Monitoring Cruise at the
Central Long Sound Disposal Site
July 1994

Disposal Area Monitoring System DAMOS

D A M O S

DISPOSAL AREA MONITORING SYSTEM

Contribution 117
November 1997

US Army Corps
of Engineers®
New England District

REPORT DOCUMENTATION PAGE

form approved
OMB No. 0704-0188

1. AGENCY USE ONLY (LEAVE BLANK)

2. REPORT DATE
NOVEMBER 1997

3. REPORT TYPE AND DATES COVERED
FINAL REPORT

4. TITLE AND SUBTITLE
MONITORING CRUISE AT THE CENTRAL LONG ISLAND DISPOSAL SITE, JULY 1994

5. FUNDING NUMBERS

6. AUTHOR(S)
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8. PERFORMIGORGANIZATION REPORT NUMBER
SAIC-327

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
US Army Corps of Engineers-New England Division
424 Trapelo Road
Waltham, MA 02254-9149

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
DAMOS Contribution No. 117

11. SUPPLEMENTARY NOTES
Available from DAMOS Program Manager, Regulatory Division
USACE-NED, 424 Trapelo Road, Waltham, MA 02254-9149

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT

Science Applications International Corporation (SAIC) conducted a monitoring survey at the Central Long Island Sound Disposal Site (CLIS) from 10 to 18 July 1994 as part of the Disposal Area Monitoring System (DAMOS) Program. The July 1994 field operations were concentrated over the New Haven 1993 (NHAV 93) and Mill-Quinnipiac River (MQR) disposal mounds and consisted of precision bathymetric, subbottom, surface sediment characterization, and Remote Ecological Monitoring of the Seafloor (REMOTS®) sediment-profile surveys, as well as grab sampling and geotechnical coring. These surveying techniques were used to monitor the stability, cap thickness, and benthic recolonization of the NHAV 93 and MQR mounds.

In September 1993, two disposal buoys were deployed at CLIS. The NHAV buoy was in the center of a ring of disposal mounds as part of a large scale confined aquatic disposal (CAD) project. The CDA buoy was deployed over the previously capped MQR mound as part of a de facto capping and cap augmentation project. Approximately 65,000 m^3 of sediment was deposited at the CDA buoy, adding to the existing layers of dredged material that compose the MQR mound.

During the 1993/94 New Haven Capping Project, the NHAV 93 mound received approximately 590,000 m^3 of unacceptably contaminated dredged material (UDM), followed by 569,000 m^3 of CDM. The ring of mounds greatly reduced the lateral spread of the UDM mound apron, facilitating the efficient capping operations and yielding a flat, stable CAD mound. The latest field effort, four months after the completion of capping operations, found no major topographic changes in the NHAV 93 mound in comparison to the postcap bathymetric survey of March 1994. The MQR mound height increased 1.5 m, creating a new apex, with no increase in overall diameter relative to the bathymetric survey of December 1991.

The cap thickness over the NHAV 93 mound was found to meet the minimum cap thickness requirements of the project, 0.5 m. A full spectrum subbottom profile survey (X-Star), in conjunction with precision bathymetric and geotechnical core data, detected an average of 0.75 m of cap material along the margins of the UDM deposit to 1.25 m at its center. Surface layer grain sizes were assessed with the use of SAIC's Sediment Acoustic Characterization System (SACS) as well as REMOTS® sediment-profile photography and bottom grab samples. The surface layers of cap material over the NHAV 93 mound were comprised mainly of silt and clay. The MQR mound exhibited a heterogeneous mixture of grain sizes ranging from silt and clay at the margins of the mound to pebble and cobble size grains at the center of the supplemental CDM deposit.

Benthic recolonization of the project mounds was also determined from the REMOTS® photographs. The MQR and the majority of NHAV 93 project mounds met or exceeded the predicted recolonization rates from the DAMOS tiered monitoring and management protocol. However, three stations on the NHAV 93 mound were found to be areas of concern. Patchy Stage I communities and shallow redox potential discontinuity (RPD) depths were apparent in REMOTS® photographs collected at Stations 200N, CTR, and 400S.

In September 1994 additional sediment samples were collected to conduct *Ampelisca* bioassay testing and determine whether further action by NED was required (i.e., cap supplementation). The results of bioassay testing indicated no significant difference in comparison to reference area sediments. Therefore no immediate action was required, but as part of the DAMOS tiered monitoring protocol, RPD depths and successional stage status at Stations 200N, CTR, 400S continued to be closely monitored for changes in the benthic community.

Sediment samples were obtained for chemical analysis at the NHAV 93 and MQR mounds, as well as the three CLIS reference areas. The results of the chemical analyses indicate that the sediments obtained from the surface of both disposal mounds were, in general, similar to the samples collected within the CLIS reference areas. The PAH concentrations of the NHAV 93 and MQR mound sediments were found to be lower than the average values for several National Status and Trends (NS&T) stations within the central Long Island Sound region. The results of this sampling and chemical analysis verify the placement of suitable capping materials over both mounds.

14. SUBJECT TERMS
Central Long Island Sound Disposal Site (CLIS), Mill-Quinnipiac River (MQR), Confined Aquatic Disposal (CAD), New Haven Capping Project

15. NUMBER OF PAGE 146

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT Unclassified

18. SECURITY CLASSIFICATION OF THIS PAGE

19. SECURITY CLASSIFICATION OF ABSTRACT

20. LIMITATION OF ABSTRACT

MONITORING CRUISE AT THE CENTRAL LONG ISLAND SOUND DISPOSAL SITE JULY 1994

CONTRIBUTION #117

NOVEMBER 1997

Report No.
SAIC-327

Submitted to:

Regulatory Branch
New England District
U.S. Army Corps of Engineers
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EXECUTIVE SUMMARY

Science Applications International Corporation (SAIC) conducted a monitoring survey at the Central Long Island Sound Disposal Site (CLIS) from 10 to 18 July 1994 as part of the Disposal Area Monitoring System (DAMOS) Program. The July 1994 field operations were concentrated over the New Haven 1993 (NHAV 93) and Mill-Quinnipiac River (MQR) disposal mounds and consisted of precision bathymetric, subbottom, surface sediment characterization, and Remote Ecological Monitoring of the Seafloor (REMOTS®) sediment-profile surveys, as well as grab sampling and geotechnical coring. These surveying techniques were used to monitor the stability, cap thickness, and benthic recolonization of the NHAV 93 and MQR mounds.

In September 1993, two disposal buoys were deployed at CLIS. The NHAV buoy was positioned at 41°09.122' N, 72°53.453' W in the center of a ring of disposal mounds as part of a large scale confined aquatic disposal (CAD) project. The CDA buoy was deployed over the previously capped MQR mound (41°08.637'N, 72°53.859'W) as part of a de facto capping and cap augmentation project. Approximately 65,000 m^3 of sediment was deposited at the CDA buoy, adding to the existing layers of dredged material that compose the MQR mound.

Since 1984, the management strategy at CLIS has been to develop a ring of disposal mounds creating an artificial lateral containment cell for the deposition of large volumes of dredged material. Utilizing the ten-year dredging cycle in the central Long Island Sound region, the US Army Corps of Engineers, New England Division (NED) managed the disposal of small to moderate volumes of material in order to fabricate a containment cell at CLIS. During the 1993/94 New Haven Capping Project, this feature received approximately 590,000 m^3 of unacceptably contaminated dredged material (UDM), followed by 569,000 m^3 of CDM. The ring of mounds greatly reduced the lateral spread of the UDM mound apron, facilitating the efficient capping operations and yielding a flat, stable CAD mound.

During the 1993/94 disposal season, six bathymetric and two REMOTS® sediment-profiling surveys were conducted over the NHAV 93 mound to monitor the progress of the CAD mound construction. The latest field effort, four months after the completion of capping operations, found no major topographic changes in the NHAV 93 mound in comparison to the postcap bathymetric survey of March 1994. The MQR mound height increased 1.5 m, creating a new apex, with no increase in overall diameter relative to the bathymetric survey of December 1991.

The cap thickness over the NHAV 93 mound was found to meet the minimum cap thickness requirements of the project, 0.5 m. A full spectrum subbottom profile survey (X-Star), in conjunction with precision bathymetric and geotechnical core data, detected an average of 0.75 m of cap material along the margins of the UDM deposit to 1.25 m at its center. The subbottom profiler allowed for the quantification of the cap material deposited northwest of the NHAV buoy that previously could not be discerned through conventional bathymetric data processing. Surface layer grain sizes were assessed with the use of SAIC's Sediment Acoustic Characterization System (SACS) as well as REMOTS® sediment-profile photography and bottom grab samples. The surface layers of cap material over the NHAV 93 mound were comprised mainly of silt and clay. The MQR mound exhibited a heterogeneous mixture of grain sizes ranging from silt and clay at the margins of the mound to pebble and cobble size grains at the center of the supplemental CDM deposit.

Benthic recolonization of the project mounds was also determined from the REMOTS® photographs. Data collected at the MQR and NHAV 93 mounds were compared to three reference areas surrounding CLIS. The MQR and the majority of NHAV 93 project mounds met or exceeded the predicted recolonization rates from the DAMOS tiered monitoring and management protocol. Stage I assemblages were predominant, and occasional Stage II or Stage III organisms were present at peripheral stations. However, three stations on the NHAV 93 mound were found to be areas of concern. Patchy Stage I communities and shallow redox potential discontinuity (RPD) depths were apparent in REMOTS® photographs collected at Stations 200N, CTR, and 400S.

In September 1994 additional sediment samples were collected to conduct *Ampelisca* bioassay testing and determine whether further action by NED was required (i.e., cap supplementation). The results of bioassay testing indicated no significant difference in comparison to reference area sediments. Therefore no immediate action was required, but as part of the DAMOS tiered monitoring protocol, RPD depths and successional stage status at Stations 200N, CTR, 400S continued to be closely monitored for changes in the benthic community.

REMOTS® photographs collected over reference area 2500W indicated a recent benthic disturbance consistent with the effects of trawling activity. Surface layer disturbances and shallow RPD depths made comparisons between 2500W and the project mounds difficult. However, the multiple reference area approach used by the DAMOS Program required the collection of REMOTS® data at two additional reference areas, CLIS-REF and 4500E. The data collected at CLIS-REF and 4500E displayed the characteristics of healthy, well-established benthic communities in ambient sediments for comparison to the NHAV 93 and MQR mounds.

Sediment samples were obtained for chemical analysis at the NHAV 93 and MQR mounds, as well as the three CLIS reference areas. The sediments were tested for grain size distribution, total organic carbon (TOC), polynuclear aromatic hydrocarbons (PAHs), and heavy metals. The results of the chemical analyses indicate that the sediments obtained from the surface of both disposal mounds were, in general, similar to the samples collected within the CLIS reference areas. In all cases, the sediment metals concentrations were categorized as "low" to "moderate" in accordance with the guidelines set forth by the New England River Basins Commission (NERBC). The PAH concentrations of the NHAV 93 and MQR mound sediments were found to be lower than the average values for several National Status and Trends (NS&T) stations within the central Long Island Sound region. The results of this sampling and chemical analysis verify the placement of suitable capping materials over both mounds.

1.0 INTRODUCTION

Subaqueous capping of dredged material disposal mounds with clean, natural sediment was introduced to the Central Long Island Sound Disposal Site (CLIS) in 1979 with the formation of the Stamford-New Haven mounds (STNH-N and STNH-S; SAIC 1995). During the following 15 years, monitoring and research activities within the Disposal Area Monitoring System (DAMOS) Program regarding the open water disposal of dredged material have evolved, resulting in significant progress in pre-project planning and the development of long-term management strategies.

A capped sediment mound consists of an initial deposit of unacceptably contaminated dredged material (UDM) that has been completely overlain by uncontaminated, capping dredged material (CDM), isolating the contaminants from the marine environment (Fredette 1994). Several capped mounds currently exist at CLIS, seven of which (Stamford-New Haven North [STNH-N], Stamford-New Haven South [STNH-S], Norwalk, Mill Quinnipiac River [MQR], Cap Site 1 [CS-1], Cap Site 2 [CS-2], CLIS 86, 87, 88, Cap Site 90-1 [CS 90-1]) originated as small, independent bottom features to simplify long-term physical, chemical, and biological monitoring operations. The ratios of CDM volume to UDM volume for these historic capped mounds ranged from 2:1 to 11:1, contingent upon the effectiveness of disposal control and the lateral spread of the initial UDM mound, and the UDM volume (SAIC 1995).

The latest capped mound, New Haven 1993 (NHAV 93), was developed as a subaqueous confined aquatic disposal (CAD) mound. A CAD mound is a capped dredged material deposit developed in conjunction with artificial or natural containment measures, limiting the lateral spread of the UDM apron and facilitating efficient capping operations (Morris et al. 1996). The successful construction of the NHAV 93 mound represents the culmination of ten years of management of CLIS by the US Army Corps of Engineers, New England Division (NED).

The Central Long Island Sound Disposal Site encompasses a 6.86 km^2 area (2 nmi^2) and is centered at 41°08.950' N latitude and 72°52.850' W longitude. It is located approximately 10.39 km (5.6 nmi) south of South End Point, East Haven, Connecticut (Figure 1-1). The effects of dredged material deposition at CLIS have been monitored since 1977 as part of the DAMOS Program for NED (NUSC 1979). Historically, CLIS has been one of the most active disposal sites in the New England region, accepting sediments dredged from New Haven, Bridgeport, Stamford, and Norwalk Harbors, as well as the adjacent coastal areas.

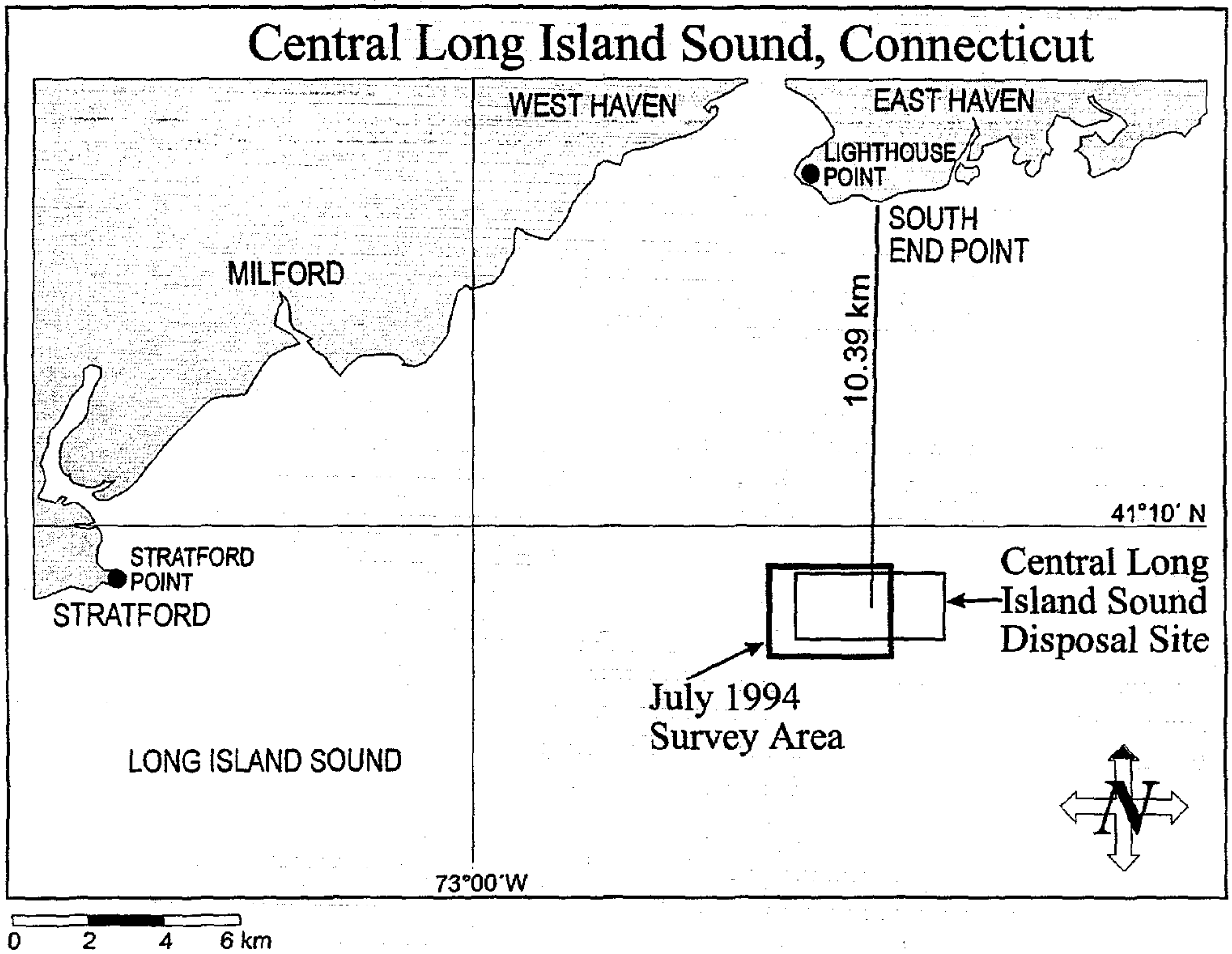


Figure 1-1. Location of the Central Long Island Sound Disposal Site and shore station benchmarks

In 1988, a new strategy for managing the sediments deposited at CLIS was instituted. Utilizing the ten-year dredging cycle for large federal projects that exist in the central Long Island Sound region, NED controlled the deposition of small to moderate volumes of dredged material, forming a disposal mound ring (Morris et al. 1996). Upon completion in 1992, this network of disposal mounds formed an artificial containment cell that was capable of accepting a large volume of UDM, limiting the lateral spread of the deposit and facilitating efficient capping operations (Figure 1-2). During the 1993/94 disposal season, this containment structure was utilized for the disposal of approximately 1,159,000 m^3 of material dredged from New Haven Harbor.

From October 1993 to February 1994 Great Lakes Dredging Company conducted a large scale disposal and capping operation at CLIS as part of the New Haven Harbor Capping Project (Morris et al. 1996). An estimated barge volume of 590,000 m^3 of material classified as UDM was dredged from inner New Haven Harbor, as well as five private marine terminals, and deposited in close proximity to the "NHAV" buoy (41°09.122' N, 72°53.453' W). The UDM was subsequently capped with an approximate barge volume of 569,000 m^3 of CDM dredged from the outer New Haven Harbor, resulting in a flat, stable CAD mound with a CDM to UDM ratio of 0.96:1.0. Upon completion of the disposal and capping operations in March 1994, the NHAV 93 mound displayed a height of 2.5 m and an overall diameter of approximately 820 m (Morris et al. 1996).

A variety of smaller dredging projects along the coast of Connecticut during the 1993/94 disposal season generated approximately 65,000 m^3 of material for subaqueous disposal at CLIS. Barges were directed to the "CDA" taut-wired buoy (41°08.637' N, 72°53.859' W) deployed over the MQR mound in September 1993. The MQR mound is a capped mound in the southwest quadrant of the disposal site. This bottom feature is actually composed of several alternating layers of UDM and CDM deposited during the 1981/82, 1982/83, and 1993/94 disposal seasons.

In the spring of 1982, an estimated barge volume of 42,000 m^3 of UDM was dredged from the Mill River and placed on a relatively flat area of CLIS seafloor. The UDM deposit was quickly capped with approximately 133,200 m^3 of CDM removed from the Quinnipiac River. During the 1982/83 disposal season, in conjunction with the US Environmental Protection Agency (EPA) and the US Army Corps of Engineers, Waterways Experiment Station (WES) Field Verification Program (FVP), an additional 67,000 m^3 of UDM from Black Rock Harbor was released over the MQR mound. The Black Rock Harbor material was followed by 400,000 m^3 of CDM originating from a project in New Haven Harbor (SAIC 1995).

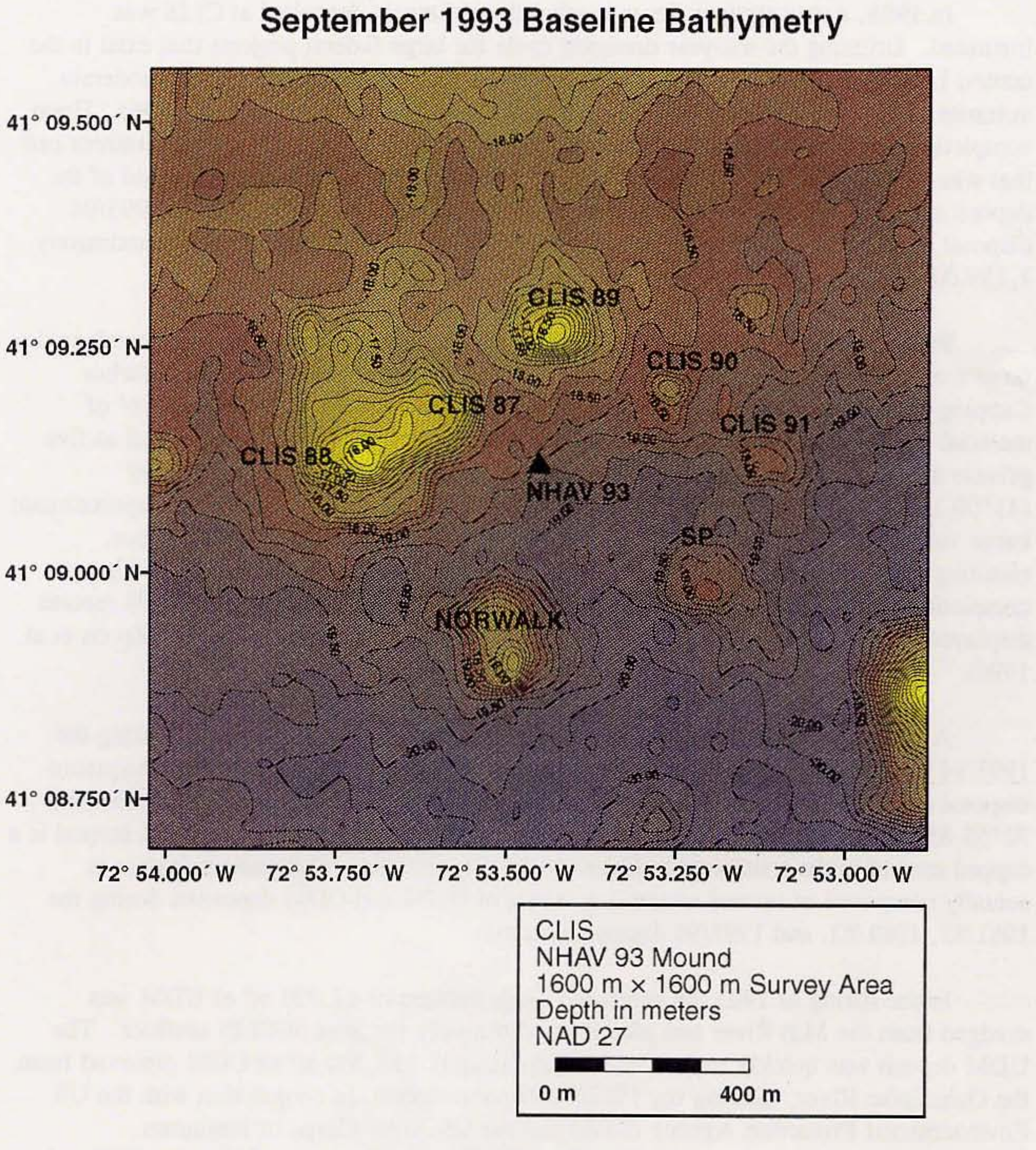


Figure 1-2. September 1993 baseline bathymetry depicting a ring of seven historic disposal mounds with plotted position of the NHAV 93 buoy, 0.25 m contour interval

A sediment cap of 400,000 m^3 was expected to fully cover the original MQR mound, as well as the recent deposit of UDM. However, complications in the disposal sequence during the 1982/83 disposal season caused two barge loads of Black Rock Harbor UDM to be placed over the final CDM deposit, leaving a thin layer of UDM exposed at the sediment-water interface. As a result, monitoring activity over MQR from 1983 through 1992 had shown cycles of benthic habitat decline and slow recovery, relative to other capped mounds at CLIS (Murray 1996a).

In 1993, the decision was made by NED to spread additional capping material over the MQR mound in response to the anomalous benthic conditions. In addition, volumes of UDM and CDM generated by a de facto capping project were also directed to the MQR mound during the 1993/94 disposal season. A total of 65,000 m^3 produced by the smaller dredging projects was released at the CDA 93 buoy position over the MQR mound during the 1993/94 disposal season. The deposition of the supplemental material covered much of the northeastern region of the mound, increasing the mound height and improving benthic conditions.

The scope of the most recent sampling activity at CLIS was expanded to include the collection of data over the MQR mound, observing changes in mound height and environmental conditions at the sediment-water interface. SAIC conducted several bathymetric, sediment profiling, and geotechnical coring surveys over the NHAV 93 project area to monitor the progress of the 1993/94 disposal and capping operations, producing a comprehensive time-series dataset. From 10 to 18 July 1994 Science Applications International Corporation (SAIC) conducted field operations over the most active area of CLIS to monitor the long-term progress of the disposal site, evaluate the success in the formation of the CAD mound, and document the improving conditions over the MQR mound.

Results of the July field surveys over NHAV 93 indicated the successful development of a stable CAD mound with an adequate cap material thickness, and a recolonization rate over the majority of the mound, that met or exceeded the predicted recolonization rates of the DAMOS tiered monitoring and management protocol (Germano et al. 1994). The data collected over MQR mound indicated a net increase in mound height at the apex and an overall improvement in habitat quality at the sediment-water interface.

The objectives of the field operations conducted from 10 to 18 July 1994, over a 5.68 km^2 area of CLIS, were to

- delineate the dredged material footprints of, and examine any topographic changes to, the NHAV 93 and MQR mounds;
- demonstrate the capabilities of acoustic remote sensors in collecting surface and subbottom sediment characterization data;
- assess the benthic recolonization rate of the NHAV 93 and MQR mounds and monitor the successional status of the portions of the MQR mound unaffected by cap supplementation operations; and
- collect sediment samples at NHAV 93, MQR, and three reference areas for grain size, TOC, metals, and PAH analysis.

The July 1994 field effort at CLIS tested the following predictions:

1. With the exception of some compaction of basement material, there will be little to no change in topography of the NHAV 93 mound, while the MQR mound will display a moderate increase in mound height.

2. Benthic recolonization at the NHAV 93 mound will be mostly Stage I with progression into Stage II in some areas. The successional status of the MQR mound will be mostly Stage I and II in close proximity to the center and progressing to Stage III in locations not affected by the 1993/94 disposal activities.

3. Capping material will have covered the majority of the dredged material at the NHAV 93 project area. However, more capping material may be required north and west of the NHAV 93 buoy location.

2.0 METHODS

2.1 Survey Area

From 10 July to 18 July 1994 SAIC conducted a comprehensive field effort at CLIS consisting of precision bathymetry, surface sediment characterization, subbottom sediment profiling, Remote Ecological Monitoring of the Seafloor (REMOTS®) sediment-profile photography, grab sampling, and geotechnical coring. The bathymetric, surface sediment characterization, and subbottom sediment profiling were conducted over a 2553 m × 2225 m survey area centered at 41°08.951' N, 72°53.413' W (Figure 2-1). This survey required 89 lanes at 25 m lane spacing, and focused on the western two-thirds of CLIS. Detailed bathymetric, surface, and subbottom charts were generated for this 5.68 km^2 area.

The REMOTS® sediment-profile photography and grab sampling were performed at predetermined stations over both disposal mounds as well as the three reference areas surrounding CLIS (2500W, 4500E, and CLIS-REF; Figure 2-1). The geotechnical cores were collected over the NHAV 93 mound in a sampling pattern that provided a southwest-northeast cross-section of the CAD mound.

2.2 Bathymetry and Navigation

The SAIC Integrated Navigation and Data Acquisition System (INDAS) provided the precision navigation and data collection required for all SAIC field operations. This system utilizes a Hewlett-Packard 9920® series computer to provide real-time navigation, as well as collect position, depth, and time data for later analysis. A Del Norte Trisponder® System provided positioning to an accuracy of ±3 m. Shore stations were established along the Connecticut coast at the known benchmarks of Stratford Point (41°09.112' N, 72°06.227' W) and Lighthouse Point (41°14.931' N, 72°54.255' W). A detailed description of the navigation system and its operation can be found in the DAMOS Reference Report (Murray and Selvitelli 1996).

An ODOM DF3200 Echotrac® Survey Fathometer with a narrow beam, 208 kHz transducer measured individual depths to a resolution of 3.0 cm (0.1 ft) (Murray and Selvitelli 1996). Depth values transmitted to INDAS were adjusted for the 1.0 m transducer depth. The acoustic returns of the fathometer can reliably detect changes in depth of 20 cm or greater due to the accumulation of errors introduced by the positioning system, changes in sound velocity through the water column, the slope of the bottom, vertical motion of the survey vessel, and tidal corrections.

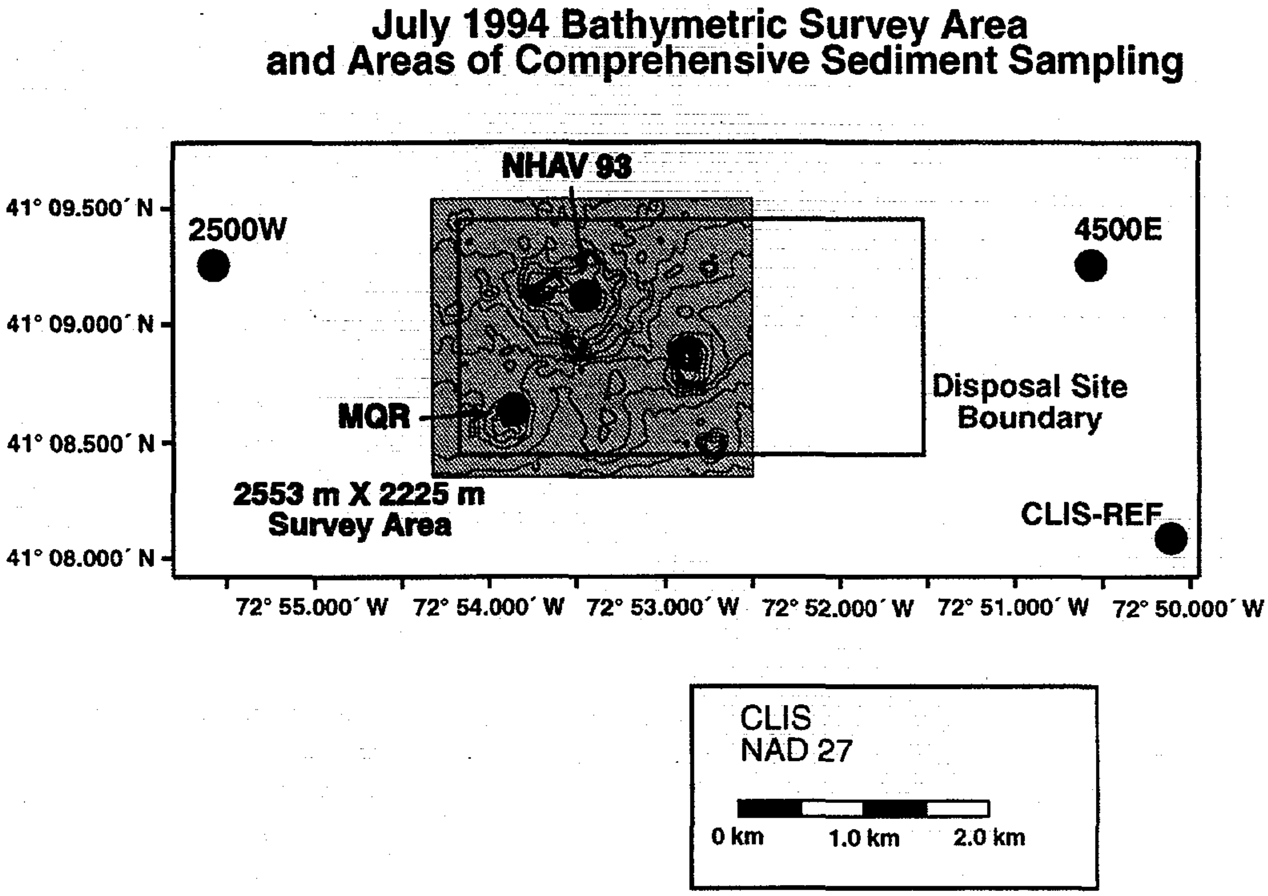


Figure 2-1. Base map displaying 2553 m × 2225 m bathymetric survey area relative to the project mounds, reference areas, and disposal site boundaries

In 1995, the expanding resources of the Internet allowed SAIC to access the National Oceanographic and Atmospheric Administration (NOAA), Ocean and Lake Levels Division's National Water Level Observation Network. This network is composed of 181 water level stations located throughout the Great Lakes and coastal regions of United States interest. These stations are equipped with the Next Generation Water Level Measurement System tide gauges and satellite transmitters that have collected and transmitted tide data to the central NOAA database every six minutes, since 1 January 1994.

Observed tide data are available 1 to 6 hours from the time of collection in a station datum or referenced to Mean Lower Low Water (MLLW) and based on Coordinated Universal Time (UTC). Data from NOAA tide station 8467150 in Bridgeport Harbor, Bridgeport, Connecticut, was used to re-correct both the July 1994 and March 1994 surveys at CLIS. The NOAA 6-minute tide data was downloaded in the MLLW datum, corrected to local time, and modified to reflect tidal differences based on the entrance to New Haven Harbor, New Haven, Connecticut.

During the bathymetric survey a Seabird Instruments, Inc. SBE 26-03 Sea Gauge wave and tide recorder was used to collect tidal data. The tide gauge, deployed in the survey area, recorded pressure values every six minutes. After conversion, the pressure readings provided a constant record of tidal variations in the survey area. These observed tidal data were later used to compare and verify the corrected NOAA data generated by the Bridgeport Harbor station (Figure 2-2).

A Seabird Instruments, Inc. SEACAT SBE 19-01 Conductivity, Temperature, and Depth (CTD) probe was used to obtain sound velocity measurements at the start, midpoint, and end of each survey day. The data collected by the CTD probe were bin-averaged to 1 meter depth bins to account for any pycnoclines (rapid changes in density creating distinct layers within the water column). A correction factor based on the mean sound velocity was then calculated using the bin-averaged values and applied to the raw bathymetric data.

Analysis of the bathymetric data was performed with the use of SAIC's Hydrographic Data Analysis System (HDAS), version 1.03. Raw position and depth values were imported into HDAS, corrected for sound velocity, and standardized to MLLW. The bathymetric data were then used to construct depth models of the surveyed area (Murray and Selvitelli 1996).

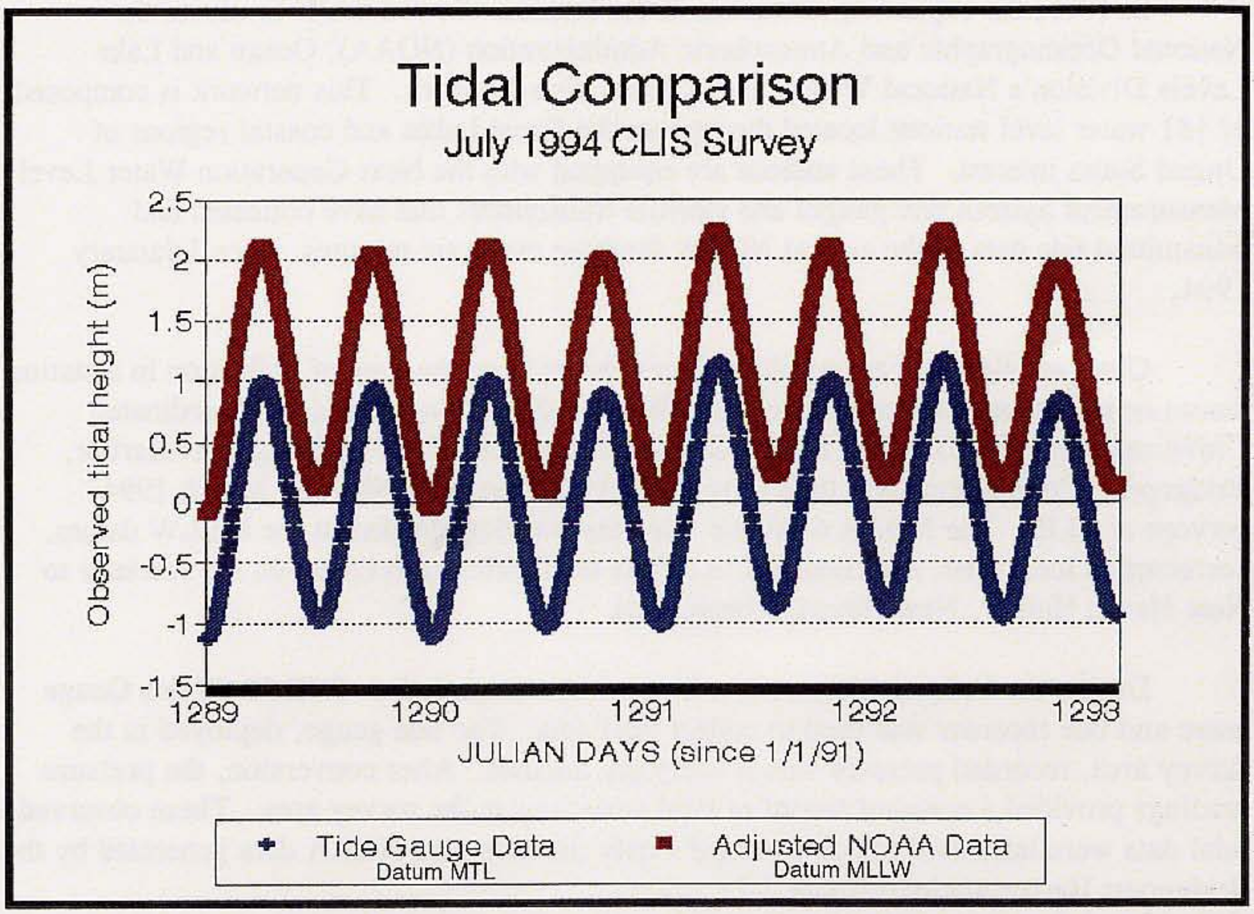


Figure 2-2. Comparisons of the two types of tidal data collected as part of the July 1994 bathymetric survey

2.3 Subbottom Profiling Operations

An X-Star Model SB-216 Full Spectrum Digital Subbottom Profiler, manufactured by Precision Signal, Inc., was used to acquire high-resolution subbottom profile data at CLIS. Subbottom seismic profiling is a standard technique for determining changes in acoustic impedance below the sediment/water interface. Acoustic impedance is the product of the density of a layer and the speed of sound within that layer. The depth of penetration and degree of resolution are dependent upon signal frequency, pulse width, and the characteristics of the penetrated material.

The narrow beam (13°) transducers of the X-Star system are mounted in a towfish body that trails approximately 15 meters behind a survey vessel. During a subbottom survey, the X-Star system generates a frequency-modulated pulse that is swept over an acoustic range from 2 to 10 kHz. The return signals are transmitted via a data cable through an analog to digital (A/D) signal converter to an onboard Sun Sparc II Workstation for data display and archive. The X-Star data acquisition system consists of computer components for automatic data storage, real-time color data display, and hard-copy printouts of profile data. Data were displayed on the screen in real time and ported to an Alden thermal printer for a hard copy record (Figure 2-3). Data were also stored on Exabyte tapes for further processing on shore.

