was not detected in mussels but was found in hardshell clams and oysters. Copper concentrations in blue mussels and hardshell clams ranged from 1.8 to 7.5 mg/kg wet weight, but ranged from 62.9 to 253 mg/kg wet weight in oysters. Zinc concentrations ranged from 18.1 to 34.6 mg/kg wet weight in blue mussels and hardshell clams but ranged from 1,210 to 2,960 mg/kg wet weight in oysters.

Only a few biota COPCs were identified during screening. Heptachlor and arsenic were identified as both oyster and clam COPCs. Cadmium, copper and zinc were identified as oyster COPCs only.

2.5 DATA EVALUATION

The following subsections summarize the results of the baseline human health and ecological risk assessments performed for the Thames River during the Phase II RI. The baseline human health risk assessment results presented in this document are the latest version of results that have been completed to resolve comments received from the regulators on the draft final Phase II RI. In addition, contaminant fate and transport and comparison of data with state standards, as provided in the Phase II RI, are also provided below. An evaluation of the Thames River using the decision tree provided in Figure 1-3 is also included in this section.

2.5.1 Contaminant Fate and Transport

The chemicals detected in the Thames River in the vicinity of NSB-NLON consist primarily of PAHs, pesticides, and metals. Typically, these chemicals are not particularly soluble and tend to sorb to sediments. Metals may be soluble in surface water (as a function of pH), but are more likely to remain in dissolved form at near-neutral pH. All three groups of chemicals are persistent in anaerobic environments, which indicates that the concentrations are not likely to decrease as a function of time. These chemicals may exist and be transported in several phases including the following: dissolved; adsorbed to suspended sediments; associated with dissolved organic carbon; adsorbed to sediments which have settled to the bottom; dissolved in the interstitial water of the bottom sediments; and associated with dissolved organic carbon in the interstitial water of the bottom sediments.

The fate and transport of PAHs, pesticides, and metals in the Thames River are governed by various physical and chemical processes. The physical processes affecting contaminant fate and transport are related to the flow of water in the river. Processes such as advection, dispersion, diffusion, and settling/resuspension of sediment are typical physical processes. The Thames River is a tidally influenced river and tidal dispersion would also be a physical process affecting contaminant transport. Tidal dispersion encompasses mixing attributable to the temporal variation of tidal velocity, lateral and vertical velocity gradients, and density differences.

It is also possible for contaminants adsorbed to sediments to be resuspended into the water column by the mechanical process of biotic movement. However, the magnitude of contaminant migration by this method is likely to be much less than that caused by the physical processes related to the flow of water in the tidally influenced river.

Biotic movement can also include movement of contaminants from the sediments through the food chain to predatory fish. This type of movement can result in tissue concentrations in predatory fish being orders of magnitude greater than the sediment concentrations. A typical contaminant which would move through the food chain by biotic movement would be mercury. Mercury will biomagnify in the tissue of fish.

2.5.2 Baseline Human Health Risk Assessment

The baseline human health risk assessment for the Thames River conducted in the Phase II RI considered three potential exposure routes: incidental ingestion and dermal contract with surface water by a recreational adult user (e.g., water skier) and ingestion of oysters, clams, finfish, and other shellfish (in spite of a ban on shellfish harvesting). Given the manmade shoreline, steep banks, depth of the river

at the Lower Subase, tidal flow, and heavily industrialized nature of this reach of the Thames River, exposure to sediment in the river is considered unlikely since small children are not expected to wade in the river waters and recreational users would not contact deep sediments. Therefore, sediments were not considered as a medium of concern.

Incidental ingestion and dermal contact with surface water by the adult recreational user were found to constitute negligible noncarcinogenic and carcinogenic risks [Hazard Indices (HIs) were less than unity and incremental cancer risks (ICRs) were below the lower bound ($1x10^{-6}$) of the USEPA target risk range of $1x10^{-6}$ to $1x10^{-4}$]. ICRs associated with potential ingestion of oysters, clams, or finfish/other shellfish each exceeded the USEPA target risk range of $1x10^{-6}$ to $1x10^{-4}$ under the reasonable maximum exposure (RME) scenario. In addition, HIs for finfish/shellfish ingestion exceeded unity under the RME scenario. Primary contributors to both the elevated risks for shellfish/finfish ingestion include heptachlor, arsenic, cadmium, and zinc. It should be noted that individuals are not permitted to harvest shellfish in the area and there are no licensed recreational shellfishing areas in the Thames River. No commercial shellfish beds are located in proximity to NSB-NLON.

2.5.3 Ecological Risk Assessment

An ecological risk assessment for the Thames River was performed in support of the NSB-NLON Phase II RI (B&R Environmental, 1996). Surface water and sediment sampling and benthic macroinvertebrate analysis was conducted. Native shellfish, including blue mussels, oysters, and hardshell clams, were collected, and a caged mussel deployment study was performed. Only a few COCs were identified in surface water. In sediments, elevated concentrations of some metals and PAHs were detected. Several exceedances of ER-L values were observed; exceedances of ER-M values were sporadic. A detailed description of individual COCs in surface water and sediment is provided below. Several VOCs were detected in deployed ribbed mussels, but with the exception of low levels of tetrachloroethane and styrene, these compounds were also detected in control mussels. Two PAHs were detected in one blue mussel sample near the Lower Subase. A few PAHs as well as 2-methylphenol, dibenzofuran, benzyl alcohol, and benzoic acid were also detected in one caged mussel sample in the Lower Subase. PAHs were not detected in upstream or downstream samples in the Thames River.

Several organochlorine pesticides were detected in deployed mussels, but were present in concentrations lower or comparable to non-deployed mussels. Low levels of metals were detected in caged and native shellfish. However, concentrations of metals in deployed ribbed mussels were similar to those measured in the non-deployed control mussels. Mercury was not detected in control mussels but was detected in one of the two samples off Goss Cove at a concentration of 1.6 mg/kg wet weight. Benthic community

analyses included measures of taxa richness, total number of individuals, diversity indices, indicator species identification, similarity indices, and statistical analyses. The results of the benthic macroinvertebrate study indicated that, in general, the benthic community near NSB-NLON was similar to that in the upstream and downstream samples.

Due to the potential for ecological risks displayed by some analyses in the risk assessment, a supplementary ecological investigation was performed as part of the Phase II RI, which focused on the Thames River closer to the base. The supplemental investigation consisted of surface water and sediment sampling, toxicity tests with *Ampelisca* and *Leptocheirus*, modeling of potential risks to the herring gull and double-crested cormorant, and acid volatile sulfide/simultaneously-extracted metals (AVS/SEM) analysis of sediments. Data from the initial surface water and sediment sampling were evaluated with data from the supplemental investigation to identify surface water and sediment COCs for the Phase II RI. Maximum concentrations of contaminants in surface water and sediment at each individual sampling location were compared to benchmarks. The exception was for three sediment sampling locations that were sampled during both portions of the Phase II RI. In that instance, average concentrations from those three samples were also used to identify COCs. It should also be noted that since the detection limits of a number of organic sediment contaminants were greater than their respective benchmark values, the detection limits served as representative concentrations.

Some exceedances of benchmark values were observed in surface water samples. In particular, cadmium exceeded its benchmark value near Goss Cove, and endrin aldehyde exceeded its benchmark value in one surface water sample near the Lower Subase. For sediment sampling locations near the Lower Subase, 4,4'-DDT, 4,4'-DDE, 4,4'-DDD at all locations and acenapthene and flourene at some locations were retained as COCs, but only since their detection limits exceeded benchmark values. Maximum concentrations of several metals and PAHs exceeded ER-L values at a number of sampling sites near the Lower Subase. Yet exceedances of ER-M values were sporadic, as mentioned above. At sampling location T4SD2, the average concentrations of several metals and lindane exceeded conservative benchmark values.

Nonetheless, sediments from only one sampling location near the Lower Subase (i.e., EC-SDTR04) exhibited toxicity to *Ampelisca*. No sediments from sampling locations in the Thames River exhibited toxicity to *Leptocheirus*. AVS concentrations exceeded semi-extractable metals concentrations at all locations. In addition, the concentrations of SEM at each station were significantly less than zero, indicating decreased bioavailability of five cationic metals (cadmium, copper, nickel, lead, and zinc). These results also suggest that contaminants, or the sediment physical characteristics, other than these five metals are responsible for the toxicity exhibited by *Ampelisca*.

As mentioned above, modeling of potential chronic risks to the cormorant and herring gull was also performed. Potential exposure pathways included consumption of contaminated shellfish and sediment for the herring gull and cormorant. Both maximum and average concentrations were used in the model. For the cormorant, zinc, mercury, boron, and copper were the major contributors to risk using maximum concentrations, with a total HI of 1.3×10^2. The average concentration HI was 2.1×10^1. For the herring gull, zinc, mercury, 4,4'-DDE, and 4,4'-DDD were the major contributors to risk for the maximum concentration scenario, with a total HI of 1.6×10^2; the average concentration HI for the herring gull was 2.7×10^1. Although the chronic HI values indicated potential risks to these receptors, potential risks are most likely much lower due to the use of several conservative assumptions in the models. In particular, the receptors were assumed to forage 100% of the time in the river near the Lower Subase, while the Lower Subase comprises only a fraction of the home range of these receptors. They were assumed to forage exclusively on contaminated shellfish, which are known to bioaccumulate contaminants. Although the HI values cannot be completely dismissed because of these conservative assumptions, again, it is likely that potential risks are markedly lower.

For the reasons described above, and taking into account the results of the other studies performed on the Thames River described earlier, the Phase II RI ecological risk assessment concluded that, with the possible exception of the Lower Subase area, potential risks to ecological receptors from Thames River contaminants are relatively low. Potential risks to benthic receptors, primarily shellfish near the Lower Subase, are the only potential risks that appear to be significant enough to require further characterization.

2.5.4 Comparison of Site Data to Connecticut's Standards

Surface water analytical data for the Thames River were compared to Connecticut Water Quality Standards (CTDEP, 1992) for human health, which are similar to Federal Ambient Water Quality Criteria (AWQC). Trichloroethane (detected in the upstream sample location only) and mercury were detected at maximum concentrations exceeding the state AWQC for the consumption of organisms and/or water and organisms in shallow and deep surface water. Note that mercury did not exceed risk-based screening criteria for tap water ingestion and was therefore not identified as a COC in the baseline human health risk assessment. For aquatic life, lead and mercury detections exceeded freshwater standards and cadmium and mercury concentrations exceeded saltwater standards. No qualitative assessment of sediment was performed, since direct exposure to sediment by humans is not expected to occur because of the depth of the river.

2.5.5 Decision Tree

The general decision tree for the evaluation of sites is provided in Figure 1-3. The evaluation of data using this decision tree for the Thames River is as follows:

- Existing data have been collected and evaluated. Information describing the site, previous investigations, and physical characteristics of the Thames River are provided in Sections 2.1, 2.2 and 2.3, respectively. The nature and extent of contamination and COPC screening are described in Section 2.4.

- Based on the existing data, potential threats to human health and the environment were identified for the Thames River, but none of the threats were considered imminent. The potential risks to humans were mainly due to ingestion of shellfish/finfish and were not considered imminent because individuals are not permitted to harvest shellfish in the area and there are no licensed recreational shellfishing areas in the Thames River. The potential risks to ecological receptors were mainly associated with macroinvertebrates. The risks were not considered imminent because only two areas of the river (Zone 7 and DRMO) showed high risks, only two chemicals contributed to the risks and very conservative assumptions were made for conducting the ecological risk assessment.

- The potential for contaminant fate and transport has been described, baseline human health and ecological risk assessments have been conducted, and data have been compared to CTDEP Standards.

- Contamination in the Thames River in the vicinity of the Lower Subase has not been fully characterized; however, available information indicates that contamination in the river may have come from activities and contamination at the Lower Subase. Sources of contamination may still be present at the Lower Subase. Potential risks to human health and the environment from exposure to contaminants in the Thames River have been identified.

- Further actions are required for the Thames River in the vicinity of the Lower Subase as discussed in Section 2.6.

2.6 RECOMMENDATIONS

The Phase II RI provided recommendations for the Thames River. Based on the Phase II RI, contamination was identified in the Thames River in the vicinity of the Lower Subase. Other areas of the

Thames River along NSB-NLON had chemical concentrations similar to upgradient and downgradient locations. Only the area near the Lower Subase showed elevated chemical concentrations. Further characterization of the Thames River in the vicinity of the Lower Subase was therefore recommended. It was recommended that the characterization focus on sediment sampling for SVOCs to define the nature and extent of sediment contamination along the Lower Subase. It was also noted that additional characterization of the potential impacts to the shellfish community in the vicinity of the Lower Subase may be required. These recommendations are supported by the following:

- Concentrations of SVOCs, particularly PAHs, in sediments were noted to increase in the vicinity of the Lower Subase compared to upstream and downstream locations. Also SVOCs were detected in caged ribbed mussel samples located adjacent to the Lower Subase at concentrations above the caged ribbed mussel control sample concentrations. PAHs were also detected in a native blue mussel sample which was collected adjacent to the Lower Subase.

- In general, with the exception of a pesticide (endrin aldehyde at 0.14 μg/L), no other organic compounds were detected in surface water in the vicinity of the Lower Subase.

- The results of the ecological risk assessment indicate that the Thames River near NSB-NLON presents a minimal potential risk to ecological receptors. Shellfish adjacent to the Lower Subase are the only ecological receptors that may require further characterization.

- Although human health risks associated with ingestion of shellfish exceeded the USEPA target risk range, recreational shellfishing has been closed as a result of fecal bacterial contamination. In addition, there are no commercial shellfish beds located in proximity to NSB-NLON. The features of the river by the Lower Subase (steep bank, depth, tidal flow, industrialized nature of the river) preclude human contact with sediments.

- Human health risks associated with ingestion of finfish slightly exceeded (HI=1.2) the USEPA acceptable level (HI=1.0). This minor exceedance resulted from the maximum concentration (i.e., the concentration used for the RME scenario) of one chemical (cadmium), and further characterization of finfish is not warranted. This conclusion is based on the following information: the HI for the CTE scenario was below 1.0; the maximum fish-tissue concentration used for the RME scenario was estimated from chemical concentrations measured in surface water, which may not approximate true fish-tissue concentrations; and the exposure parameters used were very conservative.

It is further recommended that because activities and contamination at the Lower Subase have been identified as the likely source of contamination in the Thames River adjacent to the Lower Subase, remedial actions to remove the source(s) of contamination or to minimize contaminant migration/exposure pathways be conducted. Remedial actions for source areas could occur as part of any action conducted for the separate zones within the Lower Subase. Therefore, it is necessary to coordinate characterization of contaminated sediment with source area investigations. Sampling of sediment along the shore of the zones within the Lower Subase where significant soil or groundwater contamination has been identified is recommended to clearly identify whether this contamination has migrated to the Thames River. Characterization of the nature and extent of contaminated sediment will provide information to link the contamination to particular source areas.

It is believed that additional surface water sampling in the Thames River would not provide conclusive evidence of contaminant migration from the Lower Subase for the following reasons:

- Historically, there have been limited, discrete discharges of petroleum from the Lower Subase groundwater to the Thames River and these have occurred only during warm weather, a low groundwater table and low tide.

- A single round of surface water measurements (i.e., a "snap shot") is unlikely to detect a discrete release of contaminants.

- The Navy has limited migration of the petroleum released to the Thames River using buoys and collected it using adsorbent material. In addition, preferential flow pathways were blocked to eliminate further migration of the petroleum to the Thames River.

- Surface water sampling results would be inconclusive due to the dilution and tidal flushing of the Thames River.

TABLE 2-1
COPC SCREENING FOR THAMES RIVER
FILTERED, BOTTOM SURFACE WATER
NSB-NLON, GROTON, CONNECTICUT
PAGE 1 OF 1

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	Human Health			Surface Water Background (5)	Ecological Benchmark Value (6)	Select as COPC? (7)
						COC Screening Level (2)	State AWQC Consumption of Water and Organisms (3)	Federal AWQC Consumption of Water and Organisms (4)			
Metals (ug/L)											
Barium	2/2	5.2	-	5.2	8SW1B/6SW1B	260	-	-	20	500 (8)	N
Boron	2/2	2580 - 3210	-	2895	8SW1B	330	-	-	4500	- (10)	Y
Calcium	2/2	208000 - 258000	-	233000	8SW1B	-	-	-	410000	- (10)	N
Chromium	1/2	3.4	3	2.45	6SW1B	18	33000/170 (9)	33000/170 (9)	0.05	50 (11)	Y (12)
Magnesium	2/2	680000 - 852000	-	766000	8SW1B	-	-	-	1350000	- (10)	N
Manganese	1/2	16.2	8.6	10.25	6SW1B	18	-	-	2	- (10)	Y
Potassium	2/2	363000 - 499000	-	431000	8SW1B	-	-	-	390000	- (10)	Y (12)

- Not available or not applicable.

(1) Includes data from the following samples: 6SW1B-DISS and 8SW1B-DISS.

(2) For residential tap water ingestion, based on current EPA Region III guidance (USEPA Region III, May 10, 1996).

(3) Connecticut Water Quality Standards, 1992.

(4) Ambient Water Quality Criteria (USEPA, 1986).

(5) Background concentrations established using data taken from USGS Water Supply Paper 2254 "Study and Interpretation of the Chemical Characteristics of Natural Water" (Hem, 1985).

(6) Benchmark value used to identify Ecological Contaminants of Potential Concern.

(7) Contaminant of Potential Concern; A Yes (Y) indicates that the maximum detection exceeds one or more criteria; a No (N) indicates that the maximum does not exceed any of the criteria.

(8) ACQUIRE (USEPA, 1995).

(9) Trivalent chromium/hexavalent chromium.

(10) Criteria not available or chemical not toxic to receptor.

(11) Chronic Aquatic Life Criteria for hexavalent chromium, Connecticut Water Quality Standards, January 1992.

(12) Exceeds background only.

TABLE 2-2
COPC SCREENING FOR THAMES RIVER
UNFILTERED, BOTTOM SURFACE WATER
NSB-NLON, GROTON, CONNECTICUT
PAGE 1 OF 1

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	Human Health			Surface Water Background (5)	Ecological Benchmark Value (6)	Select as COPC? (7)
						COC Screening Level (2)	State AWQC Consumption of Water and Organisms (3)	Federal AWQC Consumption of Water and Organisms (4)			
Pesticides/PCBs (ug/L)											
Endrin aldehyde	1/7	0.14	0.1	0.063	T3SW2B	-	0.76	-	-	0.01 (8)	Y
Metals (ug/L)											
Boron	7/7	2430 - 3330	-	2889	8SW1B	330	-	-	4500	- (9)	Y
Calcium	7/7	191000 - 261000	-	225000	8SW1B	-	-	-	410000	- (9)	N
Iron	7/7	51 - 90.2	-	72.5	T3SW1BB	1100	-	-	3	88000 (10)	Y (11)
Magnesium	7/7	630000 - 858000	-	744571	8SW1B	-	-	-	1350000	- (9)	N
Manganese	7/7	6.2 - 15.7	-	9.63	T3SW1BB	18	-	-	2	-	Y (11)
Mercury	7/7	0.26 - 0.39	-	0.321	T3SW2B	1.1	0.14	0.14	0.2	1.1	Y
Potassium	7/7	324000 - 503000	-	414714	8SW1B	-	-	-	390000	- (9)	Y (11)
Sodium	7/7	117000 - 6730000	-	1550571	T3SW1BB	-	-	-	10500000	- (9)	N
Vanadium	3/7	5 - 6.9	5	4.09	T3SW1BB	26	-	-	2	669	Y (11)
Miscellaneous (ug/L)											
Hardness as CaCO3	7/7	2240 - 4840	-	3611	6SW1B	-	-	-	-	-	N (12)

- Not availabe or not applicable.

(1) Includes data from the following samples: 6SW1B, 8SW1B, T3SW1AB, T3SW1BB, T3SW1BB-D, T3SW2B, and T3SW3B.

(2) For residential tap water ingestion, based on current EPA Region III guidance (USEPA Region III, May 10, 1996).

(3) Connecticut Water Quality Standards, 1992.

(4) Ambient Water Quality Criteria (USEPA, 1986).

(5) Background concentrations established using data taken from USGS Water Supply Paper 2254 "Study and Interpretation of the Chemical Characteristics of Natural Water" (Hem, 1985).

(6) Benchmark value used to identify Ecological Contaminants of Potential Concern.

(7) Contaminant of Potential Concern; A Yes (Y) indicates that the maximum detection exceeds one or more criteria; a No (N) indicates that the maximum does not exceed any of the criteria.

(8) Chronic value taken from ECOTOX (USEPA, 1995).

(9) Criteria not available or chemical not toxic to receptor.

(10) Federal CAWQC.

(11) Exceeds background only. Not appropriate for COPC screening.

TABLE 2-3
COPC SCREENING FOR THAMES RIVER
FILTERED, SHALLOW SURFACE WATER
NSB-NLON, GROTON, CONNECTICUT
PAGE 1 OF 1

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	Human Health			Surface Water Background (5)	Ecological Benchmark Value (6)	Select as COPC? (7)
						COC Screening Level (2)	State AWQC Consumption of Water and Organisms (3)	Federal AWQC Consumption of Water and Organisms (4)			
Metals (ug/L)											
Aluminum	1/4	14	14	8.75	6SW1S	3700	-	-	1	87 (8)	Y (13)
Barium	4/4	5.8 - 7.8	-	6.65	T3SW1AS	260	-	-	20	0.5 (9)	Y
Boron	4/4	1560 - 2160	-	1743	8SW1S	330	-	-	4500	- (11)	Y
Calcium	4/4	130000 - 177000	-	143750	8SW1S	-	-	-	410000	- (11)	N
Chromium	1/4	3.1	3	1.9	8SW1S	18	33000/170 (10)	33000/170 (10)	0.05	50 (12)	Y (13)
Magnesium	4/4	411000 - 578000	-	460250	8SW1S	-	-	-	1350000	- (11)	N
Manganese	4/4	19.9 - 25.9	-	24.1	6SW1S	18	-	-	2	- (11)	Y
Potassium	4/4	183000 - 289000	-	213500	8SW1S	-	-	-	390000	- (11)	N
Vanadium	2/4	5.6 - 5.8	5	4.1	8SW1S	26	-	-	2	669	Y (13)

- Not available or not applicable.

(1) Includes data from the following samples: 6SW1S-DISS, 8SW1S-DISS, T3SW1AS-DISS, and T3SW1AS-DISS-D.

(2) For residential tap water ingestion, based on current EPA Region III guidance (USEPA Region III, May 10, 1996).

(3) Connecticut Water Quality Standards, 1992.

(4) Ambient Water Quality Criteria (USEPA, 1986).

(5) Background concentrations established using data taken from USGS Water Supply Paper 2254 "Study and Interpretation of the Chemical Characteristics of Natural Water" (Hem, 1985).

(6) Benchmark value used to identify Ecological Contaminants of Potential Concern.

(7) Contaminant of Potential Concern; A Yes (Y) indicates that the maximum detection exceeds one or more criteria; a No (N) indicates that the maximum does not exceed any of the criteria or there was no criteria available.

(8) Federal CAWQC.

(9) ACQUIRE (USEPA, 1995).

(10) Trivalent chromium/hexavalent chromium.

(11) Criteria not available or chemical not toxic to receptor.

(12) Chronic Aquatic Life Criteria for hexavalent chromium, Connecticut Water Quality Standards, January 1992.

(13) Exceeds background only.

TABLE 2-4

COPC SCREENING FOR THAMES RIVER UNFILTERED, SHALLOW SURFACE WATER NSB-NLON, GROTON, CONNECTICUT

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	Human Health			Surface Water Background (5)	Ecological Benchmark Value (6)	Select as COPC? (7)
						COC Screening Level (2)	State AWQC Consumption of Water and Organisms (3)	Federal AWQC Consumption of Water and Organisms (4)			
Volatile Organic Compounds (ug/L)											
Trichloroethene	1/8	3	10	4.75	6SW1S	1.6	2.7	2.7	-	350 (8)	Y
Semivolatile Organic Compounds (ug/L)											
Di-N-butyl phthalate	1/8	0.6	10	4.45	T3SW1S	370	2700	2700	-	33 (8)	N
Butyl benzyl phthalate	1/8	0.5	10	4.44	6SW1S	730	-	3000	-	19 (8)	N
Metals (ug/L)											
Aluminum	7/8	16.3 - 79.6	14	29	T3SW1S	3700	-	-	1	87 (9)	Y (12)
Barium	1/1	25.9	-	25.9	T3SW1S	260	-	-	20	500 (10)	Y (12)
Boron	8/8	518 - 2210	-	1646	T3SW3S	330	-	-	4500	- (11)	Y
Cadmium	1/8	10.2	2	2.15	8SW1S	1.8	16	16.0	0.11	9.3	Y
Calcium	8/8	50900 - 176000	-	133238	T3SW3S	-	-	-	410000	- (11)	N
Iron	8/8	95.9 - 425	-	155	T3SW1S	1100	-	-	3	88000	Y (12)
Lead	3/8	1 - 1.5	1 - 10	2.5	T3SW1AS	15	50	50	0.03	8.1 (9)	Y (12)
Magnesium	8/8	128000 - 575000	-	426375	T3SW3S	-	-	-	1350000	- (11)	N
Manganese	8/8	16.7 - 148	-	36.9	T3SW1S	18	-	-	2	- (11)	Y
Mercury	8/8	0.24 - 0.49	-	0.314	8SW1S	1.1	0.14	0.14	0.2	1.1 (9)	Y
Potassium	8/8	46700 - 288000	-	197338	T3SW3S	-	-	-	390000	- (11)	N
Sodium	8/8	118000 - 596000	-	431125	T3SW3S	-	-	-	10500000	- (11)	N
Vanadium	2/8	5.3 - 6.9	5	3.4	T3SW1AS	26	-	-	2	669	Y (12)
Zinc	1/8	6.7	2	1.71	T3SW1S	1100	-	-	10	81 (9)	N
Miscellaneous (ug/L)											
Hardness as CaCO3	8/8	960 - 3560	-	2695	T3SW3S	-	-	-		- (11)	N (13)

- Not available or Not applicable.

(1) Includes data from the following samples: 6SW1S, 8SW1S, T3SW1AS, T3SW1AS-D, T3SW1BS, T3SW1S, T3SW2S, and T3SW3S.

(2) For residential tap water ingestion, based on current EPA Region III guidance (USEPA Region III, May 10, 1996).

(3) Connecticut Water Quality Standards, 1992.

(4) Ambient Water Quality Criteria (USEPA, 1986).

(5) Background concentrations established using data taken from USGS Water Supply Paper 2254 "Study and Interpretation of the Chemical Characteristics of Natural Water" (Hem, 1985).

TABLE 2-4

COPC SCREENING FOR THAMES RIVER UNFILTERED, SHALLOW SURFACE WATER NSB-NLON, GROTON, CONNECTICUT PAGE 2 OF 2

(6) Benchmark value used to identify Ecological Contaminants of Potential Concern.

(7) Contaminant of Potential Concern; A Yes (Y) indicates that the maximum detection exceeds one or more criteria; a No (N) indicates that the maximum does not exceed any of the criteria or there was no criteria available.

(8) Chronic value taken from ECOTOX (USEPA, 1995).

(9) Federal CAWQC.

(10) ACQUIRE (USEPA, 1995).

(11) Criteria not available or chemical not toxic to receptor.

(12) Exceeds only background.

(13) Not appropriate for COPC screening.

TABLE 2-5

COPC SCREENING FOR THAMES RIVER
UPSTREAM SEDIMENT
NSB-NLON, GROTON, CONNECTICUT
PAGE 1 OF 3

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	Background (2)	Benchmark Value (3)	Select as COPC? (4)
Volatile Organic Compounds (mg/kg)								
Acetone	1/1	0.019	-	0.019	EC-SDTR01	-	-	Y (5)
Semivolatile Organic Compounds (mg/kg)								
Acenaphthylene	1/3	0.1	0.57-1.8	0.43	T1SD2	-	34.6	N
Anthracene	3/3	0.073-0.16	-	0.12	T1SD2	-	1.98 - 44.8	N
Benzo(a)anthracene	3/3	0.36-0.5	-	0.42	T1SD2	-	3.47 - 78.5	N
Benzo(a)pyrene	3/3	0.47-0.62	-	0.53	T1SD2	-	7.01 - 159	N
Benzo(b)fluoranthene	2/3	0.88-1.1	0.57	0.76	T1SD2	-	112 - 129	N
Benzo(g,h,i)perylene	3/3	0.2-0.38	-	0.32	T1SD1	-	25.4 - 576	N
Benzo(k)fluoranthene	1/3	0.62	1.2-1.8	0.71	EC-SDTR01	-	3.51	N
Carbazole	1/3	0.081	0.57-1.8	0.42	T1SD2	-	31	N
Chrysene	3/3	0.48-0.68	-	0.58	T1SD2	-	3.47 - 78.5	N
Di-N-octyl phthalate	1/3	0.009	1.2-1.8	0.5	EC-SDTR01	-	5.56	N
Dibenzo(a,h)anthracene	1/3	0.066	1.2-1.8	0.52	EC-SDTR01	-	4.4	N
Fluoranthene	3/3	0.37-1	-	0.68	T1SD2	-	1.26 - 28.7	N
Indeno(1,2,3-cd)pyrene	3/3	0.22-0.5	-	0.4	T1SD2	-	67.3 - 1530	N
Phenanthrene	3/3	0.17-0.54	-	0.36	T1SD2	-	0.133 - 3.02	Y
Pyrene	3/3	0.64-1	-	0.81	T1SD2	-	2.7 - 61.2	N
Pesticides/PCBs (mg/kg)								
4,4'-DDD	2/3	0.014-0.017	0.0057	0.011	T1SD2	-	0.0101 - 0.0116	Y
4,4'-DDE	2/3	0.0063-0.0078	0.0057	0.0057	T1SD2	-	0.0051 - 0.0059	Y
alpha-Chlordane	1/3	0.0031	0.0029-0.092	0.017	T1SD2	-	151	N
Dieldrin	2/3	0.0053-0.014	0.0057	0.0074	T1SD1	-	0.015 - 0.017	N
Endrin aldehyde	1/3	0.0075	0.0057-0.18	0.034	T1SD2	-	0.011	Y
gamma-Chlordane	1/3	0.011	0.0029-0.092	0.02	T1SD2	-	0.000035	Y
Heptachlor	1/3	0.014	0.0029-0.064	0.016	T1SD1	-	0.00099	Y
Metals (mg/kg)								
Aluminum	3/3	7230-13700	-	10810	T1SD1	54500	27000 (6)	N
Antimony	3/3	1.5-38.1	-	22.2	T1SD1	0.405	64 (6)	Y

TABLE 2-5

COPC SCREENING FOR THAMES RIVER
UPSTREAM SEDIMENT
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 3

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	Background (2)	Benchmark Value (3)	Select as COPC? (4)
Arsenic	3/3	5.6-10.9	-	8.3	T1SD1	6.75	8.2	Y
Barium	3/3	27-48.5	-	39	T1SD1	580	-	N
Beryllium	3/3	0.47-0.69	-	0.57	T1SD1	3	-	N
Boron	1/3	26.5	72.9-151	46	EC-SDTR01	100	-	N
Calcium	3/3	3230-5110	-	4160	T1SD1	-	-	N (7)
Chromium	3/3	34-79.6	-	61	T1SD1	73	81	Y
Cobalt	3/3	4.5-7	-	6	T1SD1	19	50(9)	N
Copper	3/3	28.5-83.7	-	61	T1SD1	36.8	34	Y
Iron	3/3	13400-23800	-	18567	T1SD1	29250	-	N
Lead	3/3	26.5-91.2	-	68	T1SD2	42.2	46.7	Y
Magnesium	3/3	4700-7490	-	6103	T1SD1	-	-	N (7)
Manganese	3/3	162-234	-	195	T1SD1	486	1800	N
Mercury	2/3	0.48-0.5	0.21	0.36	T1SD1	0.169	0.15	Y
Nickel	3/3	14.3-23	-	20	T1SD2	34.5	20.9	N
Potassium	3/3	2600-3590	-	2970	T1SD1	-	-	N (7)
Sodium	3/3	9450-16400	-	12317	T1SD1	-	-	N (7)
Vanadium	3/3	23-38.7	-	32	T1SD1	130	-	N
Zinc	3/3	58-130	-	102	T1SD1	112.5	150	Y
Miscellaneous (mg/kg)								
Cadmium(avs) (8)	1/1	0.22	-	0.22	EC-SDTR01	-	-	N (10)
Chromium(avs)	1/1	5.2	-	5.2	EC-SDTR01	-	-	N (10)
Copper(avs)	1/1	7.5	-	7.5	EC-SDTR01	-	34	N (10)
Lead(avs)	1/1	21	-	21	EC-SDTR01	-	-	N (10)
Nickel(avs)	1/1	1.9	-	1.9	EC-SDTR01	-	-	N (10)
Zinc(avs)	1/1	3.1	-	3.1	EC-SDTR01	-	-	N (10)
Acid volatile sulfide	1/1	270	-	270	EC-SDTR01	-	-	N (10)
Total organic carbon	3/3	662-15000	-	9554	T1SD2	-	-	N (10)

TABLE 2-5

COPC SCREENING FOR THAMES RIVER
UPSTREAM SEDIMENT
NSB-NLON, GROTON, CONNECTICUT
PAGE 3 OF 3

- Not available or Not applicable.
(1) Includes data from the following samples: EC-SDTR01-02, T1SD1, and T1SD2.
(2) Background concentrations established using NOAA Technical Memorandum NOS OCRA80, "Biological Effects of Toxic Contaminants in Sediments from Long Island Sound and Environs," NOAA, 1994.
(3) Benchmark values for organics are sample location-specific benchmarks based on equilibrium partitioning (EqP) using sample specific total organic carbon and benchmark for surface water. Range indicates organic parameter was detected at more than one sample location. Except as indicated, benchmarks for inorganics are the effects range-low (ER-L) from Long, et. al., 1995.
(4) Contaminant of Potential Concern; Yes (Y) indicates that the maximum concentration exceeds one or more criteria; No (N) indicates that the maximum does not exceed any of the criteria.
(5) Criteria not available.
(6) Washington State Department of Ecology (1994).
(7) Naturally occurring chemical, not considered for screening.
(8) Acid Volatile Sulfide/Simultaneously Extracted Metal.
(9) OME, 1988.
(10) Not appropriate for COPC screening.

TABLE 2-6

COPC SCREENING FOR THAMES RIVER
DRMO SEDIMENT
NSB-NLON, GROTON, CONNECTICUT
PAGE 1 OF 3

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	Background (2)	Benchmark Value (3)	Select as COPC? (4)
Volatile Organic Compounds (mg/kg)								
Acetone	1/1	0.018	-	0.018	EC-T3SD4	-	-	Y (5)
Semivolatile Organic Compounds (mg/kg)								
4-Methylphenol	1/5	0.13	0.9-1.6	0.52	EC-T3SD4	-	0.764	N
Anthracene	5/5	0.049-0.17	-	0.11	T3SD4	-	21.5 - 23	N
Benzo(a)anthracene	5/5	0.17-0.54	-	0.37	EC-T3SD4	-	37.7 - 40.4	N
Benzo(a)pyrene	5/5	0.2-0.57	-	0.41	EC-T3SD4/T3SD4	-	76.2 - 81.7	N
Benzo(b)fluoranthene	4/5	0.12-0.48	0.75	0.89	T3SD4	-	62.1 - 66.5	N
Benzo(g,h,i)perylene	5/5	0.062-0.21	-	0.15	EC-T3SD4/T3SD4	-	277 - 296	N
Benzo(k)fluoranthene	5/5	0.19-1.1	-	0.49	EC-T3SD4	-	38.1 - 40.3	N
Butyl benzyl phthalate	1/5	0.42	0.9-1.6	0.58	EC-T3SD4	-	7.33	N
Chrysene	5/5	0.19-0.68	-	0.44	EC-T3SD4	-	37.7 - 40.4	N
Di-N-butyl phthalate	1/5	0.058	0.9-1.6	0.51	EC-T3SD4	-	32.9	N
Dibenzo(a,h)anthracene	1/5	0.087	0.9-1.6	0.51	EC-T3SD4	-	51.3	N
Fluoranthene	5/5	0.3-1.1	-	0.67	T3SD4	-	13.8 - 14.7	N
Indeno(1,2,3-cd)pyrene	5/5	0.09-0.36	-	0.21	T3SD4	-	732 - 784	N
Phenanthrene	5/5	0.14-0.49	-	0.33	T4SD4	-	1.45 - 1.55	N
Pyrene	5/5	0.33-1	-	0.71	T3SD4	-	29.4 - 31.5	N
Pesticides/PCBs (mg/kg)								
4,4'-DDD	2/5	0.035-0.11	0.09-0.16	0.063	EC-T3SD4	-	0.00597	Y
4,4'-DDE	2/5	0.0077-0.014	0.09-0.16	0.039	EC-T3SD4	-	0.00303	Y
4,4'-DDT	2/5	0.025-0.046	0.09-0.16	0.049	T3SD4	-	0.00939	Y
Dieldrin	1/5	0.0048	0.0075-0.16	0.042	T5SD4	-	0.00831	Y
Endrin aldehyde	1/5	0.014	0.09-0.16	0.052	EC-T3SD4	-	0.00568	Y
Heptachlor	2/5	0.0036-0.0042	0.0039-0.081	0.0149	T3SD4	-	0.000588 - 0.000548	Y
Metals (mg/kg)								
Aluminum	5/5	5110-19100	-	8924	T3SD4	54500	27000 (6)	N
Antimony	4/4	9.8-42.3	-	20	T3SD4	0.405	64 (6)	Y

TABLE 2-6

COPC SCREENING FOR THAMES RIVER
DRMO SEDIMENT
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 3

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	Background (2)	Benchmark Value (3)	Select as COPC? (4)
Arsenic	5/5	2.2-12.6	-	6.9	T3SD4	6.75	8.2	Y
Barium	5/5	18.4-64.2	-	31	T3SD4	580	-	N
Beryllium	4/4	0.16-0.8	-	0.36	T3SD4	3	-	N
Boron	1/5	68.2	43.5-200	51	EC-T3SD4	100	-	N
Calcium	5/5	2010-6000	-	4632	T3SD4	-	-	N (7)
Chromium	5/5	20.4-89.9	-	40	T3SD4	73	81	Y
Cobalt	5/5	3-9.9	-	4.8	T3SD4	19	50 (9)	N
Copper	5/5	16.9-119	-	48	T3SD4	36.8	34	Y
Iron	5/5	7150-30500	-	15808	T3SD4	29250	-	Y
Lead	5/5	17.4-123	-	47	T3SD4	42.2	46.7	Y
Magnesium	5/5	2980-10200	-	5380	T3SD4	-	-	N (7)
Manganese	5/5	84.8-293	-	157	T3SD4	486	1800	N
Mercury	2/5	0.17-0.62	0.14-0.38	0.22	T3SD4	0.169	0.15	Y
Nickel	5/5	8.5-28.6	-	15	T3SD4	34.5	20.9	Y
Potassium	5/5	1300-5160	-	2664	T3SD4	-	-	N (7)
Sodium	5/5	4000-26700	-	12162	T3SD4	-	-	N (7)
Vanadium	5/5	15.3-54.2	-	28	T3SD4	130	-	N
Zinc	5/5	32.4-173	-	82	T3SD4	112.5	150	Y
Miscellaneous (mg/kg)								
Cadmium(avs) (8)	1/1	0.22	-	0.22	EC-T3SD4	-	-	N (10)
Chromium(avs)	1/1	3.9	-	3.9	EC-T3SD4	-	-	N (10)
Copper(avs)	1/1	10	-	10	EC-T3SD4	-	34	N (10)
Lead(avs)	1/1	19	-	19	EC-T3SD4	-	-	N (10)
Nickel(avs)	1/1	1.7	-	1.7	EC-T3SD4	-	-	N (10)
Zinc(avs)	1/1	41	-	41	EC-T3SD4	-	-	N (10)
Acid volatile sulfide	1/1	260	-	260	EC-T3SD4	-	-	N (10)
Total organic carbon	4/4	1432-14000	-	7558	T3SD4	-	-	N (10)

TABLE 2-6

COPC SCREENING FOR THAMES RIVER
DRMO SEDIMENT
NSB-NLON, GROTON, CONNECTICUT
PAGE 3 OF 3

- Not available or Not applicable.

(1) Includes data from the following samples: EC-T3SD4-02, T3SD4, T4SD4, T5SD4, and T5SD4-D.

(2) Background concentrations established using NOAA Technical Memorandum NOS OCRA80, "Biological Effects of Toxic Contaminants in Sediments from Long Island Sound and Environs," NOAA, 1994.

(3) Benchmark values for organics are sample location-specific benchmarks based on equilibrium partitioning (EqP) using sample specific total organic carbon and benchmark for surface water. Range indicates organic parameter was detected at more than one sample location. Except as indicated, benchmarks for inorganics are the effects range-low (ER-L) from Long, et. al., 1995.

(4) Contaminant of Potential Concern; Yes (Y) indicates that the maximum concentration exceeds one or more criteria; No (N) indicates that the maximum does not exceed any of the criteria.

(5) Criteria not available.

(6) Washington State Department of Ecology (1994).

(7) Naturally occurring chemical not considered for screening.

(8) Acid Volatile Sulfide/Simultaneously Extracted Metal.

(9) OME, 1988.

(10) Not appropriate for COPC screening.

TABLE 2-7

COPC SCREENING FOR THAMES RIVER
ZONE 5 SEDIMENT
NSB-NLON, GROTON, CONNECTICUT
PAGE 1 OF 3

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	Background (2)	Benchmark Value (3)	Select as COPC? (4)
Volatile Organic Compounds (mg/kg)								
2-Butanone	1/1	0.061	-	0.061	EC-SDTR02	-	0.738	N
Acetone	1/1	0.32	-	0.32	EC-SDTR02	-	-	Y (5)
Semivolatile Organic Compounds (mg/kg)								
Acenaphthene	1/4	0.13	1.6-1.9	0.7	EC-SDTR02	-	0.299	N
Acenaphthylene	2/4	0.063-0.082	1.8-1.9	0.5	T5SD3	-	4.2 - 32.3	N
Anthracene	3/4	0.18-0.25	0.13	0.18	T3SD3	-	5.44 - 41.8	N
Benzo(a)anthracene	4/4	0.39-0.85	-	0.58	EC-SDTR02	-	9.54 - 73.3	N
Benzo(a)pyrene	4/4	0.6-0.87	-	0.68	EC-SDTR02	-	19.3 - 148	N
Benzo(b)fluoranthene	3/4	0.42-0.76	1	0.57	T3SD3	-	86.2 - 121	N
Benzo(g,h,i)perylene	4/4	0.24-0.41	-	0.33	EC-SDTR02	-	70 - 538	N
Benzo(k)fluoranthene	4/4	0.43-1.7	-	0.82	EC-SDTR02	-	9.65 - 74.2	N
Chrysene	4/4	0.54-1.1	-	0.74	EC-SDTR02	-	9.54 - 73.3	N
Dibenzo(a,h)anthracene	1/4	0.14	1.6-1.9	0.7	EC-SDTR02	-	12.1	N
Dibenzofuran	1/4	0.058	1.6-1.9	0.68	EC-SDTR02	-	0.409	N
Fluoranthene	3/4	1.3-1.9	1.1	1.3	EC-SDTR02	-	3.48 - 26.7	N
Fluorene	1/4	0.06	1.6-1.9	0.68	EC-SDTR02	-	0.0913	N
Indeno(1,2,3-cd)pyrene	4/4	0.35-0.53	-	0.44	EC-SDTR02	-	185 - 1420	N
Naphthalene	1/4	0.055	1.6-1.9	0.68	EC-SDTR02	-	0.0898	N
Phenanthrene	3/4	0.42-0.52	0.46	0.41	T3SD3	-	0.366 - 2.82	Y
Pyrene	3/4	0.97-2.2	0.86	1.2	EC-SDTR02	-	7.43 - 57.1	N
Pesticides/PCBs (mg/kg)								
4,4'-DDD	3/4	0.0031-0.018	0.01	0.0079	T4SD3	-	0.00773 - 0.0108	Y
4,4'-DDE	2/4	0.0053-0.0063	0.01-0.18	0.027	T4SD3	-	0.00549	Y
Aldrin	1/4	0.0051	0.0053-0.094	0.024	T4SD3	-	0.0192	N
Endrin aldehyde	1/4	0.014	0.01-0.18	0.047	T4SD3	-	0.0103	Y
Heptachlor	1/4	0.0059	0.0053-0.1	0.026	T5SD3	-	0.00107	Y
Metals (mg/kg)								
Aluminum	4/4	15100-16400	-	15650	T5SD3	54500	27000 (6)	N

TABLE 2-7

COPC SCREENING FOR THAMES RIVER
ZONE 5 SEDIMENT
NSB-NLON, GROTON, CONNECTICUT
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Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	Background (2)	Benchmark Value (3)	Select as COPC? (4)
Antimony	4/4	2.5-36.3	-	26	T4SD3	0.405	64 (6)	Y
Arsenic	4/4	10.2-15.1	-	13	EC-SDTR02	6.75	8.2	Y
Barium	4/4	54.1-69.3	-	62	T3SD3	580	-	N
Beryllium	4/4	0.68-1.1	-	0.8	EC-SDTR02	3	-	N
Boron	1/4	70.2	115-159	67	EC-SDTR02	100	-	N
Calcium	4/4	6010-8440	-	7180	EC-SDTR02	-	-	N (7)
Chromium	4/4	59.8-83.1	-	74	EC-SDTR02	73	81	Y
Cobalt	4/4	7.3-8.9	-	8.1	EC-SDTR02	19	50 (9)	N
Copper	4/4	76.7-109	-	89	EC-SDTR02	36.8	34	Y
Iron	4/4	23700-32300	-	27175	EC-SDTR02	29250	-	Y
Lead	4/4	62.2-101	-	87.3	T5SD3	42.2	46.7	Y
Magnesium	4/4	7470-11000	-	8963	EC-SDTR02	-	-	N (7)
Manganese	4/4	271-435	-	344	EC-SDTR02	486	1800	N
Mercury	3/4	0.37-0.43	0.4	0.35	T3SD3	0.169	0.15	Y
Nickel	4/4	25.2-32.8	-	27.4	EC-SDTR02	34.5	20.9	Y
Potassium	4/4	3900-5610	-	4733	EC-SDTR02	-	-	N (7)
Sodium	4/4	14100-25600	-	18325	EC-SDTR02	-	-	N (7)
Vanadium	4/4	44.7-51	-	47	EC-SDTR02	130	-	N
Zinc	4/4	132-179	-	147	EC-SDTR02	112.5	150	Y
Miscellaneous (mg/kg)								
Cadmium(avs) (8)	1/1	0.6	-	0.6	EC-SDTR02	-	-	N (10)
Chromium(avs)	1/1	17	-	17	EC-SDTR02	73	81	N (10)
Copper(avs)	1/1	61	-	61	EC-SDTR02	-	-	N (10)
Lead(avs)	1/1	78	-	78	EC-SDTR02	-	-	N (10)
Nickel(avs)	1/1	6.9	-	6.9	EC-SDTR02	-	-	N (10)
Zinc(avs)	1/1	110	-	110	EC-SDTR02	-	-	N (10)
Acid volatile sulfide	1/1	1100	-	1100	EC-SDTR02	-	-	N (10)
Total organic carbon	4/4	1821-14000	-	9955	T4SD3/T5SD3	-	-	N (10)

TABLE 2-7

COPC SCREENING FOR THAMES RIVER
ZONE 5 SEDIMENT
NSB-NLON, GROTON, CONNECTICUT
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- Not available or not applicable.

(1) Includes data from the following samples: EC-SDTR02-02, T3SD3, T4SD3, and T5SD3.

(2) Background concentrations established using NOAA Technical Memorandum NOS OCRA80, "Biological Effects of Toxic Contaminants in Sediments from Long Island Sound and Environs," NOAA, 1994.

(3) Benchmark values for organics are sample location-specific benchmarks based on equilibrium partitioning (EqP) using sample specific total organic carbon and benchmark for surface water. Range indicates organic parameter was detected at more than one sample location. Except as indicated, benchmarks for inorganics are the effects range-low (ER-L) from Long, et. al., 1995.

(4) Contaminant of Potential Concern; Yes (Y) indicates that the maximum concentration exceeds one or more criteria; No (N) indicates that the maximum does not exceed any of the criteria.

(5) Criteria not available.

(6) Washington State Department of Ecology (1994).

(7) Nautrally occurring chemical not considered for screening.

(8) Acid Volatile Sulfide/Simultaneously Extracted Metal.

(9) OME, 1988.

(10) Not appropriate for COPC screening.

TABLE 2-8

COPC SCREENING FOR THAMES RIVER
ZONE 6 SEDIMENT
NSB-NLON, GROTON, CONNECTICUT
PAGE 1 OF 3

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	Background (2)	Benchmark Value (3)	Select as COPC? (4)
Volatile Organic Compounds (mg/kg)								
2-Butanone	1/1	0.12	-	0.12	EC-SDTR03	-	0.811	N
Acetone	1/1	0.43	-	0.43	EC-SDTR03	-	-	Y (5)
Semivolatile Organic Compounds (mg/kg)								
Acenaphthylene	1/1	0.056	-	0.056	EC-SDTR03	-	4.62	N
Anthracene	1/1	0.16	-	0.16	EC-SDTR03	-	5.98	N
Benzo(a)anthracene	1/1	0.57	-	0.57	EC-SDTR03	-	10.5	N
Benzo(a)pyrene	1/1	0.68	-	0.68	EC-SDTR03	-	21.2	N
Benzo(b)fluoranthene	1/1	0.72	-	0.72	EC-SDTR03	-	17.3	N
Benzo(g,h,i)perylene	1/1	0.41	-	0.41	EC-SDTR03	-	76.9	N
Benzo(k)fluoranthene	1/1	0.69	-	0.69	EC-SDTR03	-	10.6	N
Chrysene	1/1	0.78	-	0.78	EC-SDTR03	-	10.5	N
Dibenzo(a,h)anthracene	1/1	0.18	-	0.18	EC-SDTR03	-	13.3	N
Fluoranthene	1/1	1.5	-	1.5	EC-SDTR03	-	3.83	N
Fluorene	1/1	0.07	-	0.07	EC-SDTR03	-	0.1	N
Indeno(1,2,3-cd)pyrene	1/1	0.41	-	0.41	EC-SDTR03	-	204	N
Phenanthrene	1/1	0.42	-	0.42	EC-SDTR03	-	0.403	Y
Pyrene	1/1	1.2	-	1.2	EC-SDTR03	-	8.17	N
Metals (mg/kg)								
Aluminum	1/1	17100	-	17100	EC-SDTR03	54500	27000 (6)	N
Antimony	1/1	2.3	-	2.3	EC-SDTR03	0.405	64 (6)	Y
Arsenic	1/1	16.6	-	17	EC-SDTR03	6.75	8.2	Y
Barium	1/1	64.7	-	65	EC-SDTR03	580	-	N
Beryllium	1/1	1.1	-	1.1	EC-SDTR03	3	-	N
Boron	1/1	62.6	-	63	EC-SDTR03	100	-	N
Cadmium	1/1	0.56	-	0.56	EC-SDTR03	0.39	1.2	Y
Calcium	1/1	8300	-	8300	EC-SDTR03	-	-	N (7)
Chromium	1/1	88.4	-	88	EC-SDTR03	73	81	Y

TABLE 2-8

COPC SCREENING FOR THAMES RIVER
ZONE 6 SEDIMENT
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 3

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	Background (2)	Benchmark Value (3)	Select as COPC? (4)
Cobalt	1/1	9.1	-	9.1	EC-SDTR03	19	50 (9)	N
Copper	1/1	121	-	121	EC-SDTR03	36.8	34	Y
Iron	1/1	34500	-	34500	EC-SDTR03	29250	-	Y
Lead	1/1	97.5	-	98	EC-SDTR03	42.2	46.7	Y
Magnesium	1/1	10100	-	10100	EC-SDTR03	-	-	N (7)
Manganese	1/1	416	-	416	EC-SDTR03	486	1800	N
Nickel	1/1	34.7	-	35	EC-SDTR03	34.5	20.9	Y
Potassium	1/1	5870	-	5870	EC-SDTR03	-	-	N (7)
Silver	1/1	1.4	-	1.4	EC-SDTR03	0.615	1	Y
Sodium	1/1	18000	-	18000	EC-SDTR03	-	-	N (7)
Vanadium	1/1	54.1	-	54	EC-SDTR03	130	-	N
Zinc	1/1	195	-	195	EC-SDTR03	112.5	150	Y
Miscellaneous (mg/kg)								
Cadmium(avs) (8)	1/1	0.54	-	0.54	EC-SDTR03	-	-	N (10)
Chromium(avs)	1/1	16	-	16	EC-SDTR03	-	-	N (10)
Copper(avs)	1/1	60	-	60	EC-SDTR03	-	-	N (10)
Lead(avs)	1/1	73	-	73	EC-SDTR03	-	-	N (10)
Nickel(avs)	1/1	6.6	-	6.6	EC-SDTR03	-	-	N (10)
Zinc(avs)	1/1	110	-	110	EC-SDTR03	-	-	N (10)
Acid volatile sulfide	1/1	920	-	920	EC-SDTR03	-	-	N (10)
Total organic carbon	1/1	2003	-	2003	EC-SDTR03	-	-	N (10)

- Not available or not applicable.
(1) Includes data from sample EC-SDTR03-02.
(2) Background concentrations established using NOAA Technical Memorandum NOS OCRA80, "Biological Effects of Toxic Contaminants in Sediments from Long Island Sound and Environs," NOAA, 1994.

TABLE 2-8

COPC SCREENING FOR THAMES RIVER
ZONE 6 SEDIMENT
NSB-NLON, GROTON, CONNECTICUT
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(3) Benchmark values for organics are sample location-specific benchmarks based on equilibrium partitioning (EqP) using sample specific total organic carbon and benchmark for surface water. Range indicates organic parameter was detected at more than one sample location. Except as indicated, benchmarks for inorganics are the effects range-low (ER-L) from Long, et. al., 1995.
(4) Contaminant of Potential Concern; Yes (Y) indicates that the maximum concentration exceeds one or more criteria; No (N) indicates that the maximum does not exceed any of the criteria.
(5) Criteria not available.
(6) Washington State Department of Ecology (1994).
(7) Naturally occurring chemical, not considered for screening.
(8) Acid Volatile Sulfide/Simultaneously Extracted Metal.
(9) OME, 1988.
(10) Not appropriate for COPC screening

TABLE 2-9

COPC SCREENING FOR THAMES RIVER
ZONE 7 SEDIMENT
NSB-NLON, GROTON, CONNECTICUT
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Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	Background (2)	Benchmark Value (3)	Select as COPC? (4)
Semivolatile Organic Compounds (mg/kg)								
Acenaphthylene	1/1	0.24	-	0.24	C1-PIER17 NORTH	-	4.02	N
Anthracene	1/1	0.25	-	0.25	C1-PIER17 NORTH	-	5.21	N
Benzo(a)anthracene	1/1	0.97	-	0.97	C1-PIER17 NORTH	-	9.14	N
Benzo(a)pyrene	1/1	0.87	-	0.87	C1-PIER17 NORTH	-	18.5	N
Benzo(b)fluoranthene	1/1	0.73	-	0.73	C1-PIER17 NORTH	-	-	Y (5)
Benzo(g,h,i)perylene	1/1	0.26	-	0.26	C1-PIER17 NORTH	-	67	N
Benzo(k)fluoranthene	1/1	0.88	-	0.88	C1-PIER17 NORTH	-	9.24	N
Chrysene	1/1	1.2	-	1.2	C1-PIER17 NORTH	-	9.14	N
Fluoranthene	1/1	3	-	3	C1-PIER17 NORTH	-	3.33	N
Indeno(1,2,3-cd)pyrene	1/1	0.55	-	0.55	C1-PIER17 NORTH	-	177	N
Phenanthrene	1/1	0.72	-	0.72	C1-PIER17 NORTH	-	0.351	Y
Pesticides/PCBs (mg/kg)								
Aroclor-1248	1/1	0.055	-	0.055	C1-PIER17 NORTH	-	-	Y (5)
Aroclor-1260	1/1	0.07	-	0.07	C1-PIER17 NORTH	-	-	Y (5)
beta-BHC	1/1	0.0054	-	0.0054	C1-PIER17 NORTH	-	-	Y (5)
Endosulfan sulfate	1/1	0.0084	-	0.0084	C1-PIER17 NORTH	-	-	Y (5)
Heptachlor epoxide	1/1	0.0032	-	0.0032	C1-PIER17 NORTH	-	-	Y (5)
Metals (mg/kg)								
Arsenic	1/1	13.5	-	14	C1-PIER17 NORTH	6.75	8.2	Y
Cadmium	1/1	1.7	-	1.7	C1-PIER17 NORTH	0.39	1.2	Y
Chromium	1/1	102	-	102	C1-PIER17 NORTH	73	81	Y
Copper	1/1	127	-	127	C1-PIER17 NORTH	36.8	34	Y
Lead	1/1	117	-	117	C1-PIER17 NORTH	42.2	46.7	Y
Mercury	1/1	0.51	-	0.51	C1-PIER17 NORTH	0.169	0.15	Y
Nickel	1/1	32.1	-	32	C1-PIER17 NORTH	34.5	20.9	Y
Zinc	1/1	200	-	200	C1-PIER17 NORTH	112.5	150	Y

TABLE 2-9

COPC SCREENING FOR THAMES RIVER
ZONE 7 SEDIMENT
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 2

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	Background (2)	Benchmark Value (3)	Select as COPC? (4)
Miscellaneous (mg/kg)								
Total organic carbon	1/1	2600	-	2600	C1-PIER17 NORTH	-	-	N (6)

- Not available or not applicable.
(1) Includes data from sample C1.
(2) Background concentrations established using NOAA Technical Memorandum NOS OCRA80, "Biological Effects of Toxic Contaminants in Sediments from Long Island Sound and Environs," NOAA, 1994.
(3) Benchmark values for organics are sample location-specific benchmarks for sediment sample EC-SDTR04 which was located in close proximity to C1-Pier 17 North (EC-SDTR04 has since been excavated). The benchmarks were calculated based on equilibrium partitioning (EqP) using sample location-specific total organic carbon and benchmark for surface water. Range indicates organic parameter was detected at more than one sample location (see footnote 1). Except as indicated, benchmarks for inorganics are the effects range-low (ER-L) from Long et. al., 1995.
(4) Contaminant of Potential Concern; Yes (Y) indicates that the maximum concentration exceeds one or more criteria; No (N) indicates that the maximum does not exceed any of the criteria.
(5) Criteria not available.
(6) Not appropriate for COPC screening.

TABLE 2-10

COPC SCREENING FOR THAMES RIVER
ZONE 1 SEDIMENT
NSB-NLON, GROTON, CONNECTICUT
PAGE 1 OF 3

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	Background (2)	Benchmark Value(3)	Select as COPC? (4)
Volatile Organic Compounds (mg/kg)								
2-Butanone	1/1	0.074	-	0.074	EC-SDTR05	-	0.515	N
Acetone	1/1	0.2	-	0.2	EC-SDTR05	-	-	Y (5)
Semivolatile Organic Compounds (mg/kg)								
Acenaphthylene	1/1	0.069	-	0.069	EC-SDTR05	-	2.93	N
Anthracene	1/1	0.2	-	0.2	EC-SDTR05	-	3.79	N
Benzo(a)anthracene	1/1	1.1	-	1.1	EC-SDTR05	-	6.65	N
Benzo(a)pyrene	1/1	0.88	-	0.88	EC-SDTR05	-	13.4	N
Benzo(b)fluoranthene	1/1	0.74	-	0.74	EC-SDTR05	-	11	N
Benzo(g,h,i)perylene	1/1	0.52	-	0.52	EC-SDTR05	-	48.8	N
Benzo(k)fluoranthene	1/1	0.88	-	0.88	EC-SDTR05	-	6.73	N
Carbazole	1/1	0.062	-	0.062	EC-SDTR05	-	2.63	N
Chrysene	1/1	1.3	-	1.3	EC-SDTR05	-	6.65	N
Di-N-butyl phthalate	1/1	0.055	-	0.055	EC-SDTR05	-	5.42	N
Dibenzo(a,h)anthracene	1/1	0.22	-	0.22	EC-SDTR05	-	8.45	N
Fluoranthene	1/1	1.6	-	1.6	EC-SDTR05	-	2.43	N
Fluorene	1/1	0.077	-	0.077	EC-SDTR05	-	0.0637	Y
Indeno(1,2,3-cd)pyrene	1/1	0.46	-	0.46	EC-SDTR05	-	129	N
Naphthalene	1/1	0.06	-	0.06	EC-SDTR05	-	0.0627	N
Phenanthrene	1/1	0.47	-	0.47	EC-SDTR05	-	0.255	Y
Pyrene	1/1	2.2	-	2.2	EC-SDTR05	-	5.18	N
Metals (mg/kg)								
Aluminum	1/1	12900	-	12900	EC-SDTR05	54500	27000 (6)	N
Antimony	1/1	2.6	-	2.6	EC-SDTR05	0.405	64 (6)	Y
Arsenic	1/1	14.5	-	14.5	EC-SDTR05	6.75	8.2	Y
Barium	1/1	58.8	-	58.8	EC-SDTR05	580	-	N
Beryllium	1/1	0.93	-	0.93	EC-SDTR05	3	-	N
Boron	1/1	55.8	-	55.8	EC-SDTR05	100	-	N

TABLE 2-10

COPC SCREENING FOR THAMES RIVER
ZONE 1 SEDIMENT
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 3

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	Background (2)	Benchmark Value(3)	Select as COPC? (4)
Calcium	1/1	6680	-	6680	EC-SDTR05	-	-	N (7)
Chromium	1/1	74.8	-	74.8	EC-SDTR05	73	81	Y
Cobalt	1/1	8	-	8	EC-SDTR05	19	50 (9)	N
Copper	1/1	119	-	119	EC-SDTR05	36.8	34	Y
Iron	1/1	29600	-	29600	EC-SDTR05	29250	-	Y
Lead	1/1	96.7	-	96.7	EC-SDTR05	42.2	46.7	Y
Magnesium	1/1	9300	-	9300	EC-SDTR05	-	-	N (7)
Manganese	1/1	322	-	322	EC-SDTR05	486	1800	N
Nickel	1/1	31.2	-	31.2	EC-SDTR05	34.5	20.9	Y
Potassium	1/1	5010	-	5010	EC-SDTR05	-	-	N (7)
Sodium	1/1	23400	-	23400	EC-SDTR05	-	-	N (7)
Vanadium	1/1	46.3	-	46.3	EC-SDTR05	13	-	N
Zinc	1/1	231	-	231	EC-SDTR05	112.5	150	Y
Miscellaneous (mg/kg)								
Cadmium(avs) (8)	1/1	0.59	-	0.59	EC-SDTR05	-	-	N (10)
Chromium(avs)	1/1	15	-	15	EC-SDTR05	-	-	N (10)
Copper(avs)	1/1	35	-	35	EC-SDTR05	-	-	N (10)
Lead(avs)	1/1	75	-	75	EC-SDTR05	-	-	N (10)
Nickel(avs)	1/1	6.3	-	6.3	EC-SDTR05	-	-	N (10)
Zinc(avs)	1/1	110	-	110	EC-SDTR05	-	-	N (10)
Acid volatile sulfide	1/1	3300	-	3300	EC-SDTR05	-	-	N (10)
Total organic carbon	1/1	1270	-	1270	EC-SDTR05	-	-	N (10)

- Not available or not applicable.
(1) Includes data from sample EC-SDTR05-02.
(2) Background concentrations established using NOAA Technical Memorandum NOS OCRA80, "Biological Effects of Toxic Contaminants in Sediments from Long Island Sound and Environs," NOAA, 1994.

TABLE 2-10

COPC SCREENING FOR THAMES RIVER
ZONE 1 SEDIMENT
NSB-NLON, GROTON, CONNECTICUT
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(3) Benchmark values for organics are sample location-specific benchmarks based on equilibrium partitioning (EqP) using sample specific total organic carbon and benchmark for surface water. Range indicates organic parameter was detected at more than one sample location. Except as indicated, benchmarks for inorganics are the effects range-low (ER-L) from Long, et. al., 1995.
(4) Contaminant of Potential Concern; Yes (Y) indicates that the maximum concentration exceeds one or more criteria; No (N) indicates that the maximum does not exceed any of the criteria.
(5) Criteria not available.
(6) Washington State Department of Ecology (1994).
(7) Naturally occurring chemical, not considered for screening.
(8) Acid Volatile Sulfide/Simultaneously Extracted Metal.
(9) OME, 1988.
(10) Not appropriate for COPC screening

TABLE 2-11

COPC SCREENING FOR THAMES RIVER
ZONES 2 AND 3 SEDIMENT
NSB-NLON, GROTON, CONNECTICUT
PAGE 1 OF 3

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	Background (2)	Benchmark Value(3)	Select as COPC? (4)
Volatile Organic Compounds (mg/kg)								
2-Butanone	1/1	0.058	-	0.058	EC-T4SD2	-	3.47	N
Acetone	1/1	0.24	-	0.24	EC-T4SD2	-	-	Y (5)
Semivolatile Organic Compounds (mg/kg)								
Acenaphthene	1/4	0.14	0.78-1.6	0.45	T4SD2	-	1.41	N
Acenaphthylene	2/4	0.052-0.17	0.78-1.6	0.35	T4SD2	-	19.8	N
Anthracene	3/4	0.15-0.68	0.78	0.36	T4SD2	-	25.6 - 35.8	N
Benzo(a)anthracene	3/4	0.46-2	0.78	0.99	T4SD2	-	44.9 - 62.8	N
Benzo(a)pyrene	4/4	0.088-1.4	-	0.72	T4SD2	-	90.7 - 127	N
Benzo(b)fluoranthene	2/4	0.45-1.8	0.78-0.94	0.78	T4SD2	-	73.9 - 103	N
Benzo(g,h,i)perylene	3/4	0.4-0.66	0.78	0.47	T4SD2	-	329 - 461	N
Benzo(k)fluoranthene	3/4	0.47-1.4	0.78	0.79	EC-T4SD2	-	45.4 - 63.6	N
Bis(2-ethylhexyl)phthalate	1/4	0.09	0.94-2.1	0.6	T5SD2	-	57.1	N
Carbazole	2/4	0.084-0.14	0.78-1.6	0.35	T4SD2	-	17.7	N
Chrysene	3/4	0.68-2	0.78	1.1	T4SD2	-	44.9 - 62.8	N
Di-N-butyl phthalate	2/4	0.05-0.16	0.78-1.6	0.35	T4SD2	-	36.6	N
Dibenzo(a,h)anthracene	1/4	0.2	0.78-2.1	0.61	EC-T4SD2	-	57	N
Dibenzofuran	1/4	0.11	0.78-1.6	0.44	T4SD2	-	1.92	N
Fluoranthene	3/4	0.83-5.3	0.78	2.4	T4SD2	-	16.4 - 22.9	N
Fluorene	2/4	0.08-0.19	0.78-1.6	0.37	T4SD2	-	0.43	N
Indeno(1,2,3-cd)pyrene	3/4	0.42-0.85	0.78	0.53	T4SD2	-	871 - 1220	N
Naphthalene	1/4	0.066	0.78-2.1	0.58	EC-T4SD2	-	0.423	N
Phenanthrene	3/4	0.43-2.1	0.78	0.84	T4SD2	-	1.72 - 2.41	Y
Pyrene	3/4	0.79-5.3	0.78	2.1	T4SD2	-	35 - 49	N
Pesticides/PCBs (mg/kg)								
gamma-BHC (Lindane)	1/4	0.0038	0.048-0.083	0.028	T4SD2	-	0.00105	Y
Metals (mg/kg)								
Aluminum	4/4	15200-18500	-	16925	EC-T4SD2	-	27000(6)	N
Antimony	4/4	2.6-41.1	-	29	T4SD2	0.405	64(6)	Y

TABLE 2-11

COPC SCREENING FOR THAMES RIVER
ZONES 2 AND 3 SEDIMENT
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 3

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	Background (2)	Benchmark Value(3)	Select as COPC? (4)
Arsenic	4/4	6.9-18.5	-	12	EC-T4SD2	6.75	8.2	Y
Barium	4/4	41.8-79	-	64	EC-T4SD2	580	-	N
Beryllium	4/4	0.54-1.2	-	0.79	EC-T4SD2	3	-	N
Boron	1/4	69.2	134-185	77	EC-T4SD2	100	-	N
Cadmium	1/4	0.61	0.51-0.65	0.37	EC-T4SD2	0.39	1.2	Y
Calcium	4/4	6550-9840	-	8460	T5SD2	-	-	N (7)
Chromium	4/4	37.1-100	-	72	EC-T4SD2	73	81	Y
Cobalt	4/4	7.3-10.9	-	8.5	EC-T4SD2	19	50 (8)	N
Copper	4/4	22.6-176	-	99	EC-T4SD2	36.8	34	Y
Iron	4/4	22400-40400	-	29525	EC-T4SD2	29250	-	Y
Lead	4/4	12.7-139	-	92	T4SD2	42.2	46.7	Y
Magnesium	4/4	7930-11900	-	9443	EC-T4SD2	-	-	N (7)
Manganese	4/4	245-466	-	339	EC-T4SD2	486	1800	N
Mercury	2/4	0.56-0.63	0.28-0.43	0.39	T3SD2	0.169	0.15	Y
Nickel	4/4	18.8-54.6	-	35	EC-T4SD2	34.5	20.9	Y
Potassium	4/4	4330-6280	-	5098	EC-T4SD2	-	-	N (7)
Silver	1/4	1.4	1.1-2.2	0.99	EC-T4SD2	0.615	1	Y
Sodium	4/4	16300-22900	-	19300	EC-T4SD2	-	-	N (7)
Vanadium	4/4	40.7-64.3	-	50	EC-T4SD2	130	-	N
Zinc	4/4	59.6-235	-	157	EC-T4SD2	112.5	150	Y
Miscellaneous (mg/kg)								
Cadmium(avs) (8)	1/1	0.59	-	0.59	EC-T4SD2	-	-	N (10)
Chromium(avs)	1/1	15	-	15	EC-T4SD2	-	-	N (10)
Copper(avs)	1/1	51	-	51	EC-T4SD2	-	-	N (10)
Lead(avs)	1/1	76	-	76	EC-T4SD2	-	-	N (10)
Nickel(avs)	1/1	8.1	-	8.1	EC-T4SD2	-	-	N (10)
Zinc(avs)	1/1	110	-	110	EC-T4SD2	-	-	N (10)
Acid volatile sulfide	1/1	1700	-	1700	EC-T4SD2	-	-	N (10)
Total organic carbon	4/4	1136-16000	-	10034	T4SD2	-	-	N (10)

TABLE 2-11

COPC SCREENING FOR THAMES RIVER
ZONES 2 AND 3 SEDIMENT
NSB-NLON, GROTON, CONNECTICUT
PAGE 3 OF 3

- Not available or not applicable.
(1) Includes data from the following samples: EC-T4SD2-02, T3SD2, T4SD2, and T5SD2.
(2) Background concentrations established using NOAA Technical Memorandum NOS OCRA80, "Biological Effects of Toxic Contaminants in Sediments from Long Island Sound and Environs," NOAA, 1994.
(3) Benchmark values for organics are sample location-specific benchmarks based on equilibrium partitioning (EqP) using sample specific total organic carbon and benchmark for surface water. Range indicates organic parameter was detected at more than one sample location. Except as indicated, benchmarks for inorganics are the effects range-low (ER-L) from Long, et. al., 1995.
(4) Contaminant of Potential Concern, Yes (Y) indicates that the maximum concentration exceeds one or more criteria; No (N) indicates that the maximum does not exceed any of the criteria.
(5) Criteria not available.
(6) Washington State Department of Ecology (1994).
(7) Naturally occurring chemical, not considered for screening.
(8) Acid Volatile Sulfide/Simultaneously Extracted Metal.
(9) OME, 1988.
(10) Not appropriate for COPC screening.