Following the survey, the subbottom profile data residing on Exabyte tapes were digitized using a C-compiled program to read and analyze X-Star data. The subbottom data were read and displayed on a personal computer (PC) monitor as both a continuous profile, duplicating the shipboard display, and as individual pulses. The sediment/water interface and subbottom layers were digitized manually and stored for further processing. A continuous record of the surface reflection coefficient was also stored and processed.

For subbottom analyses, each acoustic horizon or layer was digitized while the data were played back on a PC monitor. Only lanes 53 through 74 of the survey were processed, in the area of most recent disposal. The subbottom analyses concentrated on the 2553 m × 525 m and 1600 m × 525 m survey areas over the northern portion of the NHAV 93 mound (Appendix A, Table 1; Figure 2-4). Each acoustic horizon measurement within the digitized layers was stored in a file as a depth from the sediment-water interface and geodetic position. The depths were corrected using 1500 $m \cdot s^{-1}$ as a standard sound velocity and were later modified with estimates of actual sound velocities in each layer during postprocessing.

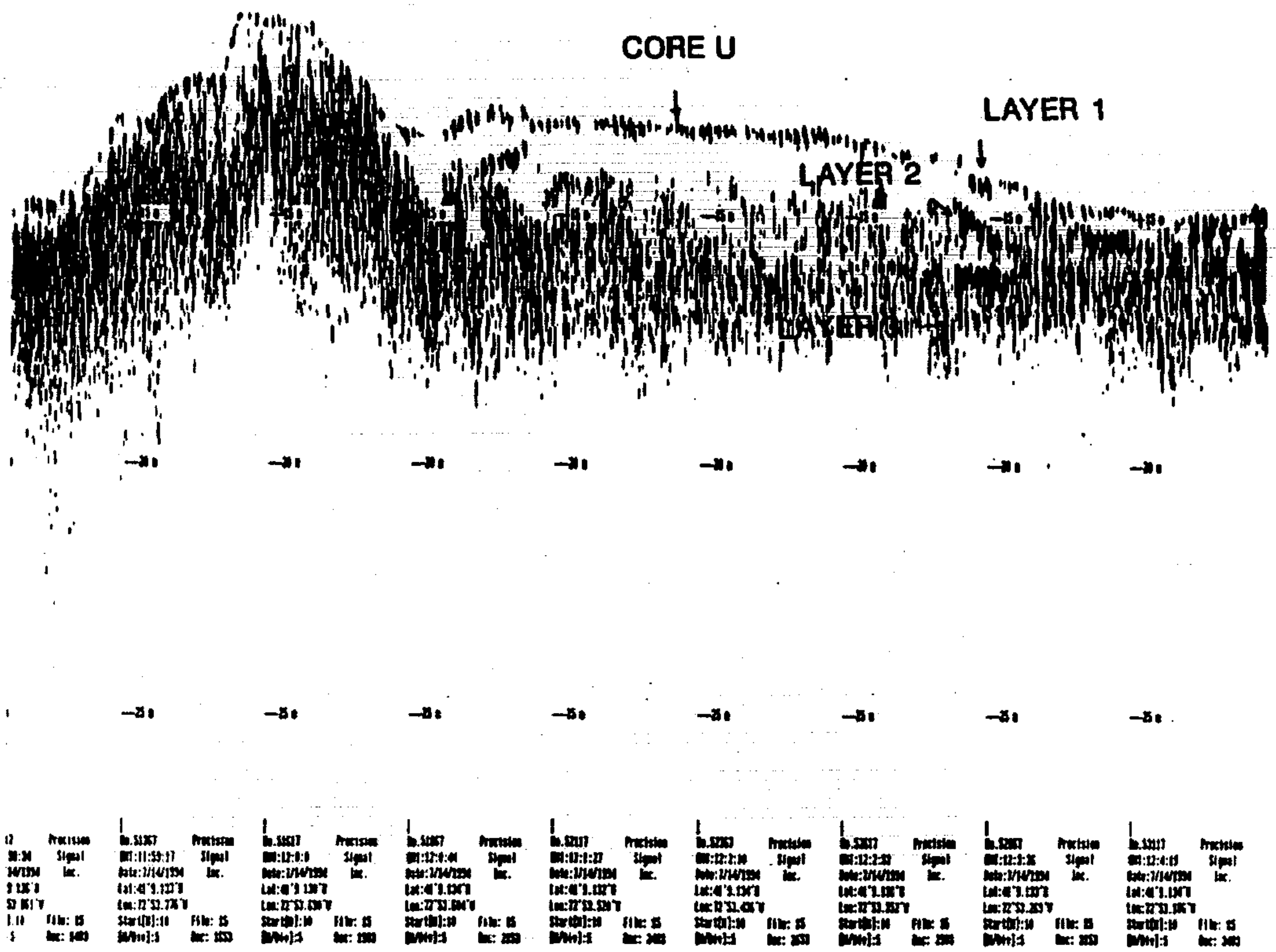


Figure 2-3. Hard copy printout of X-Star subbottom profiling data complete with layers 1, 2, and 3 indicated and plotted position of Core U

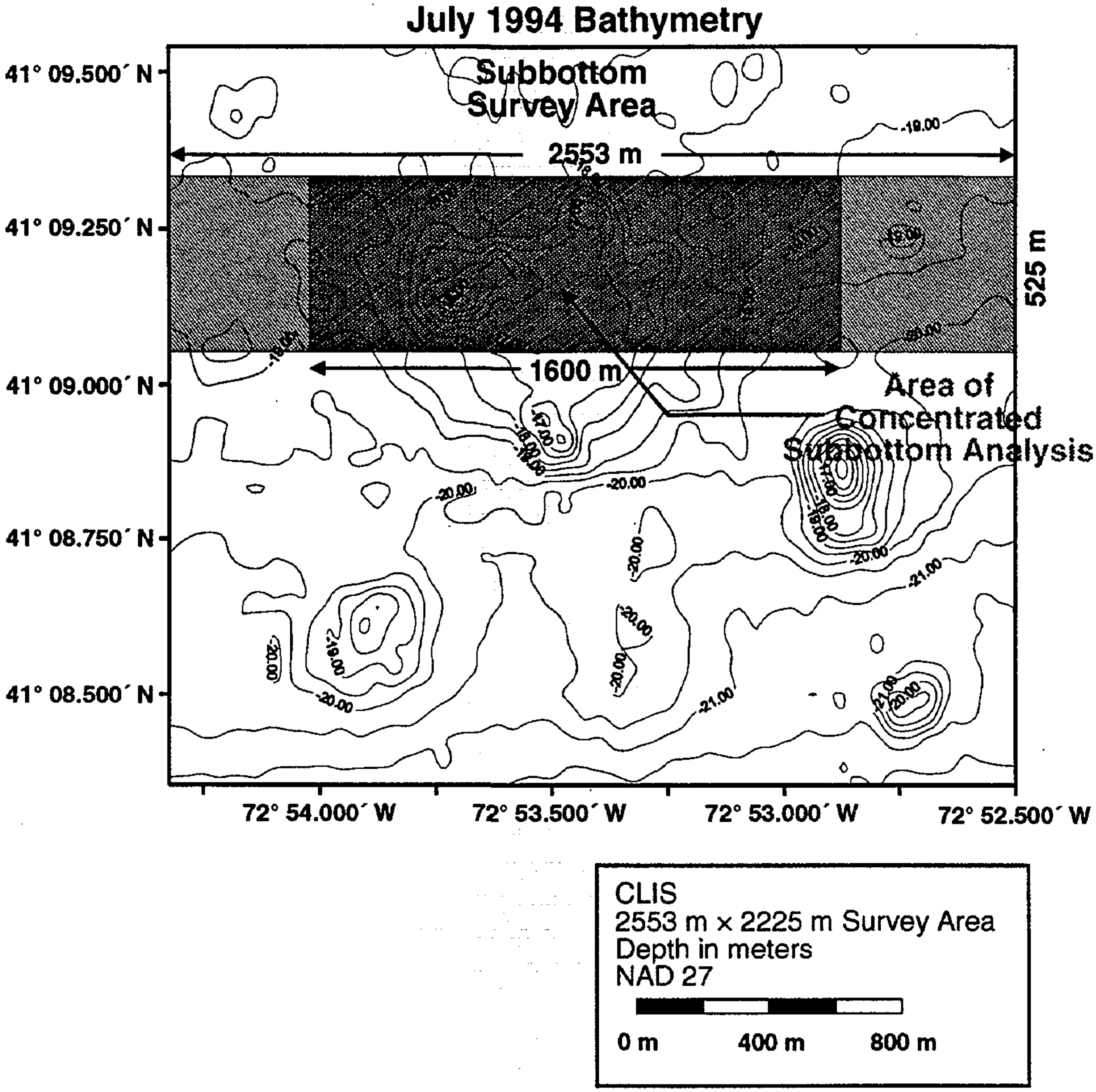


Figure 2-4. Chart of 2553 m × 525 m subbottom survey area complete with shaded 1600 m × 525 m concentrated analysis area

Models were constructed using SAIC's HDAS program. The models generated by HDAS contained a distance-weighted average depth value within each cell (25 m × 12.5 m). Models were then contoured to produce isopach maps of sediment layer thicknesses. The thickness of the dredged material layers determined from the subbottom profile data within the project area was compared to measurements obtained from both the March 1994 postcap and July 1994 large bathymetric surveys.

2.4 Surface Sediment Characterization

SAIC's Sediment Acoustic Characterization System (SACS) was utilized to remotely characterize the surface sediments at CLIS. This system uses acoustic bottom reflection data collected concurrently with bathymetric survey data to continuously map the surface sediments of a survey area. SACS is a dual-beam acoustic system that gathers bottom reverberation and interprets the acoustic returns as surface sediment type. The high-frequency (208 kHz) transducer of the ODOM DF3200 Echotrac® Survey Fathometer is used to obtain precise surface reflection data. A low-frequency (24 kHz) transducer is used to collect subbottom reflection data. The wavelength of the low-frequency transducer results in a subbottom depth resolution of approximately 6 cm. The bottom surface area sonified by the 23° beam of the 24 kHz transducer, using an average water depth of 20 m at CLIS, was calculated to be a circle approximately 8 m in diameter.

2.5 REMOTS® Sediment-Profile Photography

REMOTS® photography was used to detect the distribution of dredged material layers, map benthic disturbance gradients, and monitor the benthic infaunal recolonization and/or successional status of the NHAV 93 and MQR mounds in relation to the CLIS reference areas. Cross-sectional photographs of the top 20 cm of sediment were taken for analysis and intercomparison with the adjacent CLIS reference areas. Three replicate photographs were taken at each of the NHAV 93, MQR, 2500W, 4500E, and CLIS-REF stations. A detailed description of the REMOTS® sediment-profile camera and its operation can be found in DAMOS Contribution No. 48 (SAIC 1985).

The REMOTS® surveys centered on the NHAV 93 (41°09.122' N, 72°53.453' W) and MQR (41°08.637' N, 72°53.859' W) disposal mounds were conducted in 13-station cross grids with station spacing at 200 m and 50 m, respectively (Appendix A, Table 2; Figure 2-5). The reference areas 2500W (41°09.254' N, 72°55.569' W) and 4500E (41°09.254' N, 72 50.565' W) were sampled at four randomly selected stations. CLIS-REF (41°08.085' N, 72°50.109' W) was sampled at five randomly selected stations

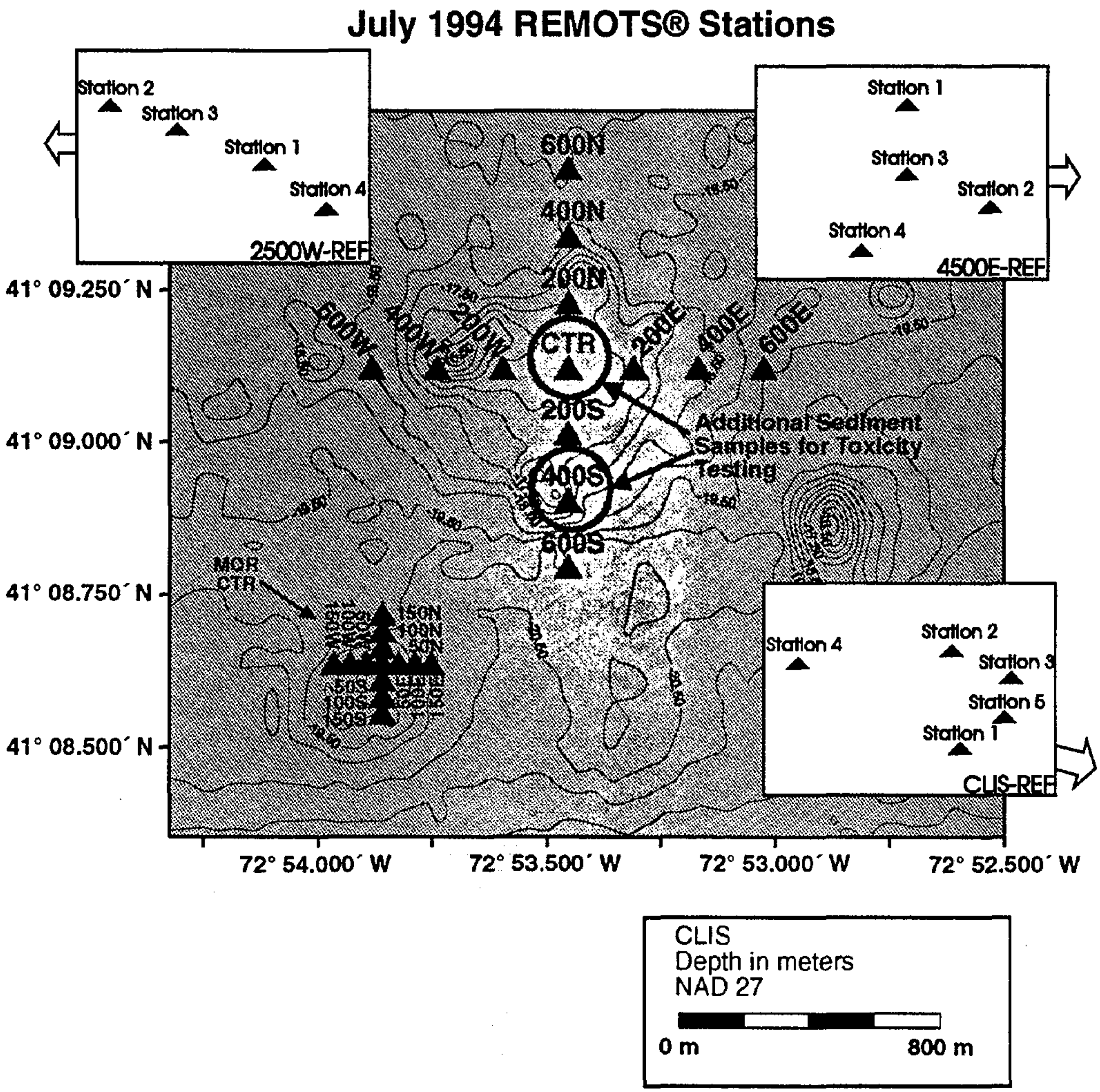


Figure 2-5. Chart of 2553 m × 2225 m survey area complete with plotted REMOTS® station locations and names for both project mounds and reference areas

(Appendix A, Table 3, Figure 2-5). Data from the CLIS-REF, 2500W, and 4500E reference areas were used for comparison of ambient central Long Island Sound sediments relative to the sediments deposited at CLIS through disposal operations.

2.6 Sediment Sampling and Analysis

2.6.1 Sediment Toxicity Testing

The benthic conditions displayed at three REMOTS® sediment-profile photography stations over NHAV 93 (CTR, 200N, and 400S) prompted a return to CLIS in late September 1994 to acquire additional bottom grab samples for toxicity testing. The surface sediments from two of the three stations over the NHAV 93 mound (CTR and 400S) were collected and exposed to a 10-day *Ampelisca abdita* bioassay (Figure 2-5). Station 200N was not re-visited due to its relative position and strong probability of similar chemical content in comparison with CTR sediments.

Two bottom grabs were collected from each station using a 0.1 m^2 Kynar-coated, Young-modified, van Veen grab sampler. The top 6 cm of sediment in each grab was collected, homogenized, and placed into one gallon polyvinylchloride (PVC) containers. The PVC containers were held at 4° Celsius (C) and transported to SAIC's Environmental Testing Center (ETC) in Narragansett, RI, for further processing. Upon arrival at the ETC, the sample containers were held at 4° C in the dark until final preparations for testing were complete.

Several days later, the sediments were extracted from each sample container and 10-day *Ampelisca* bioassays conducted using Green Book protocols (Appendix A, Table 9; EPA/USACE 1991).

Reference sediments used for comparison of the NHAV 93 material were collected from the historic South Reference Site (41°07.950' N, 72°52.700' W) approximately 700 m south of CLIS (Rogerson et al. 1985). Delineated at the inception of the DAMOS Program, these reference area sediments have been used to compare the results of many NED, WES, and EPA environmental monitoring programs.

2.6.2 Sediment Chemistry

Sediment samples for chemical analysis were also collected with the use of the 0.1 m^2 Kynar-coated, Young-modified, van Veen grab sampler. Eleven stations were randomly selected over the NHAV 93 and MQR disposal mounds (Appendix A, Table 4; Figure 2-6). The current DAMOS reference areas 2500W and 4500E were sampled at

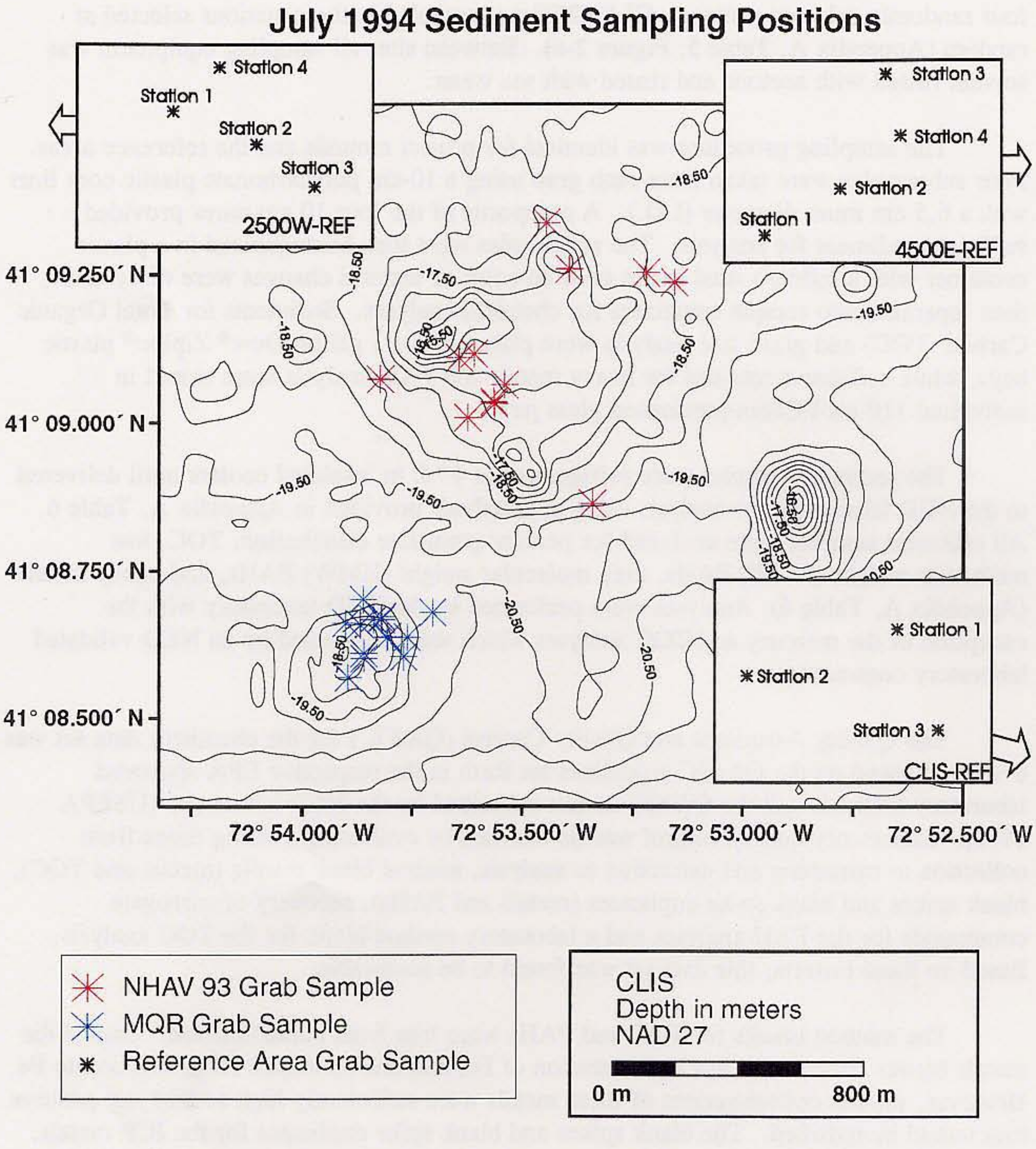


Figure 2-6. Chart of 2553 m × 2225 m survey area complete with plotted grab sampling stations for both project mounds and reference areas

four randomly selected stations. CLIS-REF was sampled at three stations selected at random (Appendix A, Table 5; Figure 2-6). Between sites all sampling equipment was solvent rinsed with acetone and rinsed with sea water.

The sampling procedure was identical for project mounds and the reference areas. Four subsamples were taken from each grab using a 10-cm polycarbonate plastic core liner with a 6.5 cm inner diameter (I.D.). A composite of the four 10 cm cores provided sufficient sediment for analysis. The subsamples were then homogenized in a plastic container with a teflon-coated spoon until no color or textural changes were discernible, then separated into sample containers for chemical analyses. Sediments for Total Organic Carbon (TOC) and grain size analysis were placed into a 1 gallon Dow® Ziploc® plastic bags, while sediments retained for heavy metals and PAH analysis were stored in individual 110 ml I-Chem precleaned glass jars.

The sediment samples were refrigerated at 4° C in insulated coolers until delivered to the NED laboratory for analysis using the methods provided in Appendix A, Table 6. All sediment samples were analyzed for percent grain size distribution, TOC, low molecular weight (LMW) PAHs, high molecular weight (HMW) PAHs, and heavy metals (Appendix A, Table 6). Analyses were performed by the NED laboratory with the exception of the mercury and TOC analyses which were conducted by an NED validated laboratory contractor.

The Quality Assurance and Quality Control (QA/QC) for the chemistry data set was evaluated based on the QA/QC guidelines set forth in the respective EPA approved laboratory methods and the QA/QC results submitted by the NED laboratory (USEPA 1986). Laboratory quality control was determined by evaluating holding times from collection to extraction and extraction to analysis, method blank results (metals and TOC), blank spikes and blank spike duplicates (metals and PAHs), recovery of surrogate compounds for the PAH analyses and a laboratory method blank for the TOC analysis. Based on these criteria, this data set was found to be acceptable.

The method blanks for TOC and PAHs were free from contamination. One of the metals blanks contained a low concentration of Fe, and one contained Al in addition to Fe. However, sample concentrations of these metals were sufficiently high so that any positive bias would be nullified. The blank spikes and blank spike duplicates for the ICP metals, furnace metals, and PAHs were all in control for both accuracy and precision. All samples submitted for metals analysis and PAHs were extracted and analyzed within EPA recommended holding times (USEPA 1986).

Each PAH sample was spiked with three system monitoring or surrogate compounds (2-fluorobiphenyl, nitrobenzene-D_5, and terphenyl-D_{14}) as a measure of accuracy. Surrogate samples are analyzed as a check on the laboratory's ability to extract known concentrations of compounds not normally found in the sample. All PAH surrogate recoveries for this data set were within acceptance limits and indicate no laboratory extraction problem (USEPA 1988).

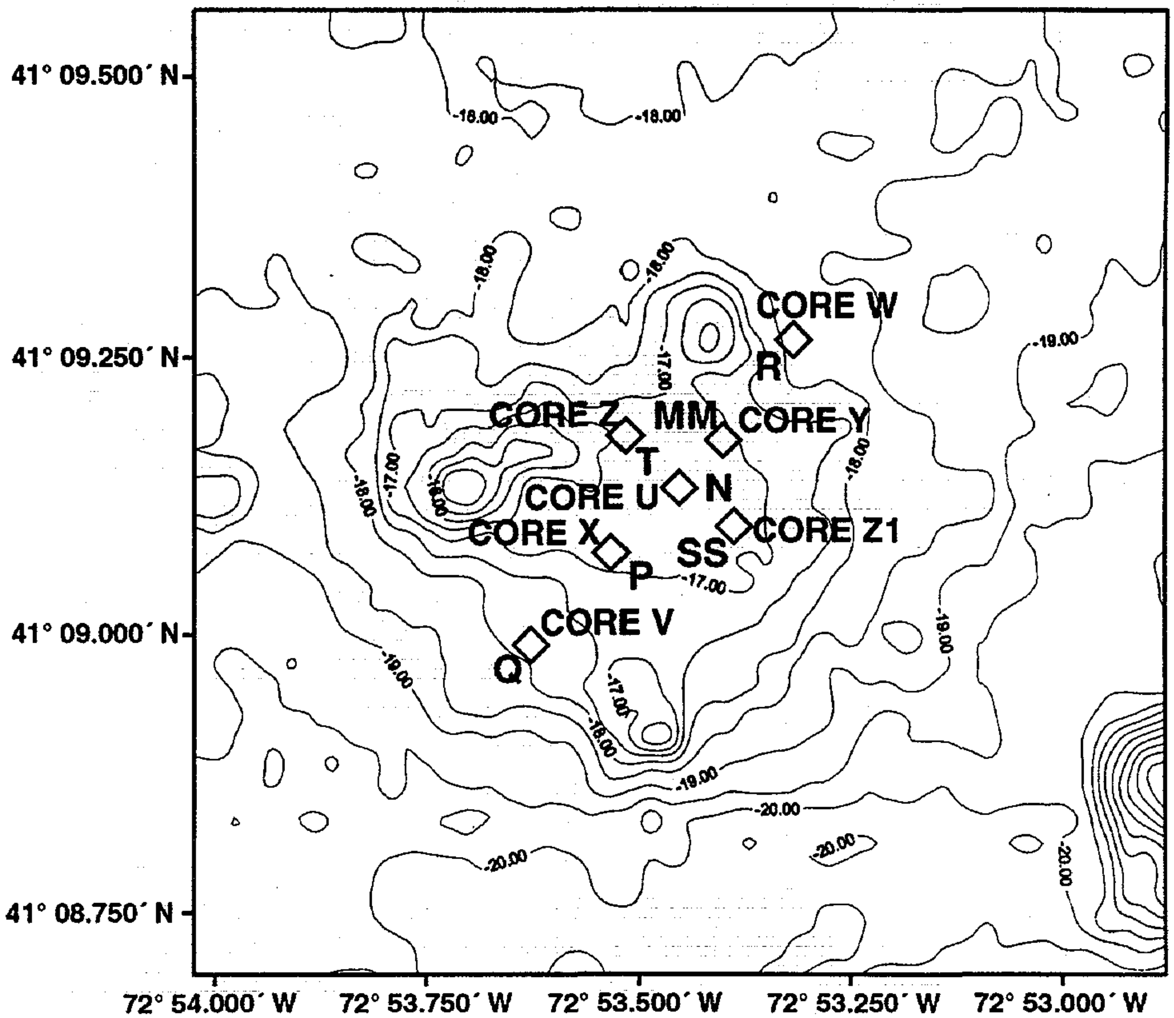
2.7 Geotechnical Coring

The coring operations completed on 18 July were part of the fourth phase in a five-part geotechnical survey of the NHAV 93 mound. Seven sediment cores, oriented to produce a cross-section of the NHAV 93 mound, were obtained through an SAIC and University of Rhode Island (URI) joint effort. The sampling scheme was centered on the NHAV 93 buoy position (41°09.122' N, 72°53.453' W) (Appendix A, Table 7; Figure 2-7). Cores U through Y were taken in a northeast-southwest transect across the NHAV 93 mound. Cores Z and Z1 were obtained on a northwest-southeast transect of NHAV 93 mound.

The sediment cores were obtained with the use of the PVC core barrel version of the University of Rhode Island/Marine Geomechanics Laboratory (URI/MGL) Large Diameter Gravity Corer (LGC) (Figure 2-8) (Silva et al. 1994). The core barrels consist of a 3 m (10 ft) section of Schedule 40 PVC piping (10.2 cm or 4.0 I.D.) and includes a nose cone and core catcher on the end.

All cores were transported back to the URI laboratory facilities and refrigerated during storage. The CLIS sediment cores were processed to obtain overall sediment composition, bulk density, water content, grain size, Atterberg Limits, specific gravity, and shear strength (Silva et al. 1994). A detailed description of the methods used for the analysis of sediment Cores U through Z1 is included in a report submitted by Armand J. Silva of the Marine Geomechanics Laboratory, University of Rhode Island (Silva et al. 1994).

July 1994 Geotechnical Core Positions



CORE X - Geotechnical core collected 7/18/94

MM - corresponding 3rd member geotechnical core collected March 1994

CLIS
NHAV 93 Mound
Depth in meters
NAD 27

0 m 400 m

Figure 2-7. Chart of 1600 m × 1600 m area over the NHAV 93 mound, complete with plotted geotechnical core positions and names

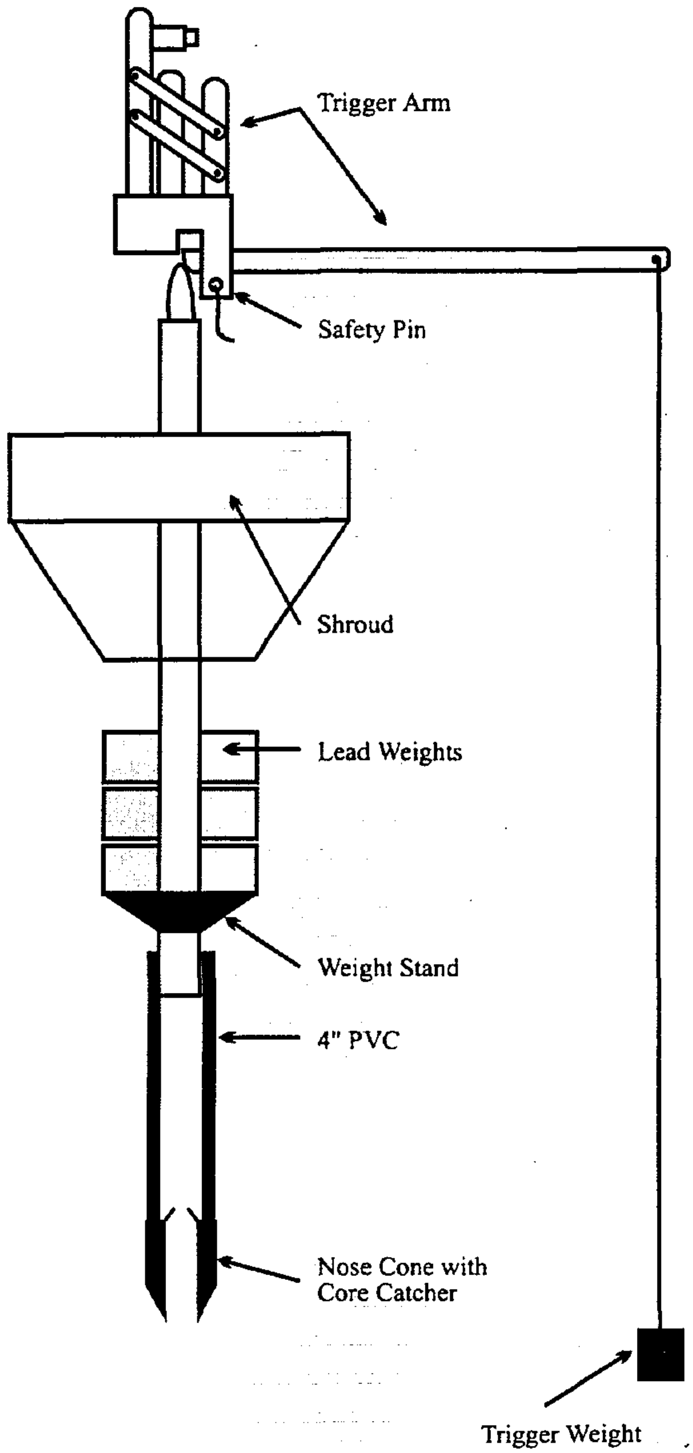


Figure 2-8. Diagram of the URI/MGL large diameter gravity corer

3.0 RESULTS

The 2553 m × 2225 m precision bathymetric survey was conducted over the western two-thirds of CLIS to monitor the region for changes in topography and mound stability. This survey yielded a bathymetric chart of a 5.68 km^2 area with a minimum depth of 15.0 m over the CLIS 88 mound (Figure 3-1). At a contour interval of 0.25 m the mound formations become more defined, depicting the remnants of eighteen discrete and/or coalesced dredged material disposal mounds detected within the surveyed area (Figure 3-2).

To improve the resolution and focus on both subject disposal mounds (NHAV 93 and MQR), the data collected over the 2553 m × 2225 m survey area was re-gridded into smaller analysis areas. Depth difference calculations for apparent accumulation and consolidation of dredged material were performed within the analysis area of each mound.

3.1 NHAV 93 Mound

3.1.1 Bathymetry

The NHAV 93 mound, formed with 1,159,000 m^3 of UDM and CDM from the New Haven Harbor dredging project filled the shallow depression created by a ring of disposal mounds (Figure 3-3). Comparisons to the September 1993 baseline survey display a bottom feature that roughly conforms to the shape of the depression with a maximum mound height of 2.5 m (compare Figures 1-2 and 3-4). The detectable footprint of the mound (0.25 m) is approximately 950 m wide and overlaps seven surrounding mounds (CLIS 87, CLIS 88, CLIS 89, CLIS 90, CLIS 91, SP, and Norwalk). Depth difference calculations using the March 1994 postcap survey indicate small pockets of consolidation (0.25 to 0.5 m) over the surface of the NHAV 93 mound (Figures 3-5 and 3-6).

3.1.2 Subbottom

Subbottom data were collected by the X-Star system for the entire survey area. However, the analysis was concentrated on the northern half of the NHAV 93 mound. Due to the deposition of CDM northwest of the NHAV 93 buoy prior to the November 1993 precap bathymetric survey, the results of the March 1994 postcap survey detected an apparent lack of capping material over the northwest quadrant of the NHAV 93 mound (Figure 3-7). A total of 76,000 m^3 of capping material was deposited on the northwest flank of the mound between the interim disposal and precap bathymetric surveys of 1993,

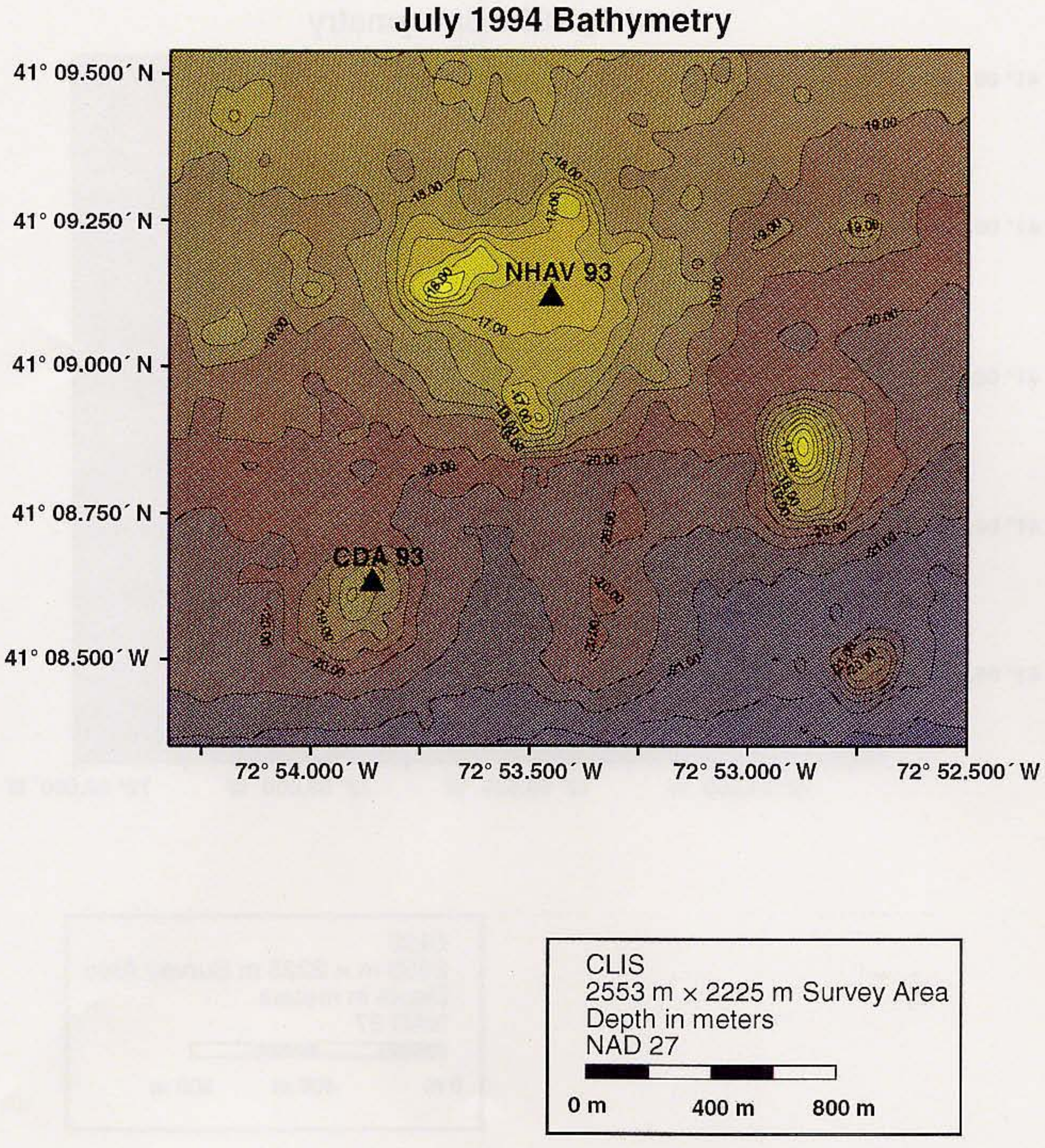


Figure 3-1. Bathymetric chart of the 2553 m × 2225 m survey area with plotted positions of the 1993 DAMOS disposal buoys, 0.5 m contour interval

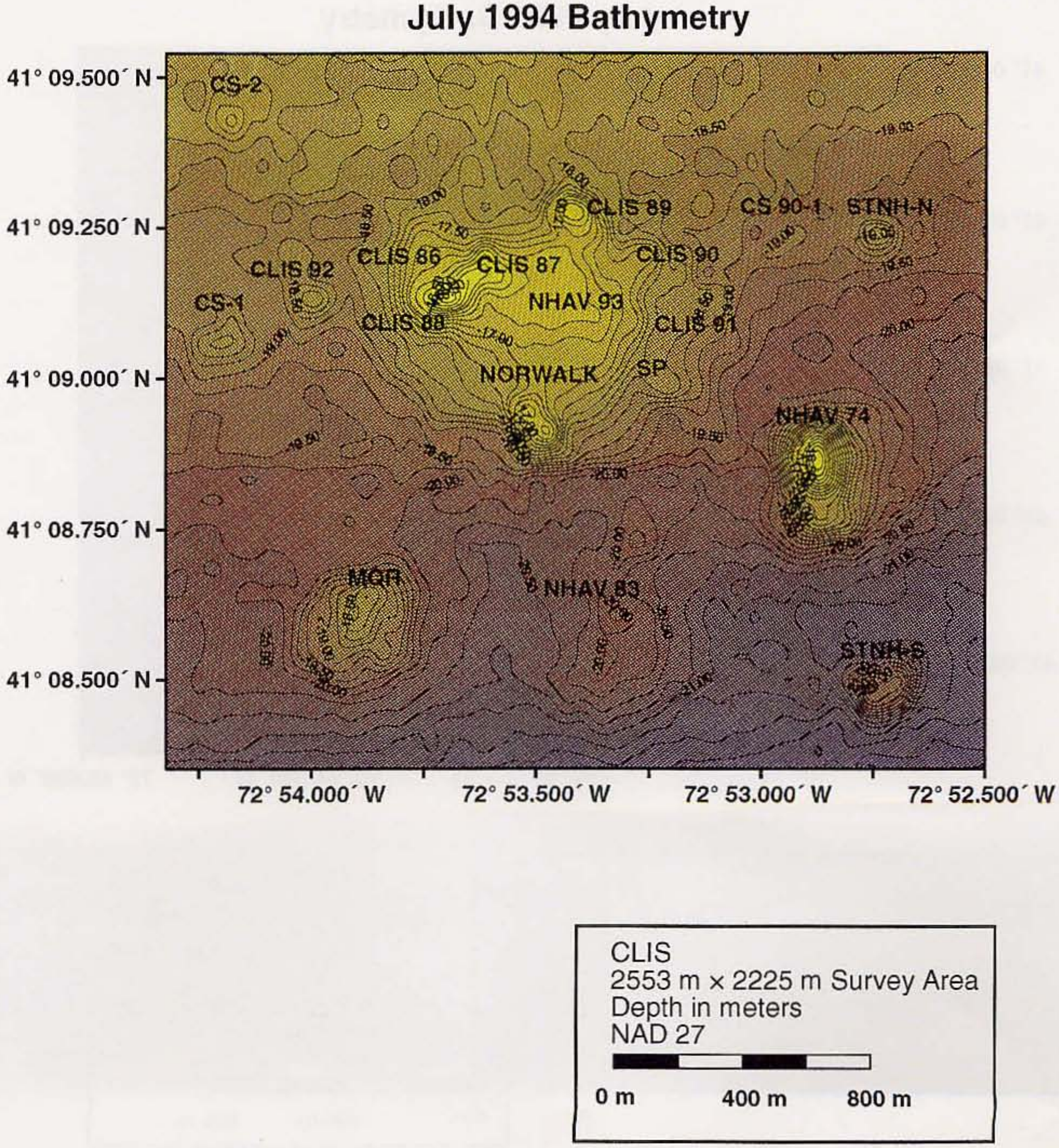


Figure 3-2. Bathymetric chart of the 2553 m × 2225 m survey area with mound names, 0.25 m contour interval

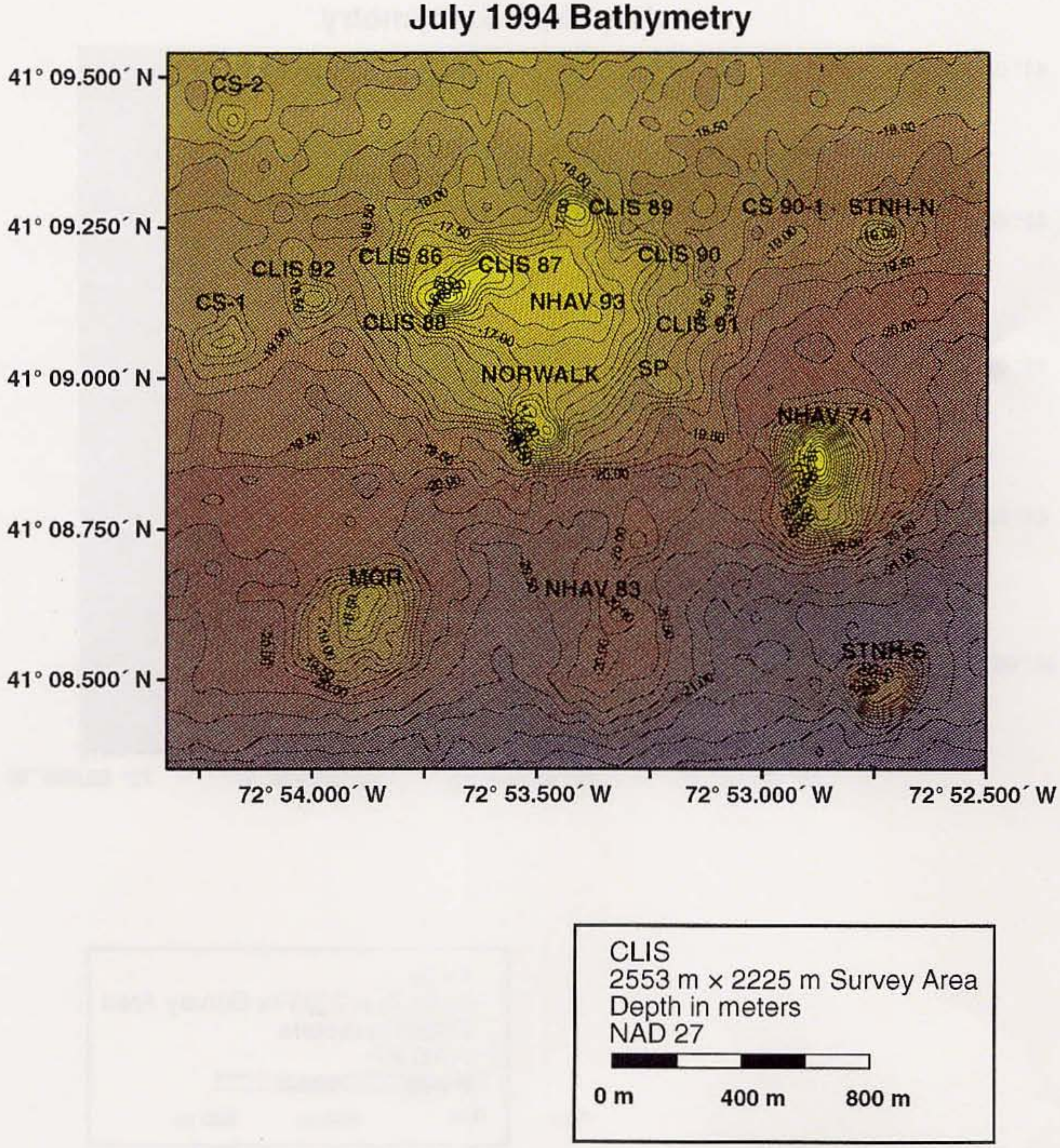


Figure 3-2. Bathymetric chart of the 2553 m × 2225 m survey area with mound names, 0.25 m contour interval

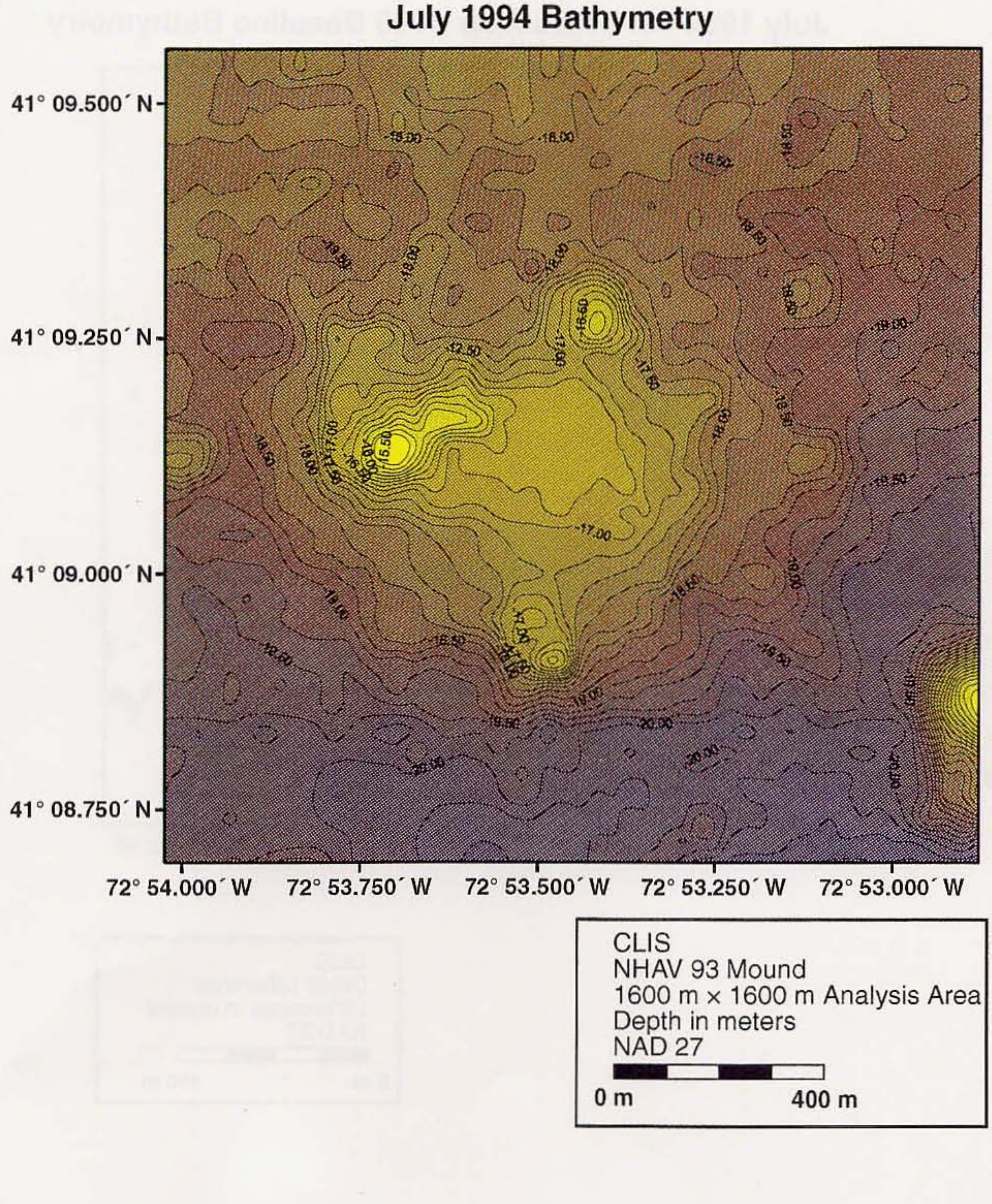


Figure 3-3. Bathymetric chart of the 1600 m × 1600 m area over the NHAV 93 mound, 0.25 m contour interval

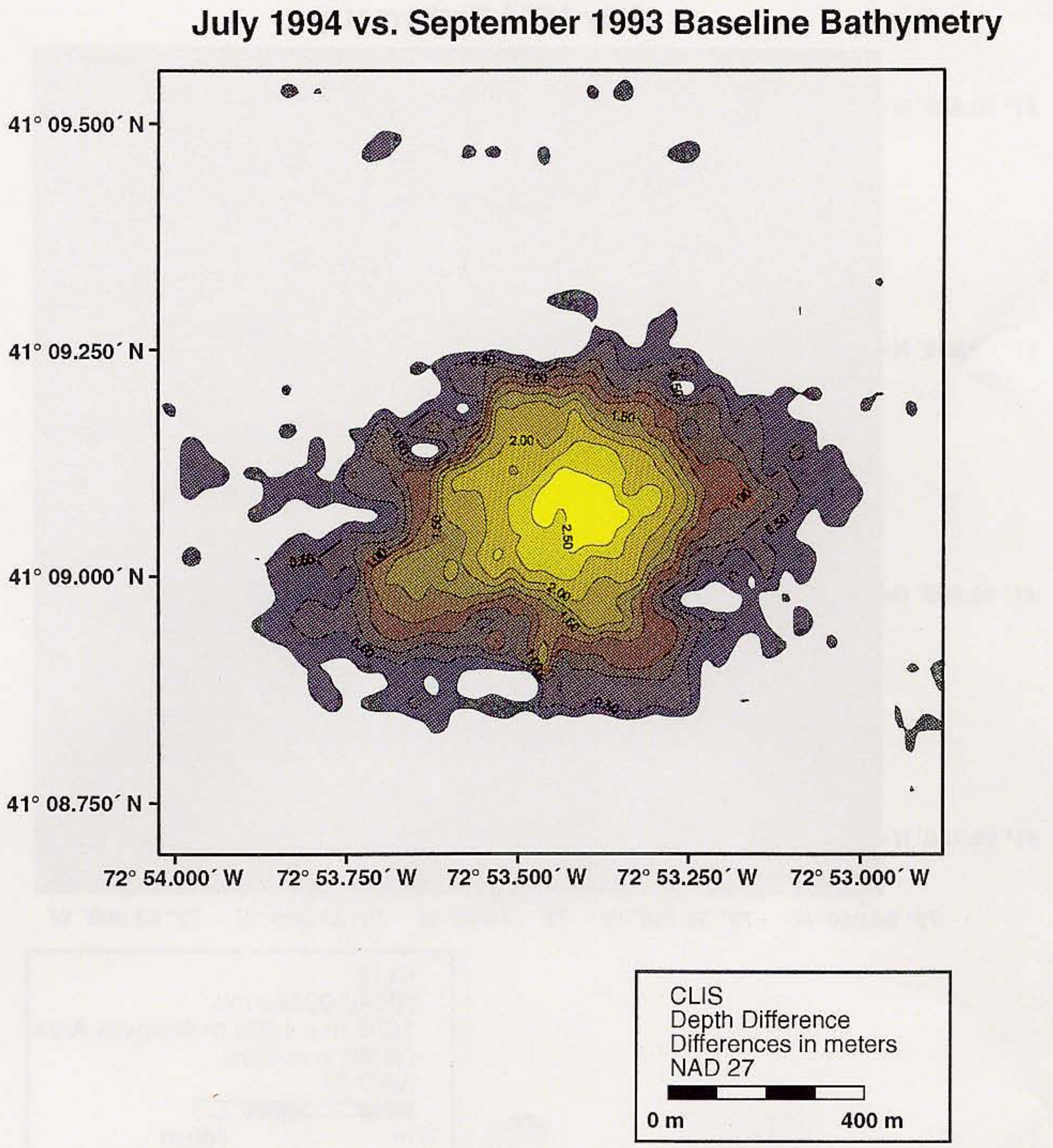


Figure 3-4. Depth difference plot of the July 1994 survey vs. the September 1993 survey, 0.25 m contour interval

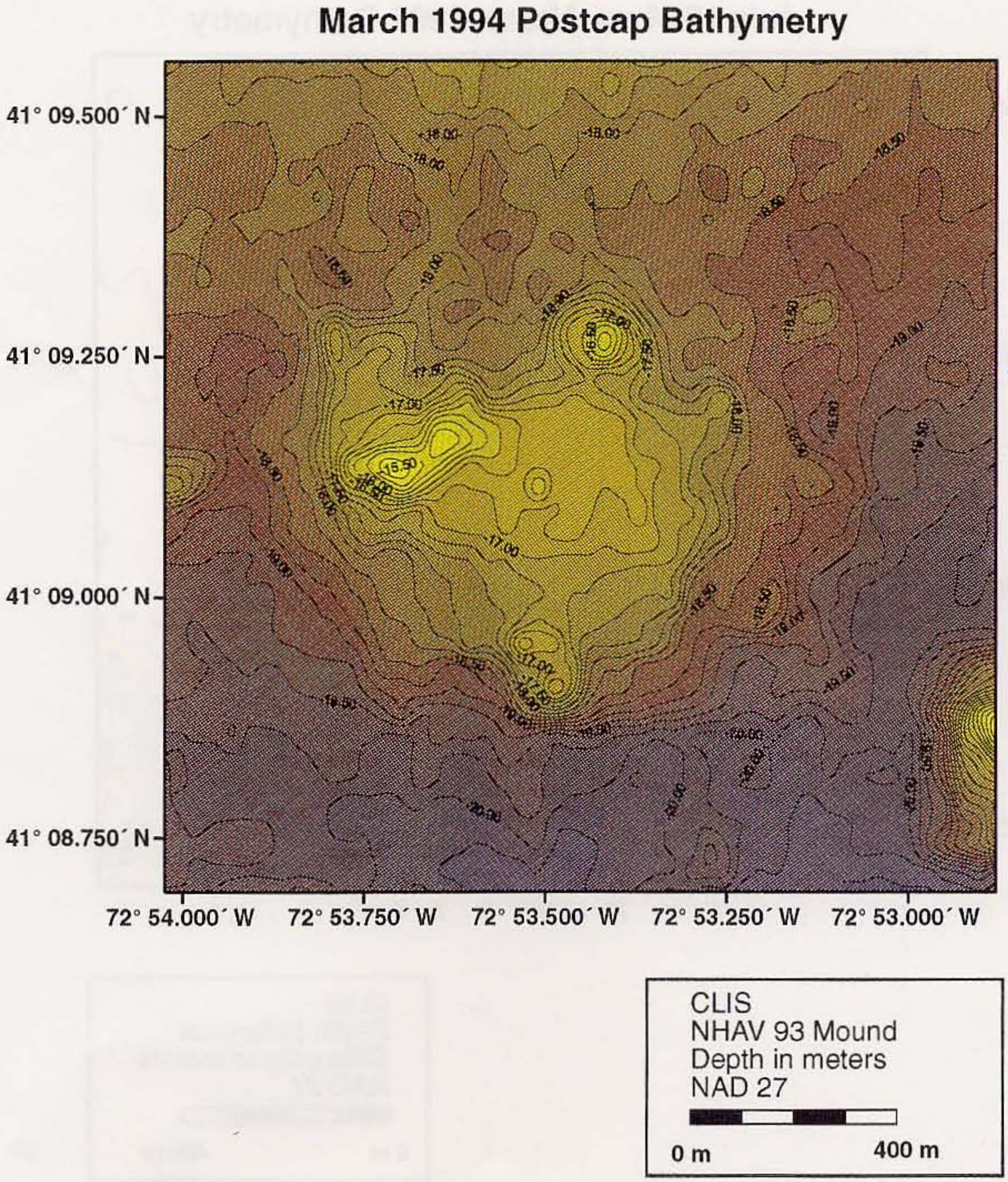


Figure 3-5. Bathymetric chart of the March 1994 postcap survey, 0.25 m contour interval

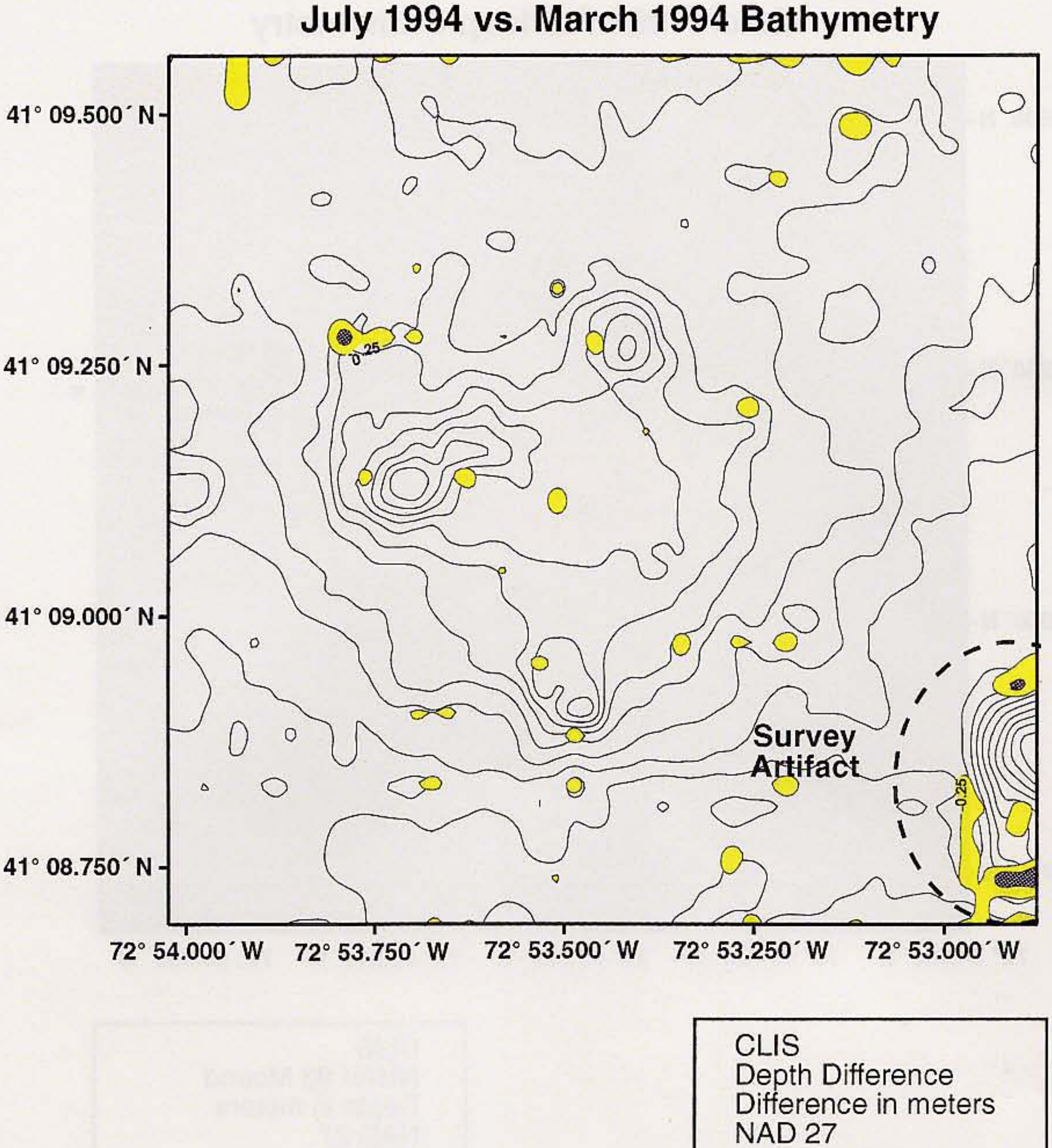


Figure 3-6. Depth difference plot of the July 1994 survey vs. the March 1994 postcap survey showing apparent consolidation, 0.25 m contour interval displayed over July 1994 bathymetric results (0.5 m contour interval)

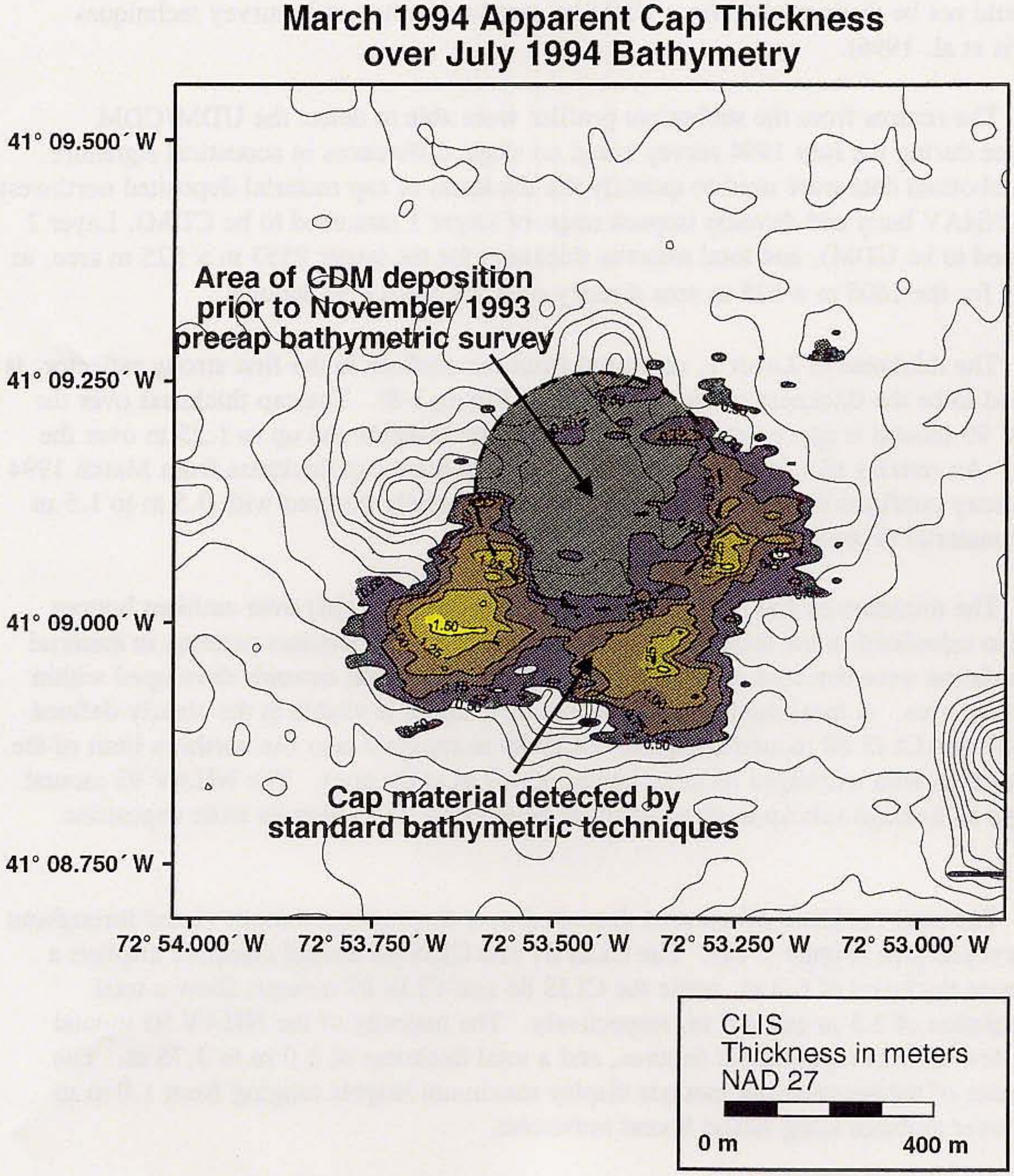


Figure 3-7. March 1994 apparent cap thickness plot overlaid onto July 1994 bathymetry, 0.25 m contour interval displayed over July 1994 bathymetric results (0.5 m contour interval)

but could not be distinguished from UDM by standard bathymetric survey techniques (Morris et al. 1996).

The returns from the subbottom profiler were able to detect the UDM/CDM interface during the July 1994 survey based on slight differences in acoustical signature. The subbottom data were used to quantify the thickness of cap material deposited northwest of the NHAV buoy and develop isopach maps of Layer 1 (assumed to be CDM), Layer 2 (assumed to be UDM), and total material thickness for the larger 2553 m × 525 m area, as well as for the 1600 m × 525 m area directly over the NHAV 93 mound.

The thickness of Layer 1, measured from the seafloor to the first strong reflector, is assumed to be the thickness of the cap material (Figure 3-8). The cap thickness over the NHAV 93 mound is approximately 0.75 m along the margins and up to 1.25 m over the center. An overlay plot of the X-Star data on the apparent cap thickness from March 1994 bathymetry confirms that the northwest quadrant is actually covered with 0.5 m to 1.5 m of cap material (Figure 3-9).

The thickness of Layer 2 (assumed to be dredged material) over ambient bottom was also calculated in the subbottom analysis (Figure 3-10). Distinct patterns in material accumulation were detected, corresponding to historic disposal mounds developed within the survey area. A maximum height of 6.0 m of material is visible at the clearly defined CLIS 87 and CLIS 88 mound complex. CLIS 89 is apparent near the northern limit of the analysis area with a dredged material height of 4.0 m at the apex. The NHAV 93 mound displays an average subcap dredged material height of 2.75 m over its wide deposition area.

The total thickness of material deposited over the ambient bottom varied throughout the surveyed area (Figure 3-11). The CLIS 87 and CLIS 88 mound complex displays a maximum thickness of 6.5 m, while the CLIS 86 and CLIS 89 mounds show a total accumulation of 3.5 m and 4.5 m, respectively. The majority of the NHAV 93 mound shows few distinct topographic features, and a total thickness of 3.0 m to 3.75 m. The remainder of the surrounding mounds display maximum heights ranging from 1.0 m to 2.5 m over ambient Long Island Sound sediments.

3.1.3 REMOTS® Sediment Profiling

The REMOTS® sediment-profiling photography survey over the NHAV 93 mound was conducted to delineate the CDM dredged material footprint, as well as to assess the benthic recolonization rate of the surface sediments. Fresh dredged material (CDM) was

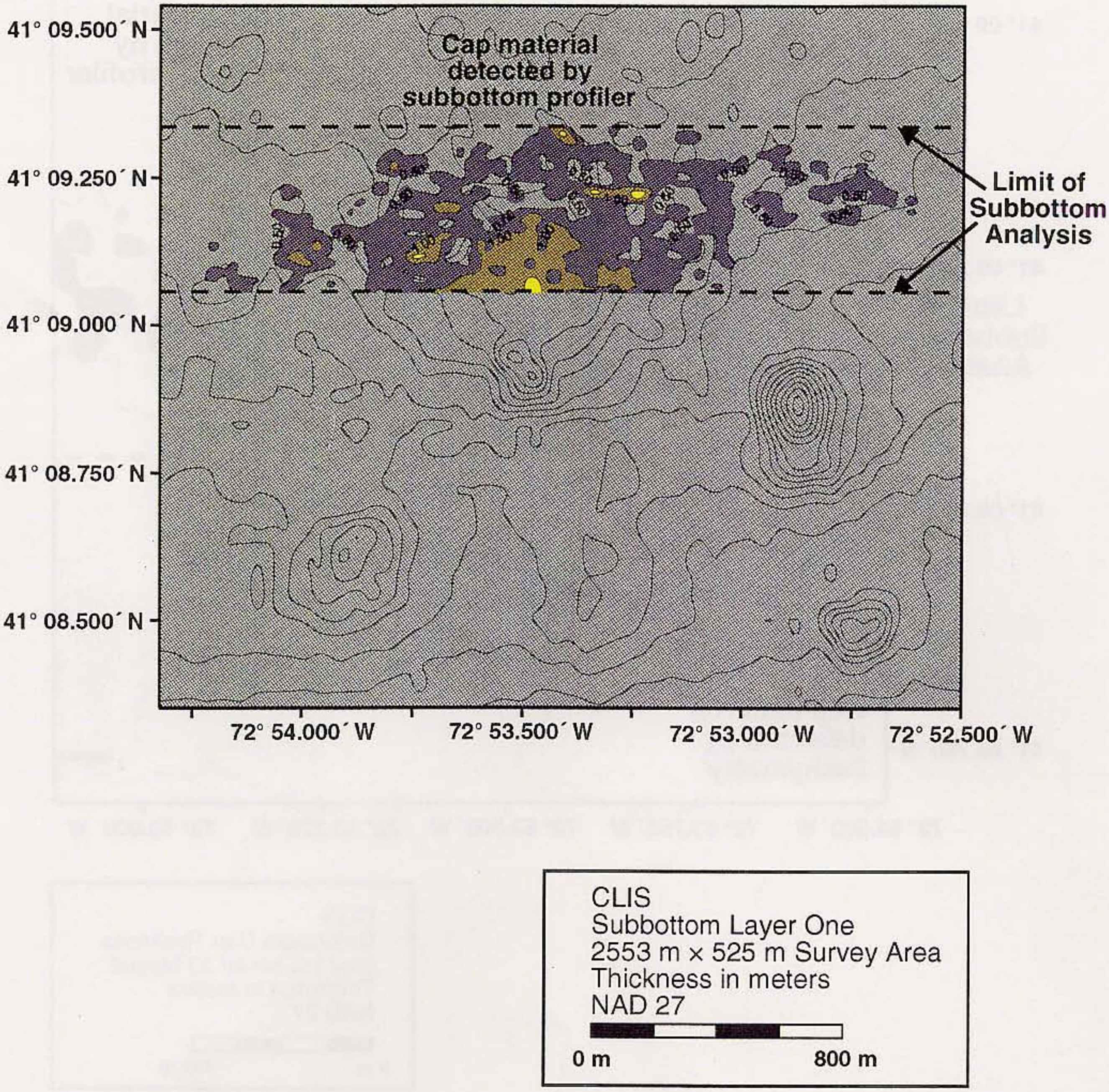


Figure 3-8. Contour plot of subbottom layer 1 (cap thickness) over the 2553 m × 525 m analysis area, 0.5 m contour interval

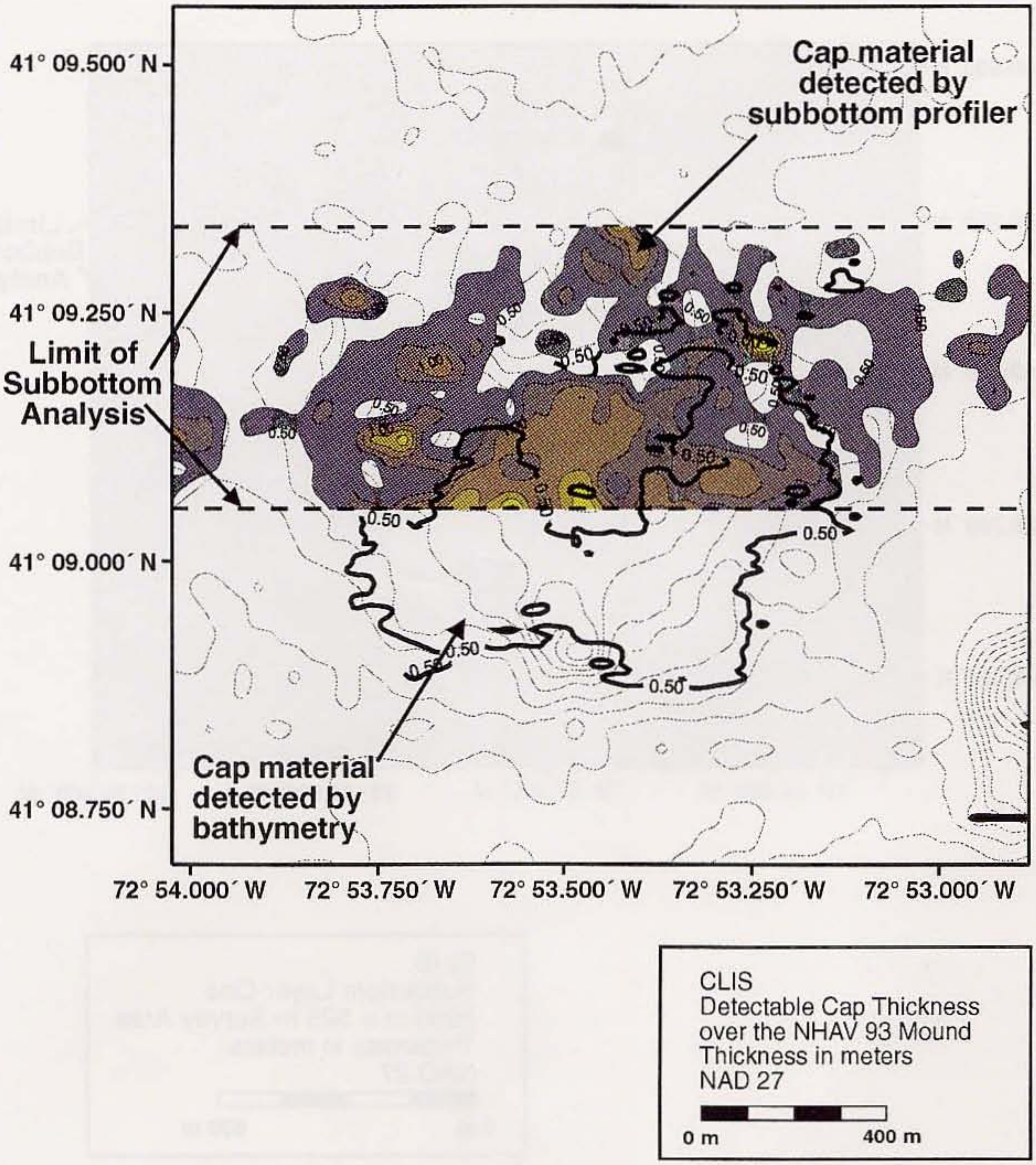


Figure 3-9. Contour plot of subbottom layer 1 (cap thickness; color) overlaid onto total cap thickness plot of March 1994 (white) 1600 m × 525 m analysis area over the NHAV 93 mound, 0.25 m contour interval

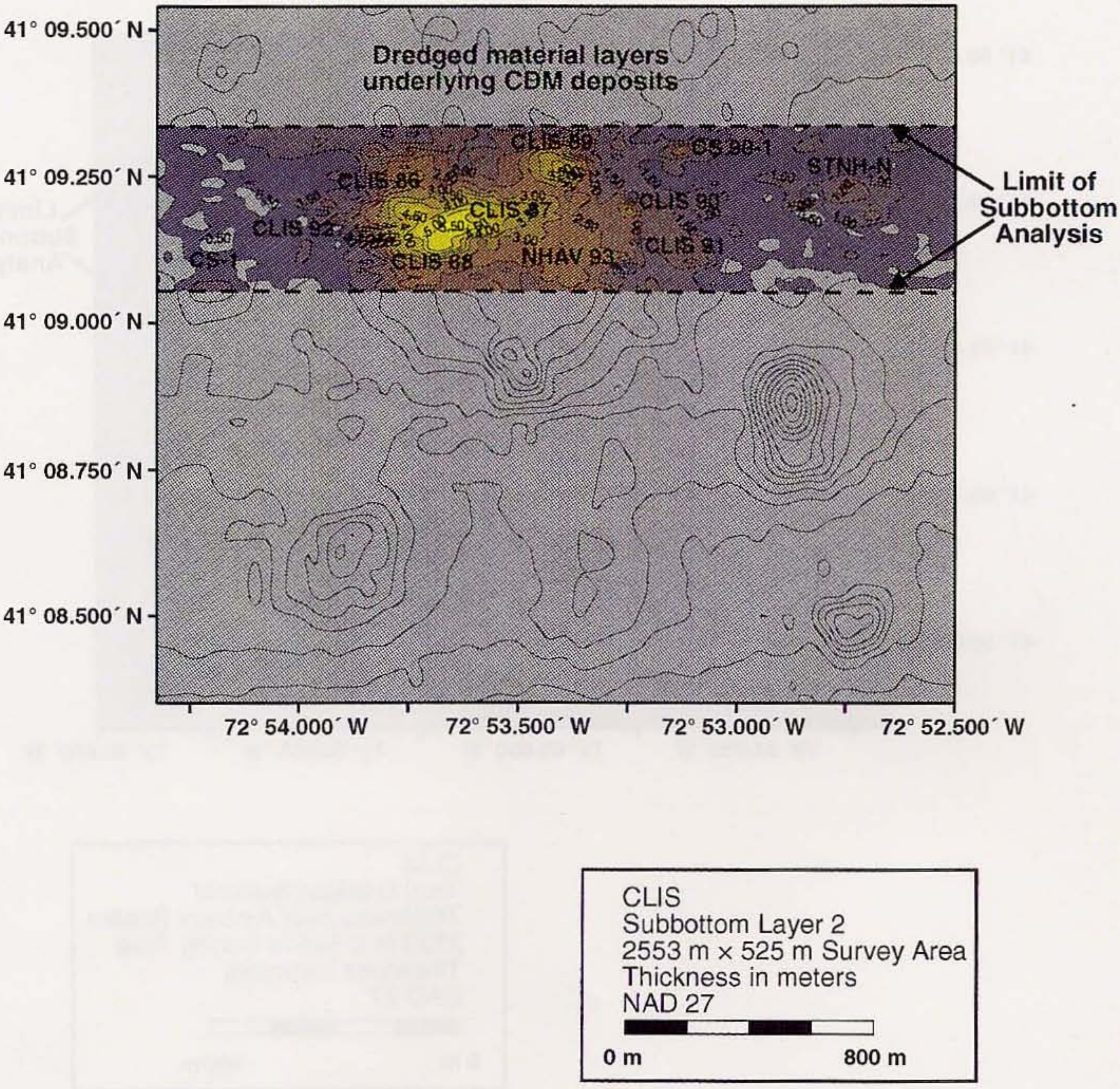


Figure 3-10. Contour plot of subbottom layer 2 (dredged material thickness) 2553 m × 525 m analysis area, 0.5 m contour interval

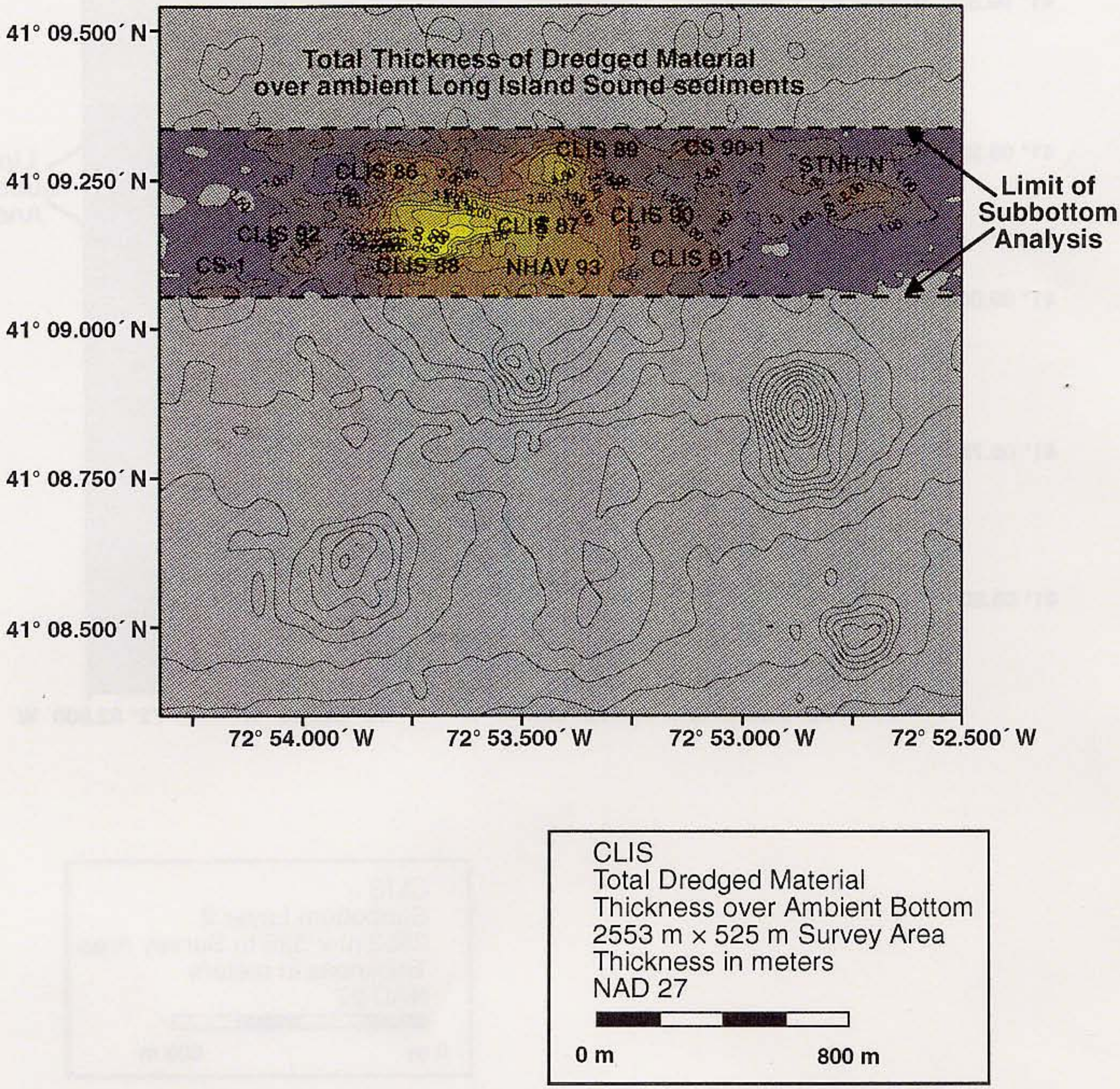


Figure 3-11. Contour plot of total material thickness over ambient bottom, 2553 m × 525 m analysis area, 0.5 m contour interval

detected to varying depths at all project mound REMOTS® stations. The data acquired from the project mounds were compared to data collected at the three reference areas surrounding CLIS. Complete REMOTS® results for the NHAV 93 disposal mound are available in Appendix B, Table 1.