TABLE 2-12

COPC SCREENING FOR THAMES RIVER
ZONE 4 SEDIMENT
NSB-NLON, GROTON, CONNECTICUT
PAGE 1 OF 3

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	Background (2)	Benchmark Value(3)	Select as COPC? (4)
Volatile Organic Compounds (mg/kg)								
2-Butanone	2/2	0.074-0.19	-	0.13	EC-SDTR06	-	0.607	N
Acetone	2/2	0.39-0.64	-	0.52	EC-SDTR06	-	-	Y (5)
Semivolatile Organic Compounds (mg/kg)								
Acenaphthylene	1/2	0.066	1	0.28	EC-SDTR06	-	3.46	N
Anthracene	2/2	0.28-0.34	-	0.31	EC-SDTR06	-	4.48	N
Benzo(a)anthracene	2/2	1.1-1.3	-	1.2	EC-SDTR06	-	7.85	N
Benzo(a)pyrene	2/2	1-1.1	-	1.1	EC-SDTR06	-	15.9	N
Benzo(b)fluoranthene	2/2	0.99-1	-	1	EC-SDTR06	-	12.9	N
Benzo(g,h,i)perylene	2/2	0.52-0.53	-	0.53	EC-SDTR06	-	57.6	N
Benzo(k)fluoranthene	2/2	0.84-1.2	-	1	EC-SDTR06	-	7.94	N
Carbazole	2/2	0.067-0.075	-	0.071	EC-SDTR06	-	3.1	N
Chrysene	2/2	1.6	-	1.6	EC-SDTR06	-	7.85	N
Di-N-butyl phthalate	1/2	0.058	1	0.28	EC-SDTR06	-	6.4	N
Dibenzo(a,h)anthracene	2/2	0.24	-	0.24	EC-SDTR06	-	9.97	N
Dibenzofuran	1/2	0.055	1.1	0.3	EC-SDTR06	-	0.337	N
Fluoranthene	2/2	2.7-3.8	-	3.3	EC-SDTR06	-	2.86	Y
Fluorene	2/2	0.087-0.1	-	0.094	EC-SDTR06	-	0.0752	Y
Indeno(1,2,3-cd)pyrene	2/2	0.5-0.57	-	0.54	EC-SDTR06	-	152	N
Phenanthrene	2/2	0.53-0.54	-	0.54	EC-SDTR06	-	0.302	Y
Pyrene	2/2	2.6-2.8	-	2.7	EC-SDTR06	-	6.12	N
Metals (mg/kg)								
Aluminum	2/2	14100-15100	-	14600	EC-SDTR06	54500	27000 (6)	N
Arsenic	2/2	13-14.6	-	14	EC-SDTR06	6.75	8.2	Y
Barium	2/2	59.7-65.8	-	63	EC-SDTR06	580	-	N
Beryllium	2/2	0.97-1	-	0.99	EC-SDTR06	3	-	N
Boron	2/2	56.1-59.2	-	58	EC-SDTR06	100	-	N
Calcium	2/2	7800-8710	-	8255	EC-SDTR06	-	-	N (7)

TABLE 2-12

COPC SCREENING FOR THAMES RIVER
ZONE 4 SEDIMENT
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 3

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	Background (2)	Benchmark Value(3)	Select as COPC? (4)
Chromium	2/2	75.3-83.1	-	79	EC-SDTR06	73	81	Y
Cobalt	2/2	8.2-9	-	8.6	EC-SDTR06	19	50 (8)	N
Copper	2/2	112-128	-	120	EC-SDTR06	36.8	34	Y
Iron	2/2	30600-33300	-	31950	EC-SDTR06	29250	-	Y
Lead	2/2	105-114	-	110	EC-SDTR06	42.2	46.7	Y
Magnesium	2/2	9690-10400	-	10045	EC-SDTR06	-	-	N (7)
Manganese	2/2	322-357	-	340	EC-SDTR06	486	1800	N
Nickel	2/2	33.5-37.2	-	35	EC-SDTR06	34.5	20.9	Y
Potassium	2/2	5480-5740	-	5610	EC-SDTR06	-	-	N (7)
Sodium	2/2	24800-25100	-	24950	EC-SDTR06	-	-	N (7)
Thallium	1/2	2.3	2	1.7	EC-SDTR06	-	-	Y (5)
Vanadium	2/2	49.6-54.1	-	52	EC-SDTR06	130	-	N
Zinc	2/2	199-213	-	206	EC-SDTR06	112.5	150	Y
Miscellaneous (mg/kg)								
Cadmium(avs) (8)	2/2	0.55-0.62	-	0.59	EC-SDTR06	-	-	N (10)
Chromium(avs)	2/2	13-14	-	14	EC-SDTR06	-	-	N (10)
Copper(avs)	2/2	23-26	-	25	EC-SDTR06	-	-	N (10)
Lead(avs)	2/2	75-83	-	79	EC-SDTR06	-	-	N (10)
Nickel(avs)	2/2	6.5-6.6	-	6.6	EC-SDTR06	-	-	N (10)
Zinc(avs)	2/2	110-120	-	115	EC-SDTR06	-	-	N (10)
Acid volatile sulfide	2/2	2800-3400	-	3100	EC-SDTR06	-	-	N (10)
Total organic carbon	2/2	1190-1499	-	1345	EC-SDTR06		-	N (10)

- Not available or not applicable.
(1) Includes data from samples EC-SDTR06-02 and DUP-07.
(2) Background concentrations established using NOAA Technical Memorandum NOS OCRA80, "Biological Effects of Toxic Contaminants in Sediments from Long Island Sound and Environs," NOAA, 1994.

TABLE 2-12

COPC SCREENING FOR THAMES RIVER
ZONE 4 SEDIMENT
NSB-NLON, GROTON, CONNECTICUT
PAGE 3 OF 3

(3) Benchmark values for organics are sample location-specific benchmarks based on equilibrium partitioning (EqP) using sample specific total organic carbon and benchmark for surface water. Range indicates organic parameter was detected at more than one sample location. Except as indicated, benchmarks for inorganics are the effects range-low (ER-L) from Long, et. al., 1995.
(4) Contaminant of Potential Concern; Yes (Y) indicates that the maximum concentration exceeds one or more criteria; No (N) indicates that the maximum does not exceed any of the criteria.
(5) Criteria not available.
(6) Washington State Department of Ecology (1994).
(7) Naturally occurring chemical, not considered for screening.
(8) Acid Volatile Sulfide/Simultaneously Extracted Metal.
(9) OME, 1988.
(10) Not appropriate for COPC screening.

TABLE 2-13

COPC SCREENING FOR THAMES RIVER
GOSS COVE SEDIMENT
NSB-NLON, GROTON, CONNECTICUT
PAGE 1 OF 3

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	Background (2)	Benchmark Value(3)	Select as COPC? (4)
Volatile Organic Compounds (mg/kg)								
2-Butanone	2/3	0.03-0.052	0.026	0.032	T3SD1	-	3.28	N
Acetone	1/3	0.096	0.14-0.2	0.089	EC-T3SD1	-	-	Y (5)
Carbon disulfide	1/3	0.007	0.026-0.027	0.011	T3SD1	-	5.67	N
Semivolatile Organic Compounds (mg/kg)								
Acenaphthylene	2/4	0.048-0.13	1.7	0.47	T5SD1	-	18.6 - 34.6	N
Anthracene	4/4	0.11-0.23	-	0.16	T5SD1	-	24.1 - 44.8	N
Benzo(a)anthracene	4/4	0.39-0.56	-	0.47	T5SD1	-	42.3 - 78.5	N
Benzo(a)pyrene	4/4	0.49-0.67	-	0.56	T5SD1	-	85.6 - 159	N
Benzo(b)fluoranthene	4/4	0.6-0.88	-	0.71	EC-T3SD1	-	69.7 - 129	N
Benzo(g,h,i)perylene	4/4	0.32-0.48	-	0.39	T5SD1	-	311 - 576	N
Benzo(k)fluoranthene	3/4	0.3-0.46	0.89	0.42	T3SD1/T5SD1	-	42.8 - 79.4	N
Chrysene	4/4	0.57-0.7	-	0.62	T5SD1	-	42.3 - 78.5	N
Di-N-butyl phthalate	2/4	0.057-0.088	1.6-1.7	0.45	T3SD1	-	34.5	N
Dibenzo(a,h)anthracene	1/4	0.14	1.6-1.7	0.66	EC-T3SD1	-	53.8	N
Fluoranthene	4/4	0.68-1.2	-	0.93	T5SD1	-	15.4 - 28.7	N
Indeno(1,2,3-cd)pyrene	4/4	0.29-0.55	-	0.43	T5SD1	-	822 - 1530	N
Phenanthrene	4/4	0.32-0.54	-	0.41	T5SD1	-	1.63 - 3.02	N
Pyrene	4/4	0.82-1.1	-	0.92	T3SD1	-	33.0 - 61.2	N
Pesticides/PCBs (mg/kg)								
4,4'-DDD	1/4	0.0063	0.089-0.17	0.054	T3SD1	-	0.00625	Y
4,4'-DDE	1/4	0.0072	0.089-0.17	0.055	T5SD1	-	0.00588	Y
4,4'-DDT	2/4	0.011-0.064	0.089-0.16	0.05	T3SD1	-	0.00983	Y
Aldrin	1/4	0.01	0.046-0.087	0.03	T3SD1	-	0.0111	Y
Endrin	1/4	0.04	0.089-0.17	0.06	T3SD1	-	0.0259	Y
Heptachlor	2/4	0.0045-0.0055	0.046-0.087	0.019	T5SD1	-	0.000616 - 0.00114	Y
Metals (mg/kg)								
Aluminum	4/4	13500-17000	-	15100	T3SD1	54500	27000 (6)	N
Antimony	4/4	2.1-42.7	-	29	T3SD1	0.405	64 (6)	Y

TABLE 2-13

COPC SCREENING FOR THAMES RIVER
GOSS COVE SEDIMENT
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 3

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	Background (2)	Benchmark Value(3)	Select as COPC? (4)
Arsenic	4/4	6.4-12.7	-	9.2	EC-T3SD1	6.75	8.2	Y
Barium	4/4	52.5-65.6	-	60	T3SD1	580	-	N
Beryllium	4/4	0.53-0.88	-	0.68	EC-T3SD1	3	-	N
Boron	1/4	53.3	97.8-122	55	EC-T3SD1	100	-	N
Calcium	4/4	5140-18700	-	10273	EC-T3SD1	-	-	N (7)
Chromium	4/4	64.3-91.5	-	73	T5SD1	73	81	Y
Cobalt	4/4	6-8.3	-	7.5	EC-T3SD1	19	50 (9)	N
Copper	4/4	81.5-91.7	-	87	T5SD1	36.8	34	Y
Iron	4/4	23000-28800	-	26350	EC-T3SD1	29250	-	N
Lead	4/4	80.9-117	-	97	T5SD1	42.2	46.7	Y
Magnesium	4/4	6960-9090	-	8293	EC-T3SD1	-	-	N (7)
Manganese	4/4	236-329	-	289	EC-T3SD1	486	1800	N
Mercury	3/4	0.49-0.66	0.35	0.47	T5SD1	0.169	0.15	Y
Nickel	4/4	25.5-33.4	-	31	T3SD1	34.5	20.9	N
Potassium	4/4	3500-5470	-	4518	EC-T3SD1	-	-	N (7)
Sodium	4/4	13400-18200	-	16050	EC-T3SD1	-	-	N (7)
Thallium	1/4	2	0.75-3.6	1.1	EC-T3SD1	-	-	Y (5)
Vanadium	4/4	40.8-45.1	-	43	EC-T3SD1	130	-	N
Zinc	4/4	133-158	-	147	EC-T3SD1	112.5	150	Y
Miscellaneous (mg/kg)								
Cadmium(avs) (8)	1/1	0.37	-	0.37	EC-T3SD1	-	-	N (10)
Chromium(avs)	1/1	12	-	12	EC-T3SD1	73	-	N (10)
Copper(avs)	1/1	39	-	39	EC-T3SD1	-	-	N (10)
Lead(avs)	1/1	61	-	61	EC-T3SD1	-	-	N (10)
Nickel(avs)	1/1	7	-	7	EC-T3SD1	-	-	N (10)
Zinc(avs)	1/1	82	-	82	EC-T3SD1	-	-	N (10)
Acid volatile sulfide	1/1	1200	-	1200	EC-T3SD1	-	-	N (10)
Total organic carbon	3/3	1169-15000	-	10390	T3SD1/T5SD1	-	-	N (10)

TABLE 2-13

COPC SCREENING FOR THAMES RIVER
GOSS COVE SEDIMENT
NSB-NLON, GROTON, CONNECTICUT
PAGE 3 OF 3

- Not available or not applicable.
(1) Includes data from the following samples: EC-T3SD1-02, T3SD1, T3SD1-D, and T5SD1.
(2) Background concentrations established using NOAA Technical Memorandum NOS OCRA80, "Biological Effects of Toxic Contaminants in Sediments from Long Island Sound and Environs," NOAA, 1994.
(3) Benchmark values for organics are sample location-specific benchmarks based on equilibrium partitioning (EqP) using sample specific total organic carbon and benchmark for surface water. Range indicates organic parameter was detected at more than one sample location. Except as indicated, benchmarks for inorganics are the effects range-low (ER-L) from Long, et. al., 1995.
(4) Contaminant of Potential Concern; Yes (Y) indicates that the maximum concentration exceeds one or more criteria; No (N) indicates that the maximum does not exceed any of the criteria.
(5) Criteria not available.
(6) Washington State Department of Ecology (1994).
(7) Naturally occurring chemical, not considered for screening.
(8) Acid Volatile Sulfice/Simultaneously Extracted Metal.
(9) OME, 1988.
(10) Not appropriate for COPC screening.

TABLE 2-14

COPC SCREENING FOR THAMES RIVER
DOWNSTREAM SEDIMENT
NSB-NLON, GROTON, CONNECTICUT
PAGE 1 OF 3

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	Background (2)	Benchmark Value(3)	Select as COPC? (4)
Semivolatile Organic Compounds (mg/kg)								
Acenaphthylene	2/2	0.1-0.17	-	0.14	T2SD1	-	27.7 - 30	N
Anthracene	2/2	0.15-0.19	-	0.17	T2SD2	-	35.8 - 38.8	N
Benzo(a)anthracene	2/2	0.47-0.48	-	0.48	T2SD1	-	62.8 - 68.1	N
Benzo(a)pyrene	1/2	0.78	1.4	0.74	T2SD1	-	138	N
Benzo(b)fluoranthene	1/2	0.34	1.4	0.52	T2SD1	-	112	N
Benzo(g,h,i)perylene	1/2	0.61	1.4	0.66	T2SD1	-	499	N
Benzo(k)fluoranthene	1/2	0.98	1.4	0.84	T2SD1	-	68.9	N
Carbazole	1/2	0.076	1.6	0.44	T2SD2	-	24.8	N
Chrysene	2/2	0.46-0.66	-	0.56	T2SD2	-	62.8 - 68.1	N
Dibenzo(a,h)anthracene	1/2	0.35	1.4	0.53	T2SD1	-	86.5	N
Fluoranthene	2/2	0.58-1.1	-	0.84	T2SD2	-	22.9 - 24.8	N
Indeno(1,2,3-cd)pyrene	1/2	0.64	1.4	0.67	T2SD1	-	1230	N
Phenanthrene	2/2	0.4-0.55	-	0.48	T2SD2	-	2.41 - 2.62	N
Pyrene	2/2	1-1.1	-	1.1	T2SD2	-	49 - 53	N
Pesticdes/PCBs (mg/kg)								
4,4'-DDD	2/2	0.011-0.012	-	0.012	T2SD2	-	0.00928 - 0.0101	Y
4,4'-DDE	2/2	0.0059-0.0065	-	0.0062	T2SD1	-	0.00471 - 0.00510	Y
Dieldrin	1/2	0.005	0.14	0.038	T2SD1	-	0.015	N
Endrin aldehyde	2/2	0.0076-0.0087	-	0.0082	T2SD2	-	0.00883 - 0.00957	N
Heptachlor	2/2	0.0098-0.01	-	0.0099	T2SD2	-	0.000914 - 0.00099	Y
Metals (mg/kg)								
Aluminum	2/2	13300-13800	-	13550	T2SD1	54500	27000 (6)	N
Antimony	2/2	36.1-39	-	38	T2SD1	0.405	64 (6)	Y
Arsenic	2/2	10.4-11.2	-	11	T2SD1	6.75	8.2	Y
Barium	2/2	57.9-73	-	67	T2SD1	580	-	N
Beryllium	2/2	0.72-1.3	-	1	T2SD1	3	-	N
Boron	1/2	129	96.8	89	T2SD1	100	-	Y

TABLE 2-14

COPC SCREENING FOR THAMES RIVER
DOWNSTREAM SEDIMENT
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 3

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	Background (2)	Benchmark Value(3)	Select as COPC? (4)
Cadmium	1/2	0.51	0.47	0.37	T2SD1	0.39	1.2	Y
Calcium	2/2	4600-4910	-	4755	T2SD1	-	-	N (7)
Chromium	2/2	64.2-81.6	-	73	T2SD1	73	81	Y
Cobalt	2/2	7.2-8.5	-	7.9	T2SD1	19	50 (8)	N
Copper	2/2	77.5-151	-	114	T2SD1	36.8	34	Y
Iron	2/2	22600-25400	-	24000	T2SD1	29250	-	N
Lead	2/2	120-186	-	153	T2SD1	42.2	46.7	Y
Magnesium	2/2	6850-7160	-	7005	T2SD2	-	-	N (7)
Manganese	2/2	249-256	-	253	T2SD1	48.6	1800	N
Mercury	2/2	0.38-0.44	-	0.41	T2SD1	0.169	0.15	Y
Nickel	2/2	31.1-34	-	33	T2SD2	34.5	20.9	Y
Potassium	2/2	3590-3600	-	3595	T2SD1	-	-	N (7)
Selenium	1/2	0.51	0.64	0.42	T2SD1	-	-	Y (5)
Silver	1/2	1.2	1.7	1	T2SD1	0.615	1	Y
Sodium	2/2	12100-13900	-	13000	T2SD2	-	-	N (7)
Thallium	1/2	0.76	0.71	0.56	T2SD1	-	-	Y (5)
Vanadium	2/2	36.5-37.7	-	37	T2SD2	130	-	N
Zinc	2/2	163-297	-	230	T2SD1	112.5	150	Y
Miscellaneous (mg/kg)								
Total organic carbon	2/2	12000-13000	-	12500	T2SD1	-	-	N (9)

- Not available or not applicable.

(1) Includes data from the following samples: T2SD1 and T2SD2.

(2) Background concentrations established using NOAA Technical Memorandum NOS OCRA80, "Biological Effects of Toxic Contaminants in Sediments from Long Island Sound and Environs," NOAA, 1994.

(3) Benchmark values for organics are sample location-specific benchmarks based on equilibrium partitioning (EqP) using sample location-specific total organic carbon and benchmark for surface water. Range indicates organic parameter was detected at more than one sample location. Except as indicated, benchmarks for inorganics are the effects range-low (ER-L) from Long, et. al., 1995.

TABLE 2-14

COPC SCREENING FOR THAMES RIVER
DOWNSTREAM SEDIMENT
NSB-NLON, GROTON, CONNECTICUT
PAGE 3 OF 3

(4) Contaminant of Potential Concern; Yes (Y) indicates that the maximum concentration exceeds one or more criteria; No (N) indicates that the maximum does not exceed any of the criteria.
(5) Criteria not available.
(6) Washington State Department of Ecology (1994).
(7) Naturally occurring chemical, not considered for screening.
(8) OME, 1988.
(9) Not appropriate for COPC screening.

TABLE 2-15

FREQUENCY OF DETECTIONS
FOR RIBBED MUSSEL SAMPLES
NSB-NLON, GROTON, CONNECTICUT
PAGE 1 OF 2

Parameter	Frequency (1)	Range of Detections (2)	Range of Nondetects	Average	Location of Maximum
Volatile Organic Compounds (mg/kg)					
2-Butanone	3/11	0.022 - 0.03	0.01	0.011	CMU2
Acetone	4/9	0.075 - 0.17	0.1 - 0.48	0.127	CMU4
Benzene	10/11	0.002 - 0.012	0.01	0.005	CMU2
Carbon disulfide	11/11	0.014 - 0.28	-	0.08	CMU2
Ethylbenzene	7/11	0.001 - 0.008	0.01	0.004	CMU2
Methylene chloride	11/11	0.004 - 0.064	-	0.025	MU-C
Styrene	1/11	0.001	0.01 - 0.012	0.005	CMU2
Tetrachloroethene	1/11	0.002	0.01 - 0.012	0.005	CMU2
Toluene	11/11	0.003 - 0.024	-	0.009	CMU2
Xylenes, total	11/11	0.004 - 0.04	-	0.013	CMU2
Semivolatile Organic Compounds (mg/kg)					
2-Methylnaphthalene	2/11	0.02 - 0.023	0.33	0.139	MU-C
2-Methylphenol	1/11	0.044	0.33	0.154	CMU3
Acenaphthene	1/11	0.02	0.33	0.152	CMU3
Benzoic acid	10/11	0.029 - 0.87	0.33	0.163	CMU3
Benzyl alcohol	1/11	0.07	0.33	0.156	CMU3
Bis(2-Ethylhexyl)phthalate	5/11	0.039 - 0.074	0.33	0.116	CMU3
Dibenzofuran	1/11	0.02	0.33	0.152	CMU3
Fluoranthene	3/11	0.01 - 0.12	0.33	0.133	CMU3
Fluorene	1/11	0.02	0.33	0.152	CMU3
Naphthalene	2/11	0.031 - 0.05	0.33	0.142	MU-C
Phenanthrene	1/11	0.092	0.33	0.158	CMU3
Pyrene	4/11	0.017 - 0.13	0.33	0.122	CMU3
Pesticides/PCBs (mg/kg)					
4,4'-DDD	1/11	0.0033	0.0033	0.002	MU-C
4,4'-DDE	5/11	0.0047 - 0.007	0.0033	0.004	MU-C
4,4'-DDT	1/7	0.0049	0.0033	0.002	MU-C
Aldrin	1/11	0.0043	0.0017	0.001	CMU4
Alpha-Bhc	1/11	0.0018	0.0017	0.001	CMU3
Beta-Bhc	7/11	0.0018 - 0.0045	0.0017	0.002	MU-C

TABLE 2-15

FREQUENCY OF DETECTIONS
FOR RIBBED MUSSEL SAMPLES
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 2

Parameter	Frequency (1)	Range of Detections (2)	Range of Nondetects	Average	Location of Maximum
Dieldrin	2/11	0.0037 - 0.005	0.0033	0.002	MU-C
Endrin aldehyde	3/11	0.0035 - 0.006	0.0033	0.003	MU-C
Gamma-Bhc (lindane)	1/11	0.0022	0.0017	0.001	CMU4
Gamma-Chlordane	2/11	0.0017 - 0.0018	0.0017	0.001	MU-C
Heptachlor	7/11	0.0017 - 0.0031	0.0017	0.002	MU-C
Heptachlor epoxide	2/11	0.0027 - 0.0033	0.0017	0.001	MU-C
Metals (mg/kg)					
Aluminum	11/11	3.2 - 24.9	-	11.7	CMU4
Arsenic	11/11	0.61 - 1.9	-	0.956	MU-C
Boron	11/11	2.9 - 5.8	-	4.2	CMU2
Calcium	11/11	132 - 995	-	361	MU-C
Chromium	11/11	0.37 - 0.68	-	0.525	CMU4
Copper	11/11	1.5 - 3.6	-	2.3	CMU1
Iron	11/11	13.4 - 66.7	-	40	CMU4
Lead	10/11	0.05 - 0.15	0.05	0.08	CMU4
Magnesium	11/11	289 - 603	-	491	CMU1
Manganese	11/11	0.84 - 1.8	-	1.2	MU-C
Mercury	1/11	1.6	0.1	0.191	CMU2
Potassium	11/11	519 - 1470	-	809	MU-C
Selenium	11/11	0.17 - 0.43	-	0.297	MU-C
Silver	11/11	0.2 - 1.8	-	0.733	CMU1
Sodium	11/11	2020 - 4380	-	346	CMU1
Zinc	11/11	4.6 - 12	-	8.02	CMU1

- Not available or not applicable.

(1) Includes data from the following samples: CMU1, CMU1-R, CMU2, CMU2-R, CMU3, CMU4, CMU4-R, CMU5 CMU5-R, MU-C, MU-and CD.

(2) Not evaluated for COPC selection because species is not typically harvested commercially for consumption.

TABLE 2-16

FREQUENCY OF DETECTIONS
FOR BLUE MUSSEL SAMPLES
NSB-NLON, GROTON, CONNECTICUT
PAGE 1 OF 2

Parameter	Frequency (1)	Range of Detections (2)	Range of Nondetects	Average	Location of Maximum
Semivolatile Organic Compounds (mg/kg)					
Bis(2-Ethylhexyl)phthalate	2/6	0.12 - 0.13	0.33	0.152	MU1
Di-N-octyl phthalate	3/6	0.018 - 0.035	0.33	0.096	MU-5
Fluoranthene	1/6	0.032	0.33	0.143	MU-5
Pyrene	1/6	0.028	0.33	0.142	MU-5
Pesticides/PCBs (mg/kg)					
4,4'-DDD	1/6	0.005	0.033	0.0146	MU3
4,4'-DDE	3/6	0.0071 - 0.016	0.033	0.0139	MU-5
Aldrin	1/6	0.0024	0.017	0.0075	MU-4
Gamma-Chlordane	3/6	0.0032 - 0.013	0.017	0.0075	MU-4
Heptachlor	6/6	0.002 - 0.0045	-	0.0029	MU3
Metals (mg/kg)					
Aluminum	6/6	14 - 111	-	69.8	MU-5
Arsenic	6/6	1.1 - 2.5	-	1.93	MU-6
Barium	4/6	0.63 - 1.4	1.2	0.878	MU2
Boron	2/6	70.9 - 77.5	4 - 10	26.7	MU-6
Cadmium	4/6	0.41 - 0.94	0.4	0.44	MU-6
Calcium	6/6	378 - 774	-	494	MU-5
Chromium	3/6	1 - 1.5	0.6	0.75	MU2
Copper	6/6	1.8 - 4	-	2.8	MU1
Iron	6/6	67.1 - 207	-	138	MU1
Lead	4/6	0.78 - 2	0.1 - 1.6	0.9983	MU2
Magnesium	6/6	698 - 850	-	777	MU1
Manganese	6/6	1.5 - 6.4	-	3.75	MU1
Nickel	3/6	0.75 - 1.3	2.2	1.05	MU2
Potassium	6/6	777 - 1630	-	1221	MU1
Selenium	3/6	0.83 - 1.1	0.53 - 0.92	0.66	MU1
Sodium	6/6	4760 - 6310	-	5520	MU-6
Vanadium	3/6	0.26 - 0.45	0.6	0.34	MU1/MU2
Zinc	6/6	15.7 - 47.6	-	33.8	MU3

- Not available or not applicable.

TABLE 2-16

FREQUENCY OF DETECTIONS
FOR BLUE MUSSEL SAMPLES
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 2

(1) Includes data from the following samples: MU-4, MU-5, MU-6, MU1, MU2, and MU3.
(2) Not evaluated for COPC selection because species is not typically harvested commercially for consumption.

TABLE 2-17

COPC SCREENING FOR THAMES RIVER
OYSTER SAMPLES
NSB-NLON, GROTON, CONNECTICUT
PAGE 1 OF 1

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	Fish COC Screening Level (2)	Select as COPC? (3)
Semivolatile Organic Compounds (mg/kg)							
Bis(2-Ethylhexyl)phthalate	3/5	0.089 - 0.16	0.33	0.135	BV04	0.23	N
Pesticides/PCBs (mg/kg)							
Heptachlor	5/5	0.002 - 0.0031	-	0.002	BV04	0.0007	Y
Metals (mg/kg)							
Aluminum	4/5	33.6 - 40.6	21.1	32	BV03	1400	N
Arsenic	5/5	0.9 - 1.5	-	1.15	BV03	0.0021	Y
Barium	5/5	0.83 - 1.5	-	1.13	BV03	95	N
Cadmium	5/5	0.61 - 0.92	-	0.8	BV04	0.68	Y
Calcium	5/5	981 - 3470	-	2280	BV03	-	N (4)
Chromium	5/5	1 - 1.5	-	1.26	BV03	6.8	N
Copper	5/5	62.9 - 253	-	145	BV02	54	Y
Iron	5/5	48.3 - 79.1	-	68.5	BV01	410	N
Magnesium	5/5	548 - 776	-	619	BV03	-	N (4)
Manganese	5/5	2.3 - 3.8	-	2.98	BV03	31	N
Nickel	5/5	0.6 - 1.1	-	0.81	BV03	27	N
Potassium	5/5	1760 - 2480	-	2088	BV03	-	N (4)
Selenium	5/5	0.32 - 0.42	-	0.37	BV03	6.8	N
Silver	5/5	0.79 - 2.5	-	1.74	BV04	6.8	N
Sodium	5/5	2720 - 5020	-	3610	BV03	-	N (4)
Vanadium	2/5	0.16 - 0.2	0.15	0.12	BV02	9.5	N
Zinc	5/5	1210 - 2960	-	1968	BV02	410	Y

- Not available or not applicable.

(1) Includes data from the following samples: BV01, BV02, BV03, BV03-D, and BV04.

(2) For Finfish/Shellfish ingestion, based on current USEPA Region III guidance (USEPA Region III, October, 1995).

(3) Contaminant of Potential Concern; A Yes (Y) indicates that the maximum detection exceeds the screening criteria; A No (N) indicates that the maximum does not exceed the screening criteria or there was no criteria available.

(4) No criteria available.

TABLE 2-18

COPC SCREENING FOR THAMES RIVER
CLAM SAMPLES
NSB-NLON, GROTON, CONNECTICUT
PAGE 1 OF 1

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	Fish COC Screening Level (2)	Select as COPC? (3)
Semivolatile Organic Compounds (mg/kg)							
Benzoic acid	1/3	5.4	0.8 - 1.6	2.2	BVC2	5400	N
Benzyl alcohol	1/3	0.57	0.33	0.3	BVC2	410	N
Bis(2-Ethylhexyl)phthalate	2/3	0.059 - 0.082	0.33	0.102	BVC2	0.23	N
Pesticides/PCBs (mg/kg)							
Gamma-Chlordane	1/3	0.0021	0.017	0.0064	BVC1	0.0024	N
Heptachlor	2/3	0.002 - 0.0021	0.017	0.0042	BVC1	0.0007	Y
Metals (mg/kg)							
Arsenic	3/3	4.1 - 6.7	-	5.37	BVC2	0.0021	Y
Barium	3/3	0.5 - 0.86	-	0.69	BVC3	95	N
Cadmium	3/3	0.11 - 0.59	-	0.28	BVC2	0.68	N
Calcium	3/3	885 - 2580	-	1645	BVC3	-	N (4)
Chromium	3/3	0.98 - 4.1	-	2.16	BVC2	6.8	N
Copper	3/3	2.9 - 7.5	-	5.7	BVC1	54	N
Iron	3/3	36.3 - 48	-	41.5	BVC2	410	N
Magnesium	3/3	726 - 790	-	757	BVC1	-	N (4)
Manganese	3/3	5.1 - 15.1	-	9.4	BVC2	31	N
Nickel	3/3	1.1 - 1.7	-	1.4	BVC2	27	N
Potassium	3/3	1960 - 2020	-	1990	BVC1	-	N (4)
Selenium	3/3	0.27 - 0.95	-	0.57	BVC2	6.8	N
Silver	1/3	1.1	0.1	0.4	BVC2	6.8	N
Sodium	3/3	4390 - 4740	-	4516	BVC1	-	N (4)
Vanadium	2/3	0.22 - 0.58	0.15	0.29	BVC2	9.5	N
Zinc	3/3	18.1 - 34.6	-	24	BVC2	410	N

- Not available or not applicable.

(1) Includes data from the following samples: BVC1, BVC2, and BVC3.

(2) For Finfish/Shellfish ingestion, based on current USEPA Region III guidance (USEPA Region III, October, 1995).

(3) Contaminant of Potential Concern; A Yes (Y) indicates that the maximum detection exceeds the screening criteria; A No (N) indicates that the maximum does not exceed the screening criteria or there was no criteria available.

(4) No criteria available.

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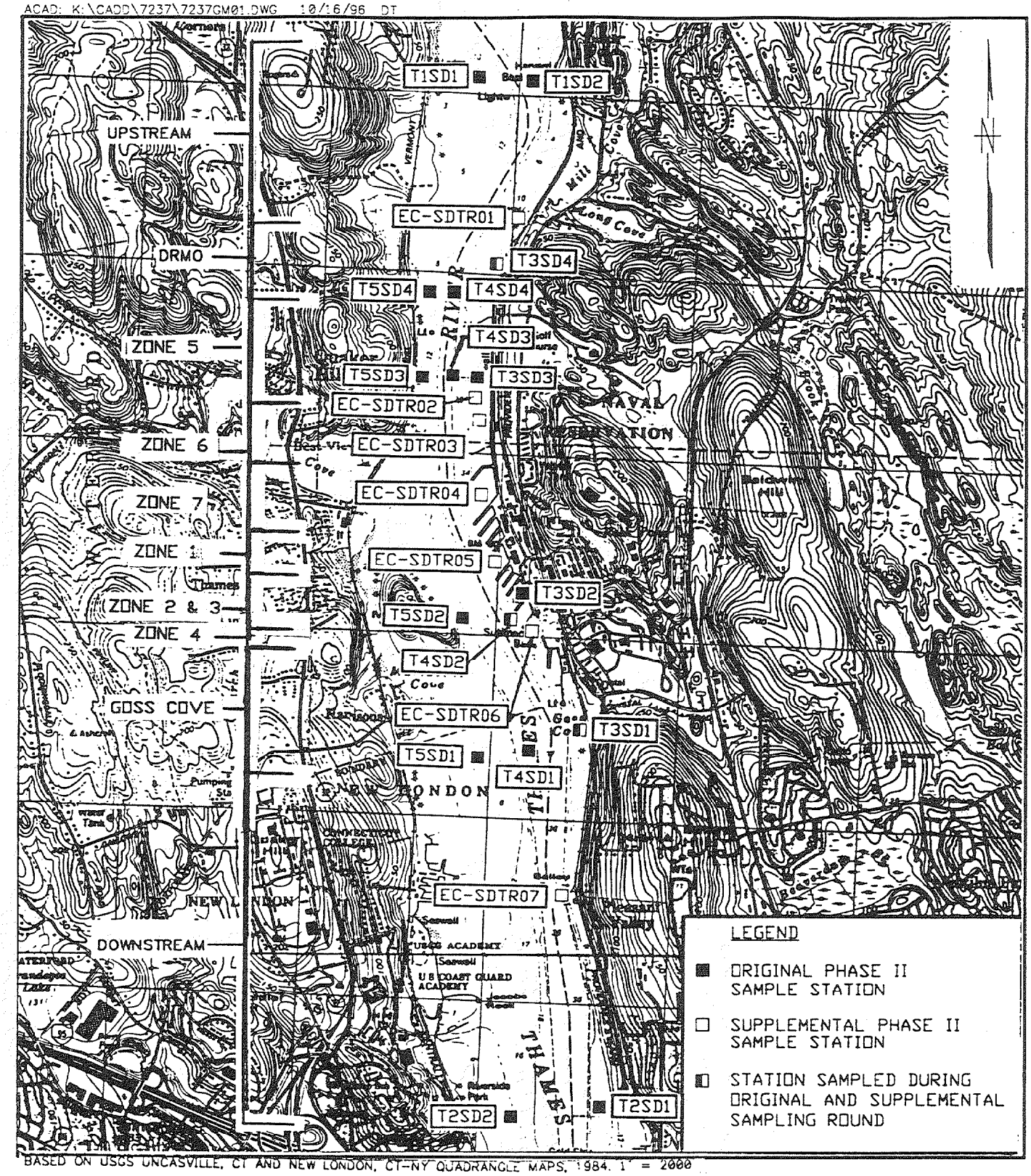


BASED ON USGS UNCASVILLE, CT AND NEW LONDON, CT-NY QUADRANGLE MAPS, 1984. 1" = 2000

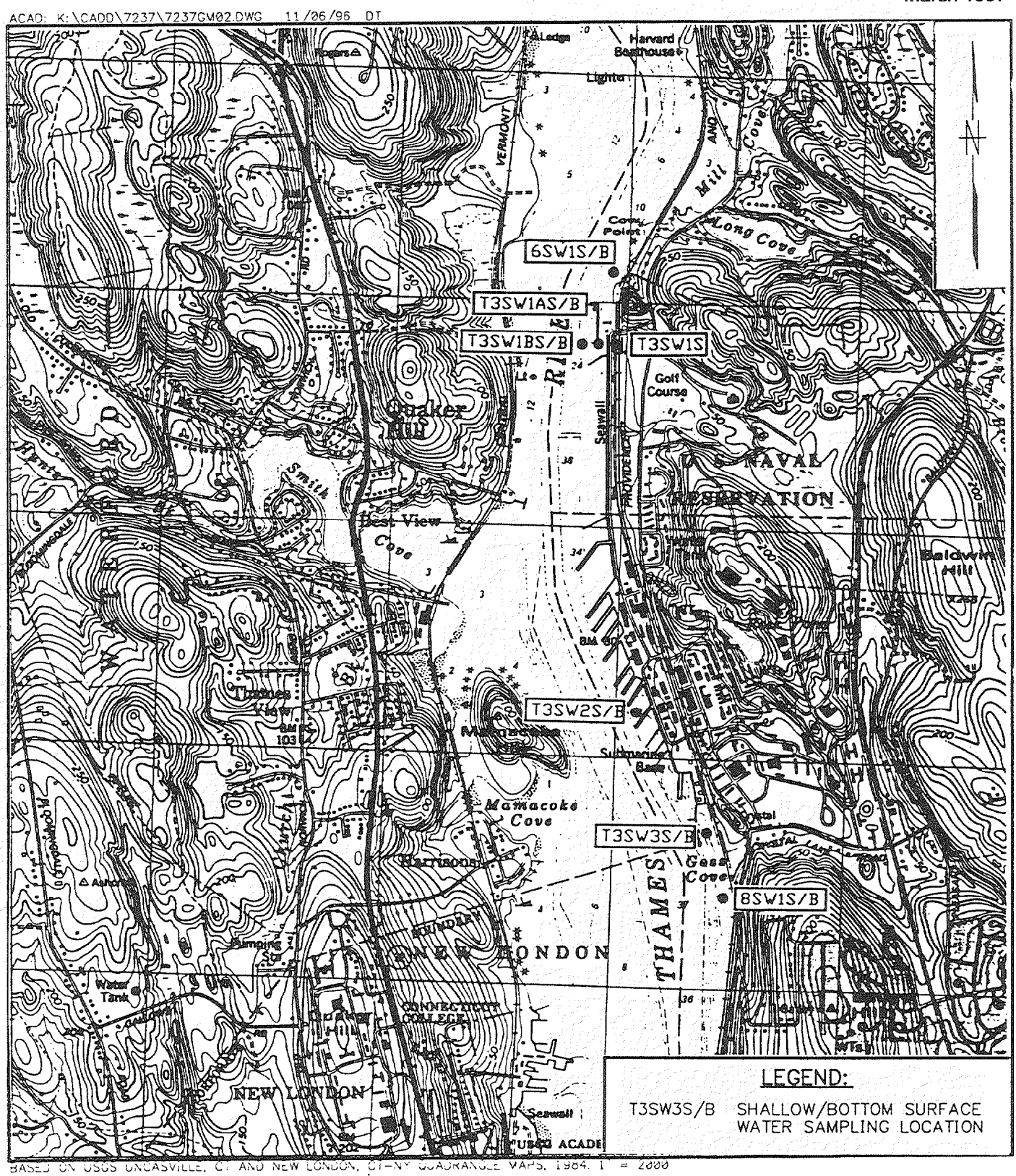
THAMES RIVER SEDIMENT AND BENTHIC SAMPLING LOCATIONS
NSB-NLON, GROTON, CONNECTICUT

0 2500 5000
SCALE IN FEET

FIGURE 2-1

Brown & Root Environmental

ACAD: K:\CADD\7237\7237GM02.DWG 11/06/96 DT



BASED ON USGS UNCASVILLE, CT AND NEW LONDON, CT-NY QUADRANGLE MAPS, 1984. 1" = 2000'

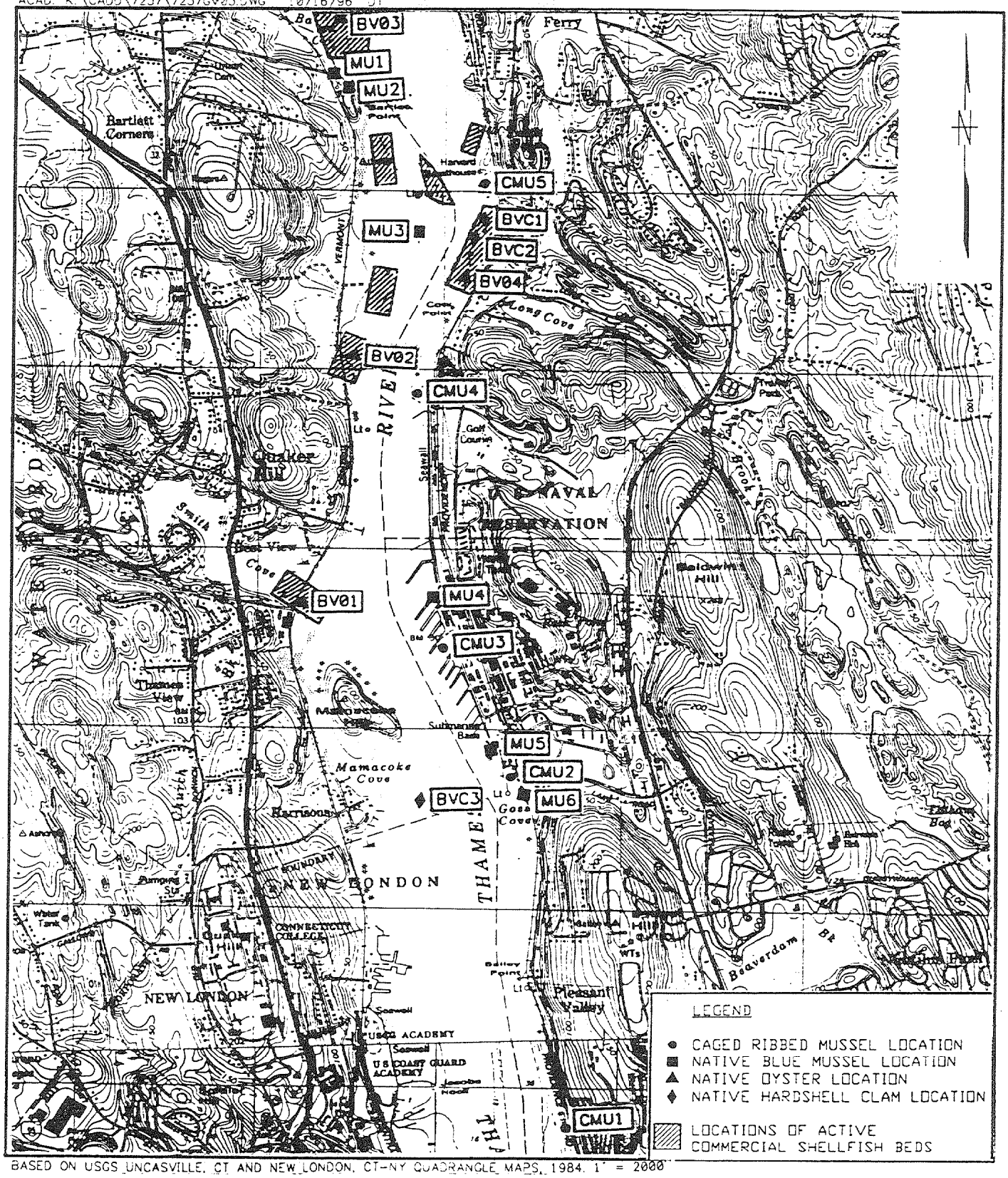
THAMES RIVER SURFACE WATER SAMPLING LOCATIONS
NSB-NLON, GROTON, CONNECTICUT

0 2000 4000
SCALE IN FEET

FIGURE 2-2

Brown & Root Environmental

ACAD: K:\CADD\7237\7237GV03.DWG 10/16/96 DT



BASED ON USGS UNCASVILLE, CT AND NEW LONDON, CT-NY QUADRANGLE MAPS, 1984. 1" = 2000'

THAMES RIVER NATIVE AND DEPLOYED BIVALVE LOCATIONS
NSB-NLON, GROTON, CONNECTICUT

0 2500 5000
SCALE IN FEET

FIGURE 2-3

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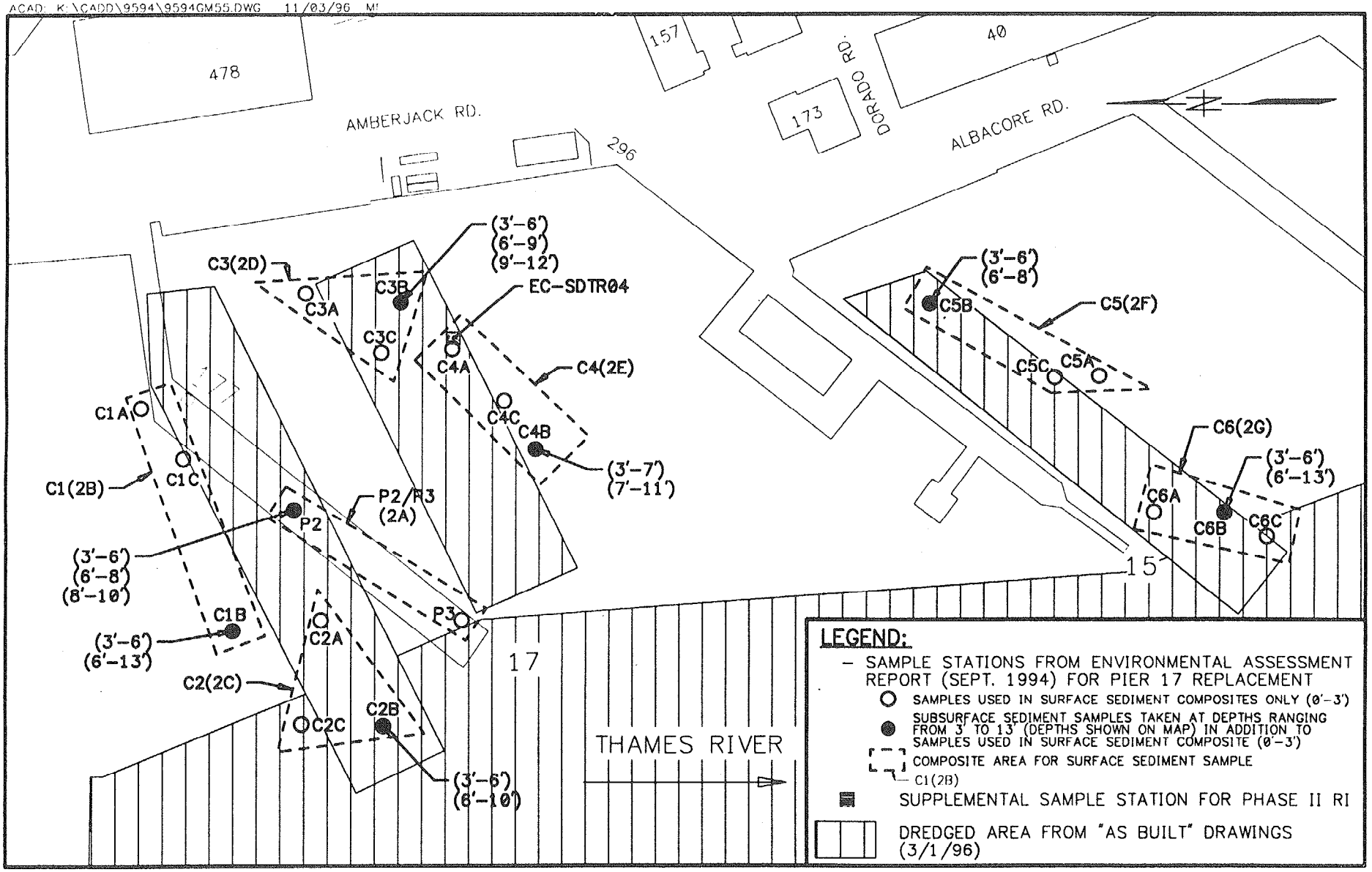
FIGURE 2-4 Thames River Sediment Sampling Locations and Limit of Dredging

(FOLDOUT)

FIGURE 2-4 (backside)

ACAD: K:\CADD\9594\9594GM55.DWG 11/03/96 MI



PIER 15/17 SEDIMENT SAMPLING LOCATIONS AND LIMIT OF DREDGING

NSB-NLON, GROTON, CONNECTICUT

0 150 300

SCALE IN FEET

FIGURE 2-5

Brown & Root Environmental

K:\GIS\9594\95949705.PSD 03/22/97 MJJ

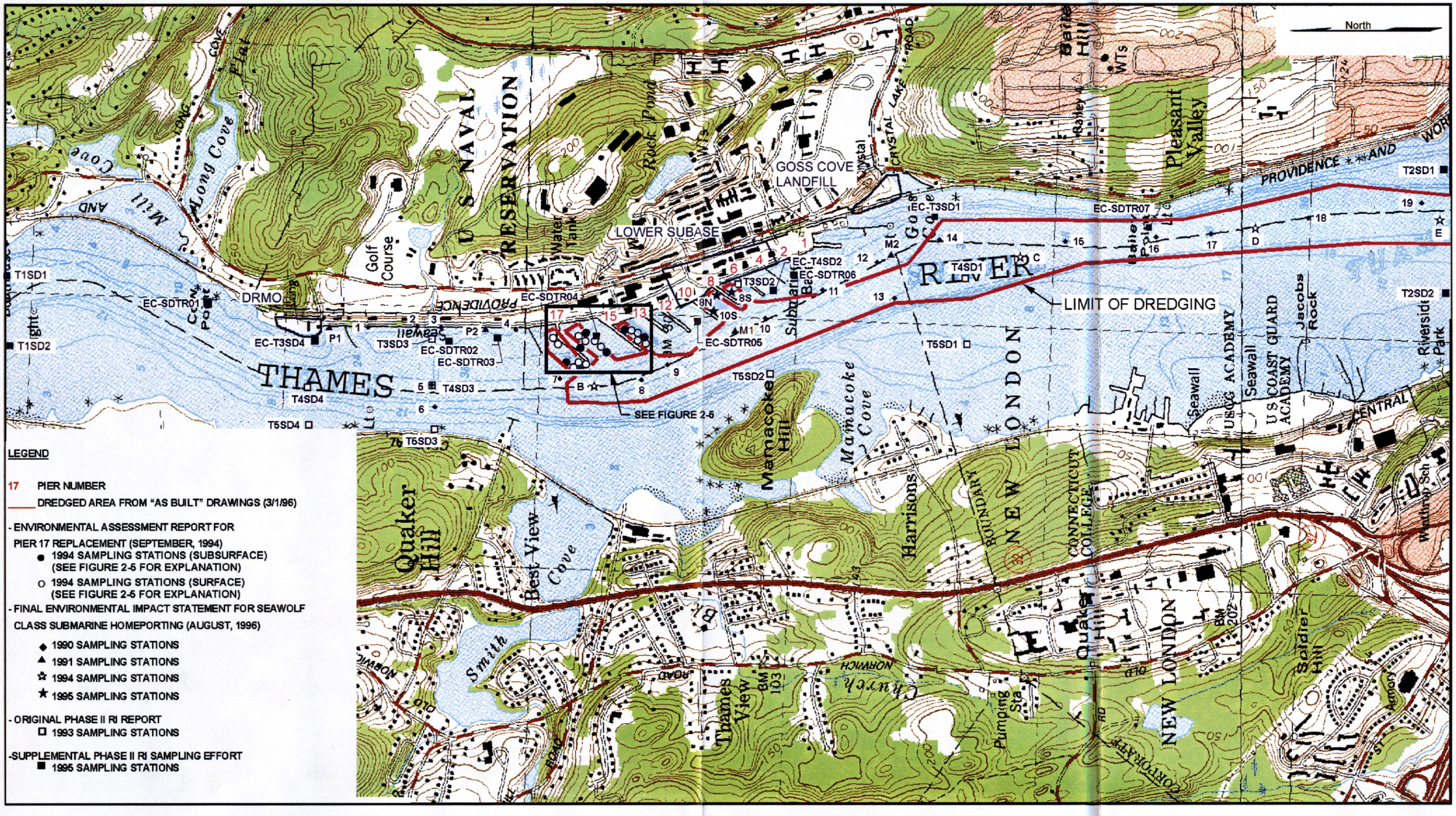


FIGURE 2-4

THAMES RIVER SEDIMENT SAMPLING LOCATIONS AND LIMIT OF DREDGING
NSB-NLON, GROTON, CONNECTICUT

0 1200 2400
SCALE IN FEET

Brown & Root Environmental

0109703Y

3.0 ZONE 1

3.1 SITE DESCRIPTION

Zone 1 extends from Darter Road (just south of Building 89) to the south side of Corvina Road. Figure 3-1 shows the sites included in Zone 1 and the limits of the zone. Site 10 - Fuel Storage Tanks and Tank 54-H, and Site 11 - Power Plant Oil Tanks are included in Zone 1. The Building 89 UST Site is located directly adjacent to Zone 1 and is considered as a Zone 1 Site in this report even though it falls outside the zone boundary. Fuel oil distribution lines and steam, condensate, and electrical ducts are also located within Zone 1.

3.1.1 Site 10 - Lower Subase - Fuel Storage Tanks and Tank 54-H

Five concrete underground storage tanks, located southwest of Building 107, were placed in service during World War II. Three of the tanks (E, F, and G) had 125,000-gallon capacities and were used to store diesel fuel from 1942 to 1987. Tanks K and L were used to store lubrication and hydraulic oils from 1954 to 1989; each had a 25,000-gallon capacity. A sixth tank (Tank 54-H) was located adjacent to and north of Tank E. This tank had a 30,000-gallon capacity and was used as a reclamation tank for the other five tanks. Tanks E, F and G were decommissioned in 1987. Tank 54-H has also been decommissioned. Tanks K and L were decommissioned in 1989 and new steel tanks have been installed within the shells of these two tanks.

3.1.2 Site 11 - Lower Subase - Power Plant Oil Tanks

Four underground tanks (A, B, C, and D) were located adjacent to and east of the power plant (Building 29), each with 170,000-gallon capacity. Tanks A and B were used to store No. 6 fuel oil, which was pumped from the tank farm at the south end of NSB-NLON. Tank C was used to store diesel oil, and Tank D was used to store waste oil generated by the bilge water oil recovery system at the power plant. The tanks have been in place since World War II. Past oil leakage was apparent when the old tanks were cleaned; however, the old tanks were repaired and are now used as containment structures for three 150,000-gallons steel tanks.

3.1.3 Building 89 UST

Underground Storage Tank (UST) Z01 was installed adjacent to the southwest corner of Building 89 in 1982. The tank was used to store fuel oil (No. 2) for power motors operated in Building 89. The tank was constructed of lined steel and had a capacity of 3,000 gallons. The bottom of the tank was approximately 8 feet below ground surface. Because of the shallow groundwater (approximately 7 feet below ground surface) in the vicinity, the tank was attached to a concrete tie-down pad with steel tie downs to prevent flotation. The tank was tested twice; once in 1992 when the tightness testing results were inconclusive and once in 1993 when the tank failed tightness testing. The tank was drained of its contents and, in early 1994, the tank and the associated piping were excavated and removed from the site. Post excavation sampling was conducted by Halliburton NUS (HNUS, 1995b).

3.1.4 Fuel Oil Distribution Lines and Utility Ducts

Fuel oil distribution lines and utility ducts and trenches run through Zone 1. Descriptions of the distribution lines and utility ducts and trenches are provided in Sections 1.2.4.3 and 1.2.4.4, respectively. The locations of the distribution lines and utility ducts are shown in Figure 3-1.

3.2 SITE INVESTIGATIONS

The following investigations were conducted at Zone 1 and are discussed in the subsections which follow:

- Oil Contamination of Groundwater at Subase (NESO, 1979)
- Final Initial Assessment Study (Envirodyne, 1983)
- Final Site Investigation of Subsurface Oil Contamination (Wehran, 1987)
- Hydrogeologic Investigation UST OT-4, OT-7, OT-8, OT-9, and Tank 54-H (Fuss & O'Neill, 1989)
- Phase I Remedial Investigation (Atlantic, 1992)
- Site Characterization Report for OT-10, Building 325, and Building B-89 (HNUS, 1995b)
- Site Investigation Report for Tank Farm Investigation (B&R Environmental, 1996b)
- Phase II Remedial Investigation (B&R Environmental, 1996a)

3.2.1 Oil Contamination of Groundwater at Subase

In 1979, the Navy Environmental Support Office (NESO) conducted a study to identify the source and extent of oil found in soils along the Thames River at three sites on the Lower Subase. The three sites are Building 29 Power Plant Oil Tanks (Site 11), Building 107/345 Fuel Storage Tanks (Site 10), and Building

79 Waste Oil Pit (Site 13). NESO drilled a total of 12 soil borings and installed piezometers in each soil boring. Soil samples collected from each boring were analyzed for oil content. Groundwater samples were collected from each piezometer to check for the presence of oil and, where present, to measure product thickness.

Four borings/piezometers were installed during this study at Zone 1 (NESO2, 3, 4, and 7). One boring/piezometer, NESO1, was installed just north of Zone 1. Sample locations are shown on Figure 3-1. Oil and grease content in soils ranged from 400 ppm to 32,900 ppm. Oil content in groundwater samples ranged from 20 ppm to 670 ppm. The study found oil extending toward the Thames River near the Power Plant Oil Tanks (Site 11). Significant contamination was not detected at Building 107/345 (Site 10); however, the report recommended monitoring of groundwater around Building 107.

3.2.2 Final Initial Assessment Study

In 1982, Envirodyne Engineers, Inc. performed an Initial Assessment Study (IAS) at NSB-NLON as part of the Navy Assessments and Control of Installation Pollutants (NACIP) program. The purpose of this study was to identify and evaluate past waste disposal practices and to assess the potential for environmental impacts. Envirodyne reviewed installation records, interviewed long-term and former employees, toured the installation, and photographed sites as part of the IAS.

Envirodyne identified 11 sites at NSB-NLON as having contained hazardous material; two of which are located within Zone 1 (Sites 10 and 11). The IAS concluded that there was some measurable leakage from the tanks at Site 10 and recommended monitoring of the tank levels to see if the tanks were leaking. For Site 11, the report concluded that there was leakage from the tanks and the petroleum had migrated to groundwater, into the steam, and fuel pipeline tunnels and underground vaults. The IAS recommended replacing the tanks at Site 11 and implementing oil recovery.

3.2.3 Final Site Investigation of Subsurface Oil Contamination

In 1987, Wehran Engineering Corporation completed an investigation to identify and delineate the sources of heavy oils in the subsurface of the Lower Subase (Sites 10, 11, and 13). Activities during the investigation included collecting soil samples from soil borings, oil samples from manholes and trenches, and groundwater samples from monitoring wells. These samples were tested to identify the type, degree of weathering, and general concentrations of oil contamination at the three sites. One oil sample (MH-5) and one groundwater sample from an existing monitoring well (NESO4) were collected in Zone 1. Soil borings and groundwater monitoring wells were not installed in Zone 1 as part of this investigation.

Wehran identified one area within Zone 1 that was contaminated with heavy oil. This area, electrical conduits and manholes along Corvina Road, contained a mixture of No. 5 and No. 6 fuel oils. Wehran recommended that further review of the operation and distribution of oil in Building 29 be conducted.

3.2.4 Hydrogeologic Investigation UST OT-4, OT-7, OT-8, OT-9, and Tank 54-H

In 1989, Fuss & O'Neill, Inc. conducted a hydrogeologic investigation of two UST areas at NSB-NLON; one at the tank farm located south of the Lower Subase (OT-4, OT-7, OT-8, and OT-9) and the other in Zone 1 (Tank 54-H) of the Lower Subase. The study was initiated as a result of subsurface soil contamination encountered during construction activities in the two areas. At Zone 1, four monitoring wells (FOMW-13 through 16) were installed around Tank 54-H. Soil samples were collected from each well and field screened with an organic vapor monitor (OVA). Groundwater samples from each of the monitoring wells were analyzed by a laboratory for volatile aromatic hydrocarbons and scanned for petroleum products.

No. 2 fuel oil was detected in monitoring wells at Tank 54-H ranging in concentrations from 21 mg/L to 1100 mg/L. In addition, low concentrations (less than 15 µg/L) of benzene and xylene were detected in FOMW13. Fuss & O'Neill concluded that petroleum contamination had impacted groundwater in the area.

3.2.5 Phase I Remedial Investigation

An investigation of 11 sites was completed at NSB-NLON by Atlantic Environmental Services, Inc., from 1990 through 1992. One site, identified as the Lower Subase - Site 13, included the area represented by Zones 1 through 4.

The Lower Subase Phase I field investigation consisted of a utility manhole inspection and waterfront bulkhead inspection for evidence of contamination sources. Also included were a soil gas survey, test boring completion, monitoring well installation, and soil and groundwater sampling.

During the utility manhole inspection, manhole covers were removed and inspected for visual evidence of oil. Four areas of significant petroleum accumulation were observed during the manhole inspection. One of these areas, three manholes west of Building 29 (the power plant), was located within Zone 1. Possible sources for the accumulation were noted as previous product releases from underground fuel lines or storage tank leaks. No evidence of petroleum contamination was noted along the fuel oil lines which run

along Corvina Road. The report indicated that there was no evidence of an ongoing release; the petroleum contamination appeared to be related to previous releases.

Inspection of the waterfront bulkhead was conducted from a boat during low tide. Seeps or sheens have been historically observed at the waterfront near the power plant; however, no oil seeps or sheens or evidence of such were observed anywhere along the waterfront at the Lower Subase during the inspection.

A shallow soil gas survey (at depths of 12 to 18 inches) was also conducted within Zones 1 through 4. The results for Zone 1 indicated low concentrations of VOCs on the west side of Building 29, near the three manholes, high concentrations of VOCs in an area south of Building 29, and low concentrations of VOCs near the Building 29 storage tanks. These areas were further characterized by the subsurface investigation.

Eight borings, converted to monitoring wells, were installed within Zone 1 (13MW1 through 5 and 13MW7 through 9) and are shown on Figure 3-1. A previously installed well (NESO4) was also sampled during the Phase I RI. Soil and groundwater samples collected from the monitoring wells were analyzed for VOCs, inorganics, TPH, and fluorescence.

Based on TPH and fluorescence soil analysis, the report indicated that No. 2 fuel oil and lubricating oil have leaked from USTs near Building 29 and 107. Since underground storage tanks and fuel lines have been replaced, ongoing releases were believed to have been predominately corrected. Measurable free product was only detected in 13MW5, at a thickness of less than 1/16 inch. The oil was bailed from this well and an oil layer was not evident 3 hours later.

3.2.6 OT-10, Building 325, and Building B-89 UST Site Characterization

Halliburton NUS conducted site investigations at OT-10, Building 325, and Building 89 in 1994 to determine whether the USTs at these sites had impacted the surrounding soil and groundwater. The UST (Tank Z01) at Building 89 is included within Zone 1. In June 1994, M&G Associates removed the tank. Field activities were performed by Halliburton NUS to assess the quality of soil in the vicinity of the tank to support permanent closure of the tank site. Three soil samples were collected from the tank excavation by Halliburton NUS and analyzed for TPH and benzene, toluene, ethylbenzene and xylenes (BTEX). One of these samples was also analyzed for Target Compound List (TCL) VOCs and SVOCs, Target Analyte List (TAL) inorganics plus boron, and TCLP characterization. M&G Associates also collected two soil samples, one from the tank excavation and one from the excavated material, and one groundwater

sample. The samples collected by M&G Associates were analyzed for lead, TPH and aromatic volatiles. In addition, the soil samples were analyzed for TCLP characterization.

At Building 89 the detections in the soil samples were below CTDEP cleanup standards. Although TPH exceeded CTDEP groundwater standards, the results were inconclusive because the sampling and analysis protocols used by M&G Associates were questionable. Although groundwater in the vicinity of Building 89 may have been impacted by petroleum related to the tank, it was recommended that no further action be taken as part of the tank closure and that groundwater be addressed as part of the Phase II RI investigation.

3.2.7 Site Investigation Report for Tank Farm Investigation

B&R Environmental conducted an investigation in 1995 of the UST farm along Crystal Lake Road. The primary objectives of the investigation were to define the extent of soil and groundwater contamination from the UST farm, evaluate the impact of the UST farm on the stormwater discharge, and recommend remedial alternatives, if needed. As part of the tank farm investigation, underground pipelines from the fuel loading dock (Pier 1), throughout a portion of the Lower Subase (Zones 1 through 4), and the gate valve (Building 322) to tanks within the tank farm were investigated. Soil samples were collected along the new and old diesel underground pipelines at approximately 100-foot intervals. The samples were analyzed for TPH. The No. 6 fuel oil lines were not included as part of the investigation, as they are installed within concrete lined trenches, which would prevent or minimize any potential soil and groundwater impact from leaks. Seven samples were collected within Zone 1 (GS-25L, GS-26L, GS-28L through GS-32L). TPH was detected in all the samples collected in Zone 1 (up to a maximum of 26,800 mg/kg); however, the TPH contamination is suspected to be associated with the USTs located at Building 29 and not a result of leaking pipelines.

The report recommended that additional integrity inspections be performed to determine the locations of previous line leaks on the active and inactive product lines throughout the Lower Subase. In addition, a records review should be performed to identify previous leaks based on the results of line inspections and tightness tests.

3.2.8 Phase II Remedial Investigation

A Phase II RI at 13 sites at NSB-NLON was conducted by B&R Environmental. The Lower Subase was included in this investigation. Soil boring and groundwater well installation and soil and groundwater sampling at Zone 1 were conducted as part of the investigation. Nine soil samples were collected from

five borings (13TB13, 13TB15 through 17, and 13MW18) and were analyzed for lead, TPH, and TCLP metals. Four monitoring wells were installed (13MW18 through 21) and ten groundwater samples were collected from new and existing monitoring wells (13MW1 through 3, 13MW8, 13MW9, 13MW18 through 21, and NESO4). The groundwater samples were analyzed for VOCs, SVOCs, metals (total and dissolved) and TPH. The data and results of the Phase II RI are discussed as part of the nature and extent and data evaluation discussions in Sections 3.4 and 3.5, respectively.