The relatively homogeneous cap of the NHAV 93 mound is composed of silts and clays dredged from the outer New Haven Harbor. The major modal grain size for the 13 REMOTS® stations over the NHAV 93 mound was consistently greater than 4 phi, indicating no significant coarsening of the surface layers by bedload transport of fine-grained material. The replicate-averaged boundary roughness values, a measure of the relative complexity of the sediment-water interface, ranged from 0.04 cm at 400E to 4.31 cm at 600S (Appendix A, Table 8). The type of surface roughness was classified as physical disturbance in the majority of replicates.

Dredged material was identified and measured at all 13 REMOTS® camera stations. Replicate-averaged dredged material thickness ranged from 6.41 cm at 600S to full penetration (20 cm) at 200E. The thickness of dredged material was greater than camera penetration at all stations except 600S and one replicate at 400S. As expected with a recent dredged material deposit, there were no indications of redox rebound intervals, areas of intermittent or seasonal oxidation below the oxidized surface layer, in any replicate. No methane gas was noted in the subsurface sediments; however, a layer of reduced dredged material was seen in two replicates of 400S.

Three parameters were used to assess the benthic recolonization rate and overall health of the project mounds relative to the CLIS reference areas. The apparent Redox Potential Discontinuity (RPD) depth, infaunal successional stages, and the Organism-Sediment Index (OSI) were mapped on station location plots to outline the biological conditions at each station (Figures 3-12 and 3-13).

The apparent RPD depth is the depth of oxygenation in the upper sediment layers. This value indicates dissolved oxygen conditions within sediment pore waters as well as the availability and consumption of molecular oxygen (O_2) in the surface sediments. Since the actual oxygen status in the sediment is not measured, the apparent RPD is estimated by measuring the thickness of the layer of high reflectance in contrast to the usually gray to black reduced sediments at depth (Rhoads and Germano 1982).

The mapping of successional stages is based on the theory that organism-sediment interactions follow a predictable sequence after a major seafloor disturbance (Rhoads and Germano 1982). This sequence is defined by end-member assemblages of benthic organisms. Stage I is made up of pioneering assemblages usually consisting of dense

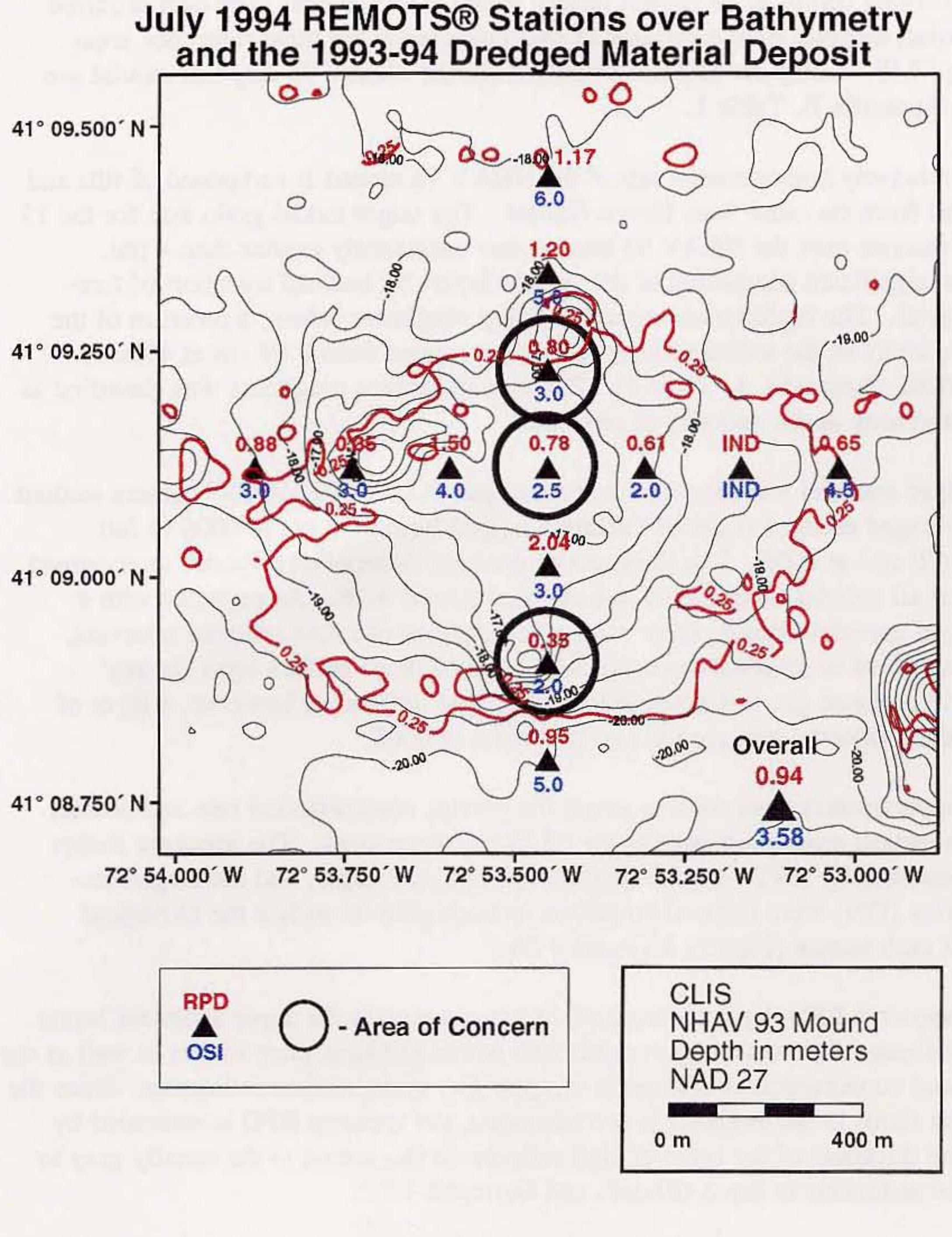


Figure 3-12. Distribution of RPD and OSI values over the NHAV 93 mound, overlaid on July 1994 bathymetry and detectable margins of the mound

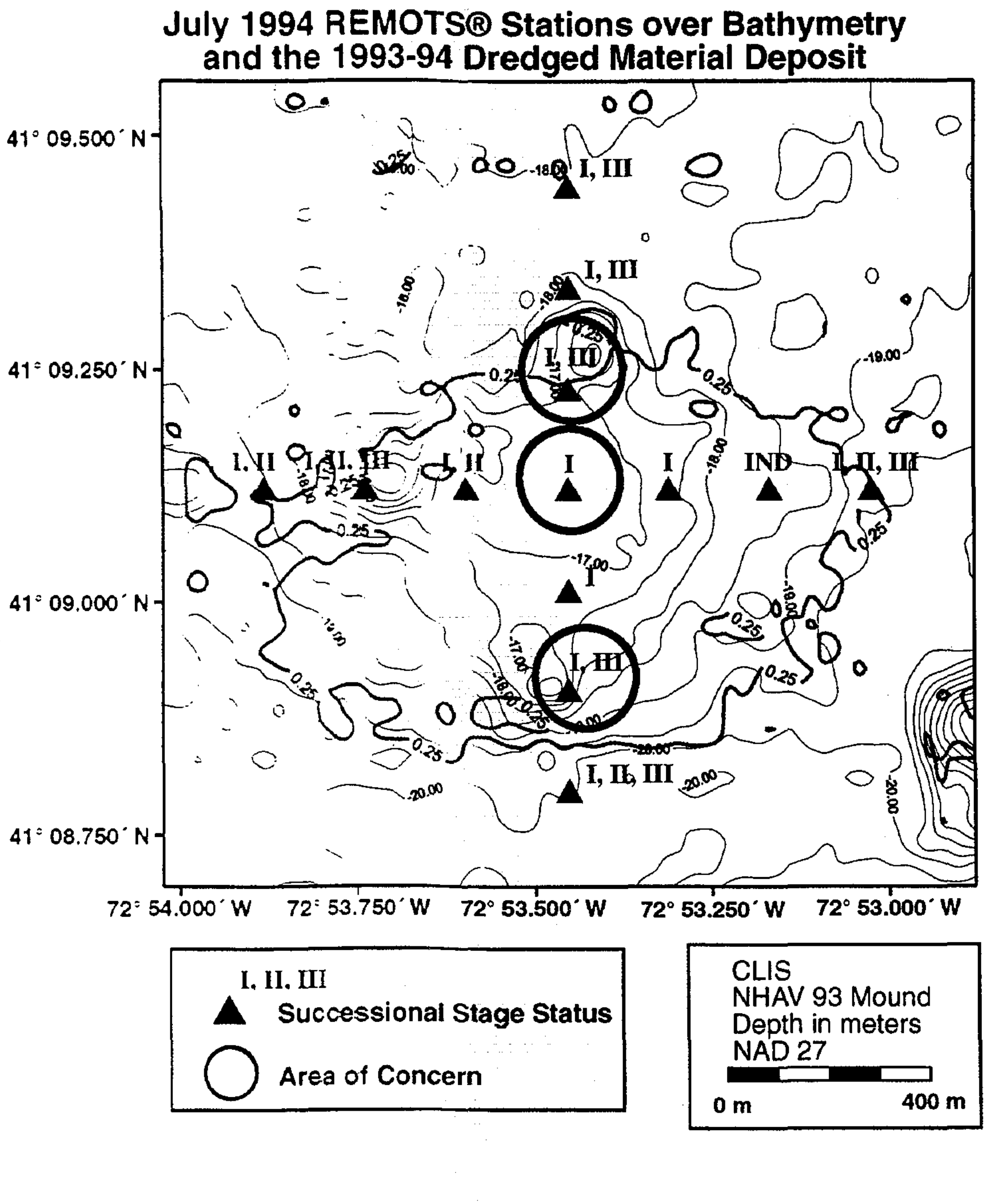


Figure 3-13. Distribution of successional stage assemblages over the NHAV 93 mound, overlaid on July 1994 bathymetry and detectable margins of the mound

aggregations of near-surface, tube-dwelling polychaetes. If left undisturbed, Stage II infaunal deposit feeders such as shallow-dwelling bivalves or tubicolous amphipods then colonize the recovering seafloor. Stage III organisms are generally head down-deposit feeding invertebrates whose presence results in distinctive subsurface feeding voids. Stage III taxa are associated with relatively low-disturbance regimes (Rhoads and Germano 1986).

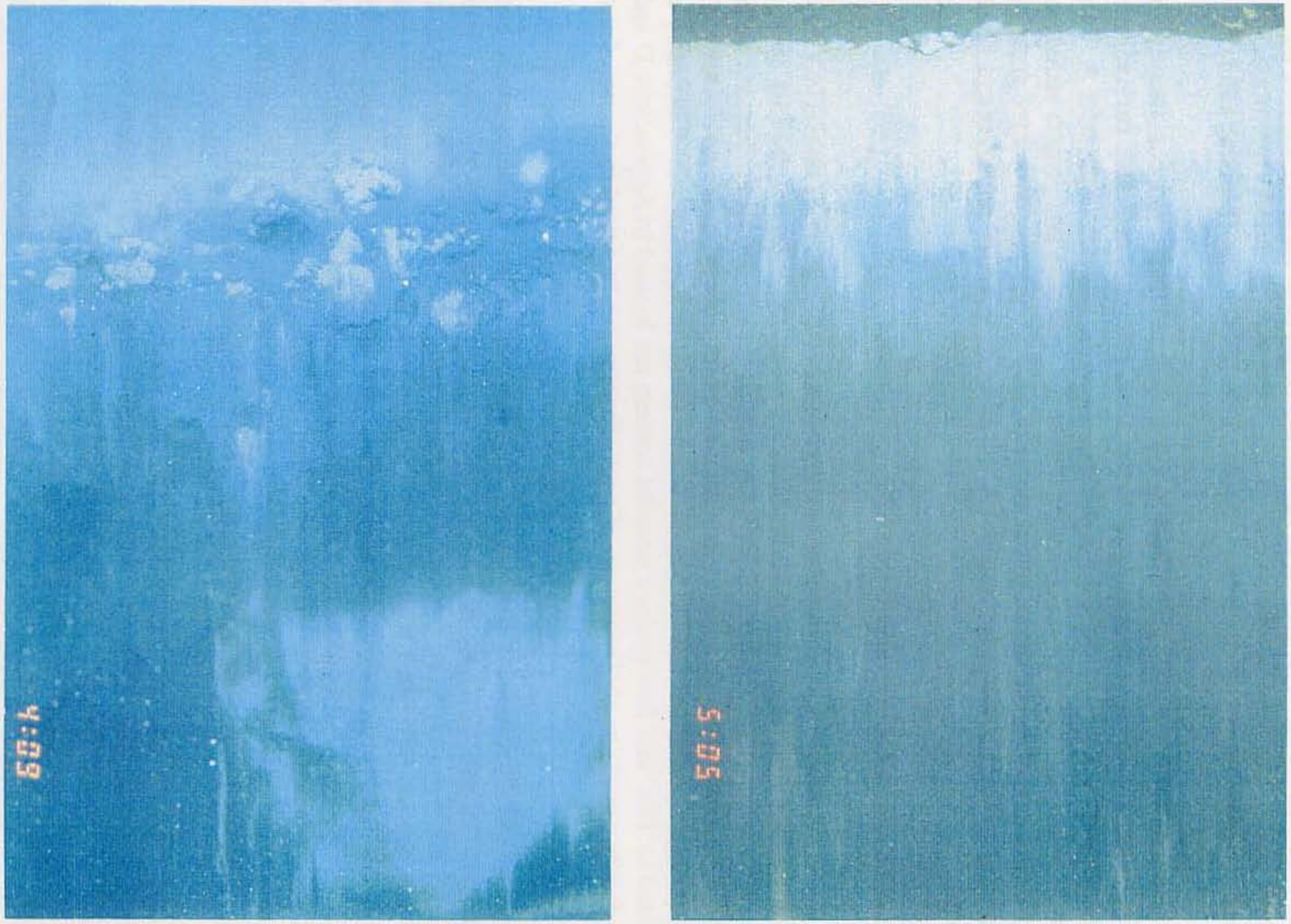
Organism-sediment index values are calculated by summarizing the apparent RPD depth, successional status, and indicators of methane or low oxygen. OSIs can range from -10 (azoic with methane gas present in sediment) to 11 (aerobic bottom with deep apparent RPD, evidence of mature macrofaunal assemblage, and no apparent methane). OSI values are useful in mapping disturbances and quantifying ecosystem recovery (Rhoads and Germano 1982).

The NHAV 93 mound is showing the beginning stages of recovery four months after completion of disposal activity. The replicate-averaged RPD values for the 13 stations in the NHAV 93 project area ranged from 0.35 cm at Stations 400S and 400W to 2.04 cm at Station 200S (Appendix A, Table 8; Figure 3-12). The mean RPD value for the entire NHAV 93 project area was 0.94 cm. The successional stage was predominantly Stage I organisms with occasional Stage II and Stage III assemblages present at peripheral stations (Figure 3-13). As a result, median OSI values for the NHAV 93 project area also indicated the beginning stages of ecosystem recovery, ranging from 2.0 at 200E and 400S to 6.0 at 600N (Appendix A, Table 8; Figure 3-12).

As the REMOTS® analysis progressed, three areas of concern were discovered on the NHAV 93 project mound. Several of the REMOTS® photographs obtained at Stations CTR, 200N, and 400S indicated limited recolonization, possibly caused by sediment toxicity or high labile organic content (Figures 3-12 and 3-13). The REMOTS® photographs were taken approximately four months post disposal, revealing shallow or discontinuous layers of oxidized sediment over black reduced cap material, with patchy Stage I benthic infaunal communities (Figure 3-14A). An example of healthy recovery was the conditions existing at Station 200S with an average RPD depth of 1.50 cm and a solid Stage I community (Figure 3-14B).

3.1.4 Sediment Toxicity Testing

As part of the DAMOS tiered monitoring protocol, two of the three stations exhibiting anomalous REMOTS® results were revisited in late September 1994 (Germano et al. 1994). Due to the apparent unhealthy benthic conditions, comprehensive sediment toxicity testing was performed on the surface sediment layers of Stations CTR and 400S



A B

Figure 3-14. REMOTS® photographs of NHAV 93 mound Stations 400S and 200S

(Figures 3-12 and 3-13). The results of the 10-day *Ampelisca* bioassay showed no significant differences between the sediments collected over the NHAV 93 mound relative to the reference sediments of the historic Southern Reference Site (Mueller 1994).

The mean survivability percentage in the project sediments was consistently above 80 (CTR 81%, 400S 84%). In comparison, the mean reference sediment survival rate of 90% indicates no statistically significant differences in the samples (Appendix A, Table 9). As a result of the survival rate acceptability within the reference and project sediments, no toxicity was observed in the sediments of either NHAV 93 station. The three areas of concern will continue to be monitored on an annual basis to verify improvement in benthic conditions.

3.1.5 Sediment Chemistry and Grain Size

A total of eleven sediment chemistry grabs were collected over the NHAV 93 mound and analyzed relative to the CLIS reference areas. In addition, the July 1994 results were compared to data sets collected as part of the pre-dredging chemical testing of the outer New Haven Harbor sediments. Detailed tables displaying the raw sediment chemistry results for the NHAV 93 mound can be found in Appendix C. Chemistry data normalized to TOC and fine-grained material content are located in Appendices D and E; further details pertaining to the process of normalization can be found in Section 4.0 of this report.

Results of the grain size analysis for the NHAV 93 mound indicate that the capping sediments are composed mainly of fine-grained material, averaging 70.5% fines (Appendix C, Tables 1 and 8). Individual station values for fine-grained materials ranged from a low of 65.3% at Station NH-3 to a high of 74.4% at Station NH-11. In general, these fine-grained materials were comprised of nearly equal percentages of silts and clays, which averaged 38.9% and 31.5%, respectively. Sand was the second major constituent of the cap material, averaging 29.2%. There was relatively little variability between the sand fractions of individual stations, ranging from 25.6% (Station NH-11) to 34.4% (Station NH-10). The average percent gravel on the NHAV 93 mound was 0.3%.

The NHAV 93 mound was found to have an average TOC concentration of 23360 ppm (Appendix C, Table 1). Among individual stations, TOC ranged from 12000 ppm (1.2%) at NH-8 to 28000 ppm (2.8%) at NH-4 (Figure 3-15). The distribution of station values was generally uni-modal (approximately 26000 ppm), with the exception of Stations NH-8 and NH-10, which were found to have concentrations of 12000 ppm and 15000 ppm, respectively. There was little variation between the remaining nine NHAV 93 chemistry stations, with TOC concentrations ranging from 24000 ppm to 28000 ppm.

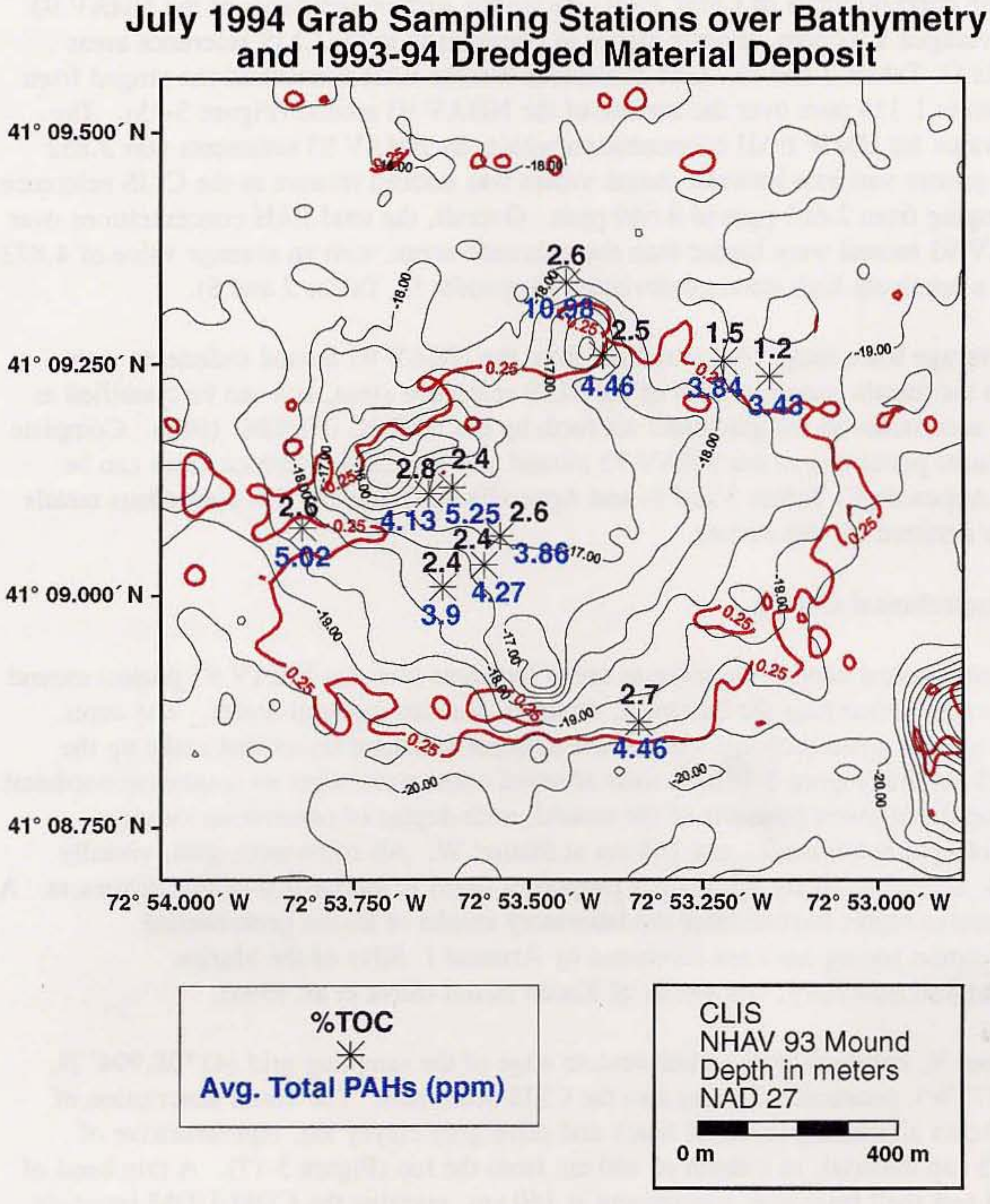


Figure 3-15. Distribution of TOC and total PAH values over the NHAV 93 mound, overlaid on July 1994 bathymetry and detectable margins of the mound

The concentrations of LMW PAHs within the surface sediments of the NHAV 93 mound averaged 1.02 ppm, slightly higher in comparison to the CLIS reference areas (Appendix C, Tables 2 and 8). Low Molecular Weight PAH concentrations ranged from 0.828 ppm to 1.119 ppm over the surface of the NHAV 93 mound (Figure 3-15). The average value for HMW PAH concentration within the NHAV 93 sediments was 3.852 ppm. A greater variance between station values was noticed relative to the CLIS reference areas, ranging from 2.601 ppm to 9.660 ppm. Overall, the total PAH concentrations over the NHAV 93 mound were higher than the reference areas, with an average value of 4.872 ppm and a relatively high standard deviation (Appendix C. Tables 2 and 8).

Average trace metal concentrations from the NHAV 93 mound sediments were similar to the metals concentrations of the CLIS reference areas, and can be classified as "low" in accordance to the guidelines set forth by the NERBC (NERBC 1980). Complete metals results pertaining to the NHAV 93 mound and the CLIS reference areas can be found in Appendix C, Tables 3 and 9, and Appendix A, Table 10. No anomalous metals data were detected for this survey.

3.1.6 Geotechnical Coring

Geotechnical cores were taken at seven locations over the NHAV 93 project mound to acquire data concerning the basement, dredged, and cap material layers. The cores provided a deep, cross-sectional view of the multiple sediment layers that make up the NHAV 93 mound (Figure 3-16). A total of seven cores were taken on southwest-northeast and southeast-northwest transects of the mound, with depths of penetration varying between 143 cm at Station Z1 and 260 cm at Station W. All cores were split, visually described, and analyzed for the various properties listed in section 2.6 of this document. A comprehensive report documenting the laboratory results of all the geotechnical characterization testing has been submitted by Armand J. Silva of the Marine Geomechanics Laboratory, University of Rhode Island (Silva et al. 1994).

Core V, obtained on the southwestern edge of the sampling grid (41°08.994' N, 72°53.627' W), penetrated 210 cm into the CLIS sediments. The visual description of Core V shows alternating layers of black and olive-grey clayey silt, representative of NHAV 93 cap material, to a depth of 160 cm from the top (Figure 3-17). A thin band of dark sand and shell fragments was present at 160 cm, marking the CDM/UDM interface. A 40 cm thick layer of inner New Haven Harbor UDM and historic dredged material (CLIS 88 and Norwalk) was detected as olive-green to gray silts and clays with varying amounts of sand, gravel, and shell fragments. A layer of firm, olive-grey, clayey silt indicative of ambient central Long Island Sound sediments was sampled at 200 cm of penetration.

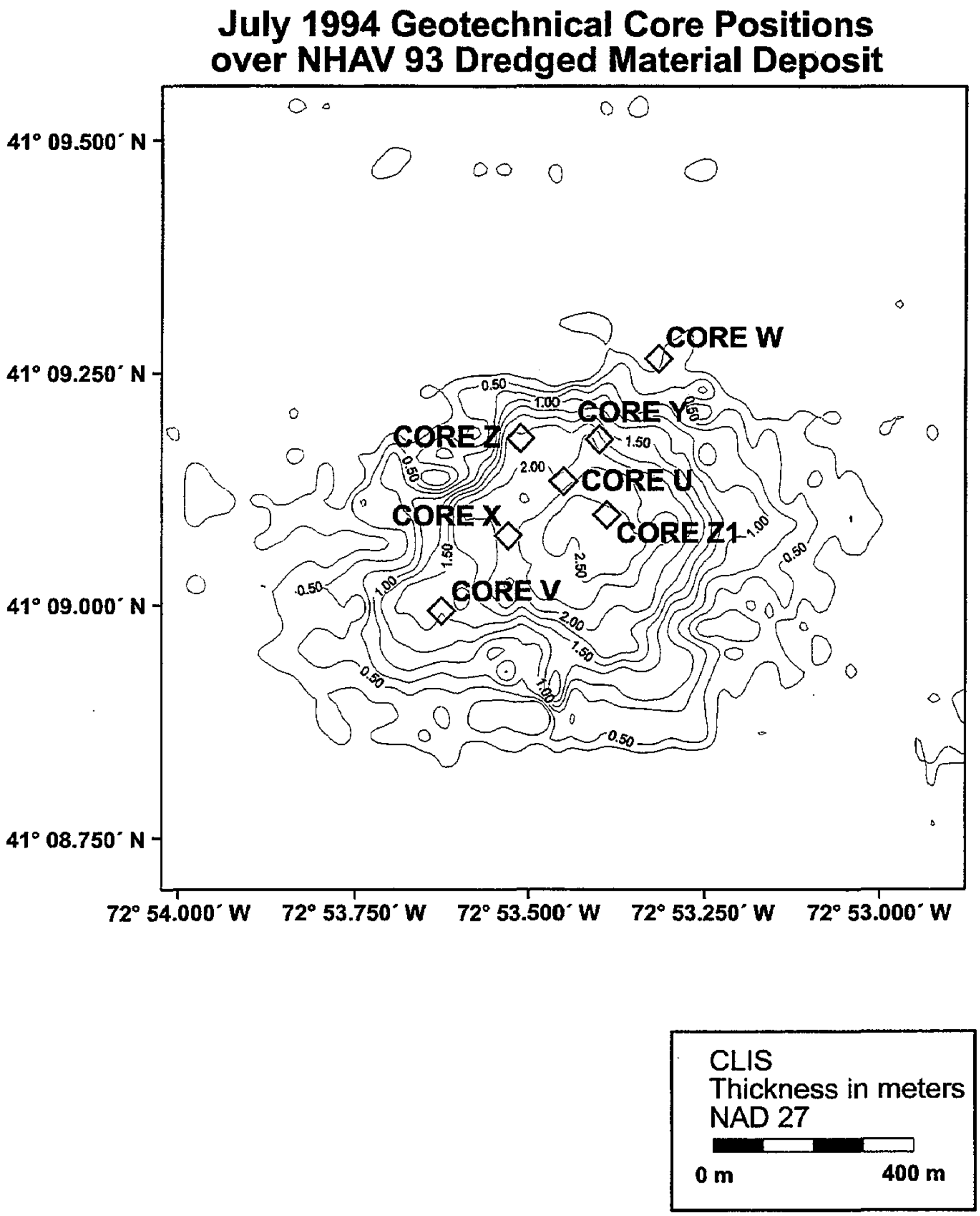


Figure 3-16. Location of geotechnical cores U through Z1 over the apparent total accumulation of dredged material since September 1993

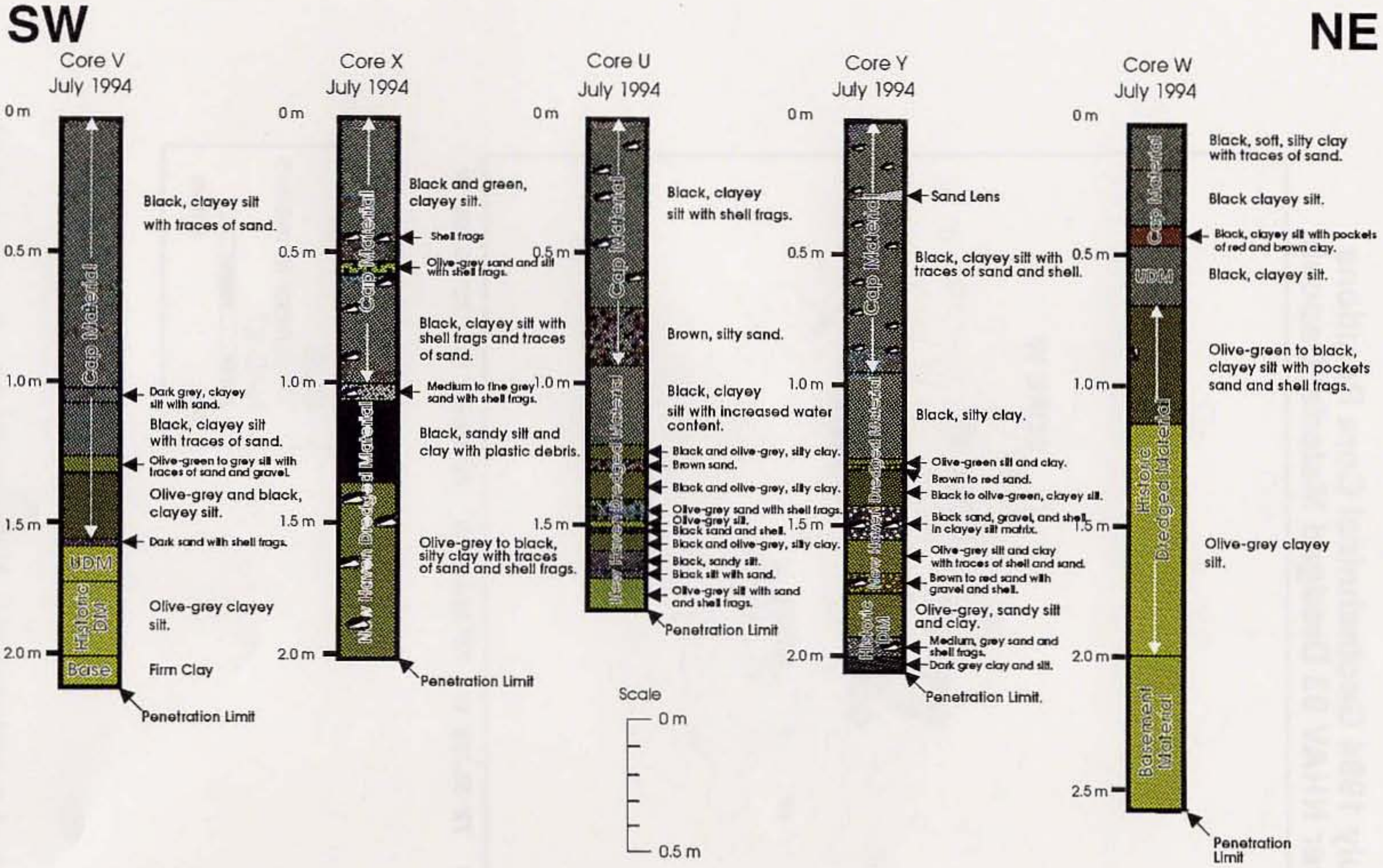


Figure 3-17. Color geotechnical core descriptions oriented to display the results of the SW-NE transect over the NHAV 93 mound

Core X, collected at 41°09.076' N, 72°53.530' W, 150 m southwest of the NHAV 93 mound center, penetrated 200 cm into the NHAV 93 mound. From the description of Core X it appears that the top 100 cm is composed of thick layers of black to green clayey silt bisected by a thin layer of olive-grey sand with shell fragments. These three strata constitute the NHAV 93 mound CDM layer (Figure 3-17). A 10 cm thick sand layer at 100 cm of penetration provided a sharp line of demarcation between the project CDM and UDM. The remainder of Core X was made up of black sandy silt and olive-grey to black silty clay dredged from the inner New Haven Harbor.

Core U, representing the center of the geotechnical core sampling grid, was collected in close proximity to the NHAV 93 disposal buoy position (41°09.135' N, 72°53.452' W). The description of Core U depicts the top 87 cm of sediment as cap material composed of layers of black clayey silt and brown, silty sand considered to be CDM (Figures 3-17 and 3-18). The remaining 93 cm of sediment displayed the multiple layers of UDM present at the NHAV 93 mound center. The top layer of UDM, from 87 cm to 125 cm of penetration, was made up of black silt with an oily odor. The remainder of the sediments in Core U were a heterogenous mixture of various size class sands inter-layered with silt and rock fragments to form ten distinct strata. The ten layers, thicknesses ranging from 2 cm to 9 cm, were deposits of sediments derived from the dredging of the inner New Haven Harbor.

Core Y was acquired at 41°09.179' N, 72°53.401' W, approximately 100 m northeast of the NHAV 93 buoy position, and penetrated 205 cm into the sediment. The top 90 cm of material, which comprises the cap, was black clayey silt with traces of, sand, and shell fragments (Figure 3-17). A small pocket or lens of sand was sampled at 30 cm of penetration within an otherwise uniform sediment deposit. From 90 cm to 120 cm of penetration a layer of black silty clay devoid of sand and shell fragments represents the top UDM layer of the inner New Haven Harbor sediments. The remaining layers of UDM extend down to approximately 180 cm of penetration and consist of distinct strata of granule, sand, silt, and clay size grains. Historic dredged material from the CLIS 89 mound apron was sampled from 180 cm to the penetration limit. No ambient Long Island Sound sediments were present in Core Y.

Core W, collected over the northeast margin of the detectable NHAV 93 mound apron (41°09.265' N, 72°53.317' W), penetrated to a depth of 260 cm. The top 48 cm of Core W was composed of layers of silt and fine sand and is classified as NHAV 93 cap material (Figure 3-17). The sediment sampled from 48 cm to 70 cm depicted as a layer of black clayey silt may represent the apron of the NHAV 93 UDM deposit. Historic dredged material from the CLIS 89 mound was sampled from 70 cm to 150 cm of penetration. The next 60 cm was described as a more uniform olive-grey clayey silt with fine shell fragments, identified as ambient sediments.

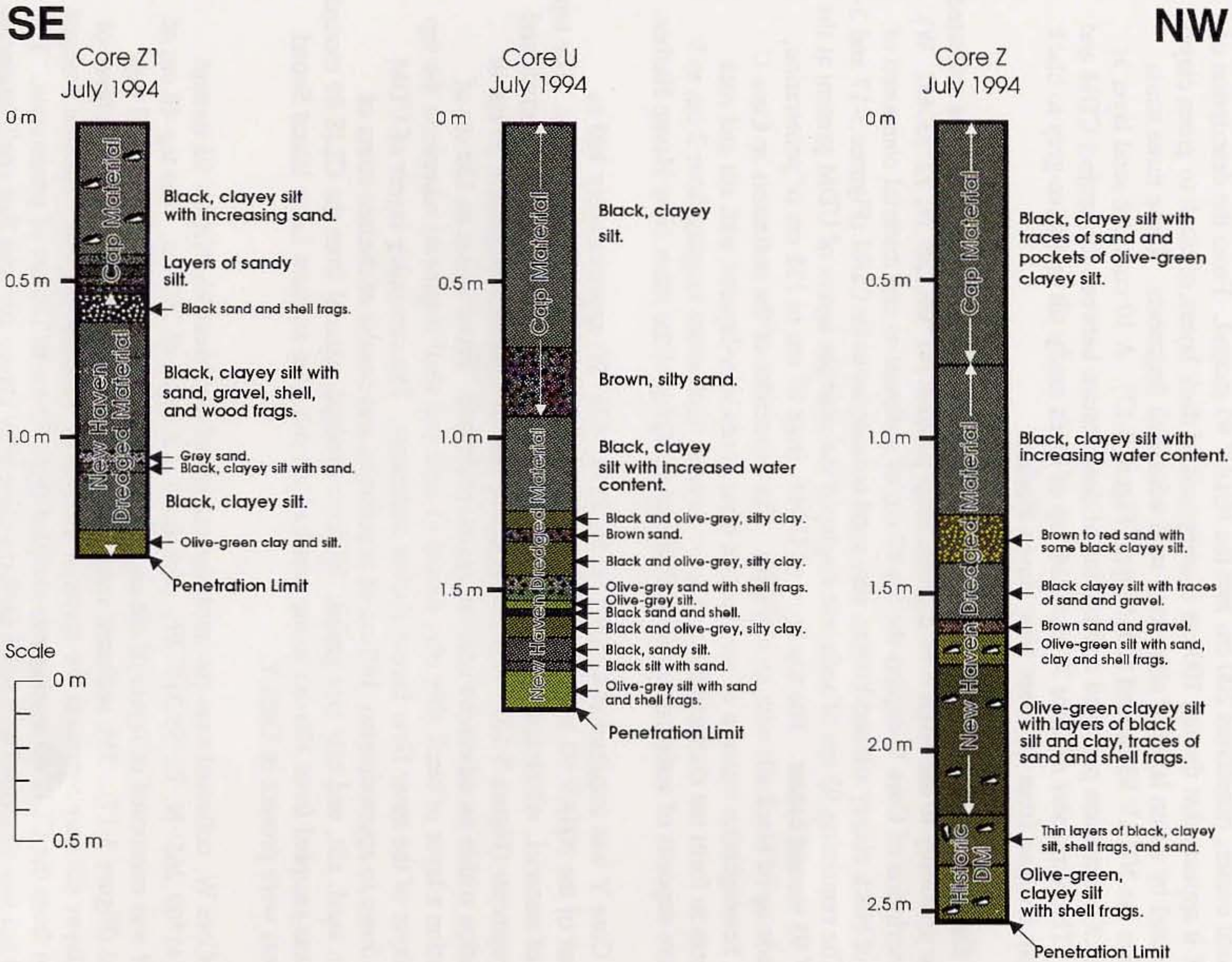


Figure 3-18. Color geotechnical core descriptions oriented to display the results of the NW-SE transect over the NHAV 93 mound

Core Z1, obtained at 41°09.099' N, 72°53.390' W, approximately 100 m southeast of the NHAV 93 buoy position, sampled the apex of the CAD mound (Figure 3-16). This geotechnical core penetrated 143 cm into the center of the NHAV 93 dredged material deposit. The top 44 cm of Core Z1 was made up of a uniform layer of black silty clay with scattered shell fragments (Figure 3-18). At 46 cm of penetration, layers of sandy silt are visible. A line between CDM and UDM in Core Z1 becomes visible at 66 cm of penetration with the transition from black and grey sandy silt, to a layer of black sand and shell fragments over black clayey silt with sand, gravel, and wood fragments. The UDM deposit continues from 66 cm to 143 cm of penetration. No historic dredged material or ambient Long Island Sound sediments were detected.

Core Z, taken at 41°09.180' N, 72°53.513' W, approximately 110 m northwest of NHAV 93 buoy position, penetrated to a depth of 250 cm. The top 120 cm of Core Z was composed of black clayey silt with traces of sand (Figure 3-18). A layer of fine-grained brown to red sand at 120 cm divided the uniform silt layer from the remainder of the core. The border between CDM and UDM was determined by a distinct increase in sediment pore water at 75 cm of penetration. The first layer of UDM is characterized as black clayey silt, similar to the overlying CDM deposit. Alternating layers of sand and silt continued down the core to a penetration depth of 220 cm where a transition from NHAV 93 mound UDM to historic dredged material was discovered.

3.2 MQR Mound

3.2.1 Bathymetry

The MQR mound, centered at 41°08.600' N, 72°53.900' W, received a total of 65,000 m^3 of new dredged material to supplement the existing cap (Figure 3-2). This material was generated by a de facto capping operation originating from the US Coast Guard facility in New Haven Harbor; additional volumes of CDM were generated by the Guilford Harbor, Housatonic River, Lex Atlantic Gateway, and Pine Orchard Harbor dredging projects. A smaller depth model (850 m × 1000 m) of the area surrounding the MQR mound was constructed in order to determine the placement and quantify the volume of the recently deposited dredged material over the mound (Figure 3-19). The MQR mound now exhibits a diameter of 425 m at its base and a depth of 17.5 m at the apex. The last bathymetric survey conducted at the MQR mound was in December 1991.

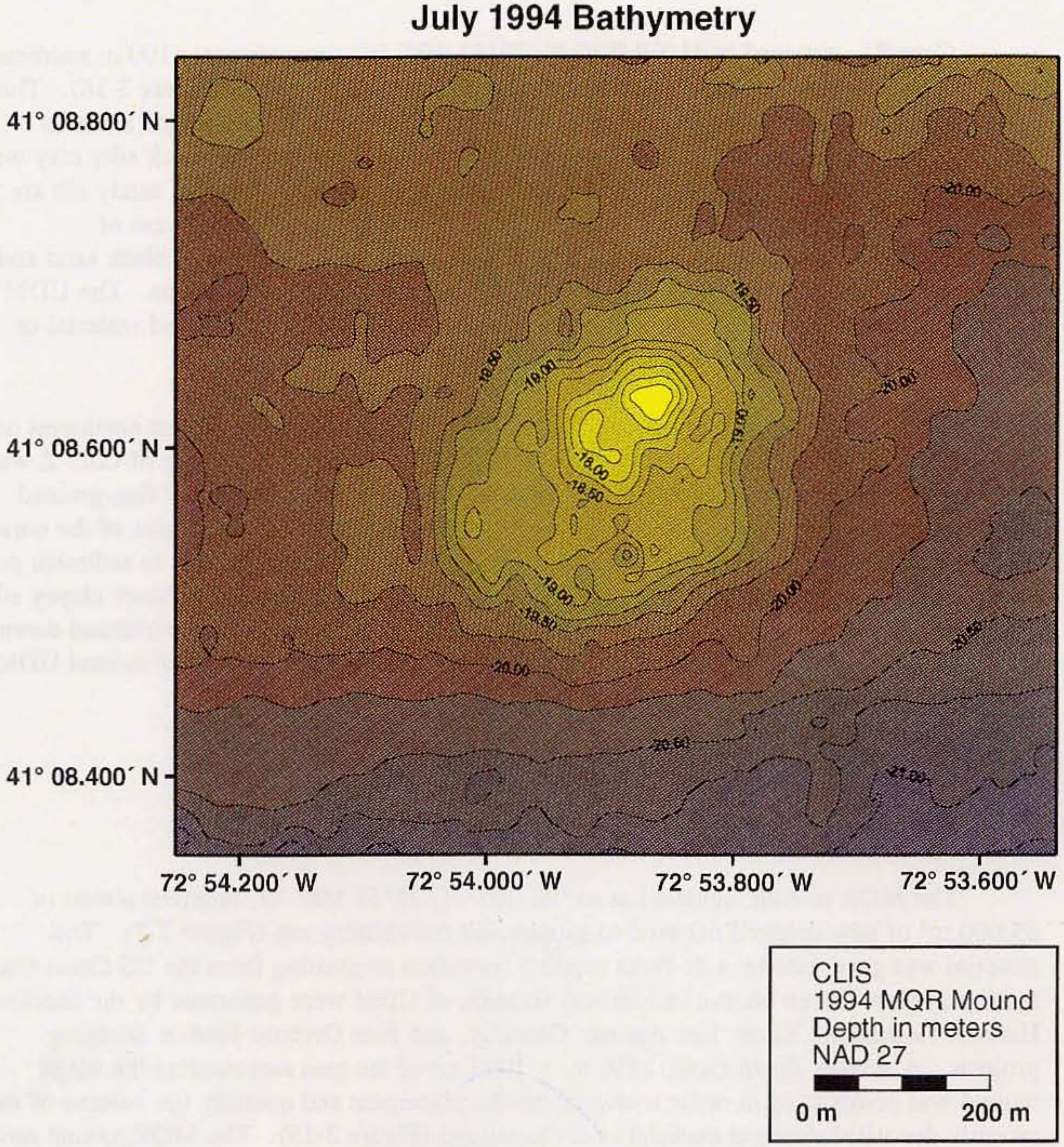


Figure 3-19. Bathymetric chart of the July 1994 850 m × 1000 m analysis area over the MQR mound, 0.25 m contour interval

The results of the December 1991 survey display the MQR mound with a diameter of approximately 425 m and a minimum depth of 18.0 m (Figure 3-20). The addition of 65,000 m^3 of UDM and CDM at the CDA 93 buoy has created a new apex at 41°08.627' N, 72° 53.864' W, approximately 100 m northeast of the 1991 mound apex. Depth difference calculations between the July 1994 and December 1991 datasets show a 1.5 m increase in mound height south-southwest of the CDA 93 buoy position (Figure 3-21). A total volume of 15,300 m^3 of additional sediment was found within the detectable footprint of the dredged material deposit. The remaining 49,700 m^3 of material spread down the flanks of the MQR mound, in layers too thin to be detected by standard hydrographic techniques. The majority of the detectable dredged material accumulation was concentrated over the northeast quadrant of the MQR mound with a smaller deposit visible along the southern flank (Figure 3-22).

3.2.2 Surface Sediment Characterization

Acoustic sediment surface classification is based on the premise that bulk sediment properties (i.e., bulk density, porosity, and grain size) affect the interaction between an acoustic signal and the sediment column. Penetration of sound in sediment is both a function of the system frequency and the impedance contrast between the water column and the sediments.

Acoustic impedance (vr), the product of the density and the velocity of sound in a layer of sediment, is also affected by differences in porosity, surface roughness, and grain size, among other factors (LeBlanc et al. 1992). Sound penetrates deeper in softer sediment since the impedance of high-water content silts and clays is more like that of the water column, resulting in an increase in the amount of acoustic signal lost in the sediment and a decrease in the strength of the returning signal. A weaker signal return translates as a "softer" surface sediment type. In contrast, a stronger signal return translates into a "harder" sediment type.

Using these principles, SAIC developed the Sediment Acoustic Characterization System (SACS) to remotely characterize surface sediments and distinguish between dredged material deposits and ambient bottom. This system was utilized over the southern half of the July 1994 bathymetric survey area, and a plot of the acoustic signal returns was generated (Figure 3-23). From SACS data, most of the surface sediments at CLIS can be interpreted as "softer" less dense material (fine sand, silt, and clay). The plot also shows returns of 96.0 dB to 104.0 dB, which suggests that patches of dense "harder" material exist in the vicinity of the MQR, NHAV 83, STNH-S, and NHAV 74 mounds. The majority of these increases in surface sediment density can be attributed to the consolidation and de-watering of dredged material in these historic mounds. However, REMOTS® sediment

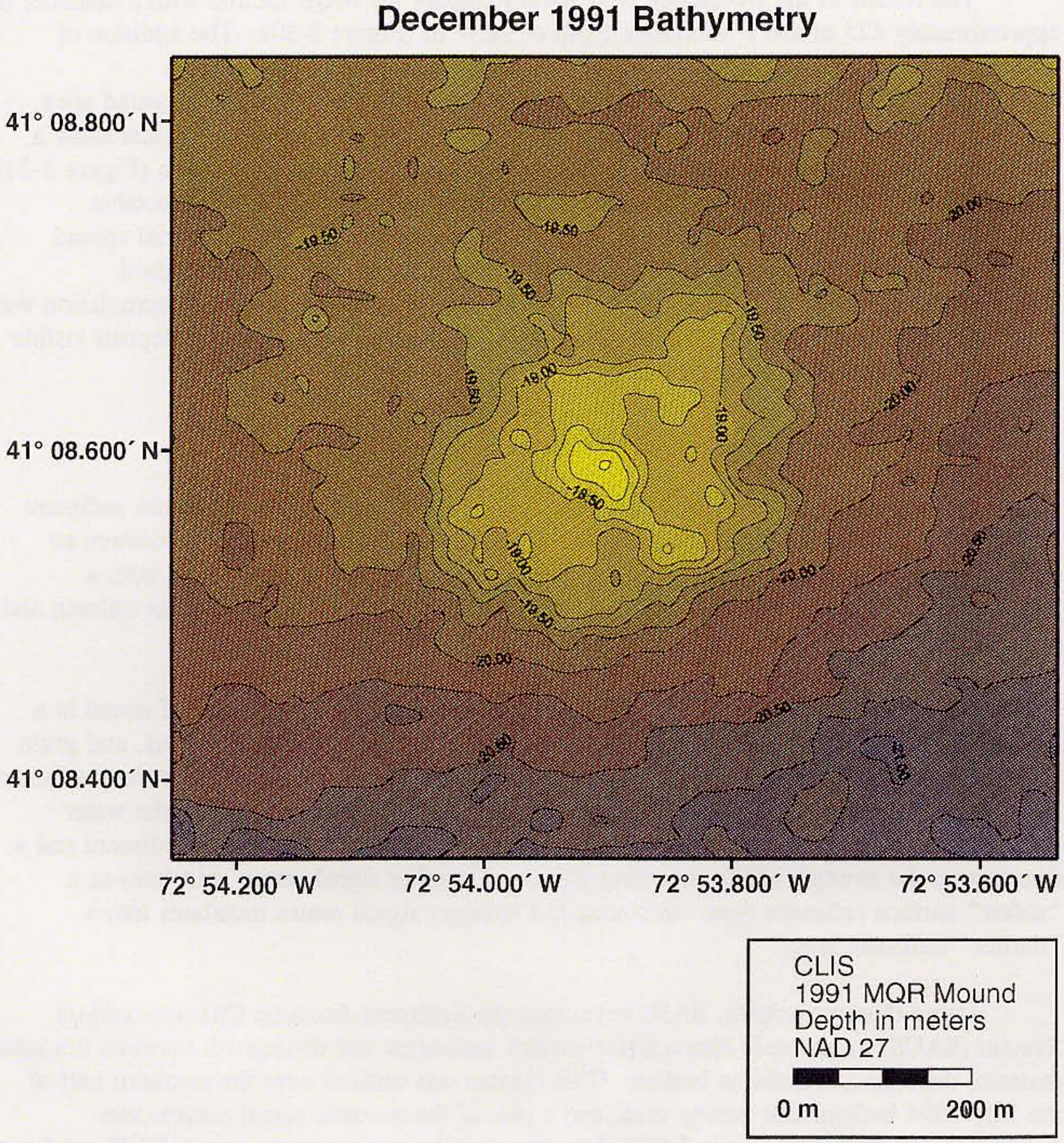


Figure 3-20. Bathymetric chart of the December 1991 survey re-gridded to an 850 m × 1000 m analysis area over the MQR mound, 0.25 m contour interval

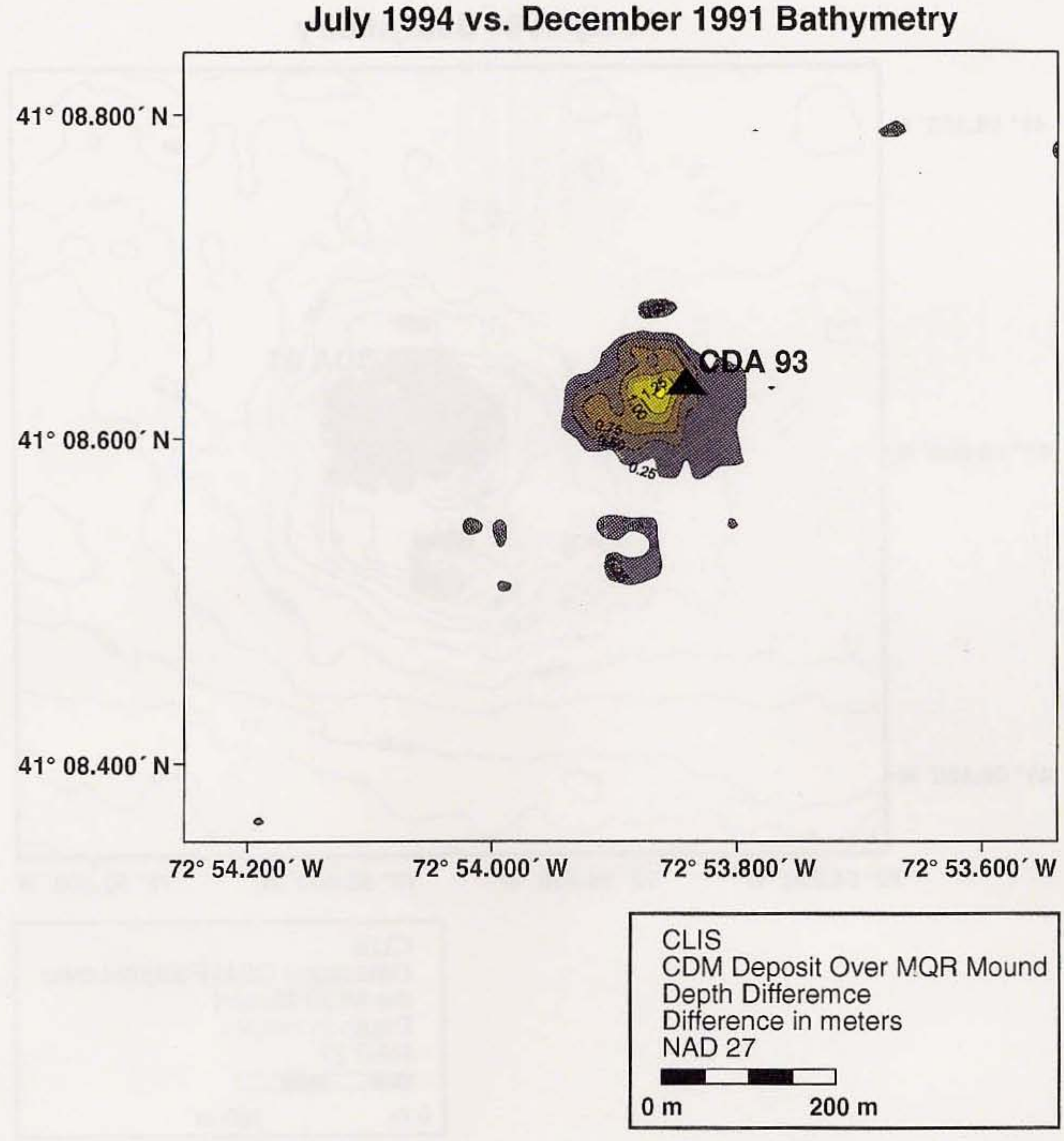


Figure 3-21. Depth difference plot of the July 1994 survey vs. the December 1991 survey showing apparent accumulation over the MQR mound in proximity to the CDA 93 buoy, 0.25 m contour interval

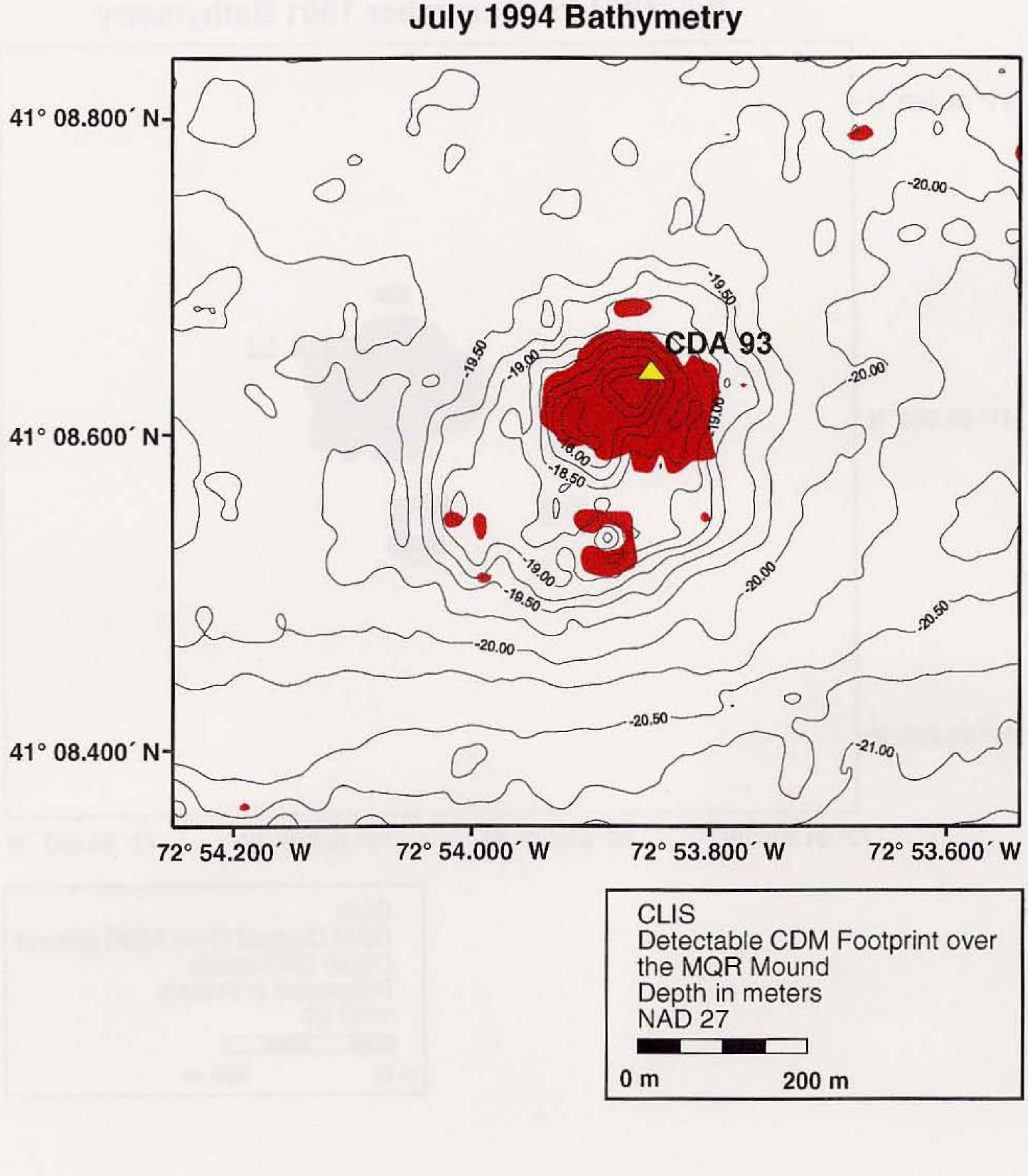


Figure 3-22. Detectable CDM footprint over the MQR mound, overlaid on July 1994 bathymetry, 0.25 m contour interval

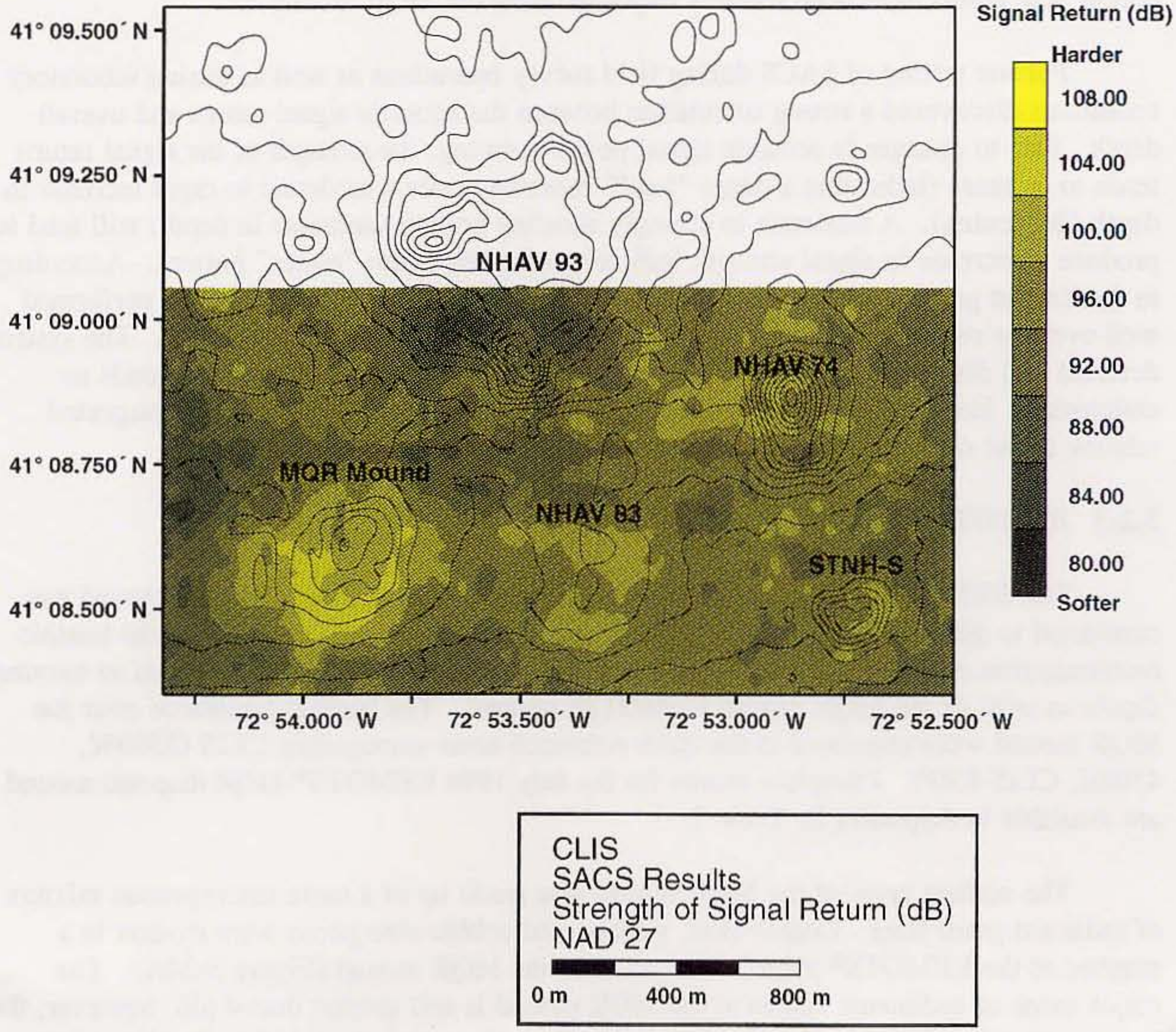


Figure 3-23. Color contour plot of the SACS signal returns, overlaid on July 1994 bathymetry over the 2553 m × 2225 m survey area, 4.0 dB shading interval (SACS), 0.25 m contour interval (bathymetry)

profiling and grab sampling over the MQR mound confirm that coarse sand, pebble, and cobble size grains have been recently deposited over the MQR mound.

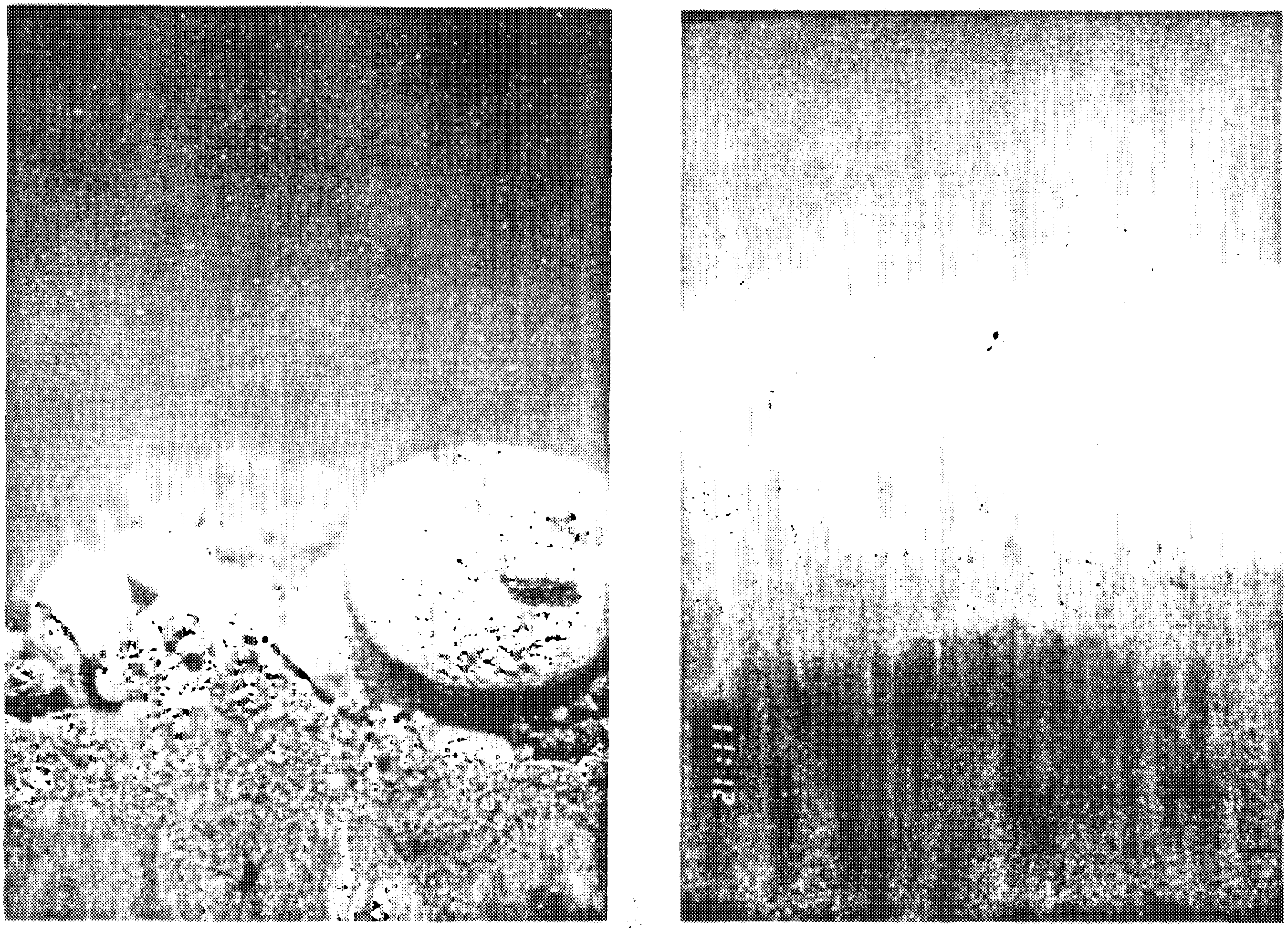
Further testing of SACS during field survey operations as well as during laboratory conditions discovered a strong correlation between the acoustic signal return and overall depth. Due to changes in acoustic signal power ramping, the strength of the signal return tends to increase (indicating a dense "hard" substrate) over a moderate to rapid increase in depth (deepening). A moderate to strongly shoaling bottom (decrease in depth) will tend to produce a decrease in signal strength indicative of a less dense "softer" bottom. According to the limited ground-truthing data collected over NHAV 93 and MQR, SACS performed well over the relatively flat bottom and constant depth (18 m to 22 m) at CLIS. The system detected and displayed differences in bottom type over the various disposal mounds as anticipated. However, the results over individual bottom features should be interpreted relative to the slope of the mound, as well as sediment grain size.

3.2.3 REMOTS Sediment-Profile Photography

The REMOTS® sediment-profiling photography survey over the MQR mound was conducted to delineate the new dredged material footprint, as well as to assess the benthic recolonization rate of the surface sediments. Supplemental CDM was penetrated to varying depths at most of the MQR mound REMOTS® stations. The benthic conditions over the MQR mound were compared to the three reference areas surrounding CLIS (2500W, 4500E, CLIS-REF). Complete results for the July 1994 REMOTS® MQR disposal mound are available in Appendix B, Table 2.

The surface layer of the MQR mound was made up of a more heterogenous mixture of sediment grain sizes. Coarse sand, pebble, and cobble size grains were evident in a number of the REMOTS® photos obtained over the MQR mound (Figure 3-24A). The major mode of sediments visible at the MQR mound is still greater than 4 phi; however, the larger grain sizes in the surface layers tend to skew the mean towards 2 to 3 phi.

The original MQR mound was the product of multiple disposal projects over a two-year period. This capped mound is actually a complex inter-layered mound consisting of material from the Mill and Quinnipiac Rivers, as well as Black Rock and New Haven Harbors (SAIC 1995). The addition of material during the most recent disposal activity is evident at Station 150S, on the southern slope of the MQR mound (Figure 3-24B). Three distinct strata are visible within the top 20 cm of sediment and represent various disposal events in the history of MQR.



A B

Figure 3-24. REMOTS® photographs of MQR mound Stations 100N and 150S

Irregularities or disturbances in the surface were quantified by determining the boundary roughness for each replicate. With the majority of surface disturbance classified as physical, replicate-averaged boundary roughness values ranged from 0.66 cm at 150W to 4.64 cm at CTR (Appendix A, Table 11). Replicate-averaged camera penetration depths tended to be shallower than expected with ten of the thirteen stations displaying values less than 12.0 cm. The mean camera penetration values over the MQR mound ranged from 7.19 cm at 150W to 18.67 cm at 50S.

Dredged material was identified and measured at all 13 REMOTS® camera stations. Replicate-averaged dredged material thickness ranged from 7.45 cm at 150W to near full penetration (19.10 cm) at 50S, with the thickness of dredged material consistently greater than camera penetration (Appendix A, Table 11). Redox rebound intervals were not detected in the subsurface sediments of MQR. No methane gas or indications of low DO were noted in any REMOTS® replicate.

The replicate-averaged RPD values for the 13 stations in the MQR project area ranged from 0.55 cm at 100S to 1.88 at 150N. The mean RPD value for the entire MQR project area was 0.91 cm (Figure 3-25). Stage I organisms were present at all stations, often accompanied by Stage II or Stage III organisms (Figure 3-26). Median OSI values for the MQR project area ranged from 2.5 at CTR and 100N to 9.0 at 150N (Figure 3-25). With the presence of stable benthic infaunal populations over the supplemental cap material deposit, the OSI values appear to be primarily affected by the low to moderate RPD depths. This indicates moderate to strong benthic recovery over the area of the MQR mound affected by the recent deposition.

3.2.4 Surface Sediment Chemistry and Grain Size

Eleven sediment chemistry grabs were collected over the MQR mound and analyzed for sediment grain size distribution, TOC, LMW PAHs, HMW PAHs, and metals content. Comprehensive tables of the raw sediment chemistry data collected over the MQR mound are located in Appendix C. Results normalized to TOC concentrations as well as fine-grained material can be found in Appendix D.