3.3 PHYSICAL CHARACTERISTICS

General physical characteristics of the Lower Subase are discussed in Section 1.3. Site-specific physical characteristics are discussed in the subsections following.

3.3.1 Topography and Surface Features

Zone 1 is primarily paved or covered with buildings and the terrain slopes gently toward the Thames River. The Providence and Worcester Railroad runs along the eastern border of the zone, while the Thames River forms the western border of the zone.

3.3.2 Surface Water Features

Zone 1 is located along the Thames River. No other significant surface water features are located within or adjacent to Zone 1 with the exception of local storm sewers. Catch basins and storms sewers in Zone 1 are shown on Figure 3-1. From the drawing, it can be seen that the storm sewer along Corvina Road discharges into the Thames River. This storm sewer may act as a preferential contaminant migration pathway.

3.3.3 Soil Characteristics, Geology, and Hydrogeology

The SCS soils map classifies the soil at Zone 1 as Urban Land. The USGS surficial geology map indicates that Zone 1 soil is artificial fill. Based on logs for borings installed during the Phase I and Phase II RIs, Zone 1 soil consists of 15 to 20 feet of sand and gravel with thin layers (up to 5 feet) of sand and silt. The sand and gravel is underlain by at least 1 to 10 feet of sand and silt. The depth of this layer is not known as borings were not installed to the bottom of this layer.

Bedrock in Zone 1 is mapped as Mamacoke Formation on USGS bedrock maps. This was not confirmed by soil borings.

The depth to groundwater is approximately 10 feet. Groundwater generally flows west toward the Thames River.

3.4 NATURE AND EXTENT OF CONTAMINATION

Soil and groundwater sampling was conducted at Zone 1 during the Phase I and Phase II RIs as well as other investigations as discussed in Section 3.2. The results of these investigations for soil and groundwater are presented in this section. In addition, the medium-specific COPC screening results are also summarized in this section.

3.4.1 Soil

The analytical results and COPC screening results for Zone 1 soil are shown in Tables 3-1 through 3-4. Tables 3-1 and 3-2 summarize the analytical and COPC screening results for shallow soil (0 to 5 feet below ground surface) and deep soil (greater than 5 feet below ground surface), respectively. Tables 3-3 and 3-4 summarize the TCLP and COPC screening results for shallow soil and deep soil, respectively.

Background concentrations of inorganics in soil, used below for comparison purposes, were taken from the *Background Concentrations of Inorganics in Soil Report* (Atlantic, 1995b).

Drawings 1 through 4 (back pocket) at the end of this report delineate total petroleum hydrocarbon (TPH) and lead concentrations in all zones, including Zone 1, being investigated as part of the Lower Subase RI. Drawings 1 and 2 depict TPH isoconcentration contours for shallow soil and deep soil, respectively, whereas Drawings 3 and 4 show lead isoconcentration contours in shallow soil and deep soil, respectively. Drawings 3 and 4 also show the lead concentration for any Thames River sediment samples collected adjacent to the Lower Subase.

Shallow

Five shallow soil samples were analyzed for lead, whereas only one shallow soil sample was analyzed for a full list of TCL metals. This sample was collected at the pipe chase at Tank Z01 near Building 89. Concentrations of metals in this shallow soil sample were similar to, although generally lower than, those found in deeper soils in Zone 1. Table 3-1 indicates that 18 metals were detected in shallow soil at Zone 1. Of these, the following NSB-NLON background levels (Atlantic, 1995b) were exceeded: cadmium (0.24 mg/kg); calcium (499 mg/kg); lead (17.5 mg/kg); silver (0.385 mg/kg); and sodium (20.5 mg/kg). Antimony,

beryllium, iron, and manganese concentrations in the shallow soils exceeded one or more screening levels.

Drawing 3 shows the distribution of lead in shallow soil within Zone 1. The contours indicate that shallow soils within this zone of the Lower Subase contain less than 100 mg/kg of lead. This drawing also indicates that all lead concentrations are well below the CTDEP residential human health risk criteria of 500 mg/kg and the 400 mg/kg OSWER residential soil screening level.

Lead concentrations measured in sediment samples taken from the Thames River are also provided on Drawing 3. The lead concentrations measured in the river sediments along Zone 1 (EC-SDTR05) are roughly twice the average concentrations measured in shallow Zone 1 soil. As discussed in Section 2, lead concentrations in the Thames River sediment, which exceed both background and benchmark values, could pose a risk to ecological receptors in the river.

Table 3-3 indicates that five shallow soil samples were collected for TCLP analysis and several metals including barium, cadmium, chromium, lead and selenium were detected in the leachates from shallow Zone 1 soil. However, only lead, at a maximum concentration of 194 µg/L, exceeded the CTDEP Pollutant Mobility Standard for GB classified groundwater (150 µg/L).

Table 3-1 indicates that three VOCs, fourteen SVOCs, and TPH were detected in the shallow Zone 1 soil. Six shallow soil samples were analyzed for TPH, but only one sample, collected at the pipe chase at Tank Z01, was analyzed for VOCs and SVOCs. Of the three VOCs detected, only the concentration of methylene chloride at 0.015 mg/kg exceeded one or more screening levels. Concentrations of two of the fourteen SVOCs, benzo(a)anthracene at 0.14 mg/kg and benzo(a)pyrene at 0.13 mg/kg, exceeded one or more screening levels. TPH was detected in all but one of the shallow soil samples analyzed. Only the TPH concentration at 13TB17 (546 mg/kg) exceeded screening levels. This test boring is located northwest of Building 29 (between two existing fuel pipelines) and just north of Site 11 - Power Plant Oil Tanks, as shown on Drawing 1, which also shows isoconcentration contours of TPH. This small area of TPH contamination in the shallow Zone 1 soil exceeds the CTDEP residential human health risk criteria of 500 mg/kg. However, this area of contamination is well below the industrial risk criteria of 2,500 mg/kg.

Based on sample results, methylene chloride, benzo(a)anthracene, benzo(a)pyrene, and metals were identified as COPCs for shallow Zone 1 soil at the pipe chase at Tank Z01 on the southwest side of Building 89. Metals of potential concern include antimony, beryllium, iron, lead and manganese. TPH is the only COPC in shallow Zone 1 soil outside the Tank Z01 pipe chase area. A small area of shallow soil

to the northwest of Building 29 accounts for the exceedance of CTDEP human health risk screening levels for TPH.

Deep

Table 3-2 indicates that twenty metals were detected in deep soil at Zone 1. Of these, the following NSB-NLON background levels (Atlantic, 1995) were exceeded: arsenic (3.6 mg/kg); cadmium (0.24 mg/kg); calcium (499 mg/kg); copper (25.6 mg/kg); lead (17.5 mg/kg); mercury (0.05 mg/kg); nickel (5.95 mg/kg); potassium (2,580 mg/kg); silver (0.385 mg/kg); sodium (20.5 mg/kg); and zinc (31.3 mg/kg). Although thirteen deep soil samples were analyzed for lead, eight soil samples were analyzed for other TCL metals. A majority of the maximum concentrations of metals were detected in samples collected from wells 13MW4 and 13MW5. Concentrations of metals in deep soil samples in Zone 1 were similar to those found in other areas of the Lower Subase. Arsenic, beryllium, cadmium, iron, manganese, mercury, nickel, and silver concentrations in the deep soils exceeded one or more screening levels.

Drawing 4 shows isoconcentration contours of lead concentrations measured in Zone 1 deep soils. It indicates that all deeper soil within Zone 1 of the Lower Subase contains less than 400 mg/kg of lead (i.e., OSWER soil screening level for residential land use) and also shows that all lead concentrations are below the CTDEP residential human health risk criteria of 500 mg/kg.

Table 3-4 indicates that three deep Zone 1 soil samples were collected for TCLP analysis and two metals, arsenic and selenium, were detected in the leachates from these soil samples. However, TCLP concentrations of these metals did not exceed any of the screening level criteria.

Table 3-2 indicates that two VOCs and TPH were detected in the deeper Zone 1 soil. Twenty of twenty-two deep soil samples had measurable levels of TPH, one of ten samples had detectable levels of xylenes and one of eight samples had measurable levels of carbon disulfate. Of the two VOCs detected, neither exhibited concentrations which exceeded screening levels. SVOCs were not analyzed for in the deeper soil samples of Zone 1. TPH concentrations detected in thirteen of the twenty-two deep soil samples analyzed exceeded one or more screening levels. The highest TPH concentrations were found at sample location 13MW18 and in samples in the vicinity of the tanks at Sites 10 and 11. Based upon the results of the fluorescence analyses from the Phase I RI, it appears that both diesel oil and lubricating oil have leaked from tanks. Soils collected from the borings of Wells 13MW1, 13MW5, and 13MW7 were identified as containing lubricating oil. Adjacent to and coincident with the lubricating oil is an area of diesel oil contamination as indicated by the results from the borings of Wells 13MW2, 13MW3, and 13MW8. Diesel oil and lubricating oil contamination extends from the tanks to the Thames River. In

addition, petroleum contamination along Albacore Road by Corvina Road was also identified. Fuel pipeline leaks or ducts acting as preferential flow pathways may be the source of this contamination.

Drawing 2 shows isoconcentration contours of TPH measured in deep soil. It indicates that well over fifty percent of the deeper Zone 1 soil exceeds the CTDEP residential human health risk criteria of 500 mg/kg for TPH. In addition, most of this soil also exceeds the less stringent industrial risk criteria of 2,500 mg/kg for TPH. Since most of the deep soil oil contamination in Zone 1 was not seen in the shallow soils (Drawing 1), it is likely that the source of the contamination is a fuel line leak rather than a surface spill.

Based on sample results, TPH and metals were identified as the COPCs for deeper Zone 1 soil at the Lower Subase. Metals of potential concern include arsenic, beryllium, cadmium, iron, manganese, mercury, nickel, and silver. Areas of maximum metals concentrations in deeper soil are varied throughout Zone 1. Widespread petroleum contamination is apparent throughout most of Zone 1 with the highest concentrations noted around the tanks at Sites 10 and 11.

3.4.2 Groundwater

The analytical results and COPC screening results for Zone 1 groundwater are shown in Tables 3-5 and 3-6. Table 3-5 summarizes the analytical and COPC screening results for unfiltered groundwater while Table 3-6 summarizes the analytical and COPC screening results for filtered groundwater.

Drawings 5 through 7 (back pocket) at the end of this report delineate TPH and lead concentrations in Lower Subase groundwater. Drawing 5 depicts isoconcentration contours of TPH in groundwater, whereas Drawings 6 and 7 show lead isoconcentration contours in unfiltered and filtered groundwater, respectively.

Table 3-5 indicates that twenty-two metals were detected in unfiltered groundwater samples collected at Zone 1 in the Lower Subase. Although maximum concentrations of metals were found in ten different monitoring wells within the zone, samples from wells 13MW19 and 13MW9 contained about sixty percent of the maxima. Concentrations of thirteen metals exceeded one or more screening levels. These included aluminum, arsenic, beryllium, boron, cadmium, copper, iron, lead, manganese, mercury, selenium, sodium (exceeds only a notification level), and vanadium. It should be noted that out of 31 samples, beryllium had only one positive detection, and mercury and selenium had only two detections.

Table 3-6 indicates that eighteen metals were detected in filtered groundwater samples collected at Zone 1. In general, metals results for filtered groundwater samples were slightly lower, but similar to the

results for unfiltered samples. Although maximum concentrations of metals were found at seven different locations, samples from wells 13MW19 and 13MW9 contained two-thirds of the maxima. Concentrations of ten metals found in Zone 1 filtered groundwater exceeded one or more screening levels. These included aluminum, antimony, arsenic, beryllium, boron, iron, lead, manganese, sodium (exceeds only a notification level), and vanadium. It should be noted that out of 21 samples, antimony and beryllium had only one positive detection, and lead had only three detections. The detection of antimony in the filtered groundwater sample is questionable because the detected concentration is near the detection limit and antimony was not detected in the unfiltered sample.

The distribution of lead in unfiltered and filtered groundwater samples is shown on Drawings 6 and 7, respectively. Drawing 6 shows that a small plume of lead contamination, which exceeds the CTDEP groundwater protection standard of 15 μg/L, exists beneath the northeast corner of Building 29 in Zone 1 of the Lower Subase. Drawing 7 indicates that the dissolved lead concentrations found in the same groundwater would not exceed the state protection standard of 15 μg/L.

Several VOCs and SVOCs were also detected in groundwater samples collected in Zone 1. Table 3-5 indicates that seven VOCs and nineteen SVOCs were detected in groundwater samples collected at Zone 1 in the Lower Subase.

Concentrations of organics were low (generally below 10 μg/L), although SVOCs were detected as high as 47 μg/L. Monocyclic aromatic compounds were detected most frequently and at the highest concentrations. Carbon disulfide and 1,1-dichloroethane were also detected. Benzene was detected at a concentration of 3 μg/L in the sample from well 13MW2 in Rounds 1 and 2 of the Phase II RI. Maximum concentrations of xylenes, ethylbenzene, and 1,1-dichloroethane were detected in the sample from well 13MW19 during Round 1 of the Phase RI.

A few PAHs were detected in groundwater samples at concentrations between 1 μg/L and 10 μg/L, although 2-methylnaphthalene (C_{max} = 47 μg/L), fluorene (C_{max} = 15 μg/L), and naphthalene (C_{max} = 28 μg/L) concentrations were slightly higher. The sample from Well 13MW2 contained many PAHs. Chlorinated benzenes, benzoic acid, phthalates, carbazole, dibenzofuran, and phenolic compounds were also infrequently detected in groundwater samples. With the exception of phenol (28 μg/L in one sample), all concentrations were less than 12 μg/L, with many less than 1 μg/L.

Concentrations of TPH ranged from 600 μg/L to 2,100 μg/L. No. 2 fuel oil was detected in groundwater in the vicinity of Tank 54-H during a previous investigation (Fuss & O'Neill, 1989). Fluorescence spectroscopy performed on the Phase I RI groundwater samples identified the presence of residual fuel oil

in well NESOMW4. Additionally, a mixture of diesel fuel and heavy residual fuel oil (i.e., No. 6 fuel oil) was identified in wells 13MW1, 13MW2, 13MW3 and 13MW7. Fluorescence spectroscopy also indicated the presence of waste lubricating oil and No. 2 diesel oil in wells 13MW5 and 13MW4, respectively. Trace levels of petroleum hydrocarbons were detected in wells 13MW8 and 13MW9, but concentrations were too low to identify the type of oil.

Of the seven VOCs detected in Zone 1 groundwater, only the concentration of benzene at 3 μg/L exceeded one or more screening levels. Benzene was detected in only two of thirty-five groundwater samples collected in Zone 1. Concentrations of three of the nineteen SVOCs, acenaphthylene at 1 μg/L, bis(2-ethylhexyl)phthalate at 3 μg/L and phenanthrene at 9 μg/L, exceeded one or more screening levels. However, each of these three SVOCs were detected infrequently in Zone 1 groundwater samples (i.e., in only 4 or less of the 21 samples). Screening criteria were not available for 2-methylnaphthalene or 4-methylphenol to determine whether or not these chemicals are COPCs, therefore they were retained as COPCs.

Drawing 5 shows that a large plume of TPH contamination exists in the groundwater beneath Site 10 that exceeds the CTDEP groundwater protection standard of 500 μg/L. Another less concentrated TPH plume, extending from the northeast of Building 29 and proceeding in a southwest direction to the Thames River, also exceeds the CTDEP groundwater protection standard.

Based on sample results, benzene, acenaphthylene, bis(2-ethylhexyl)phthalate, phenanthrene, TPH, and metals were identified as COPCs for Zone 1 groundwater at the Lower Subase. Metals of potential concern include aluminum, antimony, arsenic, beryllium, boron, cadmium, copper, iron, lead, manganese, mercury, selenium, sodium and vanadium. Widespread petroleum contamination in the groundwater beneath Sites 10 and 11 extends from the eastern side of Zone 1 all the way to the Thames River.

3.5 DATA EVALUATION

Data was evaluated based on contaminant fate and transport, human health and ecological risk assessments, and a comparison to state standards in the Phase II RI. These are summarized in this section. In addition, an evaluation of Zone 1 using the decision tree provided in Figure 1-3 is also included in this section.

3.5.1 Contaminant Fate and Transport

Metals are not typically considered to be mobile contaminants in the environment. Lead and other metals do not degrade via any of the identified fate processes (e.g., hydrolysis, photolysis, etc.) although under acidic soil conditions, metals may be solubilized and transported vertically with infiltrating precipitation. The presence of these analytes at depth may reflect the nature of the fill material used to construct the Lower Base, as well as some potential vertical transport associated with industrial activities occurring on the surface. In addition, the presence of lead at the site may be attributable to the fact that, until the 1950s, all submarines depended on lead batteries for principal means of underwater propulsion. One preferential contaminant migration pathway for Zone 1 contaminants to migrate the Thames River would be the storm sewer along Corvina Road.

With the exception of TPH, substantial groundwater contamination at Zone 1 was not observed. Petroleum hydrocarbons in soil have apparently migrated to groundwater. This is evident on Drawings 1, 2, and 5 (back pocket) and was previously discussed in Section 3.4.

3.5.2 Baseline Human Health Risk Assessment

The baseline human health risk assessment conducted in the Phase II RI for Zone 1 at the Lower Subase focused on two potential receptor groups: construction workers and future residents. Two exposure scenarios were considered for each receptor, in accordance with USEPA Region I guidance, the CTE and RME scenarios. Based on the revisions to the RI, all HIs were less than unity and all incremental cancer risks were less than the $1x10^{-6}$ lower limit of the USEPA target risk range.

Maximum concentrations of lead in soil did not exceed the associated OSWER lead screening level for residential land use (400 mg/kg); therefore, soil lead levels were not considered to pose a risk to human health. Although maximum concentrations of lead in groundwater exceeded the Federal drinking water action level (15 ug/L), lead exposure was not further evaluated as groundwater is unlikely to be used for potable water supply primarily because of salt water intrusion.

3.5.3 Ecological Risk Assessment

The only potential ecological habitat near the Lower Subase is the Thames River. Note that the ecological risk assessment for the Thames River, discussed in Section 2.5.3, concluded that the Lower Subase represented a minimal potential risk to ecological receptors. PAHs and metals are the primary chemicals of concern for the Thames River (see Section 2.0). Metals and TPH were detected in Zone 1 soils;

however, SVOC data for soils are not available. PAHs are common constituents of petroleum products. Contamination at Zone 1 may be impacting the Thames River.

3.5.4 Comparison of Site Data to Connecticut Standards

Analytical data were compared to Connecticut drinking water standards and remediation standards. Site-specific soil data were compared to Connecticut remediation standards for direct exposure and pollutant mobility. Direct exposure criteria for residential exposure were used to conservatively evaluate potential exposure to soil at the site. Only soil concentrations of TPH for shallow and deep soils in Zone 1 exceeded the residential direct exposure criteria. Only soil concentrations of TPH in deep soil exceeded the industrial direct exposure criteria.

To address concerns regarding migration of chemicals from soil to groundwater, site soil data were compared to Connecticut remediation standards for pollutant mobility. Data were compared to GB pollutant mobility criteria. For Zone 1, TPH was the only chemical reported at maximum concentrations in shallow and deep soils exceeding the GB pollutant mobility criteria. All TCLP concentrations were below Federal toxicity characteristic regulatory levels; however, concentrations of lead in TCLP leachates from shallow soil exceeded state pollutant mobility criteria for GB waters.

Analytical groundwater data for Zone 1 were compared to Connecticut MCLs and remediation standards for groundwater and surface water protection. Cadmium was detected in the unfiltered groundwater samples at a maximum concentration exceeding the state MCL. No exceedances of primary MCLs were noted in the filtered samples. Maximum concentrations of sodium in the filtered and unfiltered groundwater samples exceeded the state Notification Level of 28,000 µg/L.

Maximum groundwater concentrations of benzene, bis(2-ethylhexyl)phthalate (BEHP), cadmium (unfiltered), lead (unfiltered), vanadium (filtered and unfiltered) and TPH exceeded Connecticut remediation standards for groundwater protection. It should be noted that the groundwater protection criteria are applicable for GA or GAA designated groundwater, and in some cases this criteria may in fact be set at the state MCL. Use of these standards is conservative because the groundwater at NSB-NLON has been reclassified to GB.

Since groundwater at the Lower Subase eventually discharges to a surface water body (i.e., Thames River), groundwater data were also compared to Connecticut remediation standards for surface water protection. Those chemicals found at maxima in Zone 1 exceeding the surface water protection criteria

are acenaphthylene, phenanthrene, arsenic (filtered and unfiltered), cadmium (unfiltered), copper (unfiltered), lead (filtered and unfiltered), and mercury (unfiltered).

3.5.5 Decision Tree

The general decision tree for the evaluation of sites is provided in Figure 1-3. The evaluation of data using this decision tree for Zone 1 is as follows:

- Existing data have been collected and evaluated. Information describing the site, previous investigations, and physical characteristics of the site are provided in Sections 3.1, 3.2, and 3.3, respectively. The nature and extent of contamination is provided in Section 3.4.

- Based on the existing data, no imminent threat to human health or the environment was identified for Zone 1.

- Contaminant fate and transport have been described, baseline human health and ecological risk assessments have been conducted and data have been compared to CTDEP Standards.

- Although contamination in Zone 1 has not been fully characterized because of the lack of SVOC data for soils, available information indicates that the source of contamination is from prior activities at the Subase and that significant risks do not exist for human health or the environment.

- A hot spot area, where high concentrations of TPH (maximum of 51,600 mg/kg) have been identified, is evident in the vicinity of Site 10 and Site 11 (see Drawing 2). A smaller hot spot area with lower TPH concentrations (maximum of 6670 mg/kg) is also evident along Albacore Road at Corvina Road.

- Further action is required for Zone 1 and is discussed in Section 3.6.

3.6 RECOMMENDATIONS

The Phase II RI provides recommendations for Zone 1. In general, further characterization focusing on sampling and analysis to evaluate the nature and extent of TPH in shallow soil and SVOCs in soil are recommended. Continued groundwater sampling and analysis were also recommended to monitor contamination levels. These recommendations are supported by the following information:

- High concentrations of TPH in soil are present at Zone 1 (Site 10 Fuel Oil Storage Tanks and Tank 54-H, Site 11 Power Plant Oil Tanks; maximum concentration = 51,600 mg/kg).

- SVOCs have not been analyzed in soil during the Phase I and II RI activities. Monitoring of these compounds are needed to evaluate risks associated with these contaminants. It is highly probable that SVOCs will be detected at significant levels in soil, based on the presence of TPH. SVOCs are common components of TPH, and the concentrations of these compounds are not known.

- Petroleum products and oily substances have historically migrated into the Thames River. As discussed in Section 2.0, the Thames River sediment and shellfish community may be impacted in the vicinity of the Lower Subase.

Additional sampling and analysis should also be conducted to confirm whether lead detected in the shallow soils is truly mobile, as indicated by the TCLP results. The SPLP method should be used to analyze the additional samples.

It is further recommended that in conjunction with sampling at Zone 1, integrity inspections on the active and inactive fuel lines located in Zone 1 (and throughout the Lower Subase) be conducted to determine potential line leaks. In addition, a review of records to identify previous leaks based on the results of inspections and tightness tests is recommended. The integrity inspections and review of data are important to identify sources of petroleum contamination.

Because contaminants associated with the Lower Subase have been detected in the sediments in the Thames River, sampling of the sediments is recommended in conjunction with characterization activities to aid in the identification of source areas and contaminants of concern. Sampling of media from the Thames River is discussed in Section 2.6.

Based on the results of the additional sampling and analyses and the integrity inspection activities, source areas will be able to be defined and remedial activities for the source areas will be conducted as necessary. Remedial activities should focus on the removal of free product and highly contaminated areas (hot spots) which may act as sources of contamination to other media/receptors. However, because Zone 1 is located in an active, industrialized area which is vital to national security, petroleum contamination is widespread in the Lower Subase, and contamination represents minimal risks to human health and the environment (i.e., limited exposure pathways), remediation of all contaminated material at Zone 1 by excavation is not feasible or practical. Therefore, in-situ remedial options such as containment,

air sparging, soil vapor extraction (SVE), natural attenuation, or bioremediation should also be explored and used as applicable.

TABLE 3-1

COPC SCREENING FOR LOWER SUBASE
ZONE 1 - SHALLOW SOILS (<5 FEET)
NSB-NLON, GROTON, CONNECTICUT
PAGE 1 OF 2

Parameter	Frequency (1)	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	SSL Inhalation (3)	SSL Migration to Groundwater (3)	State Residential Direct Exposure (4)	State Industrial Direct Exposure (4)	State Pollutant Mobility (GB) (4)	Select as COPC? (5)
Volatile Organic Compounds (mg/kg)												
Acetone	1/1	0.054	-	0.054	Pipe Chase	780	100000	0.8	500	1000	140	N
Methylene chloride	1/1	0.015	-	0.015	Pipe Chase	85	13	0.001	82	760	1	Y
Xylenes, Total	1/2	0.0013	0.011	0.003	Pipe Chase	16000	-	-	500	1000	19.5	N
Semivolatile Organic Compounds (mg/kg)												
Acenaphthene	1/1	0.024	-	0.024	Pipe Chase	470	-	29	-	-	-	N
Anthracene	1/1	0.03	-	0.03	Pipe Chase	2300	-	590	1000	2500	400	N
Benzo(a)anthracene	1/1	0.14	-	0.14	Pipe Chase	0.88	-	0.08	1	7.8	1	Y
Benzo(a)pyrene	1/1	0.13	-	0.13	Pipe Chase	0.088	-	0.4	1	1	1	Y
Benzo(b)fluoranthene	1/1	0.13	-	0.13	Pipe Chase	0.88	-	0.2	1	7.8	1	N
Benzo(g,h,i)perylene	1/1	0.088	-	0.088	Pipe Chase	-	-	-	-	-	-	N (6)
Benzo(k)fluoranthene	1/1	0.11	-	0.11	Pipe Chase	8.8	-	2	8.4	78	1	N
Bis(2-ethylhexyl)phthalate	1/1	0.097	-	0.097	Pipe Chase	46	31000	180	44	410	11	N
Carbazole	1/1	0.029	-	0.029	Pipe Chase	32	-	0.03	-	-	-	N
Chrysene	1/1	0.14	-	0.14	Pipe Chase	88	-	8	-	-	-	N
Fluoranthene	1/1	0.31	-	0.31	Pipe Chase	310	-	210	1000	2500	56	N
Indeno(1,2,3-cd)pyrene	1/1	0.081	-	0.081	Pipe Chase	0.88	-	0.7	-	-	-	N
Phenanthrene	1/1	0.19	-	0.19	Pipe Chase	-	-	-	1000	2500	40	N
Pyrene	1/1	0.23	-	0.23	Pipe Chase	230	-	210	1000	2500	40	N
Metals (mg/kg)												
Aluminum	1/1	5710	-	5710	Pipe Chase	7800	-	-	-	-	-	N
Antimony	1/1	0.64	-	0.640	Pipe Chase	3.1	-	0.3	27	8200	-	Y
Barium	1/1	20.5	-	20.5	Pipe Chase	550	690000	82	4700	140000	-	N
Beryllium	1/1	0.2	-	0.2	Pipe Chase	0.15	1300	3	2	2	-	Y
Cadmium	1/1	0.34	-	0.34	Pipe Chase	3.9	1800	0.4	34	1000	-	N
Calcium	1/1	838	-	838	Pipe Chase	-	-	-	-	-	-	N (7)
Chromium	1/1	4.9	-	4.9	Pipe Chase	39	270	-	3900/100 (8)	5.1E+4/100 (8)	-	N
Copper	1/1	8	-	8	Pipe Chase	310	-	-	2500	76000	-	N
Iron	1/1	6810	-	6810	Pipe Chase	2300	-	-	-	-	-	Y
Lead	5/5	7.7 - 112	-	46.6	13TB15	400	-	-	500	1000	-	N
Magnesium	1/1	1420	-	1420	Pipe Chase	-	-	-	-	-	-	N (7)
Manganese	1/1	122	-	122	Pipe Chase	39	-	-	-	-	-	Y
Nickel	1/1	3.4	-	3.4	Pipe Chase	160	13000	7	1400	7500	-	N

TABLE 3-1

COPC SCREENING FOR LOWER SUBASE
ZONE 1 - SHALLOW SOILS (<5 FEET)
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 2

Parameter	Frequency (1)	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	SSL Inhalation (3)	SSL Migration to Groundwater (3)	State Residential Direct Exposure (4)	State Industrial Direct Exposure (4)	State Pollutant Mobility (GB) (4)	Select as COPC? (5)
Potassium	1/1	1280	-	1280	Pipe Chase	-	-	-	-	-	-	N (7)
Silver	1/1	0.54	-	0.54	Pipe Chase	39	-	2	340	10000	-	N
Sodium	1/1	422	-	422	Pipe Chase	-	-	-	-	-	-	N (7)
Vanadium	1/1	8.9	-	8.9	Pipe Chase	55	-	300	470	14000	-	N
Zinc	1/1	18.3	-	18.3	Pipe Chase	2300	-	620	20000	610000	-	N
Miscellaneous (mg/kg)												
TPH	5/6	23.8 - 546	10.8	212	13TB17	500	-	-	500	2500	2500	Y

- Not available or not applicable.

(1) Includes data from the following samples 13TB13-0305, 13TB15-0305, 13TB16-0204, 13TB17-0406, FPTB28L-04, and Pipe Chase.

(2) Based on current USEPA Region III guidance (USEPA Region III, May 10, 1996). Residential Soil Ingestion for soil and sediment.

(3) USEPA Soil Screening Levels (USEPA, May 1996). For migration to groundwater, values associated with a dilution and attenuation factor (DAF) of 1.0.

(4) CTDEP, December 1995.

(5) Contaminant of Potential Concern; Yes (Y) indicates that the maximum concentration exceeds one or more of the criteria; No (N) indicates that the maximum does not exceed any of the criteria.

(6) Criteria not available.

(7) Essential nutrient. Not evaluated for COPC selection.

(8) Trivalent chromium/hexavalent chromium.

TABLE 3-2

COPC SCREENING FOR LOWER SUBASE
ZONE 1 - DEEP SOILS (>5 FEET)
NSB-NLON, GROTON, CONNECTICUT
PAGE 1 OF 2

Parameter	Frequency (1)	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	SSL Inhalation (3)	SSL Migration to Groundwater (3)	State Residential Direct Exposure (4)	State Industrial Direct Exposure (4)	State Pollutant Mobility (GB) (4)	Select as COPC? (5)
Volatile Organic Compounds (mg/kg)												
Carbon disulfide	1/8	0.005	0.005 - 0.56	0.039	13MW7	780	720	2	-	-	-	N
Xylenes, Total	1/10	0.0007	0.0011 - 0.56	0.031	North End-Tank Grave	16000	-	-	500	1000	19.5	N
Metals (mg/kg)												
Aluminum	8/8	3250 - 6980	-	4730	13MW5	7800	-	-	-	-	-	N
Arsenic	7/8	0.53 - 4.3	0.47	1.45	13MW3	0.43	750	1	10	10	-	Y
Barium	8/8	14.7 - 40.5	-	29	13MW5	550	690000	82	4700	140000	-	N
Beryllium	3/8	0.25 - 0.4	0.21 - 0.24	0.19	13MW4	0.15	1300	3	2	2	-	Y
Cadmium	8/8	0.57 - 1.4	-	0.95	13MW8	3.9	1800	0.4	34	1000	-	Y
Calcium	8/8	539 - 1870	-	896	13MW4	-	-	-	-	-	-	N (6)
Chromium	8/8	4.6 - 15.4	-	9.5	13MW1	39	270	-	3900/100 (7)	5.1E+4/100 (7)	-	N
Cobalt	8/8	1.8 - 5.5	-	3.63	13MW4/13MW5	470	-	-	-	-	-	N
Copper	8/8	7.7 - 59.6	-	17.2	13MW4	310	-	-	2500	76000	-	N
Iron	8/8	3770 - 10400	-	7136	13MW5	2300	-	-	-	-	-	Y
Lead	13/13	2.6 - 383	-	44.3	13MW4	400	-	-	500	1000	-	N
Magnesium	8/8	1310 - 3020	-	2120	13MW4	-	-	-	-	-	-	N (6)
Manganese	8/8	56.1 - 173	-	118	13MW5	39	-	-	-	-	-	Y
Mercury	2/8	0.12 - 0.48	0.1 - 0.12	0.12	13MW4	2.3	-	0.1	20	610	-	Y
Nickel	8/8	2.4 - 12	-	5.9	13MW4	160	13000	7	1400	7500	-	Y
Potassium	8/8	1170 - 2830	-	1828	13MW1	-	-	-	-	-	-	N (6)
Silver	1/8	2.2	1.5 - 1.7	0.99	13MW4	39	-	2	340	10000	-	Y
Sodium	8/8	74 - 821	-	282	13MW9	-	-	-	-	-	-	N (6)
Vanadium	8/8	5.7 - 27.1	-	14	13MW4	55	-	300	470	14000	-	N
Zinc	8/8	20.3 - 70.4	-	33	13MW4	2300	-	620	20000	610000	-	N
Miscellaneous (mg/kg)												
TPH	20/22	23.5 - 51600	10.9 - 70	6838	13MW18	500	-	-	500	2500	2500	Y

TABLE 3-2

COPC SCREENING FOR LOWER SUBASE
ZONE 1 - DEEP SOILS (>5 FEET)
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 2

- Not available or not applicable.

(1) Includes data from the following samples 13MW1(12-14), 13MW2(10-12), 13MW3(12-14), 13MW4(6-8), 13MW7(8-10), 13MW8(8-10), 13MW9(6-8), 13MW5(10-12) 13MW18-0911, 13TB13-0911, 13TB15-0709, 13TB16-0810, 13TB17-0608, FPTB25L-06, FPTB26L-05, FPTB13L-07 DUP04-100795, FPTB30L-07, FPTB31L-07, FPTB32L-11, Tank Grave-N, and Tank Grave-S.

(2) Based on current USEPA Region III guidance (USEPA Region III, May 10, 1996). Residential Soil Ingestion for soil and sediment.

(3) USEPA Soil Screening Levels (USEPA, May 1996). For migration to groundwater, values associated with a dilution and attenuation factor (DAF) of 1.0.

(4) CTDEP, December 1995.

(5) Contaminant of Potential Concern; Yes (Y) indicates that the maximum concentration exceeds one or more of the criteria; No (N) indicates that the maximum does not exceed any of the criteria.

(6) Essential nutrient. Not evaluated for COPC selection.

(7) Trivalent chromium/hexavalent chromium.

TABLE 3-3

COPC SCREENING FOR LOWER SUBASE
ZONE 1 - TCLP SHALLOW SOILS (<5 FEET)
NSB-NLON, GROTON, CONNECTICUT

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	State Pollutant Mobility (GB) (2)	Federal Pollutant Mobility (3)	Select as COPC? (4)
Metals (ug/L)								
Barium	4/5	106 - 284	-	190	13TB17	10,000	100,000	N
Cadmium	1/5	2.5	2-3	1.4	13TB17	50	1,000	N
Chromium	3/5	5 - 9.3	3-4	5.02	13TB13	500	5,000	N
Lead	3/5	20 - 194	16-20	56.6	13TB17	150	5,000	Y
Selenium	2/5	25 - 26.9	24-32	18.4	13TB13	500	1,000	N

- Not available or Not applicable.

(1) Includes data from the following samples: 13TB13-0305, 13TB15-0305, 13TB16-0204, 13TB17-0406, and Pipe Chase.

(2) CTDEP Pollutant Mobility Remediation Standard for GB classified groundwater; CTDEP, December 1995.

(3) Federal Toxicity Characteristic Regulatory Level (58 FR 46049).

(4) Contaminant of Potential Concern; Yes (Y) indicates that the maximum concentration exceeds one or more of the criteria; No (N) indicates that the maximum does not exceed any of the critiera.

TABLE 3-4

COPC SCREENING FOR LOWER SUBASE
ZONE 1 - TCLP DEEP SOILS (>5 FEET)
NSB-NLON, GROTON, CONNECTICUT

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	State Pollutant Mobility (GB) (2)	Federal Pollutant Mobility (3)	Select as COPC? (4)
Metals (ug/L)								
Arsenic	1/13	362	26 - 500	161	13TB16	500	5000	N
Selenium	3/13	26.9 - 64.4	24 - 200	73	13TB16	500	1000	N

- Not available or Not applicable.

(1) Includes data from the following samples: 13MW1(12-14), 13MW18-0911, 13MW2(10-12), 13MW3(12-14), 13MW4(6-8), 13MW5(10-12), 13MW7(8-10), 13MW8(8-10), 13MW9(6-8), 13TB13-0911, 13TB15-0709, 13TB16-0810, and 13TB17-0608.

(2) CTDEP Pollutant Mobility Remediation Standard for GB classified groundwater; CTDEP, December 1995.

(3) Federal Toxicity Characteristic Regulatory level (58 FR 46049).

(4) Contaminant of Potential Concern; Yes (Y) indicates that the maximum concentration exceeds one or more of the criteria; No (N) indicates that the maximum does not exceed any of the criteria.

TABLE 3-5

COPC SCREENING FOR LOWER SUBASE
ZONE 1 - UNFILTERED GROUNDWATER
NSB-NLON, GROTON, CONNECTICUT
PAGE 1 OF 3

Parameter	Frequency (1)	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	Federal MCL (3)	State MCL (4)	State Remediation Standards (5)		Select as COPC? (6)
									Groundwater Protection	Surface Water Protection	
Volatile Organic Compounds (ug/L)											
1,1-Dichloroethane	1/31	3	5 - 10	4	13MW19	81	-	-	70	-	N
Benzene	2/35	3	1 - 10	4	13MW2	0.36	5	5	1	710	Y
Carbon disulfide	3/31	1 - 3	5 - 10	4	13MW9	100	-	-	-	-	N
Ethylbenzene	3/35	2 - 11	1 - 10	4	13MW19	130	700	700	700	580000	N
Styrene	1/31	2	5 - 10	4	13MW8	160	100	100	100	-	N
Toluene	1/35	11	1 - 10	4	FOMW13	75	1000	1000	1000	4000000	N
Xylenes, Total	3/35	8 - 44	1 - 10	5	13MW19	1200	10000	10000	530	-	N
Semivolatile Organic Compounds (ug/L)											
1,2,4-Trichlorobenzene	1/21	0.7	10	5	NESO4	19	70	70	-	-	N
1,3-Dichlorobenzene	2/25	0.5	1 - 10	4	NESO4/13MW3	54	600	-	600	26000	N
2-Methylnaphthalene	6/21	1 - 47	10	7	13MW2	-	-	-	-	-	Y (7)
4-Methylphenol	4/21	1 - 6	10	5	13MW3	-	-	-	-	-	Y (7)
Acenaphthene	10/21	0.6 - 10	10	4	13MW2	220	-	-	-	-	N
Acenaphthylene	1/21	1	10	5	13MW2	-	-	-	420	0.3	Y
Anthracene	2/21	1 - 2	10	5	13MW2	1100	-	-	2000	1100000	N
Benzoic acid	1/21	0.6	50	24	13MW1	15000	-	-	-	-	N
Bis(2-ethylhexyl)phthalate	3/21	0.8 - 3	10	5	13MW1	4.8	6	6	2	59	Y
Carbazole	4/21	1	10	4	13MW2/13MW20	3.4	-	-	-	-	N
Di-N-butyl phthalate	2/21	0.6 - 1	10	5	13MW21	370	-	-	700	-	N
Dibenzofuran	5/21	1 - 11	10	5	13MW2	15	-	-	-	-	N
Diethyl phthalate	5/21	0.6 - 3	10	4	13MW1	2900	-	-	-	-	N
Fluoranthene	4/21	0.7 - 2	10	4	13MW2	150	-	-	280	3700	N
Fluorene	5/21	1 - 15	10	5	13MW2	150	-	-	280	140000	N
Naphthalene	5/21	1 - 28	10	6	13MW2	150	-	-	280	-	N
Phenanthrene	4/21	1 - 9	10	5	13MW2	-	-	-	200	0.077	Y
Phenol	1/21	28	10	6.1	13MW3	2200	-	-	4000	92000000	N

TABLE 3-5

COPC SCREENING FOR LOWER SUBASE
ZONE 1 - UNFILTERED GROUNDWATER
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 3

Parameter	Frequency (1)	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	Federal MCL (3)	State MCL (4)	State Remediation Standards (5)		Select as COPC? (6)
									Groundwater Protection	Surface Water Protection	
Pyrene	6/21	0.5 - 1	10	4	13MW2/13MW9	110	-	-	200	110000	N
Metals (ug/L)											
Aluminum	16/31	23.5 - 26100	10 - 342	1622	13MW19	3700	50 TO 200 (8)	-	-	-	Y
Arsenic	16/31	1.5 - 16.8	2 - 3	3.1	13MW21	0.045	50	50	50	4	Y
Barium	19/31	9.6 - 210	2.9 - 40.6	35	13MW5	260	2000	2000	1000	-	N
Beryllium	1/31	1.3	1	0.52	13MW19	0.016	4	4	4	4	Y
Boron	18/21	52 - 1430	50	204	13MW9	330	-	-	-	-	Y
Cadmium	4/31	1.4 - 20.9	2 - 5	2.2	NESO4	1.8000	5	5	5	6	Y
Calcium	31/31	4820 - 139000	-	36630	13MW9	-	-	-	-	-	N (9)
Chromium	5/31	5.1 - 11.6	1 - 14	3	13MW7	18	100	100	50	1200	N
Cobalt	3/31	5.4 - 8.2	1 - 5	2.6	13MW3	220	-	-	-	-	N
Copper	10/31	2.6 - 68.4	2 - 5	7.3	13MW19	150	1300	-	1300	48	Y
Iron	29/31	43.1 - 11600	17 - 40.5	2219	13MW2	1100	300	-	-	-	Y
Lead	14/30	2 - 39.3	1 - 10	4.9	13MW19	15	15	-	15	13	Y
Magnesium	27/31	129 - 443000	399 - 5800	39369	13MW9	-	-	-	-	-	N (9)
Manganese	31/31	10.2 - 2290	-	347	13MW8	18	50	5000	-	-	Y
Mercury	2/31	0.43 - 0.97	0.2	0.14	13MW19	1.1000	2	2	2	0.4	Y
Nickel	12/31	10.4 - 27.2	3 - 11	10.4	13MW1	73	100	100	100	880	N
Potassium	31/31	2090 - 138000	-	16950	13MW9	-	-	-	-	-	N (9)
Selenium	2/31	1 - 22	1 - 30	3	13MW9	18	50	50	50	50	Y
Silver	1/31	7.4	2 - 7	1.9	13MW8	18	100	50	36	12	N
Sodium	31/31	14800 - 2980000	-	381584	13MW9	-	-	28000 (10)	-	-	Y
Vanadium	9/31	3.2 - 689	1 - 20	35	13MW19	26	-	-	50	-	Y
Zinc	20/31	4 - 121	2 - 26.5	14	13MW19	1100	5000	-	5000	123	N
Miscellaneous (ug/L)											
Hardness as CaCO3 (mg/l)	21/21	20 - 2170	-	292	13MW9	-	-	-	-	-	N (11)
DRO - Fuel Oil #2	4/4	21000 - 1100000	-	492000	FOMW14	-	-	-	-	-	N (11)

TABLE 3-5

COPC SCREENING FOR LOWER SUBASE
ZONE 1 - UNFILTERED GROUNDWATER
NSB-NLON, GROTON, CONNECTICUT
PAGE 3 OF 3

- Not available or Not applicable.

(1) Includes data from the following samples: 13MW7S, 13MW27S, 13MW1S, 13MW2S, 13MW3S, 13MW4S, 13MW5S, 13MW9S, NESOMW4S, 13MW8, 13GW1, 13GW1-2, 13GW18-2, 13GW19-2, 13GW2, 13GW20-2, 13GW21-2, 13GW3, 13GW3-2, 13GW8, 13GW8-2, 13GW9, 13GW18, 13GW19, 13GW20, 13GW20-D, 13GW21, 13GW9-2, MW-13, MW-14, MW-15, MW-16, NESO4, and NESO4-2.

(2) For residential tap water ingestion, based on current USEPA Region III guidance (USEPA Region III, May 10, 1996).

(3) Maximum Contaminant Level (USEPA, May 1995).

(4) Title 19, Health and Safety, the Public Health Code of the State of Connecticut, Chapter 11, Environmental Health.

(5) CTDEP, December, 1995.

(6) Contaminant of Potential Concern: A Yes (Y) indicates that the maximum contaminant concentration exceeds one or more of the criteria; A No (N) indicates that the maximum contaminant concentration does not exceed any of the criteria.

(7) Criteria not available.

(8) Secondary MCL, based on aesthetic drinking water qualities.

(9) Essential nutrient, not evaluated for COPC selection.

(10) Notification Level.

(11) Not appropriate for COPC screening.

TABLE 3-6

COPC SCREENING FOR LOWER SUBASE
ZONE 1 - FILTERED GROUNDWATER
NSB-NLON, GROTON, CONNECTICUT

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	Federal MCL (3)	State MCL (4)	State Remediation Standards (5)		Select as COPC? (6)
									Groundwater Protection	Surface Water Protection	
Metals (ug/l)											
Aluminum	7/21	20 - 18700	10 - 88.7	1284	13MW19	3700	50 TO 200 (7)	-	-	-	Y
Antimony	1/21	5.7	5 - 15.6	6.9	NESO4	1.5	6	6	6	86000	Y
Arsenic	11/21	1.2 - 24.8	2	3.28	13MW19	0.045	50	50	50	4	Y
Barium	10/21	14.1 - 95	1.4 - 40.3	28.6	13MW18	260	2000	2000	1000	-	N
Beryllium	1/21	1	1	0.52	13MW19	0.016	4	4	4	4	Y
Boron	18/21	50 - 1410	50	202	13MW9	330	-	-	-	-	Y
Calcium	21/21	5730 - 138000	-	40773	13MW9	-	-	-	-	-	N (8)
Chromium	6/21	1 - 9.3	3 - 4	2.3	13MW19	18	100	100	50	1200	N
Copper	8/21	2.3 - 44.2	2 - 5	5.2	13MW19	150	1300	-	1300	48	N
Iron	18/21	127 - 7520	17 - 47.6	1560	13MW2	1100	300	-	-	-	Y
Lead	3/19	7.7 - 13.5	1 - 2	2.5	13MW21	15	15	-	15	13	Y
Magnesium	21/21	195 - 449000	-	42882	13MW9	-	-	-	-	-	N (8)
Manganese	19/21	8.4 - 1930	8.3 - 10.6	392	13MW8	18	50	5000	-	-	Y
Mercury	2/21	0.31 - 0.35	0.2	0.12	13MW21	1.1000	2	2	2	0.4	N
Potassium	21/21	4120 - 141000	-	18251	13MW9	-	-	-	-	-	N (8)
Sodium	21/21	30100 - 3660000	-	439038	13MW9	-	-	28000 (9)	-	-	Y
Vanadium	7/21	1.5 - 593	4 - 5	41.7	13MW19	26	-	-	50	-	Y
Zinc	6/21	3.4 - 20	2 - 15.7	4.6	13MW19	1100	5000	-	5000	123	N

- Not available or not applicable.

(1) Includes data from the following samples: 13GW1-2, 13GW1, 13GW18-2, 13GW19-2, 13GW2-2, 13GW2, 13GW20-2, 13GW21-2, 13GW3-2, 13GW3, 13GW8-2, 13GW8, 13GW9, 13GW18, 13GW19, 13GW20, 13GW20-D, 13GW21, 13GW9-2, NESO4, and NESO4-2.

(2) For residential tap water ingestion, based on current USEPA Region III guidance (USEPA Region III, May 10, 1996).

(3) Maximum Contaminant Level (USEPA, May 1995).

(4) Title 19, Health and Safety, the Public Health Code of the State of Connecticut, Chapter 11, Environmental Health.

(5) CTDEP, December, 1995.

(6) Contaminant of Potential Concern: A Yes (Y) indicates that the maximum contaminant concentration exceeds one or more of the criteria; A No (N) indicates that the maximum contaminant concentration does not exceed any of the criteria.

(7) Secondary MCL, based on aesthetic drinking water qualities.

(8) Essential nutrient, not evaluated for COPC selection.

(9) Notification Level.

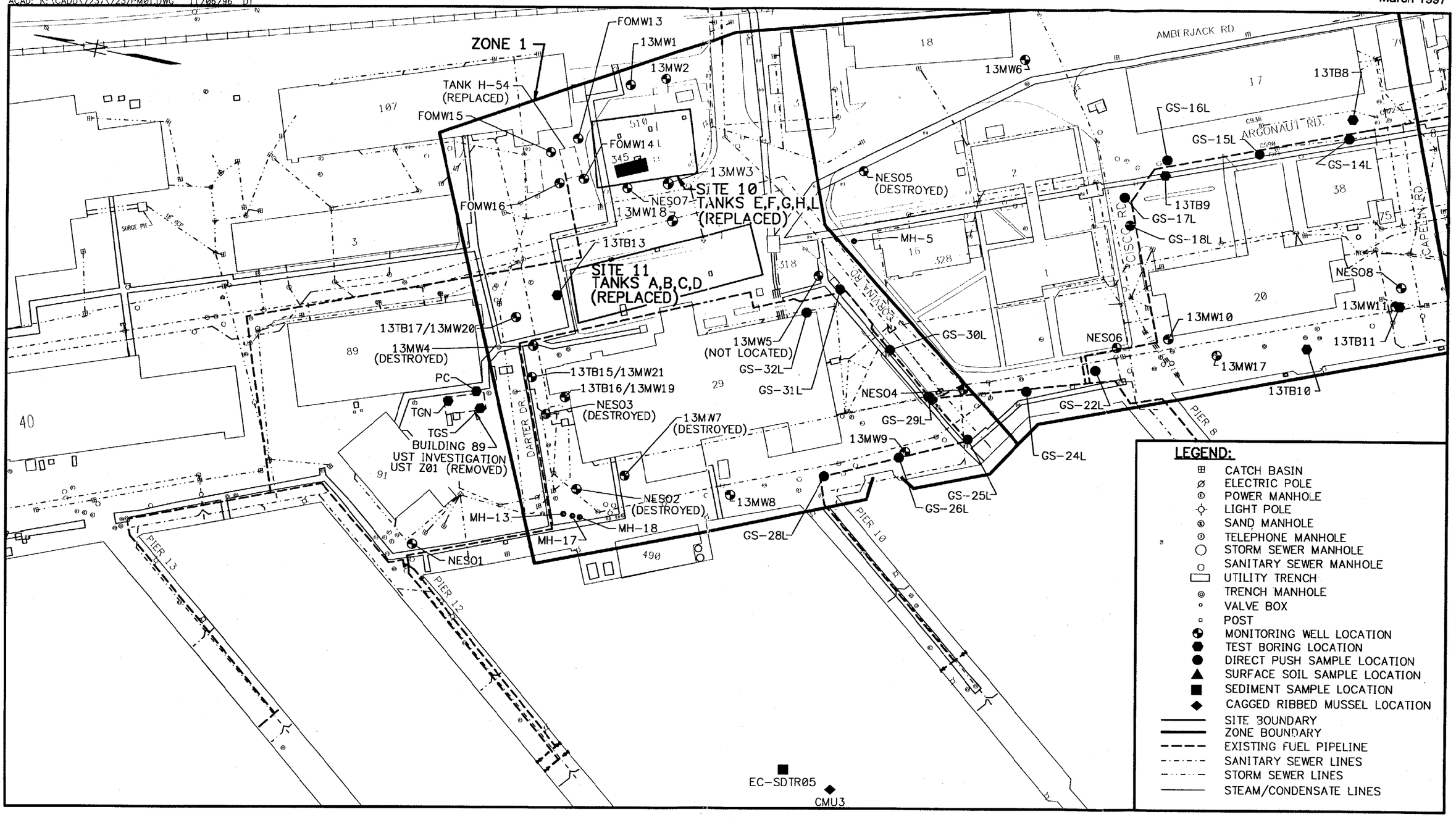


FIGURE 3-1

SAMPLE LOCATION MAP
ZONE 1
NSB-NLON, GROTON, CONNECTICUT

0 90 180
SCALE IN FEET

Brown & Root Environmental

4.0 ZONE 2

4.1 SITE DESCRIPTION

Zone 2 extends from the southern boundary of Zone 1 to Capelin Road (just north of Building 31). The site map, which shows the limits of the zone, is provided as Figure 4-1. With the exception of portions of the fuel oil distribution line and the steam, condensate, and electrical ducts that run through this zone, no IRP sites have been identified within Zone 2. The distribution system and ducts are discussed in Sections 1.2.4.3 and 1.2.4.4, respectively. Approximately 10 buildings are located with Zone 2. Most of the buildings within this zone (i.e., Buildings 1, 2, 16, 17, 18, 20 and 76) have historically and are currently used for administrative activities. Other buildings within the zone, such as Buildings 38, 75, and 328, are currently used to house a carpenter's shop, a sanitary sewer pump station/emergency generator, and utilities, respectively.

4.2 SITE INVESTIGATIONS

Zone 2 was included in the following investigations:

- Oil Contamination of Groundwater at Subase (NESO, 1979)
- Phase I Remedial Investigation (Atlantic, 1992)
- Site Investigation Report for Tank Farm Investigation (B&R Environmental, 1996b)
- Phase II Remedial Investigation (B&R Environmental, 1996a)

4.2.1 Oil Contamination of Groundwater at Subase

In 1979, NESO conducted a study to identify the source and extent of oil found in soils along the Thames River at three sites at the Lower Subase. As part of the investigation, NESO drilled a total of 12 soil borings and installed piezometers in each boring. Soil samples collected from each boring were analyzed for oil content. Groundwater samples were collected from each piezometer to check for the presence of oil and, where present, to measure product thickness.

Three borings/piezometers were installed during this study within Zone 2 (NESO5, 6, and 8). Sample locations are shown in Figure 4-1. Oil and grease content in soil ranged from 400 mg/kg to 14,100 mg/kg. Oil content in groundwater ranged from less than 10 mg/L to 150 mg/L.

4.2.2 Phase I Remedial Investigation

An investigation of 11 sites was completed at NSB-NLON by Atlantic Environmental Services, Inc., from 1990 to 1992. One site, identified as the Lower Subase - Site 13, included the area represented by Zones 1 through 4.

The Lower Subase Phase I field investigation consisted of a utility manhole inspection and waterfront bulkhead inspection for evidence of contamination sources. Also included were a soil gas survey, test boring completion, monitoring well installation, and soil and groundwater sampling.

During the utility manhole inspection, manhole covers were removed and inspected for visual evidence of oil. Four areas of significant petroleum accumulation were observed during the manhole inspection. One of these areas, north of Building 16, was located within Zone 2. Thick black oil was noted on the west side of the manhole where conduits enter. Possible sources for the accumulation were noted as previous product releases from underground fuel lines or storage tank leaks. The report indicated that there was no evidence of an ongoing release; the petroleum contamination appeared to be related to previous releases.

Inspection of the waterfront bulkhead was conducted by boat at low tide. During the waterfront inspection no oil seeps or sheens or evidence of such were observed anywhere along the waterfront at the Lower Subase.

A shallow soil gas survey (at depths of 12 to 18 inches) was also conducted within Zones 1 through 4. The results for Zone 2 indicated high VOCs on the southwest side of Building 18. However, this was likely a result of surface contamination. This area was further characterized by the subsurface investigation. Four soil borings, converted to monitoring wells (13MW6, 10, 11, and 17) were installed within Zone 2 and are shown in Figure 4-1. Monitoring well 13MW6 was installed at the location were VOC contamination was detected during the soil gas survey. Soil and groundwater samples collected from the monitoring wells were analyzed from VOCs, inorganics, TPH and fluorescence. In addition, an existing installed well (NESOMW6) was also sampled during the Phase I RI.

Base on TPH and fluorescence results, the area identified in the soil gas survey does not extend to the subsurface soil or to groundwater. The results do not indicate significant concentrations of TPH in the soil (TPH concentrations less than 200 mg/kg) or groundwater. Heavy residual fuel oil was identified in three

of the monitoring wells; however, TPH was not detected in groundwater collected from any of the wells sampled within Zone 2.

4.2.3 Site Investigation for Tank Farm Investigation

B&R Environmental conducted an investigation in 1995 of the UST farm along Crystal Lake Road. The primary objectives of the investigation were to define the extent of soil and groundwater contamination from the UST farm, evaluate the impact of the UST farm on the stormwater discharge, and recommend remedial alternatives, if needed. As part of the tank farm investigation, underground pipelines from the fuel loading dock (Pier 1), throughout a portion of the Lower Subase (Zones 1 through 4), and the gate valve (Building 322) to tanks within the tank farm were investigated. Soil samples were collected along the new and old diesel underground pipeline at approximately 100-foot intervals. The samples were analyzed for TPH. The No. 6 fuel oil lines were not included as part of the investigation, as they are installed within lined trenches, which would prevent or minimize any potential soil and groundwater impact from leaks. Seven samples were collected within Zone 2 (GS-14L through GS-18L, GS-22L, and GS-24L). Except the sample located north of Pier 8 (GS-22L), TPH concentrations were low (less than 100 mg/kg). Elevated TPH concentrations were detected north of Pier 8 (8210 mg/kg). Contamination was suspected to be associated with previous USTs located east of Building 29 (Zone 1).

The report recommended that additional integrity inspections be performed to determine the locations of previous line leaks on both active and inactive product lines throughout the Lower Subase. In addition, a records review was recommended to identify previous leaks based on the results of line inspections and tightness tests.

4.2.4 Phase II Remedial Investigation

A Phase II RI at 13 sites at NSB-NLON was conducted by B&R Environmental. The Lower Subase was included in this investigation. Soil boring installation and soil and groundwater sampling at Zone 2 were conducted as part of the investigation. Three soil samples were collected from three borings (13TB8, 13TB9, and 13TB11) and were analyzed for lead, TPH, and TCLP metals. Groundwater samples were collected from five existing monitoring wells (13MW6, 13MW10, 13MW11, 13MW17, and NESO6). The groundwater samples were analyzed for VOCs, SVOCs, metals (total and dissolved), and TPH. The data and results of the Phase II RI are discussed as part of the nature and extent and data evaluation discussions in Sections 4.4 and 4.5, respectively.

4.3 PHYSICAL CHARACTERISTICS

General physical characteristics of the Lower Subase are discussed in Section 1.3. Site-specific physical characteristics are discussed in the subsections following.

4.3.1 Topography and Surface Features

Zone 2 is paved or covered with buildings and the terrain gently slopes toward the Thames River. The Providence and Worcester Railroad runs along the eastern border of the zone, while the Thames River forms the western border of the zone.

4.3.2 Surface Water Features

Zone 2 is located along the Thames River. No other significant surface water features are located within or adjacent to Zone 2 with the exception of local storm sewers. Catch basins and storm sewers in Zone 2 are shown in Figure 4-1. From the drawing, it can be seen that three storm sewers within Zone 2 outlet to the Thames River. The storm sewers include the two along Cisco Road and the one along Capelin Road.

4.3.3 Soil Characteristics, Geology, and Hydrogeology

The SCS soils map classifies the soil at Zone 2 as Urban Land. USGS surficial geology maps indicate that Zone 2 soil is artificial fill. Based on boring logs for borings installed during the Phase I and Phase II RIs, along the east side of Zone 2 consists of 10 to 15 feet of sand and gravel, underlain by 5 to 10 feet of fine to medium sand. The medium sand is underlain by 0 to 5 feet of sand and gravel. Along the west side (near the Thames River), the sand and gravel layer is approximately 15 to 20 feet and is underlain by 0 to 5 feet of sand and silt. The depth of the bottom layer is not known, as borings were not installed to the bottom of the layer.

Bedrock in Zone 2 is mapped as Mamacoke Formation on USGS bedrock maps. This was not confirmed by soil borings.

The depth to groundwater ranges from 6 to almost 20 feet, and the elevation of groundwater ranges from 3 msl on the east side of Zone 2 to approximately 1 msl on the west side.

4.4 NATURE AND EXTENT OF CONTAMINATION

Soil and groundwater sampling were conducted at Zone 2 during the Phase I and Phase II RIs, as well as other investigations as discussed Section 4.2. The results of these investigations for soil and groundwater are summarized below. In addition, the media-specific COPC screening results are also summarized in this section.

4.4.1 Soil

The analytical results and COPC screening results for Zone 2 soil are shown in Tables 4-1 through 4-4. Tables 4-1 and 4-2 summarize the analytical and COPC screening results for shallow soil (0 to 4 feet below ground surface) and deep soil (greater than 4 feet below ground surface), respectively. Tables 4-3 and 4-4 summarize the TCLP and COPC screening results for shallow soil and deep soil, respectively.

Background concentrations of inorganics in soil, used below for comparison purposes, were taken from the *Background Concentrations of Inorganics in Soil* report (Atlantic, 1995b).

Drawings 1 through 4 (back pocket) at the end of this report delineate total petroleum hydrocarbon (TPH) and lead concentrations in all zones, including Zone 2, being investigated as part of the Lower Subase RI. Drawings 1 and 2 depict TPH isoconcentration contours for shallow soil and deep soil, respectively, while Drawings 3 and 4 show lead isoconcentration contours in shallow soil and deep soil, respectively. Drawings 3 and 4 also show the lead concentration for any Thames River sediment samples collected adjacent to the Lower Subase.

Shallow

Three shallow soil samples were analyzed for lead, but only one shallow soil sample was analyzed for a full list of TAL metals. This sample was collected at 13MW11 just south of Building 20. Concentrations of metals in this shallow soil sample were similar, although generally lower than those found in deeper soils in Zone 2. Table 4-1 indicates that nineteen metals were detected in shallow soil at Zone 2. Of these, the following NSB-NLON background levels (Atlantic, 1995b) were exceeded: cadmium (0.24 mg/kg); calcium (499 mg/kg); lead (17.5 mg/kg); mercury (0.05 mg/kg); nickel (5.95 mg/kg); sodium (20.5 mg/kg); and zinc (31.3 mg/kg). Arsenic, beryllium, cadmium, iron, manganese, mercury, and nickel concentrations in the shallow soils exceeded one or more screening levels.

Drawing 3 shows the distribution of lead in shallow soil within Zone 2. The contours indicate that shallow soils within this zone of the Lower Subase contain less than 200 mg/kg of lead, which is well below the CTDEP residential human health risk criteria of 500 mg/kg and the 400 mg/kg OSWER residential soil screening level.

Lead concentrations measured in sediment samples taken from the Thames River are also provided on Drawing 3. The lead concentrations measured in the river sediments along Zone 2 (T3SD2) are roughly half the average concentrations measured in shallow Zone 2 soil. As discussed in Section 2, lead concentrations in the Thames River sediment, which exceed both background and benchmark values, could pose a risk to ecological receptors in the river.

Table 4-3 indicates that three shallow soil samples were collected for TCLP analysis and two metals, barium and cadmium, were detected in the leachates from shallow Zone 2 soil. However, TCLP concentrations of these metals did not exceed any of the screening level criteria.

Table 4-1 also indicates that TPH was detected in the shallow Zone 2 soil. Three shallow soil samples were analyzed for TPH with the maximum concentration occurring at sample location 13TB8 (856 mg/kg) collected at the southeastern side of Building 38 next to the fuel pipeline along Argonaut Road. TPH was detected in all three shallow soil samples analyzed but exceeded only one or more screening levels at the maximum concentration. No VOCs were found in the shallow Zone 2 soil and SVOCs were not analyzed. Drawing 1 which shows isoconcentration contours of TPH indicates that an area of TPH contamination in the shallow soil at the southern edge of Zone 2 exceeds the CTDEP residential human health risk criteria of 500 mg/kg. However, this area of contamination is well below the industrial risk criteria of 2,500 mg/kg.

Based on sample results, TPH and metals were identified as COPCs for shallow Zone 2 soil. Metals of potential concern include arsenic, beryllium, cadmium, iron, manganese, mercury and nickel. Two areas of shallow soil, one at the southeast side of Building 38 which has contaminant levels in excess of CTDEP human health risk screening levels for TPH and one to the southwest of Building 20 adjacent to the Thames River which has contaminant levels in excess of screening levels for metals, account for all COPCs in shallow Zone 2 soil.

Deep

Four deep soil samples were analyzed for lead, three soil samples were analyzed for other TAL metals. A majority of the maximum concentrations of metals were detected in samples collected from well 13MW6 near Building 18 at the eastern edge of Zone 2. Concentrations of metals in deep soil samples in Zone 2

were similar to those found in other areas of the Lower Subase. Table 4-2 indicates that seventeen metals were detected in deep soil at Zone 2. Of these, the following NSB-NLON background levels (Atlantic, 1995b) were exceeded: cadmium (0.24 mg/kg); calcium (499 mg/kg); lead (17.5 mg/kg); manganese (188 mg/kg); nickel (5.95 mg/kg); and sodium (20.5 mg/kg). Arsenic (1.9 mg/kg), cadmium (1.2 mg/kg), iron (7,830 mg/kg), lead (404 mg/kg), and manganese (208 mg/kg) concentrations in the deep soils exceeded one or more screening levels. Lead concentrations in soil were generally less than 400 mg/kg (OSWER lead screening level for residential land use). Only the lead concentration in the deep sample collected at 13TB11 (404 mg/kg) was slightly above the screening level. This boring is located near Building 31 where remediation of lead contaminated soil was conducted.

Drawing 4 shows isoconcentration contours of lead concentrations measured in Zone 2 deep soils. It indicates that all deeper soil within Zone 2 of the Lower Subase contain lead concentrations below the CTDEP residential human health risk criteria of 500 mg/kg.

Table 4-4 indicates that four deep Zone 2 soil samples were collected for TCLP analysis and two metals, barium and lead, were detected in the leachates from these soil samples. However, only lead, at a maximum concentration of 3,430 μg/L at sample location 13TB11, exceeded the CTDEP Pollutant Mobility Standard for GB classified groundwater and the Federal toxicity characteristic regulatory level.

Table 4-2 also indicates that two VOCs, and TPH were detected in the deeper Zone 2 soil. Eleven deep soil samples were analyzed for TPH and three were analyzed for VOCs. Of the two VOCs detected, only methylene chloride exhibited a concentration which exceeded one or more screening levels. It should be noted that the methylene chloride detection is relatively low (i.e., <CRQL and near detection limit) and this chemical is a common lab contaminant. TPH was detected in six of the eleven deep soil samples analyzed, but only the maximum concentration found exceeded one or more screening levels. The highest TPH concentration was found at sample location GS-22L in the area of several fuel pipelines next to the Thames River at Pier 8.

Drawing 2 shows isoconcentration contours of TPH measured in deep soil. It indicates that only a small area of the deeper Zone 2 soil around sampling location GS-22L exceeds the CTDEP residential human health criteria of 500 mg/kg for TPH. In addition, some of this soil also exceeds the less stringent industrial criteria of 2,500 mg/kg for TPH. It is likely that the source of contamination in this area is from a fuel line leak.

Based on sample results, TPH, methylene chloride, and metals were identified as COPCs for deeper Zone 2 soil at the Lower Subase. Metals of potential concern include arsenic, cadmium, iron, lead, and

manganese. The area of maximum metals concentrations in deeper soil are centered around the eastern edge of this zone near Building 18, except for lead, which is prevalent in a small area next to the Thames River at Pier 6 near the southern edge of Zone 2. Petroleum contamination is apparent throughout most of Zone 2 with the highest concentrations located adjacent to the Thames River at Pier 8.

4.4.2 Groundwater

The analytical results and COPC screening results for Zone 2 groundwater are shown in Tables 4-5 and 4-6. Table 4-5 summarizes the analytical and COPC screening results for unfiltered groundwater while Table 4-6 summarizes the analytical and COPC screening results for filtered groundwater.

Drawings 5 through 7 (back pocket) at the end of this report delineate TPH and lead concentrations in Lower Subase groundwater. Drawing 5 depicts isoconcentration contours of TPH contamination in groundwater, while Drawings 6 and 7 show lead isoconcentration contours in unfiltered and filtered groundwater, respectively.

Table 4-5 indicates that seventeen metals were detected in unfiltered groundwater samples collected at Zone 2. Samples from wells 13MW10 and 13MW11 contributed about ninety percent of the maxima. Concentrations of seven metals found in Zone 2 unfiltered groundwater exceeded one or more screening levels. These included arsenic, boron, cadmium, iron, lead, manganese, and sodium (exceeds only a notification level). It should be noted that out of 18 samples, cadmium had only one positive detection and arsenic had only three positive detections.

Table 4-6 indicates that sixteen metals were detected in filtered groundwater samples collected at Zone 2 in the Lower Subase. In general metals results for filtered groundwater samples were slightly lower, but similar to the results for unfiltered samples. Samples from wells 13MW10 and 13MW11 contributed about eighty percent of the maxima. Concentrations of six metals exceeded one or more screening levels. These included antimony, arsenic, boron, iron, manganese, and sodium (exceeds only a notification level). It should be noted that out of 12 samples analyzed, arsenic was detected only in three samples and iron was detected in two samples.