Results of the individual stations over MQR indicate that the mound is basically comprised of two different sediment types. Sediments collected at the five stations located on the eastern side of the mound (MQR-1, MQR-4, MQR-5, MQR-6, and MQR-7) were comprised mainly of fine-grained sediments; of these, the major constituent was determined to be silt (Figure 3-27). Silts and clays compose between 59.8% and 81.9% of the total bulk sediment deposit on the eastern flank of MQR (Appendix C, Table 4). Six stations on the western side of the mound (MQR-2, MQR-3, MQR-8, MQR-9, MQR-10, and MQR-11)

July 1994 REMOTS® Stations over Bathymetry and the 1993-94 Supplemental Cap Material Deposit

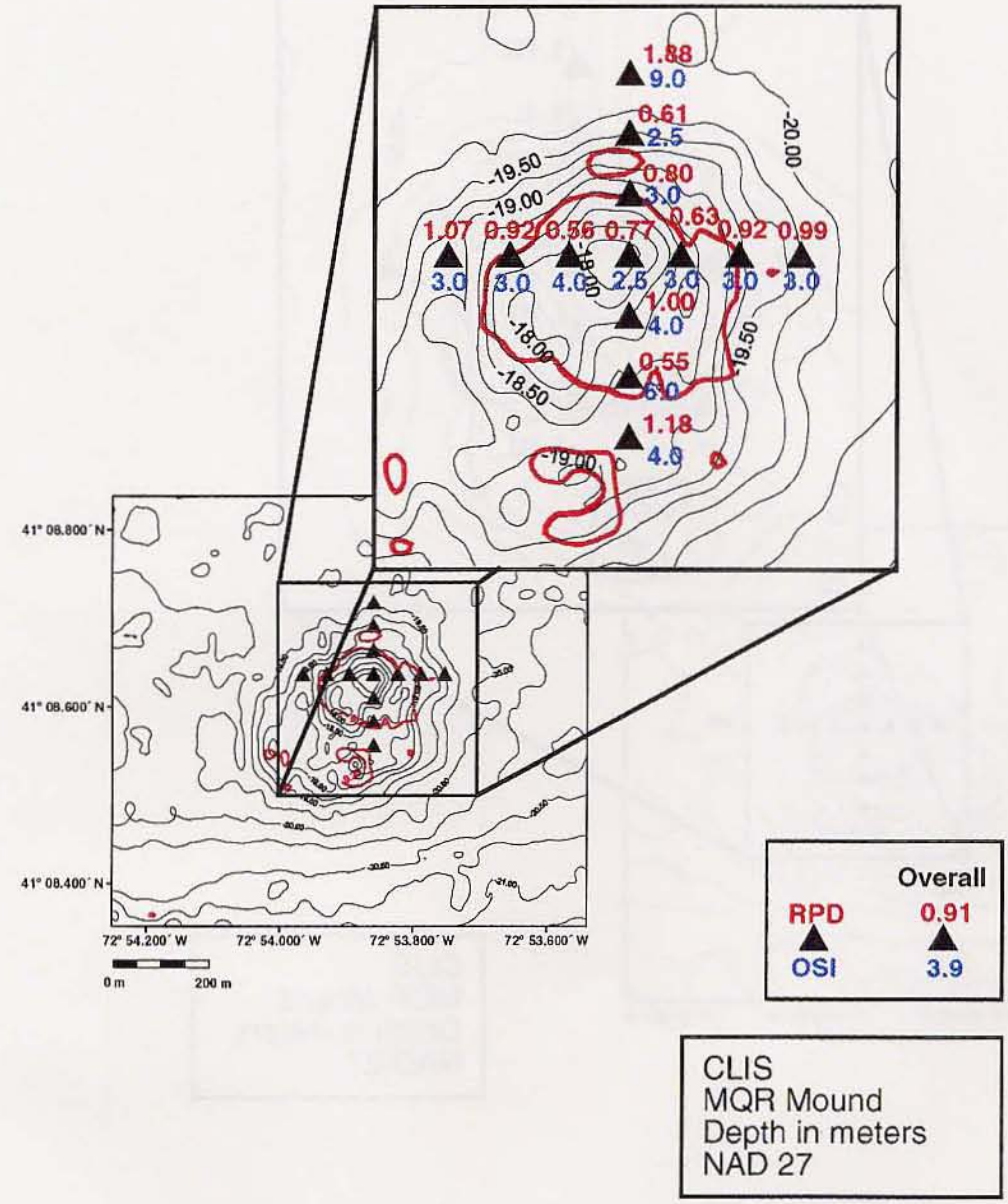


Figure 3-25. Distribution of RPD and OSI values over the MQR mound, overlaid on July 1994 bathymetry and detectable margins of the mound

July 1994 REMOTS® Stations over Bathymetry and the 1993-94 Supplemental Cap Material Deposit

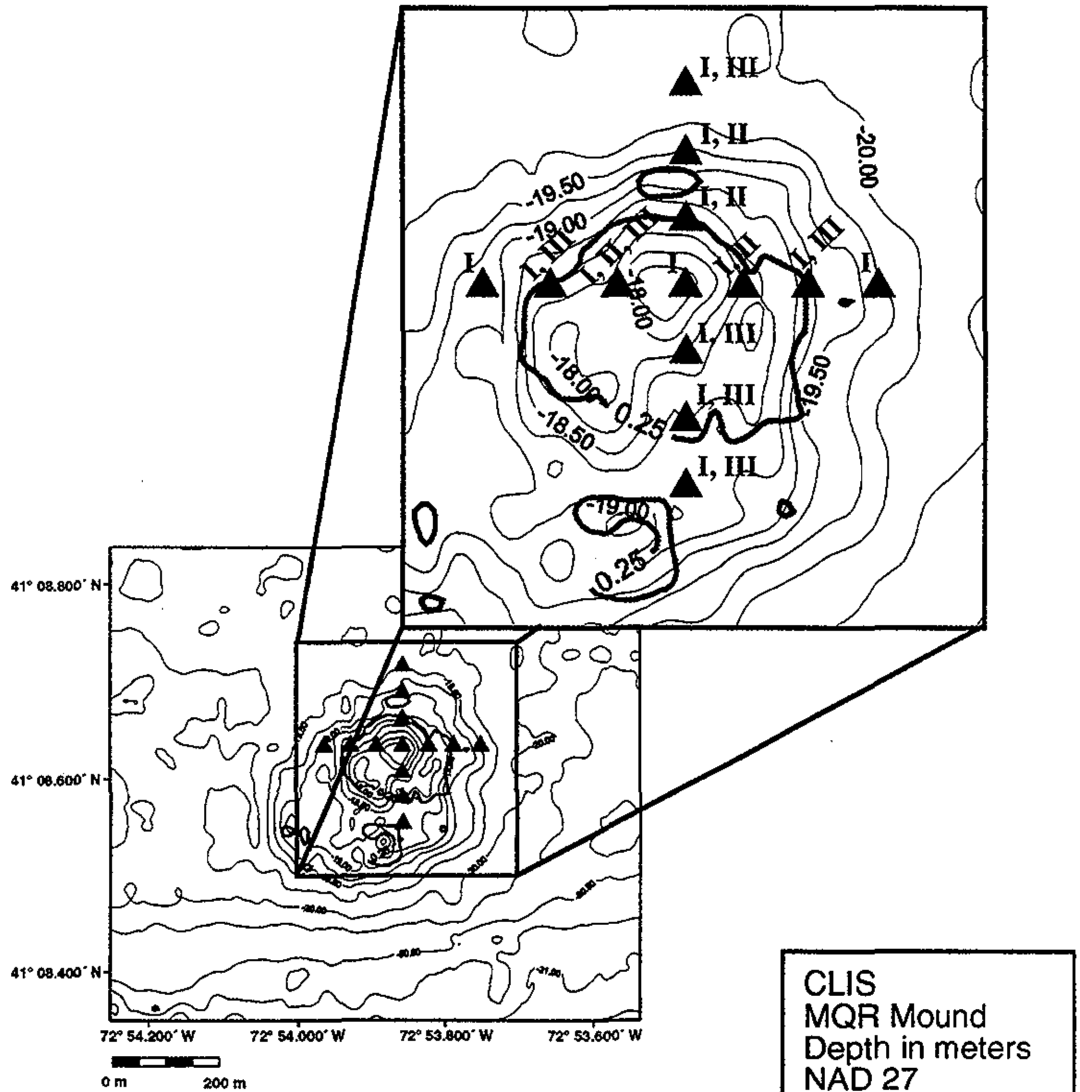


Figure 3-26. Distribution of successional stage assemblages over the MQR mound, overlaid on July 1994 bathymetry and detectable margins of the mound

were comprised mainly of sand. Average sand fractions for these stations ranged from 57.9% to 73.2% (Figure 3-27; Appendix C, Table 4). As expected, these stations exhibited the lowest reported values of fine-grained material for normalization procedures.

The average TOC concentration of the sediments collected from the surface of the MQR mound was 18364 ppm (Appendix C, Table 4). Individual TOC values ranged from 11000 ppm at MQR-2 and MQR-9 to 27000 ppm (MQR-4). These data exhibited bi-modality, with higher TOC concentrations found on the eastern side of the MQR mound, corresponding to the higher percentage of fine-grained material (Figure 3-27).

Total LMW PAH values were slightly higher for the MQR mound in comparison to the reference areas, averaging 0.944 ppm (Appendix C, Table 5). Individual analyte and total LMW values between stations showed increased variability within the MQR mound data relative to the reference areas. Total LMW values from the MQR mound ranged from 0.498 ppm to 1.567 ppm. The total HMW PAHs from the MQR mound were also slightly higher than the reference areas, averaging 3.924 ppm, with a range of values from 1.630 ppm to 6.260 ppm.

The results of metals analysis of the MQR mound sediments were similar to the results of the reference area sediments (Appendix C, Table 6). The raw concentrations of the eight metals associated with anthropogenic activity for the MQR mound fall within the "low" level of contamination category as defined by the NERBC (Appendix A, Table 10; NERBC 1980).

3.3 CLIS Reference Areas

As part of the DAMOS tiered monitoring protocols, data are collected from multiple reference areas surrounding the disposal site to provide a baseline against which results from the dredged material disposal mounds are compared. CLIS-REF has been a reference area for CLIS since the beginning of the DAMOS Program. The two newer reference areas, 2500W and 4500E, have been monitored since the late-1980s. During the July 1994 survey at CLIS, REMOTS® sediment-profile photography and sediment grab sampling were conducted for comparison with the environmental monitoring data collected over the NHAV 93 and MQR mounds. Complete REMOTS® results for the CLIS reference areas are available in Appendix B, Table 3. Raw and normalized sediment chemistry and grain size analysis results for 2500W, 4500E, and CLIS-REF are located in Appendices C and D, respectively.

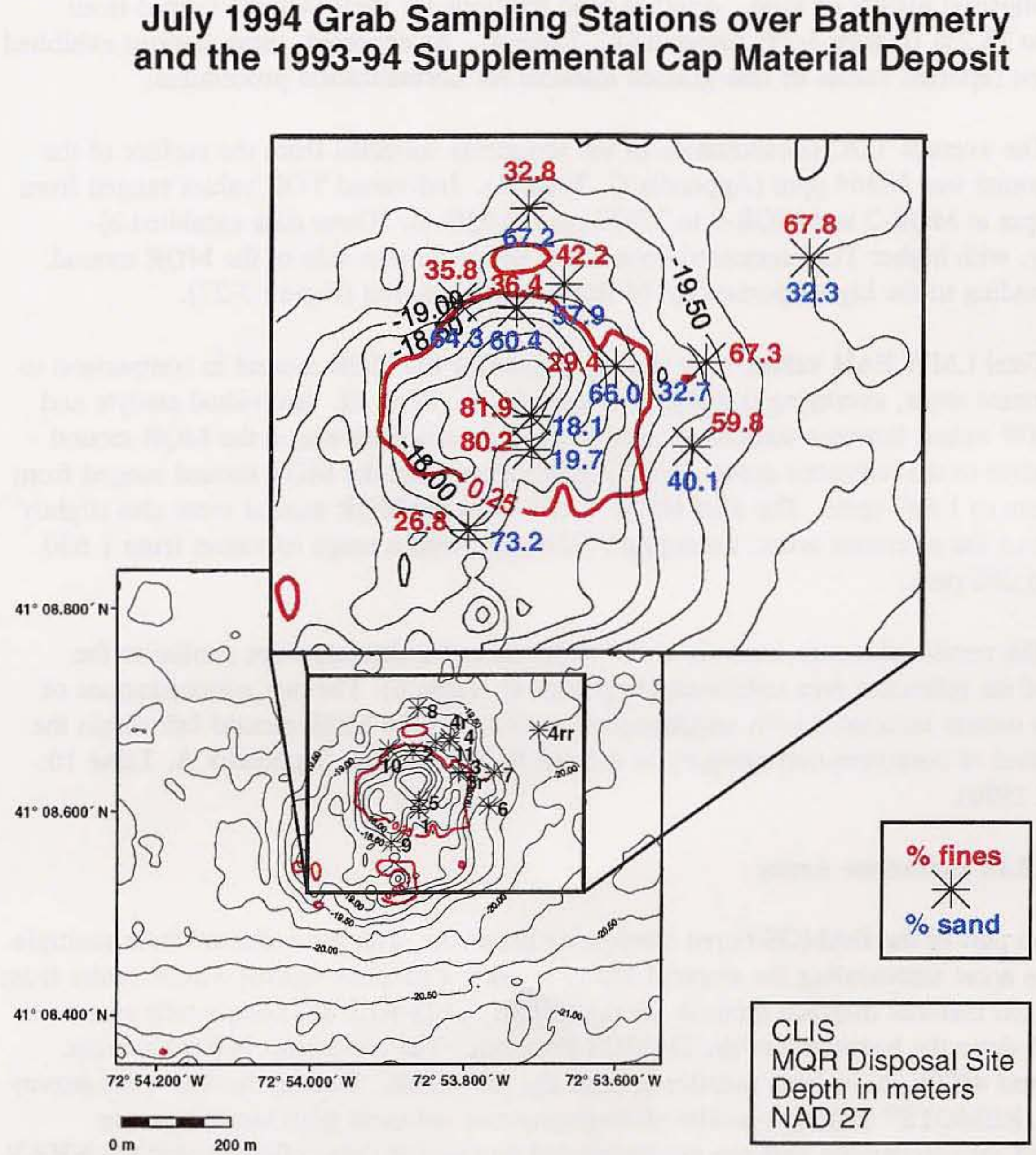


Figure 3-27. Distribution of sand and fine sediment fractions over the MQR mound, overlaid on July 1994 bathymetry and detectable margins of the mound

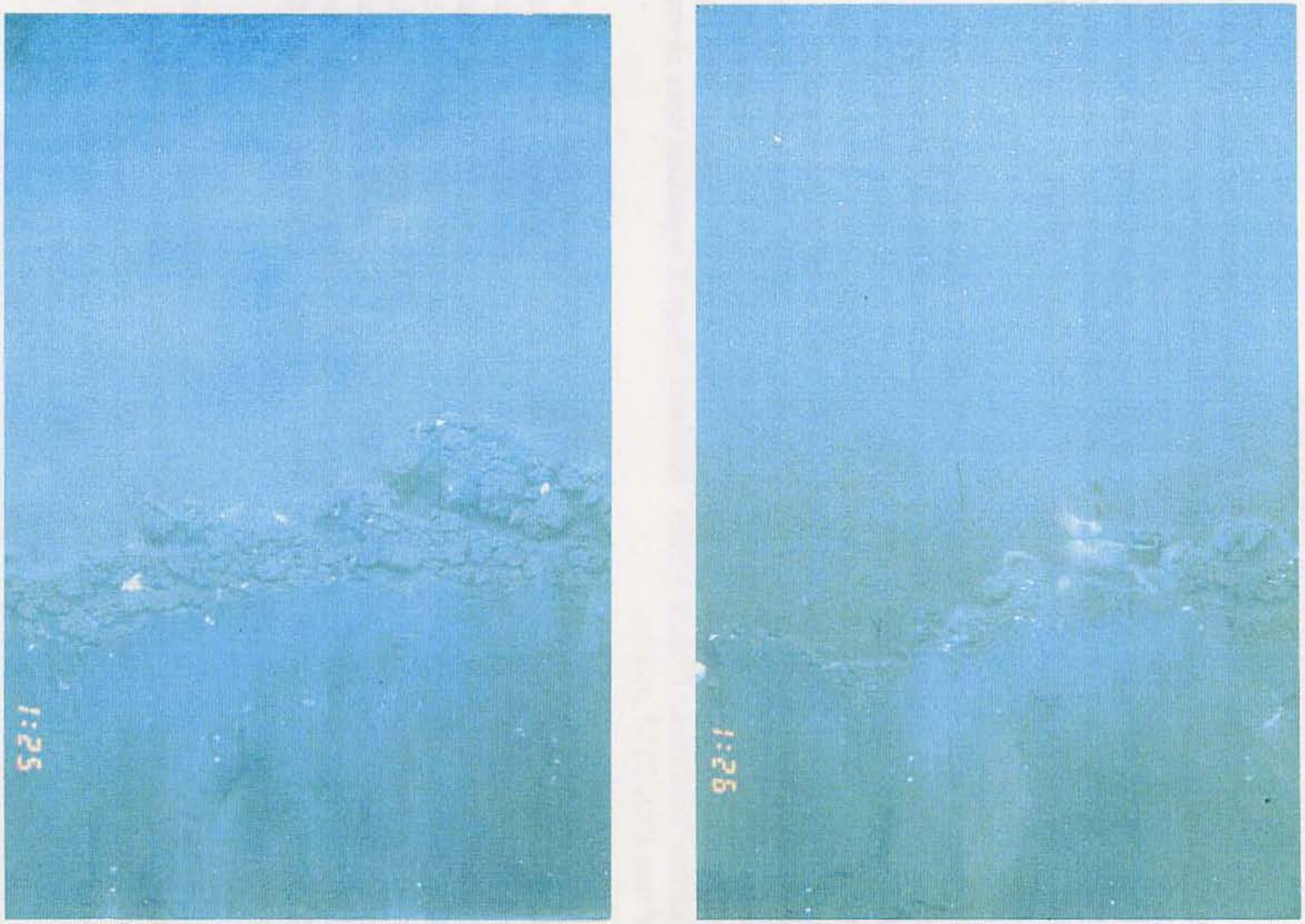
3.3.1 REMOTS® Sediment-Profile Photography

Data collected from the thirteen REMOTS® camera stations indicated the presence of a uniform grain size distribution within all three of the CLIS reference areas. The REMOTS® photographs obtained at randomly selected stations within the CLIS-REF, 2500W, and 4500E reference areas display a major modal grain size of >4 phi, consistent with ambient central Long Island Sound sediment. All three reference areas appear to be free from dredged material, with no evidence of errant disposal in any of the replicate photographs.

Reference areas 4500E and CLIS-REF exhibited the characteristics of a well-established, relatively undisturbed environment in Long Island Sound. However, REMOTS® photographs obtained at 2500W showed evidence of heavy trawling disturbances (Figure 3-28A). The action of the trawl net and tickle chains across the bottom scoured the oxidized surface layer of sediment and displaced the surface and shallow-dwelling organisms. As a result, both the RPD and OSI values for 2500W were lower than expected, with means of 0.62 cm and 5.75, respectively (Appendix A, Table 12). Apparently, Stage I assemblages were quick to recover, and deep burrowing Stage III organisms were unaffected by the surface disturbance (Figure 3-28B). However, Stage II organisms were absent at three of four REMOTS® stations.

At reference area 4500E, Stage III assemblages were present at all REMOTS® stations, with Stage I and Stage II organisms present at three of the four. The replicate-averaged RPD depths ranged from 0.77 cm at STA 4 to 0.97 cm at STA 1. A mature benthic assemblage and moderate RPDs yielded median OSI values of 6.0 for all four REMOTS® stations. The replicate-averaged RPD depths for CLIS-REF ranged from 0.64 cm at the western-most station (STA 4) to 2.7 cm at STA 2 (Appendix A, Table 12). The biological diversity of the area was intact with Stages I, II, and III represented at all five REMOTS® stations. The deep RPD depths and a diverse benthic community elevated the OSI values. Median OSI values ranged from 4.0 at STA 3 to 8.0 at STA 1 and STA 2 with an overall mean RPD of 1.37 cm.

There was no evidence of redox rebound intervals or methane gas in any reference area REMOTS® photograph. However, conditions indicating low dissolved oxygen conditions were detected in one replicate within 2500W, a direct result of the recent surface disturbance. Sediment surface layer roughness was predominantly classified as physical at 2500W, 4500E, and CLIS-REF. Boundary roughness values for the three reference areas ranged from 0.73 cm at CLIS-REF to 2.87 cm at 2500W (Appendix A, Table 12).



A B

Figure 3-28. REMOTS® photographs of reference area 2500W Station 2

3.3.2 Sediment Chemistry and Grain Size

The results of the sediment grain size analyses indicate that the grain size distribution between the three reference areas is quite similar. In all cases, reference area sediments were comprised mainly of fine-grained material (silts and clay), followed by sand, and then gravel. The results of the grain size analyses are reported in Appendix C, Table 7.

Further analysis shows that 2500W has the highest fine-grained sediment fraction of the reference areas, averaging 74.6%, followed by 4500E (68.1%) and CLIS-REF (54.2 %) (Appendix C, Table 7). The widest range of individual values was also found at 2500W; ranging from 54% to 85.5%. The ranges between station values at 4500E and CLIS-REF were lower, ranging from 53.3% to 76.9% at 4500E, and 48.7% to 61.5% at CLIS-REF. The highest percentage of sand was at CLIS-REF, averaging 44.1%, followed by 4500E (31.4%) and 2500W (25.0%). Gravel was only a minor constituent at the reference areas, comprising only 1.7% of the sediments at CLIS-REF, and 0.5% and 0.4% at 4500E and 2500W, respectively.

The results of the TOC analyses were similar in comparisons between the three reference areas. Average concentrations for 4500E, 2500W, and CLIS-REF were 21750 ppm, 22500 ppm, and 20000 ppm, respectively (Appendix C, Table 7).

Comprehensive sediment chemistry analysis indicated the averaged LMW PAH values were 0.863 ppm, 0.643 ppm, and 0.619 ppm at 2500W, 4500E, and CLIS-REF, respectively (Appendix C, Table 8). Variation of all individual analytes between stations within each area was low, indicated by the low standard deviations for each compound. Total LMW value variation between stations of individual areas was also low, ranging from 0.595 ppm to 0.641 ppm at CLIS-REF, 0.593 ppm to 0.731 ppm at 4500E, and 0.783 ppm to 1.052 ppm at 2500W.

High molecular weight PAH results were similar to the results above, in that CLIS-REF contained the lowest average HMW PAH concentrations of 1.850 ppm, followed by 4500E with 2.327 ppm, and 2500W with 2.981 ppm (Appendix C, Table 8). Variability between reference areas and intraspecific station data was low. Values at CLIS-REF ranged from 1.740 ppm to 1.908 ppm. The range of HMW PAH values at 4500E was 2.186 ppm to 2.478 ppm. Variability at 2500W was the highest of the three reference areas with values ranging from 2.414 ppm to 2.958 ppm. The average values of total PAHs (LMW plus HMW) at the 4500E, 2500W, and CLIS-REF were 2.970 ppm, 3.844 ppm, and 2.470 ppm, respectively (Appendix C, Table 8).

The CLIS-REF and 4500E reference areas were very similar in average metals concentrations as well as the range of variability for individual metals between stations (Appendix C, Table 9). All reference areas exhibited the same trends in individual average metals concentrations in that Fe was the most abundant metal within each reference area, followed hierarchically by Al, Zn, Cr, Cu, Pb, Ni, As, Cd, and Hg.

3.4 Data Comparisons

The July 1994 survey at CLIS provided SAIC and NED the opportunity to acquire a wealth of physical, chemical, and biological data by utilizing a wide variety of oceanographic equipment. The performance of six separate survey operations (precision bathymetry, REMOTS® sediment-profile photography, sediment grab sampling, remote surface sediment characterization, subbottom-profiling, and geotechnical coring) within the confines of a single monitoring cruise allowed for comparisons between the various elements verifying, reinforcing, or ground-truthing overlapping data sets. These overlaps provided a unique opportunity to use the data regularly collected on a standard DAMOS disposal site monitoring cruise (bathymetry, REMOTS®, and grab sampling) to evaluate the newer technology utilized during the July 1994 survey at CLIS.

3.4.1 Sequential Bathymetric Surveys, X-Star Subbottom Profiler, Geotechnical Core Comparison

Since the inception of the DAMOS Program in 1977, precision bathymetry has been used to monitor the development of dredged material mounds on the seafloor at each disposal site (NUSC 1979). Comparisons between sequential bathymetric surveys determined the size and shape of dredged material deposits, thickness of cap material layers, and rates of mound consolidation. Although this is an accurate and reliable approach, the results are directly dependent upon consistency in the timing of disposal and survey operations, as demonstrated during the New Haven Capping Project (Morris et al. 1996).

Due to the timing of the precap survey over the NHAV 93 mound, approximately 76,000 m^3 of CDM was left undetectable through conventional bathymetric data processing. An X-Star subbottom profiler used during the July 1994 survey was successful in discerning the capping material over the northern flanks of the NHAV 93 mound. In addition, the subbottom profiler was capable of quantifying UDM and total dredged material thicknesses over ambient bottom. Slight differences in acoustic signature between the various dredged material layers were detected and mapped, providing a representation of the NHAV 93 mound morphology similar to the bathymetric data products.

The geotechnical cores collected over the NHAV 93 mound during the July 1994 monitoring cruise confirmed the subbottom profiler data set. The X-Star system detected the differences in acoustical signature based on a sharp increase in sediment pore water at the CDM/UDM interface. The increase in water content corresponded to a sharp decrease in sediment density, creating an acoustic reflector within the sediment deposit. Geotechnical cores were originally obtained over NHAV 93 at several stages of mound development to supplement the bathymetric data set as well as examine and quantify mound consolidation. This suite of geotechnical cores provided a solid comparison for the bathymetric models and exceptional ground truth data for the subbottom profiler data (Figures 3-29 and 3-30).

Core U, collected over the center of the NHAV 93 mound, penetrated 180 cm into the sediments. Bathymetry detected 2.0 m of UDM and an undetermined thickness of CDM deposited in the area of Core U (Figure 3-29). The subbottom data indicated the presence of 2.0 m of UDM and 1.0 m of CDM over the center of the mound (Figure 3-30). The geotechnical analysis of Core U observed CDM at the sediment-water interface and extending to 87 cm of penetration (Figure 3-31A). The New Haven project UDM extended down the core an additional 93 cm to the penetration limit.

Core V penetrated 210 cm into the southwestern flank of the NHAV 93 mound, outside the area of concentrated subbottom analysis. Both the bathymetric and subbottom paper trace data reveal that the area around Core V received less than 0.25 m of UDM from the 1993-1994 New Haven Capping Project. However, approximately 1.5 m of capping material was deposited over the southwest flank of the mound in February 1994 as part of the final phase of CDM deposition (Figures 3-29 and 3-30). The core sampled approximately 160 cm of CDM over a 15 cm thick layer of project UDM and a 25 cm layer of historic dredged material originating from the Norwalk and CLIS 88 mounds (Figure 3-31B).

Core W was collected over the northeast margin of the NHAV 93 mound, penetrating 260 cm into the CLIS sediments. The bathymetric data indicated approximately 0.25 m of CDM and less than 0.25 m of UDM in the vicinity of Core W (Figure 3-29). Subbottom returns detected approximately 1.5 m of dredged material (project UDM and historic) overlaid by 0.25 m to 0.5 m of NHAV 93 CDM (Figure 3-30). The core description reported the presence of a CDM layer 40 cm thick overlaying a 15 cm to 20 cm layer of project UDM. Historic dredged material from the CLIS 89 mound was visible to 200 cm of penetration (Figure 3-32A).

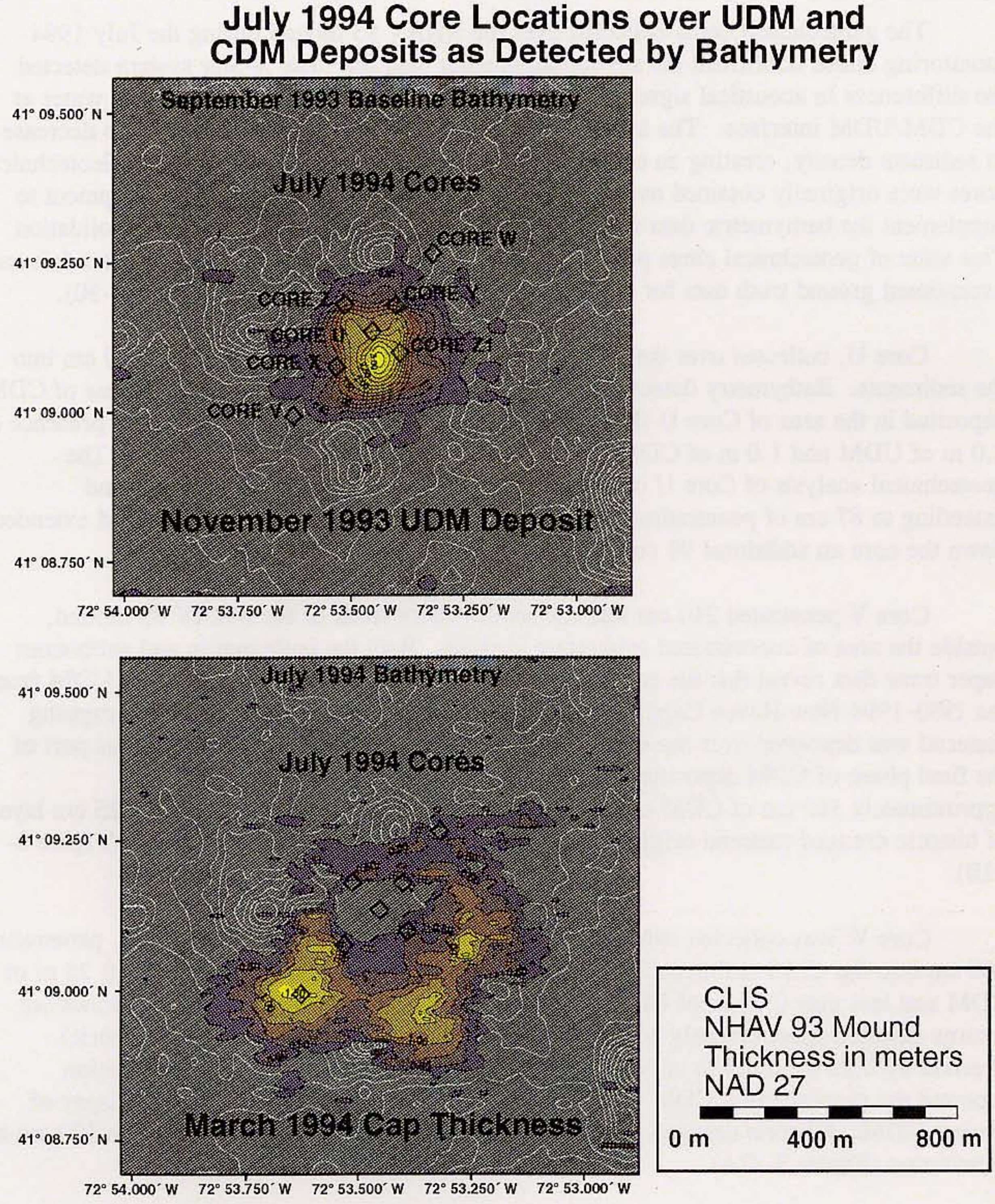


Figure 3-29. Apparent UDM and CDM deposit thickness based on sequential bathymetric surveys with plotted positions of the July 1994 geotechnical cores, overlaid on September 1993 and July 1994 bathymetric contours, respectively, 0.25 m contour interval

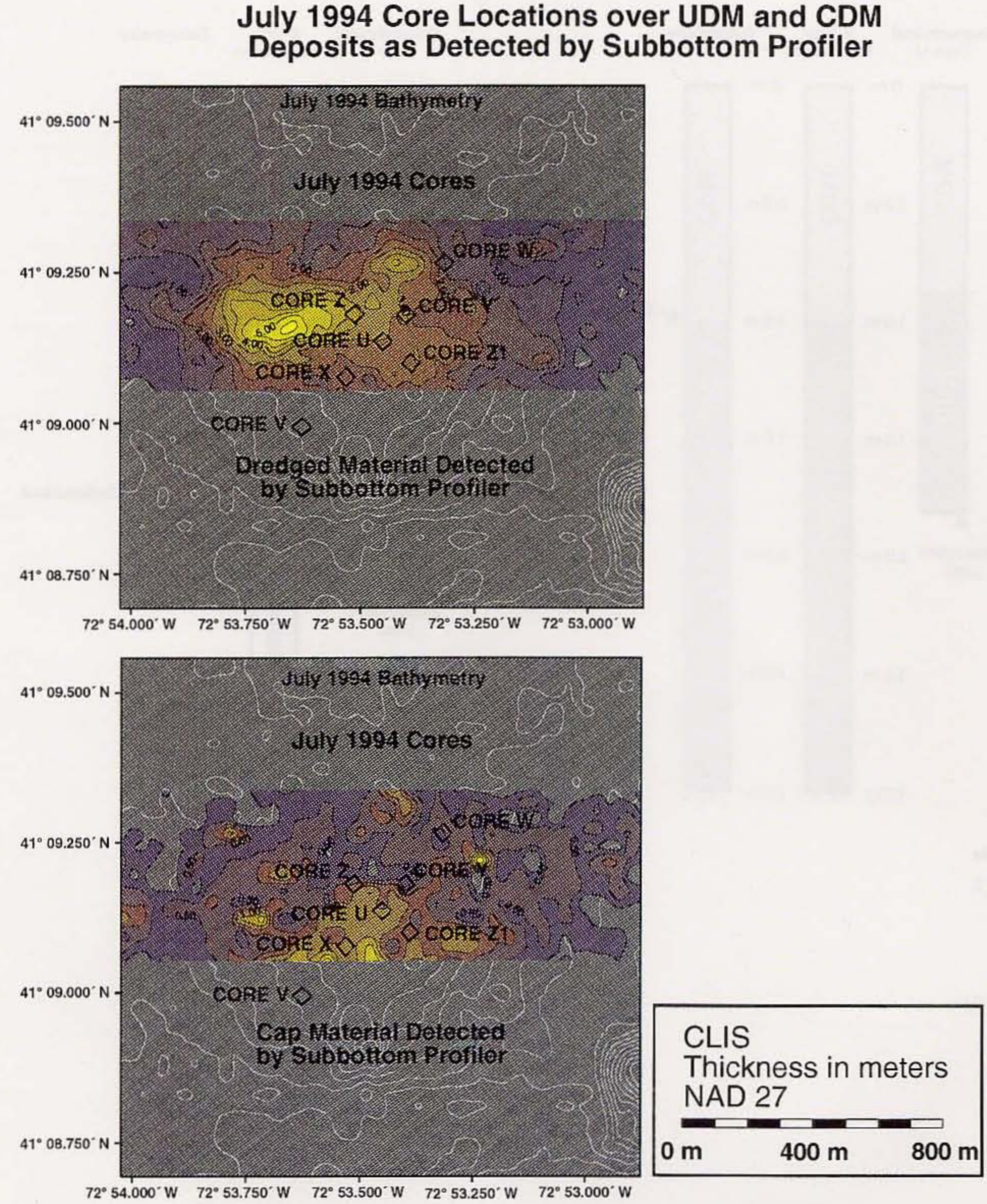


Figure 3-30. UDM and CDM deposit thickness based on subbottom profiling with plotted positions of the July 1994 geotechnical cores, overlaid on July 1994 bathymetric contours

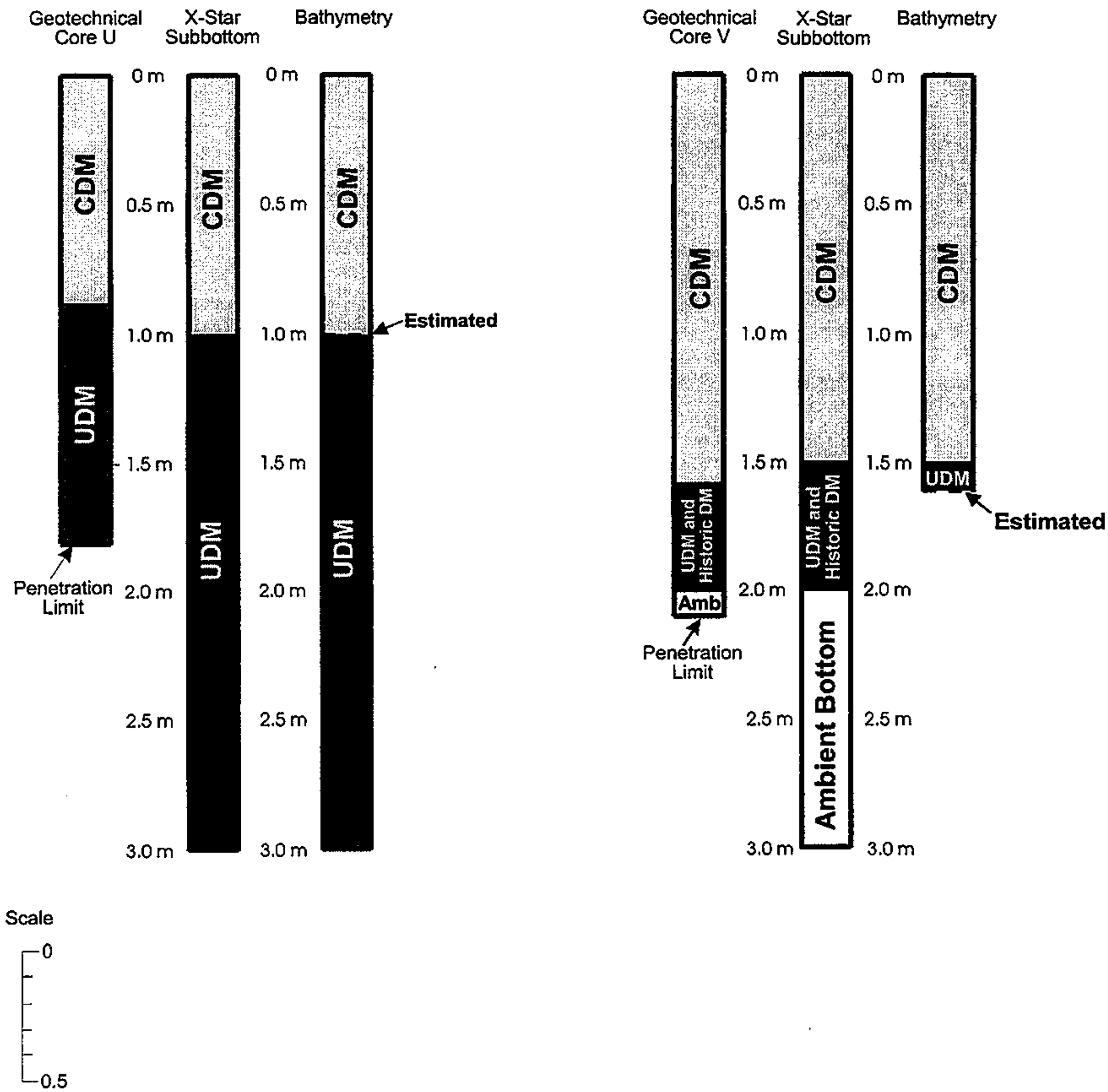


Figure 3-31. Diagrams comparing the results of geotechnical cores U and V vs. corresponding subbottom and bathymetric data

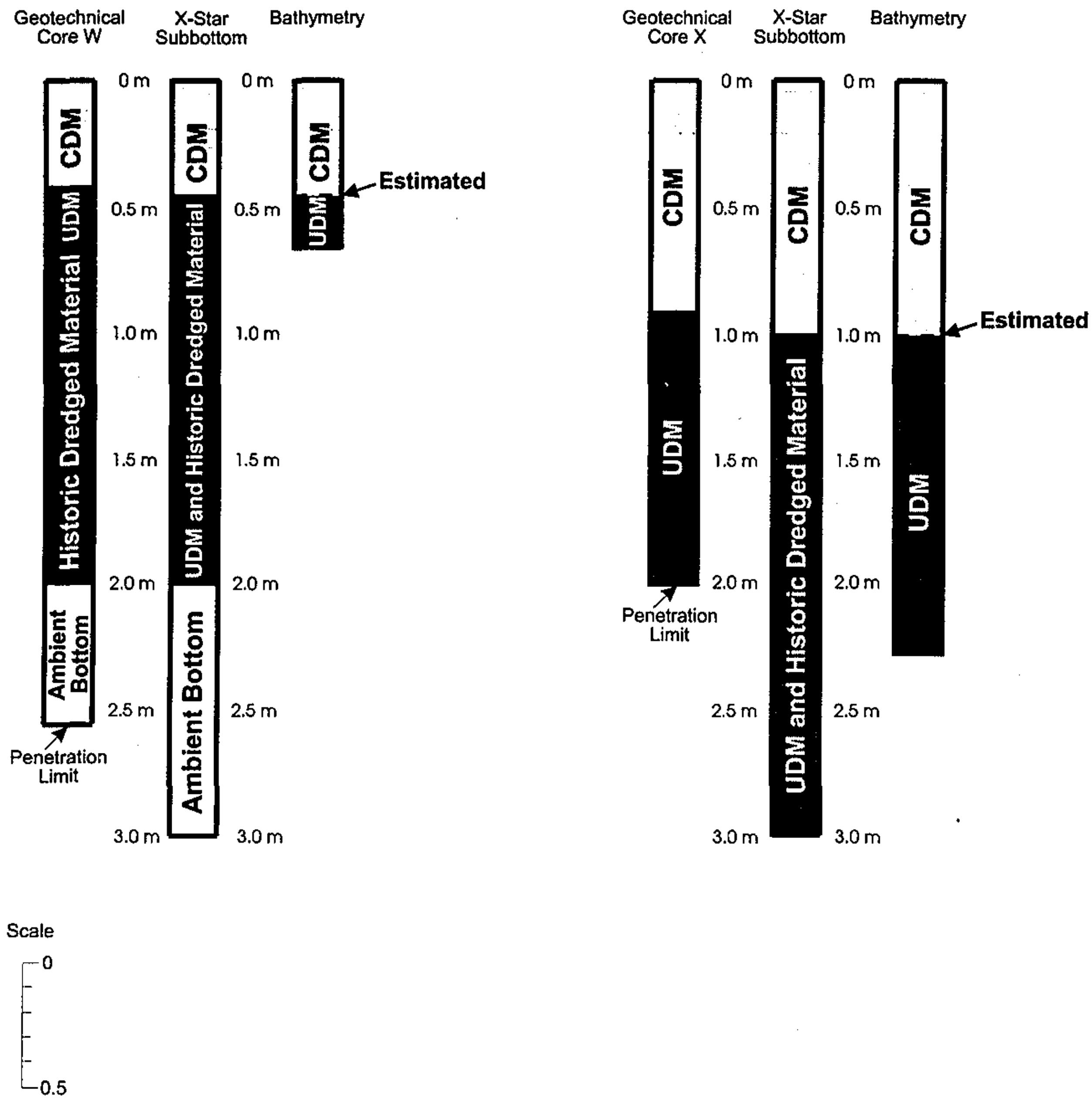


Figure 3-32. Diagrams comparing the results of geotechnical cores W and X vs. corresponding subbottom data

Core X, obtained 150 m southwest of the NHAV 93 mound center, penetrated 200 cm into the NHAV 93 mound. According to the November 1993 and March 1994 bathymetry, the area surrounding Core X received approximately 1.25 m of UDM and 0.5 m of CDM (Figure 3-29). The subbottom data indicated the presence of approximately 1.0 m of cap material overlaying 2.25 m of UDM and historic dredged material (Figure 3-30). Upon extrusion, Core X displayed a layer of capping material 90 cm thick over a deposit of New Haven UDM that extended an additional 110 cm to the penetration limit (Figure 3-32B).

Core Y was acquired approximately 100 m northeast of the NHAV mound center, and penetrated 205 cm into the sediment. The results of the bathymetric data processing suggest that a layer of CDM was placed over a 0.75 m thick UDM deposit. The subbottom profiler detected 0.25 m of CDM over 3.0 m of New Haven UDM and historic dredged material. During the processing of Core Y, a small lens of sand was discovered at 27 cm of penetration, confined by layers of black clayey silt (Figure 3-17). The X-Star system detected the sand layer as a change in sediment density and tracked it as the CDM/UDM interface reflector. As a result, the subbottom profiler quantified less capping material than was actually present. Core Y shows the CDM/UDM interface at approximately 90 cm of penetration with UDM sampled to approximately 180 cm of penetration (Figure 3-33A).

Core Z, collected approximately 110 m northwest of the NHAV 93 mound center, penetrated the seafloor to a depth of 250 cm. According to the 1993-1994 bathymetric analysis, the area surrounding Core Z received 1.25 m of New Haven project UDM and was capped to an unknown CDM thickness (Figure 3-29). The subbottom profiler successfully quantified the cap thickness as 0.75 m during the July 1994 survey. In addition, the UDM and historic dredged material thickness in the vicinity of Core Z were determined to be 3.75 m (Figure 3-30). The description of Core Z characterized the top 80 cm of sediment as New Haven capping material. New Haven Harbor UDM was sampled from 80 cm to 215 cm with historic dredged material from CLIS 87 extending from 215 cm to the penetration limit (Figure 3-33A).

Core Z1 was obtained approximately 100 m southeast of the mound center and penetrated 143 cm into the NHAV 93 sediments. Calculations based on successive bathymetric surveys detected approximately 2.5 m of UDM and an unknown thickness of CDM in the area surrounding Core Z1 (Figure 3-29). The X-Star system calculated the thickness of the CDM as a layer approximately 0.75 m thick. The UDM/historic dredged material deposit was found to be 2.5 m thick (Figure 3-30). The analysis of Core Z1 found CDM composing the top 70 cm of sediment, with underlying layers of New Haven Harbor UDM extending down the core 73 cm to the penetration limit (Figure 3-34).

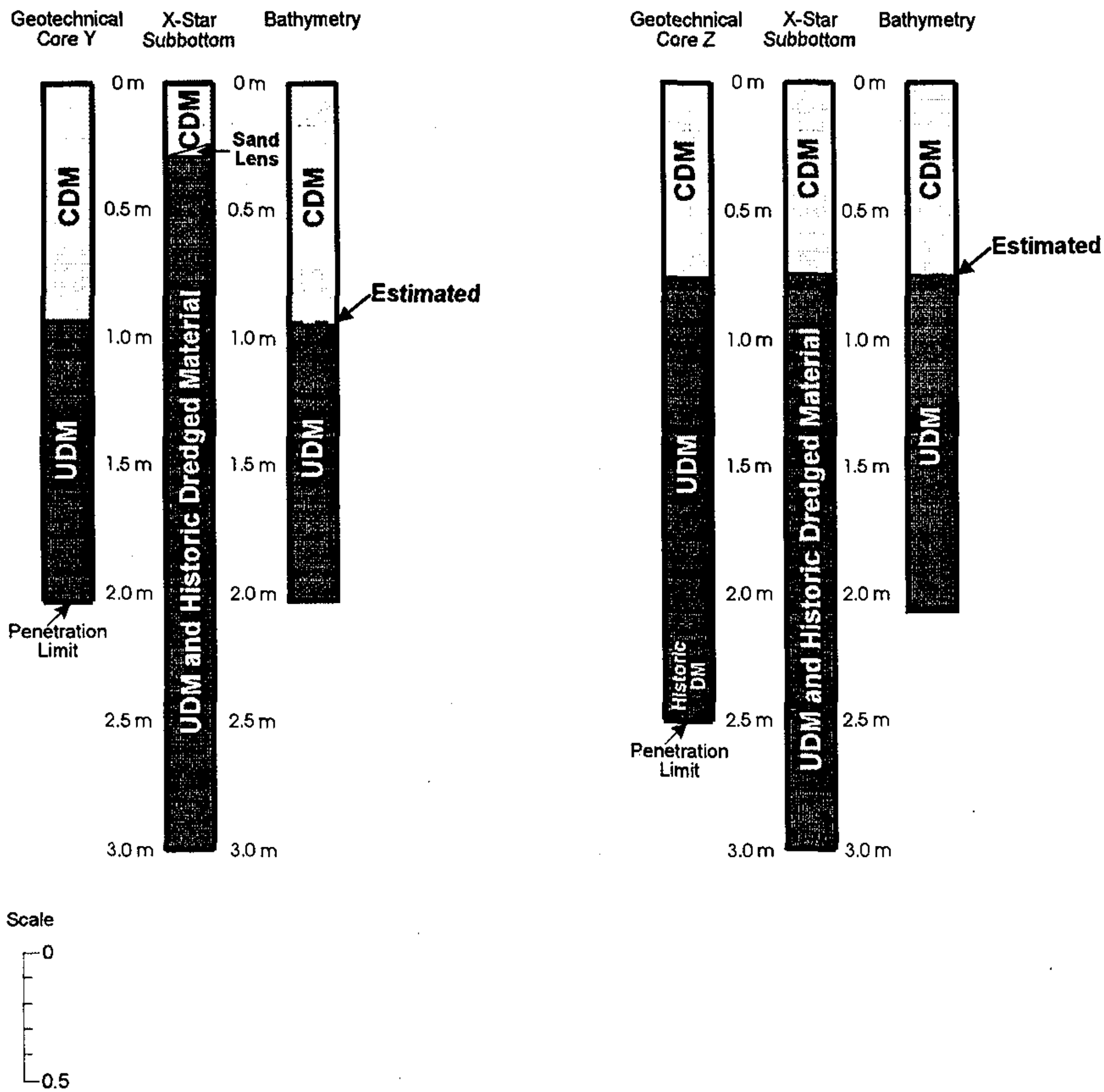


Figure 3-33. Diagrams comparing the results of geotechnical cores Y and Z vs. corresponding subbottom data

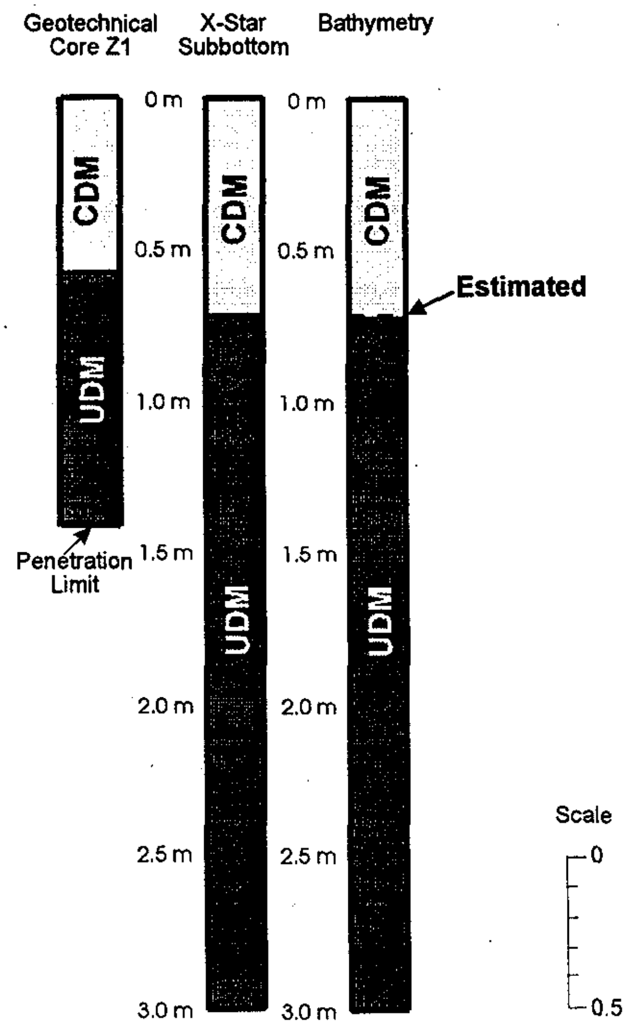


Figure 3-34. Diagrams comparing the results of geotechnical core Z1 vs. corresponding subbottom data

3.4.2 Sediment Acoustic Characterization System, Sediment Grab Sampling Comparison

As stated earlier, the July 1994 survey at CLIS provided an opportunity to evaluate the use of acoustic remote sensors relative to traditional DAMOS Program monitoring techniques. The Sediment Acoustic Characterization System, developed by SAIC, collected bottom reverberation data over the southern half of the 2553 m × 2225 m bathymetric survey area to map sediment types based on the relative density of the CLIS sediments. Grain size data compiled as part of the sediment chemistry testing was used to ground-truth the SACS returns and assess the effectiveness of this sensor.

In general, SACS was able to differentiate between "harder" (sand, pebble, and cobble sized grains) and "softer" (silt and clay) sediments on the seafloor. By comparing the SACS return signal strength over a 1260 m × 1100 m analysis area to point grain size data, relationships between harder or stronger surface reflections and lower fine-grained sediment fractions were observed (Figure 3-35). The three NHAV 93 mound grab sampling stations that fall inside the concentrated analysis area were found to be composed of high silt and clay content sediment (mean 72.9 ±1%). As expected, the amount of surface reflection was relatively low (86.0 dB to 96.0 dB) due to signal attenuation, or dispersion, in the finer grained material. The coarser grained material deposited over the surface of the MQR mound appeared to be a better acoustic reflector, providing a stronger signal return to the 24 kHz transducer. Surface reflections of 96.0 dB to 106 dB were detected in close proximity to the MQR mound, correlating well with the percentage of fine-grained material in the supplemental CDM (mean 51.0 ±18.6%). The variation in fine-grained content of the MQR CDM is reflected in the overall SACS return from surface sediments. However, due to the smoothing of the acoustic data set, a few individual grain size samples did not correlate well with dB values.

Although the SACS data showed significant agreement with the sediment grain size, the results appeared to be directly affected by the amount of consolidation within the top 6 cm of the CLIS bottom. The area of most recent CDM deposition over the southwestern flank of the NHAV 93 mound displayed a significant amount of signal loss (Morris et al. 1996). An unconsolidated marine sediment, such as fresh dredged material, typically has a high water content, often approaching 200%. The increased volume of pore water modifies the acoustic characteristics of the sediment deposit to be comparable to the overlying seawater (LeBlanc et al. 1992). The sound wave generated by the 24 kHz SACS transducer tends to pass through the unconsolidated dredged material deposit until it reaches a stronger reflector, increasing signal attenuation. As a result, the sound wave returning to SACS is considerably weaker than when it originated from the low frequency transducer.

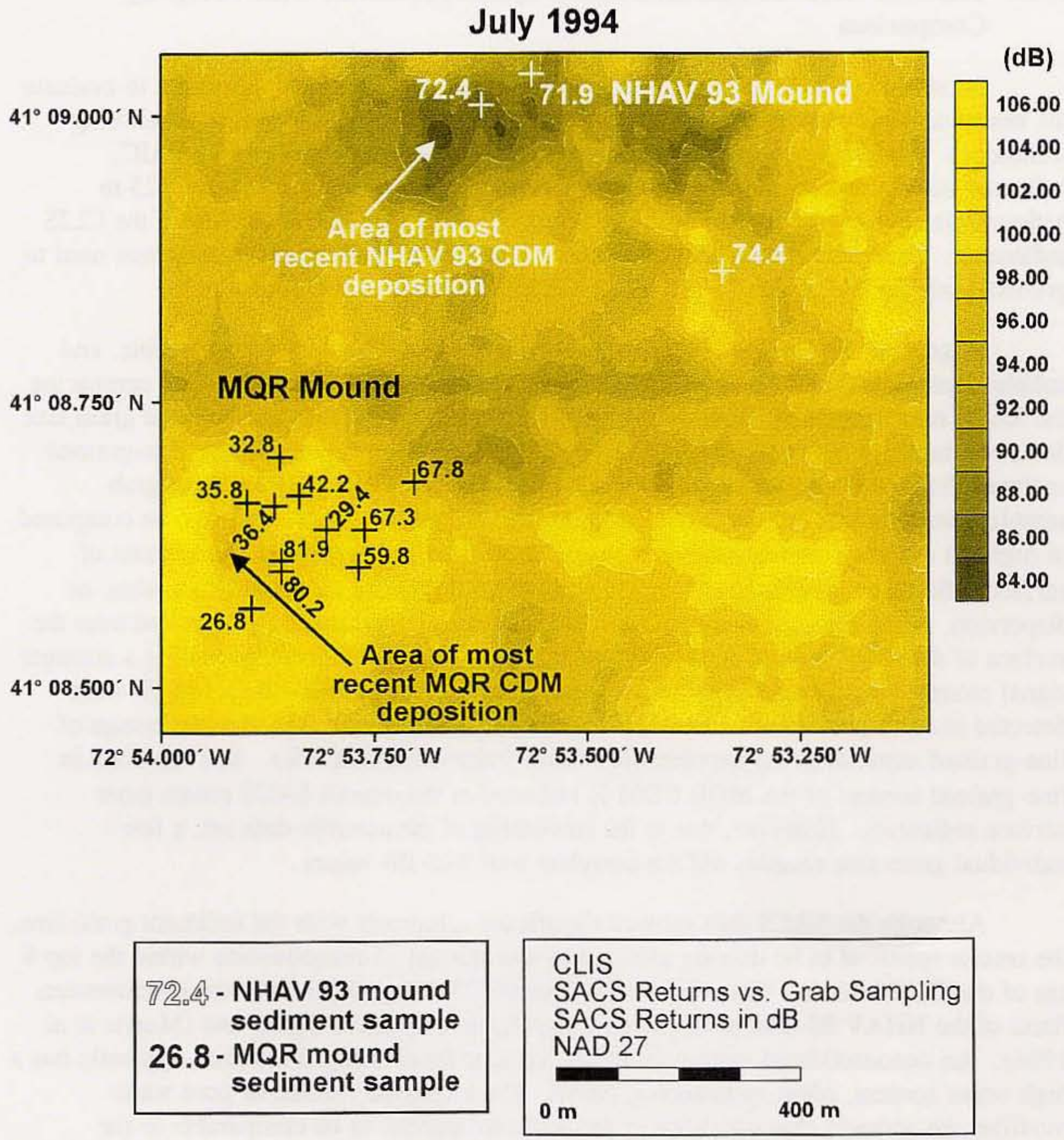


Figure 3-35. Color contour plot of the SACS signal returns with a 1260 m × 1100 m analysis area with plotted position of NHAV 93 and MQR mound sediment grab samples and percent fine-grained material content, 2.0 dB shading interval

Further evidence of this signal loss in unconsolidated sediment was documented on the MQR mound. Several pockets of material on the western and southern slopes of MQR showed a decrease in material hardness relative to the surrounding dredged material. Disposal logs indicate that sediments dredged from Pine Orchard Harbor were being deposited south and west of the CDA buoy as late as 21 May 1994, 51 days before the July 1994 survey activity. Again, the SACS system was detecting the unconsolidated nature of the recent deposit in comparison to the older CDM layer.

3.4.3 Sediment Acoustic Characterization System, X-Star Subbottom Profiler Comparison

SAIC utilized the July 1994 survey operations as an opportunity to compare the prototype Sediment Acoustic Characterization System (SACS) to the X-Star subbottom profiler. An attempt was made to run the two systems concurrently and compare the data collected from the sediment surface returns. However, a comprehensive comparison of the digital data was not conducted due to the relative location of the concentrated area of X-Star analysis and shortcomings of the SACS system.

The preliminary results of lane by lane comparisons show agreement between the two systems when confined to relative scales of dB (SACS) and reflection coefficient (RF) for X-Star (Figure 3-36). Further comparison efforts were hampered by the differences in the acoustic frequency, level of penetration, and performance in the two systems. A complete comparison would require the precise calculation of acoustic signal bottom loss for both SACS and X-Star. The SACS software did not record the strength of the outgoing pulse from the 24 kHz transducer. Therefore, calculation of signal loss by the formula ($SL = Out_{dB} - In_{dB}$) where Out is the strength of the outgoing acoustic signal and In represents the known signal return strength was not possible.

The power settings for SACS were modified for optimal performance and appear to have remained constant throughout individual surveys (CLIS 1994, MBDS 1993; DeAngelo and Murray 1996). As a result, the data collected with SACS remains valid, although it does so within the confines of a relative signal strength scale for each disposal site survey. Modifications to SACS software are currently underway to correct the signal power ramping problems within the system and provide the DAMOS Program with another disposal site monitoring tool.

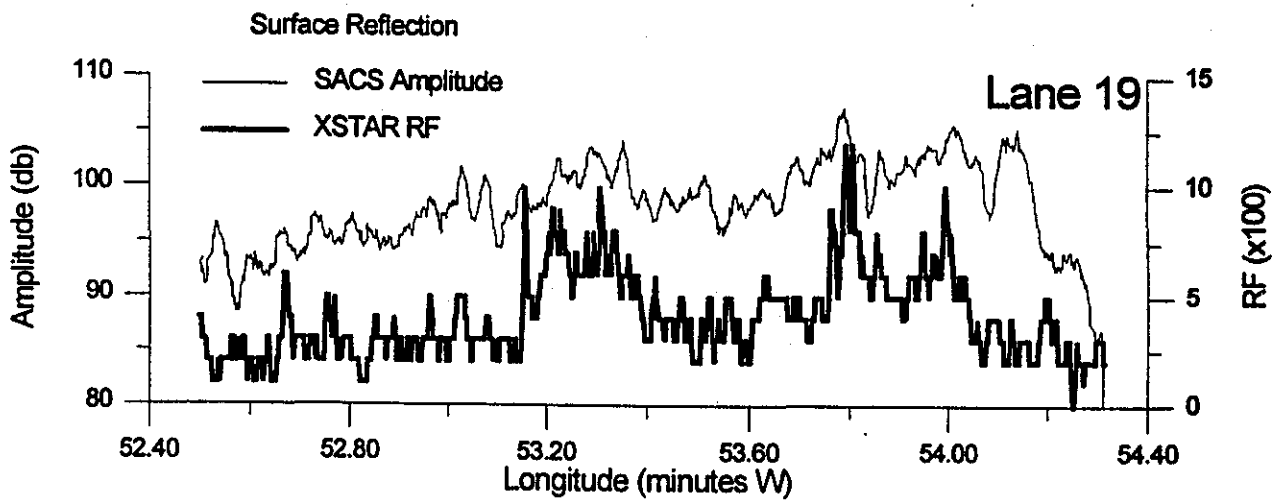


Figure 3-36. Plot of the SACS signal return amplitude (dB) versus X-Star subbottom reflection coefficient (RF) over lane 19 of the July 1994 bathymetric survey area

4.0 DISCUSSION

The current 1994 survey was the largest conducted at CLIS since the 1986 master survey which encompassed the entire disposal site, an area of 8.375 km^2 (SAIC 1990). The large July 1994 survey allowed SAIC and NED to reconstruct the history of CLIS, assess the status of the NHAV 93 and MQR mounds, and establish a new baseline for future bathymetric data comparisons.

The NHAV 93 mound is an example of a new type of CAD mound, utilizing seven historic disposal mounds (CLIS 87, CLIS 88, CLIS 89, CLIS 90, CLIS 91, SP, and Norwalk) as an artificial lateral containment structure. These seven mounds were systematically placed on the bottom by changing the position of the CDA taut-wire moored buoy annually and employing precision disposal operations (Figure 4-1). The formation of a ring of small to moderate dredged material disposal mounds developed a containment cell on the CLIS seafloor capable of receiving a large volume of UDM and facilitating quick and efficient capping operations (Morris et al. 1996).

During the 1993/94 disposal season, 590,000 m^3 of UDM was deposited at the NHAV buoy located over the center of the cell. Due to this added containment measure, the lateral spread of the UDM deposit did not exceed 500 m. The capping process was completed within 75 days due to the restricted shape and size of the disposal mound. A total of 569,000 m^3 of cap material was required to cap the entire NHAV 93 mound to a thickness of 0.5 m to 1.0 m. The end result was a wide, flat, and stable central mound that yielded a historically low CDM to UDM ratio of 0.96:1.0 (SAIC 1995).

In contrast to the New Haven Harbor Capping Project at CLIS, a recent capping project conducted at the New York Mud Dump Site required significantly more cap material to cover a lesser volume of contaminated dredged material. In June and July of 1993 approximately 445,000 m^3 of dioxin contaminated material was dredged from the Port of Newark/Elizabeth (SAIC 1994). This material was deposited on the bottom of the New York Mud Dump Site without the use of a containment cell to restrict the size of the deposit. An additional requirement of the project was to limit the height of the mound by creating a broad flat mound. To achieve this, disposal operations were conducted along predetermined lanes rather than at a single buoy. The apron of the dioxin-contaminated mound that was formed by this disposal covered an area with a diameter of approximately 1.25 km. Capping operations at the New York Mud Dump Site were conducted from July 1993 through February 1994. The final volume of sand required to cap the dredged material mound to a uniform thickness of 1 m was 1,862,000 m^3, resulting in a cap to mound ratio of 4.18:1.0 (SAIC 1994). The final volume of material required to cap the

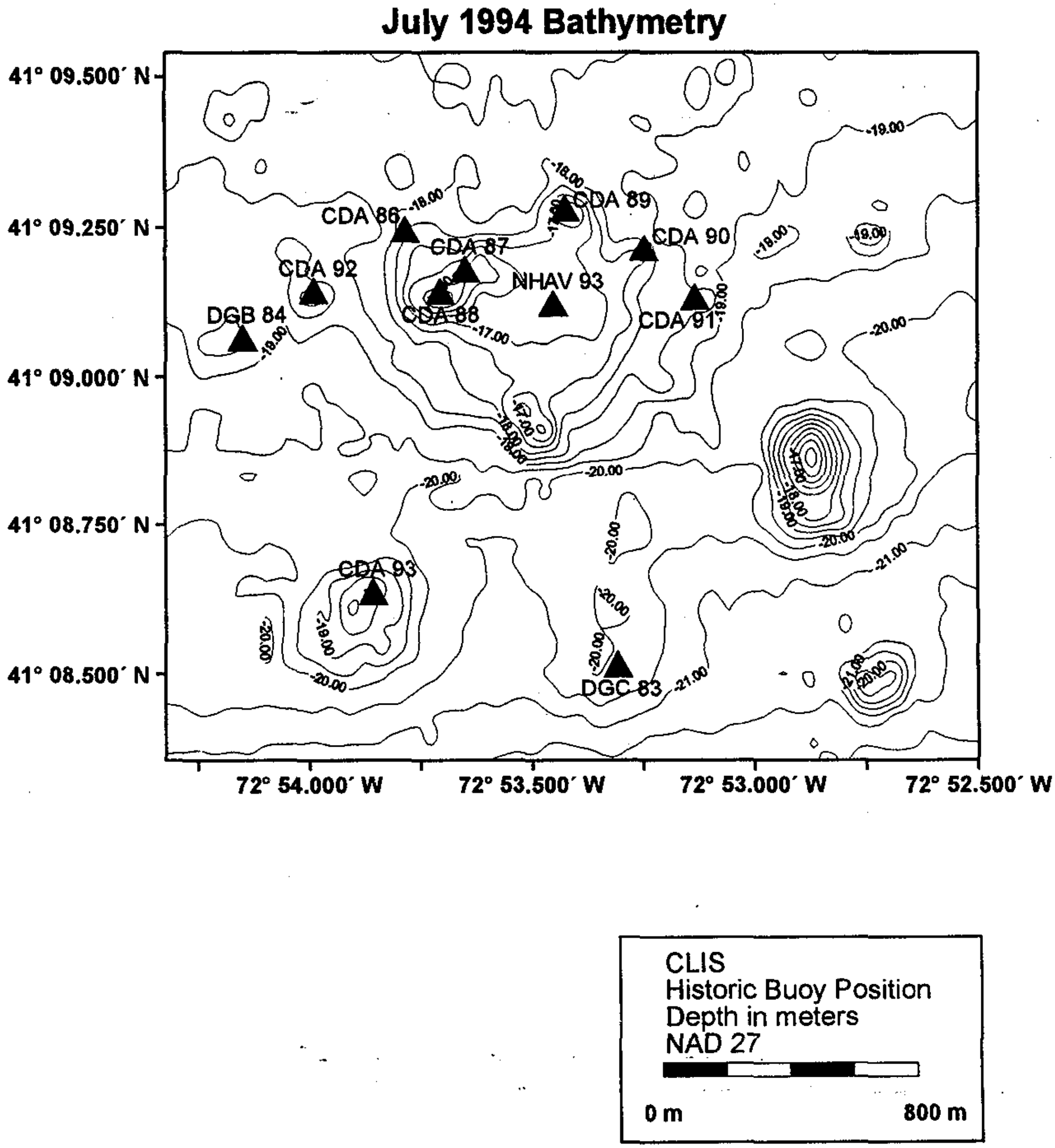


Figure 4-1. A plot of historic buoy locations overlaid on the July 1994 2553 m × 2225 m bathymetric survey results

contaminated material to a thickness of 1.0 m was directly related to the lateral spread of the mound during disposal.

Dredging operations conducted in urbanized or industrialized areas may not produce an abundance of CDM for use in capping operations. At CLIS, approximately 145,000 m^3 more UDM was deposited than at the New York Mud Dump, requiring the investment of 1,293,000 m^3 less CDM. The systematic deposition of dredged material to form a lateral containment ring proved to be a valuable and viable management strategy at CLIS. The ring of mounds acted as an artificial containment ridge and facilitated the deposition of a large volume of sediment in a relatively small area. In addition, the pattern of disposal over the past seven to ten years allowed for the incorporation of historic mounds, minimizing bottom coverage. The continued management strategy of containment cell formation followed by central deposition will efficiently utilize the 8.375 km^2 area of seafloor to conduct disposal operations at CLIS well into the future (Morris et al. 1996).

The comparison of the July 1994 survey to the March 1994 post-cap bathymetry indicates little or no change in NHAV 93 mound topography occurred over the four month period. Depth difference plots completed during the five previous bathymetric surveys show that the majority of consolidation occurred during disposal and capping operations (Morris et al. 1996). The long-term outlook for NHAV 93 suggests slow consolidation of the CAD mound as a result of pore water extrusion and basement material compression over time (Poindexter-Rollings 1990).

There is sufficient agreement between the subbottom and bathymetric data comparisons of the cap material thickness to state that cap thickness over the entire NHAV 93 project area conforms to project requirements of 50 cm. The X-Star subbottom system detected as much as 1.25 m of cap material in the northwest quadrant of the NHAV 93 mound.

A depth difference plot comparing the March 1994 postcap bathymetric survey to the November 1993 precap survey detected an apparent hole in the NHAV 93 cap over the northwest quadrant of the mound (Morris et al. 1996). Disposal logs indicated the deposition of approximately 76,000 m^3 of CDM prior to the completion of the November 1993 precap survey. As a result, this capping material could not be discerned from the UDM deposit during subsequent surveys that utilized conventional bathymetric data processing techniques. However, the subbottom survey confirmed the presence of 0.5 m to 1.25 m of CDM northwest of the NHAV buoy, indicating the NHAV 93 mound had been completely capped. Through the use of sequential bathymetric and subbottom profiling surveys, an average cap thickness of 0.75 m was detected over the surface of the NHAV 93 mound.

The geotechnical cores are in agreement with the bathymetric and subbottom results with respect to cap and dredged material thickness, as well as depth of ambient bottom. Cap material can be detected in the top sections of each core. The thickness of the cap varied between 40 cm in Core W to 160 cm at Core V. The depth and thickness of the dredged material varied in each core, but multiple layers of black and brown sands, silts, and clays were consistently part of the dredged material descriptions. Cores V and W were the only samples of the NHAV 93 mound that reached ambient bottom. In both cases, ambient Long Island Sound sediments, consisting of firm, olive-grey clayey silt, were found at depths of 200 cm.

Although the cap thickness over the NHAV 93 mound was found to be sufficient, REMOTS® sediment-profile analysis revealed a possible problem with the quality of CDM in three areas. At four months post disposal a healthy Stage I advancing to Stage II community was expected to be established around the center of the NHAV 93 mound. Shallow to diffusional RPD depths, slow recolonization rates, and low OSI values at REMOTS® Stations 200N, CTR, and 400S indicated a possible sediment toxicity issue.

In accordance with the DAMOS tiered monitoring protocol, these areas of concern were re-visited in late September 1994 to collect sediment samples in order to perform laboratory bioassay studies (Germano et al. 1994). The results of the September 1994 toxicity testing showed no significant difference in toxicity levels between the NHAV 93 capping material and sediment collected from the historic South Reference Site. The three areas of concern were monitored closely for changes in benthic environment. The results of the August 1995 REMOTS® survey over the NHAV 93 mound showed marked improvement in benthic conditions at 16 months after CAD mound completion (Morris 1996).

The results of the sediment chemistry analyses for the NHAV 93, as well as the MQR mound, show that the sediments covering these mounds are equal to or below the chemical concentrations of the CLIS reference areas. All PAH values are below the values of the National Status and Trends (NS&T) averages for sediments found within Long Island Sound (NOAA 1991). Metals concentrations were categorized within the "low" level of contamination based upon their average values and statistical variabilities when compared to the guidelines set forth by the NERBC (NERBC 1980). These results indicate that the capping sediments and conditions of the NHAV 93 and the MQR mounds are broadly representative of the ambient seafloor conditions that are found throughout Central Long Island Sound.

The remaining July 1994 REMOTS® photographs show the majority of the NHAV 93 mound is recovering well from the disposal activity. Stage I assemblages are known to be present at 12 of 13 stations with progression into Stage II and Stage III communities at the fringes of the mound (400 m and 600 m away from the center). The majority of the RPD depths within the NHAV 93 CDM are above 0.5 cm.

The CDM used for capping operations over the NHAV 93 mound was dredged from four individual locations within New Haven Harbor: the Outer Federal Channel (Stations E-J), Northeast Petroleum, Lex Atlantic/Gateway Terminal, and Wyatt, Inc. (Morris et al. 1996). Sediment samples from these locations were analyzed for grain size distribution, TOC, trace metals, and PAHs prior to capping operations to insure their suitability for use as CDM. The complete results of these analyses can be found in Appendix F, with summary values available in Appendix A, Table 13.

During this survey, sediment samples were collected from 11 stations located over the NHAV 93 mound to monitor the postcap chemical composition of the CDM. As a means of quantifying the chemistry results of this survey, statistical ranges of the raw average chemistry values from the pre-dredging surveys in outer New Haven Harbor were used to provide the expected ranges of the average and individual TOC, grain size, metal, and PAH concentrations in the NHAV 93 capping material. This range of values will be referred to as the "composite cap material" throughout this discussion. In addition to this comparison, chemical information on ambient values was collected at the 4500E, 2500W, and the CLIS-REF disposal site reference areas.

The results of this survey show that the average TOC, grain size (sand and fines), metals, and PAH values from the cap surface generally lie well within, or are below, the expected ranges of the composite cap material (Appendix A, Table 13). The average values of arsenic, mercury, and LMW PAHs appear to be slightly elevated, however, the average values that define the composite cap material ranges represent worst case estimates. The expected range values of the cap material were derived from four data sets that included a number of non-detected values (ND) (Appendix F, Tables 1-5F). In cases where values were reported as below the instrument detection limits (<), the reported detection limit value was used for a conservative estimate when calculating the ranges, although for statistical analysis one half of the detection limit is also sometimes used (Clarke 1994). In addition, the average values for the composite cap material were derived from incomplete data sets (some values not available, N/A, Appendix F, Tables 1-5F).

Metals and PAH values from both the pre-dredging and the postcap surveys were also normalized to percent TOC and percent fine-grained material to allow for comparison of chemical concentrations in sediments where the controlling phase (TOC and fine-grained sediments) is variable in each sample (Lake et al. 1990, O'Connor 1990). Normalization to fine-grained material is performed to account for the variability of TOC concentrations in sediments that have been influenced by anthropogenic activity near urban activities (NOAA 1991). In this report, PAHs and metals were normalized to TOC and the fine-grained fraction of the sediments by dividing the raw chemical concentration (in $mg \cdot l^{-1}$) of the sediment by the percentage of TOC or fine-grained material at each station. Complete results of the normalization process are presented in Appendices D and E, Table 1 (PAHs) and Appendices D and E, Table 2 (metals). The NHAV 93 mound TOC and fine-grained normalized metals and PAH data resulted in values that were within or below the respective composite cap material ranges (Appendix A, Table 13).

Bioturbation, or biological reworking of the surface sediments, is the primary process which incorporates molecular oxygen into the surface sediments, increasing the RPD depth. Biological demand, chemical redox reactions, and detrital decay reduce oxygen concentrations within the sediment, and as a result reduce the apparent RPD. Higher RPD depths indicate increased bioturbation as a result of a well-established benthic community with low mortality and chemical oxygen demand (COD).

A lack of a well-established benthic community was the motivating factor behind the cap replenishment operations on the MQR mound. The recolonization rate of the MQR mound had been slow after benthic disturbances, relative to adjacent CLIS disposal mounds and reference area conditions. After a series of REMOTS® surveys from 1983 through 1992, it was recommended that MQR be capped with additional clean material to replenish the existing cap and further isolate the Black Rock Harbor contaminants (Murray 1996b).

To supplement the existing cap during the 1993/94 disposal season, 65,000 m^3 of material was deposited over the surface of the MQR mound. Disposal at the CDA buoy commenced in mid-October 1993 with the deposition of UDM dredged from the inner basin of the US Coast Guard facility in New Haven Harbor. This UDM deposit was subsequently capped with CDM excavated from the US Coast Guard access channel in late October 1993. This CDM deposit was followed by an estimated barge volume of 44,000 m^3 of capping material originating from Housatonic River in December 1993 and May 1994; Guilford Harbor in January 1994; Lex Atlantic Gateway in February 1994; and Pine Orchard Harbor in April 1994.

As a result, the mound increased in height 1.5 m, shifting the apex of the mound 100 m to the northeast. Hard SACS returns, confirmed by REMOTS® photographs and grab samples, indicated that coarse sand, pebble, and cobble size grains were deposited on the surface of the MQR mound along with silts and clays as components of the supplemental capping material. The results of the grain size analysis for the MQR mound indicate that the overlaying cap material is comprised basically of two sediment types. The CDM released over the western side of the mound (Stations MQR-2, MQR-3, MQR-8, MQR-9, MQR-10, and MQR-11) is composed mainly of sands, while the surface sediment collected over the eastern side (Stations MQR-1, MQR-4, MQR-5, MQR-6, and MQR-7) consists mainly of fines.

The supplemental cap material placed over the MQR mound originated from several small dredging projects along the Long Island Sound coast during the 1993/94 disposal season. Dredged material from six separate areas was transported to CLIS and deposited at the CDA buoy from October 1993 through May of 1994. Upon review of the DAMOS disposal logs, distinct patterns of deposition around the CDA buoy were observed for each project.

The UDM dredged from the inner basin of the US Coast Guard facility in New Haven Harbor in October 1993 was composed of silts and clays, while the CDM excavated from the access channel was found to be predominantly sands and pebble. All of the US Coast Guard material (21,000 m^3) tended to be deposited on the northern and western sides of the buoy, producing a coarser surface layer. Sediment removed from the Lex Atlantic Gateway terminal (21,500 m^3 of sand, silt, and clay) was reportedly deposited south and west of the CDA buoy. As a result of the consistent disposal barge approaches for the larger volumes of CDM, in conjunction with the placement patterns of smaller volumes of sediment from Pine Orchard Yacht Club (16,500 m^3), Pootatuck Yacht Club (4900 m^3), Breakwater Key Inc. (2000 m^3) and Guilford Harbor (650 m^3), the material deposited over the MQR mound became segregated.

Average grain size values developed from the 11 grab sampling stations over the MQR mound are very similar to CLIS-REF in terms of percent gravel, sand, silt, and clay. Comparison of the average MQR grain size results to the 4500E and 2500W reference area averages shows that the MQR mound had a slightly higher percent sand content and a lower percent silt and clay fraction than these two reference areas. When comparing the individual results for the eastern area of the mound, it is found that this side is similar in grain size to the 4500E and 2500W reference areas. In addition, the average total organic carbon (% TOC) content of the MQR mound surface sediments was comparable to the reference areas. Individual TOC values tended to be more variable for the MQR mound than the reference areas due to differences in sediment types over the mound surface.

The July 1994 REMOTS® photographs also indicate that the area is recovering well from the latest disposal. The recolonization rate suggests that the MQR mound is quickly establishing a stable, healthy benthic community within the newly deposited sediment layer. RPD depths, successional stage status, and OSI values all indicate that this trend will continue well into the future.