The distribution of lead in unfiltered and filtered groundwater samples is shown on Drawings 6 and 7, respectively. Drawing 6 shows that a small plume of lead contamination, which exceeds the CTDEP groundwater protection standard of 15 μg/L, exists beneath the southwest section of Zone 2 near the Thames River at Pier 6. Drawing 7 indicates that the dissolved lead concentrations found in the same groundwater do not exceed the state protection standard of 15 μg/L.

Several VOCs and SVOCs were also detected in groundwater samples collected in Zone 2. Table 4-5 indicates that four VOCs and two SVOCs were detected in groundwater samples collected at Zone 2 in the Lower Subase. Of the four VOCs detected in Zone 2 groundwater, only the concentrations of chloroform at 1 µg/L and tetrachloroethene at 2 µg/L, exceeded one or more screening levels. Each of these contaminants was detected in only one of eighteen groundwater samples collected in Zone 2. None of the SVOC concentrations exceeded any of the screening levels.

Drawing 5 incorrectly shows that no TPH was detected in Zone 2. However, TPH concentrations of 600 µg/L were detected in 13MW6 and 13MW11. The average of one-half of the TPH detection limits are shown for the other monitoring wells. All of these detection limits are at or above the state's TPH remediation criteria of 500 µg/L. This information suggests that there is a high level of uncertainty in the TPH results in Zone 2.

Fluorescence spectroscopy was performed on the Phase I RI groundwater samples. Oil identification was not possible for well 13MW11 as only trace petroleum hydrocarbon concentrations were detected. No petroleum hydrocarbons were observed in the spectra for well 13MW6. However, spectra for wells NESO6 and 13MW10 indicated the presence of heavy residual fuel oil and spectra from well 13MW17 displayed a mixture of waste oil and heavy residual fuel oil (i.e., No. 6 fuel oil).

Based on sample results, chloroform, tetrachloroethene, TPH and metals were identified as COPCs for Zone 2 groundwater at the Lower Subase. Metals of potential concern include arsenic, boron, cadmium, iron, lead, manganese, and sodium. Prevalent petroleum contamination in the groundwater exists beneath both the eastern side and western side of Zone 2.

4.5 DATA EVALUATION

Data were evaluated based on contaminant fate and transport, human health and ecological risk assessments, and a comparison to state standards in the Phase II RI. These are summarized in this section. In addition, an evaluation of Zone 2 using the decision tree provided in Figure 1-3 is also included in this section.

4.5.1 Contaminant Fate and Transport

Metals are not typically considered to be mobile contaminants in the environment. Lead and other metals do not degrade via any of the identified fate processes (e.g., hydrolysis, photolysis, etc.) although under

acidic soil conditions, metals may be solubilized and transported vertically with infiltrating precipitation. The presence of these analytes at depth may reflect the nature of the fill material used to construct the Lower Base, as well as some potential vertical transport associated with industrial activities occurring on the surface. In addition, the presence of lead at the site may be the result of, until the 1950s, all submarines depended on lead batteries for principal means of underwater propulsion. Storm sewers along Cisco and Capelin Roads could act as preferential contaminant migration pathways for Zone 2 contaminants.

With the exception of TPH (in 13MW6 and 13MW11), substantial groundwater contamination at Zone 2 was not observed. Petroleum hydrocarbon contamination in soil has apparently migrated to groundwater. This is evident on Drawings 1, 2, and 5 (back pocket) and was previously discussed in Section 4.4.

4.5.2 Baseline Human Health Risk Assessment

The baseline human health risk assessment for the Lower Subase conducted in the Phase II RI focused on three potential receptor groups: full-time employees, construction workers, and future residents. Two variations of exposure were considered for each receptor, as per USEPA Region I guidance, central tendency exposure (CTE) and reasonable maximum exposure (RME). For all receptors, noncarcinogenic risks (Hazard Indices) were less than unity and carcinogenic risks (incremental cancer risks) were within the USEPA target risk range.

Exposure to lead in soils was addressed using the USEPA IEUBK Model. Estimated blood levels for children in a residential setting were calculated. Estimated levels (3.2 to 4.6 µg/dL) were below the established level of "concern", 10 µg/dL, indicating that no adverse effects are anticipated for children and other potential receptors exposed to surface and subsurface soils at Zone 2. The USEPA IEUBK Model was not used to evaluate groundwater since it is currently not used as a potable water supply and is not likely to be used in the future.

4.5.3 Ecological Risk Assessment

The only potential ecological habitat identified near the Lower Subase is the Thames River. PAHs and metals are the primary chemicals of concern for the Thames River (see Section 2.0). Metals and petroleum hydrocarbons were detected in Zone 2 soils; however, SVOC data for soils are not available. PAHs are common constituents of petroleum hydrocarbons. Chemicals detected in Zone 2 may be impacting the Thames River. Note that the ecological risk assessment, discussed in Section 2.5.3, concluded that the Lower Subase represented a minimal potential risk to ecological receptors.

4.5.4 Comparison of Site Data to Connecticut Standards

Analytical data for the Lower Subase were compared to Connecticut drinking water standards and remediation standards. Site-specific soil data were compared to Connecticut remediation standards for direct exposure and pollutant mobility. Direct exposure criteria for residential exposure were used to conservatively evaluate potential exposure to soil at the site. Only concentrations of TPH in shallow and deep soils at Zone 2 exceeded the residential direct exposure criteria. Concentrations of TPH in deep soil also exceeded the industrial direct exposure criteria.

To address concerns regarding migration of chemicals from soil to groundwater, site soil data were compared to Connecticut remediation standards for pollutant mobility. Data were compared to GB pollutant mobility criteria. For Zone 2, TPH was the only chemical reported at maximum concentrations in deep soil exceeding the GB pollutant mobility criteria.

Analytical groundwater data for Zone 2 were also compared to Connecticut MCLs. No exceedances of primary MCLs were noted in the unfiltered samples. Antimony was the only chemical detected in the filtered samples at a maximum concentration exceeding the Connecticut MCL. Maximum detections of sodium in the unfiltered and filtered groundwater samples were in excess of the 28,000 µg/L state Notification Level.

Maximum groundwater concentrations of antimony (filtered), lead (unfiltered), and TPH exceeded the Connecticut remediation standards for groundwater protection. Arsenic (filtered and unfiltered) and lead (unfiltered) were the only chemicals detected in Zone 2 at maximum concentrations exceeding the surface water protection criteria.

4.5.5 Decision Tree

The general decision tree for the evaluation of sites is provided in Figure 1-3. The evaluation of data using this decision tree for Zone 2 is as follows:

- Existing data have been collected and evaluated. Information describing the site, previous investigations, and physical characteristics of the site are provided in Sections 4.1, 4.2, and 4.3, respectively. The nature and extent of contamination is provided in Section 4.4.

- Based on existing data, no imminent threat to human health or the environment was identified for Zone 2.

- Contaminant fate and transport have been described, baseline human health and ecological risk assessments have been conducted, and data have been compared to CTDEP Standards.

- Contamination within Zone 2 has not been fully characterized, since there is no SVOC data for soils (SVOCs are associated with petroleum hydrocarbons).

- Limited contamination in Zone 2 has been detected. A small hot spot area of TPH contamination (maximum concentration of 8210 mg/kg) is evident along Albacore Road near Cisco Road (see Drawing 2). In addition, an area near Corvina Road (discussed as part of Zone 1) has been identified (maximum TPH concentration of 6670 mg/kg). This contamination appears to be associated with either tank leaks at Zone 1 or fuel pipeline leaks.

- Further action is required for Zone 2 and is discussed in Section 4.6.

4.6 RECOMMENDATIONS

The Phase II RI provides recommendations for Zone 2. Further characterization focusing on sampling and analysis to evaluate the nature and extent of TPH and semivolatile organic compounds in soil is recommended. Continued groundwater sampling and analysis are recommended to monitor contamination levels. These recommendations are supported by the following information:

- TPH concentrations as great as 8210 mg/kg were detected in soil along the fuel pipeline on the west side of Zone 2.

- SVOCs have not been analyzed for in soil during the Phase I or II RI activities. Monitoring of these compounds is needed to evaluate risks associated with these contaminants. It is highly probable that SVOCs will be detected at significant levels in soil, based on the presence of TPH. SVOCs are common components of TPH, and the concentrations of these compounds are unknown.

- Petroleum products and oily substances have historically migrated into the Thames River. As discussed Section 2.0, the Thames River sediment and shellfish community may be impacted in the vicinity of the Lower Subase.

Additional sampling and analysis should also be conducted to confirm whether lead detected in deep soils is truly mobile, as indicated by the TCLP results. The SPLP method should be used to analyze the additional samples.

It is further recommended that in conjunction with sampling at Zone 2, integrity inspections on the active and inactive fuel lines located in Zone 2 (and throughout the Lower Subase) be conducted to determine potential line leaks. In addition, a review of records to identify previous leaks based on the results of inspections and tightness tests is recommended. The integrity inspections and review of data are important to identify sources of petroleum contamination.

As contaminants associated with the Lower Subase have been detected in the sediments in the Thames River, sampling of the sediments is recommended in conjunction with characterization activities to aid in the identification of source areas and contaminants of concern. Sampling of media from the Thames River is discussed in Section 2.6.

Based on the results of the additional sampling and analyses and the integrity inspection activities, source areas will be able to be defined and remedial activities for the source areas will be conducted as necessary. Remedial activities should focus on the removal of free product and highly contaminated areas (hot spots), which may act as sources of contamination to other media/receptors. However, because Zone 2 is located in an active, industrialized area that is vital to national security, petroleum contamination is widespread in the Lower Subase, and contamination presents minimal risk to human health and the environment (i.e., limited exposure pathways), remediation of all contaminated material at Zone 2 by excavation is not feasible or practical. Therefore, in-situ remedial options such as containment, air sparging, soil vapor extraction (SVE), natural attenuation, or bioremediation will also be explored and used as applicable.

TABLE 4-1

COPC SCREENING FOR LOWER SUBASE
ZONE 2 - SHALLOW SOILS (<4 FEET)
NSB-NLON, GROTON, CONNECTICUT

Parameter	Frequency (1)	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	SSL Inhalation (3)	SSL Migration to Groundwater (3)	State Residential Direct Exposure (4)	State Industrial Direct Exposure (4)	State Pollutant Mobility (GB) (4)	Select as COPC? (5)
Metals (mg/kg)												
Aluminum	1/1	7210	-	7210	13MW11	7800	-	-	-	-	-	N
Arsenic	1/1	1.8	-	1.8	13MW11	0.43	750	1	10	10	-	Y
Barium	1/1	30.1	-	30.1	13MW11	550	690000	82	4700	140000	-	N
Beryllium	1/1	0.29	-	0.29	13MW11	0.15	1300	3	2	2	-	Y
Cadmium	1/1	1.3	-	1.3	13MW11	3.9	1800	0.4	34	1000	-	Y
Calcium	1/1	1540	-	1540	13MW11	-	-	-	-	-	-	N (6)
Chromium	1/1	12.4	-	12.4	13MW11	39	270	-	3900/100 (7)	5.1E+4/100 (7)	-	N
Cobalt	1/1	4.1	-	4.1	13MW11	470	-	-	-	-	-	N
Copper	1/1	17.8	-	17.8	13MW11	310	-	-	2500	76000	-	N
Iron	1/1	9560	-	9560	13MW11	2300	-	-	-	-	-	Y
Lead	3/3	149 - 178	-	159	13MW11	400	-	-	500	1000	-	N
Magnesium	1/1	2330	-	2330	13MW11	-	-	-	-	-	-	N (6)
Manganese	1/1	153	-	153	13MW11	39	-	-	-	-	-	Y
Mercury	1/1	0.11	-	0.11	13MW11	2.3	-	0.1	20	610	-	Y
Nickel	1/1	8.2	-	8.2	13MW11	160	13000	7	1400	7500	-	Y
Potassium	1/1	1590	-	1590	13MW11	-	-	-	-	-	-	N (6)
Sodium	1/1	184	-	184	13MW11	-	-	-	-	-	-	N (6)
Vanadium	1/1	16.8	-	16.8	13MW11	55	-	300	470	14000	-	N
Zinc	1/1	54.3	-	54.3	13MW11	2300	-	620	20000	610000	-	N
Miscellaneous												
TPH	3/3	26.8 - 856	-	344	13TB8	500	-	-	500	2500	2500	Y

- Not available or not applicable.

(1) Includes data from the following samples 13MW11(2-4), 13TB8-0103, and 13TB9-0103.

(2) Based on current USEPA Region III guidance (USEPA Region III, May 10, 1996). Residential Soil Ingestion for soil and sediment.

(3) USEPA Soil Screening Levels (USEPA, May 1996). For migration to groundwater, values associated with a dilution and attenuation factor (DAF) of 1.0.

(4) CTDEP, December 1995.

(5) Contaminant of Potential Concern; Yes (Y) indicates that the maximum concentration exceeds one or more of the criteria; No (N) indicates that the maximum does not exceed any of the criteria.

(6) Essential nutrient. Not evaluated for COPC selection.

(7) Trivalent chromium/hexavalent chromium.

TABLE 4-2

COPC SCREENING FOR LOWER SUBASE
ZONE 2 - DEEP SOILS (>4 FEET)
NSB-NLON, GROTON, CONNECTICUT

Parameter	Frequency (1)	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	SSL Inhalation (3)	SSL Migration to Groundwater (3)	State Residential Direct Exposure (4)	State Industrial Direct Exposure (4)	State Pollutant Mobility (GB) (4)	Select as COPC? (5)
Volatile Organic Compounds (mg/kg)												
Methylene chloride	1/3	0.002	0.005 - 0.012	0.004	13MW17	85	13	0.001	82	760	1	Y
Trichloroethene	1/3	0.001	0.005 - 0.012	0.003	13MW17	58	5	0.003	56	520	1	N
Metals (mg/kg)												
Aluminum	3/3	2670 - 4720	-	3993	13MW6	7800	-	-	-	-	-	N
Arsenic	1/3	1.9	0.61 - 0.71	0.85	13MW10	0.43	750	1	10	10	-	Y
Barium	3/3	15.3 - 39.6	-	26.5	13MW6	550	690000	82	4700	140000	-	N
Cadmium	3/3	0.6 - 1.2	-	0.83	13MW6	3.9	1800	0.4	34	1000	-	Y
Calcium	3/3	604 - 1650	-	966	13MW10	-	-	-	-	-	-	N (6)
Chromium	3/3	3.9 - 9.6	-	6.8	13MW6	39	270	-	3900/100 (7)	5.1E+4/100 (7)	-	N
Cobalt	3/3	2.2 - 3.9	-	2.8	13MW6	470	-	-	-	-	-	N
Copper	3/3	8.6 - 9.6	-	9.0	13MW6	310	-	-	2500	76000	-	N
Iron	3/3	4310 - 7830	-	5753	13MW6	2300	-	-	-	-	-	Y
Lead	4/4	2 - 404	-	105	13TB11	400	-	-	500	1000	-	Y
Magnesium	3/3	1150 - 2520	-	1840	13MW6	-	-	-	-	-	-	N (6)
Manganese	3/3	125 - 208	-	159	13MW17	39	-	-	-	-	-	Y
Nickel	3/3	3.8 - 6.6	-	5.3	13MW6	160	13000	7	1400	7500	-	N
Potassium	3/3	1120 - 2570	-	1693	13MW6	-	-	-	-	-	-	N (6)
Sodium	3/3	123 - 250	-	204	13MW10	-	-	-	-	-	-	N (6)
Vanadium	3/3	6 - 13.5	-	9.6	13MW6	55	-	300	470	14000	-	N
Zinc	3/3	14 - 24.5	-	19.6	13MW6	2300	-	620	20000	610000	-	N
Miscellaneous (mg/kg)												
TPH	6/11	16.3 - 8210	10.2 - 80	796	GS-22L	500	-	-	500	2500	2500	Y

- Not available or not applicable.

(1) Includes data from the following samples 13MW10(6-8), 13MW17(8-10), 13MW6(14-16), 13TB11-0406, FPTB14L-04, FPTB15L-09, FPTB16L-11, FPTB17L-11, FPTB18L-05, FPTB22L-07, and FPTB24L-07.

(2) Based on current USEPA Region III guidance (USEPA Region III, May 10, 1996). Residential Soil Ingestion for soil and sediment.

(3) USEPA Soil Screening Levels (USEPA, May 1996). For migration to groundwater, values associated with a dilution and attenuation factor (DAF) of 1.0.

(4) CTDEP, December 1995.

(5) Contaminant of Potential Concern; Yes (Y) indicates that the maximum concentration exceeds one or more of the criteria; No (N) indicates that the hmaximum does not exceed any of the criteria.

(6) Essential nutrient. Not evaluated for COPC selection.

(7) Trivalent chromium/hexavalent chromium.

TABLE 4-3

COPC SCREENING FOR LOWER SUBASE
ZONE 2 - TCLP SHALLOW SOILS (<4 FEET)
NSB-NLON, GROTON, CONNECTICUT

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	State Pollutant Mobility (GB) (2)	Federal Pollutant Mobility (3)	Select as COPC? (4)
Metals (ug/L)								
Barium	3/3	260 - 303	-	279	13TB8	10000	100000	N
Cadmium	2/3	2.4 - 2.6	2	2	13TB9	50	1000	N

- Not available or not applicable.
(1) Includes data from the following samples: 13MW11(2-4), 13TB8-0103, and 13TB9-0103.
(2) CTDEP Pollutant Mobility Remediation Standard for GB classified groundwater; CTDEP, December 1995.
(3) Federal Toxicity Characteristic Regulatory level (58 FR 46049).
(4) Contaminant of Potential Concern; Yes (Y) indicates that the maximum concentration exceeds one or more of the criteria; No (N) indicates that the maximum does not exceed any of the criteria.

TABLE 4-4

COPC SCREENING FOR LOWER SUBASE
ZONE 2 - TCLP DEEP SOILS (>4 FEET)
NSB-NLON, GROTON, CONNECTICUT

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	State Pollutant Mobility (GB) (2)	Federal Pollutant Mobility (3)	Select as COPC? (4)
Metals (ug/L)								
Barium	4/4	44 - 171	-	134	13TB11	10000	100000	N
Lead	2/4	200 - 3430	300	983	13TB11	150	5000	Y

- Not available or not applicable.

(1) Includes data from the following samples: 13MW10(6-8), 13MW17(8-10), 13MW6(14-16), and 13TB11-0406.

(2) CTDEP Pollutant Mobility Remediation Standard for GB classified groundwater; CTDEP, December 1995.

(3) Federal Toxicity Characteristic Regulatory Level (58 FR 46049).

(4) Contaminant of Potential Concern; Yes (Y) indicates that the maximum concentration exceeds one or more of the criteria; No (N) indicates that the maximum does not exceed any of the criteria.

TABLE 4-5

COPC SCREENING FOR LOWER SUBASE
ZONE 2 - UNFILTERED GROUNDWATER
NSB-NLON, GROTON, CONNECTICUT
PAGE 1 OF 2

Parameter	Frequency (1)	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	Federal MCL (3)	State MCL (4)	State Remediation Standards (5)		Select as COPC? (6)
									Groundwater Protection	Surface Water Protection	
Volatile Organic Compounds (ug/l)											
1,1,1-Trichloroethane	1/18	3	5 - 10	4	13MW6	130	200	200	200	62000	N
Carbon disulfide	1/18	2	5 - 10	4	NESO6	100	-	-	-	-	N
Chloroform	1/18	1	5 - 10	4	13MW10	0.15	100	100	6	14100	Y
Tetrachloroethene	1/18	2	5 - 10	4	13MW6	1.1	5	5	5	88	Y
Semivolatile Organic Compounds (ug/l)											
Benzoic acid	1/12	1	50	23	NESO6	15000	-	-	-	-	N
Bis(2-ethylhexyl)phthalate	1/12	0.8	10	5	13MW10	4.8	6	6	2	59	N
Metals (ug/l)											
Aluminum	2/18	17.3 - 23.8	10 - 67.5	14	13MW6	3700	50 TO 200 (7)	-	-	-	N
Arsenic	3/18	1.3 - 4.7	2 - 10	1.8	13MW11	0.045	50	50	50	4	Y
Barium	7/18	18.4 - 41.8	5.6 - 26	15.3	13MW11	260	2000	2000	1000	-	N
Boron	10/12	60.8 - 630	50 - 72.9	183	13MW10	330	-	-	-	-	Y
Cadmium	1/18	3.3	1 - 3.1	1.1	13MW10	1.8000	5	5	5	6	Y
Calcium	18/18	15300 - 113000	-	41756	13MW10	-	-	-	-	-	N (8)
Chromium	2/18	1.1 - 1.2	1 - 5	1.7	13MW11	18	100	100	50	1200	N
Copper	3/18	4 - 34.7	2 - 5	4	13MW11	150	1300	-	1300	48	N
Iron	10/18	29.2 - 6620	4 - 50.3	893	13MW11	1100	300	-	-	-	Y
Lead	9/17	1.3 - 23.2	1 - 10	3.6	13MW11	15	15	-	15	13	Y
Magnesium	18/18	4540 - 215000	-	41079	13MW10	-	-	-	-	-	N (8)
Manganese	7/18	9.5 - 356	1 - 7.3	55	13MW11	18	50	5000	-	-	Y
Nickel	7/18	12.4 - 23.9	3 - 12	10	NESO6	73	100	100	100	880	N
Potassium	18/18	3970 - 68800	-	16061	13MW10	-	-	-	-	-	N (8)
Selenium	3/17	1.2 - 2.8	1 - 3	1.3	13MW10	18	50	50	50	50	N
Sodium	18/18	15500 - 1850000	-	331644	13MW10	-	-	28000 (9)	-	-	Y
Zinc	12/18	5 - 37.6	2.9 - 10.5	14	13MW10	1100	5000	-	5000	123	N

TABLE 4-5

COPC SCREENING FOR LOWER SUBASE
ZONE 2 - UNFILTERED GROUNDWATER
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 2

Parameter	Frequency (1)	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	Federal MCL (3)	State MCL (4)	State Remediation Standards (5)		Select as COPC? (6)
									Groundwater Protection	Surface Water Protection	
Miscellaneous (ug/l)											
Ammonia, as nitrogen (mg/l)	1/2	0.4	0.1	0.2	13MW11	-	-	-	-	-	N (10)
Hardness as CaCO3 (mg/l)	12/12	84 - 1240	-	335	13MW10	-	-	-	-	-	N (10)
Total suspended solids (mg/l)	1/2	8	1	4	13MW11	-	-	-	-	-	N (10)
TPH	2/18	600	500 - 3000	706	13MW6/13MW11	500	-	-	500	-	Y

- Not available or not applicable.

(1) Includes data from the following samples: 13MW17S, 13MW10S, 13MW18S, 13MW6S, 13MW11S, NESOMW6S, 13GW10, 13GW10-2, 13GW11, 13GW11-2, 13GW17, 13GW17D, 13GW6, 13GW6-2, 13GW17-2, 13GW17-D-2, NESO6, and NESO6-2.

(2) For residential tap water ingestion, based on current USEPA Region III guidance (USEPA Region III, May 10, 1996).

(3) Maximum Contaminant Level (USEPA, May 1995).

(4) Title 19, Health and Safety, the Public Health Code of the State of Connecticut, Chapter 11, Environmental Health.

(5) CTDEP, December, 1995.

(6) Contaminant of Potential Concern: A Yes (Y) indicates that the maximum contaminant concentration exceeds one or more of the criteria; A No (N) indicates that the maximum contaminant concentration does not exceed any of the criteria.

(7) Secondary MCL, based on aesthetic drinking water qualities.

(8) Essential nutrient, not evaluated for COPC selection.

(9) Notification Level.

(10) Not applicable for COPC screening.

TABLE 4-6

COPC SCREENING FOR LOWER SUBASE ZONE 2 - FILTERED GROUNDWATER NSB-NLON, GROTON, CONNECTICUT

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	Federal MCL (3)	State MCL (4)	State Remediation Standards (5)		Select as COPC? (6)
									Groundwater Protection	Surface Water Protection	
Metals (ug/l)											
Aluminum	1/12	33.9	10 - 24.8	10.7	13MW11	3700	50 TO 200 (7)	-	-	-	N
Antimony	5/12	5.2 - 15.1	5 - 15	7.8	13MW11	1.5000	6	6	6	86000	Y
Arsenic	3/12	3.1 - 10	2	2.2	13MW10	0.045	50	50	50	4	Y
Barium	6/12	6.3 - 44.3	5 - 23.6	18	13MW11	260	2000	2000	1000	-	N
Boron	10/12	57 - 627	50 - 78.4	182	13MW10	330	-	-	-	-	Y
Calcium	12/12	21900 - 113000	-	50283	13MW10	-	-	-	-	-	N (8)
Chromium	2/12	1.3 - 3.5	1 - 4	1.4	13MW11	18	100	100	50	1200	N
Copper	5/12	2.2 - 5.3	2 - 5	2.2	NESO6	150	1300	-	1300	48	N
Iron	2/12	3320 - 5070	8.1 - 37.8	707	13MW11	1100	300	-	-	-	Y
Lead	1/8	1.6	1 - 20	2	13MW17	15	15	-	15	13	N
Magnesium	12/12	5600 - 212000	-	49112	13MW10	-	-	-	-	-	N (8)
Manganese	6/12	1.1 - 387	1 - 4.9	56	13MW11	18	50	5000	-	-	Y
Potassium	12/12	5910 - 68100	-	18933	13MW10	-	-	-	-	-	N (8)
Selenium	2/10	2.2 - 2.7	2 - 3	1.6	13MW17	18	50	50	50	50	N
Sodium	12/12	55300 - 1880000	-	440767	13MW10	-	-	28000 (9)	-	-	Y
Zinc	4/12	4.5 - 37.7	3.2 - 14.5	7.9	13MW10	1100	5000	-	5000	123	N

- *Not available or not applicable.*

(1) Includes data from the following samples: 13GW10-2, 13GW10, 13GW11, 13GW11-2, 13GW17, 13GW17D, 13GW6, 13GW6-2, 13GW17-2, 13GW17-D-2, NESO6, and NESO6-2.

(2) For residential tap water ingestion, based on current USEPA Region III guidance (USEPA Region III, May 10, 1996).

(3) Maximum Contaminant Level (USEPA, May 1995).

(4) Title 19, Health and Safety, the Public Health Code of the State of Connecticut, Chapter 11, Environmental Health.

(5) CTDEP, December, 1995.

(6) Contaminant of Potential Concern: A Yes (Y) indicates that the maximum contaminant concentration exceeds one or more of the criteria; A No (N) indicates that the maximum contaminant concentration does not exceed any of the criteria.

(7) Secondary MCL, based on aesthetic drinking water qualities.

(8) Essential nutrient, not evaluated for COPC selection.

(9) Notification Level.

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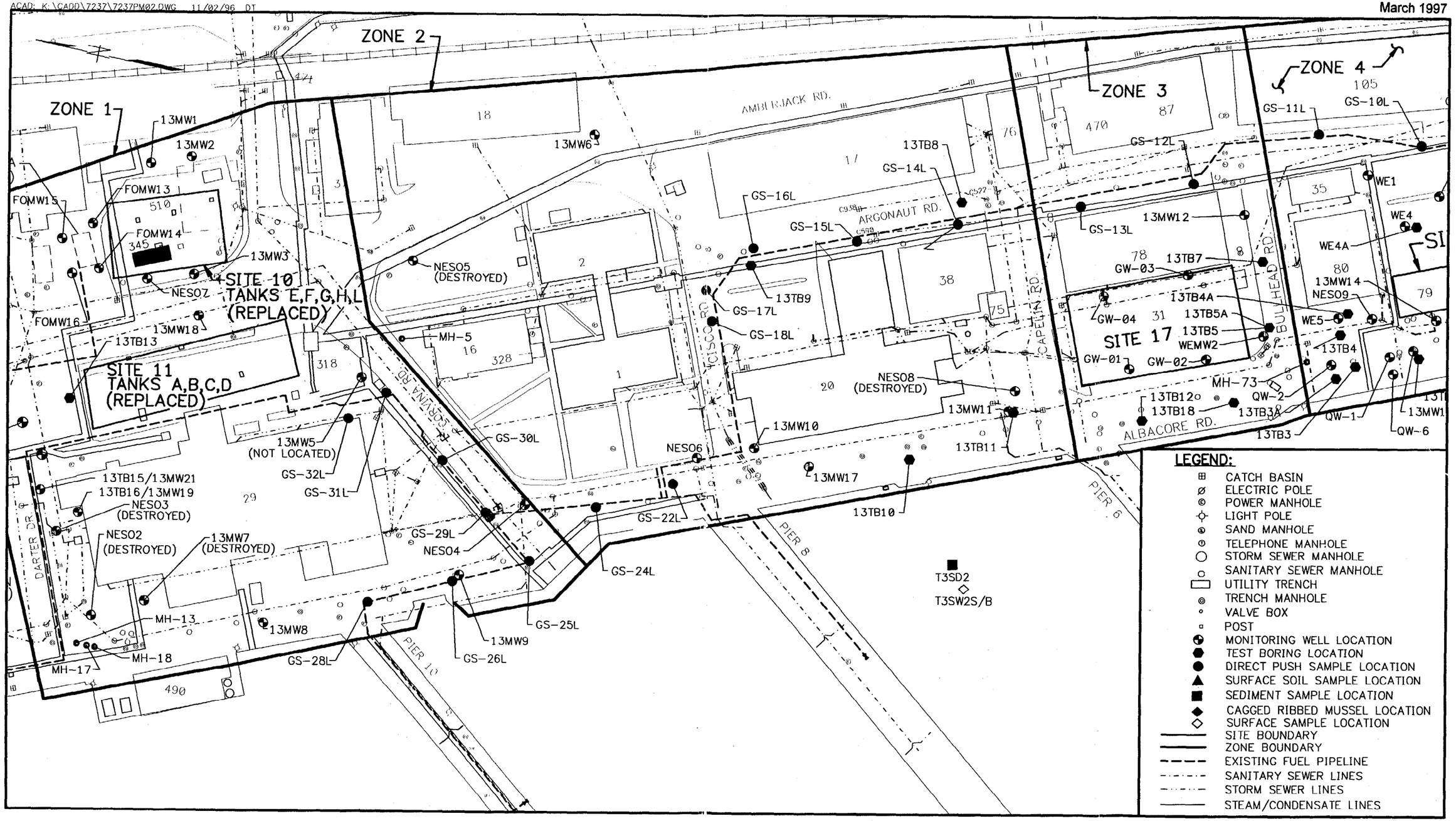

FIGURE 4-1

SAMPLE LOCATION MAP
ZONE 2
NSB-NLON, GROTON, CONNECTICUT

0 90 180
SCALE IN FEET

Brown & Root Environmental

01097052

5.0 ZONE 3

5.1 SITE DESCRIPTION

Zone 3 extends from the southern end of Zone 2 to the southside of Bullhead Road and includes Site 17 - Hazardous Materials/Solvent Storage Area (Building 31). Figure 5-1 shows the sites included in Zone 3 and the limits of the zone. Fuel oil distribution lines and steam, condensate, and electrical ducts are also located within Zone 3.

5.1.1 Site 17

Building 31 was constructed in 1917 and was originally used as a battery shop until the mid 1950s. Battery overhaul was one of the largest operations conducted at the Subase prior to nuclear power. Old diesel submarines, containing approximately 100 batteries, were routinely serviced in the Battery Overhaul Shop at Building 31. Services ranged from charging batteries to complete battery overhaul. Spent acid from the overhauled batteries was disposed of in a spent acid tank located at the Spent Acid Storage and Disposal Area - Site 15 (Envirodyne, 1983).

Building 31 has been used as the main hazardous/flammable materials warehouse from the 1970s to the present. Items such as sulfuric acid, methyl isobutyl ketone, potassium hydroxide, potassium tetraborate, hydrofluoric acid, and nitric acid were stored in containers of up to 55 gallon capacity. In 1992, while the concrete floor of the building was being replaced to comply with RCRA regulations, a yellow discoloration was discovered in the soil beneath the floor slab. Analysis of soil samples revealed elevated levels of lead. As a result, an Action Memorandum was prepared (HNUS, 1993a) which identified excavation, onsite solidification of all soils with a total lead concentration of 500 mg/kg or greater or a TCLP leachate lead concentration of 5 mg/L or greater, onsite backfilling, and offsite disposal of contaminated debris as the time-critical remedial action of choice. A remedial design was performed and the remedial action was completed during the first half of 1995 (HNUS, 1995a). Figure 5-2 shows the cells within Building 31 that were remediated.

5.1.2 Fuel Oil Distribution Lines and Utility Ducts

Fuel oil distribution lines and utility ducts and trenches run through Zone 3. Descriptions of the distribution lines and utility ducts and trenches are provided in Sections 1.2.4.3 and 1.2.4.4, respectively. The location of the distribution lines and utility ducts are shown in Figure 5-1.

5.2 SITE INVESTIGATIONS

The following investigations were conducted at Zone 3 and are discussed in the subsections following:

- Final Site Investigation Subsurface Oil Contamination (Wehran, 1987)
- Phase I Remedial Investigation (Atlantic, 1992)
- Action Memorandum for Building 31 (HNUS, 1993a)
- Post Removal Action Report for Building 31 Lead Remediation (HNUS, 1995a)
- Site Investigation Report for Tank Farm Investigation (B&R Environmental, 1996b)
- Phase II Remedial Investigation (B&R Environmental, 1996a)

5.2.1 Final Site Investigation Subsurface Oil Contamination

In 1987, Wehran Engineering Corporation completed an investigation to identify and delineate the sources of heavy oils in the subsurface of the Lower Subase (Sites 10, 11, and 13). Activities completed during the investigation included collecting soil samples from soil borings, oil samples from manholes and trenches, and groundwater samples from monitoring wells. These samples were tested to identify the type, degree of weathering, and general concentrations of oil contamination at the three sites. One soil boring, later converted to a monitoring well, was installed within Zone 3 (WE2) during this investigation. The location is shown on Figure 5-1.

Oil contamination (determined to be No. 6 fuel oil weathered less than a year) was observed in the trench which runs along Argonaut Road from approximately Building 85 (Zone 4) to near the northeast corner of Building 78 (Zone 3). The fluorescence results indicated trace levels of No. 6 fuel oil in soils collected from the soil boring. The groundwater spectra was typical of waste oil. Wehran recommended inspection of the fuel lines within the trench and subsequent cleaning of the trench.

5.2.2 Phase I Remedial Investigation

An investigation of 11 sites was completed at NSB-NLON by Atlantic Environmental Services, Inc. from 1990 to 1992. One site, identified as the Lower Subase - Site 13, included the area represented by Zones 1 through 4.

The Lower Subase Phase I field investigation consisted of a utility manhole inspection and waterfront bulkhead inspection for evidence of contamination sources. Also included were a soil gas survey, test boring completion, monitoring well installation, and soil and groundwater sampling.

During the utility manhole inspection, manhole covers were removed and inspected for visual evidence of oil. Four areas of significant petroleum accumulation were observed during the manhole inspection. One of these areas, Manhole 73, southwest of Building 31 and northwest of Building 80 on Albacore Road, was partially located within Zone 3. A thick black oil was observed in a manhole in this area. Possible sources for the accumulation were noted as previous product releases from underground fuel lines or storage tank leaks. The report indicated that there was no evidence of an ongoing release; the petroleum contamination appeared to be related to previous releases.

Inspection of the waterfront bulkhead was conducted from a boat during low tide. During the waterfront inspection no oil seeps or sheens or evidence of such were observed anywhere along the waterfront at the Lower Subase.

A shallow soil gas survey (at depths of 12 to 18 inches) was also conducted within Zones 1 through 4. The results for Zone 3 indicated low VOCs at southwest corner of Building 31 and one area of low VOCs west of Buildings 80 and 79. All of the soil gas points to the west of Building 79 extending approximately 100 feet to the east side of the building contained trace or low levels of VOCs. While most of the area by Building 80 is within Zone 4, a portion extends into Zone 3. The source of the contamination is likely from Zone 4. These areas were further characterized by the subsurface investigation. One test boring (13TB5) and one soil boring, converted to a monitoring well (13MW12) were installed within Zone 3 and locations are shown in Figure 5-1. Soil and groundwater samples collected from 13MW12 were analyzed for VOCs, inorganics, TPH and fluorescence. Soils from the test boring were screened in the field for organic vapors and examined visually, but were not chemically analyzed.

Based on TPH and fluorescence results, subsurface soil along Bullhead Road contains No. 2 fuel oil/diesel oil, but petroleum contamination is not present in groundwater.

5.2.3 Action Memorandum for Building 31

An action memorandum was prepared by Halliburton NUS to document the decision to conduct a time-critical removal action at Building 31. After discovery of yellow discoloration underneath a concrete slab of Building 31, soil samples were collected underneath the floor at depths of 18 inches to 60 inches. Soils were found to be a RCRA hazardous waste (as defined under 40 CFR 261.24) based on TCLP lead concentrations exceeding 5.0 mg/L. An additional soil and groundwater investigation was conducted to better define the extent of contamination. Twenty-seven borings were drilled inside Building 31 and six borings were drilled outside. Sampling locations for this investigation are shown on Figure 5-2. A total of 101 subsurface soil samples were collected. Three surface soil samples (depths of 0 to 6 inches) were collected between Building 31 and Building 78. All soil samples were analyzed for lead. Also, 28 of the subsurface samples (collected from within Building 31) were analyzed for TCLP lead, and four of these were analyzed for RCRA metals. Four subsurface soils were also analyzed for TCL VOCs, SVOCs, and Pesticides/PCBs and TAL metals plus cyanide. Four temporary well points (GW-01 to 04) were installed to determine groundwater quality within the Building 31 area. Two rounds of sampling were collected. With the exception of two groundwater samples collected during the first round, samples were analyzed for total and dissolved RCRA metals. The two groundwater samples collected during the first round of sampling were analyzed for TCL organics and TAL metals plus cyanide (these samples were unfiltered).

Based on the results of sampling and analysis, the areas inside and outside Building 31 with lead concentrations in soil greater than 500 mg/kg were identified and the proposed action for removal of the contaminated soils was identified. The removal action taken at Building 31 is discussed below.

5.2.4 Post Removal Action Report for Building 31 Lead Remediation

The time-critical removal action for Building 31, initiated by the Navy, consisted of excavation of lead contaminated soil above mean low tide elevation and onsite or offsite treatment and disposal. A cleanup level for lead of 500 mg/kg was set for the removal action. The removal action included on-site solidification and stabilization of soil excavated from within Building 31 and backfilling of the stabilized soil within Building 31; installation of a concrete floor over the backfilled stabilized, soil; and offsite solidification and stabilization and disposal of contaminated soil excavated from three areas outside of Building 31 and backfilling with clean fill. The three areas outside of Building 31 that were excavated include between Buildings 31 and 78, adjacent to Building 31 along Bullhead Road, and adjacent to Building 31 along Albacore Road. The removal action was conducted by National Environmental Services Corporation. Also, demolition debris and excavated materials not suitable for solidification/stabilization were screened

for contamination and offsite landfilled either as hazardous or non-hazardous material. The cells that were excavated as part of the removal action within Building 31 are shown on Figure 5-2.

Based on the results of the post-removal action field verification sampling and analysis, B&R Environmental indicated that the excavation areas beneath Building 31, along Bullhead Road, and between Buildings 31 and 78 were no longer contaminated (i.e., lead concentrations were less than 500 mg/kg in soils above the mean low tide elevation), and no further action was required. Verification sampling after excavation along Albacore Road indicated lead concentrations were still above 500 mg/kg. However, as further excavation of soils along Albacore Road would interfere with base operations, the Navy postponed further removal action in this area and the excavated area was backfilled with clean soil. Prior to backfilling, a non-woven geotextile liner was installed in the excavation along Albacore Road to prevent further contaminant migration and to allow for easy resumption of future removal actions.

5.2.5 Site Investigation for Tank Farm Investigation

B&R Environmental conducted an investigation in 1995 of the UST farm along Crystal Lake Road. The primary objectives of the investigation were to define the extent of soil and groundwater contamination from the UST farm, evaluate the impact of the UST farm on the stormwater discharge, and recommend remedial alternatives, if needed. As part of the tank farm investigation, underground pipelines from the fuel loading dock (Pier 1), throughout a portion of the Lower Subase (Zones 1 through 4), and the gate valve (Building 322) to tanks within the tank farm were investigated. Soil samples were collected along the new and old diesel underground pipeline at approximately 100-foot intervals. The samples were analyzed for TPH. The No. 6 fuel oil lines were not included as part of the investigation as they are installed within lined trenches, which would prevent or minimize any potential soil and groundwater impact from leaks. Two samples (FPTB12L-08 and FPTB13L-07) and one duplicate (DUP17-111895) were collected within Zone 3 (GS-12L and GS-13L). TPH concentrations were less than 25 mg/kg.

The report recommended that additional integrity inspections be performed to determine the locations of previous line leaks on both active and inactive product lines throughout the Lower Subase. In addition, a records review was recommended to identify previous leaks based on the results of line inspections and tightness tests.

5.2.6 Phase II Remedial Investigation

A Phase II RI at 13 sites at NSB-NLON was conducted by B&R Environmental. The Lower Subase was included in this investigation. Soil boring installation and soil and groundwater sampling at Zone 3 were

included in the investigation. Six soil samples were collected from four borings (13TB5A, 13TB7, 13TB12, and 13TB18) and were analyzed for lead, TPH, and TCLP metals. Groundwater samples were collected from one existing monitoring well (13MW12). The groundwater samples were analyzed for VOCs, SVOCs, metals (total and dissolved) and TPH. The data and results of the Phase II RI are discussed as part of the nature and extent and data evaluation discussions in Sections 5.4 and 5.5, respectively.

5.3 PHYSICAL CHARACTERISTICS

General physical characteristics of the Lower Subase are discussed in Section 1.3. Site-specific physical characteristics are discussed in the subsections following.

5.3.1 Topography and Surface Features

The ground surface in Zone 3 slopes gently to the west towards the Thames River. Zone 3 is primarily paved or covered with buildings. The Providence and Worcester Railroad runs along the eastern border of the zone, while the Thames River forms the western border of the zone.

5.3.2 Surface Water Features

Zone 3 is located along the Thames River. No other significant surface water features are located within or adjacent to Zone 3 with the exception of local storm sewers. Catch basins and storm sewers in Zone 3 are shown on Figure 5-1. From the drawing it can be seen that one storm sewer (i.e., the one along the south side of Capelin Road) from Zone 3 outlets to the Thames River at Pier 6.

5.3.3 Soil Characteristics, Geology, and Hydrogeology

The SCS soils map classifies the soil at Zone 3 as Urban Land. USGS surficial geology map indicates that Zone 3 soil is artificial fill. Based on boring logs for borings installed during the Phase I and Phase II RIs, along the east side, Zone 3 consists of 5 to 10 feet of sand and gravel, underlain by 3 to 7 feet of fine to medium sand and 0 to 5 feet of fine sand. The sand is underlain by approximately 8 feet of sand and gravel. Along the west side (near the Thames River) the sand and gravel layer is approximately 15 to 20 feet and is underlain by 3 to 10 feet of sand and silt. The depth of the bottom layer is not known, as borings were not installed to the bottom of the layer.

Bedrock in Zone 3 is mapped as Mamacoke Formation on USGS bedrock maps. This was not confirmed by soil borings.

The depth to groundwater is approximately 6 to 10 feet below ground surface and the elevation of groundwater ranges from 3 msl on the east side of Zone 3 to approximately 1 msl on the west side.

5.4 NATURE AND EXTENT

Soil and groundwater sampling was conducted at Zone 3 during Phase I and Phase II RIs, as well as other investigations as discussed in Section 5.2. The analytical results from these investigations are summarized below as well as the results of the medium-specific COPC screening.

5.4.1 Soil

Tables 5-1 through 5-4 summarize the analytical results of the soil samples collected from Zone 3 and summarize the COPC screening results. The analytical data is grouped using sample depth and analytical method. Analytical data for shallow soils (sample depth of < 4 feet) are summarized in Table 5-1, while data for deep samples (sample depth of >4 feet) are shown in Table 5-2. Analytical results from the TCLP performed on shallow and deep soils are shown in Tables 5-3 and 5-4, respectively.

Background concentrations of inorganics in soil, used below for comparison purposes, were taken from the *Background Concentrations of Inorganics in Soil Report* (Atlantic, 1995b).

Drawings 1 through 4 (back pocket) show the distribution of TPH and lead contamination in soil in all zones, including Zone 3, being investigated as part of the Lower Subase RI. Drawings 1 and 3 show TPH and lead isoconcentration contours, respectively, for shallow soils, while Drawings 2 and 4 show the same respective contours for deep soils.

Shallow

A majority of the shallow soil samples (0 to 4 feet below ground surface) at Zone 3 were analyzed for lead. A limited number of samples were also analyzed for VOCs, SVOCs, Metals and TPH. A majority of the soil samples were collected within Building 31. A few were also collected along Albacore Road and Bullhead Road. Lead concentrations were detected above background (17.5 mg/L, Atlantic 1995b) in many shallow soil samples and several concentrations exceeded the highest screening criteria (i.e., State's Industrial, Direct Exposure screening criteria = 1000 mg/kg). Other inorganics identified as COPCs include aluminum, arsenic, beryllium, cadmium, iron, manganese and nickel. All of these COPCs were identified from the analytical results for one sample.

Drawing 3 shows the distribution of lead in shallow soils of Zone 3. The majority of the data points used to generate the contours are in Building 31. Due to the large number of samples collected within this building, the actual measured concentrations were not able to be presented on the drawing. The contours suggest that the lead detected along Albacore Road in Zone 3 is related to high detections of lead in Building 31. Lead concentrations in soil samples collected as part of the investigation for the time-critical removal action at Building 31 were as high as 16,000 mg/kg prior to excavation. In addition, TCLP lead concentrations in some of these soil samples exceeded both state criteria and federal toxicity characteristic regulatory levels. Most lead contaminated soil underneath and adjacent to Building 31 was remediated in 1995 as part of the removal action. Lead at concentrations exceeding 500 mg/kg (the cleanup level for lead used for the removal action) are still present in soils along Albacore Road.

Lead concentrations measured in sediment samples taken from the Thames River are also provided on Drawing 3. The maximum lead concentration measured in the river sediment along Zone 3 is roughly 30 times less than the maximum concentration measured in shallow Zone 3 soil. The sediment concentrations adjacent to Zone 3 are generally the same to slightly above other levels detected in the Thames River. As discussed in Section 2, the levels of lead detected in these sediment samples pose a potential problem to ecological receptors (i.e., exceeds background and ecological benchmark value).

TCLP results for shallow soils indicate that lead is the only COPC (See Table 5-3). Lead is a COPC only when concentrations are compared to the CTDEP Pollutant Mobility Standard for GB classified groundwater. None of the TCLP lead concentrations exceeded the Federal toxicity characteristic regulatory level.

Three VOCs and one SVOC were detected in a single soil sample collected from Zone 3. Of the VOCs detected, only methylene chloride was detected at a concentration which exceeded any screening criteria. The only criteria exceeded by the concentration was the most conservative soil screening criteria, the Soil Screening Level for Migration to Groundwater (0.001 mg/kg). It should also be noted that methylene chloride is a typical laboratory contaminant. The only SVOC detected (BEHP) did not exceed any of the screening criteria.

TPH concentrations in shallow soils ranged from 65.2 mg/kg to 552 mg/kg. One detection of TPH in 13TB5A exceeded the Federal and state residential screening levels; however, none of the concentrations exceeded the state industrial or pollutant mobility criteria. This test boring is located along Bullhead Road as shown on Drawing 1. The drawing also shows isoconcentration contours of TPH. From the information provided on the drawing, it appears that the TPH detected along Bullhead Road in Zone 3 may

be related to higher levels of TPH detected in Zone 4. No samples were collected from other areas of Zone 3 to evaluate the distribution of TPH.

In summary, the results of the COPC screening indicated that lead and to a lesser extent TPH are the primary COPCs for shallow soil in Zone 3. Other shallow soil COPCs include methylene chloride, aluminum, arsenic, beryllium, cadmium, iron, manganese and nickel. The uncertainty associated with these COPCs is high due to the limited number of analytical results which were available for comparison.

Deep

A majority of the deep soil samples (greater than 4 feet below ground surface) at Zone 3 were analyzed for lead. A limited number of samples were also analyzed for VOCs, SVOCs, Metals and TPH. A majority of the soil samples were collected within Building 31. A few were also collected along Albacore Road and Bullhead Road. Of the nineteen metals detected in the two deep soil samples analyzed for the full list of TAL metals, only cadmium, calcium, lead, nickel, silver, sodium and zinc concentrations exceeded NSB-NLON background levels (0.24 mg/kg, 499 mg/kg, 17.5 mg/kg, 5.95 mg/kg, 0.385 mg/kg, 20.5 mg/kg and 31.3 mg/kg, respectively). Calcium and sodium are considered essential nutrients and were not evaluated during COPC selection. In addition, the groundwater in Zone 3 is brackish from the Thames River and may be the cause of the high sodium concentrations. Lead concentrations measured in the deep samples ranged from 2.6 mg/kg to 6060 mg/kg and exceeded both background (17.5 mg/L) and screening levels. Aluminum, arsenic, beryllium, cadmium, iron, and manganese exceeded one or more screening criteria. Concentrations of these other metals in the Zone 3 soils were generally similar to concentrations detected within all zones of the Lower Subase.

Drawing 4 shows isoconcentration contours of lead concentrations measured in Zone 3 deep soils. The majority of the data points used to generate the contours are in Building 31. Due to the large number of samples collected within this building, the actual measured concentrations were not able to be presented on the drawing. The maximum concentration of lead (6060 mg/kg) was detected along Albacore Road in a sample collected as part of the Building 31 remediation. The lead concentrations measured in the deep soil are roughly the same order of magnitude as the concentrations measured in the shallow soils.

Lead concentrations measured in sediment samples taken from the Thames River are also provided on Drawing 4. The maximum lead concentration measured in the river sediment along Zone 3 is approximately 45 times less than the maximum concentration measured in deep Zone 3 soil. As discussed above, the lead concentrations measured in the sediment adjacent to Zone 3 are generally the

same to slightly above other levels detected in the Thames River and the concentrations of lead pose a potential problem to ecological receptors.

TCLP results for deep soils indicate that lead is the only COPC (See Table 5-3). Contrary to shallow soils, lead is a COPC when concentrations are compared to either the CTDEP Pollutant Mobility Standard for GB classified groundwater or the Federal toxicity characteristic regulatory level. The maximum TCLP leachate concentration from deep soil (5,880 μg/L) is approximately 2 times higher than the maximum TCLP leachate concentration from shallow soil (2,890 μg/L).

Six VOCs were detected in one of two deep soil samples analyzed for these compounds (SB22). This sample was collected during the investigation/remediation of Building 31. Methylene chloride, a common laboratory contaminant, was the only VOC identified as a COPC. Nine SVOCs were also detected in the soil sample collected from SB22. None of the concentrations detected were above any screening criteria.

TPH concentrations in deep soil ranged from 18.6 mg/kg to 3,400 mg/kg. The only concentration of TPH exceeding screening levels was detected in the sample from 13MW12. Based on fluorescence analysis from the Phase I RI, an area of No. 2 fuel/diesel oil is present in the vicinity of 13MW12. Drawing 2 shows isoconcentration contours of TPH measured in deep soil. The high detection of TPH at 13MW12 is most likely due to a leak in the fuel pipeline located east and upgradient of the monitoring well.

Based on the results of the COPC screening (Tables 5-2 and 5-4), lead and TPH are the primary COPCs for deep soil in Zone 3. Other COPCs of note include methylene chloride, aluminum, arsenic, beryllium, cadmium, iron, lead and manganese. The uncertainty associated with these COPCs is high due to the limited number of analytical results which were available for comparison.

5.4.2 Groundwater

Tables 5-5 and 5-6 summarize analytical results for groundwater samples collected in Zone 3 and summarize the COPC screening results. Analytical results from unfiltered samples are provided in Table 5-5 and the results for filtered samples are summarized in Table 5-6.

Drawings 5 through 7 (back pocket) show the distribution of TPH and lead contamination in groundwater for all zones, including Zone 3, being investigated as part of the Lower Subase RI. Drawing 5 shows isoconcentration contours of TPH concentrations measured in groundwater. Isoconcentration contours of filtered and unfiltered lead concentrations in groundwater are presented on Drawings 6 and 7, respectively.

Four temporary wells (GW-01 through GW-04) and one permanent monitoring well (13MW12) are located in Zone 3. Two rounds of groundwater samples were collected from each temporary well for the investigation completed for the Action Memorandum at Building 31. Three rounds of groundwater samples have been collected from well 13MW12 during the Phase I and Phase II RIs. Unfiltered metals were analyzed for during all five rounds. Twenty inorganics were detected in at least one round (see Table 5-5). Of these arsenic, barium, calcium, chromium, iron, lead, magnesium, manganese, nickel, potassium, sodium, and zinc were consistently detected. Calcium, magnesium, and potassium are essential nutrients and were not evaluated during the COPC screening. Aluminum, arsenic, barium, beryllium, cadmium, chromium, iron, manganese, mercury, nickel, vanadium, and zinc concentrations in unfiltered groundwater exceeded one or more screening levels. Sodium concentrations only exceeded a notification level.

Filtered metals were analyzed for in well 13MW12 during the two rounds of sampling for the Phase II RI (in March and June of 1994) and in wells GW-01 through GS-04 during two rounds of sampling for the Building 31 Action Memorandum. Eleven inorganics were detected in the groundwater (see Table 5-6). Barium, calcium, iron, magnesium, manganese, potassium, and sodium were detected in all samples, while selenium was only detected in the sample from Round 1 of the Phase II RI, and zinc was only detected in the sample from Round 2 of the Phase II RI. The magnitude of the metals concentrations detected in unfiltered samples were higher than concentrations in filtered samples. Arsenic, iron, manganese, and sodium in filtered groundwater also exceeded one or more screening levels. Sodium concentrations only exceeded a notification level.

The distribution of lead in unfiltered and filtered groundwater samples is shown on Drawings 6 and 7. By comparing the two drawings it can be seen that unfiltered groundwater concentrations were substantially higher than filtered groundwater concentrations. These results indicate that lead is sorbed to the suspended soil particles in the groundwater and may not be soluble. These high levels of lead are most likely due to the former activities within Building 31. All of the lead concentrations detected in the unfiltered groundwater samples collected in the temporary wells from within Building 31 exceeded the state and federal screening criteria. None of lead concentrations detected in the filtered groundwater samples collected in the temporary wells exceeded any screening criteria. Groundwater in the vicinity of well 13MW12 does not appear to have been impacted as much as groundwater beneath Building 31, where significant lead contamination was identified. Groundwater samples collected from well WE5, located within Zone 4, show lead concentrations as high as 140 µg/L and an average concentration of 64 µg/L. It is unknown if the contamination detected in well WE5 is a result of Zone 3 or Zone 4 contamination, or both.

No VOCs were detected in any of the sampling rounds. BEHP and fluorene were the only SVOCs detected in groundwater. Concentrations of these two SVOCs were detected at well 13MW12 in Round 2 of Phase II RI sampling. Neither SVOC was selected as a COPC because the concentrations were below screening criteria. SVOCs were not analyzed for in Phase I. SVOCs were analyzed for in wells GW01 and GW02 during Round 1 of the sampling for the Building 31 Action Memorandum; however, no SVOCs were detected. TPH was not detected in any of the samples collected for the Phase I or II RIs. No samples collected from the temporary wells were analyzed for TPH. Fluorescence spectroscopy conducted during Phase I showed trace TPH at concentrations too low to identify the type of oil or fuel present. A well installed and sampled previous to the Phase I investigation (WE2) had a spectra typical of waste oil.

TPH was not detected in monitoring well 13MW12 of Zone 3. However, the average of one-half of the detection limits for 3 samples (666.67 µg/L) is shown on Drawing 5. This average detection limit was calculated from detection limits of 3,000 µg/L, 500 µg/L, and 500 µg/L. All of these detection limits are at or above the state's TPH remediation criteria of 500 µg/L. This information suggests that there is a high level of uncertainty in the TPH results for Zone 3.

5.5 DATA EVALUATION

Data was evaluated based on contaminant fate and transport, human health and ecological risk assessments, and a comparison to state standards in the Phase II RI. These are summarized in this section. In addition, an evaluation of Zone 3 using the decision tree provided in Figure 1-3 is also included in this section. Data collected during the investigation/remediation of Building 31 is not evaluated in this section because it was not available when the Phase II RI was being completed. This data will be included in the data evaluation performed for the upcoming Lower Subase RI.

5.5.1 Contaminant Fate and Transport

Metals are not typically considered to be mobile contaminants in the environment. Lead and other metals do not degrade via any of the identified fate processes (e.g., hydrolysis, photolysis, etc.) although under acidic soil conditions, metals may be solubilized and transported vertically with infiltrating precipitation. The presence of these analytes at depth may reflect the nature of the fill material used to construct the Lower Base, as well as some potential vertical transport associated with industrial activities occurring on the surface. In addition, the presence of lead at the site may be the result of, until the 1950s, all

submarines depended on lead batteries for principal means of underwater propulsion. The storm sewer along Capelin Road could act as a preferential contaminant migration pathway for Zone 3 contaminants.

5.5.2 Baseline Human Health Risk Assessment

The baseline human health risk assessment for the Lower Subase focused on two potential receptor groups: construction workers and future residents. Two variations of exposure were considered for each receptor, as per USEPA Region I guidance; CTE and RME. Noncarcinogenic risks (Hazard Indices) were less than unity. Carcinogenic risks (incremental cancer risks) for all receptors were less than $1x10^{-6}$ or within the USEPA target risk range of $1x10^{-6}$ to $1x10^{-4}$.

Exposure to lead in soils was addressed using the USEPA IEUBK Model. Estimated blood levels for children in a residential setting were calculated. Estimated levels (5.1 to 8.4 µg/dL) were below the established level of "concern", 10 µg/dL, indicating that no adverse effects are anticipated for children and other potential receptor exposed to surface and subsurface soils at Zone 3. The USEPA IEUBK Model was not used to evaluate groundwater since it is not used for potable water supply.

5.5.3 Ecological Risk Assessment

The only potential ecological habitat near the Lower Subase is the Thames River. PAHs and metals are the primary chemicals of concern for the Thames River (see Section 2.0). Metals (particularly lead) and TPH were detected in Zone 3 soils; however only limited SVOC data for soils is available. PAHs are common constituents of petroleum products. Chemicals detected at Zone 3 may be impacting the Thames River. Note that the ecological risk assessment for the Thames River, discussed in Section 2.5.3, concluded that the Lower Subase represented a minimal potential risk to ecological receptors.

5.5.4 Comparison of Site Data to Connecticut Standards

Analytical data were compared to Connecticut drinking water standards and remediation standards. Site-specific soil data were compared to Connecticut remediation standards for direct exposure and pollutant mobility. Direct exposure criteria for residential exposure were used to conservatively evaluate potential exposure to soil at the site. Concentrations of TPH and lead in shallow and deep soils in Zone 3 exceeded the residential direct exposure criteria. Concentrations of TPH in deep soil and lead in shallow and deep soil exceeded industrial direct exposure criteria.

To address concerns regarding migration of chemicals from soil to groundwater, site soil data were compared to Connecticut remediation standards for pollutant mobility. Data were compared to GB pollutant mobility criteria. For Zone 3, a single TPH concentration in deep soil (3,400 mg/kg at 13MW12) was the only concentration which exceeded the GB pollutant mobility criteria. Concentrations of lead in TCLP analyses conducted during the Phase II RI and Building 31 remediation exceeded the state criteria (shallow and deep soils) and Federal toxicity characteristic regulatory levels (only deep soils).

Several exceedances of state standards were noted for unfiltered groundwater at Zone 3. Beryllium, mercury, nickel, and sodium were detected in the unfiltered groundwater at maximum concentrations above the primary state MCLs. Beryllium, lead, mercury, nickel and vanadium were detected at maximum concentrations in unfiltered groundwater that exceeded remediation standards for groundwater. Maximum concentrations of arsenic, beryllium, copper, lead, mercury, and zinc in unfiltered groundwater were in excess of the remediation standard for the protection of surface water. The only exceedance noted in filtered groundwater was sodium. This chemical was detected in both the unfiltered and filtered groundwater samples at maximum concentrations in excess of the 28,000 µg/L state Notification Level. However, the Thames River which is brackish and influences the groundwater of the Lower Subase, is the likely cause of the high levels of sodium.

5.5.5 Decision Tree

The general decision tree for the evaluation of sites is provided in Figure 1-3. The evaluation of data using this decision tree for Zone 3 is as follows:

- Existing data has been collected and evaluated. Information describing the site, previous investigations, and physical characteristics of the site are provided in Sections 5.1, 5.2, and 5.3, respectively. The nature and extent of contamination is provided in Section 5.4.

- Based on the existing data, no imminent threat to human health or the environment was identified for Zone 3.

- Contaminant fate and transport have been described, baseline human health and ecological risk assessments have been conducted and data have been compared to CTDEP Standards. Data from the Building 31 investigation/remediation was not used for the human health or ecological risk assessments.

- Although contamination in Zone 3 has not been fully characterized, particularly because of lack of SVOC data for soils, available information indicates that the source of contamination is from prior activities at the Subase and that significant risks do not exist for human health or the environment.

- A removal action for lead contamination at Building 31 was conducted in 1995. With the exception of soils adjacent to Building 31 along Albacore Road, soils above the mean low tide elevation with lead concentrations greater than 500 mg/kg were remediated inside and adjacent to Building 31. Soils along Albacore Road still contain lead concentrations greater than 500 mg/kg and leaching tests indicate that the lead is potentially mobile.

- A hot spot area (TPH concentrations greater than 2500 mg/kg) exists by Argonaut Road and Bullhead Road.

- Further action is required for Zone 3 and is discussed in Section 5.6.

5.6 RECOMMENDATIONS

The Phase II RI provides recommendations for Zone 3. Further characterization focusing on sampling and analysis to evaluate the nature and extent of lead, TPH, and SVOCs in soil are recommended. Continued groundwater sampling and analysis are also recommended to monitor contamination levels. These recommendations are supported by the following information:

- Relatively high concentrations of lead in soil are present at Zone 3 in the vicinity of Site 17 (Building 31). Concentrations of lead were as high as 4,390 mg/kg in shallow soil and 6,060 mg/kg in deep soil of Zone 3 (see Drawings 3 and 4).

- High concentrations of TPH in soil are also present at Zone 3 (maximum concentration of 3,400 mg/kg in deep soils as shown on Drawing 1).

- SVOCs have been detected in the groundwater beneath Zone 3. SVOCs were not analyzed for in soil during Phase I or II RI activities. One shallow and one deep soil sample, collected during the Building 31 investigation/remediated, were analyzed for SVOCs. Low levels of SVOCs were detected in each sample. Further characterization of these compounds are needed to evaluate risks associated with these contaminants. It is highly probable that semivolatile organic compounds will be detected at significant levels in soil, based on the presence of TPH. Semivolatile organic

compounds are common components of TPH, and the concentrations of these compounds are unknown.

- Petroleum products and oily substances have historically migrated into the Thames River. As discussed Section 17, the Thames River sediment and shellfish community may be impacted in the vicinity of the Lower Subase.

Additional sampling and analysis is necessary to determine the nature and extent of lead in soils; to monitor lead levels in groundwater; to confirm by the SPLP method whether lead detected in shallow and deep soils is truly mobile, as indicated by the existing TCLP results; to quantify the amount of lead entering the Thames River; and to evaluate the cumulative ecological impacts.

It is further recommended that in conjunction with sampling at Zone 3, integrity inspections on the active and inactive fuel lines located in Zone 3 (and throughout the Lower Subase) be conducted to determine previous line leaks. In addition, a review of records to identify previous leaks based on the results of inspections and tightness tests is recommended. The integrity inspections and review of data are important to identify sources of petroleum contamination.

Because contaminants associated with the Lower Subase have been detected in the sediments in the Thames River, sampling of the sediments is recommended in conjunction with characterization activities to aid in the identification of source areas and contaminants of concern. Sampling of media from the Thames River is discussed in Section 2.6.

Based on the results of the additional sampling and analyses and the integrity inspection activities, source areas will be able to be defined and remedial activities for the source areas will be conducted as necessary. Remedial activities should focus on the removal of free product and highly contaminated areas (hot spots) which may act as sources of contamination to other media/receptors. However, because Zone 3 is located in an active, industrialized area that is vital to national security, petroleum contamination is widespread in the Lower Subase, and contamination presents minimal risks to human health and the environment (i.e., limited exposure pathways), remediation of all contaminated material at Zone 3 by excavation is not feasible or practical. Therefore, in-situ remedial options such as containment, air sparging, soil vapor extraction (SVE), natural attenuation or bioremediation will also be explored and used as applicable.

TABLE 5-1

COPC SCREENING FOR LOWER SUBASE
ZONE 3 - SHALLOW SOILS (<4 FEET)
NSB-NLON, GROTON, CONNECTICUT
PAGE 1 OF 2

Parameter	Frequency (1)	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	SSL Inhalation (3)	SSL Migration to Groundwater (3)	State Residential Direct Exposure (4)	State Industrial Direct Exposure (4)	State Pollutant Mobility (GB) (4)	Select as COPC? (5)
Volatiles (mg/kg)												
Acetone	1/1	0.13	-	0.13	SB14	780	100000	0.8	500	1000	140	N
Chloroform	1/1	0.001	-	0.001	SB14	100	0.3	0.03	100	940	1.2	N
Methylene chloride	1/1	0.004	-	0.004	SB14	85	13	0.001	82	760	1	Y
Semivolatiles (mg/kg)												
Bis(2-Ethylhexyl)phthalate	1/1	0.16	-	0.16	SB14	46	31000	180	44	410	11	N
Metals (mg/kg)												
Aluminum	1/1	8790	-	8790	SB14	7800	-	-	-	-	-	Y
Arsenic	1/1	2.2	-	2.2	SB14	0.43	750	1	10	10	-	Y
Barium	1/1	43.8	-	43.8	SB14	550	690000	82	4700	140000	-	N
Beryllium	1/1	0.38	-	0.38	SB14	0.15	1300	3	2	2	-	Y
Cadmium	1/1	0.46	-	0.46	SB14	3.9	1800	0.4	34	1000	-	Y
Calcium	1/1	2500	-	2500	SB14	-	-	-	-	-	-	N(6)
Chromium	1/1	16.9	-	16.9	SB14	39	270	-	3900/100(7)	5.1E+4/100(7)	-	N
Cobalt	1/1	5	-	5	SB14	470	-	-	-	-	-	N
Copper	1/1	12	-	12	SB14	310	-	-	2500	76000	-	N
Iron	1/1	9440	-	9440	SB14	2300	-	-	-	-	-	Y
Lead	68/70	2.8 - 4390	4.8 - 19.3	273	ALBACORE RD	400	-	-	500	1000	-	Y
Magnesium	1/1	3260	-	3260	SB14	-	-	-	-	-	-	N(6)
Manganese	1/1	155	-	155	SB14	39	-	-	-	-	-	Y
Nickel	1/1	13.4	-	13.4	SB14	160	13000	7	1400	7500	-	Y
Potassium	1/1	2130	-	2130	SB14	-	-	-	-	-	-	N(6)
Sodium	1/1	474	-	474	SB14	-	-	-	-	-	-	N(6)
Vanadium	1/1	18.9	-	18.9	SB14	55	-	300	470	14000	-	N
Zinc	1/1	20.4	-	20.4	SB14	2300	-	620	20000	610000	-	N

TABLE 5-1

COPC SCREENING FOR LOWER SUBASE
ZONE 3 - SHALLOW SOILS (<4 FEET)
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 2

Parameter	Frequency (1)	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	SSL Inhalation (3)	SSL Migration to Groundwater (3)	State Residential Direct Exposure (4)	State Industrial Direct Exposure (4)	State Pollutant Mobility (GB) (4)	Select as COPC? (5)
Miscellaneous (mg/kg)												
TPH	3/3	65.2 - 552	-	356	13TB5A	500	-	-	500	2500	2500	Y

- Not available or not applicable.

(1) Includes data from the following samples: 13TB12-0204-X, 13TB18-0103, 13TB5A-1.5-3.5, 13TB5A-1.5-3.5-X, 13TB7-0103, 2-EXBE78-06, 2-EXNW09-06, 2-EXNW78-09, 2-EXSW78-09, 2-EXWW-ALBACORE-06, 2-EXWW09-06, 3-EXSW09-06, 4-EXEW03-07, EXBE-BULLHEAD-07, EXEW-BULLHEAD-08, EXEW02-06, EXNW02-06, EXNW03-07, EXNW04-06, EXSW-ALBACORE-06, EXSW-BULLHEAD-08, EXSW01-07, EXSW02-06, EXSW03-07, EXSW04-06, EXWW-ALBACORE-06, EXWW01-07, EXWW02-06, SB06-2.0, SB06-2.0-CLP, SB06-4.0, SB06-4.0-CLP, SB06-4.0-CLP-D, SB06-4.0-D, SB07-2.0, SB07-2.0-CLP, SB07-4.0, SB07-4.0-CLP, SB09-2.0, SB09-2.0-CLP, SB09-4.0, SB09-4.0-CLP, SB10-2.0, SB10-2.0-CLP, SB10-4.0, SB10-4.0-CLP, SB12-2.0, SB12-2.0-CLP, SB12-4.0, SB12-4.0-CLP, SB13-2.0, SB13-2.0-CLP, SB13-2.0-CLP-D, SB13-2.0-D, SB13-4.0, SB13-4.0-CLP, SB14-2.0, SB14-2.0-CLP, SB14-2.0-TAL, SB14-4.0, SB14-4.0-CLP, SB15-2.0, SB15-2.0-CLP, SB15-4.0, SB15-4.0-CLP, SB19-2.0, SB19-2.0-CLP, SB19-4.0, SB19-4.0-CLP, SB20-2.0, SB20-2.0-CLP, SB20-4.0, SB20-4.0-CLP, SB20-4.0-CLP-D, SB20-4.0-D, SB21-2.0, SB21-2.0-CLP, SB21-4.0, SB21-4.0-CLP, SB22-2.0, SB22-2.0-CLP, SB22-4.0, SB22-4.0-CLP, SB23-2.0, SB23-2.0-CLP, SB23-4.0, SB23-4.0-CLP, SB25-2.0, SB25-2.0-CLP, SB25-4.0, SB25-4.0-CLP, SB25-4.0-CLP-D, SB25-4.0-D, SB26-2.0, SB26-2.0-CLP, SB26-4.0, SB26-4.0-CLP, SB27-2.0, SB27-2.0-CLP, SB27-4.0, SB27-4.0-CLP, SB29-4.0, SB29-4.0-CLP, SB30-2.0, SB30-2.0-CLP, SB30-4.0, SB30-4.0-CLP, SB32-2.0, SB32-2.0-CLP, SB33-2.0, SB33-2.0-CLP

(2) *Based on current USEPA Region III guidance (USEPA Region III, May 10, 1996). Residential Soil Ingestion for soil and sediment.*

(3) USEPA Soil Screening Levels (USEPA, May 1996). For migration to groundwater, values associated with a dilution and attenuation factor (DAF) of 1.0.

(4) CTDEP, December 1995.

(5) Contaminant of Potential Concern; Yes (Y) indicates that the maximum concentration exceeds one or more of the criteria; No (N) indicates that the maximum does not exceed any of the criteria.

(6) Essential nutrients, not evaluated for COPC selection.

(7) *Trivalent chromium/hexavalent chromium.*

TABLE 5-2

COPC SCREENING FOR LOWER SUBASE
ZONE 3 - DEEP SOILS (>4 FEET)
NSB-NLON, GROTON, CONNECTICUT
PAGE 1 OF 2

Parameter	Frequency (1)	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	SSL Inhalation (3)	SSL Migration to Groundwater (3)	State Residential Direct Exposure (4)	State Industrial Direct Exposure (4)	State Pollutant Mobility (GB) (4)	Select as COPC? (5)
Volatiles (mg/kg)												
1,1,1-Trichloroethane	1/2	0.006	0.006	0.0045	SB22	700	1200	0.1	500	1000	40	N
Acetone	1/2	0.084	0.013	0.0453	SB22	780	100000	0.8	500	1000	140	N
Methylene chloride	1/2	0.003	0.006	0.003	SB22	85	13	0.001	82	760	1	Y
Tetrachloroethene	1/2	0.001	0.006	0.002	SB22	12	11	0.003	12	110	1	N
Toluene	1/2	0.0008	0.006	0.0019	SB22	1600	650	0.6	500	1000	67	N
Xylenes, total	1/2	0.001	0.006	0.002	SB22	16000	-	-	500	1000	19.5	N
Semivolatiles (mg/kg)												
Anthracene	1/1	0.034	-	0.034	SB22	2300	-	590	-	-	-	N
Benzo(a)anthracene	1/1	0.021	-	0.021	SB22	0.88	-	0.08	1000	2500	400	N
Bis(2-Ethylhexyl)phthalate	1/1	0.26	-	0.26	SB22	46	31000	180	1	7.8	1	N
Chrysene	1/1	0.026	-	0.026	SB22	88	-	8	44	410	11	N
Di-N-butyl phthalate	1/1	0.02	-	0.02	SB22	780	2300	270	-	-	-	N
Dibenzofuran	1/1	0.038	-	0.038	SB22	31	-	-	1000	2500	140	N
Fluoranthene	1/1	0.089	-	0.089	SB22	310	-	210	-	-	-	N
Phenanthrene	1/1	0.14	-	0.14	SB22	-	-	-	1000	2500	56	N
Pyrene	1/1	0.061	-	0.061	SB22	230	-	210	1000	2500	40	N
Metals (mg/kg)												
Aluminum	2/2	7220 - 8120	-	7670	13MW12	7800	-	-	-	-	-	Y
Arsenic	2/2	1.6 - 2.8	-	2.2	13MW12	0.43	750	1	10	10	-	Y
Barium	2/2	29.2 - 37.9	-	33.6	SB22	550	690000	82	4700	140000	-	N
Beryllium	1/2	0.33	0.22	0.22	13MW12	0.15	1300	3	2	2	-	Y
Cadmium	1/2	0.83	0.67	0.5825	13MW12	3.9	1800	0.4	34	1000	-	Y
Calcium	2/2	1100 - 13800	-	7450	SB22	-	-	-	-	-	-	N(6)
Chromium	2/2	10.5	-	10.5	13MW12/SB22	39	270	-	3900/100(7)	5.1E+4/100(7)	-	N
Cobalt	2/2	3.7 - 4.4	-	4.05	13MW12	470	-	-	-	-	-	N
Copper	2/2	8.8 - 12.4	-	10.6	SB22	310	-	-	2500	76000	-	N
Iron	2/2	7230 - 7560	-	7395	SB22	2300	-	-	-	-	-	Y

TABLE 5-2

COPC SCREENING FOR LOWER SUBASE
ZONE 3 - DEEP SOILS (>4 FEET)
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 2

Parameter	Frequency (1)	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	SSL Inhalation (3)	SSL Migration to Groundwater (3)	State Residential Direct Exposure (4)	State Industrial Direct Exposure (4)	State Pollutant Mobility (GB) (4)	Select as COPC? (5)
Lead	46/46	2.6 - 6060	-	374	ALBACORE RD	400	-	-	500	1000	-	Y
Magnesium	2/2	1930 - 2660	-	2295	SB22	-	-	-	-	-	-	N(6)
Manganese	2/2	88.1 - 158	-	123	SB22	39	-	-	-	-	-	Y
Nickel	2/2	5.2 - 7	-	6.1	13MW12	160	13000	7	1400	7500	-	N
Potassium	2/2	910 - 1280	-	1095	SB22	-	-	-	-	-	-	N(6)
Silver	1/2	1.7	1.8	1.3	SB22	39	-	2	340	10000	-	N
Sodium	2/2	114 - 530	-	322	SB22	-	-	-	-	-	-	N(6)
Vanadium	2/2	14.7 - 15.7	-	15.2	13MW12	55	-	300	470	14000	-	N
Zinc	2/2	17 - 49.9	-	33.5	SB22	2300	-	620	20000	610000	-	N
Miscellaneous (mg/kg)												
TPH	4/5	18.6 - 3400	11.1	716.6	13MW12	500	-	-	500	2500	2500	Y

- Not available or not applicable.

(1) Includes data from the following samples: 13MW12(8-10), 13TB12-0406, 13TB12-0608-X, 2-EXBE-ALBACORE-04, 2-EXWW06-06, EXBE-ALBACORE-03, EXBE-ALBACORE-04-D, EXBE01-04, EXBE02-04, EXBE03-04, EXBE05-04, EXBE06-07, EXBE07-03, EXEW07-05, EXEW07-05-D, EXNW07-05, EXNW08-07, EXSW07-04, EXSW08-07, EXWW06-07, EXWW07-05, EXWW08-07, FPTB12L-08, FPTB13L-07, DUP17-111895, SB06-6.0, SB06-6.0-CLP, SB07-6.0, SB07-6.0-CLP, SB08-6.0, SB08-6.0-CLP, SB09-6.0, SB09-6.0-CLP, SB10-6.0, SB10-6.0-CLP, SB10-6.0-CLP-D, SB10-6.0-D, SB12-6.0, SB12-6.0-CLP, SB13-6.0, SB13-6.0-CLP, SB14-6.0, SB14-6.0-CLP, SB15-6.0, SB15-6.0-CLP, SB16-6.0, SB16-6.0-CLP, SB17-6.0, SB17-6.0-CLP, SB19-6.0, SB19-6.0-CLP, SB20-6.0, SB20-6.0-CLP, SB21-6.0, SB21-6.0-CLP,SB22-6.0, SB22-6.0-CLP, SB22-6.0-TAL, SB23-6.0, SB23-6.0-CLP, SB24-6.0, SB24-6.0-CLP, SB25-6.0, SB25-6.0-CLP, SB26-6.0, SB26-6.0-CLP, SB27-6.0, SB27-6.0-CLP, SB29-6.0, SB29-6.0-CLP, SB30-6.0, SB30-6.0-CLP

(2) Based on current USEPA Region III guidance (USEPA Region III, May 10, 1996). Residential Soil Ingestion for soil and sediment.

(3) USEPA Soil Screening Levels (USEPA, May 1996). For migration to groundwater, values associated with a dilution and attenuation factor (DAF) of 1.0.

(4) CTDEP, December 1995.

(5) Contaminant of Potential Concern; Yes (Y) indicates that the maximum concentration exceeds one or more of the criteria; No (N) indicates that the maximum does not exceed any of the criteria.

(6) *Essential nturient. Not evaluated for COPC selection.*

(7) Trivalent chromium/hexavalent chromium.

TABLE 5-3

COPC SCREENING FOR LOWER SUBASE
ZONE 3 - TCLP SHALLOW SOILS (<4 FEET)
NSB-NLON, GROTON, CONNECTICUT

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	State Pollutant Mobility (GB) (2)	Federal Pollutant Mobility (3)	Select as COPC? (4)
Metals (ug/L)								
Barium	3/3	211 - 264	-	237	13TB18	10000	100000	N
Chromium	2/3	6.1 - 12.5	6.2	7.23	13TB7	500	5000	N
Lead	10/13	29.3 - 2890	26 - 50	422	SB25	150	5000	Y

- Not available or not applicable.

(1) Includes data from the following samples: 13TB18-0103, 13TB5A-1.5-3.5, 13TB7-0103, SB09-2.0, SB10-4.0, SB13-2.0, SB14-4.0, SB15-2.0, SB20-2.0, SB21-2.0, SB25-2.0, SB26-2.0, and SB27-2.0.

(2) CTDEP Pollutant Mobility Remediation Standard for GB classified groundwater; CTDEP, December 1995.

(3) Federal Toxicity Characteristic Regulatory Level (58 FR 46049).

(4) Contaminant of Potential Concern; Yes (Y) indicates that the maximum concentration exceeds one or more of the criteria; No (N) indicates that the maximum does not exceed any of the criteria.

TABLE 5-4

COPC SCREENING FOR LOWER SUBASE
ZONE 3 - TCLP DEEP SOILS (>4 FEET)
NSB-NLON, GROTON, CONNECTICUT

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	State Pollutant Mobility (GB) (2)	Federal Pollutant Mobility (3)	Select as COPC? (4)
Metals (ug/L)								
Barium	2/2	63.2 - 210	-	137	13MW12	10000	100000	N
Chromium	2/2	4.7 - 71	-	37.9	13MW12	500	5000	N
Lead	7/9	54.6 - 5880	26 - 100	1034	SB17	150	5000	Y

- Not available or not applicable.

(1) Includes data from the following samples: 110890-13MW12(8-10), 13TB12-0406, SB06-6.0, SB07-6.0, SB12-6.0, SB17-6.0, SB19-6.0, SB22-6.0, and SB23-6.0.

(2) CTDEP Pollutant Mobility Remediation Standard for GB classified groundwater; CTDEP, December 1995.

(3) Federal Toxicity Characteristic Regulatory Level (58 FR 46049).

(4) Contaminant of Potential Concern; Yes (Y) indicates that the maximum concentration exceeds one or more of the criteria; No (N) indicates that the maximum does not exceed any of the criteria.

TABLE 5-5

COPC SCREENING FOR LOWER SUBASE
ZONE 3 - UNFILTERED GROUNDWATER
NSB-NLON, GROTON, CONNECTICUT
PAGE 1 OF 2

Parameter	Frequency (1)	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	Federal MCL (3)	State MCL (4)	State Remediation Standards (5)		Select as COPC? (6)
									Groundwater Protection	Surface Water Protection	
Semivolatile Organic Compounds (ug/L)											
Bis(2-Ethylhexyl)phthalate	2/6	0.6 - 1	10	3.6	13MW12	4.8	6	6	2	59	N
Fluorene	2/6	1	10	3.67	13MW12	150	-	-	280	140000	N
Metals (ug/L)											
Aluminum	3/7	14800 - 75000	14 - 30	16405	GW02	3700	50 TO 200 (8)	-	-	-	Y
Arsenic	10/14	2.1 - 8.3	2 - 3	3.09	GW01	0.045	50	50	50	4	Y
Barium	14/14	22.4 - 609	-	144.9	GW02	260	2000	2000	1000	-	Y
Beryllium	2/7	1.4 - 6.9	1	1.54	GW02	0.016	4	4	4	4	Y
Cadmium	1/14	4.8	2 - 3	1.66	GW02	1.8	5	5	5	6	Y
Calcium	7/7	8760 - 28000	-	21259	13MW12	-	-	-	-	-	N(7)
Chromium	10/14	7.4 - 78	3 - 5	18.7	GW02	18	100	100	-	-	Y
Cobalt	2/7	9.6 - 47.6	4 - 6	9.96	GW02	220	-	-	-	-	N
Copper	3/7	35.7 - 142	2 - 5	34.9	GW02	150	1300	-	1300	48	Y
Iron	7/7	3160 - 62200	-	15973	GW02	1100	300	-	-	-	Y
Lead	12/14	2.2 - 392	2	123.5	GW02	15	15	-	15	13	Y
Magnesium	7/7	2980 - 17200	-	5406	GW02	-	-	-	-	-	N(7)
Manganese	7/7	253 - 3890	-	841.7	GW02	18	50	5000	-	-	Y
Mercury	5/14	0.3 - 8.9	0.2	0.856	GW04	1.1	2	2	2	0.4	Y
Nickel	4/7	19.1 - 133	10 - 11	42.5	GW02	73	100	100	100	880	Y
Potassium	7/7	4020 - 11000	-	6386	GW02	-	-	-	-	-	N(7)
Silver	3/14	2 - 4.2	2 - 7.6	1.85	GW02	18	100	50	36	12	N
Sodium	7/7	28200 - 99700	-	60800	13MW12	-	-	28000 (9)	-	-	Y
Vanadium	3/7	21.8 - 87.2	4 - 20	23.1	GW02	26	-	-	50	-	Y
Zinc	4/7	27.8 - 338	3 - 3.7	86.4	GW02	1100	5000	-	5000	123	Y
Miscellaneous (ug/L)											
Hardness as CaCO3 (mg/l)	3/3	72 - 88	-	77	13MW12	-	-	-	-	-	N (10)

TABLE 5-5

COPC SCREENING FOR LOWER SUBASE
ZONE 3 - UNFILTERED GROUNDWATER
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 2

- Not available or not applicable.

(1) Includes data from the following samples: 13MW12S, 13GW12, 13GW12-2, and 13GW12-D-2, GW-01-1, GW-01-1-D, GW-01-2, GW-02-1, GW-02-02, GW-02-2-D, GW-03-1, GW-03-2, GW-04-1, GW-04-2.

(2) For residential tap water ingestion, based on current USEPA Region III guidance (USEPA Region III, May 10, 1996).

(3) Maximum Contaminant Level (USEPA, May 1995).

(4) Title 19, Health and Safety, the Public Health Code of the State of Connecticut, Chapter 11, Environmental Health.

(5) CTDEP, December, 1995.

(6) Contaminant of Potential Concern: A Yes (Y) indicates that the maximum contaminant concentration exceeds one or more of the criteria; A No (N) indicates that the maximum contaminant concentration does not exceed any of the criteria.

(7) Essential nutrient, not evaluated for COPC selection.

(8) Secondary MCL, based on aesthetic drinking water qualities.

(9) Notification Level.

(10 Not applicable for COPC screening.

TABLE 5-6

COPC SCREENING FOR LOWER SUBASE
ZONE 3 - FILTERED GROUNDWATER
NSB-NLON, GROTON, CONNECTICUT

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	Federal MCL (3)	State MCL (4)	State Remediation Standards (5)		Select as COPC? (6)
									Groundwater Protection	Surface Water Protection	
Metals (ug/l)											
Arsenic	4/10	1.2 - 3.2	2	1.47	13MW12	0.045	50	50	50	4	Y
Barium	10/10	18.2 - 54.1	-	33.8	13MW12	260	2000	2000	1000	-	N
Calcium	3/3	24000 - 27300	-	25133	13MW12	-	-	-	-	-	N(7)
Iron	3/3	5200 - 5900	-	5633	13MW12	1100	300	-	-	-	Y
Lead	5/10	1 - 7.3	1 - 2	1.73	GW03	15	15	-	15	13	N
Magnesium	3/3	2940 - 3290	-	3063	13MW12	-	-	-	-	-	N(7)
Manganese	3/3	282 - 321	-	296	13MW12	18	50	5000	-	-	Y
Potassium	3/3	6050 - 6380	-	6177	13MW12	-	-	-	-	-	N(7)
Selenium	1/10	3.2	1 - 3	1.07	13MW12	18	50	50	50	50	N
Sodium	3/3	86800 - 97700	-	90500	13MW12	-	-	28000(8)	-	-	Y
Zinc	1/3	5.1	3 - 9.6	3.8	13MW12	1100	5000	-	5000	123	N

- Not available or not applicable.

(1) Includes data from the following samples: 13GW12-2, 13GW12D-2, 13GW12, GW-01-2-DISS, GW-02-2-DISS, GW-02-2-DISS-D, GW-03-1-DISS, GW-03-2-DISS, GW-04-1-DISS, and GW-04-2-DISS.

(2) For residential tap water ingestion, based on current USEPA Region III guidance (USEPA Region III, May 10, 1996).

(3) Maximum Contaminant Level (USEPA, May 1995).

(4) Title 19, Health and Safety, the Public Health Code of the State of Connecticut, Chapter 11, Environmental Health.

(5) CTDEP, December, 1995.

(6) Contaminant of Potential Concern: A Yes (Y) indicates that the maximum contaminant concentration exceeds one or more of the criteria; A No (N) indicates that the maximum contaminant concentration does not exceed any of the criteria.

(7) Essential nutrient, not evaluated for COPC selection.

(8) Notification Level.

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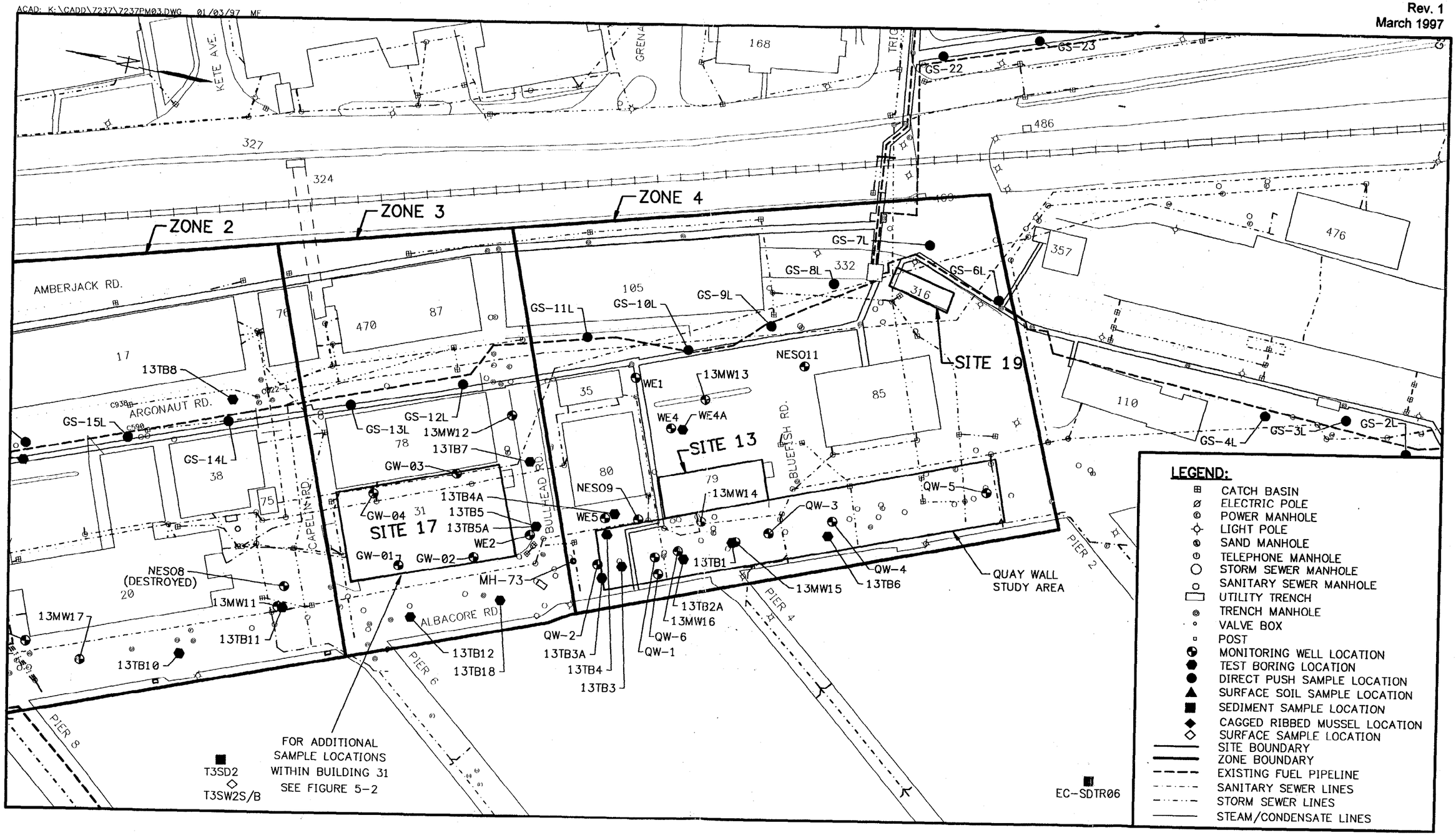
Rev. 1
March 1997



SAMPLE LOCATION MAP
ZONE 3
NSB-NLON, GROTON, CONNECTICUT

0 80 160
SCALE IN FEET

FIGURE 5-1

059606/P

Brown & Root Environmental

01097062

CTO 0260

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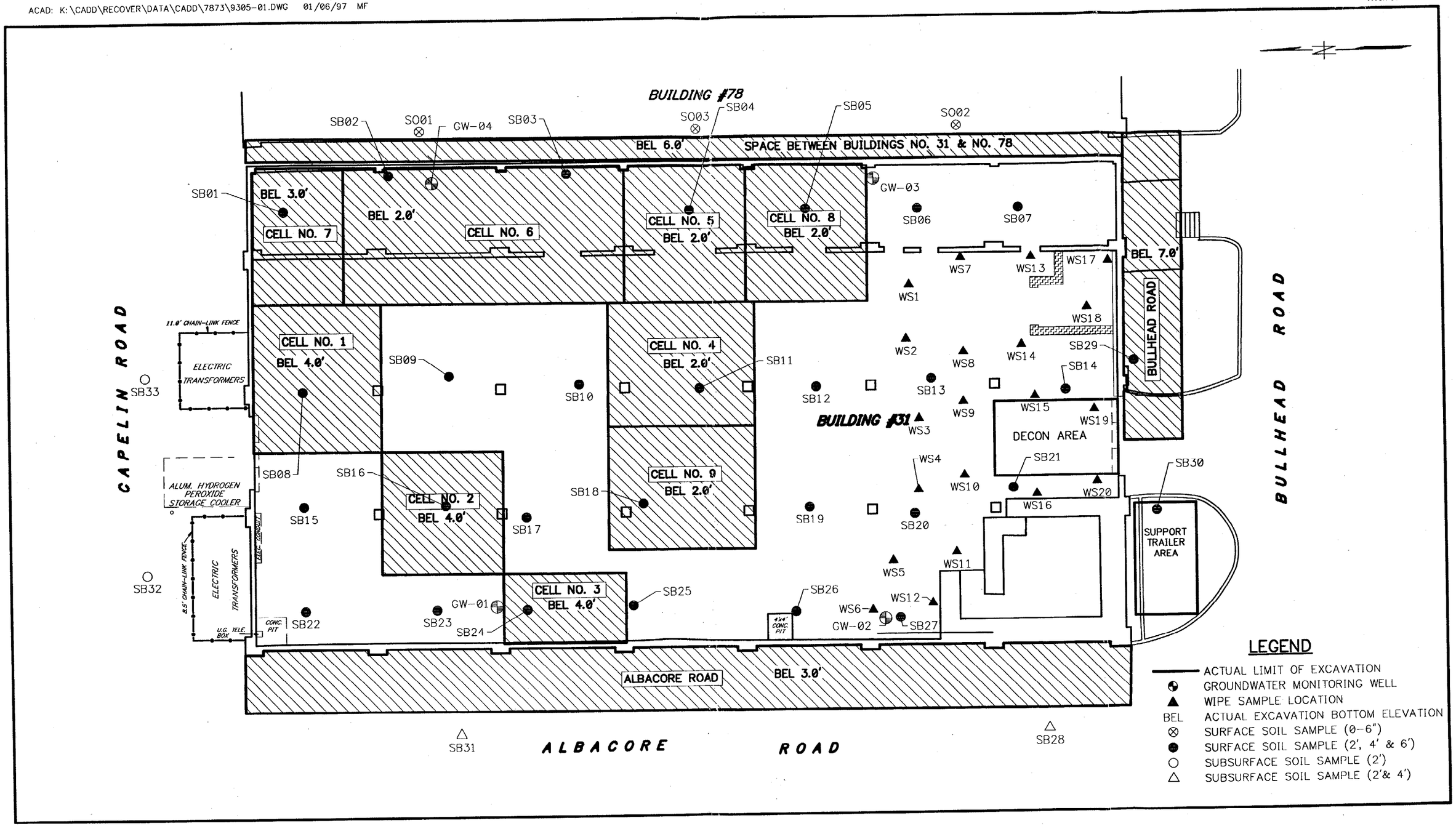

CONTAMINATED SOIL EXCAVATION PLAN
AND SAMPLING LOCATIONS
BUILDING 31 LEAD REMEDIATION
NSB-NLON, GROTON, CONNECTICUT

0 15 30
SCALE IN FEET

FIGURE 5-2

Brown & Root Environmental

CTO 0260

0109707Z

059606/P

6.0 ZONE 4

6.1 SITE DESCRIPTION

Zone 4 extends from the south side of Bullhead Road to the southern boundary of the Lower Subase. Figure 6-1 shows the sites included in Zone 4 and the limits of the zone. Sites within this zone include Site 13 - Building 79 Waste Oil Pit, Site 19 - Solvent Storage Area (Building 316) and the Quay Wall. Utility trenches and fuel distribution lines run through this zone. The gate valve (Building 332) to the tank farms is also located in this zone.

6.1.1 Site 13 - Building 79 Waste Oil Pit

Building 79 is located adjacent to one of the oil contamination areas identified in the Navy Environmental Support Office (NESO) and Wehran Engineers reports (NESO, 1979 and Wehran, 1987) (see Sections 6.2.1 and 6.2.3, respectively). This area features a railroad spur, and diesel train engines were serviced inside the building during World War II through the 1950's. The service area included a pit in the northwest corner of the building into which waste oil and solvents were reportedly drained during the cleaning and servicing of diesel engines. The pit is no longer in use and is filled with concrete. Available building maps show a subsurface drain pipe extending from the pit to Albacore Road.

6.1.2 Site 19 - Solvent Storage Area (Building 316)

Building 316 is located south of the gate valve building (Building 332). Various solvents used for equipment cleaning are stored in Building 316. No major spills have been reported for this building.

6.1.3 The Quay Wall

The Quay Wall study area runs from approximately Pier 2 to Pier 6. A wooden platform and quay wall were constructed in 1940. The wooden platform is 4 inches thick and supported by 10- to 12-inch-square wooden joists and 8-inch timber pilings. A steel bulkhead along the Thames River was erected in 1952 and constructed of steel sheet piling and supports. During construction of the bulkhead, the quay wall and wooden platform were covered with approximately 6 to 7 feet of sand and gravel fill, and the area was paved for vehicle access along Albacore Road. The quay wall is located approximately 4 feet east of the steel bulkhead immediately beneath the paved surface. Fill soil below the wooden platform and quay wall

may periodically wash out. Void spaces of 3 to 8 feet exist discontinuously beneath the wooden platform. Sand and gravel fill separate the void spaces, and can be replaced with sand poured into a series of manholes along the length of the Albacore Road. Natural river deposits of silt and sand underlie the void spaces and sand fill.

Zones of visible petroleum contamination were present in the soil immediately above the wooden platform and in the fill below the wooden platform. The petroleum was found in the area around the storm sewer manhole northeast of Pier 4. Globules of floating product were also present in the standing water in the void spaces below the wooden platform. Releases of petroleum products and oily substances were observed in the Thames River in the vicinity of the storm sewer outfall just north of Pier 4 in November, 1994. It was determined that the probable source of the releases was the storm sewer manhole near Pier 4 and Building 79. An expandable rubber plug was placed in the storm sewer outfall in November 1994, and the storm sewer pipe leading to the outfall was filled with sand in late December 1994. This measure appears to have remedied the problem, since no visible release of petroleum product has been observed in the Thames River to date.

6.1.4 Fuel Oil Distribution Lines and Utility Ducts

Fuel oil distribution lines and utility ducts and trenches run through Zone 4. Descriptions of the distribution lines and utility ducts and trenches are provided in Sections 1.2.4.3 and 1.2.4.4, respectively. The locations of these are shown in Figure 6-1.

6.2 SITE INVESTIGATIONS

The following investigations were conducted at Zone 4 and are discussed in the following subsections:

- Oil Contamination of Groundwater at Subase (NESO, 1979)
- Final Initial Assessment Study (Envirodyne, 1983)
- Final Site Investigation of Subsurface Oil Contamination (Wehran, 1987)
- Phase I Remedial Investigation (Atlantic, 1992)
- Quay Wall Removal Site Evaluation (HNUS, 1995c)
- Site Investigation Report for Tank Farm Investigation (B&R Environmental, 1996b)
- Phase II Remedial Investigation (B&R Environmental, 1996a)

6.2.1 Oil Contamination of Groundwater at Subase

In 1979, the NESO conducted a study to identify the source and extent of oil found in soils along the Thames River at three sites on the Lower Subase including Building 79 Waste Oil Pit (Site 13). NESO drilled a total of 12 soil borings and installed piezometers in each soil boring. Soil samples collected from each boring were analyzed for oil content. Groundwater samples were collected from each piezometer to check for the presence of oil and, where present, to measure product thickness.

Four borings/piezometers were installed during this study at Zone 4 (NESO9 through 12). Locations of these wells are shown in Figure 6-1. Oil and grease content in soils ranged from 500 ppm to 1,600 ppm. Oil content in groundwater ranged from 15 ppm (NESO10 and 11) to 982,000 ppm (NESO9). Oil thickness in NESO9 was reported to range from 10 inches to over 5 feet. Oil, identified as lubricating oil, was found in the vicinity of Building 79 (Site 13). The NESO report recommended the abandonment of the Building 79 waste oil pit and the installation of a recovery well system.

The Building 79 waste oil pit was eventually filled with concrete, and a recovery well system was installed sometime around 1985. It operated for a period of several months but was determined to be ineffective and later abandoned.

6.2.2 Final Initial Assessment Study

Envirodyne Engineers, Inc. performed an Initial Assessment Study (IAS) at NSB-NLON as part of the NACIP program. The purpose of this study was to identify and evaluate past waste disposal practices and to assess the potential for environmental impacts. Envirodyne reviewed installation records, interviewed long-term and former employees, toured the installation, and photographed sites as part of the IAS.

Envirodyne identified 11 sites at NSB-NLON as having contained hazardous material; one of which is located within Zone 4 (Site 13). The report recommended no further actions be pursued at Building 79 (Site 13) as the pit was no longer in use, had been filled with concrete and was closed to all drainage.

6.2.3 Final Site Investigation of Subsurface Oil Contamination

In 1987, Wehran Engineering Corporation completed an investigation to identify and delineate the sources of heavy oils in the subsurface of the Lower Subase (Sites 10, 11, and 13). Activities during the investigation included collecting soil samples from soil borings, oil samples from manholes and trenches,

and groundwater samples from monitoring wells. These samples were tested to identify the type, degree of weathering, and general concentrations of oil contamination at the three sites.

Four borings, converted to monitoring wells were installed in Zone 4 (WE1, 3, 4, and 5). Six oil samples were collected from manholes and trenches (MH-1, 2, 3, 4, T-1, and T-2). In addition, one existing well (NESO10) was also sampled. One of the manhole samples (MH-3) was also analyzed for PCBs. Wehran identified two areas located within Zone 4, that were contaminated with heavy oil. Oil contamination (determined to be No. 6 fuel oil weathered less than a year) was observed in the trench which runs along Argonaut Road from approximately Building 85 (Zone 4) to near the northeast corner of Building 78 (Zone 3). Manholes and the area underneath the supporting platform in the vicinity of Building 79 (Site 13) contained No. 6 fuel oil older than 1 year and trace levels of waste oil. PCBs were not detected.

Wehran recommended removal of the oil from the manholes near Building 79 by using absorption pads and/or excavation of oil-laden soil and inspection of fuel lines within the trench and subsequent cleaning of the trench.

6.2.4 Phase I Remedial Investigation

An investigation of 11 sites was completed at NSB-NLON by Atlantic Environmental Services, Inc. One site, identified as the Lower Subase - Site 13, included the area represented by Zones 1 through 4.

The Lower Subase Phase I field investigation consisted of a utility manhole inspection and waterfront bulkhead inspection for evidence of contamination sources. Also included were a soil gas survey, test boring completion, monitoring well installation, and soil and groundwater sampling.

During the utility manhole inspection, manhole covers were removed and inspected for visual evidence of oil. Four areas of significant petroleum accumulation were observed during the manhole inspection. Two of these areas are located within Zone 4. Thick black oil was identified in an area west of Building 80, on the boundary of Zones 3 and 4. The accumulation appeared to be from product release. There was no evidence of ongoing releases. In the other area, a brown milky oil was identified west of Building 79. The report indicated this oil possibly originated from the former waste pit in Building 79. An old drawing shows the outlet from the waste oil pit, 29 feet south of the northside of Building 79.

The waterfront inspection was conducted by boat during low tide. Seeps or sheens have historically been observed at the waterfront near Pier 4; however, no oil seeps or sheens or evidence of such were observed anywhere along the waterfront at the Lower Subase during the inspection.

A shallow soil gas survey (depths of 12 to 18 inches) was conducted within Zones 1 through 4. The results for Zone 4 showed a large area of low concentrations of VOCs west of Buildings 79 and 80. This area was further characterized by subsurface investigations.

Four test borings (13TB1 through 4) and four borings converted to monitoring wells (13MW13 through 16) were installed within Zone 4 and are shown on Figure 6-1. The soils from the test borings were screened in the field for organic vapors and examined visually, but were not chemically analyzed. Soil and groundwater samples collected from the monitoring wells were analyzed for VOCs, inorganics, TPH, and fluorescence. Existing monitoring wells (NESO 10 and 11 and WE1, 4 and 5) were also sampled and analyzed during the Phase I RI.

Based on TPH and fluorescence, an area of subsurface soil west and adjacent to Building 79 contained a mixture of No. 6 fuel oil and waste oil. This mixture was also identified in groundwater; however, positive detections of TPH was only identified in one monitoring well (13MW16).

6.2.5 Quay Wall Removal Site Evaluation

Halliburton NUS prepared the Quay Wall Removal Site Evaluation to summarize removal actions performed in November and December 1994 to remedy petroleum product releases that occurred along the Quay Wall of the Lower Subase. Five monitoring/product wells were installed in five of six soil borings drilled along Albacore Road to remove residual petroleum from the void spaces located below the platform. Five subsurface soil samples were collected from five of the six borings. Four of the soil samples (QW-2, QW-3, QW-4 and QW-5) were analyzed for BTEX and TPH. The fifth soil sample (QW-1) was analyzed for TCL organics, TAL inorganics plus boron, TPH, and TCLP metals. Lead was identified as the only chemical of concern. Based on current and anticipated land use of the area, direct lead exposures to lead were not considered likely to occur except during construction activities. Therefore, the Removal Site Evaluation recommended that no further removal action be performed at that time, but that further site investigations need to focus on lead concentrations. It was estimated that no more than 800 gallons of petroleum were pumped from the void spaces.

6.2.6 Site Investigation Report for Tank Farm Investigation

B&R Environmental conducted an investigation in 1995 of the UST farm along Crystal Lake Road. The primary objectives of the investigation were to define the extent of soil and groundwater contamination from the UST farm, evaluate the impact of the UST farm on the stormwater discharge, and recommend

remedial alternatives, if needed. As part of the tank farm investigation, underground pipelines from the fuel loading dock (Pier 1), throughout a portion of the Lower Subase (Zones 1 through 4), and the gate valve (Building 332) to tanks within the tank farm were investigated. Soil samples were collected along the new and old diesel underground pipelines at approximately 100-foot intervals. The samples were analyzed for TPH. The No. 6 fuel oil lines were not included as part of the investigation as they are installed within concrete lined trenches, which would prevent or minimize any potential soil and groundwater impact form leaks. Six samples were collected within Zone 4 (GS-6L through GS-11L). Except for one sample located near the southwest corner of Building 105 (GS-9L), TPH concentrations were less than 50 mg/kg. The concentration near Building 105 was greater than 2500 mg/kg. This contamination was apparently from a leak along the pipeline.

The report recommended that additional integrity inspections be performed to determine the locations of the previous line leaks on both active and inactive product lines throughout the Lower Subase. In addition, a records review was recommended to identify previous leaks based on the results of line inspections and tightness tests.

6.2.7 Phase II Remedial Investigation

A Phase II RI at 13 sites at NSB-NLON was conducted by B&R Environmental. The Lower Subase was included in this investigation. Soil boring installation and soil and groundwater sampling at Zone 4 was included in the investigation. Seven soil samples were collected from five borings (13TB2A, 13TB3A, 13TB4A, 13TB6, WE4A) and were analyzed for lead, TPH, and TCLP metals. Groundwater samples were collected from 8 new and existing monitoring wells (13MW13 through 16, WE1 and 5, and NESO10 and 11) and analyzed for VOCs, SVOCs, metals (total and dissolved) and TPH. The data and results of the Phase II RI are discussed as part of the nature and extent and data evaluation discussions in Sections 6.4 and 6.5, respectively.

6.3 PHYSICAL CHARACTERISTICS

General physical characteristics of the Lower Subase are discussed in Section 1.3. Site-specific physical characteristics are discussed in the subsections following.

6.3.1 Topography and Surface Features

Zone 4 is primarily paved or covered with buildings. The Providence and Worcester Railroad runs along the eastern border of the zone and the Thames River forms the western border of the zone. The ground surface in Zone 4 slopes gently to the west toward the Thames River.

6.3.2 Surface Water Features

Zone 4 is located along the Thames River. No other significant surface water features are located within or adjacent to Zone 4 with the exception of local storm sewers. Catch basins and storm sewers in Zone 4 are shown on Figure 6-1. From the drawing it can be seen that four storm sewers from Zone 4 discharge into the Thames River.

6.3.3 Soil Characteristics, Geology, and Hydrogeology

The SCS soils map classifies the soil at Zone 4 as Urban Land. The USGS surficial geology map indicates that Zone 4 soil is artificial fill. Based on boring logs for borings installed during the Phase I and Phase II RIs, on the east side, Zone 4 consists of 10 to 15 feet of sand and gravel (fill material) underlain by 5 to 10 feet of sand and silt (natural deposits). On the east side of the site the sand and silt layer was not encounter; however, a thin layer of fine to medium sand (3 to 5 feet) underlain by fine sand (3 to 5 feet) was encounter within approximately 10 feet below ground surface. The sand was underlain by sand and gravel. The depth of the bottom layers are not known as borings were not installed to the bottom of these layers.

Bedrock in Zone 4 is mapped as Mamacoke Formation on USGS bedrock maps. This was not confirmed by soil borings.

The depth to groundwater is approximately 5 to 8 feet. The elevation ranged from 3 msl on the east side to less than 1 msl on the west side. Groundwater flows west toward the Thames River.

6.4 NATURE AND EXTENT

Soil and groundwater sampling was conducted at Zone 4 during the Phase I and Phase II RIs as well as other investigations as discussed in Section 6.2. The analytical results from these investigations are summarized below, as well as the results of the medium-specific COPC screening.

6.4.1 Soil

Tables 6-1 through 6-4 summarize the analytical results of the soil samples collected from Zone 4 and summarize the COPC screening results. The analytical data is grouped using sample depth and analytical method. Analytical data for shallow soils (sample depth of < 5 feet) are summarized in Table 6-1, while data for deep soils (sample depth of > 5 feet) are shown in Table 6-2. Analytical results from the TCLP performed on shallow and deep soils are shown in Tables 6-3 and 6-4, respectively.

Background concentrations of inorganics in soil, used below for comparison purposes, were taken from the *Background Concentrations of Inorganics in Soil Report* (Atlantic, 1995b).

Drawings 1 through 4 (back pocket) show the distribution of TPH and lead contamination in soil in all zones, including Zone 4, being investigated as part of the Lower Subase RI. Drawings 1 and 3 show TPH and lead isoconcentration contours, respectively, for shallow soils, whereas Drawings 2 and 4 show the same respective contours for deep soils.

Shallow

Shallow soil samples (0 to 5 feet below ground surface) at Zone 4 were only analyzed for lead and/or TPH. Seven samples were analyzed for lead and six were analyzed for TPH. Lead concentrations were detected above background (17.5 mg/kg) in all shallow soil samples at concentrations ranging from 280 mg/kg (13TB4A) to 10,600 mg/kg (WE4A). Lead concentrations exceeded screening levels at all locations sampled except 13TB4A.

Drawing 3 shows the distribution of lead in shallow soils of Zone 4. The contours show that there are significant levels of lead (i.e., in excess of the CTDEP Industrial Remediation Standard) in shallow soils in the north west corner of Zone 4 near Buildings 79 and 80. The lead contamination may be from the Waste Oil Pit at Building 79 or Building 31 in Zone 3.

Lead concentrations measured in sediment samples taken from the Thames River are also provided on Drawing 3. The lead concentrations measured in the river sediments along Zone 4 are roughly 1 to 2 orders of magnitude less than the concentrations measured in shallow Zone 4 soil. The sediment concentrations adjacent to Zone 4 are generally the same to slightly above other levels detected in the Thames River. As discussed in Section 2, the levels of lead detected in these sediment samples pose a potential problem to ecological receptors (i.e., exceeds background and ecological benchmark value).

TCLP results for shallow soils indicate that lead is the only COPC (See Table 6-3). Lead is a COPC when concentrations are compared to the CTDEP Pollutant Mobility Standard for GB classified groundwater and the Federal toxicity characteristic regulatory level. The maximum TCLP leachate concentration (150,000 μg/L) was measured in the soil sample collected from 13TB4A.

TPH concentrations in shallow soils ranged from 31.8 mg/kg to 3,440 mg/kg. Only TPH concentrations detected at 13TB4A and WE4A exceeded the Federal and state residential screening levels, while only the concentration detected at 13TB4A exceeded the state's industrial or pollutant mobility criteria. This test boring is located west of Building 80 and north of the utility trench shown on Drawing 1. The drawing also shows isoconcentration contours of TPH. From the information provided on the drawing, it appears that the TPH contamination is the result of either activities at Buildings 79 or 80 or from leaking fuel lines. No samples were collected from the southern part of Zone 4 to evaluate the distribution of TPH.

Deep

Nineteen deep soil samples were collected in Zone 4. Seven to eleven of the samples were analyzed for VOCs, one sample was analyzed for SVOCs and pesticide/PCBs, seven to nine of the samples were analyzed for inorganics and nineteen of the samples were analyzed for TPH. Of the twenty metals detected in deep soils (greater than 5 feet below ground surface) at Zone 4, arsenic, cadmium, calcium, chromium, copper, lead, magnesium, manganese, nickel, potassium, selenium, sodium, vanadium, and zinc concentrations exceeded NSB-NLON background levels (3.6 mg/kg, 0.24 mg/kg, 499 mg/kg, 21.5 mg/kg, 25.6 mg,/kg, 17.5 mg/kg, 3,650 mg/kg, 188 mg/kg, 5.95 mg/kg, 2,580 mg/kg, 0.445 mg/kg, 20.5 mg/kg, 35.1 mg/kg, and 31.3 mg/kg, respectively). Cadmium, calcium, lead, nickel, sodium, and zinc concentrations were above background in all or most of the locations sampled. Only maximum concentrations of arsenic, chromium, copper, manganese, selenium, and vanadium exceeded background; other concentrations were less than background. Most of the maximum concentrations were detected at 13MW16. Concentrations of metals detected at Zone 4 were similar to, although generally greater than, concentrations detected within the Lower Subase. Aluminum, antimony, arsenic, beryllium, cadmium, iron, lead, manganese, nickel, and selenium were identified as COPCs in deep soil because their concentrations exceeded one or more screening levels. It should be noted that antimony and beryllium were detected infrequently (i.e., two or less times out of seven samples that were analyzed) and their detected concentrations were near detection limits.

Drawing 4 shows isoconcentration contours of lead concentrations measured in Zone 4 deep soils. High levels of lead are evident along Albacore Road at 13TB3A and QW-1. The maximum lead concentration measured in the deep soil (1,990 mg/kg) is roughly 5 times less than the maximum concentration

measured in the shallow soils (10,600 mg/kg). By comparing Drawings 3 and 4, it can be seen that the lead contamination in deep soil is less pervasive than in shallow soil. This information may indicate one of the following: that there is a shallow source of contamination; that there are multiple sources of contamination; or that the lead contamination found only in deep soils to the west of Buildings 79 and 80 is more mobile. Lead contamination may be a result of activities at Building 79 (former location of pit) or from activities at Building 31 in Zone 3. Other metals contamination, particularly at 13MW16, is likely the result of activities at Building 79.

Lead concentrations measured in sediment samples taken from the Thames River are also provided on Drawing 4. The lead concentrations measured in the river sediments along Zone 4 are approximately 1 order of magnitude less than the maximum concentration measured in deep Zone 4 soil. As discussed above, the sediment concentrations adjacent to Zone 4 are generally the same to slightly above other levels detected in the Thames River and the levels of lead pose a potential problem to ecological receptors.

TCLP results for deep soils indicate that lead is also the only COPC (See Table 6-4). As was the case for shallow soils, lead is a COPC when concentrations are compared to the CTDEP Pollutant Mobility Standard for GB classified groundwater and the Federal toxicity characteristic regulatory level. The maximum TCLP leachate concentration for deep soil was from soil collected from the same boring (13TB3A) from which the maximum TCLP leachate concentration for shallow soil was detected. However, the maximum TCLP leachate concentration from deep soil (21,300 μg/L) was approximately 7 times less than the TCLP leachate concentration from shallow soil (150,000 μg/L).

A variety of VOCs were detected in deep soil samples, although the maximum detected concentration was only 0.0203 mg/kg (xylene). One or more BTEX compounds were detected in soil from the borings of Wells QW1, QW2, QW3, QW4, and 13MW16. Halogenated aliphatics (methylene chloride, tetrachloroethene, and trichloroethene) were detected in most of the seven samples in which they were analyzed for, at concentrations ranging from 0.001 mg/kg to 0.012 mg/kg. Only these halogenated aliphatic compounds were identified as COPCs in deep soil. The only criteria exceeded by the concentrations of these compounds is the USEPA Soil Screening Level for migration to groundwater. SVOCs, pesticides and PCBs were only analyzed for one sample (QW1). Twelve SVOCs (all PAHs) were detected at concentrations ranging from 0.039 mg/kg to 0.83 mg/kg. Benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene were the only SVOCs which exceeded screening criteria. Benzo(g,h,i)perylene was also retained as a SVOC COPC for Zone 4 by default because no criteria were available for screening. Only one pesticide (endrin) was detected in the sample from location QW-1;

however, this chemical was not identified as a COPC as the detected concentration was less than screening criteria.

TPH was detected in most of the deep samples. TPH concentrations in deep soils ranged from 15.3 mg/kg to 11,800 mg/kg. TPH concentrations detected along Albacore Road exceeded both residential and industrial soil screening levels as did the TPH concentration measured along the pipeline on Argonaut Road at Bluefish Road (GS-9L). Drawing 2 shows isoconcentration contours of TPH measured in deep soil. As discussed above, high levels of TPH are evident in Zone 4 along Albacore Road and Argonaut Road. TPH concentrations detected in deep soil are generally the same magnitude or higher than those detected in shallow soil. By comparing Drawings 1 and 2, it is apparent that the contamination detected along Argonaut Road at GS-9L (sample depth of 8 feet) was not detected in the shallow soil at GS-10 (sample depth of 3 feet). This information indicates that the source of the contamination is a fuel line leak instead of a surface spill. The source of the other area of contamination within Zone 4, located along Albacore Road west of Building 79, is likely from the pit at Building 79. The area located on the boundary of Zones 3 and 4 is likely a result of pipeline leaks.

Based on the Phase I RI and the SI (Wehran, 1987) fluorescence analyses, soil samples were identified to contain a mixture of No. 6 fuel oil and waste oil. In addition, some evidence of oil was apparent in each of the five borings drilled near Building 79 during the Phase I RI except 13TB1. Two borings, 13TB2 and 13TB3, had heavier concentrations of oil present as indicated by the presence of oil globules.

6.4.2 Groundwater

Tables 6-5 and 6-6 summarize analytical results for groundwater samples collected in Zone 4 and summarize the COPC screening results. Analytical results from unfiltered samples are provided in Table 6-5 and the results for filtered samples are summarized in Table 6-6.

Drawings 5 through 7 (back pocket) show the distribution of TPH and lead contamination in groundwater for all zones, including Zone 4, being investigated as part of the Lower Subase RI. Drawing 5 shows isoconcentration contours of TPH concentrations measured in groundwater. Isoconcentration contours of filtered and unfiltered lead concentrations in groundwater are presented on Drawings 6 and 7.

Three rounds of groundwater samples were collected from 8 monitoring wells installed within Zone 4 (13MW13, 13MW14, 13MW15, 13MW16, NESO10, NESO11, WE1, and WE5) during the Phase I and Phase II RIs. One well, WE4, was only sampled during the Phase I RI. Unfiltered metals were analyzed during all three rounds, and filtered metals were analyzed during the two sampling rounds of the Phase II

RI. Sixteen inorganics were detected in unfiltered and filtered samples. Six inorganics (beryllium, cadmium, chromium, cobalt, mercury, and nickel) were only detected in unfiltered groundwater and one inorganic (antimony) was only detected in filtered groundwater. Concentrations between unfiltered and filtered samples were similar, although typically greater in the unfiltered samples. Concentrations of inorganics in groundwater at Zone 4 were generally similar to concentrations in other zones at the Lower Subase with the exception of lead which had the highest concentrations of any zone. Most of the metals detected in unfiltered groundwater (17 analytes of 22 analytes) exceeded one or more of the screening levels, while half of the metals detected in filtered groundwater (8 analytes of 16 analytes) exceeded one or more of the screening levels.

A majority of the maximum concentrations of metals in both unfiltered and filtered groundwater were detected in well NESO11 during Round 1 of the Phase II RI. These concentrations exceeded those detected elsewhere at the Lower Subase. The metals of note in this Round 1 sample include cadmium (13.2 μg/L), copper (649 μg/L), lead (2,760 μg/L), manganese (1,980 μg/L), nickel (80 μg/L), vanadium (105 μg/L) and zinc (924 μg/L). Similar concentrations were not found in the filtered Round 1 sample or the other samples collected from this well.

The distribution of lead in unfiltered and filtered groundwater samples is shown on Drawings 6 and 7, respectively. Two plumes of lead contamination are evident on Drawing 6 in Zone 4, at the northeast corner of Building 85 and along the west side of Building 80. The average concentration of lead at NESO11 (near Building 85) is significantly higher than the average concentration anywhere else in the Lower Subase. Lead concentrations measured in NESO11 over the three rounds of sampling at this well were 22.2 μg/L (Phase I), 2760 μg/L (Phase II - Round 1) and 11.4 μg/L (Phase II - Round 2). As discussed above, the results indicate that the average is skewed by the one high detection during Round 1 of the Phase II RI. In addition, the dissolved concentrations of lead in Zone 4, shown on Drawing 7, are much lower than the total concentrations shown on Drawing 6 and no distinct plumes are discernible.

Since Well NESO11 is an upgradient well, one of two conclusions can be reached. Either an upgradient source is indicated (Site 19, railroad tracks, diesel lines and condensate ducts upgradient of this well) or the sample contained suspended solids exhibiting metals contamination. Since the prior (for metals only) and subsequent results for this well are much lower, the second possibility is more likely.

Eight VOCs, *including halogenated aliphatics* (e.g., 1,1-dichloroethane) *and monocyclic aromatics* (e.g., BTEX compounds), were detected in Zone 4 groundwater samples. These compounds, however, were detected in only one to three samples per sampling event. With the exceptions of methylene chloride and

xylene (both detected at a maximum during Round 2 of the Phase II RI), maximum concentrations of all VOCs were detected during the Phase I RI. Concentrations detected in the Phase I RI samples ranged up to 57 µg/L (1,1-dichloroethene). Only three VOCs were detected during Round 1 of the Phase II RI and concentrations were 5 µg/l or less. Three of the VOCs (1,1-dichloroethene, methylene chloride, and vinyl chloride) detected in Zone 4 were identified as COPCs.

Fourteen SVOCs were detected in groundwater samples. Eight of the SVOCs were identified as COPCs. Benzo(g,h,i)perylene was identified as a COPC by default because no screening criteria was available. Most of the SVOCs were only detected in the sample from well NESO11 collected during Round 1 of the Phase II RI. Ten PAHs were only detected in well NESO11 at concentrations ranging from 0.6 µg/L to 2 µg/L during Round 1 of the Phase II RI. BEHP (10 µg/L) was also detected in this well during Round 1. SVOCs were not detected in NESO11 during Round 2 of the Phase II RI. Concentrations of PAHs in wells 13MW16 and 13MW15 and BEHP in well WE1 ranged from 0.6 µg/L to 1 µg/L.

TPH was detected in samples from well 13MW16 (at a maximum concentration of 5,400 µg/L). TPH was also detected in one sample from well WE1 during the Phase II RI-Round 2 (500 µg/L). Average TPH concentrations were contoured and are shown on Drawing 5. Small plumes are discernible around wells 13MW16 and WE1. Averages of one-half of the detection limits are shown on Drawing 5 for wells with no detections. All of these average detection limits are at or above the state's TPH remediation criteria of 500 µg/L. This information suggests that there is a high level of uncertainty in the TPH results for Zone 4.

Wells 13MW14 and 13MW15 contained mixtures of waste oil and heavy residual fuel oil (i.e., No. 6 fuel oil) as indicated by fluorescence spectroscopy. The spectra for the sample from well 13MW16 was typical of some type of heavy residual fuel oil. Trace petroleum hydrocarbons were found in wells NESO10 and NESO11, but concentrations were too low to identify the type of oil. Spectra for samples from wells 13MW13, WE1, WE4, and WE5 did not indicate the presence of oils.

6.5 DATA EVALUATION

Data were evaluated based on contaminant fate and transport, human health and ecological risk assessments, and comparison with state standards in the Phase II RI. These are summarized in this section. In addition, an evaluation of Zone 4 using the decision tree provided in Figure 1-3 is also included in this section.

6.5.1 Contaminant Fate and Transport

Metals are not typically considered to be mobile contaminants in the environment. Lead and other metals do not degrade via any of the identified fate processes (e.g., hydrolysis, photolysis, etc.) although under acidic soil conditions, metals may be solubilized and transported vertically with infiltrating precipitation. The presence of these analytes at depth may reflect the nature of the fill material used to construct the Lower Base, as well as some potential vertical transport associated with industrial activities occurring on the surface. In addition, the presence of lead at the site may be the result of, until the 1950s, all submarines depended on lead batteries for principal means of underwater propulsion. Four storm sewers from Zone 4 outlet into the Thames River and could act as preferential contaminant migration pathways for Zone 4 contaminants.

Groundwater contamination, particularly TPH and SVOCs, is evident in Zone 4. Petroleum contaminants in soil have apparently migrated to groundwater. Inconclusive results are available for metals contamination in groundwater.

6.5.2 Baseline Human Health Risk Assessment

The baseline human health risk assessment for the Lower Subase conducted during the Phase II RI focused on two potential receptor groups: construction workers and future residents. Two variations of exposure were considered for each receptor, in accordance with USEPA Region I guidance; CTE and RME. Noncarcinogenic risks (Hazard Indices) for all receptors were less than unity. Carcinogenic risks (incremental cancer risks) for all receptors were below $1x10^{-6}$ or within the USEPA's acceptable target risk range of $1x10^{-6}$ to $1x10^{-4}$.

The USEPA IEUBK Model was used to evaluate exposure to lead for Zones 2 and 3; however, exposure to lead in soil at Zone 4 was only addressed qualitatively. The highest reported concentration of lead in soil at this zone (10,600 mg/kg in sample WE4A) exceeded 400 mg/kg (OSWER soil screening criteria for residential land use) and exceeded maximum lead concentrations in Zones 2 and 3 by as much as one order of magnitude. While estimated blood lead levels for children in a residential setting for Zones 2 and 3 (3.2 µg/dL to 8.4 µg/dL) were below the established level of "concern" (10 µg/dL), based on this qualitative comparison, it is expected that blood lead levels for Zone 4 would be greater than Zones 2 and 3. Therefore, based on the significant detection of lead at Zone 4, blood lead levels would be greater than 10 µg/dL, indicating that adverse effects for children and other potential receptors in a residential setting are possible. The USEPA IEUBK Model was not used to evaluate groundwater since it is not used as a potable water supply.

6.5.3 Ecological Risk Assessment

The only potential ecological habitat near the Lower Subase is the Thames River. PAHs and metals are the primary chemicals of concern in the Thames River (see Section 2.0). Metals and TPH were detected in Zone 4 soils; however, SVOC data for soils are limited. PAHs are common constituents of petroleum products. Chemical detected at Zone 4 may be impacting the Thames River. Note that the ecological risk assessment, discussed in Section 2.5.3, concluded that the Lower Subase represented a minimal potential risk to ecological receptors.

6.5.4 Comparison of Site Data to Connecticut Standards

Analytical data for the Lower Subase were compared to Connecticut drinking water standards and remediation standards. Site-specific soil data were compared to remediation standards for direct exposure and pollutant mobility. Direct exposure criteria for residential exposure were used to conservatively evaluate potential exposure to soil at the site. Soil concentrations, both shallow and deep, of TPH and lead exceeded both residential and industrial direct exposure criteria in Zone 4.

To address concerns regarding migration of chemicals from soil to groundwater, site soil data were compared to Connecticut remediation standards for pollutant mobility. TPH and lead in both shallow and deep soils were reported at maximum concentrations exceeding the GB pollutant mobility criteria.

Analytical groundwater data for Zone 4 were also compared to state standards. The following chemicals were detected in the unfiltered groundwater samples in Zone 4 at maxima exceeding the Connecticut MCLs: 1,1-dichloroethene, methylene chloride, vinyl chloride, benzo(a)pyrene, BEHP, cadmium, chromium, and thallium. Exceedances of MCLs were noted for antimony and thallium in the Zone 4 filtered groundwater samples. Sodium was also detected in unfiltered and filtered groundwater samples at maximum concentrations exceeding the state Notification Level of 28 mg/L.

For Zone 4, maximum groundwater concentrations exceeded the Connecticut remediation standards for groundwater protection for 1,1-dichloroethene, methylene chloride, vinyl chloride, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, BEHP, antimony (filtered), cadmium (unfiltered), chromium (unfiltered), lead (unfiltered), thallium (filtered and unfiltered), vanadium (unfiltered), and TPH. Those chemicals found in Zone 4 at maxima exceeding the surface water protection criteria are benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, phenanthrene,

arsenic (filtered and unfiltered), cadmium (unfiltered), copper (unfiltered), lead (filtered and unfiltered), mercury unfiltered), and zinc (unfiltered).

6.5.5 Decision Tree

The general decision tree for the evaluation of sites is provided in Figure 1-3. The evaluation of data using this decision tree for Zone 3 is as follows:

- Existing data have been collected and evaluated. Information describing the site, previous investigations, and physical characteristics of the site are provided in Sections 6.1, 6.2, and 6.3, respectively. The nature and extent of contamination is provided in Section 6.4.

- Based on the existing data an imminent threat to the environment was identified for Zone 4. No significant human health risks were noted. A removal site evaluation was conducted for the Quay Wall and no imminent threat currently exists.

- Contaminant fate and transport have been described, baseline human health and ecological risk assessments have been conducted and data have been compared to CTDEP Standards.

- Although contamination in Zone 4 has not been fully characterized, particularly because of the lack of SVOC data for soils, available information indicates that the source of contamination is from prior activities at the Subase and that significant risks do not exist for human health and the environment.

- Hot spot areas (TPH concentrations greater than 2500 mg/kg and lead concentrations greater than 500 mg/kg) exist by Argonaut Road and Bullhead Road, along Albacore Road, and Bluefish Road and Argonaut Road (see Drawings 1 through 4).

- Further action is required for Zone 4 and is discussed in Section 6.6.

6.6 RECOMMENDATION

The Phase II RI provides recommendations for Zone 4. Further characterization focusing on sampling and analysis to evaluate the nature and extent of lead, TPH, and semivolatile organic compounds in soil were recommended. Continued groundwater sampling and analyses is also required to monitor contamination levels. This recommendation is supported by the following information:

- Relatively high concentrations of lead in soil are present at Zone 4 in the vicinity of Site 13 and the Quay Wall. Concentrations of lead were as high as 10,600 mg/kg in Zone 4.

- High concentrations of TPH in soil are also present at Zone 4 (maximum concentration 11,800 mg/kg).

- SVOCs have not been analyzed in soil during the Phase I and II RI activities. Monitoring of these compounds are needed to evaluate risks associated with these contaminants. It is highly probable that SVOCs will be detected at significant levels in soil, based on the presence of TPH. SVOCs are common components of TPH, and the concentrations of these compounds are unknown.

- Petroleum products and oily substances have historically migrated into the Thames River. As discussed Section 17, the Thames River sediment and shellfish community may be impacted in the vicinity of the Lower Subase.

Additional sampling and analysis is necessary to determine the nature and extent of lead in soils; to monitor lead levels in groundwater; to confirm by the SPLP method whether lead detected in shallow and deep soils is truly mobile, as indicated by the existing TCLP results; to quantify the amount of lead entering the Thames River; and to evaluate the cumulative ecological impacts.

It is further recommended that in conjunction with sampling at Zone 4, integrity inspections on the active and inactive fuel lines located in Zone 4 (and throughout the Lower Subase) be conducted to determine previous line leaks. In addition, a review of records to identify previous leaks based on the results of inspections and tightness tests is recommended. The integrity inspections and review of data are important to identify sources of petroleum contamination.

With the exception of samples along the fuel pipeline by Building 316 (GS-6L, 7L and 8L), sampling has not been conducted in the southeastern corner of Zone 4. A review of records and background information on Building 316 is recommended and limited sampling to identify whether contaminated soils and/or groundwater have resulted from activities at Building 316 is also recommended.

Because contaminants associated with the Lower Subase have been detected in the sediments in the Thames River, sampling of the sediments and surface water is recommended in conjunction with characterization activities to aid in the identification of source areas and contaminants of concern. Sampling of media from the Thames River is discussed in Section 2.6.

Based on the results of the additional sampling and analyses and the integrity inspection activities, source areas will be able to be defined and remedial activities for the source areas will be conducted as necessary. Remedial activities should focus on the removal of free product and highly contaminated areas (hot spots) which may act as sources of contamination to other media-receptors. However, because Zone 4 is located in an active, industrialized area which is vital to national security, petroleum contamination is widespread in the Lower Subase, and contamination presents minimal risks to human health and the environment (i.e., limited exposure pathways), remediation of all contaminated material at Zone 4 by excavation is not feasible or practical. Therefore, in-situ remedial options such as containment, air sparging, soil vapor extraction (SVE), natural attenuation or bioremediation will also be explored and used as applicable.

TABLE 6-1

COPC SCREENING FOR LOWER SUBASE
ZONE 4 - SHALLOW SOILS (<5 FEET)
NSB-NLON, GROTON, CONNECTICUT

Parameter	Frequency (1)	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	SSL Inhalation (3)	SSL Migration to Groundwater (3)	State Residential Direct Exposure (4)	State Industrial Direct Exposure (4)	State Pollutant Mobility (GB) (4)	Select as COPC? (5)
Metals (mg/kg)												
Lead	7/7	280 - 10600	-	4237	WE4A	400	-	-	500	1000	-	Y
Miscellaneous (mg/kg)												
TPH	6/6	31.8 - 3440	-	862	13TB4A	500	-	-	500	2500	2500	Y

- Not available or not applicable.

(1) Includes data from the following samples 13TB2A-0406, 13TB2A-0406-X, 13TB3A-2.5-4.5, 13TB3A-2.5-4.5D, 13TB4A-0002, 13TB4A-0002-X, 13WE4A-0002, and FPTB10L-03.

(2) Based on current USEPA Region III guidance (USEPA Region III, May 10, 1996). Residential Soil Ingestion for soil and sediment.

(3) USEPA Soil Screening Levels (USEPA, May 1996). For migration to groundwater, values associated with a dilution and attenuation factor (DAF) of 1.0.

(4) CTDEP, December 1995.

(5) Contaminant of Potential Concern; Yes (Y) indicates that the maximum concentration exceeds one or more of the criteria; No (N) indicates that the maximum does not exceed any of the criteria.

TABLE 6-2

COPC SCREENING FOR LOWER SUBASE
ZONE 4 - DEEP SOILS (>5 FEET)
NSB-NLON, GROTON, CONNECTICUT
PAGE 1 OF 2

Parameter	Frequency (1)	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	SSL Inhalation (3)	SSL Migration to Groundwater (3)	State Residential Direct Exposure (4)	State Industrial Direct Exposure (4)	State Pollutant Mobility (GB) (4)	Select as COPC? (5)
Volatile Organic Compounds (mg/kg)												
Benzene	1/11	0.0014	0.0012 - 0.013	0.003	QW-3	22	0.8	0.002	21	200	0.2	N
Carbon disulfide	1/7	0.005	0.006 - 0.013	0.004	13MW16	780	720	2	-	-	-	N
Ethylbenzene	3/11	0.0007 - 0.018	0.0012 - 0.013	0.004	QW-2	780	400	0.7	500	1000	10.1	N
Methylene chloride	6/7	0.001 - 0.012	0.013	0.005	13MW13	85	13	0.001	82	760	1	Y
Tetrachloroethene	5/7	0.003 - 0.008	0.006 - 0.013	0.005	13MW13	12	11	0.003	12	110	1	Y
Toluene	2/11	0.003 - 0.0032	0.0012 - 0.008	0.003	QW-3	1600	650	0.6	500	1000	67	N
Trichloroethene	6/7	0.002 - 0.005	0.013	0.004	13MW13	58	5	0.003	56	520	1	Y
Xylenes, Total	4/11	0.0006 - 0.0203	0.0012 - 0.013	0.006	QW-2	16000	-	-	500	1000	19.5	N
Semivolatile Organic Compounds (mg/kg)												
Anthracene	1/1	0.059	-	0.059	QW-1	2300	-	590	1000	2500	400	N
Benzo(a)anthracene	1/1	0.4	-	0.4	QW-1	0.88	-	0.08	1	7.8	1	Y
Benzo(a)pyrene	1/1	0.41	-	0.41	QW-1	0.088	-	0.4	1	1	1	Y
Benzo(b)fluoranthene	1/1	0.26	-	0.26	QW-1	0.88	-	0.2	1	7.8	1	Y
Benzo(g,h,i)perylene	1/1	0.29	-	0.29	QW-1	-	-	-	-	-	-	Y (6)
Benzo(k)fluoranthene	1/1	0.39	-	0.39	QW-1	8.8	-	2	8.4	78	1	N
Chrysene	1/1	0.43	-	0.43	QW-1	88	-	8	-	-	-	N
Fluoranthene	1/1	0.62	-	0.62	QW-1	310	-	210	1000	2500	56	N
Indeno(1,2,3-cd)pyrene	1/1	0.29	-	0.29	QW-1	0.88	-	0.7	-	-	-	N
Naphthalene	1/1	0.039	-	0.039	QW-1	310	-	4	1000	2500	56	N
Phenanthrene	1/1	0.19	-	0.19	QW-1	-	-	-	1000	2500	40	N
Pyrene	1/1	0.83	-	0.83	QW-1	230	-	210	1000	2500	40	N
Pesticides/PCBs (mg/kg)												
Endrin	1/1	0.0067	-	0.007	QW-1	2.3	-	0.05	20	610	-	N
Metals (mg/kg)												
Aluminum	7/7	4060 - 10600	-	6324	13MW16	7800	-	-	-	-	-	Y
Antimony	1/7	1.3	2.3 - 3.4	1.3	QW-1	3.1	-	0.3	27	8200	-	Y
Arsenic	5/7	0.77 - 4	0.71 - 0.72	1.7	13MW16	0.43	750	1	10	10	-	Y
Barium	7/7	22.2 - 48.3	-	31.6	13MW13	550	690000	82	4700	140000	-	N

TABLE 6-2

COPC SCREENING FOR LOWER SUBASE
ZONE 4 - DEEP SOILS (>5 FEET)
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 2

Parameter	Frequency (1)	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	SSL Inhalation (3)	SSL Migration to Groundwater (3)	State Residential Direct Exposure (4)	State Industrial Direct Exposure (4)	State Pollutant Mobility (GB) (4)	Select as COPC? (5)
Beryllium	2/7	0.15 - 0.34	0.23 - 0.24	0.15	13MW16	0.15	1300	3	2	2	-	Y
Cadmium	7/7	0.11 - 2.5	-	1.2	13MW16	3.9	1800	0.4	34	1000	-	Y
Calcium	7/7	603 - 2710	-	1042	13MW16	-	-	-	-	-	-	N (7)
Chromium	7/7	7.8 - 27.8	-	16.7	13MW16	39	270	-	3900/100 (8)	5.1E+4/100 (8)	-	N
Cobalt	7/7	2.8 - 6.7	-	4.2	13MW16	470	-	-	-	-	-	N
Copper	7/7	9.7 - 32.5	-	18.3	13MW14	310	-	-	2500	76000	-	N
Iron	7/7	5880 - 16900	-	9564	13MW16	2300	-	-	-	-	-	Y
Lead	9/9	25.2 - 1990	-	428	13TB3A	400	-	-	500	1000	-	Y
Magnesium	7/7	1870 - 5510	-	3184	13MW16	-	-	-	-	-	-	N (7)
Manganese	7/7	100 - 191	-	140	13MW16	39	-	-	-	-	-	Y
Nickel	7/7	5.8 - 16.3	-	9.6	13MW16	160	13000	7	1400	7500	-	Y
Potassium	7/7	1280 - 2780	-	1950	13MW16	-	-	-	-	-	-	N (7)
Selenium	2/7	0.28 - 1	0.23 - 0.56	0.29	13MW16	39	-	0.3	340	10000	-	Y
Sodium	7/7	124 - 5890	-	1222	13MW16	-	-	-	-	-	-	N (7)
Vanadium	7/7	9.6 - 35.9	-	17.1	13MW16	55	-	300	470	14000	-	N
Zinc	7/7	28.1 - 62.4	-	42.5	13MW13	2300	-	620	20000	610000	-	N
Miscellaneous (mg/kg)												
TPH	17/19	15.3 - 11800	10.4 - 13.1	1800	13TB2A	500	-	-	500	2500	2500	Y

- Not available or not applicable.

(1) Includes data from the following samples 13MW15(12-14), 13MW16(10-12), 13MW13(8-10), 13MW23(8-10), 13MW14(12-14), 13MW24(12-14), 13TB2A-0608, 13TB3A-0608-X, 13TB6-0507, FPTB06L-07, FPTB07L-08, FPTB08L-07, FPTB09L-08, DUP-16-111695, FPTB11L-07, QW-2, QW-3, QW-4, and QW-5.

(2) Based on current USEPA Region III guidance (USEPA Region III, May 10, 1996). Residential Soil Ingestion for soil and sediment.

(3) USEPA Soil Screening Levels (USEPA, May 1996). For migration to groundwater, values associated with a dilution and attenuation factor (DAF) of 1.0.

(4) CTDEP, December 1995.

(5) Contaminant of Potential Concern; Yes (Y) indicates that the maximum concentration exceeds one or more of the criteria; No (N) indicates that the maximum does not exceed any of the criteria.

(6) Criteria not available.

(7) Essential nutrient. Not evaluated for COPC selection.

(8) Trivalent chromium/hexavalent chromium.

TABLE 6-3

COPC SCREENING FOR LOWER SUBASE
ZONE 4 - TCLP SHALLOW SOILS (<5 FEET)
NSB-NLON, GROTON, CONNECTICUT

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	State Pollutant Mobility (GB) (2)	Federal Pollutant Mobility (3)	Select as COPC? (4)
Metals (ug/L)								
Arsenic	3/6	30.9 - 37.5	3 - 26	21.9	13TB3A	500	5000	N
Barium	6/6	125 - 408	-	270	13TB3A	10000	100000	N
Cadmium	3/6	2.2 - 10.6	2	3.03	13TB4A	50	-	N
Chromium	4/6	8.1 - 11.2	3	6.6	13TB2A	500	5000	N
Lead	5/6	909 - 150000	14	75803	13TB3A	150	5000	Y

- Not available or not applicable.

(1) Includes data from the following samples: 13TB2A-0406, 13TB3A-2.5-4.5, 13TB3A-2.5-4.5D, 13TB4A-0002, 13WB4A-0002, and QW-1.

(2) CTDEP Pollutant Mobility Remediation Standard for GB classified groundwater; CTDEP, December 1995.

(3) Federal Toxicity Characteristic Regulatory Level (58 FR 46049).

(4) Contaminant of Potential Concern; Yes (Y) indicates that the maximum concentration exceeds one or more of the criteria; No (N) indicates that the maximum does not exceed any of the criteria.

TABLE 6-4

COPC SCREENING FOR LOWER SUBASE
ZONE 4 - TCLP DEEP SOILS (>5 FEET)
NSB-NLON, GROTON, CONNECTICUT

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	State Pollutant Mobility (GB) (2)	Federal Pollutant Mobility (3)	Select as COPC? (4)
Metals (ug/L)								
Cadmium	1/8	2.2	2 - 5	2.28	13TB3A	50	1000	N
Lead	5/8	430 - 21300	57.8 - 300	3,867	13TB3A	150	5000	Y
Selenium	1/8	45.3	24 - 300	120	13TB3A	500	1000	N

- Not available or Not applicable.

(1) Includes data from the following samples: 13MW13-8-10, 13MW23-8-10, 13MW14-12-14, 13MW24-12-14, 13MW15-12-14, 13MW16-10-12, 13TB3A-0608, and 13TB6-0507.

(2) CTDEP Pollutant Mobility Remediation Standard for GB classified groundwater; CTDEP, December 1995.

(3) Federal Toxicity Characteristic Regulatory Level (58 FR 46049).

(4) Contaminant of Potential Concern; Yes (Y) indicates that the maximum concentration exceeds one or more of the criteria; No (N) indicates that the maximum does not exceed any of the criteria.

TABLE 6-5

COPC SCREENING FOR LOWER SUBASE
ZONE 4 - UNFILTERED GROUNDWATER
NSB-NLON, GROTON, CONNECTICUT
PAGE 1 OF 2

Parameter	Frequency (1)	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	Federal MCL (3)	State MCL (4)	State Remediation Standards (5)		Select as COPC? (6)
									Groundwater Protection	Surface Water Protection	
Volatile Organic Compounds (ug/L)											
1,1,1-Trichloroethane	1/26	1	5 - 10	4	NESO11	130	200	200	200	62000	N
1,1-Dichloroethane	7/26	1 - 15	5 - 10	4	13MW13	81	-	-	70	-	N
1,1-Dichloroethene	4/26	4 - 57	5 - 10	7	13MW13	0.044	7	7	7	96	Y
Ethylbenzene	2/26	2 - 8	5 - 10	4	WE1	130	700	700	700	580000	N
Methylene chloride	1/26	9	5 - 11	4	WE5	4.1	5	5	5	48000	Y
Toluene	1/26	36	5 - 10	5	NESO10	75	1000	1000	1000	4000000	N
Vinyl chloride	2/26	5 - 12	10	5	13MW13	0.019	2	2	2	15750	Y
Xylenes, Total	3/26	5 - 27	5 - 10	5	WE1	1200	10000	10000	530	-	N
Semivolatile Organic Compounds (ug/L)											
Acenaphthene	2/16	0.8 - 1	10	5	13MW16	220	-	-	-	-	N
Benzo(a)anthracene	1/16	1	10	5	NESO11	0.092	-	-	0.06	0.3	Y
Benzo(a)pyrene	1/16	0.8	10	5	NESO11	0.0092	0.2	0.2	0.2	0.3	Y
Benzo(b)fluoranthene	1/16	0.6	10	5	NESO11	0.092	-	-	0.08	0.3	Y
Benzo(g,h,i)perylene	1/16	1	10	5	NESO11	-	-	-	-	-	Y (7)
Benzo(k)fluoranthene	1/16	1	10	5	NESO11	0.92	-	-	0.5	0.3	Y
Bis(2-ethylhexyl)phthalate	2/16	1 - 10	10	5	NESO11	4.8	6	6	2	59	Y
Chrysene	1/16	0.9	10	5	NESO11	9.2	-	-	-	-	N
Di-N-butyl phthalate	1/16	0.6	10	5	13MW16	370	-	-	700	-	N
Fluoranthene	1/16	2	10	5	NESO11	150	-	-	280	3700	N
Indeno(1,2,3-cd)pyrene	1/16	0.7	10	5	NESO11	0.092	-	-	-	-	Y
Naphthalene	2/16	0.6 - 0.8	10	5	13MW15	150	-	-	280	-	N
Phenanthrene	1/16	1	10	5	NESO11	-	-	-	200	0.077	Y
Pyrene	3/16	1 - 2	10	4	NESO11	110	-	-	200	110000	N
Metals (ug/L)											
Aluminum	5/26	18.2 - 40800	14 - 78.7	1597	NESO11	3700	50 TO 200 (8)	-	-	-	Y
Arsenic	14/26	1.3 - 29.6	2 - 20	7.1	WE5	0.045	50	50	50	4	Y
Barium	21/26	6 - 283	10.9 - 37.6	47	NESO11	260	2000	2000	1000	-	Y
Beryllium	2/26	1.1 - 2.6	1	0.6	NESO11	0.016	4	4	4	4	Y
Boron	16/16	80.8 - 2070	-	787	13MW15	330	-	-	-	-	Y
Cadmium	4/25	1.5 - 25.5	1 - 3	2.7	NESO10	1.8000	5	5	5	6	Y
Calcium	26/26	22400 - 181000	-	84258	13MW15	-	-	-	-	-	N (9)

TABLE 6-5

COPC SCREENING FOR LOWER SUBASE
ZONE 4 - UNFILTERED GROUNDWATER
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 2

Parameter	Frequency (1)	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	Federal MCL (3)	State MCL (4)	State Remediation Standards (5)		Select as COPC? (6)
									Groundwater Protection	Surface Water Protection	
Chromium	2/26	1.4 - 116	1 - 5	6.2	NESO11	18	100	100	50	1200	Y
Cobalt	1/26	25.6	1 - 5	2.91	NESO11	220	-	-	-	-	N
Copper	8/25	5 - 649	1 - 5	29	NESO11	150	1300	-	1300	48	Y
Iron	24/26	95.2 - 36700	16 - 40.6	5290	NESO11	1100	300	-	-	-	Y
Lead	13/22	1.6 - 2760	2 - 20	140	NESO11	15	15	-	15	13	Y
Magnesium	26/26	2530 - 776000	-	226375	13MW15	-	-	-	-	-	N (9)
Manganese	25/26	3.4 - 1980	11.9	255	NESO11	18	50	5000	-	-	Y
Mercury	1/26	0.47	0.2	0.11	NESO11	1.1000	2	2	2	0.4	Y
Nickel	12/26	11.6 - 80	3 - 12	12.8	NESO11	73	100	100	100	880	Y
Potassium	26/26	4490 - 259000	-	80918	13MW15	-	-	-	-	-	N (9)
Selenium	1/23	7.7	1 - 30	2.5	13MW14	18	50	50	50	50	N
Sodium	26/26	40800 - 6310000	-	1918723	13MW15	-	-	28000 (10)	-	-	Y
Thallium	4/17	3.6 - 11.5	1 - 10	4.8	13MW15	0.26	2	2	5	63	Y
Vanadium	3/26	4.6 - 105	1 - 20	9.1	NESO11	26	-	-	50	-	Y
Zinc	18/26	4.9 - 924	2 - 10	50	NESO11	1100	5000	-	5000	123	Y
Miscellaneous (ug/L)											
Hardness as CaCO3 (mg/l)	16/16	80 - 5900	-	1467	13MW15	-	-	-	-	-	N (11)
TPH	4/26	500 - 5400	500 - 3000	823	13MW16	500	-	-	500	-	Y

- Not available or not applicable.

(1) Includes data from the following samples: 13MW14S, 13MW13S, NESO11, NESOMW10S, 13MW15S, 13MW19S, WEMW1S, WEMW4S, 13MW16S, WEMW5S, 13GW13, 13GW13-2, 13GW14-2, 13GW15, 13GW15-2, 13GW16-2, 13GW14, 13GW16, NESO10-2, NESO11-2, NESO10, NESO11, WE-1, WE-5, WE1-2, and WE5-2.

(2) For residential tap water ingestion, based on current USEPA Region III guidance (USEPA Region III, May 10, 1996).

(3) Maximum Contaminant Level (USEPA, May 1995).

(4) Title 19, Health and Safety, the Public Health Code of the State of Connecticut, Chapter 11, Environmental Health.

(5) CTDEP, December, 1995.

(6) Contaminant of Potential Concern: A Yes (Y) indicates that the maximum contaminant concentration exceeds one or more of the criteria; A No (N) indicates that the maximum contaminant concentration does not exceed any of the criteria.

(7) Criteria not available.

(8) Secondary MCL, based on aesthetic drinking water qualities.

(9) Essential nutrient, not evaluated for COPC selection.

(10) Notification Level.

(11) Not appropriate for COPC screening.

TABLE 6-6

COPC SCREENING FOR LOWER SUBASE
ZONE 4 - FILTERED GROUNDWATER
NSB-NLON, GROTON, CONNECTICUT

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	Federal MCL (3)	State MCL (4)	State Remediation Standards (5)		Select as COPC? (6)
									Groundwater Protection	Surface Water Protection	
Metals (ug/L)											
Aluminum	1/16	11	10 - 37.6	8	13MW16	3700	50 TO 200 (7)	-	-	-	N
Antimony	2/16	8.1 - 14.8	12 - 22.3	7.9	13MW14	1.5000	6	6	6	86000	Y
Arsenic	5/16	2.3 - 11	1 - 20	5.5	NESO10	0.045	50	50	50	4	Y
Barium	13/16	6 - 139	9.6 - 39.1	44.9	NESO10	260	2000	2000	1000	-	N
Boron	16/16	78.8 - 2370	-	830	13MW15	330	-	-	-	-	Y
Calcium	16/16	24500 - 238000	-	100344	13MW15	-	-	-	-	-	N (8)
Copper	6/15	3.5 - 20.4	2 - 5	4.6	13MW16	150	1300	-	1300	48	N
Iron	13/16	56.2 - 8490	17.8 - 50	2441	WE5	1100	300	-	-	-	Y
Lead	4/15	2.5 - 14.1	1 - 20	5.8	NESO11	15	15	-	15	13	Y
Magnesium	16/16	2900 - 781000	-	233788	13MW16	-	-	-	-	-	N (8)
Manganese	15/16	6.1 - 611	10.9	172	WE5	18	50	5000	-	-	Y
Potassium	16/16	6950 - 263000	-	91723	13MW15	-	-	-	-	-	N (8)
Selenium	1/15	2.1	2 - 30	3.1	NESO10	18	50	50	50	50	N
Sodium	14/16	56200 - 6350000	142	1173353	13MW16	-	-	28000 (9)	-	-	Y
Thallium	1/15	6.8	1 - 20	4.6	WE5	0.26	2	2	5	63	Y
Vanadium	1/16	5.7	1 - 5	2.3	13MW16	26	-	-	50	-	N
Zinc	6/16	8.5 - 20.6	2 - 17.1	6.5	NESO10	1100	5000	-	5000	123	N

- Not available or not applicable.
(1) Includes data from the following samples: 13GW13, 13GW13-2, 13GW14-2, 13GW15, 13GW15-2, 13GW16-2, 13GW14, 13GW16 NESO10-2, NESO11-2, NESO10, NESO11, WE-1, WE-5, WE1-2, and WE5-2.
(2) For residential tap water ingestion, based on current USEPA Region III guidance (USEPA Region III, May 10, 1996).
(3) Maximum Contaminant Level (USEPA, May 1995).
(4) Title 19, Health and Safety, the Public Health Code of the State of Connecticut, Chapter 11, Environmental Health.
(5) CTDEP, December, 1995.
(6) Contaminant of Potential Concern: A Yes (Y) indicates that the maximum contaminant concentration exceeds one or more of the criteria; A No (N) indicates that the maximum contaminant concentration does not exceed any of the criteria.
(7) Secondary MCL, based on aesthetic drinking water qualities.
(8) Essential nutrient, not evaluated for COPC selection.
(9) Notification Level.

ACAD: K:\CADD\7237\7237PM04.DWG 01/03/97 MF

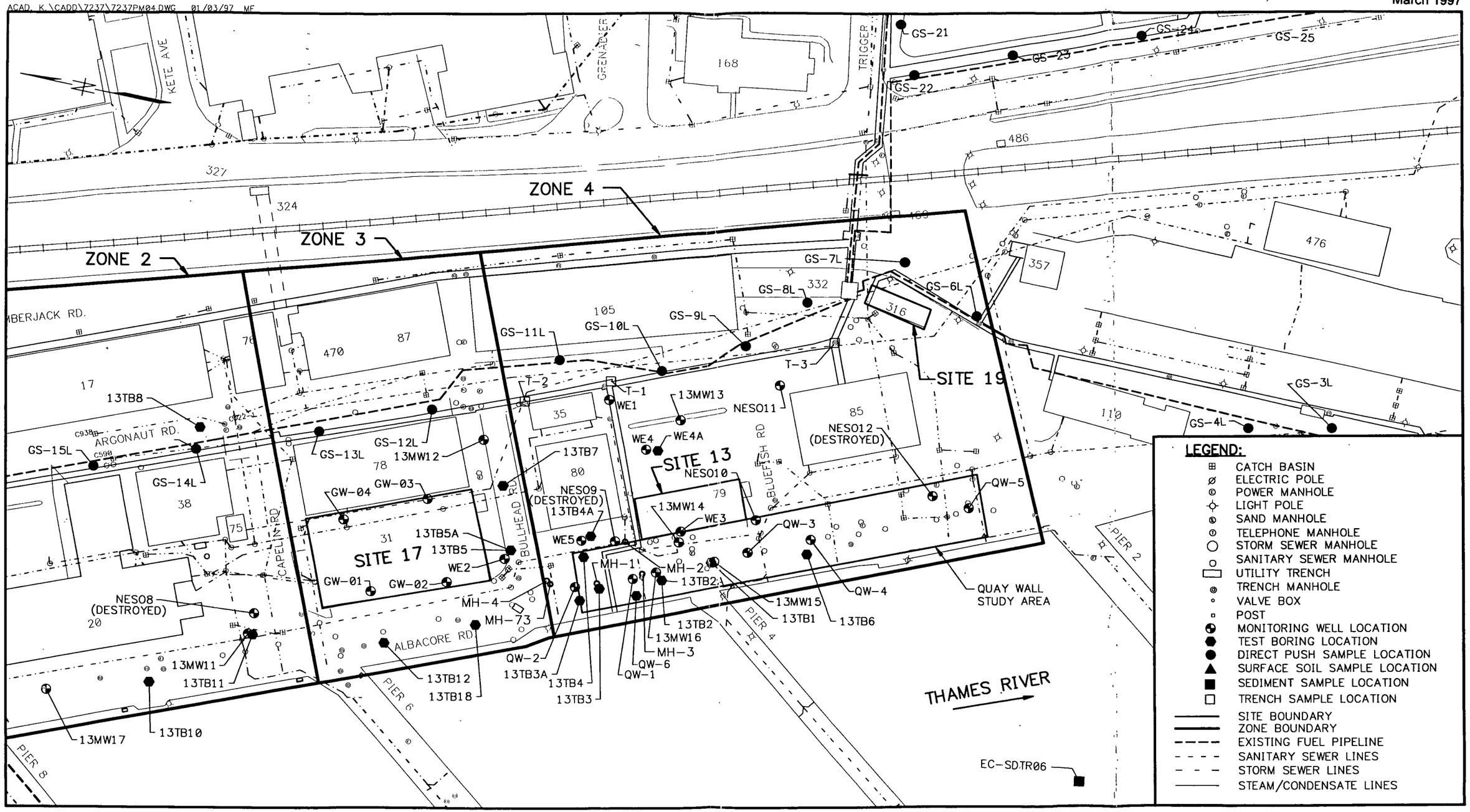

FIGURE 6-1

SAMPLE LOCATION MAP
ZONE 4
NSB-NLON, GROTON, CONNECTICUT

0 80 160
SCALE IN FEET

Brown & Root Environmental

059606/P

CTO 0260

7.0 ZONE 5

7.1 SITE DESCRIPTION

Zone 5 consists of Site 22 - Pier 33 and is located north of Zone 6 and south of the DRMO. Figure 7-1 shows the site included in Zone 5 and the limits of the zone. The Thames River lies to the west and a Penn Central Railroad to the east of Zone 5. Steam and condensate ducts and fuel oil distribution lines do not extend as far north in the Lower Subase as Zone 5.

7.1.1 Site 22 - Pier 33

Site 22 includes Pier 33, Building 175 and approximately 800 feet of additional property adjacent to these two structures. Building 175 is located northeast of Pier 33 and was originally used to house several above-ground battery acid (sulfuric acid) storage tanks. The building was completely filled with large above-ground storage tanks. Transfer lines from the battery acid storage tanks extended in trenches along Amberjack Road to the piers (not shown on Figure 7-1). These storage tanks and the associated transfer piping have been removed. There are no known or reported spills from the storage tanks or transfer system. Building 175 is currently used for miscellaneous storage and administrative purposes. Currently, no underground steam or fuel-oil utilities service Building 175.

A 1000-gallon, underground fuel storage tank was located adjacent to the southern side of Building 175. The age and type of the tank is unknown. Based on a tank test performed on May 22, 1990, no leakage was identified. Stained soil was observed around the fill pipe of the underground storage tank and concentrations of TPH detected in shallow and deep soil samples collected in the vicinity of the UST exceeded state and federal criteria (Atlantic, 1995). This information indicated that the UST was the source of the TPH contamination and this tank has since been excavated, removed and replaced by a new 1000-gallon UST. A 250-gallon, underground diesel-fuel storage tank is located adjacent to the northern side of Building 175. This tank services an emergency generator for the sewage lift station. The age and type of this tank are unknown.

7.2 SITE INVESTIGATIONS

Site 22 - Pier 33 has been investigated as part of the Pier 33 and Berth 16/Former Incinerator Site Investigation (SI) (Atlantic, 1995a). In addition, in 1989, subsurface soil samples were collected in the

vicinity of Building 175 as part of a geotechnical investigation for the replacement of the quay wall. This investigation was conducted by Morrison Geotechnical Engineering and is discussed as part of the SI Report. Sediment sampling in 1990 at Piers 33 and 32 was conducted as part of the investigation for the 18 month pre-acceptance trials of the Seawolf Class Submarine, SSN21. The discussion of this sampling is provided in Section 2.2.2 and the results are discussed as part of the nature and extent of contamination on the Thames River (Section 2.4.2).

7.2.1 Pier 33 and Berth 16/Former Incinerator SI

The SI summarizes information from the geotechnical investigation conducted by Morrison Geotechnical Engineering in 1989 for the replacement of the quay wall. During this investigation, No. 2 fuel oil was detected in subsurface soils in front of Building 175. Approximately 16 soil borings were installed during this investigation and are shown on Figure 7-1. One soil and one water sample was collected from a soil boring location (B-30) during this investigation. The samples were analyzed for metals, VOCs, TPH, oil type by fluorescence, pesticides, and PCBs. Several metals and TPH were detected in both samples. TPH was detected at 1,100 ppm in soil and 13 ppm in water and fluorescence analysis indicated that the hydrocarbons present were No. 2 fuel oil. Petroleum contamination was also evident based on odor and/or visual examination in borings B-21 and B-25.

Following discovery of petroleum hydrocarbon contamination in the soils at Site 22 - Pier 33, this site was added to the IR Program. Atlantic conducted an SI at the site to determine the presence or absence, as well as, the magnitude of specific contaminants, and to determine if the results warrant an RI/FS. The field investigation consisted of a soil-gas survey, a utility-manhole inspection, soil boring installation, monitoring well installation, and soil, groundwater, and sediment sampling and analysis. Four soil borings (19TB1 through 4) and three borings, converted to monitoring wells (19MW2 through 4), were installed within Zone 5. One soil boring (19MW1) was also installed east of Zone 5 at the golf course as an upgradient monitoring location. Atlantic collected 15 soil samples from the soil borings and one round of groundwater samples from the monitoring wells. In addition, Atlantic collected 1 surface soil sample (19SS1) from stained soil on the south side of Building 175 and two sediment samples (19SD1 and 19SD2) from storm sewer drains. Samples were analyzed for TCL organics and TAL inorganics. Some samples were also analyzed for TPH, TCLP metals, and oil identification by fluorescence. The locations of the borings, monitoring wells, and surface soil and sediment samples are shown in Figure 7-1.

Seven utility manholes were inspected as part of the SI. The utilities observed consisted of storm sewer, sanitary sewer, electric and telephone manholes. All accessible manholes in the study area were opened and inspected. Any visual evidence of oil contamination, such as an oil sheen on water, discolored

sediments, or any petroleum odors was noted. Only one manhole had a slight sheen on the water; however, as this station is a sanitary sewer, the sheen may not be a result of petroleum.

The results of the SI are further discussed under nature and extent and data evaluation provided in Sections 7.4 and 7.5, respectively.

7.3 PHYSICAL CHARACTERISTICS

The following sections summarize information provided in the SI Report (Atlantic, 1995a) on topography and surface water features, soil characteristics, geology, and hydrogeology.

7.3.1 Topography, Surface Features and Surface Water Features

The site is generally level and covered by either buildings or pavement. Surface elevations range from 20 msl on the east side of the site to 5 msl on the west side. The site is located directly adjacent to the Thames River. Pier 33 is located southwest of Building 175.

Storm sewers and sanitary sewers within Zone 5 are shown on Figure 7-1. Surface water runoff at the site drains into the river via several storm sewers. Surface drainage from areas east of Zone 5 (i.e., Stream 6 from the Area A Downstream Site) discharges to the Thames River via a box culvert midway between Buildings 175 and 176.

7.3.2 Soil Characteristics

According to SCS information, Zone 5 is mapped as Udorthents - Urban Land, 0 to 15 percent slope. This complex consists of excessively drained to moderately well drained soils that have been disturbed by cutting and filling, along with areas that are covered by buildings or pavement. About 60 percent of the complex is Udorthents, 25 percent Urban land, and 15 percent is other soils. Urban land consists mainly of areas of developed or disturbed land.

7.3.3 Geology and Hydrogeology

According to USGS surficial geology maps, the site is mapped as stratified drift shown as terrace deposits of the Thames River. USGS bedrock geology maps indicate bedrock at Zone 5 as Alaskite gneiss to the north and the Granite gneiss to the south. Bedrock is mapped as Pre-Pennsylvania age rock which consists of igneous intrusives that have been metamorphosed to granitic gneisses.

Geotechnical data collected at Zone 5 confirm the surficial geology and bedrock determinations of the USGS. Investigations indicate that the site is underlain by fill consisting of sand or sand and gravel. Fill extends to bedrock and ranges from 5 feet in the eastern portion of the site to 20 feet at the edge of the quay wall.

Groundwater is found in the overburden at a depth of approximately 4 feet below ground surface. The bedrock aquifer was not investigated at the site. Groundwater flow direction at the site was determined to be to the west toward the Thames River.

7.4 NATURE AND EXTENT

The discussion of nature and extent is based on the results of the geotechnical investigation conducted in 1989 and the SI Report (Atlantic, 1995a). The analytical results of this investigation as well as the results of the medium-specific COPC screening are summarized below.

7.4.1 Soil

Tables 7-1 through 7-4 summarize the analytical results of the soil samples collected from Zone 5 and summarize the COPC screening results. The analytical data is grouped using sample depth and analytical method. Analytical data for shallow soils (sample depth of < 4 feet) are summarized in Table 7-1, while data for deep samples (sample depth of > 4 feet) are shown in Table 7-2. Analytical results from the TCLP performed on shallow and deep soils are shown in Tables 7-3 and 7-4, respectively.

Background concentrations of inorganics in soil, used below for comparison purposes, were taken from the *Background Concentrations of Inorganics in Soil Report* (Atlantic, 1995b).

Drawings 1 through 4 (back pocket) show the distribution of TPH and lead contamination in soil in all zones, including Zone 5, being investigated as part of the Lower Subase RI. Drawings 1 and 3 show TPH and lead isoconcentration contours, respectively, for shallow soils, whereas Drawings 2 and 4 show the same respective contours for deep soils.

Shallow

Twenty-two inorganic constituents were detected in ten shallow soil samples (0 to 4 feet below ground surface). Of these, aluminum, arsenic, beryllium, iron, manganese, nickel, selenium, and thallium were

identified as COPCs. Boron, calcium, lead, nickel, potassium, sodium and zinc were detected in shallow soils within Zone 5 at maximum concentrations greater than background (3.1 mg/kg, 499 mg/kg, 17.5 mg/kg, 5.95 mg/kg, 2,580 mg/kg, 20.5 mg/kg, and 31.3 mg/kg, respectively). Boron (at 19MW3-0002), lead (at 19SS1), and potassium (at 19TB3) were only detected at one location above background. Most concentrations of calcium, nickel, and sodium were greater than background; however, concentrations of these metals were similar throughout the zone and to the upgradient offsite sample (19MW1). Maximum concentrations of ten inorganics were detected in 19MW1. Of these metals, maximum concentrations of beryllium, chromium, manganese, mercury, selenium, and zinc were greater than background. Except for zinc, concentrations of these metals were not detected in onsite shallow soils exceeding background. Zinc exceeded background in shallow soils at several onsite locations (19SS1, 19MW3, and 19TB4). Concentrations of metals in shallow soils were similar to concentrations detected throughout other zones at the Lower Subase.

A single lead concentration in TCLP leachate from 19SS1 exceeded the state pollutant mobility criteria for GB classified groundwater. No TCLP leachate concentrations from shallow soil exceeded the Federal pollutant mobility criteria.

Drawing 3 shows the distribution of lead in shallow soils of Zone 5. The contours show that lead concentrations in shallow soils of Zone 5 (< 50 mg/kg) are well below any of the applicable screening criteria.

Lead concentrations measured in sediment samples taken from the Thames River are also provided on Drawing 3. The lead concentration measured in EC-SDTR02 along Zone 5 is roughly 2 times higher than the maximum concentration measured in shallow Zone 5 soil. The sediment concentrations adjacent to Zone 5 are generally the same as other levels detected in the Thames River. As discussed in Section 2, the levels of lead detected in this sediment sample poses a potential problem to ecological receptors (i.e., exceeds background and ecological benchmark value).

Five VOCs and fourteen SVOCs were sporadically detected in shallow soils, with maximum concentrations of less than 0.96 mg/kg. One VOC (methylene chloride) and two SVOCs (benzo[a]anthracene and 2-methylnaphthalene) were identified as COPCs. 2-Methylnaphthalene was selected as a COPC by default because no screening criteria was available. Nine of the SVOCs were detected at location 19MW1 only. Except for acetone and methylene chloride, which are common laboratory contaminants, VOCs and SVOCs detected in onsite soils are associated with petroleum contamination in the vicinity of the stained soils and the UST adjacent to the south of Building 175. Pesticides were only detected at location 19MW1. PCBs (Aroclor 1260) were detected at three locations

(19MW2, 19MW3, and 19TB4) at concentrations high enough to make it a COPC (0.055 mg/kg to 0.14 mg/kg).

TPH was only analyzed in one shallow soil sample (19SS1) and was detected at 6,800 mg/kg. This sample was collected from the stained soil adjacent to the south of Building 175. This single detection is shown on Drawing 1; however, because of the limited data, the isoconcentration map does not provide significant additional information.

Deep

Eighteen inorganic constituents were detected in eight deep soil samples (greater than 4 feet below ground surface). Arsenic, beryllium, iron, manganese, and nickel were identified as COPCs. Calcium, copper, manganese, nickel, sodium, and zinc were detected at maximum concentrations greater than background (499 mg/kg, 25.6 mg/kg, 188 mg/kg, 5.95 mg/kg, 20.5 mg/kg, and 31.3 mg/kg, respectively). Copper (at location 19MW3), manganese (at location 19TB4), and zinc (at location 19MW3) were each only detected above background at one subsurface location. All concentrations of calcium and sodium and most concentrations of nickel were greater than background; however, concentrations of these metals were similar throughout the zone. Calcium and sodium are naturally occurring chemicals and the levels detected in excess of background may have been caused by the brackish water of the Thames River. Concentrations of metals in subsurface soils of Zone 5 were similar to concentrations detected throughout the Lower Subase.

Drawing 4 shows isoconcentration contours of lead concentrations measured in Zone 5 deep soils. The contours show that lead concentrations are lower (<15 mg/kg) in deep soils than in shallow soils (<50 mg/kg) of Zone 5. The concentrations in the deep soils do not exceed any screening criteria.

Lead concentrations measured in sediment samples taken from the Thames River are also provided on Drawing 4. The lead concentration measured in the river sediment along Zone 5 is approximately 6 times higher than the maximum concentration measured in deep Zone 5 soil. As discussed above, the sediment concentration adjacent to Zone 5 is generally the same as other levels detected in the Thames River and the levels of lead pose a potential problem to ecological receptors.

The lead concentration in TCLP leachate from deep soils exceeded Connecticut standards for GB classified groundwater at location 19MW2. No concentrations of chemicals in excess of Federal pollutant mobility criteria were detected.

Six VOCs and six SVOCs were generally detected infrequently in deep soils at concentrations typically less than 0.4 mg/kg. One exception was the concentrations of two SVOCs, 2-methylnaphthalene and phenanthrene, collected west and south of Building 175 that had detections as high as 23 mg/kg and 7 mg/kg, respectively. Methylene chloride, and 2-methylnaphthalene, benzo(a)anthracene, and benzo(a)fluoranthene were identified as VOC and SVOC COPCs, respectively. 2-Methylnaphthalene was selected as a COPC by default because no screening criteria was available. Except for acetone and methylene chloride, which are common laboratory contaminants, the VOCs and SVOCs detected in subsurface soils can be associated with petroleum contamination in the vicinity of the stained soils and UST adjacent to the south of Building 175. Pesticides were not detected in deep soils. PCBs (Aroclor 1260) were detected in two locations (19MW2 and 19TB4) at concentrations exceeding screening criteria.

TPH concentrations in subsurface soils collected west and south of Building 175 ranged from 3,300 mg/kg to 6,200 mg/kg. These concentrations exceed the state's industrial remediation criteria for TPH and result in a distinct area of contamination on Drawing 2. The maximum detection of TPH in shallow soil is similar to the detections in deep soil. Outside of this area TPH concentrations were less than 500 mg/kg, the CTDEP residential screening level.

Based on soil analytical results, an area of petroleum contamination is apparent west and south of Building 175 associated with the stained soils and UST adjacent to the south of Building 175. Contamination was detected from ground surface to a depth of approximately eight feet. With the exception of PCBs and sporadic detections of PAHs, VOCs and SVOCs detected at Zone 5 are within the area of petroleum contamination. Moderate to high concentrations of BTEX detected in several soil-gas sample locations also generally correlate with the area of petroleum contamination. Also minor oil staining or sheen were observed in shallow and subsurface soils at boring locations 19MW3, 19MW4, and 19TB2. Fluorescence spectroscopy for deep soils identified this area as containing No. 2 diesel fuel (detected in samples 19SS1, 19MW3, 19MW4, and 19TB2).

Several PAHs (at 19MW2) and Aroclor 1260 (at 19MW2 and 19TB4) were detected in soils collected west and northwest of the UST adjacent to the north of Building 175; however, concentrations of these organic chemicals are low (less than 0.4 mg/kg). Fluorescence spectroscopy results for deep samples in this area indicated fuel oil residuals at 19TB3, 19TB4, and 19MW2. This fuel oil residual was also detected in 19TB1. TPH concentrations at these sample locations, however, were low or nondetect.

7.4.2 Storm Sewer Sediment

Table 7-5 summarizes analytical results for sediment samples collected in Zone 5 storm sewers and summarizes the COPC screening results.

Two storm sewer sediment samples were collected from the storm sewer system which runs through Zone 5. One sample, 19SD1, was collected from the drain located near the southern end of the Building 175, on the sewer line which runs along the west side of the building. The other sample, 19SD2, was collected from the drain located approximately 200 feet south of Building 175, on the sewer line which runs along the east side of the building.

Twenty-three inorganics were detected in the storm sewer sediments. Of these, antimony, arsenic, beryllium, cadmium, copper, iron, lead, and manganese were identified as COPCs. Antimony, cadmium, calcium, chromium, copper, lead, mercury, silver, sodium, and zinc were detected above NSB-NLON background soil concentrations. In particular, antimony, cadmium, lead, and silver at 19SD1 and copper at 19SD2 were detected at concentrations at least an order of magnitude greater than background. The concentrations of metals detected in the storm sewer sediments are not similar to those detected in soils at Zone 5. In particular, the concentrations of lead detected in the sediment are much higher than the concentrations detected in the soil.

Three VOCs were detected in sediments; toluene (0.004 mg/kg), acetone (0.22 mg/kg) and methylene chloride (0.009 mg/kg) at location 19SD1 and acetone (0.058 mg/kg) and methylene chloride (0.012 mg/kg) at location 19SD2. None of the concentrations were high enough to exceed screening criteria. SVOCs, predominantly PAHs, were detected at moderate levels at 19SD2 (maximum detection of 2.1 mg/kg) and high levels at 19SD1 (maximum detection of 44 mg/kg). Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene and indeno(1,2,3-cd)pyrene were identified as COPCs. Benzo(g,h,i)perylene was selected as a COPC by default because no screening criteria was available. The concentrations of SVOCs in the storm sewer sediment were the highest detected at Zone 5. TPH was detected at 3,300 mg/kg and 1,800 mg/kg in 19SD1 and 19SD2, respectively. Both concentrations exceed the state's residential remediation criteria (500 mg/kg), but only the concentration at 19SD1 exceeded the state's industrial remediation criteria (2,500 mg/kg). Results of fluorescence spectroscopy indicate that either No. 4 or No. 6 fuel oil at 19SD1 and No. 6 fuel oil at 19SD2 were present. Pesticides and PCBs were not detected in either sediment sample.

The metals contamination in Zone 5 appears to be related to recent site activities (possibly paint removal operations or lead ballast storage) and is not related to historical site conditions or disposal activities. A

small amount of paint chips were observed in 19SD2, where copper was observed above background. Copper is a common additive in antifouling boat bottom paint (Atlantic, 1995a). Although not observed in sediment samples, lead ballast (generally 3 mm size balls) were observed on the ground in several locations on the northside of Building 175. The hoppers used to transport and load the lead ballast onto ships are often stored in the paved area adjacent to the northside of Building 175 (Atlantic, 1995a). The SVOCs detected in storm sewer sediments are likely a result of petroleum constituents, based on TPH levels, and contamination likely resulted from surface water runoff or spills.

7.4.3 Groundwater

Tables 7-6 and 7-7 summarize analytical results for groundwater samples collected in Zone 5 and summarize the COPC screening results. Analytical results from unfiltered samples are provided in Table 7-6 and the results for filtered samples are summarized in Table 7-7.

Drawings 5 through 7 (back pocket) show the distribution of TPH and lead contamination in groundwater for all zones, including Zone 5, being investigated as part of the Lower Subase RI. Drawing 5 shows isoconcentration contours of TPH concentrations measured in groundwater. Isoconcentration contours of filtered and unfiltered lead concentrations in groundwater are presented on Drawings 6 and 7.

Groundwater samples were collected from three monitoring wells during one round of sampling in 1993. Seven inorganics (calcium, cobalt, iron, magnesium, manganese, potassium, and sodium) were detected in unfiltered and filtered groundwater samples. Concentrations between unfiltered and filtered groundwater were similar. Six inorganics (aluminum, arsenic, barium, boron, lead, and zinc) were only detected in filtered groundwater samples. Iron, manganese, and sodium were identified as COPCs in unfiltered groundwater, while aluminum, arsenic, iron, manganese, and sodium were identified as COPCs in filtered groundwater. For both filtered and unfiltered detections, most of the maximum concentrations were detected in 19MW3 or 19MW4. Only sodium was detected at a maximum concentration in 19MW2 for both filtered and unfiltered analyses. Sodium only exceeds a notification level and groundwater in this area is influenced by the brackish water of the Thames River.

The distribution of lead in unfiltered and filtered groundwater samples is shown on Drawings 6 and 7, respectively. No detections of lead were measured in the unfiltered groundwater samples (Drawing 6), while only minor levels of lead were detected in the filtered samples (Drawing 7). In either case, the levels of lead measured in the groundwater do not indicate that there are any plumes of lead contamination in Zone 5 groundwater.

Limited organic compounds were detected in groundwater. Three VOCs (in 19MW3) and six SVOCs (in 19MW3 and 19MW4) were detected at low concentrations (less than 80 µg/L). Notably, 2-methylnaphthalene and phenanthrene, both detected at relatively high concentrations in subsurface soils, were also detected in groundwater. Both chemicals were identified as a groundwater COPC; however, 2-methylnaphthalene was identified as a COPC by default because no screening criteria were available. No organic compounds were detected in 19MW2. TPH, pesticides, and PCBs were not detected in groundwater at Zone 5. Fluorescence spectroscopy identified residual fuel oil or road tar at 19MW2 and No. 4 or No. 6 fuel oil at 19MW3 and 19MW4. The fluorescence data for groundwater does not correspond well with the fluorescence data obtained for soils at Zone 5.

Since no TPH was detected in the groundwater in Zone 5 averages of one-half of the detection limits are shown on Drawing 5 for the wells. All of these average detection limits are at or above the state's TPH remediation criteria of 500 mg/L. This information suggests that there is a high level of uncertainty in the TPH results for Zone 4.

Although limited groundwater contamination has been detected at Zone 5, the source of contaminants detected in groundwater samples collected from wells 19MW3 and 19MW4 appears to be from contaminated soil and the UST located on the south and west sides of Building 175.

7.5 DATA EVALUATION

Data was evaluated based on contaminant fate and transport, ecological risk assessment and comparison to state standards. In addition, an evaluation of Zone 5 using the decision tree provided in Figure 1-3 is also included in this section. A human health risk assessment has not been conducted for Zone 5.

7.5.1 Contaminant Fate and Transport

Contaminant fate and transport for these contaminants is discussed in the SI Report and is covered in this subsection.

PAHs in soil are a major chemical of concern. Sources of PAHs are petroleum and coal. PAHs can be formed during the combustion of organic matter. Lower molecular weight PAHs (such as naphthalene) are slightly soluble and are relatively mobile in the environment. They also have Henry's Law constants ranging from 10^{-3} to 10^{-5} and will tend to volatilize. The higher molecular weight PAHs have lower solubilities and low Henry's law constants. These compounds are not relatively mobile and will not volatilize to a great extent. These compounds remain adsorbed to soils or sediments. Photolysis,

chemical oxidation, and biodegradation are important degradative processes controlling the fate of PAHs in the aquatic environment.

Based on the absence of any substantial groundwater contamination at Zone 5, it does not appear that significant migration of contaminants have occurred. Based on the high concentration of contaminants in the sediments in the storm sewer, it is evident that contaminants entering the storm sewers (likely via storm runoff) are accumulating in storm sewer sediments. The storm sewers and box culvert through Zone 5 could act as preferential contaminant migration pathways for Zone 5 contaminants to the Thames River.

7.5.2 Ecological Risk Assessment

The only potential ecological habitat near the Lower Subase is the Thames River. PAHs and metals are the primary chemicals of concern for the Thames River. Significant concentrations of PAHs in soils and PAHs and metals in storm sewer sediments at Zone 5 were detected. Chemicals detected at Zone 5 may be impacting the Thames River as storm sewers discharge to the river. Note that the ecological risk assessment for the Thames River, discussed in Section 2.5.3, concluded that the Lower Subase represented a minimal potential risk to ecological receptors.

7.5.3 Comparison of Site Data to Connecticut Standards

Analytical data for the Lower Subase were compared to Connecticut drinking water standards and remediation standards. Site-specific soil data and sediment (collected from the storm sewer) data were compared to remediation standards for direct exposure and pollutant mobility. Direct exposure criteria for residential exposure were used to conservatively evaluate potential exposure to soil or storm sewer sediments at the site. Only soil concentrations (both shallow and deep soils) of TPH in Zone 5 exceeded both the residential and industrial direct exposure criteria. No other exceedances of direct exposure criteria were observed for soils. Antimony, lead, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluorene, and TPH concentrations in storm sewer sediments exceeded both the residential and industrial direct exposure criteria.

To address concerns regarding migration of chemicals from soil to groundwater, site soil data were compared to Connecticut remediation standards for pollutant mobility. TPH and Aroclor-1260 in shallow soils and TPH and methylene chloride in deep soils were the only chemicals reported at maximum concentrations exceeding GB pollutant mobility criteria.

Analytical groundwater data for Zone 5 was compared to state standards. There were no exceedances of State MCLs for either unfiltered or filtered groundwater. However, sodium was detected in the unfiltered and filtered groundwater samples in Zone 5 at maximum concentration exceeding the state Notification Level of 28,000 µg/L. There were no exceedances of the Connecticut remediation standards for groundwater protection and only maximum concentrations of phenanthrene in unfiltered groundwater and arsenic in filtered groundwater exceeded surface water protection criteria.

7.5.4 Decision Tree

The general decision tree for the evaluation of sites is provided in Figure 1-3. The evaluation of data using this decision tree for Zone 5 is as follows:

- Existing data has been collected and evaluated. Information describing the site, previous investigations, and physical characteristics of the site are provided in Sections 7.1, 7.2, and 7.3, respectively. The nature and extent of contamination is provided in Section 7.4.

- Based on existing data, no imminent threat to human health or the environment was identified for Zone 5. However, high contaminant concentrations were detected in the sediments in storm sewers which discharge to the Thames River.

- Contaminant fate and transport have been described, an ecological risk assessment has been conducted for the Thames River (as part of the Phase II RI) and data have been compared to CTDEP Standards. A baseline human health risk assessment has not been conducted for Zone 5.

- Data indicates that activities at Zone 5 have resulted in contamination of soil and minor contamination of groundwater. However, it is unknown if the contamination is from past or current activities at Zone 5. Contamination in storm sewer sediments appear to be from recent site activities. In addition, contamination has not been fully characterized.

- Further action is required for Zone 5 and is discussed in Section 7.6.

7.6 RECOMMENDATIONS

Recommendations were provided in the SI Report (Atlantic, 1995a) and are reiterated with minor changes below. Further investigation to address soils and groundwater containing petroleum constituents, stained soils at the southwest corner of Building 175, metal contaminants in storm sewer drains, and soils

containing lead TCLP levels greater than 150 µg/L was recommended. Testing of any underground storage tank and piping not recently tested was recommended to eliminate the possibility of an ongoing petroleum source. Additional investigation of site operations and sediment analysis of the storm sewer system was recommended to determine the extent and source of sediment contamination. Removal and disposal of contaminated sediments and modification of any site operations identified as contributing to the sediment contamination was also recommended.

These recommendations are justified as:

- TPH concentrations in the soils by the southwest corner of Building 175 were as high as 6600 mg/kg. This maximum concentration was detected from stained surface soils. Subsurface soil and sediments in the storm sewers also had TPH concentrations as high as 6200 mg/kg.

- Isoconcentration contours for TPH indicate that the tank located at the south side of Building 175 is a likely source of contamination (see Drawings 1 and 2).

- Sediment samples were only collected from two locations. Other portions of the storm sewer may also be contaminated. The storm sewers collect runoff from various portions of the base and discharge to the Thames River. Investigation of the storm sewers will aid in identifying the extent of contamination as well as potential sources.

Limited further action (i.e., confirmation sampling and re-analyses of the soil samples using SPLP analysis instead of TCLP analyses) is considered necessary to address lead in soils at Zone 5. This recommendation is based on the following:

- TCLP leachate concentrations for lead exceeded the state's pollutant mobility criteria for GB classified groundwater (150 µg/L).

- Lead concentrations in soil at Zone 5 were low and generally below background (17.5 mg/kg). The only soil sample with lead concentrations above background was the surface soil (19SS1) which had a lead concentration of 48.4 mg/kg.

- Groundwater concentrations of lead were less than 3 µg/L; indicating that lead in soils did not appear to be impacting groundwater.

Because contaminants associated with the Lower Subase have been detected in the sediments in the Thames River, sampling of the sediments is recommended in conjunction with characterization activities to aid in the identification of source areas and contaminants of concern. Sampling of media from the Thames River is discussed in Section 2.6.

Based on the results of the additional sampling and analyses and the integrity inspection activities, source areas will be able to be defined and remedial activities for the source areas will be conducted as necessary. Remedial activities should focus on the removal of free product and highly contaminated areas (hot spots) which may act as sources of contamination to other media/receptors. However, because Zone 5 is located in an active, industrialized area which is vital to national security, petroleum contamination is widespread in the Lower Subase, and contamination presents minimal risks to human health and the environment (i.e., limited exposure pathways), remediation of all contaminated material at Zone 5 by excavation is not feasible or practical. Therefore, in-situ remedial options such as contaminant, air sparging, soil vapor extraction (SVE), natural attenuation or bioremediation will also be explored and used as applicable.

TABLE 7-1

COPC SCREENING FOR LOWER SUBASE
ZONE 5 - SHALLOW SOILS (<4 FEET)
NSB-NLON, GROTON, CONNECTICUT
PAGE 1 OF 2

Parameter	Frequency (1)	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	SSL Inhalation (3)	SSL Migration to Groundwater (3)	State Residential Direct Exposure (4)	State Industrial Direct Exposure (4)	State Pollutant Mobility (GB) (4)	Select as COPC? (5)
Volatile Organic Compounds (mg/kg)												
Acetone	9/10	0.007 - 0.14	0.012	0.041	19MW4/19SS1	780	100000	0.8	500	1000	140	N
Ethylbenzene	1/10	0.038	0.01 - 0.012	0.009	19MW4	780	400	0.7	500	1000	10.1	N
Methylene chloride	10/10	0.004 - 0.02	-	0.008	19MW4	85	13	0.001	82	760	1	Y
Toluene	2/10	0.003 - 0.01	0.01 - 0.012	0.006	19MW4	1600	650	0.6	500	1000	67	N
Xylenes, Total	1/10	0.15	0.01 - 0.012	0.02	19MW4	16000	-	-	500	1000	19.5	N
Semivolatile Organic Compounds (mg/kg)												
2-Methylnaphthalene	3/10	0.032 - 0.96	0.34 - 20	1.2	19MW4	-	-	-	-	-	-	Y (6)
Anthracene	2/10	0.001 - 0.008	0.34 - 20	1.2	19MW1	2300	-	590	1000	2500	400	N
Benzo(a)anthracene	3/10	0.024 - 0.23	0.34 - 20	1.2	19MW3	0.88	-	0.08	1	7.8	1	Y
Benzo(a)pyrene	2/10	0.038 - 0.056	0.34 - 20	1.2	19MW1	0.088	-	0.4	1	1	1	N
Benzo(b)fluoranthene	3/10	0.032 - 0.2	0.34 - 20	1.2	19MW3	0.88	-	0.2	1	7.8	1	N
Benzo(k)fluoranthene	2/10	0.025 - 0.084	0.34 - 20	1.2	19MW1	8.8	-	2	8.4	78	1	N
Bis(2-ethylhexyl)phthalate	2/10	0.02 - 0.032	0.34 - 20	1.2	19MW1	46	31000	180	44	410	11	N
Butyl benzyl phthalate	1/10	0.024	0.34 - 20	1.2	19MW1	1600	930	810	1000	2500	200	N
Chrysene	2/10	0.062 - 0.076	0.34 - 20	1.2	19MW1	88	-	8	-	-	-	N
Di-N-octyl phthalate	1/10	0.062	0.34 - 20	1.2	19MW1	160	10000	10000	1000	2500	20	N
Fluoranthene	4/10	0.072 - 0.48	0.34 - 20	1.2	19MW3	310	-	210	1000	2500	56	N
Naphthalene	1/10	0.022	0.34 - 20	1.2	19MW1	310	-	4	1000	2500	56	N
Phenanthrene	2/10	0.064 - 0.1	0.34 - 20	1.2	19MW1	-	-	-	1000	2500	40	N
Pyrene	4/10	0.041 - 0.42	0.34 - 20	1.2	19MW3	230	-	210	1000	2500	40	N
Pesticides/PCBs (mg/kg)												
4,4'-DDD	2/10	0.01 - 0.012	0.0034 - 0.036	0.005	19MW1	2.7	-	0.8	-	-	-	N
4,4'-DDE	3/10	0.056 - 0.43	0.0034 - 0.004	0.085	19MW1	1.9	-	3	-	-	-	N
4,4'-DDT	2/10	0.52 - 0.64	0.0034 - 0.036	0.12	19MW1	1.9	-	2	-	-	-	N
alpha-Chlordane	2/10	0.005 - 0.0059	0.0017 - 0.018	0.003	19MW1	0.49	-	-	0.49	2.2	0.066	N
Aroclor-1260	3/10	0.055 - 0.14	0.034 - 0.36	0.058	19MW2	0.083	-	-	1	10	0.005	Y
Metals (mg/kg)												
Aluminum	10/10	1940 - 13600	-	6067	19MW1	7800	-	-	-	-	-	Y
Arsenic	10/10	0.46 - 3.5	-	1.4	19MW1	0.43	750	1	10	10	-	Y
Barium	10/10	23.4 - 53.6	-	35	19TB3	550	690000	82	4700	140000	-	N

TABLE 7-1

COPC SCREENING FOR LOWER SUBASE
ZONE 5 - SHALLOW SOILS (<4 FEET)
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 2

Parameter	Frequency (1)	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	SSL Inhalation (3)	SSL Migration to Groundwater (3)	State Residential Direct Exposure (4)	State Industrial Direct Exposure (4)	State Pollutant Mobility (GB) (4)	Select as COPC? (5)
Beryllium	8/10	0.09 - 0.91	0.24 - 0.29	0.31	19MW1	0.15	1300	3	2	2	-	Y
Boron	1/10	19.7	1.8 - 109	13	19MW3	700	-	-	-	-	-	N
Calcium	10/10	455 - 1560	-	870	19TB1	-	-	-	-	-	-	N (7)
Chromium	10/10	5 - 23.4	-	11	19MW1	39	270	-	3900/100 (8)	5.1E+4/100 (8)	-	N
Cobalt	10/10	1.9 - 4.8	-	3.6	19TB3	470	-	-	-	-	-	N
Copper	10/10	5.5 - 19.7	-	12	19SS1	310	-	-	2500	76000	-	N
Cyanide	1/10	0.24	0.15 - 1.2	0.2	19MW2	160	-	2	1400	41000	-	N
Iron	10/10	4290 - 13100	-	7982	19MW1	2300	-	-	-	-	-	Y
Lead	9/11	1.7 - 48.4	10.4 - 31.5	14	19SS1	400	-	-	500	1000	-	N
Magnesium	10/10	882 - 3160	-	1842	19TB3	-	-	-	-	-	-	N (7)
Manganese	10/10	84.9 - 300	-	148	19MW1	39	-	-	-	-	-	Y
Mercury	2/10	0.09 - 0.1	0.02 - 0.33	0.058	19MW1	2.3	-	0.1	20	610	-	N
Nickel	9/10	4 - 9.4	2	6.1	19MW3	160	13000	7	1400	7500	-	Y
Potassium	10/10	239 - 3100	-	1125	19TB3	-	-	-	-	-	-	N (7)
Selenium	2/10	0.67 - 1.1	0.15 - 0.2	0.25	19MW1	39	-	0.3	340	10000	-	Y
Sodium	9/10	60.9 - 318	277	146	19TB3	-	-	-	-	-	-	N (7)
Thallium	1/10	0.18	0.1 - 0.23	0.079	19SS1	0.55	-	0.04	5.4	160	-	Y
Vanadium	10/10	5.9 - 22.9	-	13	19MW1	55	-	300	470	14000	-	N
Zinc	10/10	14 - 39.9	-	29	19MW1	2300	-	620	20000	610000	-	N
Miscellaneous (mg/kg)												
TPH	1/3	6800	75 - 78	2292	19SS1	500	-	-	500	2500	2500	Y

- Not available or not applicable.

(1) Includes data from the following samples 19MW1-0.252.25, 19MW11-0.252.25, 19MW2-0204, 19MW3-0002, 19MW4-0002, 19MW4-0004, 19SS1, 19TB1-0002, 19TB1-0004, 19TB2-0002, 19TB3-0204, 19TB4-0002, and 19TB4-0204.

(2) Based on current USEPA Region III guidance (USEPA Region III, May 10, 1996). Residential Soil Ingestion for soil and sediment.

(3) USEPA Soil Screening Levels (USEPA, May 1996). For migration to groundwater, values associated with a dilution and attenuation factor (DAF) of 1.0.

(4) CTDEP, December 1995.

(5) Contaminant of Potential Concern; Yes (Y) indicates that the maximum concentration exceeds one or more of the criteria; No (N) indicates that the maximum does not exceed any of the criteria.

(6) Criteria not available.

(7) Essential nutrient. Not evaluated for COPC selection.

(8) Trivalent chromium/hexavalent chromium.

TABLE 7-2

COPC SCREENING FOR LOWER SUBASE
ZONE 5 - DEEP SOILS (>4 FEET)
NSB-NLON, GROTON, CONNECTICUT
PAGE 1 OF 2

Parameter	Frequency (1)	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	SSL Inhalation (3)	SSL Migration to Groundwater (3)	State Residential Direct Exposure (4)	State Industrial Direct Exposure (4)	State Pollutant Mobility (GB) (4)	Select as COPC? (5)
Volatile Organic Compounds (mg/kg)												
2-Butanone	1/8	0.005	0.011 - 2.8	0.18	19TB2	4700	-	-	500	1000	80	N
Acetone	7/8	0.008 - 0.18	2.8	0.23	19MW4	780	100000	0.8	500	1000	140	N
Ethylbenzene	1/8	0.033	0.011 - 2.8	0.18	19MW4	780	400	0.7	500	1000	10.1	N
Methylene chloride	8/8	0.005 - 1.9	-	0.25	19MW3	85	13	0.001	82	760	1	Y
Toluene	1/8	0.003	0.011 - 2.8	0.18	19TB2	1600	650	0.6	500	1000	67	N
Xylenes, Total	2/8	0.007 - 0.032	0.011 - 2.8	0.18	19MW4	16000	-	-	500	1000	19.5	N
Semivolatile Organic Compounds (mg/kg)												
2-Methylnaphthalene	2/8	9.7 - 23	0.37 - 22	5.6	19MW3	-	-	-	-	-	-	Y (6)
Benzo(a)anthracene	1/8	0.19	0.37 - 22	2.9	19MW2	0.88	-	0.08	1	7.8	1	Y
Benzo(b)fluoranthene	1/8	0.31	0.37 - 22	2.9	19MW2	0.88	-	0.2	1	7.8	1	Y
Fluoranthene	1/8	0.34	0.37 - 22	2.9	19MW2	310	-	210	1000	2500	56	N
Phenanthrene	1/8	7	0.37 - 22	2.9	19MW3	-	-	-	1000	2500	40	N
Pyrene	1/8	0.31	0.37 - 22	2.9	19MW2	230	-	210	1000	2500	40	N
Pesticides/PCBs (mg/kg)												
Aroclor-1260	3/8	0.042 - 0.13	0.036 - 0.039	0.048	19TB2	0.083	-	-	1	10	0.005	Y
Metals (mg/kg)												
Aluminum	8/8	1880 - 5500	-	4036	19TB3	7800	-	-	-	-	-	N
Arsenic	8/8	0.34 - 2.4	-	1.2	19TB3	0.43	750	1	10	10	-	Y
Barium	8/8	13.6 - 40.7	-	28	19TB3	550	690000	82	4700	140000	-	N
Beryllium	7/8	0.12 - 0.21	0.08	0.15	19MW3	0.15	1300	3	2	2	-	Y
Calcium	8/8	521 - 1770	-	947	19MW2	-	-	-	-	-	-	N (7)
Chromium	8/8	2.5 - 11.6	-	8	19TB3	39	270	-	3900/100 (8)	5.1E+4/100 (8)	-	N
Cobalt	8/8	0.98 - 4.9	-	3.4	19TB4	470	-	-	-	-	-	N
Copper	8/8	2.7 - 43.8	-	16	19MW3	310	-	-	2500	76000	-	N
Cyanide	1/8	0.17	0.15 - 0.19	0.10	19TB3	160	-	2	1400	41000	-	N
Iron	8/8	3450 - 8620	-	5931	19TB2	2300	-	-	-	-	-	Y
Lead	8/8	1.3 - 14.6	-	6.2	19MW3	400	-	-	500	1000	-	N

TABLE 7-2

COPC SCREENING FOR LOWER SUBASE
ZONE 5 - DEEP SOILS (>4 FEET)
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 2

Parameter	Frequency (1)	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	SSL Inhalation (3)	SSL Migration to Groundwater (3)	State Residential Direct Exposure (4)	State Industrial Direct Exposure (4)	State Pollutant Mobility (GB) (4)	Select as COPC? (5)
Magnesium	8/8	796 - 2590	-	1786	19MW2	-	-	-	-	-	-	N (7)
Manganese	8/8	48.2 - 209	-	104	19TB4	39	-	-	-	-	-	Y
Nickel	7/8	3 - 8.1	2	5.2	19MW3	160	13000	7	1400	7500	-	Y
Potassium	8/8	544 - 1910	-	1168	19TB2	-	-	-	-	-	-	N (7)
Sodium	8/8	50.7 - 529	-	197	19TB3	-	-	-	-	-	-	N (7)
Vanadium	8/8	4.3 - 14.6	-	10	19MW2	55	-	300	470	14000	-	N
Zinc	8/8	10.9 - 43	-	21	19MW3	2300	-	620	20000	610000	-	N
Miscellaneous (mg/kg)												
TPH	6/8	78 - 6200	66 - 67	1889	19TB2	500	-	-	500	2500	2500	Y

- Not available or not applicable.

(1) Includes data from the following samples 19MW2-0406, 19MW12-0406, 19MW3-0406, 19MW4-0608, 19TB1-0608, 19TB2-0608, 19TB3-1012, and 19TB4-0406.

(2) Based on current USEPA Region III guidance (USEPA Region III, May 10, 1996). Residential Soil Ingestion for soil and sediment.

(3) USEPA Soil Screening Levels (USEPA, May 1996). For migration to groundwater, values associated with a dilution and attenuation factor (DAF) of 1.0.

(4) CTDEP, December 1995.

(5) Contaminant of Potential Concern; Yes (Y) indicates that the maximum concentration exceeds one or more of the criteria; No (N) indicates that the maximum does not exceed any of the criteria.

(6) Criteria not available.

(7) Essential nutrient. Not evaluated for COPC selection.

(8) Trivalent Chromium/Hexavalent Chromium.

TABLE 7-3

COPC SCREENING FOR LOWER SUBASE
ZONE 5 - SHALLOW TCLP (<4 FEET)
NSB-NLON, GROTON, CONNECTICUT

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	State Pollutant Mobility (GB) (2)	Federal Pollutant Mobility (3)	Select as COPC? (4)
Metals (ug/L)								
Barium	3/3	260 - 557	-	374	19SS1	10000	100000	N
Cadmium	1/3	2.8	1.8 - 2	1.57	19MW1	50	1000	N
Lead	1/3	173	26 - 28	66.7	19SS1	150	5000	Y

- Not available or Not applicable.

(1) Includes data from the following samples: 19MW1-0.252.25, 19MW11-0.252.25, and 19SS1.

(2) CTDEP Pollutant Mobility Remediation Standard for GB classified groundwater; CTDEP, December 1995.

(3) Federal Toxicity Characteristic Regulatory Level (58 FR 46049).

(4) Contaminant of Potential Concern; Yes (Y) indicates that the maximum concentration exceeds one or more of the criteria; No (N) indicates that the maximum does not exceed any of the criteria.

TABLE 7-4

COPC SCREENING FOR LOWER SUBASE
ZONE 5 - DEEP TCLP SOILS (>4 FEET)
NSB-NLON, GROTON, CONNECTICUT

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	State Pollutant Mobility (GB) (2)	Federal Pollutant Mobility (3)	Select as COPC? (4)
Metals (ug/L)								
Barium	8/8	217 - 417	-	307	19TB3	10000	100000	N
Chromium	6/8	5.4 - 32.4	3.9	10.1	19MW12	5000	5000	N
Lead	8/8	12.4 - 419	-	94.7	19MW2	150	5000	Y
Silver	3/8	9.8 - 19.4	2.5	5.78	19MW12	360	5000	N

- *Not available or not applicable.*

(1) Includes data from the following samples: 19MW12-0406, 19MW2-0406, 19MW3-0406, 19MW4-0608, 19TB1-0608, 19TB2-0608, 19TB3-1012, and 19TB4-0406.

(2) CTDEP Pollutant Mobility Remediation Standard for GB classified groundwater; CTDEP, December 1995.

(3) Federal Toxicity Characteristic Regulatory Level (58 FR 46049).

(4) Contaminant of Potential Concern; Yes (Y) indicates that the maximum concentration exceeds one or more of the criteria; No (N) indicates that the maximum does not exceed any of the criteria.

TABLE 7-5

COPC SCREENING FOR LOWER SUBASE
ZONE 5 - STORM DRAIN SEDIMENTS
NSB-NLON, GROTON, CONNECTICUT
PAGE 1 OF 2

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	State Remediation Standards (3)		Select as COPC? (4)
							Residential Direct Exposure	Industrial Direct Exposure	
Volatile Organic Compounds (mg/kg)									
Acetone	2/2	0.058 - 0.22	-	0.14	19SD1	780	500	1000	N
Methylene chloride	2/2	0.009 - 0.012	-	0.011	19SD2	85	82	760	N
Toluene	1/2	0.004	0.013	0.005	19SD1	1600	500	1000	N
Semivolatile Organic Compounds (mg/kg)									
Acenaphthene	1/2	7.3	0.87	3.9	19SD1	470	-	-	N
Anthracene	1/2	9.5	0.87	5	19SD1	2300	1000	2500	N
Benzo(a)anthracene	1/2	17	0.87	8.7	19SD1	0.88	1	7.8	Y
Benzo(a)pyrene	1/2	18	0.87	9.2	19SD1	0.088	1	1	Y
Benzo(b)fluoranthene	2/2	0.53 - 26	-	13.3	19SD1	0.88	1	7.8	Y
Benzo(g,h,i)perylene	1/2	10	0.87	5.2	19SD1	-	-	-	Y (5)
Bis(2-ethylhexyl)phthalate	1/2	2.1	14	4.6	19SD2	46	44	410	N
Carbazole	1/2	8.1	0.87	4.3	19SD1	32	-	-	N
Chrysene	1/2	19	0.87	9.7	19SD1	88	-	-	N
Fluoranthene	2/2	0.63 - 44	-	22.3	19SD1	310	1000	2500	N
Fluorene	1/2	8	0.87	4.2	19SD1	310	1000	2500	N
Indeno(1,2,3-cd)pyrene	1/2	9.9	0.87	5.2	19SD1	0.88	-	-	Y
Naphthalene	1/2	8.6	0.87	4.5	19SD1	310	1000	2500	N
Phenanthrene	2/2	0.51 - 40	-	20.3	19SD1	-	1000	2500	N
Pyrene	2/2	0.68 - 31	-	15.8	19SD1	230	1000	2500	N
Metals (mg/kg)									
Aluminum	2/2	2610 - 2740	-	2675	19SD1	7800	-	-	N
Antimony	1/2	9270	3.3	4635	19SD1	3.1	27	8200	Y
Arsenic	2/2	2.1 - 3	-	2.6	19SD1	0.43	10	10	Y
Barium	2/2	22.5 - 28.8	-	25.7	19SD1	550	4700	140000	N
Beryllium	2/2	0.18 - 0.23	-	0.21	19SD2	0.15	2	2	Y
Cadmium	1/2	12.4	0.48	6.3	19SD1	3.9	34	1000	Y
Calcium	2/2	915 - 1930	-	1422	19SD2	-	-	-	N (6)

TABLE 7-5

COPC SCREENING FOR LOWER SUBASE
ZONE 5 - STORM DRAIN SEDIMENTS
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 2

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	State Remediation Standards (3)		Select as COPC? (4)
							Residential Direct Exposure	Industrial Direct Exposure	
Chromium	2/2	20.8 - 25.1	-	23	19SD2	39	3900/100 (7)	5.1E+4/100 (7)	N
Cobalt	2/2	2.7 - 4.2	-	3.5	19SD1	470	-	-	N
Copper	2/2	74 - 342	-	208	19SD2	310	2500	76000	Y
Cyanide	2/2	0.55 - 1.1	-	0.825	19SD2	160	1400	41000	N
Iron	2/2	6330 - 8570	-	7450	19SD1	2300	-	-	Y
Lead	2/2	185 - 85600	-	42892	19SD1	400	500	1000	Y
Magnesium	2/2	1120 - 1720	-	1420	19SD1	-	-	-	N (6)
Manganese	2/2	69.9 - 72.8	-	71.4	19SD1	39	-	-	Y
Mercury	1/2	0.11	0.05	0.07	19SD2	2.3	20	610	N
Nickel	2/2	8.9 - 11	-	10	19SD2	160	1400	7500	N
Potassium	2/2	560 - 1110	-	835	19SD1	-	-	-	N (6)
Silver	1/2	14.4	0.78	7.4	19SD1	39	340	10000	N
Sodium	2/2	134 - 622	-	378	19SD2	-	-	-	N (6)
Thallium	1/2	0.14	0.15	0.11	19SD1	0.55	5.4	160	N
Vanadium	2/2	8.7 - 13.1	-	10.9	19SD1	55	470	14000	N
Zinc	2/2	107 - 168	-	137	19SD2	2300	20000	610000	N
Miscellaneous (mg/kg)									
TPH	2/2	1800 - 3300	-	2550	19SD1	500	500	2500	Y

- Not available or not applicable.

(1) Includes data from samples 19SD1 and 19SD2.

(2) Based on current USEPA Region III guidance (USEPA Region III, May 10, 1996). Residential Soil Ingestion for soil and sediment.

(3) CTDEP, December 1995.

(4) Contaminant of Potential Concern; Yes (Y) indicates that the maximum concentration exceeds one or more of the criteria; No (N) indicates that the maximum does not exceed any of the criteria.

(5) Criteria not available.

(6) Essential nutrient. Not evaluated for COPC selection.

(7) Trivalent chromium/hexavalent chromium.

TABLE 7-6

COPC SCREENING FOR LOWER SUBASE
ZONE 5 - UNFILTERED GROUNDWATER
NSB-NLON, GROTON, CONNECTICUT

Parameter	Frequency (1)	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	Federal MCL (3)	State MCL (4)	State Remediation Standards (5)		Select as COPC? (6)
									Groundwater Protection	Surface Water Protection	
Volatile Organic Compounds (ug/L)											
Ethylbenzene	1/3	4	1	1.7	19MW4	130	700	700	700	580000	N
Toluene	1/3	0.8	1	0.6	19MW4	75	1000	1000	1000	4000000	N
Xylenes, Total	1/3	13	1 - 5	5.3	19MW4	1200	10000	10000	530	-	N
Semivolatile Organic Compounds (ug/L)											
2-Methylnaphthalene	2/3	37 - 75	10	39	19MW4	-	-	-	-	-	Y (7)
Acenaphthene	2/3	2 - 3	10	3.3	19MW3	220	-	-	-	-	N
Dibenzofuran	2/3	2	10	3	19MW3/19MW4	15	-	-	-	-	N
Fluorene	2/3	3 - 4	10	4	19MW3	150	-	-	280	140000	N
Naphthalene	2/3	15 - 73	10	31	19MW4	150	-	-	280	-	N
Phenanthrene	2/3	1 - 2	10	2.7	19MW4	-	-	-	200	0.077	Y
Metals (ug/L)											
Calcium	3/3	22700 - 72800	-	42933	19MW4	-	-	-	-	-	N (8)
Cobalt	1/3	11.5	3	4.8	19MW4	220	-	-	-	-	N
Iron	2/3	10700 - 31900	30.9	14205	19MW4	1100	300	-	-	-	Y
Magnesium	3/3	3360 - 4410	-	3953	19MW3	-	-	-	-	-	N (8)
Manganese	2/3	912 - 4140	6.2	1685	19MW4	18	50	5000	-	-	Y
Potassium	3/3	3840 - 6480	-	4953	19MW4	-	-	-	-	-	N (8)
Sodium	3/3	21900 - 63400	-	47567	19MW2	-	-	28000 (9)	-	-	Y

- Not available or not applicable.

(1) Includes data from the following samples: 19GW2, 19GW3, and 19MW4.

(2) For residential tap water ingestion, based on current USEPA Region III guidance (USEPA Region III, May 10, 1996).

(3) Maximum Contaminant Level (USEPA, May 1995).

(4) Title 19, Health and Safety, the Public Health Code of the State of Connecticut, Chapter 11, Environmental Health.

(5) CTDEP, December, 1995.

(6) Contaminant of Potential Concern: A Yes (Y) indicates that the maximum contaminant concentration exceeds one or more of the criteria; A No (N) indicates that the maximum contaminant concentration does not exceed any of the criteria.

(7) Criteria not available.

(8) Essential nutrient, not evaluated for COPC selection.

(9) Notification Level.

TABLE 7-7

COPC SCREENING FOR LOWER SUBASE
ZONE 5 - FILTERED GROUNDWATER
NSB-NLON, GROTON, CONNECTICUT

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	Federal MCL (3)	State MCL (4)	State Remediation Standards (5)		Select as COPC? (6)
									Groundwater Protection	Surface Water Protection	
Metals (ug/L)											
Aluminum	3/3	136 - 172	-	153.7	19MW3	3700	50 TO 200 (7)	-	-	-	Y
Arsenic	1/3	34.3	2	12.1	19MW4	0.045	50	50	50	4	Y
Barium	3/3	43.7 - 72.8	-	58.2	19MW3	260	2000	2000	1000	-	N
Boron	3/3	162 - 206	-	184	19MW4	330	-	-	-	-	N
Calcium	3/3	23900 - 68300	-	42867	19MW4	-	-	-	-	-	N (8)
Cobalt	1/3	10.5	3	4.5	19MW4	220	-	-	-	-	N
Iron	3/3	42.5 - 31100	-	14248	19MW4	1100	300	-	-	-	Y
Lead	2/3	1.4 - 2.2	1	1.4	19MW3	15	15	-	15	13	N
Magnesium	3/3	3410 - 4850	-	4090	19MW3	-	-	-	-	-	N (8)
Manganese	3/3	7.6 - 4090	-	1699	19MW4	18	50	5000	-	-	Y
Potassium	3/3	4030 - 6440	-	5150	19MW4	-	-	-	-	-	N (8)
Sodium	3/3	21600 - 66700	-	50467	19MW2	-	-	28000 (9)	-	-	Y
Zinc	2/3	3.3 - 4.8	11	4.5	19MW4	1100	5000	-	5000	123	N

- Not available or not applicable.

(1) *Includes data from the following samples: 19GW2, 19GW3, and 19MW4.*

(2) For residential tap water ingestion, based on current USEPA Region III guidance (USEPA Region III, May 10, 1996).

(3) Maximum Contaminant Level (USEPA, May 1995).

(4) Title 19, Health and Safety, the Public Health Code of the State of Connecticut, Chapter 11, Environmental Health.

(5) CTDEP, December, 1995.

(6) Contaminant of Potential Concern: A Yes (Y) indicates that the maximum contaminant concentration exceeds one or more of the criteria; A No (N) indicates that the maximum contaminant concentration does not exceed any of the criteria.

(7) Secondary MCL, based on aesthetic drinking water qualities.

(8) Essential nutrient, not evaluated for COPC selection.

(9) Notification Level.

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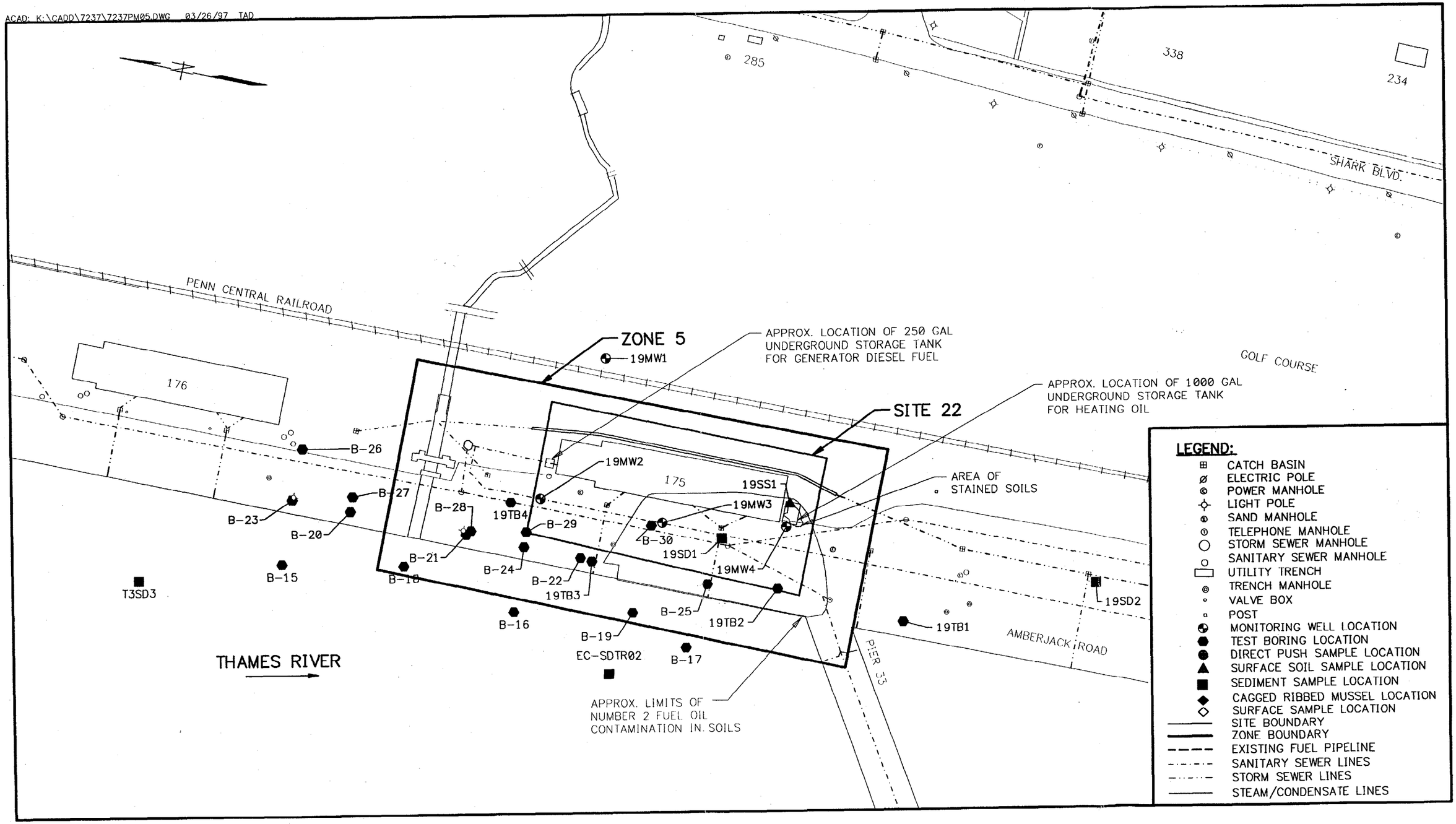

FIGURE 7-1

SAMPLE LOCATION MAP
ZONE 5
NSB-NLON, GROTON, CONNECTICUT

0 80 160
SCALE IN FEET

Brown & Root Environmental

CTO 0260

0109709Z

059606/P

8.0 ZONE 6

8.1 SITE DESCRIPTION

Zone 6 consists of Building 174 which is identified as Site 24 - Central Paint Accumulation Area. Figure 8-1 shows the one site included in Zone 6 and the limits of the zone. Steam and condensate ducts and fuel oil distribution lines do not extend as far north in the Lower Subase as Zone 6.

8.1.1 Site 24 - Central Paint Accumulation Area

In 1982, Building 174 was refitted to house boat sandblasting and paint activities. Also, in the late 1980's, the building was used as the primary paint storage facility for all paints used in boat maintenance.

8.2 SITE INVESTIGATIONS

No remedial investigations have been conducted at this site. Sediment sampling in 1990 at Piers 33 and 32 was conducted as part of the investigation for the 18 month pre-acceptance trials of the Seawolf Class Submarine, SSN21. The discussion of this sampling is provided in Section 2.2.2 and the results are discussed as part of the nature and extent of contamination in the Thames River (Section 2.4.2).

8.3 PHYSICAL CHARACTERISTICS

Physical characteristics for the Lower Subase are generally discussed in Section 1.3. Site-specific physical characteristics are discussed below.

8.3.1 Topography, Surface Features, and Surface Water Features

Zone 6 is primarily paved or covered with buildings. Zone 6 (i.e., Building 174) is located along the Thames River east of Pier 32. The Providence and Worcester Railroad runs along the eastern border of the zone. Surface water runoff at the site drains into the river via storm sewers. The catch basins and storm sewers in Zone 6 are shown on Figure 8-1. From the drawing it can be seen that there are two storm sewers in Zone 6 that convey water to the Thames River.

8.3.2 Soil Characteristics

According to SCS surface soil maps, Zone 6 is mapped as Udorthents - Urban Land, 0 to 15 percent slope. This complex consists of excessively drained to moderately well drained soils that have been disturbed by cutting and filling, along with areas that are covered by buildings and pavement. About 60 percent of the complex is Udorthents, 25 percent Urban land, and 15 percent is other soils. Urban land consists mainly of areas of developed or disturbed land.

8.3.3 Geology and Hydrogeology

According to USGS surficial geology maps, the site is mapped as stratified drift shown as terrace deposits of the Thames River. USGS bedrock geology maps indicate bedrock at Zone 6 is Granite gneiss to the north and Alaskite gneiss to the south. Bedrock is mapped as Pre-Pennsylvania age rock which consists of igneous intrusives that have been metamorphosed to granitic gneisses.

No geotechnical data is available for Zone 6.

8.4 NATURE AND EXTENT

No remedial investigations have been conducted in this zone; therefore the nature and extent of contamination cannot be evaluated. However, one sediment sample, EC-SDTR03, was collected in the Thames River adjacent to Zone 6. The sample location is shown on Figure 6-1 and Drawings 2 and 3. To determine if there is a potential problem, the lead concentration at this location was compared to other detected concentrations in the Thames River. The comparison showed that the lead concentration detected in the sediment sample was similar to other concentrations detected in the Thames River.

8.5 DATA EVALUATION

No remedial investigations have been conducted in this zone. In addition, no historical information on Site 24 was reviewed for preparation of this section. An evaluation of Zone 6 using the decision tree provided in Figure 1-3 is provided in this section.

8.5.1 Decision Tree

The evaluation of data using the decision tree (Figure 1-3) is as follows:

- Data has not been collected or evaluated. Information describing the site, previous investigation (if conducted), and physical characteristics of the site are necessary for the evaluation of Zone 6.

- No investigations of Zone 6 have been conducted therefore the nature and extent of contamination, if present, is unknown.

- It is unknown whether an imminent threat to human health or the environment is present.

- Data is required to determine contaminant fate, human health risks, and further evaluate the site.

- Further action is required for Zone 6 and is discussed in Section 8.6.

8.6 RECOMMENDATION

An investigation of Zone 6 has not been conducted. Background review, collection of historical information, interviews, and other activities are necessary to provide a site description which includes a discussion of activities at the site. This is necessary to determine potential contaminants of concern and contaminated media of concern. Based on the background information, sampling locations can be identified. Initial sampling at the site should focus on sampling of the locations expected to have the highest level of contamination. If contaminated media are identified during this initial investigation, further sampling should be conducted to determine the nature and extent of contamination and to obtain sufficient data to perform risk assessments and evaluation of the site. The media that should be investigated include soil and groundwater, as well as the Thames River sediment.

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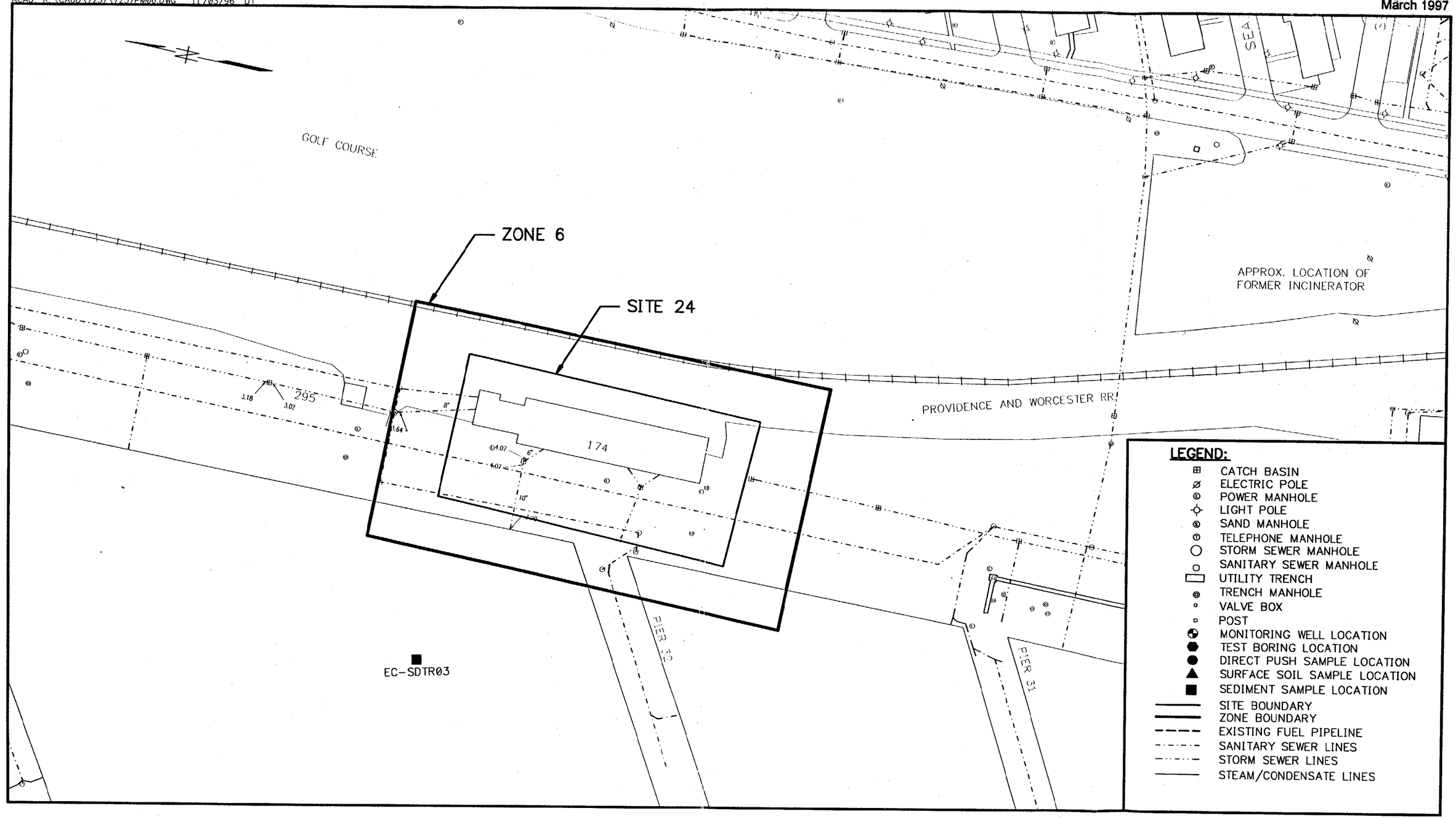

FIGURE 8-1

SAMPLE LOCATION MAP
ZONE 6
NSB-NLON, GROTON, CONNECTICUT

0 80 160
SCALE IN FEET

059606/P

Brown & Root Environmental

CTO 0260

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9.0 ZONE 7

9.1 SITE DESCRIPTION

Zone 7 extends from just north of Building 478 to the southern side of Dorado Road and includes Site 21 - Berth 16, Site 25 - Classified Materials Incinerator, and Transformers Vault 31 at Building 157. Figure 9-1 shows the sites included in Zone 7 and the limits of the zone. Fuel oil distribution lines and steam, condensate, and electrical ducts are also located within Zone 7.

9.1.1 Site 21 - Berth 16

The following structures are included in Site 21

Building	Original Use	Current Use
103	Instruction	Instruction
173	Substation	Electrical Distribution
106	Photolab and Electronics	Storage
157	Periscope Shop	Optical Shop
456, 478	Maintenance Shop	Maintenance Shop

Buildings 103, 173, 157, 106 were constructed sometime between 1918 and 1944. Building 456 and 478 were constructed sometime after the incinerator (Site 25) was demolished in 1979. Berth 16 formerly included an underground, 250-gallon, diesel fuel storage tank that was located adjacent to the northern wall of Building 157. The storage tank was connected to the diesel-fuel transfer line that extended from the storage tank and along Pier 15, east of Building 173., and an underground diesel-fuel transfer line that extended from the storage tank and along Pier 15, east of Building 173. The storage tank was used to power the emergency generator for the sewage-lift station. Besides a former septic tank with a leaching field that serviced Building 173, no other underground tank locations are reported to be located within Zone 7. The exact locations of the former septic tank and leaching field are not known

9.1.2 Site 25 - Classified Materials Incinerator

Between 1944 and 1963, the incinerator located within Building 97 was used to burn classified materials and other wastes generated at NSB-NLON. The incinerator was demolished in 1979 and Buildings 456 and 478 were constructed.

All materials generated by base operations that were not salvageable were incinerated at Site 25. Residual ash produced by materials burning were disposed in the Goss Cove Landfill (FFA, 1995). Adjacent to the incinerator was a dumpster-cleaning operation. The incinerator became inoperable in 1963 and ceased operations.

9.1.3 Transformers at Building 157 Vault 31

Transformers, which formerly contained PCB-based oils, were located in an outdoor electrical vault (Vault 31) at Building 157. The transformers reportedly contained approximately 140 gallons of PCB-containing dielectric fluid. These transformers were replaced by non-PCB-containing transformers. Secondary containment was constructed around the new (non-PCB) transformers.

9.1.4 Fuel Oil Distribution Lines and Utility Ducts

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 of these lines is unknown.

Utility ducts and trenches run through Zone 7. Descriptions of the distribution lines and utility ducts and trenches are provided in Sections 1.2.4.3 and 1.2.4.4, respectively. The locations of these are shown in Figure 9-1.

9.2 SITE INVESTIGATIONS

The following investigations were conducted at Zone 7 and are discussed in the sections following:

- Environmental Assessment for Pier 17 Replacement (Maguire Group, Inc., 1994)
- Pier 33 and Berth 16/Former Incinerator Site Investigation (Atlantic, 1995a)

No remedial investigations have been conducted at Site 25 or at the transformers at Building 157.

9.2.1 Environmental Assessment for Pier 17 Replacement

In September 1994, Maguire Group, Inc. prepared an Environmental Assessment (EA) for the proposed pier replacement and dredging alongside Pier 15 and Pier 17. The EA was conducted to determine if the proposed action would affect the offshore environment. Surface water (elutriate), sediment, and benthic species sampling in the vicinity of Pier 15 and 17 were conducted. The EA is discussed as part of the Thames River (Sections 2.2.1 and 2.2.4); however, PAHs and metals were the major contaminants in sediments detected.

9.2.2 Pier 33 and Berth 16/Former Incinerator Site Inspection

The SI summarizes information from the geotechnical investigation conducted by Morrison Geotechnical Engineering in 1989 for the replacement of the quay wall. Seven soil borings were installed northwest of Building 157 (B32, B34 through 37, B39, and B40). The locations are shown on Figure 9-1. Only one boring was sampled (B32). A soil and groundwater sample were collected at this location. The soil sample was analyzed for metals, VOCs, TPH, oil type by fluorescence, pesticides, and PCBs. The groundwater sample was only analyzed for VOCs. Low concentrations of metals and TPH were detected in the soil and the fluorescence analysis indicated that the hydrocarbons present were No. 2 fuel oil. VOCs, pesticides, and PCBs were not detected in the soil sample and VOCs were not detected in the groundwater sample. Petroleum contamination was evident based on odor and visual examination in all the borings except B-35. Another soil sample was collected from a trench dug to the north of Building 157 and analyzed for TPH, VOCs, PAHs, PCBs and TCLP metals. This sample (N.BLDG.157) contained concentrations of TPH of 490 mg/kg, trichloroethane of 1.1 mg/kg, and TCLP lead of 245 mg/L.

Following discovery of petroleum hydrocarbon contamination in the soils at Berth 16/Former Incinerator in 1989, this site was added to the IR Program. Atlantic conducted an SI at the site to determine the presence or absence, as well as, the magnitude of specific contaminants, and to determine if the results warrant an RI/FS. The field investigation consisted of a soil gas surveys, a utility-manhole inspection, drilling soil borings, installing monitoring wells, and soil, groundwater, and sediment sampling and analysis. Seven soil borings (20TB1 through 7) and six soil borings, converted to monitoring wells (20MW2 through 7), were installed within Zone 7. One soil boring (20MW1) was also installed east of Zone 6 as an upgradient monitoring location. Atlantic collected 25 soil samples from the borings and one round of groundwater samples from the monitoring wells. In addition, Atlantic collected two sediment samples (20SD1 and 20SD2) from storm sewer drains. Samples were analyzed for TCL organics and TAL inorganics. Some samples were also analyzed for TPH, TCLP metals, and oil identification by fluorescence, and dioxin.

Forty-nine utility manholes were inspected as part of the SI. The utilities observed consisted of storm sewer, sanitary sewer, electric, telephone, and steam-line manholes. All accessible manholes in the study area were opened and inspected. Any visual evidence of oil contamination, such as an oil sheen on water, discolored sediments, or any petroleum odors was noted. An apparent petroleum sheen was noted in nine of the manholes inspected. None of the manholes displayed evidence of any major petroleum contamination. Visual inspection of Zone 7 did not indicate evidence of contamination or spillage.

The results of the SI are further discussed under nature and extent and data evaluation provided in Sections 7.4 and 7.5, respectively.

9.3 PHYSICAL CHARACTERISTICS

The following sections summarize information provided in the Pier 33 and Berth 16/Former Incinerator Site Investigation (Atlantic, 1995a) on topography and surface water features, soil characteristics, geology, and hydrogeology. General physical characteristics of the Lower Subase are provided in Section 1.3.

9.3.1 Topography, Surface Features and Surface Water Features

The site topography is generally level with a gradual slope to the west. The zone is generally covered either by buildings or pavement. The site is located adjacent to the Thames River on the west and the Providence and Worcester Railroad on the east. Surface water at the site drains directly into the river via several storm sewers. The catch basins and storm sewers are shown on Figure 9-1.

9.3.2 Soil Characteristics

According to SCS information, Zone 7 is mapped as Urban Land. This group consists of land where more than 85 percent of the surface is covered by streets, parking lots, buildings, and other structures. Most of the underlying soils have been altered by excavating or have been covered with fill material.

9.3.3 Geology and Hydrogeology

According to USGS surficial geology maps, the site is located on a contact between stratified drift and artificial fill. The stratified drift is shown as terrace deposits of the Thames River. USGS bedrock geology maps indicate bedrock at Zone 7 as Alaskite gneiss to the north and Mamacoke Formation to the south.

Bedrock is mapped as Pre-Pennsylvania age rock which consists of igneous intrusives that have been metamorphosed to granitic gneisses.

Geotechnical data collected at Zone 7 confirm the surficial geology and bedrock determinations of the USGS. Investigations indicate that the site is underlain by fill material below ground surface consisting of sand and sand and gravel with pockets of debris overlying gravel. Bedrock is below the fill material at approximately 50 feet below ground surface.

Groundwater flow direction at the site was determined to be to the west toward the Thames River.

9.4 NATURE AND EXTENT

The discussion of nature and extent is based on the results of the geotechnical investigation conducted in 1989 and the SI Report (Atlantic, 1995a). The results of soil, storm sewer sediment, and groundwater sampling are summarized below as well as the results of the medium-specific COPC screening. The majority of the offshore environment in the vicinity of Zone 7, with the exception of sediments, is discussed as part of the Thames River (Sections 2.2.1 and 2.2.4).

9.4.1 Soil

Tables 9-1 through 9-4 summarize the analytical results of the soil samples collected from Zone 4 and summarize the COPC screening results. The analytical data is grouped using sample depth and analytical method. Analytical data for shallow soils (sample depth of < 4 feet) are summarized in Table 9-1, while data for deep samples (sample depth of > 4 feet) are shown in Table 9-2. Analytical results from the TCLP performed on shallow and deep soils are shown in Tables 9-3 and 9-4, respectively.

Background concentrations of inorganics in soil, used below for comparison purposes, were taken from the *Background Concentrations of Inorganics in Soil Report* (Atlantic, 1995b).

Drawings 1 through 4 (back pocket) show the distribution of TPH and lead contamination in soil in all zones, including Zone 7, being investigated as part of the Lower Subase RI. Drawings 1 and 3 show TPH and lead isoconcentration contours, respectively, for shallow soils, whereas Drawings 2 and 4 show the same respective contours for deep soils.

Shallow

Twenty-three inorganic chemicals were detected in fifteen shallow soil samples (0 to 4 feet below ground surface). Of these chemicals, aluminum, antimony, arsenic, barium, beryllium, iron, lead, manganese, mercury, nickel, selenium, and thallium are identified as COPCs. Antimony, barium, calcium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, sodium, vanadium, and zinc were detected at maximum concentrations greater than NSB-NLON background soil concentrations (2.05 mg/kg, 57.2 mg/kg, 499 mg/kg, 8 mg/kg, 25.6 mg/kg, 17,200 mg/kg, 17.5 mg/kg, 3,650 mg/kg, 188 mg/kg, 0.05 mg/kg, 5.95 mg/kg, 2,580 mg/kg, 20.5 mg/kg, 35.1 mg/kg, and 31.3 mg/kg, respectively). Antimony (at 20TB4) and cobalt, iron, magnesium, potassium, and vanadium at (20TB7) were detected above background at only one location. The concentrations of the barium, copper, lead, manganese, mercury, nickel, and zinc were generally elevated in surface soils samples in the vicinity of Buildings 478, 456, and 157, and may be related to fill material placed in these areas. Most concentrations of calcium, nickel, and sodium were greater than background; however, concentrations of these metals were similar throughout the zone and in the upgradient, offsite sample location 20MW1. Maximum concentrations of four inorganics were detected in 20MW1. Of these metals maximum concentrations of beryllium and selenium were greater than background. Concentrations of these two metals were not detected in onsite shallow soils exceeding background. Lead was detected at a significant concentration in the shallow soil sample collected at 20MW6 (189,000 mg/kg). In general, concentrations of inorganics in shallow soils are less than concentrations in deep soils.

Drawing 3 shows the distribution of lead in shallow soils of Zone 4. The contours show that there are significantly elevated levels of lead (i.e., in excess of the CTDEP Industrial Remediation Standard) in shallow soils west of Building 456 and south of Site 25 and at fairly high levels at the northeast corner of Building 157. Based on boring log information, the borings for 20MW6, located south of Site 25, and 20TB4, located in the northeast corner of Building 157, were installed in construction debris and ash, which may be the source of the elevated inorganics.

Lead concentrations measured in sediment samples taken from the Thames River are also provided on Drawing 3. As indicated on the drawing, many of these sample locations have been subsequently dredged. The lead concentrations measured in the river sediments along Zone 7 are approximately 3 orders of magnitude less than the maximum concentration measured in shallow Zone 7 soil. The sediment concentrations adjacent to Zone 7 are generally the same as other levels detected in the Thames River. As discussed in Section 2, the levels of lead detected in these sediment samples pose a potential problem to ecological receptors (i.e., exceeds background and ecological benchmark value).

Barium was the only inorganic detected in TCLP leachate for shallow soil. The concentration of barium detected in the leachate was below pollutant mobility criteria.

Although moderate to high concentrations of BTEX were detected at a number of soil-gas sample locations, acetone and methylene chloride were the only VOCs detected in shallow soils. Acetone and methylene chloride are typical laboratory contaminants. Although VOC concentrations were less than 0.1 mg/kg, methylene chloride was still identified as a COPC. Fourteen SVOCs were detected in shallow soils at concentrations as high as 19 mg/kg; although a majority of concentrations were less than 1 mg/kg. SVOCs were detected in shallow soils throughout Zone 7; with the highest concentrations detected at 20MW6 and 20MW3. All of the SVOCs identified as COPCs in Table 9-1 are PAHs. Benzo(g,h,i)perylene was retained as a SVOC COPC for Zone 7 by default because no criteria were available for screening. SVOCs were not detected in shallow soils at locations 20MW7, 20TB2, and 20TB4. Note that target compounds could not be quantified in these samples because of elevated TIC interference. Boring locations 20MW7 and 20TB4 contained visual petroleum contamination. Therefore, these samples are likely to contain elevated concentrations of SVOCs. Seven pesticides were detected in deep soils. Four pesticides were detected at location 20MW1 only. DDT was detected in shallow soils collected at 20MW1, 20TB6 and 20TB7 at concentrations less than 0.05 mg/kg. PCBs (Aroclor 1260) were not detected in any of the shallow soil samples. Dioxin was detected at 20MW6 at 0.016 µg/kg. Pesticides and PCBs were not identified as COPCs as detected concentrations were less than screening levels.

TPH was only analyzed for in one shallow soil (20MW1) and was not detected. Therefore, no isoconcentration contours for TPH are shown on Drawing 1.

Deep

Twenty-five inorganic constituents were detected in fifteen deep soil samples (greater than 4 feet below ground surface). Of these chemicals, aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, thallium, vanadium, and zinc were identified as COPCs. Except for aluminum, beryllium, and cyanide, all inorganics were detected at maximum concentrations greater than NSB-NLON background soil concentrations. Antimony, calcium, lead, sodium, and zinc were the only metals detected at concentrations exceeding background in deep soils in the vicinity of the east-northeast portion of Building 157 and the area east and southeast of the building. These inorganics were detected at concentrations similar to or lower than other portions of Zone 7 and are likely associated with fill materials placed in the area. Antimony, barium, boron, cadmium, calcium, copper, iron, lead, nickel, and zinc were detected in deep soil samples collected at locations 20TB4 and/or 20MW6 at concentrations significantly greater than (as much as one order of magnitude or

more) concentrations detected in soils collected at other locations within Zone 7 and are generally the highest detected within the Lower Subase.

Drawing 4 shows the distribution of lead in deep soils of Zone 7. The contours show that there are very high levels of lead (i.e., in excess of the CTDEP Industrial Remediation Standard) in deep soils west of Building 456 and south of Site 25, and at the northeast corner of Building 157. Based on boring log information, the borings for wells 20MW5 and 20MW6, located south and southwest of Site 25, and 20TB4, located in the northeast corner of Building 157, were installed in construction debris and ash, which may be the source of the elevated inorganics. A trace of cinders were also observed at 20TB5 (located south of Site 25). The maximum lead concentration measured in the deep soil (9,770 mg/kg) is roughly 20 times less than the maximum concentration measured in the shallow soils (189,000 mg/kg). By comparing Drawings 3 and 4, it can be seen that the lead contamination in deep soil is about as pervasive as in shallow soil.

Lead concentrations measured in sediment samples taken from the Thames River are also provided on Drawing 7. The lead concentrations measured in the river sediments along Zone 7 are approximately 40 times less than the maximum concentration measured in deep Zone 7 soil. As discussed above, the sediment concentrations adjacent to Zone 7 are generally the same to slightly above other levels detected in the Thames River and the levels of lead pose a potential problem to ecological receptors.

TCLP metals analysis was conducted on all deep samples collected in Zone 7. Concentrations of lead in TCLP leachates of Zone 7 samples ranged up to 45,900 µg/L. This is the only chemical detected in excess of remediation standards. Several samples have lead concentrations exceeding Connecticut remediation standards for pollutant mobility for GB water. Only TCLP lead concentrations at 20MW5 and 20MW6 exceeded the Federal toxicity characteristic regulatory level for lead (5,000 µg/L).

Five VOCs were detected in deep soils at concentrations of less than 0.1 mg/kg. Methylene chloride, a typical laboratory contaminant, was the only VOC identified as a COPC. Thirteen SVOCs were detected in subsurface soils at concentrations as high as 29 mg/kg (at location 20TB7); although a majority of concentrations of SVOCs were less than 2 mg/kg. All of the SVOCs identified as COPCs are PAHs. The majority of PAHs were detected at locations 20TB5, 20TB6, and 20TB7, which are in the vicinity of Buildings 478 and 456. The maximum detections were generally at location 20TB7. Limited SVOCs were detected in 20MW5, 20TB3, and 20TB4. Although SVOCs were not detected in 20MW2, 20MW4, 20MW7, 20TB1, and 20TB2, target compounds could not be quantified for all of these samples because of elevated TIC interference. Boring locations 20MW4, 20MW7, and 20TB1 contained visual petroleum contamination and the sample at 20TB2 had petroleum odor identified during drilling. Therefore, these

samples are likely to contain elevated concentrations of SVOCs. DDT and DDD were the only pesticides detected in deep soils. Neither was detected at a concentration exceeding screening criteria.

TPH concentrations in deep soil ranged from 150 mg/kg to 2500 mg/kg, with subsurface soils at 20MW3, 20MW5, 20MW7, and 20TB4 having concentrations greater than 500 mg/kg (state residential criteria). This is evident from the isoconcentrations on Drawing 2. TPH results correlate well with visual observations made during drilling. Visual petroleum contamination was noted at all of these locations. Fluorescence spectroscopy results indicated the presence of heavyweight residual fuel oil or road tar at 20MW2, 20MW4, 20MW7, and 20TB1. No. 2 diesel fuel was identified at 20MW5. Similar unknown compounds, which may be industrial lubrication oil or bituminous pavement, were identified at 20MW3, 20TB6, and 20TB7. Heavy weight fuel oil (i.e., No. 6) was identified in 20TB3, 20TB4, and 20TB5. Unknown light aromatic compounds were detected at 20TB2.

Based on soil analytical results, contamination of shallow and deep soils is evident. The major chemicals of concern, metals and TPH, were detected at concentrations of concern in three areas of Zone 7; south and southwest of Site 25, northwest of Building 157, and the northeast corner of Building 157.

9.4.2 Storm Sewer Sediment

Table 9-5 summarizes analytical results for sediment samples collected in Zone 7 storm sewers and summarizes the COPC screening results.

Two storm sewer sediment samples were collected within Zone 7. The two sediment samples were collected from separate storm sewer systems. The system where 20SD1 was collected is located in the northern portion of Zone 7, while the system where 20SD2 was collected is in the southern portion of Zone 7. Sediment sample 20SD1 was collected from the storm drain located South west of Site 25, near monitoring wells 20MW5 and 20MW7. Sediment sample 20SD2 was collected from the storm drain located southwest of Building 173, at Dorado and Albacore Roads.

Of the twenty-three inorganics detected in the sediment samples, arsenic, beryllium, iron, manganese, and silver were detected above screening criteria. Inorganic values observed at both sampling locations were very similar in concentration, with values generally slightly higher at location 20SD2. The two sediment samples were collected from two separate storm sewer systems. The system where 20SD1 was collected is located in the northern portion of the site, and the system where 20SD2 was collected is in the southern portion of the site.

A low level of carbon disulfide was detected in sediments collected at 20SD1 (0.01 mg/kg) and 4-methyl-2-pentanone was detected in sediments from 20SD2 (0.006 mg/kg). The acetone and methylene chloride detected in both samples (concentrations 0.12 mg/kg and less) are likely a result of laboratory contamination. SVOCs, predominantly PAHs, were detected at moderate levels (generally less than 0.2 mg/kg) at both sampling locations. Benzo(a)pyrene, benzo(b)fluoranthene, and benzo(g,h,i)perylene were identified as COPCs. Benzo(g,h,i)perylene was retained as a COPC by default because no criteria were available for screening. All of the maximum detections of PAHs were at 20SD2 and the concentrations of total PAHs at 20SD2 was among the highest at Zone 7 (totaling 7.09 mg/kg). The sediments from 20SD1 contained fewer SVOCs than were detected at 20SD2, as well as at lower concentrations. The SVOCs found in sediments may be petroleum-related. TPH was detected at 1,300 mg/kg and 1,100 mg/kg at 20SD1 and 20SD2, respectively. These levels indicate that TPH is a COPC. Results of fluorescence spectroscopy identified No. 6 fuel oil at both sediment locations. Pesticides and PCBs were not detected in sediment samples.

The exact source of inorganic and petroleum contamination is not clear; however, these contaminants are widespread through out the Lower Subase.

9.4.3 Groundwater

Tables 9-6 and 9-7 summarize analytical results for groundwater samples collected in Zone 7 and summarize the COPC screening results. Analytical results from unfiltered samples are provided in Table 9-6 and the results for filtered samples are summarized in Table 9-7.

Drawings 5 through 7 (back pocket) show the distribution of TPH and lead contamination in groundwater for all zones, including Zone 7, being investigated as part of the Lower Subase RI. Drawing 5 shows isoconcentration contours of TPH concentrations measured in groundwater. Isoconcentration contours of filtered and unfiltered lead concentrations in groundwater are presented on Drawings 6 and 7.

Groundwater samples were collected from six monitoring wells during one round of sampling in 1993. Twelve metals were detected in unfiltered and filtered groundwater samples. Concentrations between unfiltered and filtered groundwater are similar. Six metals (aluminum, arsenic, boron, cadmium, nickel, and thallium) were detected in filtered groundwater samples only. For both unfiltered and filtered detections, a majority of the maximum concentrations were detected in wells 20MW2 and 20MW6. Concentrations in unfiltered and filtered groundwater at Zone 7, although generally greater, were similar to concentrations in the Lower Subase. In particular, concentrations of lead and zinc at 20MW6, barium at 20MW5, and manganese at 20MW2 and 20MW3 in unfiltered and filtered groundwater were as much as

two orders of magnitude greater than other concentrations both within Zone 7 and the Lower Subase. Concentrations of barium, iron, lead, manganese, sodium, and zinc in unfiltered groundwater and aluminum, arsenic, barium, boron, cadmium, iron, lead, manganese, sodium, thallium, and zinc in filtered groundwater exceeded one or more screening levels.

The distribution of one of the inorganics, lead, in unfiltered and filtered groundwater samples is shown on Drawings 6 and 7, respectively. One small plume of lead contamination is evident at well 20MW6 on Drawings 6 and 7 in Zone 7. Low concentrations to nondetects are seen at the other wells in Zone 7. This information indicates that the lead contamination is isolated or that tidal flushing is reducing lead levels in the groundwater downgradient of 20MW6.

Limited organic compounds were detected in groundwater. Three VOCs (at 20MW4 and 20MW6) and seven SVOCs (at 20MW3, 20MW5, 20MW4, and 20MW7) were detected at low concentrations (10 µg/L or less). Most of the SVOCs were detected at 20MW3 and 20MW5. Chloroform was the only VOC identified as a COPC, while acenaphthylene and phenanthrene were the only SVOCs identified as COPCs. TPH, pesticides, and PCBs were not detected in groundwater at Zone 7. However, fluorescence spectroscopy identified heavy fuel oil (No. 4 or No. 6) in all groundwater samples.

Averages of one-half of the detection limits are shown on Drawing 5 at all wells because TPH was not detected in any well. All of these average detection limits are at or above the state's residential TPH remediation criteria of 500 mg/L. This information suggests that there is a high level of uncertainty in the TPH results for Zone 7.

The major contaminants of concern for groundwater at Zone 7 are metals. Elevated concentrations of metals in groundwater are likely from fill material at Zone 7. In particular, monitoring wells 20MW5 and 20MW6, where the highest concentrations of metals occur, were installed in construction debris and ash. Although petroleum contamination was detected in soil, groundwater does not appear to have been impacted by this type of contamination.

9.5 DATA EVALUATION

Data was evaluated based on contaminant fate and transport, ecological risk assessment and comparison to state standards. In addition, an evaluation of Zone 7 using the decision tree provided in Figure 1-3 is also included in this section. A human health risk assessment has not been conducted for Zone 7.

9.5.1 Contaminant Fate and Transport

Contaminant fate and transport for these contaminants is discussed in the SI Report and discussed in this subsection.

PAHs in soil are a major contaminant of concern. Sources of PAHs are petroleum and coal, as well as formation during the combustion of organic matter. Smaller PAHs (such as naphthalene) are slightly soluble and are relatively mobile in the environment. They also have Henry's Law constants ranging from 10^{-3} to 10^{-5} and will tend to volatilize. The larger PAHs have lower solubilities and low Henry's law constants. These compounds are not relatively mobile and will not volatilize to a great extent. These compounds remain adsorbed to soils or sediments. Photolysis, chemical oxidation, and biodegradation are important degradative processes controlling the fate of PAHs in the aquatic environment.

Metals are not typically considered to be mobile contaminants in the environment. Lead and other metals do not degrade via any of the identified fate processes (e.g., hydrolysis, photolysis, etc.) although under acidic soil conditions, metals may be solubilized and transported vertically with infiltrating precipitation. The presence of these analytes at depth may reflect the nature of the fill material used to construct the Lower Base, as well as some potential vertical transport associated with industrial activities occurring on the surface. In addition, the presence of lead at the site may be due to the fact that, until the 1950s, all submarines depended on lead batteries for principal means of underwater propulsion.

Based on the absence of any substantial organic groundwater contamination at Zone 7, it does not appear that significant migration of contaminants have occurred. Inorganic contaminants in soil have migrated to groundwater. Storm sewers within Zone 7, which outlet into the Thames River, may act as preferential contaminant migration pathways for Zone 7 contaminants.

9.5.2 Ecological Risk Assessment

The only potential ecological habitat near the Lower Subase is the Thames River. PAHs and metals are the primary contaminants of concern for the Thames River. Significant concentrations of PAHs and metals (lead) in soils at Zone 7 were detected. Contamination at Zone 7 may be impacting the Thames River. Note that the ecological risk assessment for the Thames River, discussed in Section 2.5.3, concluded that the Lower Subase represented a minimal potential risk to ecological receptors.

9.5.3 Comparison of Site Data to Connecticut Standards

Analytical data for the Lower Subase were compared to Connecticut drinking water standards and remediation standards. Site-specific soil data and sediment (from the storm sewer drain) data were compared to remediation standards for direct exposure and pollutant mobility. Direct exposure criteria for residential exposure were used to conservatively evaluate potential exposure to soil or storm drain sediments at the site. In shallow soils at Zone 7, concentrations of lead, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and benzo(k)fluoranthene exceeded the residential direct exposure criteria. Except for benzo(k)fluoranthene, concentrations of these chemicals also exceeded industrial direct exposure criteria. In deep soils at Zone 7, concentrations of antimony, arsenic, copper, lead, and TPH exceeded the residential direct exposure criteria. Concentrations of arsenic, lead, and TPH also exceeded the industrial direct exposure criteria. For storm sewer sediments, only concentrations of TPH exceeded the residential direct exposure criteria. Sediment concentrations did not exceed the industrial criteria.

To address concerns regarding migration of chemicals from soil to groundwater, site soil data were compared to Connecticut remediation standards for pollutant mobility. In shallow soils, concentrations of benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, and fluoranthene exceeded GB pollutant mobility criteria. For deep soils, only concentrations of TPH exceeded the GB pollutant mobility criteria.

Analytical groundwater data for Zone 7 were compared to state standards. There were no exceedances of State MCLs for either unfiltered or filtered groundwater. However, sodium was detected in the unfiltered and filtered groundwater samples in Zone 7 at maximum concentrations exceeding the state Notification Level of 28,000 µg/L. Concentrations of lead in unfiltered and filtered groundwater exceeded the Connecticut remediation standards for groundwater protection. Concentrations of arsenic (filtered), lead (unfiltered and filtered), zinc (unfiltered and filtered), acenaphthylene, and phenanthrene in groundwater exceeded surface water protection criteria.

9.5.4 Decision Tree

The general decision tree for the evaluation of sites is provided in Figure 1-3. the evaluation of data using this decision tree for Zone 7 is as follows:

- Existing data have been collected and evaluated. Information describing the site, previous investigations, and physical characteristics of the site are provided in Sections 9.1, 9.2, and 9.3, respectively. The nature and extent of contamination is provided in Section 9.4.

- High levels of metals were detected in soil. In particular, the concentrations of lead in shallow soils at 20MW6 were 189,000 mg/kg (see Drawing 3). Ash was observed at 20MW6 and 20MW5 and TCLP lead results for deeper soils at both locations exceeded Federal Toxicity Characteristics regulatory levels (indicating these soils are RCRA hazardous wastes).

- Contaminant fate and transport have been described, an ecological risk assessment for the Thames River has been conducted (as part of the Phase II RI) and data have been compared to CTDEP Standards. A baseline human health risk assessment has not been conducted.

- Data indicates that activities at Zone 7 have resulted in contamination of soil and groundwater. The contamination appears to be related to past activities and contaminated fill material placed at Zone 7. The extent of contamination has not been fully characterized.

- Further action is required for Zone 7 and is discussed in Section 9.6.

9.6 RECOMMENDATIONS

Recommendations were provided in the SI Report (Atlantic, 1995a) and are reiterated below with minor modifications. Further investigation to address soils and groundwater containing petroleum constituents, contamination in catch basins, lead in subsurface soils (including soils with TCLP lead levels greater than 150 µg/L) and groundwater, and the extent of ash disposal observed at 20MW6 was recommended. Testing of any underground storage tank and piping not recently tested was recommended to eliminate the possibility of an ongoing source. Additional investigation and sediment analysis of the catch basin system was recommended to determine the extent and source of sediment contamination. Removal and disposal of contaminated sediments and modification of any site operations identified as contributing to the sediment contamination was also recommended.

These recommendations are justified as:

- While TPH concentrations were 2,500 mg/kg or less, individual concentrations of PAHs were detected at concentrations as high as 19 mg/kg.

- Lead concentrations in soils were as high as 189,000 mg/kg and TCLP lead concentrations exceeded Federal Toxicity Characteristic regulatory levels. Lead was also detected in the groundwater at concentrations above MCLs.

- Ash and construction debris were observed at boring locations which also had high levels of metals contamination. Dioxin was also detected at a boring location which had ash.

- Sediment samples were only collected from two locations along the storm sewers. Other portions of the storm sewers may be contaminated. The storm sewers collect runoff from various portions of the base and discharge to the Thames River. Investigation of the storm sewers will aid in identifying the extent of contamination as well as potential sources.

It is further recommended that additional soil samples be collected to evaluate contaminant (i.e., lead) mobility and the samples should only be analyzed by the SPLP method and not by TCLP method. The SPLP method is the latest method recommended by the State of Connecticut to evaluate contaminant mobility in soils. The new SPLP results would be used to confirm the lead mobility problem currently identified by the TCLP results for deep soils. Additional sampling and analysis is also recommended to determine the nature and extent of lead in soils, to monitor lead levels in groundwater, to quantify the amount of lead entering the Thames River, and to evaluate the cumulative ecological impacts.

Because contaminants associated with the Lower Subase have been detected in the sediments in the Thames River, sampling of the sediments is also recommended in conjunction with characterization activities to aid in the identification of source areas and contaminants of concern. Sampling of media from the Thames River is discussed in Section 2.6.

Based on the results of the additional sampling and analyses and the integrity inspection activities, source areas will be able to be defined and remedial activities for the source areas will be conducted as necessary. Remedial activities should focus on the removal of free product and highly contaminated areas (hot spots) which may act as sources of contamination to other media/receptors. However, because Zone 7 is located in an active, industrialized area which is vital to national security, petroleum contamination is widespread in the Lower Subase, and contamination presents minimal risks to human health and the environment (i.e., limited exposure pathways), remediation of all contaminated material at Zone 7 by excavation is not feasible or practical. Therefore, in-situ remedial options such as containment, air sparging, soil vapor extraction (SVE), natural attenuation or bioremediation will also be explored and used as applicable.

TABLE 9-1

COPC SCREENING FOR LOWER SUBASE
ZONE 7 - SHALLOW SOILS (<4 FEET)
NSB-NLON, GROTON, CONNECTICUT
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Parameter	Frequency (1)	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	SSL Inhalation (3)	SSL Migration to Groundwater (3)	State Residential Direct Exposure (4)	State Industrial Direct Exposure (4)	State Pollutant Mobility (GB) (4)	Select as COPC? (5)
Volatile Organic Compounds (mg/kg)												
Acetone	6/15	0.007 - 0.051	0.011 - 0.032	0.012	20TB7	780	100000	0.8	500	1000	140	N
Methylene chloride	7/15	0.005 - 0.01	0.01 - 0.012	0.006	20TB7	85	13	0.001	82	760	1	Y
Semivolatile Organic Compounds (mg/kg)												
Anthracene	2/15	0.002 - 0.26	0.34 - 11	0.88	20TB5	2300	-	590	1000	2500	400	N
Benzo(a)anthracene	9/15	0.023 - 9.5	0.34 - 11	1.2	20MW6	0.88	-	0.08	1	7.8	1	Y
Benzo(a)pyrene	8/15	0.033 - 14	0.34 - 11	1.53	20MW6	0.088	-	0.4	1	1	1	Y
Benzo(b)fluoranthene	11/15	0.036 - 16	0.36 - 0.39	2.0	20MW6	0.88	-	0.2	1	7.8	1	Y
Benzo(g,h,i)perylene	3/15	0.32 - 7.3	0.34 - 11	1.04	20MW6	-	-	-	-	-	-	Y (6)
Benzo(k)fluoranthene	6/15	0.023 - 9.7	0.34 - 11	1.20	20MW6	8.8	-	2	8.4	78	1	Y
Bis(2-ethylhexyl)phthalate	2/15	0.032 - 0.093	0.34 - 11	0.87	20MW1	46	31000	180	44	410	11	N
Chrysene	9/15	0.049 - 11	0.34 - 11	1.33	20MW6	88	-	8	-	-	-	Y
Di-N-butyl phthalate	1/15	0.32	0.34 - 11	0.90	20TB7	780	2300	270	1000	2500	140	N
Di-N-octyl phthalate	1/15	0.041	0.34 - 11	0.88	20MW1	160	10000	10000	1000	2500	20	N
Fluoranthene	12/15	0.066 - 19	0.36 - 0.39	2.6	20MW6	310	-	210	1000	2500	56	N
Indeno(1,2,3-cd)pyrene	3/15	0.33 - 7	0.34 - 11	1.02	20MW6	0.88	-	0.7	-	-	-	Y
Phenanthrene	8/15	0.042 - 13	0.34 - 0.39	1.57	20MW3	-	-	-	1000	2500	40	N
Pyrene	11/15	0.059 - 14	0.36 - 0.39	1.89	20MW6	230	-	210	1000	2500	40	N
Pesticides/PCBs (mg/kg)												
4,4'-DDD	2/15	0.0035 - 0.035	0.0034 - 0.0039	0.004	20TB7	2.7	-	0.8	-	-	-	N
4,4'-DDE	2/15	0.015 - 0.017	0.0034 - 0.035	0.005	20MW1	1.9	-	3	-	-	-	N
4,4'-DDT	4/15	0.017 - 0.043	0.0035 - 0.014	0.010	20TB7	1.9	-	2	-	-	-	N
alpha-Chlordane	2/15	0.012	0.0017 - 0.018	0.003	20MW1	0.49	-	-	0.49	2.2	0.066	N
Dioxin	1/4	0.0002	NA (7)	NA (7)	20MW6	-	-	-	-	-	-	N (6)
gamma-Chlordane	2/15	0.0073 - 0.0075	0.0017 - 0.018	0.002	20MW1	0.49	-	-	0.49	2.2	0.066	N
Heptachlor epoxide	2/15	0.0039 - 0.004	0.0017 - 0.018	0.002	20MW1	0.07	5	0.03	0.067	0.63	0.02	N
Metals (mg/kg)												
Aluminum	15/15	136 - 12000	-	5663	20MW1	7800	-	-	-	-	-	Y
Antimony	1/15	7.8	1.8 - 7580	255	20TB4	3.1	-	0.3	27	8200	-	Y
Arsenic	15/15	0.32 - 3.1	-	1.4	20MW1	0.43	750	1	10	10	-	Y
Barium	15/15	23.7 - 364	-	70.6	20TB4	550	690000	82	4700	140000	-	Y

TABLE 9-1

COPC SCREENING FOR LOWER SUBASE
ZONE 7 - SHALLOW SOILS (<4 FEET)
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 2

Parameter	Frequency (1)	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	SSL Inhalation (3)	SSL Migration to Groundwater (3)	State Residential Direct Exposure (4)	State Industrial Direct Exposure (4)	State Pollutant Mobility (GB) (4)	Select as COPC? (5)
Beryllium	8/15	0.15 - 0.78	0.05 - 0.29	0.26	20MW1	0.15	1300	3	2	2	-	Y
Boron	2/15	1.7 - 2.9	1.2 - 112	7.8	20TB4	700	-	-	-	-	-	N
Calcium	15/15	367 - 5480	-	1521	20TB4	-	-	-	-	-	-	N (8)
Chromium	14/15	4.1 - 21.4	4.1	9.0	20TB7	39	270	-	3900/100 (9)	5.1E+4/100 (9)	-	N
Cobalt	13/15	1.1 - 9.1	2.6 - 2.8	3.7	20TB7	470	-	-	-	-	-	N
Copper	15/15	3 - 122	-	32.6	20MW5	310	-	-	2500	76000	-	N
Cyanide	1/15	0.18	0.15 - 1	0.15	20MW3	160	-	2	1400	41000	-	N
Iron	15/15	4510 - 18900	-	7997	20TB7	2300	-	-	-	-	-	Y
Lead	15/15	6.3 - 189000	-	12727	20MW6	400	-	-	500	1000	-	Y
Magnesium	15/15	47.9 - 5650	-	1894	20TB7	-	-	-	-	-	-	N (8)
Manganese	15/15	32.7 - 317	-	144	20TB7	39	-	-	-	-	-	Y
Mercury	4/15	0.03 - 0.12	0.02 - 1.2	0.08	20MW5	2.3	-	0.1	20	610	-	Y
Nickel	15/15	1.8 - 17.7	-	7.35	20TB6	160	13000	7	1400	7500	-	Y
Potassium	15/15	4.8 - 5240	-	1291	20TB7	-	-	-	-	-	-	N (8)
Selenium	2/15	0.69 - 0.76	0.14 - 1.7	0.22	20MW1	39	-	0.3	340	10000	-	Y
Sodium	14/15	56.3 - 164	49.5	104	20MW3	-	-	-	-	-	-	N (8)
Thallium	2/15	0.16 - 0.18	0.08 - 1	0.11	20TB1	0.55	-	0.04	5.4	160	-	Y
Vanadium	15/15	1.9 - 44.1	-	15.4	20TB7	55	-	300	470	14000	-	N
Zinc	15/15	13.6 - 608	-	101	20MW6	2300	-	620	20000	610000	-	N

- Not available or not applicable.

(1) Includes data from the following samples 20MW1-0.52.5, 20MW11-0.52.5, 20MW2-0002, 20MW3-0204, 20MW4-0204, 20MW5-0002, 20MW6-0204, and 20MW7-0204. 20TB1-0204, 20TB2-0204, 20TB3-0204, 20TB4-0002, 20TB5-0002, 20TB6-0002, and 20TB7-3242

(2) Based on current USEPA Region III guidance (USEPA Region III, May 10, 1996). Residential Soil Ingestion for soil and sediment.

(3) USEPA Soil Screening Levels (USEPA, May 1996). For migration to groundwater, values associated with a dilution and attenuation factor (DAF) of 1.0.

(4) CTDEP, December 1995.

(5) Contaminant of Potential Concern; Yes (Y) indicates that the maximum concentration exceeds one or more of the criteria; No (N) indicates that the maximum does not exceed any of the criteria.

(6) Criteria not available.

(7) Detection Limits for Dioxin nondetects not available.

(8) Essential nutrient. Not evaluated for COPC selection.

(9) Trivalent chromium/hexavalent chromium.

TABLE 9-2

COPC SCREENING FOR LOWER SUBASE
ZONE 7 - DEEP SOILS (>4 FEET)
NSB-NLON, GROTON, CONNECTICUT
PAGE 1 OF 2

Parameter	Frequency (1)	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	SSL Inhalation (3)	SSL Migration to Groundwater (3)	State Residential Direct Exposure (4)	State Industrial Direct Exposure (4)	State Pollutant Mobility (GB) (4)	Select as COPC? (5)
Volatile Organic Compounds (mg/kg)												
2-Butanone	1/15	0.02	0.011 - 0.014	0.007	20TB6	4700	-	-	500	1000	80	N
Acetone	5/15	0.025 - 0.097	0.011 - 0.035	0.024	20TB6	780	100000	0.8	500	1000	140	N
Carbon disulfide	2/15	0.006 - 0.007	0.011 - 0.014	0.006	20MW5	780	720	2	-	-	-	N
Methylene chloride	7/15	0.005 - 0.012	0.011 - 0.013	0.007	20TB7	85	13	0.001	82	760	1	Y
Toluene	1/15	0.003	0.011 - 0.014	0.006	20TB7	1600	650	0.6	500	1000	67	N
Semivolatile Organic Compounds (mg/kg)												
Acenaphthene	4/15	0.61 - 1.4	0.36 - 1.8	0.49	20TB7	470	-	29	-	-	-	N
Anthracene	3/15	0.23 - 0.81	0.36 - 1.8	0.39	20TB7	2300	-	590	1000	2500	400	N
Benzo(a)anthracene	5/15	0.25 - 0.57	0.36 - 1.8	0.38	20TB7	0.88	-	0.08	1	7.8	1	Y
Benzo(a)pyrene	2/14	0.26 - 0.37	0.26 - 1.8	0.35	20MW7/20TB7	0.088	-	0.4	1	1	1	Y
Benzo(b)fluoranthene	3/14	0.32 - 0.72	0.23 - 1.8	0.39	20TB7	0.88	-	0.2	1	7.8	1	Y
Benzo(k)fluoranthene	1/14	0.22	0.29 - 1.8	0.33	20TB5	8.8	-	2	8.4	78	1	N
Carbazole	1/15	0.18	0.36 - 1.8	0.32	20TB7	32	-	0.03	-	-	-	Y
Chrysene	5/15	0.27 - 0.64	0.36 - 1.8	0.39	20TB7	88	-	8	-	-	-	N
Dibenzofuran	2/15	0.49 - 0.77	0.36 - 1.8	0.37	20TB7	31	-	-	-	-	-	N
Fluoranthene	9/15	0.29 - 2.9	0.36 - 0.4	0.88	20TB7	310	-	210	1000	2500	56	N
Fluorene	4/15	0.39 - 1.6	0.36 - 1.8	0.50	20TB7	310	-	28	1000	2500	56	N
Phenanthrene	5/15	0.34 - 3.6	0.36 - 1.8	0.77	20TB7	-	-	-	1000	2500	40	N
Pyrene	9/15	0.23 - 1.9	0.36 - 0.4	0.66	20TB7	230	-	210	1000	2500	40	N
Pesticides/PCBs (mg/kg)												
4,4'-DDD	1/15	0.0044	0.0036 - 0.036	0.004	20TB6	2.7	-	0.8	-	-	-	N
4,4'-DDT	3/15	0.0044 - 0.071	0.0036 - 0.0048	0.011	20TB7	1.9	-	2	-	-	-	N
Metals (mg/kg)												
Aluminum	15/15	3430 - 8120	-	4991	20TB7	7800	-	-	-	-	-	Y
Antimony	5/15	2.4 - 1820	1.9 - 3.6	125	20TB4	3.1	-	0.3	27	8200	-	Y
Arsenic	15/15	0.32 - 50	-	4.56	20TB4	0.43	750	1	10	10	-	Y
Barium	15/15	17.7 - 550	-	81.6	20TB4	550	690000	82	4700	140000	-	Y
Beryllium	12/15	0.14 - 1.2	0.18 - 0.19	0.31	20MW6	0.15	1300	3	2	2	-	Y
Boron	3/15	1.4 - 25.1	1.4 - 5.7	3.03	20TB4	700	-	-	-	-	-	N
Cadmium	5/15	0.42 - 4	0.31 - 0.63	0.58	20TB4	3.9	1800	0.4	34	1000	-	Y

TABLE 9-2

COPC SCREENING FOR LOWER SUBASE
ZONE 7 - DEEP SOILS (>4 FEET)
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 2

Parameter	Frequency (1)	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	SSL Inhalation (3)	SSL Migration to Groundwater (3)	State Residential Direct Exposure (4)	State Industrial Direct Exposure (4)	State Pollutant Mobility (GB) (4)	Select as COPC? (5)
Calcium	15/15	578 - 35000	-	3767	20TB4	-	-	-	-	-	-	N (6)
Chromium	14/15	4.5 - 44.4	4.1	11.7	20TB4	39	270	-	3900/100 (7)	5.1E+4/100 (7)	-	Y
Cobalt	13/15	2.2 - 12.3	2.2 - 2.8	4.3	20TB4	470	-	-	-	-	-	N
Copper	14/15	4.2 - 9010	3.5	628	20TB4	310	-	-	2500	76000	-	Y
Cyanide	1/15	0.46	0.16 - 0.21	0.12	20TB4	160	-	2	1400	41000	-	N
Iron	15/15	4730 - 186000	-	21572	20TB4	2300	-	-	-	-	-	Y
Lead	15/15	2.2 - 9770	-	847	20TB4	400	-	-	500	1000	-	Y
Magnesium	15/15	1210 - 7610	-	2309	20TB4	-	-	-	-	-	-	N (6)
Manganese	15/15	54 - 956	-	165	20TB4	39	-	-	-	-	-	Y
Mercury	4/15	0.05 - 1.3	0.02 - 0.09	0.13	20TB4	2.3	-	0.1	20	610	-	Y
Nickel	15/15	3.5 - 254	-	32	20MW6	160	13000	7	1400	7500	-	Y
Potassium	15/15	596 - 3980	-	1491	20TB7	-	-	-	-	-	-	N (6)
Selenium	1/15	0.22	0.15 - 0.26	0.10	20TB6	39	-	0.3	340	10000	-	N
Silver	2/15	0.75 - 4.1	0.45 - 0.64	0.56	20TB4	39	-	2	340	10000	-	Y
Sodium	15/15	66.8 - 1880	-	269	20MW6	-	-	-	-	-	-	N (6)
Thallium	2/15	0.14 - 0.18	0.09 - 1.6	0.12	20TB1	0.55	-	0.04	5.4	160	-	Y
Vanadium	15/15	8.2 - 213	-	29	20MW6	55	-	300	470	14000	-	Y
Zinc	15/15	11 - 3440	-	318	20TB4	2300	-	620	20000	610000	-	Y
Miscellaneous (mg/kg)												
TPH	10/15	86 - 2500	65 - 72	458	20MW7	500	-	-	500	2500	2500	Y

- Not available or not applicable.

(1) Includes data from the following samples 20MW2-1416, 20MW3-0810, 20MW4-0406, 20MW5-0608, 20MW6-1214, 20MW7-0406, 20TB1-0608, 20TB11-0608 20TB2-1416, 20TB3-1012, 20TB4-0406, 20TB4-1416, 20TB5-0406, 20TB6-0810, 20TB7-4852, 20TB17-4852, 20TB7-4856, and 20TB17-4856.

(2) Based on current USEPA Region III guidance (USEPA Region III, May 10, 1996). Residential Soil Ingestion for soil and sediment.

(3) USEPA Soil Screening Levels (USEPA, May 1996). For migration to groundwater, values associated with a dilution and attenuation factor (DAF) of 1.0.

(4) CTDEP, December 1995.

(5) Contaminant of Potential Concern; Yes (Y) indicates that the maximum concentration exceeds one or more of the criteria; No (N) indicates that the maximum does not exceed any of the criteria.

(6) Essential nutrient. Not evaluated for COPC selection.

(7) Trivalent chromium/hexavalent chromium.

TABLE 9-3

COPC SCREENING FOR LOWER SUBASE
ZONE 7 - SHALLOW TCLP SOILS (<4 FEET)
NSB-NLON, GROTON, CONNECTICUT

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	State Pollutant Mobility (GB) (2)	Federal Pollutant Mobility (3)	Select as COPC? (4)
Metals (ug/L)								
Barium	2/2	412 - 440	-	426	20MW1	10000	100000	N

- Not applicable.

(1) Includes data from samples 20MW1-0.52.5 and 20MW11-0.52.5.

(2) CTDEP Pollutant Mobility Remediation Standard for GB classified groundwater; CTDEP, December 1995.

(3) Federal Toxicity Characteristic Regulatory level (58 FR 46049).

(4) Contaminant of Potential Concern; Yes (Y) indicates that the maximum concentration exceeds one or more of the criteria; No (N) indicates that the maximum does not exceed any of the criteria.

TABLE 9-4

COPC SCREENING FOR LOWER SUBASE
ZONE 7 - TCLP DEEP SOILS (>4 FEET)
NSB-NLON, GROTON, CONNECTICUT

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	State Pollutant Mobility (GB) (2)	Federal Pollutant Mobility (3)	Select as COPC? (4)
Metals (ug/L)								
Arsenic	1/15	146	23.4 - 32.1	24.4	20TB4	500	5000	N
Barium	15/15	122 - 4210	-	602	20TB4	10000	100000	N
Cadmium	6/15	2.8 - 10.8	1.8 - 2.5	2.62	20MW6	50	1000	N
Chromium	11/15	3.2 - 46	3.1 - 3.9	8.35	20TB4	500	5000	N
Lead	15/15	4 - 45900	-	4516	20MW5	150	5000	Y
Silver	1/15	8.1	2.5 - 2.9	1.88	20MW5	360	5000	N

- Not applicable.

(1) Includes data from the following samples: 20MW2-1416, 20MW3-0810, 20MW4-0406, 20MW5-0608, 20MW6-1214, 20MW7-0406, 20TB1-0608, 20TB11-0608, 20TB2-1416, 20TB3-1012, 20TB4-1416, 20TB5-0406, 20TB6-0810, 20TB7-4856, and 20TB17-4856.

(2) CTDEP Pollutant Mobility Remediation Standard for GB classified groundwater; CTDEP, December 1995.

(3) Federal Toxicity Characteristic Regulatory Level (58 FR 46049).

(4) Contaminant of Potential Concern; Yes (Y) indicates that the maximum concentration exceeds one or more of the criteria; No (N) indicates that the maximum does not exceed any of the criteria.

TABLE 9-5

COPC SCREENING FOR LOWER SUBASE
ZONE 7 - STORM DRAIN SEDIMENTS
NSB-NLON, GROTON, CONNECTICUT
PAGE 1 OF 2

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	State Remediation Standards (3)		Select as COPC? (4)
							Residential Direct Exposure	Industrial Direct Exposure	
Volatile Organic Compounds (mg/kg)									
4-Methyl-2-pentanone	1/2	0.006	0.013	0.006	20SD2	630	500	1000	N
Acetone	2/2	0.086 - 0.12	-	0.10	20SD2	780	500	1000	N
Carbon disulfide	1/2	0.01	0.013	0.008	20SD1	780	-	-	N
Methylene chloride	2/2	0.011 - 0.015	-	0.013	20SD2	85	82	760	N
Semivolatile Organic Compounds (mg/kg)									
Anthracene	1/2	0.26	0.85	0.034	20SD2	2300	1000	2500	N
Benzo(a)anthracene	1/2	0.53	0.85	0.48	20SD2	0.88	1	7.8	N
Benzo(a)pyrene	1/2	0.55	0.85	0.49	20SD2	0.088	1	1	Y
Benzo(b)fluoranthene	2/2	0.44 - 1	-	0.72	20SD2	0.88	1	7.8	Y
Benzo(g,h,i)perylene	1/2	0.31	0.85	0.37	20SD2	-	-	-	Y (5)
Bis(2-ethylhexyl)phthalate	2/2	2.3 - 2.4	-	2.35	20SD2	46	44	410	N
Butyl benzyl phthalate	2/2	0.47 - 0.52	-	0.5	20SD2	1600	1000	2500	N
Chrysene	1/2	0.62	0.85	0.52	20SD2	88	-	-	N
Fluoranthene	2/2	0.52 - 1.2	-	0.86	20SD2	310	1000	2500	N
Indeno(1,2,3-cd)pyrene	1/2	0.32	0.85	0.37	20SD2	0.88	-	-	N
Phenanthrene	1/2	1.1	0.85	0.76	20SD2	-	1000	2500	N
Pyrene	2/2	0.58 - 1.2	-	0.89	20SD2	230	1000	2500	N
Metals (mg/kg)									
Aluminum	2/2	1930 - 3380	-	2655	20SD2	7800	-	-	N
Arsenic	2/2	1.2 - 1.4	-	1.3	20SD1	0.43	10	10	Y
Barium	2/2	20.7 - 24.9	-	22.8	20SD1	550	4700	140000	N
Beryllium	2/2	0.15 - 0.2	-	0.18	20SD2	0.15	2	2	Y
Boron	1/2	1.8	1.7	1.3	20SD2	700	-	-	N
Cadmium	1/2	0.46	0.35	0.32	20SD2	3.9	34	1000	N
Calcium	2/2	1790 - 1910	-	1850	20SD2	-	-	-	N (6)
Chromium	2/2	12.5 - 14.1	-	13.3	20SD2	39	3900/100 (7)	5.1E+4/100 (7)	N
Cobalt	2/2	2.1 - 3.8	-	2.95	20SD2	470	-	-	N

TABLE 9-5

COPC SCREENING FOR LOWER SUBASE
ZONE 7 - STORM DRAIN SEDIMENTS
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 2

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	State Remediation Standards (3)		Select as COPC? (4)
							Residential Direct Exposure	Industrial Direct Exposure	
Copper	2/2	51.6 - 107	-	79.3	20SD2	310	2500	76000	N
Cyanide	2/2	0.39 - 1.1	-	0.75	20SD2	160	1400	41000	N
Iron	2/2	6560 - 8880	-	7720	20SD2	2300	-	-	Y
Lead	2/2	47.5 - 102	-	74.8	20SD2	400	500	1000	N
Magnesium	2/2	1380 - 3040	-	2210	20SD2	-	-	-	N (6)
Manganese	2/2	97.8 - 111	-	104	20SD2	39	-	-	Y
Mercury	1/2	0.08	0.04	0.05	20SD2	2.3	20	610	N
Nickel	2/2	14.4 - 21.5	-	18	20SD1	160	1400	7500	N
Potassium	2/2	512 - 895	-	703	20SD2	-	-	-	N (6)
Silver	1/2	1.2	0.57	0.74	20SD2	39	340	10000	Y
Sodium	2/2	359 - 495	-	427	20SD1	-	-	-	N (6)
Thallium	1/2	0.18	0.15	0.13	20SD1	0.55	5.4	160	N
Vanadium	2/2	7 - 10.7	-	8.9	20SD2	55	470	14000	N
Zinc	2/2	87.3 - 101	-	94.2	20SD1	2300	20000	610000	N
Miscellaneous (mg/kg)									
TPH	2/2	1100 - 1300	-	1200	20SD1	500	500	2500	Y

- Not available or not applicable.

(1) Includes data from samples 20SD1 and 20SD2.

(2) Based on current USEPA Region III guidance (USEPA Region III, May 10, 1996). Residential Soil Ingestion for soil and sediment.

(3) CTDEP, December 1995.

(4) Contaminant of Potential Concern; Yes (Y) indicates that the maximum concentration exceeds one or more of the criteria; No (N) indicates that the maximum does not exceed any of the criteria.

(5) Criteria not available.

(6) Essential nutrient. Not evaluated for COPC selection.

(7) Trivalent chromium/hexavalent chromium.

TABLE 9-6

COPC SCREENING FOR LOWER SUBASE
ZONE 7 - UNFILTERED GROUNDWATER
NSB-NLON, GROTON, CONNECTICUT

Parameter	Frequency (1)	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	Federal MCL (3)	State MCL (4)	State Remediation Standards (5)		Select as COPC? (6)
									Groundwater Protection	Surface Water Protection	
Volatile Organic Compounds (ug/L)											
1,1,1-Trichloroethane	1/6	0.6	1	0.52	20MW6	130	200	200	200	62000	N
Chloroform	1/6	2	1	0.75	20MW4	0.15	100	100	6	14100	Y
Trichloroethene	1/6	0.6	1	0.52	20MW6	1.6	5	5	5	2340	N
Semivolatile Organic Compounds (ug/L)											
2-Methylnaphthalene	1/6	3	11	5.1	20MW7	-	-	-	-	-	N (7)
Acenaphthene	3/6	2 - 10	11	5.4	20MW3	220	-	-	-	-	N
Acenaphthylene	2/6	1	10 - 11	3.9	20MW3/20MW4	-	-	-	420	0.3	Y
Fluoranthene	1/5	1	10 - 11	4.5	20MW3	150	-	-	280	3700	N
Fluorene	1/6	2	10 - 11	4.8	20MW5	150	-	-	280	140000	N
Phenanthrene	1/6	1	10 - 11	4.7	20MW5	-	-	-	200	0.077	Y
Pyrene	1/6	1	10 - 11	4.7	20MW3	110	-	-	200	110000	N
Metals (ug/L)											
Barium	2/6	131 - 398	27.3 - 72.8	107	20MW5	260	2000	2000	1000	-	Y
Calcium	6/6	18900 - 89200	-	52200	20MW7	-	-	-	-	-	N (8)
Cobalt	1/6	4.4	3	2	20MW2	220	-	-	-	-	N
Copper	1/6	24.4	3	5.3	20MW6	150	1300	-	1300	48	N
Iron	2/6	1600 - 12000	44.3 - 1910	2440	20MW2	1100	300	-	-	-	Y
Lead	2/6	6 - 117	1 - 2.2	21.1	20MW6	15	15	-	15	13	Y
Magnesium	6/6	4030 - 27000	-	13883	20MW3	-	-	-	-	-	N (8)
Manganese	5/6	92.7 - 3490	14.8	949	20MW2	18	50	5000	-	-	Y
Potassium	6/6	5440 - 21400	-	11968	20MW2	-	-	-	-	-	N (8)
Selenium	1/6	1.3	1	0.63	20MW6	18	50	50	50	50	N
Sodium	6/6	11400 - 156000	-	67683	20MW3	-	-	28000 (9)	-	-	Y
Zinc	1/6	816	3.2 - 9.8	138	20MW6	1100	5000	-	5000	123	Y

- Not available or not applicable.
(1) Includes data from the following samples 20GW5, 20GW7, 20MW2, 20MW3, 20MW4, and 20MW6.
(2) For residential tap water ingestion, based on current USEPA Region III guidance (USEPA Region III, May 10, 1996).
(3) Maximum Contaminant Level (USEPA, May 1995).
(4) Title 19, Health and Safety, the Public Health Code of the State of Connecticut, Chapter 11, Environmental Health.
(5) CTDEP, December, 1995.
(6) Contaminant of Potential Concern: A Yes (Y) indicates that the maximum contaminant concentration exceeds one or more of the criteria; A No (N) indicates that the maximum contaminant concentration does not exceed any of the criteria.
(7) Criteria not available.
(8) Essential nutrient, not evaluated for COPC selection.
(9) N[illegible]on Level.

TABLE 9-7

COPC SCREENING FOR LOWER SUBASE
ZONE 7 - FILTERED GROUNDWATER
NSB-NLON, GROTON, CONNECTICUT

Parameter	Frequency (1)	Range of Detections	Range of Nondetects	Average	Location of Maximum	COC Screening Level (2)	Federal MCL (3)	State MCL (4)	State Remediation Standards (5)		Select as COPC? (6)
									Groundwater Protection	Surface Water Protection	
Metals (ug/L)											
Aluminum	5/6	133 - 163	149	136	20MW5	3700	50 TO 200 (7)	-	-	-	Y
Arsenic	4/6	2.7 - 5.7	2 - 4.9	3.3	20MW2	0.045	50	50	50	4	Y
Barium	5/6	26.5 - 382	72.8	119	20MW5	260	2000	2000	1000	-	Y
Boron	5/6	241 - 939	261	394	20MW4	330	-	-	-	-	Y
Cadmium	1/6	3.1	2	1.4	20MW2	1.8000	5	5	5	6	Y
Calcium	6/6	19900 - 92300	-	51767	20MW7	-	-	-	-	-	N (8)
Cobalt	1/6	3.1	3	1.8	20MW2	220	-	-	-	-	N
Copper	1/6	21.1	3	4.8	20MW6	150	1300	-	1300	48	N
Iron	6/6	28.3 - 12500	-	2628	20MW2	1100	300	-	-	-	Y
Lead	5/6	1.5 - 97.5	1.6	17.5	20MW6	15	15	-	15	13	Y
Magnesium	6/6	4000 - 24800	-	13677	20MW3	-	-	-	-	-	N (8)
Manganese	6/6	16.9 - 3600	-	944	20MW2	18	50	5000	-	-	Y
Nickel	1/6	13.1	9	5.9	20MW6	73	100	100	100	880	N
Potassium	6/6	5390 - 22100	-	11972	20MW2	-	-	-	-	-	N (8)
Selenium	1/6	1.2	1	0.62	20MW6	18	50	50	50	50	N
Sodium	6/6	18600 - 148000	-	83683	20MW2	-	-	28000 (9)	-	-	Y
Thallium	4/6	1.2 - 2	1	1.2	20MW4	0.26	2	2	5	63	Y
Zinc	4/6	3.5 - 780	3 - 6.8	134	20MW6	1100	5000	-	5000	123	Y

- Not available or not applicable.

(1) Includes data from the following samples: 20GW5, 20GW7, 20MW2, 20MW3, 20MW4, and 20MW6.

(2) For residential tap water ingestion, based on current USEPA Region III guidance (USEPA Region III, May 10, 1996).

(3) Maximum Contaminant Level (USEPA, May 1995).

(4) Title 19, Health and Safety, the Public Health Code of the State of Connecticut, Chapter 11, Environmental Health.

(5) CTDEP, December, 1995.

(6) Contaminant of Potential Concern: A Yes (Y) indicates that the maximum contaminant concentration exceeds one or more of the criteria; A No (N) indicates that the maximum contaminant concentration does not exceed any of the criteria.

(7) Secondary MCL, based on aesthetic drinking water qualities.

(8) Essential nutrient, not evaluated for COPC selection.

(9) Notification Level.

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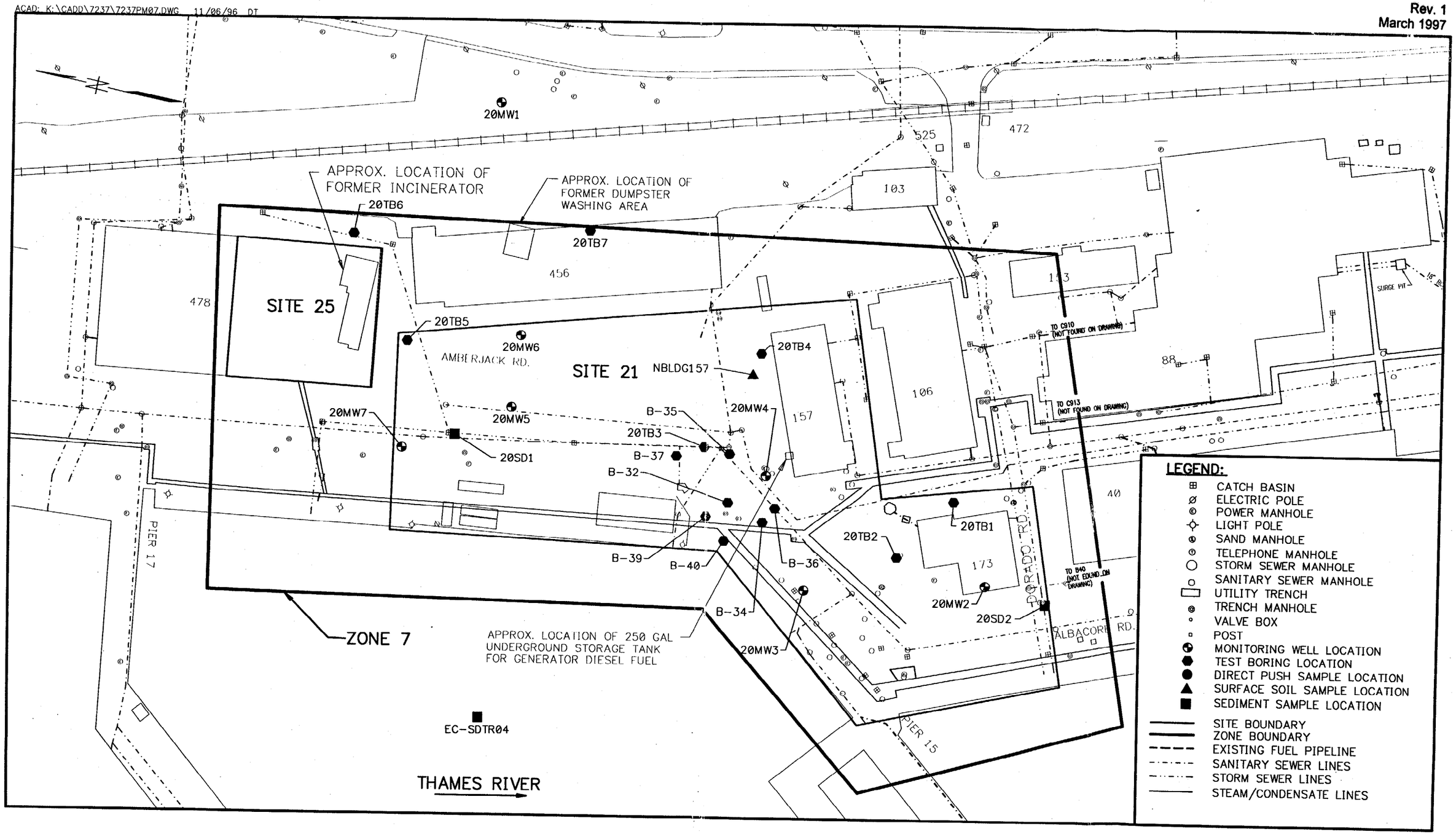

SAMPLE LOCATION MAP
ZONE 7
NSB-NLON, GROTON, CONNECTICUT

0 80 160
SCALE IN FEET

FIGURE 9-1

Brown & Root Environmental

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10.0 SUMMARY AND RECOMMENDATIONS

This section provides a summary of the findings for the Lower Subase, general recommendations for the Lower Subase, and specific recommendations for the Thames River and each zone within the Lower Subase.

10.1 SUMMARY AND GENERAL RECOMMENDATIONS

Widespread petroleum contamination was detected in soils within the Lower Subase. Inorganic contamination, particularly lead, was also detected in soils within the Lower Subase. The soil contamination has had minor detectable impacts on groundwater quality. However, activities and contamination at the Lower Subase seem to have impacted the Thames River.

Because of the industrial nature of the Lower Subase, the widespread petroleum contamination, and the results of human health and ecological risk assessments, focused remedial actions in the Lower Subase are necessary to ensure the protection of human health and the environment from contamination detected at the Lower Subase. For all zones, further characterization activities are necessary to determine the extent and sources of contamination, to ensure that these sources are no longer present and to verify that contamination from the sources cannot migrate or come into contact with receptors. In addition, free product and highly contaminated soil, which may act as secondary sources of contamination, need to be remediated. Remedial options for the Lower Subase include excavation, containment, air sparging, SVE, natural attenuation and bioremediation.

Potential contaminant sources located throughout the Lower Subase include USTs and leaking fuel lines (past and current). Utility ducts and trenches and storm sewers, also located throughout the Lower Subase, may act as preferential flow pathways for subsurface contamination. Recommendations for these potential source areas are as follows:

- While most USTs have been replaced, leak detection systems need to be evaluated to determine if a system is in place to ensure that new tanks are not and will not leak.

- Fuel line leaks, past and current, need to be identified. Fuel lines need to be inspected to identify any portions that currently are leaking. Any leaking portions need to be repaired. A review of previous inspections also needs to be conducted to identify old and new leaks. Information on currently leaking, repaired, replaced, and abandoned portions of the fuel pipelines should be identified on a map. This map would be used to identify potential sources of soil contamination.

- Utility ducts and trenches, which may be preferential flow pathways for subsurface contamination, need to be inspected and contaminated material removed. Available inspection data also needs to be reviewed. Inspection data should be used to develop a map showing clean and contaminated portions of the ducts and trenches. The map would be used to identify potential sources of soil contamination.

- Storm sewers, which may be preferential flow pathways for subsurface contamination, discharge to the Thames River. The storm sewers need to be inspected and contaminated material removed. Available inspection data also needs to be reviewed. Inspection data should be used to develop a map showing portions of the storm sewer line in which contaminated material has been identified. The map would be used to identify potential sources of soil contamination. The map would also be used to identify other potential sources, within the Lower Subase or in areas adjacent to the Lower Subase, which may be impacting the Thames River. Modification of site operations identified as contributing to the contamination in the storm sewers would be necessary.

10.2 THAMES RIVER

The activities and contamination at the Lower Subase have apparently impacted the Thames River. The main chemicals of concern are PAHs. While PAHs were detected in sediments upstream of, and downstream of NSB-NLON, the concentration of PAHs increased slightly in the vicinity of Zones 5 and 7, and increased substantially in the vicinity of Zones 1 through 4. PAHs were also detected in the biota samples (caged ribbed mussel) collected in the vicinity of the Lower Subase. Other contaminants detected in sediments of the Thames River, pesticides and metals, were not detected at concentrations in the vicinity of the Lower Subase suggesting that the Lower Subase is the source of contamination. Pesticide concentrations were found at low concentrations throughout the Thames River, while metal concentrations tended to be only slightly greater near the Lower Subase than concentrations in other areas sampled.

The only unacceptable risk identified in the human health risk assessment was from ingestion of shellfish and finfish from the Thames River. However, individuals are not permitted to harvest shellfish in the area and there are no licensed recreational shell fishing areas in the Thames River. There are also no commercial shellfish beds in close proximity to NSB-NLON. The risks from ingestion of finfish are marginally above the acceptable risk range and are likely overestimated because of the conservative assumptions made during the risk assessment. The results of the ecological risk assessment indicate that the Thames River near NSB-NLON represents a minimal potential risk to ecological receptors, mainly benthic macroinvertebrates.

Based on the nature and extent of contamination detected in the vicinity of Lower Subase and the results of the risk assessments, limited action for the Thames River is recommended. The following activities are recommended:

- Further characterization of the sediments in the Thames River in the vicinity of the Lower Subase. Characterization should focus on sediment sampling for SVOCs and lead to define the nature and extent of sediment contamination along the Lower Subase. Sampling of surface water and sediment adjacent to potential onshore sources (primary and secondary) is recommended. Characterization of the nature and extent of contaminated sediment is recommended to provide information to identify source areas and not to characterize areas of the Thames River to be remediated. Remedial action to remove contaminated sediment is not recommended.

- Identification and removal of primary and secondary sources of contamination (i.e., leaking fuel lines and highly contaminated soils) in the Lower Subase. This is discussed as part of the general discussion of the Lower Subase (Section 10.1) as well as the specific zones (Sections 10.3 through 10.9).

10.3 ZONE 1

Metals and petroleum hydrocarbons are the major soil contaminants of concern. SVOC data are not available for soils. Metals concentrations are likely the result of contaminated fill. Lead, the most prevalent metal detected in soils at Zone 1, was not detected at concentrations exceeding state or Federal soil screening levels. TPH contamination is widespread in deep soil of Zone 1 with the highest concentrations in the vicinity of the tanks at Sites 10 and 11. Fuel pipeline leaks or ducts acting as preferential flow pathways may be the source of the elevated TPH concentrations along Albacore Road by Corvina Road.

Metals and petroleum hydrocarbons were also detected in groundwater. While concentrations of metals in groundwater (mostly unfiltered samples) exceeded several of the state groundwater standards, groundwater is not used as a drinking water source and is brackish. Several metals were detected in groundwater at maximum concentrations exceeding Connecticut remediation standards for surface water protection.

No significant human health risks were calculated for exposure to media at Zone 1. The ecological risk assessment for the Thames River identified PAHs and metals as the primary chemicals of concern.

Recommendations for the inspection of USTs, fuel lines, ducts and trenches, and storm sewers are discussed in Section 10.1. Recommendations for the Thames River are discussed in Section 10.2. Other recommendations for Zone 1 are as follows:

- Characterize SVOC concentrations in Zone 1. Conduct limited soil sampling in previously sampled areas of Zone 1 and analyze for SVOCs. If a SVOC hot spot not coinciding with the TPH hot spots is identified, conduct further sampling and analysis to delineate the SVOC hot spot.

- Conduct soil sampling and analysis to delineate the two TPH hot spots in the vicinity of tanks at Sites 10 and 11 and along Albacore Road at Corvina Road. Take field measurements to determine if natural attenuation is occurring. Remediate hot spots if necessary.

- Conduct sampling and analysis to confirm whether lead detected in shallow soil is mobile. The samples should be analyzed by the SPLP method.

- Monitor Groundwater. Continue groundwater sampling and analysis to monitor contamination levels. Measure free product thickness in existing wells. Take field measurements to determine if natural attenuation is occurring.

- Coordinate further characterization activities at Zone 1 with sediment sampling of the Thames River in the vicinity of Zone 1.

10.4 ZONE 2

The major soil chemicals of concern are metals and petroleum hydrocarbons. Several metals were detected at maximum concentrations above background. Lead in particular was detected at a maximum concentration of 404 mg/kg which is slightly greater than the residential soil screening level (OSWER 400 mg/kg). Lead was the only metal to have concentrations in TCLP leachates exceeding state pollutant mobility criteria for GB classified groundwater. A specific point source for the inorganic contamination is not apparent and is most likely associated with fill material that has been placed throughout the Lower Subase.

A hot spot area of TPH soils was identified around the fuel line along Albacore Road between Corvina and Cisco Roads. TPH concentrations were as high as 8210 mg/kg. The petroleum hydrocarbon contamination may be a result of fuel line leaks or activities within Zone 1.

As with soils, the major chemicals of concern in groundwater are metals and petroleum hydrocarbons. However, the metals concentrations in groundwater are generally lower than those reported for Zone 1. Antimony was the only chemical detected (in the filtered samples only) at a maximum concentration exceeding the Connecticut MCL. While other metals exceeded Connecticut remediation standards for groundwater protection, groundwater is not used as a drinking water source and is brackish. Arsenic and lead were detected at maximum concentrations exceeding the surface water protection criteria.

TPH was detected in groundwater in the vicinity of Building 18 and the utility trench (13MW6) and south of Building 20 (13MW11). Organic compound concentrations in groundwater were low (less than 3 µg/L).

No significant human health risks were calculated for exposure to media at Zone 2. The ecological risk assessment for the Thames River identified PAHs and metals as the primary chemicals of concern.

Recommendations for the inspection of USTs, fuel lines, ducts and trenches, and storm sewers are discussed in Section 10.1. Recommendations for the Thames River are discussed in Section 10.2. Other recommendations for Zone 2 are as follows:

- Characterize SVOC concentrations in Zone 2. Conduct limited soil sampling in previously sampled areas of Zone 2 and analyze for SVOCs. If a SVOC hot spot not coinciding with a TPH hot spot is identified, conduct further sampling and analysis to delineate the SVOC hot spot.

- Conduct soil sampling and analysis to delineate the TPH hot spot. Take field measurements to determine if natural attenuation is occurring. Remediate hot spot area if necessary.

- Conduct sampling and analysis to confirm whether lead detected in deep soil is mobile. The samples should be analyzed by the SPLP method.

- Monitor Groundwater. Continue groundwater sampling and analysis to monitor contamination levels. Measure free product thickness in existing wells. Take field measurements to determine if natural attenuation is occurring.

- Coordinate further characterization activities at Zone 2 with sediment sampling of the Thames River in the vicinity of Zone 2.

10.5 ZONE 3

The major soil chemicals of concern are metals (lead) and petroleum hydrocarbons. High lead concentrations may be a result of lead contamination at Building 31. Although the majority of soils under and adjacent to Building 31 have been removed, some soils in the vicinity of Building 31 still have elevated levels of lead. TPH was also detected in soil, with higher concentrations detected in soils along Bullhead Road from Argonaut to Albacore and along Albacore from Capelin to past Bullhead Road. Sources of the petroleum contamination are likely pipeline leaks within Zones 3 and 4 and tank leaks within Zone 4.

Limited groundwater data is available for Zone 3; however, based on the data, contaminants have not migrated to groundwater.

No significant human health risks were calculated for exposure to media at Zone 3. The ecological risk assessment for the Thames River identified PAHs and metals as the primary chemicals of concern.

Recommendations for the inspection of USTs, fuel lines, ducts and trenches, and storm sewers are discussed in Section 10.1. Recommendations for the Thames River are discussed in Section 10.2. Other recommendations for Zone 3 are as follows:

- Characterize SVOC concentrations in Zone 3. Conduct limited soil sampling in previously sampled areas of Zone 3 and analyze for SVOCs. If a SVOC hot spot not coinciding with a TPH hot spots is identified, conduct further sampling and analysis to delineate the SVOC hot spot.

- Conduct soil sampling and analysis to delineate the TPH hot spot by Argonaut Road and Bullhead Road. Take field measurements to determine if natural attenuation is occurring. Remediate hot spots if necessary.

- Conduct sampling and analysis to determine the nature and extent of lead in soils; to monitor lead levels in groundwater; to confirm by the SPLP method whether lead detected in shallow and deep soils is truly mobile, as indicated by the existing TCLP results; to quantify the amount of lead entering the Thames River; and to evaluate the cumulative ecological impacts.

- Monitor Groundwater. Continue groundwater sampling and analysis to monitor contamination levels. Measure free product thickness in existing wells. Take field measurements to determine if natural attenuation is occurring.

- Coordinate further characterization activities at Zone 3 with sediment sampling of the Thames River in the vicinity of Zone 3.

10.6 ZONE 4

The major chemicals of concern are metals and petroleum hydrocarbons. Concentrations of most metals detected in Zone 4 soils exceeded background. High concentrations of lead (maximum of 10,600 mg/kg) were detected in the shallow and deep soil near Buildings 79 and 80. Lead in TCLP samples was detected at concentrations exceeding the Federal Toxicity Characteristic regulatory level. TPH was detected at a maximum concentration of 11,800 mg/kg and was detected in all soil samples collected within Zone 4. Two hot spot areas within Zone 4 and one area on the boundary of Zones 3 and 4 are evident. The hot spot area located at Argonaut Road and Bluefish Road and the area on the boundary of Zones 3 and 4 are apparently from pipeline leaks. The other hot spot area, located on Albacore Road

west of Building 79, is likely from the pit at Building 79. High concentrations of lead were also detected n the vicinity of Building 79.

Chemical concentrations in groundwater indicate that groundwater has been impacted by soil contamination. TPH as high as 5,400 µg/L was detected in groundwater. Organic and inorganic concentrations exceeded the Connecticut MCLs, remediation standards for groundwater protection, and surface water protection criteria.

The only potential adverse impact to human health for Zone 4 is exposure to lead. Lead concentrations were reported at elevated levels. The ecological risk assessment for the Thames River identified PAHs and metals as the primary chemicals of concern

Recommendations for the inspection of USTs, fuel lines, ducts and trenches, and storm sewers are discussed in Section 10.1. Recommendations for the Thames River are discussed in Section 10.2. Other recommendations for Zone 4 are as follows:

- Review records and background information on Building 316. Develop limited sampling program based on this review to identify whether contaminated soils and/or groundwater have resulted from activities at Building 316. The need for additional activities (i.e., remedial or further characterization) in the vicinity of Building 316 would be determined based on the results of the limited sampling program.

- Characterize SVOC concentrations in Zone 4. Conduct limited soil sampling in previously sampled areas of Zone 4 and analyze for SVOCs. If a SVOC hot spot not coinciding with a TPH hot spot is identified, conduct further sampling and analysis to delineate the SVOC hot spot.

- Conduct soil sampling and analysis to delineate the TPH hot spots. Take field measurements to determine if natural attenuation of the petroleum compounds is occurring. Remediate hot spots if necessary.

- Conduct sampling and analysis to determine the nature and extent of lead in soils; to monitor lead levels in groundwater; to confirm by the SPLP method whether lead detected in shallow and deep soils is truly mobile, as indicated by the existing TCLP results; to quantify the amount of lead entering the Thames River; and to evaluate the cumulative ecological impacts.

- Monitor Groundwater. Continue groundwater sampling and analysis to monitor contamination levels. Measure free product thickness in existing wells. Take field measurements to determine if natural attenuation is occurring.

- Coordinate further characterization activities at Zone 4 with sediment sampling of the Thames River in the vicinity of Zone 4.

10.7 ZONE 5

Contamination originating from the tank on the south side of Building 175 is evident at Zone 5. This contamination may be from a tank leak or from spillage during tank filling. TPH and SVOCs are the major contaminants of concern detected in this area. Contaminated sediments collected from the storm sewers in this zone generally contained the highest concentrations of contaminants. Lead in particular was detected at concentrations as high as 85,600 mg/kg. Contamination in the storm sewers may be related to recent activities at the site. Groundwater results indicated that the soil contamination has only had minor impacts on groundwater quality.

Analytical groundwater data for Zone 5 was compared to state standards and there were no exceedances of state MCLs or groundwater remediation standards for either unfiltered or filtered groundwater. Only maximum concentrations of phenanthrene in unfiltered groundwater and arsenic in filtered groundwater exceeded the state's surface water protection criteria.

A human health risk assessment was not conducted for this zone. The ecological risk assessment for the Thames River identified PAHs and metals as the primary contaminants of concern.

Recommendations for the inspection of USTs, fuel lines, ducts and trenches, and storm sewers are discussed in Section 10.1. Recommendations for the Thames River are discussed in Section 10.2. Other recommendations for Zone 5 are as follows:

- Conduct a risk assessment to determine if contaminant concentrations are at levels which pose an unacceptable risk to the receptors of concern.

- Further characterize the TPH contamination in the vicinity of the tank to delineate the area impacted. Conduct limited soil sampling and analyze the samples for TPH. Remove TPH contaminated soil in vicinity of tank; particularly in area where stained surface soil was observed. Take field measurements to determine if natural attenuation is occurring.

- Further characterize lead contamination. Perform confirmation sampling and analyses of soil samples using SPLP analysis.

- Monitor Groundwater. Continue groundwater sampling and analysis to monitor contamination levels. Measure free product thickness in existing wells. Take field measurements to determine if natural attenuation is occurring.

- Coordinate further characterization activities at Zone 5 with sediment and surface water sampling of the Thames River in the vicinity of Zone 5.

10.8 ZONE 6

Sampling and analysis have not been conducted within Zone 6; therefore, the nature and extent can not be evaluated. In addition, historical information on Site 24 was not reviewed for evaluation of this zone. A background review, collection of historical information, interviews, and other activities are recommended for this zone to provide a site description. Potential contaminants of concern and contaminated media of concern need to be identified and a sampling plan developed based on this information. It is recommended that initial sampling focus on identifying the presence of contamination, and if contamination is identified, further sampling should be conducted to characterize the contamination. The need for additional remedial activities would be determined based on an evaluation of the initial sampling.

- Any sampling of sediment and surface water of the Thames River adjacent to Zone 6 should be coordinated with sampling at Zone 6.

10.9 ZONE 7

Two general areas of petroleum hydrocarbon contamination in soils were identified in Zone 7; southwest of Building 478 and north of Building 157. Inorganic compounds, particularly lead, were also detected above background in soils at Zone 7. High levels of lead (189,000 mg/kg) were detected. Sediments samples collected from the storm drains also contained elevated concentrations of TPH, SVOCs, and inorganic compounds. The exact source of these contaminants is not known. With the exception of lead in groundwater (117 µg/L), soils containing fuel-oil residues have only had minor impacts on groundwater quality.

No contaminants were detected at concentrations which exceeded state MCLs. Lead concentrations in unfiltered and filtered groundwater samples exceeded CTDEP remediation standards for groundwater. Metals and SVOCs exceeded the state's surface water protection criteria.

A human health risk assessment was not conducted for this zone. The ecological risk assessment for the Thames River identified PAHs and metals as the primary contaminants of concern.

Recommendations for the inspection of USTs, fuel lines, tanks, ducts, trenches, and storm sewers are discussed in Section 10.1. Recommendations for the Thames River are discussed in Section 10.2. Other recommendations for Zone 7 are as follows:

- Conduct a risk assessment to determine if contaminant concentrations are at levels which pose an unacceptable risk to the receptors of concern.

- Characterize the extent of contamination in the vicinity of Buildings 478 and 157. Remediate hot spot of TPH contaminated soils. Take field measurements to determine if natural attenuation is occurring.

- Conduct sampling and analysis to determine the nature and extent of lead in soils; to monitor lead levels in groundwater; to confirm by the SPLP method whether lead detected in shallow and deep soils is truly mobile, as indicated by the existing TCLP results; to quantify the amount of lead entering the Thames River; and to evaluate the cumulative ecological impacts.

- Monitor Groundwater. Continue groundwater sampling and analysis to monitor contamination levels. Measure free product thickness in existing wells. Take field measurements to determine if natural attenuation is occurring.

- Coordinate further characterization activities at Zone 7 with sediment sampling of the Thames River in the vicinity of Zone 7.

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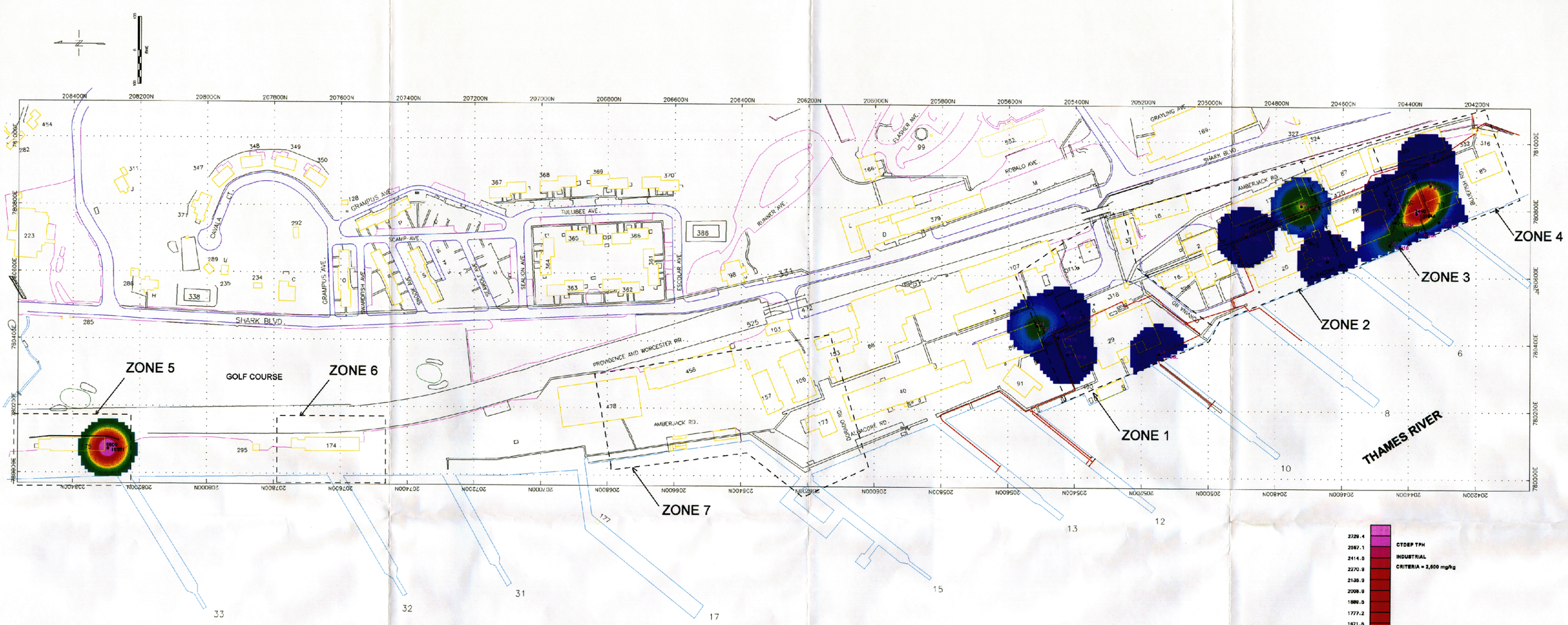

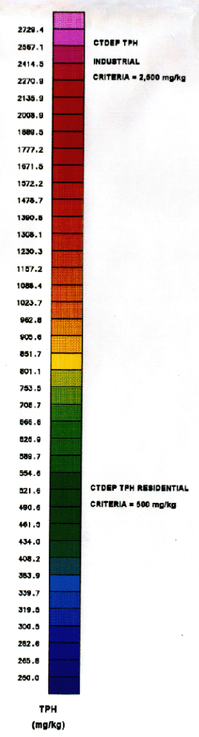

NOTE:

SHALLOW SOIL SAMPLES IN ZONE 1 WERE COLLECTED FROM LESS THAN FIVE FEET B.G.S.
DEEP SOIL SAMPLES IN ZONE 1 WERE COLLECTED FROM GREATER THAN FIVE FEET B.G.S.

SHALLOW SOIL SAMPLES IN ZONE 2 WERE COLLECTED FROM LESS THAN FOUR FEET B.G.S.
DEEP SOIL SAMPLES IN ZONE 2 WERE COLLECTED FROM GREATER THAN FOUR FEET B.G.S.

SHALLOW SOIL SAMPLES IN ZONE 3 WERE COLLECTED FROM LESS THAN FIVE FEET B.G.S.
DEEP SOIL SAMPLES IN ZONE 3 WERE COLLECTED FROM GREATER THAN FIVE FEET B.G.S.

SHALLOW SOIL SAMPLES IN ZONE 4 WERE COLLECTED FROM LESS THAN FIVE FEET B.G.S.
DEEP SOIL SAMPLES IN ZONE 4 WERE COLLECTED FROM GREATER THAN FIVE FEET B.G.S.

SHALLOW SOIL SAMPLES IN ZONE 5 WERE COLLECTED FROM LESS THAN FOUR FEET B.G.S.
DEEP SOIL SAMPLES IN ZONE 5 WERE COLLECTED FROM GREATER THAN FOUR FEET B.G.S.

SHALLOW SOIL SAMPLES IN ZONE 7 WERE COLLECTED FROM LESS THAN FOUR FEET B.G.S.
DEEP SOIL SAMPLES IN ZONE 7 WERE COLLECTED FROM GREATER THAN FOUR FEET B.G.S.

SHALLOW SOIL SAMPLE RESULTS (TPH)

NSB-NLON, GROTON, CONNECTICUT

DRAWING 1

Brown & Root Environmental

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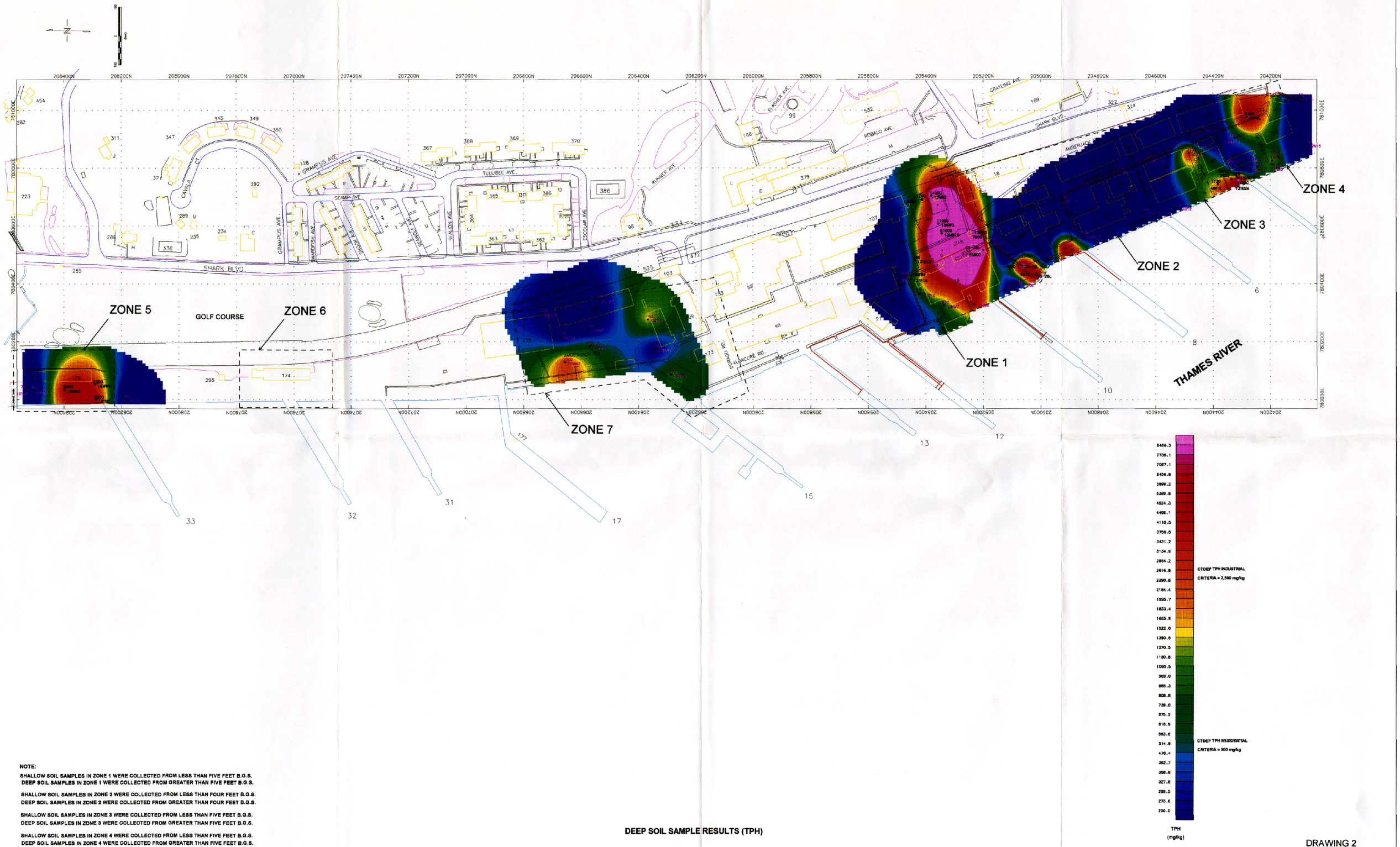

NOTE:

SHALLOW SOIL SAMPLES IN ZONE 1 WERE COLLECTED FROM LESS THAN FIVE FEET B.G.S.
DEEP SOIL SAMPLES IN ZONE 1 WERE COLLECTED FROM GREATER THAN FIVE FEET B.G.S.

SHALLOW SOIL SAMPLES IN ZONE 2 WERE COLLECTED FROM LESS THAN FOUR FEET B.G.S.
DEEP SOIL SAMPLES IN ZONE 2 WERE COLLECTED FROM GREATER THAN FOUR FEET B.G.S.

SHALLOW SOIL SAMPLES IN ZONE 3 WERE COLLECTED FROM LESS THAN FIVE FEET B.G.S.
DEEP SOIL SAMPLES IN ZONE 3 WERE COLLECTED FROM GREATER THAN FIVE FEET B.G.S.

SHALLOW SOIL SAMPLES IN ZONE 4 WERE COLLECTED FROM LESS THAN FIVE FEET B.G.S.
DEEP SOIL SAMPLES IN ZONE 4 WERE COLLECTED FROM GREATER THAN FIVE FEET B.G.S.

SHALLOW SOIL SAMPLES IN ZONE 5 WERE COLLECTED FROM LESS THAN FOUR FEET B.G.S.
DEEP SOIL SAMPLES IN ZONE 5 WERE COLLECTED FROM GREATER THAN FOUR FEET B.G.S.

SHALLOW SOIL SAMPLES IN ZONE 7 WERE COLLECTED FROM LESS THAN FOUR FEET B.G.S.
DEEP SOIL SAMPLES IN ZONE 7 WERE COLLECTED FROM GREATER THAN FOUR FEET B.G.S.

DEEP SOIL SAMPLE RESULTS (TPH)

NSB-NLON, GROTON, CONNECTICUT

DRAWING 2

Brown & Root Environmental

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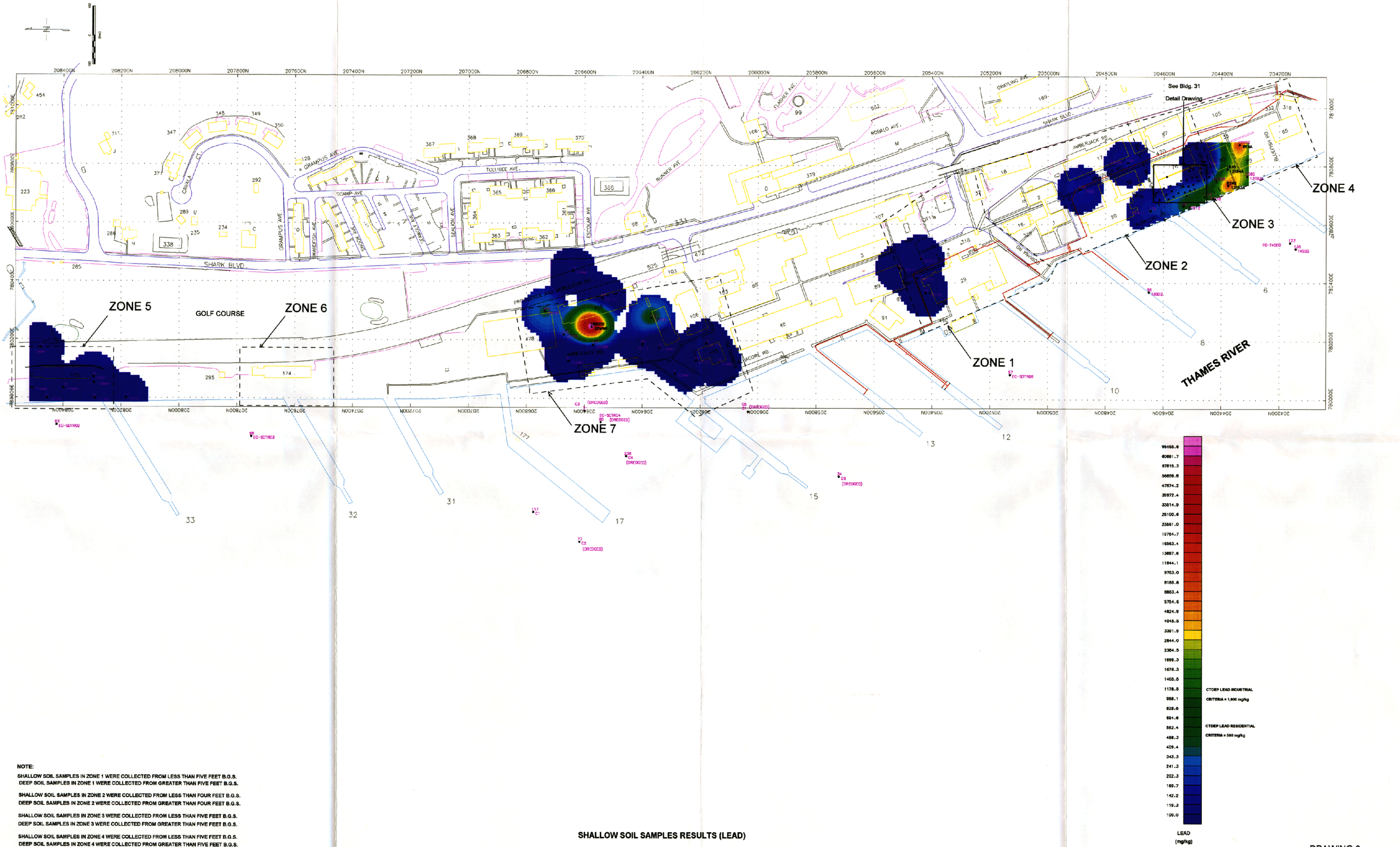

NOTE:

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DEEP SOIL SAMPLES IN ZONE 1 WERE COLLECTED FROM GREATER THAN FIVE FEET B.G.S.

SHALLOW SOIL SAMPLES IN ZONE 2 WERE COLLECTED FROM LESS THAN FOUR FEET B.G.S.
DEEP SOIL SAMPLES IN ZONE 2 WERE COLLECTED FROM GREATER THAN FOUR FEET B.G.S.

SHALLOW SOIL SAMPLES IN ZONE 3 WERE COLLECTED FROM LESS THAN FIVE FEET B.G.S.
DEEP SOIL SAMPLES IN ZONE 3 WERE COLLECTED FROM GREATER THAN FIVE FEET B.G.S.

SHALLOW SOIL SAMPLES IN ZONE 4 WERE COLLECTED FROM LESS THAN FIVE FEET B.G.S.
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SHALLOW SOIL SAMPLES IN ZONE 5 WERE COLLECTED FROM LESS THAN FOUR FEET B.G.S.
DEEP SOIL SAMPLES IN ZONE 5 WERE COLLECTED FROM GREATER THAN FOUR FEET B.G.S.

SHALLOW SOIL SAMPLES IN ZONE 7 WERE COLLECTED FROM LESS THAN FOUR FEET B.G.S.
DEEP SOIL SAMPLES IN ZONE 7 WERE COLLECTED FROM GREATER THAN FOUR FEET B.G.S.

SHALLOW SOIL SAMPLES RESULTS (LEAD)

NSB-NLON, GROTON, CONNECTICUT

DRAWING 3

Brown & Root Environmental

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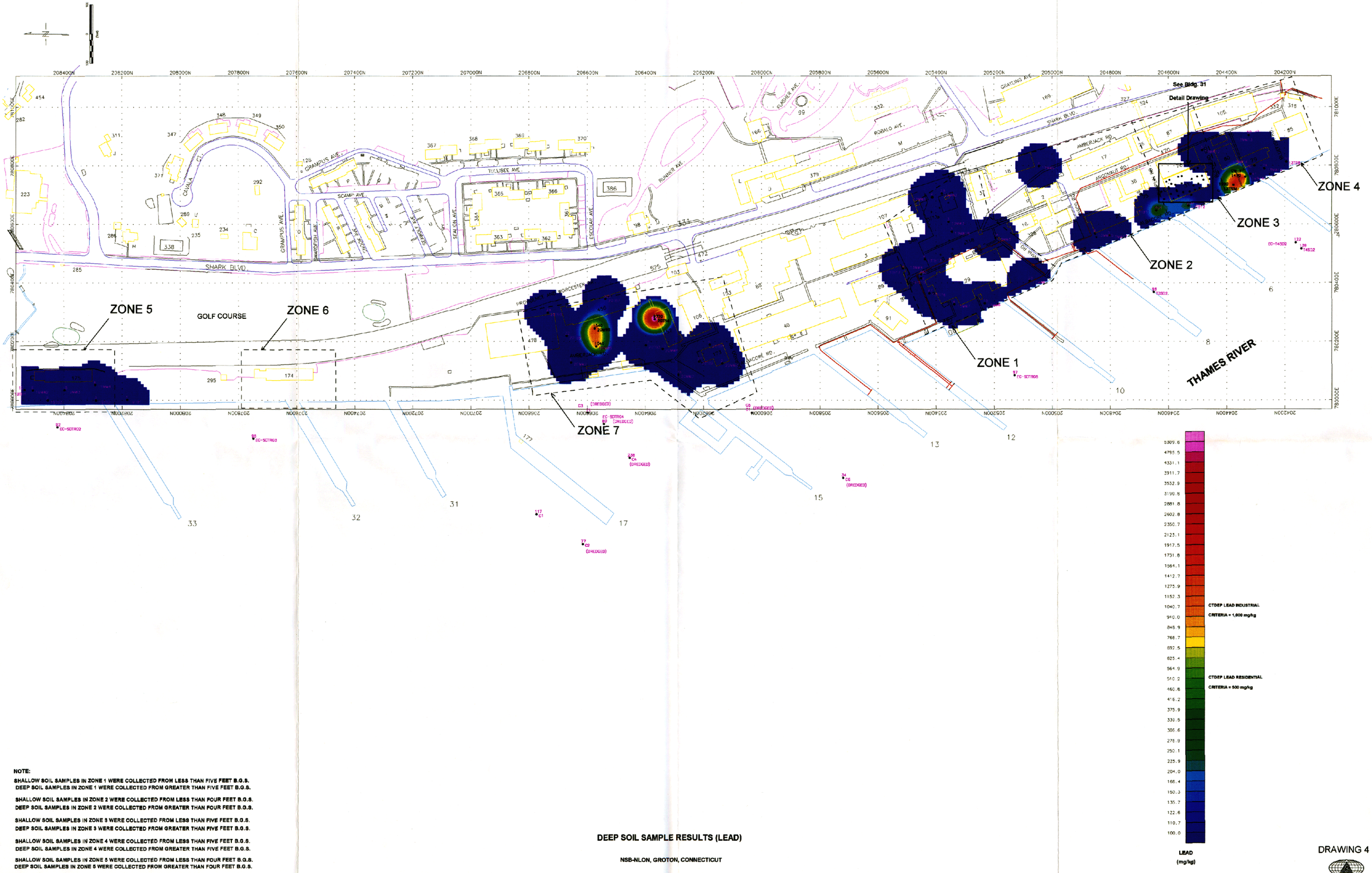

NOTE:

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DEEP SOIL SAMPLES IN ZONE 1 WERE COLLECTED FROM GREATER THAN FIVE FEET B.G.S.

SHALLOW SOIL SAMPLES IN ZONE 2 WERE COLLECTED FROM LESS THAN FOUR FEET B.G.S.
DEEP SOIL SAMPLES IN ZONE 2 WERE COLLECTED FROM GREATER THAN FOUR FEET B.G.S.

SHALLOW SOIL SAMPLES IN ZONE 3 WERE COLLECTED FROM LESS THAN FIVE FEET B.G.S.
DEEP SOIL SAMPLES IN ZONE 3 WERE COLLECTED FROM GREATER THAN FIVE FEET B.G.S.

SHALLOW SOIL SAMPLES IN ZONE 4 WERE COLLECTED FROM LESS THAN FIVE FEET B.G.S.
DEEP SOIL SAMPLES IN ZONE 4 WERE COLLECTED FROM GREATER THAN FIVE FEET B.G.S.

SHALLOW SOIL SAMPLES IN ZONE 5 WERE COLLECTED FROM LESS THAN FOUR FEET B.G.S.
DEEP SOIL SAMPLES IN ZONE 5 WERE COLLECTED FROM GREATER THAN FOUR FEET B.G.S.

SHALLOW SOIL SAMPLES IN ZONE 7 WERE COLLECTED FROM LESS THAN FOUR FEET B.G.S.
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DEEP SOIL SAMPLE RESULTS (LEAD)

NSB-NLON, GROTON, CONNECTICUT

DRAWING 4

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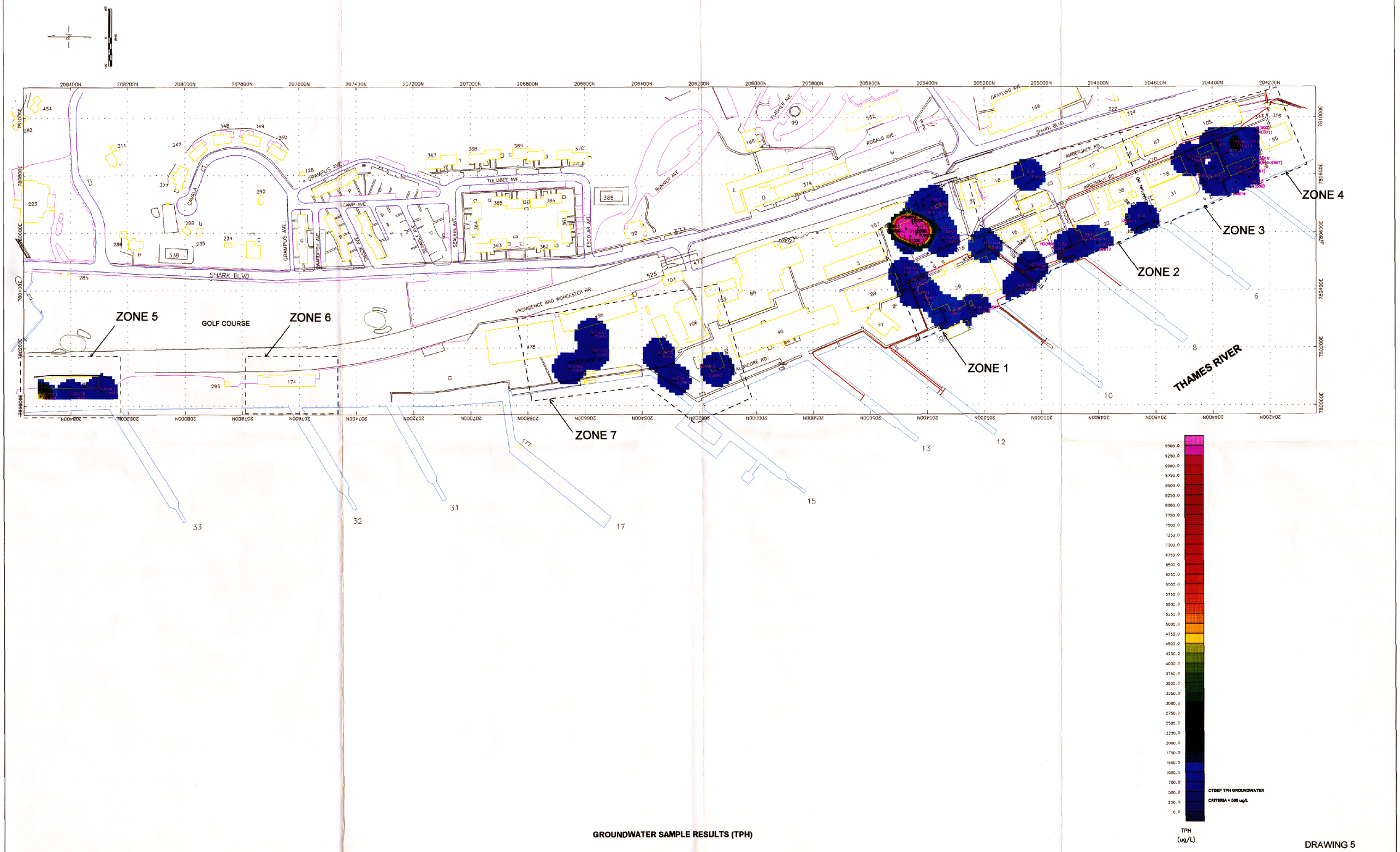

GROUNDWATER SAMPLE RESULTS (TPH)

NSB-NLON, GROTON, CONNECTICUT

NOTE:

LOCATIONS WITH ND() INDICATE THAT ALL ANALYTICAL RESULTS FOR THIS LOCATION WERE BELOW THE DETECTION LIMIT FOR ALL SAMPLING ROUNDS. THE VALUE IN PARANTHESIS IS AN ARITHMETIC AVERAGE CALCULATED USING ONE-HALF OF THE DETECTION LIMIT FOR THE NON-DETECTS

DRAWING 5

Brown & Root Environmental

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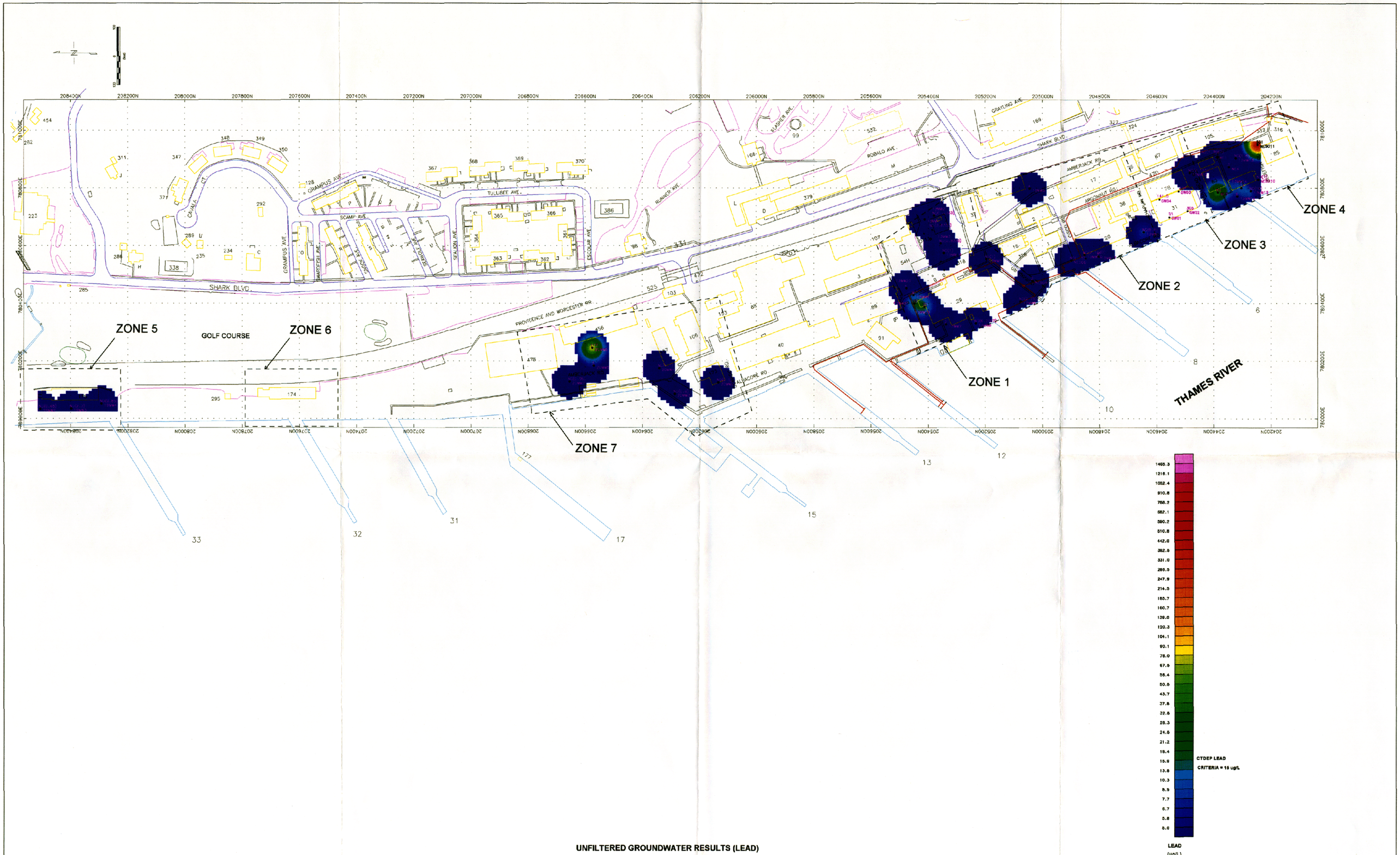

UNFILTERED GROUNDWATER RESULTS (LEAD)

NSB-NLON, GROTON, CONNECTICUT

DRAWING 6

Brown & Root Environmental

NOTE:

LOCATIONS WITH NDQ INDICATE THAT ALL ANALYTICAL RESULTS FOR THIS LOCATION WERE BELOW THE DETECTION LIMIT FOR ALL SAMPLING ROUNDS. THE VALUE OF PARAMETERS IS AN ARITHMETIC AVERAGE CALCULATED USING ONE-HALF OF TB DETECTION LIMIT FOR THE NON-DETECTS.

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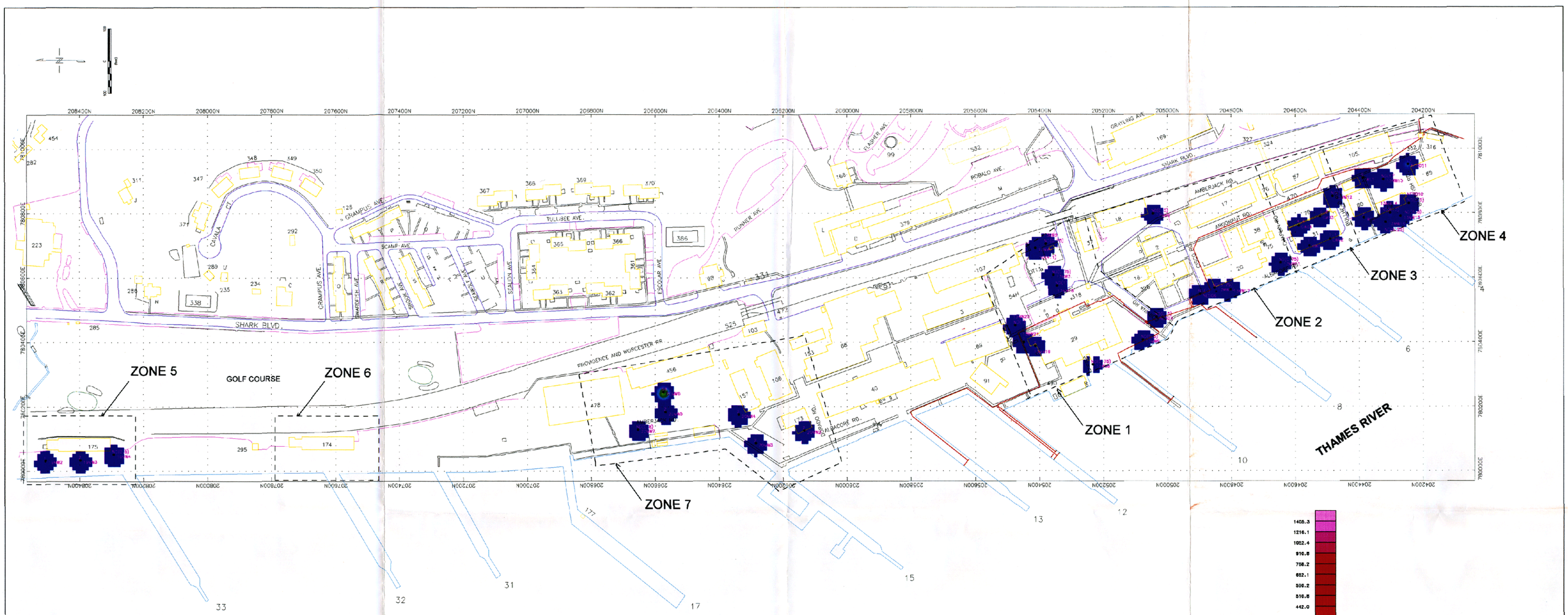

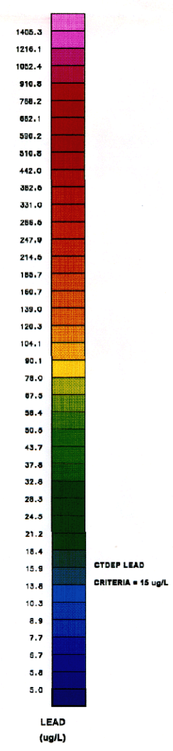

FILTERED GROUNDWATER SAMPLE RESULTS (LEAD)

NSB-NLON, GROTON, CONNECTICUT

DRAWING 7

Brown & Root Environmental

NOTE:

LOCATIONS WITH ND(INDICATE THAT ALL ANALYTICAL RESULTS FOR THIS LOCATION WERE BELOW THE DETECTION LIMIT FOR ALL SAMPLING ROUNDS. THE VALUE IN PARANTHESIS IS AN ARITHMETIC AVERAGE CALCULATED USING ONE-HALF OF THE DETECTION LIMIT FOR THE NON-DETECTS.

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