Comprehensive chemical analysis of the new surface sediment layer over the MQR mound indicates the area surrounding this bottom feature should reflect conditions found at the CLIS reference areas. Comparison of metals results at the MQR mound show that nine of the ten average metals concentrations at the mound were lower than or equal to the respective concentrations at the three reference areas. Average copper concentrations over the MQR mound were slightly elevated with a concentration of 80 ppm, versus the average reference value of 57 ppm. The Cu concentration of 80 ppm at the MQR mound is still well below the "low" category of the NERBC, which is <200 ppm (Appendix A, Table 10). As a whole, the average metals concentrations, as well as the individual station metals concentrations are all classified as "low" in accordance to the NERBC except for the following stations which are classified as "moderate": Cd at MQR-3 (4.2 ppm), Cr at MQR-7 (110 ppm), and Hg at MQR-1 (0.58 ppm), MQR-6 (0.65 ppm), MQR-7 (0.98 ppm), and MQR-10 (0.63 ppm).

Average total PAH values were slightly elevated on the MQR mound in comparison to the reference areas, as were the average LMW and HMW PAH compounds. This result can be attributed to the fact that the cap material of the MQR mound was attained from an area affected by anthropogenic activities within New Haven Harbor, which typically show increased levels of PAHs. The reference areas are representative of ambient sediments of Long Island Sound and therefore anthropogenic sources and inputs of PAHs are less in comparison to urbanized areas. The individual station and average fine-grained normalized PAH data values pertinent to the MQR mound are below the PAH fine-grained normalized values of the NS&T sites located within Long Island Sound. As with the metals concentrations, the raw and normalized PAH values do not indicate an obvious correlation between PAH concentrations between the two sediment types of the MQR mound.

5.0 CONCLUSIONS

The completion of the CAD mound at CLIS represents the end of a ten-year dredging cycle in the central Long Island Sound region. Major maintenance dredging of New Haven Harbor must be performed approximately every ten years to provide adequate water depths for commercial, military, and private vessels utilizing the harbor. Thoughtful management of smaller volumes of dredged material over the last decade not only facilitated the economic and environmentally sound disposal of over 1.1 million cubic meters of dredged material, but also demonstrated a management strategy that will maximize the site capacity of CLIS as well as other DAMOS disposal sites (Morris et al. 1996).

The management strategy of containment cell formation followed by central deposition proved to be a successful method of constructing a CAD mound and efficiently isolating a large UDM deposit from the sediment-water interface. The NHAV 93 mound is a wide, flat bottom feature that has seen little to no change in vertical topography or overall width since the March 1994 survey. This suggests that the majority of consolidation and lateral spread of the fine-grained sediments occurred during disposal and capping operations. Over the long term, the NHAV 93 mound is expected to further consolidate and settle due to compaction of the underlying ambient material.

Bathymetric, subbottom, and geotechnical core data analyses are in good agreement and indicate that the entire NHAV 93 mound is covered with a layer of cap material at least 0.5 m thick. However, the results of the REMOTS® benthic community assessment did indicate three areas of concern in existence on the surface of the NHAV 93 mound. The stations 200 m north, 400 m south, and at the center of the NHAV 93 mound exhibited lower RPD depths, recolonization rates, and OSI values than expected.

Toxicity testing was completed in September 1994 to determine the quality of the cap material at Stations CTR and 400S. The results of the toxicity testing indicated no significant difference in sediment toxicity between the project mound CDM and the historic Southern Reference Site. In accordance with the DAMOS tiered monitoring protocols, no immediate action (i.e., cap supplementation) was required. Continued monitoring of these areas in September 1995 did indicate improvement in benthic habitat quality with the development of a stable infaunal population and improving RPD and OSI values (Morris 1996).

The sediment chemistry results pertaining to the sampling effort over the NHAV 93 mound indicate that TOC, HMW PAH, and metals values for the CDM were within the ranges of expected concentrations, as derived from the sediment chemistry analysis conducted as part of the pre-dredging sampling. Raw metals concentrations from the July 1994 survey were classified as "low" in accordance with the limits established by the NERBC, with the exception of Hg at five stations which was classified as "moderate." The concentrations of LMW PAHs from the NHAV 93 capping material were slightly higher than the respective ranges derived from the pre-dredging survey. In all cases, the fine-grained PAH normalized data from the NHAV 93 mound were below the respective NS&T normalized values for ambient Long Island Sound sediments.

The de facto capping and cap augmentation project conducted over the MQR mound during the 1993/94 disposal season deposited an additional 65,000 m^3 of material over the bottom feature to improve benthic habitat quality. The MQR mound displayed a net increase in mound height of 1.5 m, resulting in a shift of the mound apex 100 m to the northeast. REMOTS® sediment-profile photography detected several distinct layers of dredged material and various sized grains incorporated in the top 20 cm of sediment, consistent with the history of the MQR mound. In addition, an overall improvement in benthic conditions was detected over the surface of the mound, as a stable benthic infaunal population has been established in the recently deposited CDM.

The results of the MQR mound grain size analysis indicated two distinct sediment types over the surface of the bottom feature. The supplemental CDM deposited over eastern side of the mound consisted mainly of fine-grained sediment, while the western side was predominantly composed of sand, corresponding to the US Coast Guard CDM. In general, trace metals concentrations on the mound were lower, and slight elevations in PAHs were detected in comparison to the CLIS reference area sediments. Based on the chemistry results of the July 1994 survey over the MQR mound, metals concentrations were classified as "low" according to the NERBC criteria, and fine-grained normalized PAHs were found to be below the NS&T values for the central Long Island Sound region.

The 2500W reference area showed evidence of trawling activity, with surface layer disturbances and lower Redox Potential Discontinuity (RPD) depths than expected. The CLIS-REF and 4500E reference areas display the characteristics of a healthy, well-established benthic community for comparison to the project mound. This demonstrates one of the many strengths of the multiple reference area approach used by the DAMOS Program. The interpretation of the REMOTS® sediment-profile photography results would have been difficult if 2500W had been the only reference area sampled.

The REMOTS® photographs and grab sample grain size data collected over the NHAV 93 and MQR mounds generally concur with the acoustic returns of the Sediment Acoustic Characterization System developed by SAIC. Coarse sand, pebble, and cobble size grains are evident at stations in close proximity to the apex of the MQR mound, consistent with the "harder" returns collected by the remote sensor. The "softer" returns from the southwestern quadrant of the NHAV 93 mound were also representative of the percentage of fine-grained material in the sediment as well as the unconsolidated nature of the fresh CDM deposit.

The acoustic sensors employed during the July 1994 survey at CLIS demonstrated their value as survey instruments by collecting surface and subbottom sediment characterization data. The results of both systems were merged with standard bathymetric, REMOTS®, grab sampling, and geotechnical coring data to develop conclusions concerning the cap thickness, grain size, and topography of the NHAV 93 and MQR mounds.

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APPENDIX A

TABLES

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Appendix A, Table 1

X-Star Subbottom Analysis Area Coordinates

Corners of large subbottom analysis area		
SW	41° 09.052' N	72° 54.325' W
SE	41° 09.052' N	72° 52.500' W
NE	41° 09.336' N	72° 52.500' W
NW	41° 09.336' N	72° 54.325' W
Corners of concentrated subbottom analysis area		
SW	41° 09.052' N	72° 54.022' W
SE	41° 09.052' N	72° 52.878' W
NE	41° 09.336' N	72° 52.878' W
NW	41° 09.336' N	72° 54.022' W

Appendix A, Table 2

REMOTS® Station Names and Coordinates for Project Mounds

Area	Station	Latitude	Longitude
NHAV93 41° 09.122' N 72° 53.453' W	CTR	41° 09.122' N	72° 53.453' W
	200N	41° 09.230' N	72° 53.453' W
	400N	41° 09.338' N	72° 53.453' W
	600N	41° 09.446' N	72° 53.453' W
	200S	41° 09.014' N	72° 53.453' W
	400S	41° 08.906' N	72° 53.453' W
	600S	41° 08.798' N	72° 53.453' W
	200E	41° 09.122' N	72° 53.310' W
	400E	41° 09.122' N	72° 53.167' W
	600E	41° 09.122' N	72° 53.024' W
	200W	41° 09.122' N	72° 53.596' W
	400W	41° 09.122' N	72° 53.739' W
	600W	41° 09.122' N	72° 53.882' W
MQR 41° 08.637' N 72° 53.859' W	CTR	41° 08.637' N	72° 53.859' W
	50N	41° 08.664' N	72° 53.859' W
	100N	41° 08.691' N	72° 53.859' W
	150N	41° 08.718' N	72° 53.859' W
	50S	41° 08.610' N	72° 53.859' W
	100S	41° 08.583' N	72° 53.859' W
	150S	41° 08.556' N	72° 53.859' W
	50E	41° 08.637' N	72° 53.823' W
	100E	41° 08.637' N	72° 53.788' W
	150E	41° 08.637' N	72° 53.752' W
	50W	41° 08.637' N	72° 53.895' W
	100W	41° 08.637' N	72° 53.930' W
	150W	41° 08.637' N	72° 53.966' W

Appendix A, Table 3

REMOTS® Station Names and Coordinates for Reference Areas

Area	Station	Latitude	Longitude
2500W 41° 09.254' N 72° 55.569' W	1	41° 09.210' N	72° 55.555' W
	2	41° 09.248' N	72° 55.777' W
	3	41° 09.236' N	72° 55.692' W
	4	41° 09.163' N	72° 55.435' W
4500E 41° 09.254' N 72° 50.565' W	1	41° 09.357' N	72° 50.548' W
	2	41° 09.224' N	72° 50.434' W
	3	41° 09.258' N	72° 50.562' W
	4	41° 09.149' N	72° 50.642' W
CLISREF 41° 08.085' N 72° 50.109' W	1	41° 08.025' N	72° 50.242' W
	2	41° 08.177' N	72° 50.283' W
	3	41° 08.101' N	72° 50.077' W
	4	41° 08.146' N	72° 50.974' W
	5	41° 08.067' N	72° 50.130' W

Appendix A, Table 4

Grab Sampling Station Names and Coordinates for Project Mounds

Area	Station	Latitude	Longitude
NHAV93 41° 09.122' N 72° 53.453' W	1	41° 09.009' N	72° 53.624' W
	2	41° 09.064' N	72° 53.541' W
	3	41° 09.259' N	72° 53.394' W
	4	41° 09.110' N	72° 53.643' W
	5	41° 09.033' N	72° 53.564' W
	5r	41° 09.036' N	72° 53.565' W
	6	41° 09.074' N	72° 53.823' W
	7	41° 09.337' N	72° 53.446' W
	8	41° 09.237' N	72° 53.155' W
	9	41° 09.117' N	72° 53.610' W
	10	41° 09.253' N	72° 53.220' W
	11	41° 08.864' N	72° 53.341' W
MQR 41° 08.637' N 72° 53.859' W	1	41° 08.602' N	72° 53.859' W
	2	41° 08.659' N	72° 53.867' W
	3	41° 08.639' N	72° 53.806' W
	3r	41° 08.637' N	72° 53.808' W
	4	41° 08.672' N	72° 53.819' W
	4r	41° 08.668' N	72° 53.820' W
	4rr	41° 08.680' N	72° 53.703' W
	5	41° 08.611' N	72° 53.859' W
	6	41° 08.605' N	72° 53.769' W
	7	41° 08.638' N	72° 53.762' W
	8	41° 08.702' N	72° 53.861' W
	9	41° 08.570' N	72° 53.895' W
	10	41° 08.662' N	72° 53.899' W
	11	41° 08.668' N	72° 53.838' W

r = second attempt
rr = third attempt

Appendix A, Table 5

Grab Sampling Station Names and Coordinates for Reference Areas

Area	Station	Latitude	Longitude
2500W 41° 09.254' N 72° 55.569' W	1 2 3 4	41° 09.248' N 41° 09.224' N 41° 09.170' N 41° 09.257' N	72° 55.620' W 72° 55.592' W 72° 55.553' W 72° 55.579' W
4500E 41° 09.254' N 72° 50.565' W	1 2 3 4	41° 09.262' N 41° 09.278' N 41° 09.395' N 41° 09.310' N	72° 50.626' W 72° 50.590' W 72° 50.496' W 72° 50.515' W
CLISREF 41° 08.085' N 72° 50.109' W	1 2 3	41° 08.184' N 41° 08.185' N 41° 08.092' N	72° 50.170' W 72° 50.590' W 72° 50.101' W

Appendix A, Table 6

Methods and Instruments used in Sediment Chemistry and Grain Size Analysis

TYPE OF TEST:	**ASTM METHOD**		
Grain Size	**D422**		Sieve and Hydrometer
	EPA TEST METHOD	**(SW 846)** (USEPA 1986)	**INSTRUMENTATION**
	Sample Prep	Analytical	
TOC	-----	9060	
PAHs	3540	8270	GC/MS
Metals			
ICAP Metals (Al,Cd,Cr,Cu, Pb, Ni, Fe, Zn)	3051	6010	ICP
Arsenic (As)	3051	7060	GFAA
Lead (Pb)	3051	7421	GFAA
Mercury (Hg)	-----	7471	CVAA

Appendix A, Table 7

Geotechnical Coring Station Names and Coordinates

Core	Latitude	Longitude	Replicate of 3/15/94
Core U	41° 09.135' N	72° 53.452' W	Core N
Core V	41° 08.994' N	72° 53.627' W	Core Q
Core W	41° 09.265' N	72° 53.317' W	Core R
Core X	41° 09.076' N	72° 53.530' W	Core P
Core Y	41° 09.179' N	72° 53.401' W	Core MM
Core Z	41° 09.180' N	72° 53.513' W	Core T
Core Z1	41° 09.099' N	72° 53.390' W	Core SS

Appendix A, Table 8

REMOTS® Parameters Summary Table for the July 1994 Survey of the NHAV 93 Mound

Station	Mean RPD (cm)	Median OSI	Mean Camera Penetration	Mean Dredged Material Thickness (cm)	Boundary Roughness
200E	0.61	2.0	19.61	20.00	0.71
400E	IND	IND	19.74	19.80	0.04
600E	0.65	4.5	16.85	17.47	1.01
200N	0.80	3.0	19.10	19.44	0.50
400N	1.20	5.0	15.90	16.77	1.86
600N	1.17	6.0	10.92	11.89	2.18
200S	2.04	3.0	19.66	19.58	0.13
400S	0.35	2.0	15.48	10.07	1.20
600S	0.95	5.0	10.08	6.405	4.31
200W	1.50	4.0	16.89	18.21	2.96
400W	0.35	3.0	10.46	11.00	1.44
600W	0.88	3.0	16.64	17.02	0.80
CTR	0.78	2.5	17.97	18.61	1.19

Appendix A, Table 9

Results Table for the September 1994 *Ampelisca abdita* Bioassay Testing

Sample ID	No. Alive	% Survival	Mean %	SD	% of Reference	P Value
LIS REF	20	100	90	7.9		
LIS REF	18	90				
LIS REF	19	95				
LIS REF	17	85				
LIS REF	16	80				
CLIS NHAV 400S	15	75	81	8.9	90	0.07
CLIS NHAV 400S	15	75				
CLIS NHAV 400S	15	75				
CLIS NHAV 400S	19	95				
CLIS NHAV 400S	17	85				
CLIS NHAV CTR	18	90	84	4.2	93	0.09
CLIS NHAV CTR	16	80				
CLIS NHAV CTR	17	85				
CLIS NHAV CTR	16	80				
CLIS NHAV CTR	17	85				

Appendix A, Table 10

New England River Basins Commission (NERBC)
Classification of Dredged Sediment (NERBC1980)

	Class I	Class II	Class III
Percent oil and grease (hexane extract)	<0.2	0.2-0.75	>0.75
Percent volatile solids (NED method)	<5	5-10	>10
Percent water	<40	40-60	>60
Percent silt	<60	60-90	>90

LEVEL OF CONTAMINATION

	LOW	MODERATE	HIGH
As	<10	10-20	>20
Cd	<3	3-7	>7
Cr	<100	100-300	>300
Cu	<200	200-400	>400
Hg	<0.5	0.5-1.5	>1.5
Ni	<50	50-100	>100
Pb	<100	100-200	>200
V	<75	75-125	>125
Zn	<200	200-400	>400

Appendix A, Table 11

REMOTS® Parameters Summary Table for the July 1994 Survey of the MQR Mound

Station	Mean RPD (cm)	Median OSI	Mean Camera Penetration	Mean Dredged Material Thickness (cm)	Boundary Roughness
50E	0.63	3.0	9.67	10.71	2.19
100E	0.92	3.0	10.62	11.39	1.61
150E	0.99	3.0	10.67	10.91	0.91
50N	0.80	3.0	8.88	10.02	2.20
100N	0.61	2.5	11.76	13.21	3.53
150N	1.88	9.0	11.44	11.94	1.24
50S	1.00	4.0	18.67	19.10	1.08
100S	0.55	6.0	14.54	14.83	0.83
150S	1.18	4.0	9.70	10.64	1.94
50W	0.56	4.0	13.26	14.24	2.22
100W	0.92	3.0	10.56	11.07	1.17
150W	1.07	3.0	7.19	7.45	0.66
CTR	0.77	2.5	10.49	12.92	4.64

Appendix A, Table 12

REMOTS® Parameters Summary Table for the July 1994 Survey of the CLIS Reference Areas

Station	Mean RPD (cm)	Median OSI	Mean Camera Penetration	Mean Dredged Material Thickness (cm)	Boundary Roughness
2500W					
STA 1	0.83	6.0	9.62	0	2.85
STA 2	0.52	5.0	9.43	0	2.87
STA 3	0.60	6.0	10.74	0	1.13
STA 4	0.54	6.0	9.96	0	1.43
4500E					
STA 1	0.97	6.0	9.84	0	1.18
STA 2	0.82	6.0	9.32	0	0.88
STA 3	0.78	6.0	10.46	0	0.79
STA 4	0.77	6.0	9.45	0	1.58
CLIS-REF					
STA 1	2.07	8.0	11.19	0	0.95
STA 2	2.02	8.0	11.14	0	0.73
STA 3	0.93	4.0	7.72	0	0.79
STA 4	0.64	5.0	8.14	0	1.47
STA 5	1.21	6.0	6.35	0	1.08

Appendix A, Table 13

Sediment Chemistry Summary Table of Raw and Normalized Values for the NHAV 93 and MQR Mounds, as well as the CLIS Reference Areas

RAW CHEMISTRY VALUES

	REFERENCE AREAS (Averages) 4500E	2500W	CLIS-REF	MQR MOUND (Average)	NHAV93 MOUND (Average)	CAP MATERIAL Range (Based on Averages)
TOC (%)	2.2	2.3	2	1.8	2.3	0.60 - 3.24
FINES (%)	68.1	74.6	54.2	50.9	70.5	27.75- 93.83
SAND (%)	31.4	25	44.1	48.4	29.2	24.89-67.61
METAL (ppm)						
ALUMINUM (Al)	21000	23500	20000	11264	14418	N/A
ARSENIC (As)	8.2	9.6	8	5.5	7.3	0.90 - 3.72
CADMIUM (Cd)	1.04	1.49	1.2	1	0.89	0.66 - 2.15
CHROMIUM (Cr)	61	77	53	55	77	34.49 - 241.50
COPPER (Cu)	53	76	42	80	109	62.68- 263.33
IRON (Fe)	25000	31000	25667	16527	22182	N/A
MERCURY (Hg)	0.63	0.31	0.2	0.41	0.54	0.11 - 0.26
NICKEL (Ni)	24	28	24	16.4	23	11.42 - 85.33
LEAD (Pb)	38	42	33	38	57	35.77 - 97.67
ZINC (Zn)	130	163	123	113	165	82.99 - 255.17
PAHs (ppm)						
LMW	0.643	0.863	0.619	0.944	1.02	0.468 - 0.787
HMW	2.327	2.981	1.85	3.924	3.852	2.410 - 12.670
TOTAL	2.97	3.844	2.47	4.868	4.872	3.197 - 13.021

NORMALIZED TO TOC

	REFERENCE AREAS 4500E	2500W	CLIS-REF	MQR MOUND (Average)	NHAV93 MOUND (Average)	CAP MATERIAL Range (Based on Averages)
METAL (ppm)						
ALUMINUM (Al)	9691.7	10514.5	9992.06	6178.23	6125.3	N/A
ARSENIC (As)	3.75	4.29	4.01	2.98	3.13	0.86 - 6.22
CADMIUM (Cd)	0.48	0.67	0.6	0.55	0.39	0.25 - 3.72
CHROMIUM (Cr)	28.06	34.19	26.66	28.82	32.3	22.14 - 425.81
COPPER (Cu)	24.13	33.87	20.85	42.79	45.74	34.20 - 454.88
IRON (Fe)	11501.5	13860.6	12855.05	9034.11	9503.58	N/A
MERCURY (Hg)	0.28	0.14	0.1	0.22	0.22	0.14 - 0.46
NICKEL (Ni)	10.92	12.64	12.02	8.95	9.72	8.06 - 148.31
LEAD (Pb)	17.28	18.64	16.52	21.28	23.85	27.56 - 168.97
ZINC (Zn)	59.81	72.63	61.69	60.24	69.59	62.91 - 428.55
PAHs (ppm)						
LMW	0.297	0.395	0.31	0.56	0.456	0.132 - 1.3242
HMW	1.075	1.33	0.928	1.779	1.686	1.4587 - 4.8443
TOTAL	1.372	1.725	1.238	2.339	2.142	1.6379 - 5.7242

NORMALIZED TO FINES (Silts plus Clay)

	REFERENCE AREAS 4500E	2500W	CLIS-REF	MQR MOUND (Average)	NHAV93 MOUND (Average)	CAP MATERIAL Range (Based on Averages)
METAL (ppm)						
ALUMINUM (Al)	315.85	321.09	369.90	225.27	203.11	N/A
ARSENIC (As)	0.12	0.13	0.10	0.11	0.10	0.03 - 0.29
CADMIUM (Cd)	0.02	0.02	0.00	0.03	0.01	0.01 - 0.08
CHROMIUM (Cr)	0.92	1.05	1.00	1.09	1.09	1.03 - 2.73
COPPER (Cu)	0.79	1.04	0.80	1.66	1.56	0.99 - 6.53
IRON (Fe)	375.89	423.64	477.10	329.09	313.59	N/A
MERCURY (Hg)	0.01	0.00	0.00	0.01	0.01	0.00 - 0.00
NICKEL (Ni)	0.36	0.39	0.40	0.33	0.32	0.61 - 1.02
LEAD (Pb)	0.56	0.57	0.60	0.80	0.80	0.87 - 3.85
ZINC (Zn)	1.95	2.23	2.30	2.22	2.33	2.29 - 6.72
PAHs (ppm)						
LMW	0.0096	0.0119	0.0116	0.0213	0.0145	0.0064 - 0.0167
HMW	0.0342	0.0412	0.0346	0.0847	0.055	0.0259 - 0.4698
TOTAL	0.0444	0.0531	0.0461	0.106	0.0695	0.0341 - 0.4823

APPENDIX B

REMOTS® RESULTS

Appendix B, Table 1
REMOTS® Results

July 1994 REMOTS® Data for the NHAV 93 Mound

Station	Rep	Date	Time	Successional Stage	Grain Size (phi) Min	Max	Maj Mode	Mud Clasts Number	Avg Dia	Camera Penetration Min	Max	Range	Mean	Dredged Material Thicknes Mean	Penetration	Redox Rebound Thicknes Min	Max	Mean	Area	Apparent RPD Thicknes Min	Max	Mean	Methan	OSI	Surface Disturbance	Low DO	Comments
200e	b	7/10/94	4:14	St I	2	>4	>4	6	0.53	18.5	19.92	1.42	19.21	20.00	DM > Pen	0	0	0	8.48	0.28	0.93	0.605	NO	2	Biogenic	NO	thin oxidized layer over anoxic DM.
200e	e	7/16/94	4:36	IND	2	>4	>4	0	0	20	20	0	20.00	20.00	DM > Pen	0	0	0	N/A	N/A	N/A	N/A	NO	IND	IND	NO	over penetration, relic burrows visable at surface.
200n	a	7/11/94	8:50	St I	2	>4	>4	2	0.41	16.14	17.56	1.42	16.85	17.85	DM > Pen	0	0	0	11.21	0.57	1.02	0.795	NO	3	Physical	NO	clumps of reduced sediment from camera in frame.
200n	b	7/11/94	8:51	INDET	3	>4	>4	0	0	20.69	20.77	0.08	20.73	20.77	DM > Pen	0	0	0	N/A	N/A	N/A	N/A	NO	IND	IND	NO	over penetration, fresh DM.
200n	d	7/16/94	3:59	St III	3	>4	>4	0	0	19.71	19.71	0	19.71	19.71	DM > Pen	0	0	0	N/A	N/A	N/A	N/A	NO	IND	IND	NO	feeding void visable top left of frame, over penetration
200s	a	7/10/94	5:04	St I	2	>4	>4	8	0.25	20.08	20.2	0.12	20.14	20.12	DM > Pen	0	0	0	2.88	0.2	0.2	0.2	NO	2	IND	NO	over penetration, fresh dredge material.
200s	b	7/10/94	5:05	St I	2	>4	>4	11	0.49	18.62	19.02	0.4	18.82	18.62	DM > Pen	0	0	0	28.83	1.79	2.28	2.035	NO	4	IND	NO	thick oxidized layer over anoxic DM.
200s	d	7/16/94	4:14	INDET	4	>4	>4	0	0	20.04	20.04	0	20.04	19.92	DM > Pen	0	0	0	N/A	N/A	N/A	N/A	NO	IND	IND	NO	over penetration, burrows and voids appear to be relics.
200s	e	7/16/94	4:14	IND	2	>4	>4	0	0	19.64	19.64	0	19.64	19.64	DM > Pen	0	0	0	N/A	N/A	N/A	N/A	NO	IND	IND	NO	over penetration
200w	b	7/10/94	3:48	St I	2	>4	>4	4	0.26	17.11	19.67	2.56	18.39	17.11	DM > Pen	0	0	0	40.33	2.44	3.41	2.925	NO	5	Physical	NO	thick oxidized layer over DM, relic void right side of frame.
200w	d	7/16/94	4:40	St I -> II	2	>4	>4	0	0	9.16	16.41	7.25	12.79	16.02	DM > Pen	0	0	0	12.67	0.8	1.08	0.94	NO	4	Physical	NO	several disposal events evident, fine sand over gray DM over black DM.
200w	e	7/16/94	4:41	St I	2	>4	>4	5	0.9	17.42	18.93	1.51	18.17	18.73	DM > Pen	0	0	0	8.75	0.45	0.82	0.635	NO	2	Physical	NO	large pocket of oxidized sediment surrounded by reduced DM.
400e	a	7/16/94	4:29	IND	3	>4	>4	0	0	19.64	19.76	0.12	19.7	19.88	DM > Pen	0	0	0	N/A	N/A	N/A	N/A	NO	IND	IND	NO	over penetration.
400e	e	7/16/94	4:30	INDET	2	>4	>4	0	0	19.8	19.8	0	19.8	19.8	DM > Pen	0	0	0	N/A	N/A	N/A	N/A	NO	IND	IND	NO	over penetration, no voids visable, relic burrow.
400e	f	7/16/94	4:31	IND	4	>4	>4	0	0	19.72	19.72	0	19.72	19.72	DM > Pen	0	0	0	N/A	N/A	N/A	N/A	NO	IND	IND	NO	over penetration
400n	a	7/11/94	8:44	St I ON St III	2	>4	>4	6	0.98	13.78	14.72	0.94	14.25	14.88	DM > Pen	0	0	0	11.43	0.57	1.06	0.815	NO	7	IND	NO	feeding void/burrow right side of frame, some reduced sediment at surface. Stage
400n	b	7/11/94	8:45	St I	2	>4	>4	13	0.62	16.67	20.2	3.53	18.43	20.24	DM > Pen	0	0	0	20.18	0.93	1.91	1.42	NO	3	Physical	NO	oxidized and reworked material over darker DM.
400n	d	7/16/94	5:01	St I ON St III	2	>4	>4	6	0.82	14.47	15.57	1.1	15.02	15.2	DM > Pen	0	0	0	18.57	1.19	1.56	1.375	NO	7	Physical	NO	burrows, surface tubes, and feeding voids.
400s	c	7/10/94	5:00	St I	2	>4	>4	4	1.87	13.82	15.28	1.46	14.55	14.84	DM > Pen	0	0	0	0	0	0	0	NO	1	Physical	YES	clumps of dark DM over compacted DM
400s	d	7/16/94	4:09	St I ON St III	2	>4	>4	0	0	16.6	17.38	0.78	16.99	16.97	DM > Pen	0	0	0	12.51	0.53	1.31	0.92	NO	7	Physical	NO	relic feeding voids at depth, more recent void at the RPD interface.
400s	e	7/18/94	4:09	St I	3	>4	>4	8	1.23	14.22	15.57	1.35	14.9	15.37	DM > Pen	0	0	0	1.89	0.12	0.12	0.12	NO	2	Physical	NO	multiple disposal events, fresh DM/oxidized sed/DM, no continuous RPD.
400w	a	7/10/94	3:40	St I -> II	2	>4	>4	2	0.73	8.7	12.07	3.37	10.39	12.11	DM > Pen	0	0	0	5.09	0.2	0.53	0.365	NO	3	Physical	NO	thin veneer of oxidized clay over dredged material.
400w	c	7/10/94	3:43	St I	2	>4	>4	0	0	12.44	12.97	0.53	12.7	12.48	DM > Pen	0	0	0	5.06	0.16	0.57	0.365	NO	2	Biogenic	NO	relic feeding void at depth, shallow RPD
400w	d	7/18/94	4:46	St I ON St III	2	>4	>4	0	0	8.07	8.48	0.41	8.28	8.4	DM > Pen	0	0	0	4.21	0.2	0.41	0.305	NO	8	IND	NO	large void in basement material.
600e	a	7/16/94	4:25	St II ON St III	2	>4	>4	8	0.68	13.94	15.06	1.12	14.5	15.06	DM > Pen	0	0	0	6.61	0.36	0.6	0.48	NO	6	Physical	NO	fine sand over DM bivalve and worm in frame.
600e	b	7/10/94	4:34	St I ON St III	2	>4	>4	0	0	16.67	16.91	0.24	16.79	16.91	DM > Pen	0	0	0	6.38	0.2	0.69	0.445	NO	6	Biogenic	NO	possible anemone burrow
600e	c	7/10/94	4:35	St I	2	>4	>4	0	0	18.41	20.08	1.67	19.25	20.45	DM > Pen	0	0	0	11.94	0.53	1.18	0.855	NO	3	Physical	NO	large clump of oxidized sed. on surface, poss. discharge from camera.
600n	e	7/11/94	8:31	St I	2	>4	>4	6	1.02	10.49	13.7	3.21	12.09	13.76	DM > Pen	0	0	0	24.8	1.34	2.15	1.745	NO	4	Physical	NO	medium sand componet over clays.
600n	g	7/11/94	8:37	St III	2	>4	>4	9	0.74	8.17	11.5	3.33	9.84	11.42	DM > Pen	0	0	0	10.41	0.65	0.81	0.73	NO	6	Physical	NO	clasts due to camera movement on bottom or discharge from frame.
600n	h	7/11/94	8:38	St I ON St III	2	>4	>4	1	0.65	9.02	9.55	0.53	9.29	9.27	DM > Pen	0	0	0	20.67	1.14	1.83	1.485	NO	7	IND	NO	burrow or void, lower left of frame, fine sand over historic dredged material.
600n	j	7/11/94	8:38	St I ON St III	2	>4	>4	4	1.87	11.63	13.29	1.66	12.46	13.09	DM > Pen	0	0	0	10.32	0.53	0.93	0.73	NO	8	IND	NO	burrow may have been enlarged by camera.
600s	a	7/10/94	4:44	St I -> II	2	>4	>4	0	0	6.91	13.54	6.63	10.22	7.4		0	0	0	19.66	1.14	1.63	1.385	NO	4	Physical	NO	large burrow in ambient, basement material
600s	b	7/10/94	4:44	St I ON St III	2	>4	>4	15	0.57	8.94	10.93	1.99	9.94	5.41		0	0	0	7.19	0.33	0.69	0.51	NO	6	Physical	NO	recent deposit of dredge material over ambient bottom, thin oxygenated layer present, a stage III organism present in ambient bottom.
600w	a	7/10/94	3:31	St I	2	>4	>4	0	0	11.99	13.33	1.34	12.66	13.37	DM > Pen	0	0	0	10.14	0.37	1.1	0.735	NO	2	IND	NO	oxidized clays over DM, camera pull away
600w	b	7/10/94	3:34	St I	1	>4	>4	0	0	19.02	19.96	0.94	19.49	20.06	DM > Pen	0	0	0	12.15	0.69	1.06	0.875	NO	3	Physical	NO	over penetration, pockets of reduced sediment at depth.
600w	d	7/16/94	4:51	St I -> II	2	>4	>4	1	0.61	17.7	17.83	0.13	17.76	17.62	DM > Pen	0	0	0	14.02	0.9	1.15	1.025	NO	4	IND	NO	small bivalve on surface, relic feeding void at depth.
ctr	a	7/16/94	4:18	St I	2	>4	>4	3	0	14.42	16.02	1.6	15.22	16.02	DM > Pen	0	0	0	14.64	0.64	1.47	1.055	NO	3	Physical	NO	fine sand over DM, surface layers reworked.
ctr	c	7/10/94	4:00	St I	2	>4	>4	4	0.53	18.86	19.76	0.9	19.31	19.64	DM > Pen	0	0	0	7.61	0.41	0.69	0.55	NO	2	IND	NO	thin sand layer over fresh DM.
ctr	e	7/16/94	4:19	St I	2	>4	>4	7	0.95	18.85	19.92	1.07	19.38	19.96	DM > Pen	0	0	0	10.13	0.61	0.86	0.735	NO	2	Physical	NO	burrows, fluid mud.

Appendix B, Table 2
REMOTS® Results

July 1994 REMOTS® Data for the MQR Mound

Station	Rep	Date	Time	Successional Stage	Grain Size (phi) Min	Max	Maj Mode	Mud Clasts Number	Avg Dia	Camera Penetration Min	Max	Range	Mean	Dredged Material Thickness Mean	Penetration	Redox Rebound Thickness Min	Max	Mean	Area	Apparent RPD Thickness Min	Max	Mean	Methane	OSI	Surface Disturbance	Low DO	Comments
50e	a	7/16/94	1:03	St 1 ON 3	2	>4	> 4	1	0.63	9.91	10.38	0.47	10.15	10.13	DM > Pen	0	0	0	16.4	1.05	1.31	1.18	NO	7	IND	NO	oxidized clay over DM.
50e	b	7/16/94	1:04	St 1	2	>4	> 4	4	1.61	9.53	11.94	2.41	10.74	11.94	DM > Pen	0	0	0	11.45	0.42	1.22	0.82	NO	3	Physical	NO	camera discharged several large clumps of oxidized sediment on surface.
50e	c	7/16/94	1:05	St 1	2	>4	> 4	2	1.1	6.88	11.35	4.47	9.12	11.48	DM > Pen	0	0	0	3.52	0.17	0.34	0.255	NO	2	Physical	NO	coarse sand over dark DM, recently disturbed.
50e	d	7/16/94	1:05	St 1	2	>4	> 4	1	0.59	7.97	9.37	1.40	8.67	9.28	DM > Pen	0	0	0	3.52	0.21	0.3	0.255	NO	2	Physical	NO	coarse sand over DM, area recently disturbed.
50n	a	7/17/94	10:39	St 1 ON 2	2	>4	> 4	3	1	9.08	10.60	1.52	9.84	10.64	DM > Pen	0	0	0	17.57	0.96	1.59	1.275	NO	4	Physical	NO	a length of wire stuck into sand layer, settlement of bivalves spat evident.
50n	b	7/11/94	9:23	St 1	<-1	>4	3 to 4	3	1.5	4.35	7.89	3.54	6.12	7.8	DM > Pen	0	0	0	10.63	0.73	0.85	0.79	NO	3	Physical	NO	heterogenous bottom,
50n	c	7/11/94	9:24	St 1	2	>4	> 4	2	0.69	9.92	11.46	1.54	10.69	11.63	DM > Pen	0	0	0	4.34	0.24	0.41	0.325	NO	2	Physical	NO	oxidized clay over black fine grained DM.
50s	a	7/11/94	10:46	St 1	2	>4	> 4	15	0.59	19.03	19.62	0.59	19.33	19.37	DM > Pen	0	0	0	27.69	1.9	2.07	1.985	NO	4	IND	NO	oxidized sediment over dark DM clays.
50s	c	7/11/94	10:48	St 1 ON 3	2	>4	> 4	7	0.46	19.7	20.55	0.85	20.13	20.25	DM > Pen	0	0	0	11.45	0.8	0.84	0.82	NO	7	Physical	NO	burrows at the sand/ clay interface
50s	d	7/11/94	10:55	St 1	2	>4	> 4	0	0	18.69	20.17	1.48	19.43	20.17	DM > Pen	0	0	0	7.69	0.63	0.8	0.715	NO	2	Physical	NO	Sand over darker DM, fluid mud at surface.
50s	d	7/17/94	10:35	St 1 ON 3	2	>4	> 4	7	0.86	15.12	16.51	1.39	15.82	16.6	DM > Pen	0	0	0	6.47	0.37	0.57	0.47	NO	6	Physical	NO	oxidized sediment over darker dredge material, viesble burrow in left frame.
50w	a	7/16/94	12:57	Stage I -> II	2	>4	> 4	3	0.72	12.66	15.74	3.08	14.20	15.36	DM > Pen	0	0	0	11.38	0.42	1.22	0.82	NO	4	Physical	NO	thin layer of oxidized sediment over DM, clam at sand/clay interface
50w	b	7/16/94	12:58	St 1 ON 3	2	>4	> 4	5	0.89	15.44	17.42	1.98	16.43	17.42	DM > Pen	0	0	0	9.57	0.46	0.93	0.695	NO	6	Physical	NO	oxidized sediment over DM.
50w	c	7/16/94	12:58	Indet	2	>4	> 4	0	0	14.72	16.58	1.86	15.65	16.58	DM > Pen	0	0	0	3.22	0.17	0.3	0.235	NO	IND	Physical	NO	appears to have suffered a recent disturbance, fluid mud at the surface.
50w	d	7/16/94	12:59	St 1	2	>4	> 4	3	0.93	5.78	7.72	1.94	6.75	7.59	DM > Pen	0	0	0	7.03	0.46	0.55	0.505	NO	2	Physical	NO	area suffered a recent disturbance, fresh DM.
100e	a	7/16/94	1:08	St 1	2	>4	> 4	1	0.72	8.56	9.24	0.68	8.90	9.28	DM > Pen	0	0	0	11.75	0.8	0.89	0.845	NO	3	Biogenic	NO	oxidized sediment over DM.
100e	b	7/16/94	1:09	St 1	2	>4	> 4	5	0.78	8.82	11.77	2.95	10.30	11.81	DM > Pen	0	0	0	10.87	0.68	0.89	0.785	NO	3	Physical	NO	fine sand over DM.
100e	c	7/16/94	1:10	St 1	2	>4	> 4	9	0.89	6.92	8.14	1.22	7.53	8.18	DM > Pen	0	0	0	17.52	0.64	1.69	1.265	NO	3	Physical	NO	moderate penetration, fine sand over DM.
100e	d	7/16/94	1:11	St 1 ON 3	<-1	>4	> 4	3	0.97	14.94	16.54	1.60	15.74	16.29	DM > Pen	0	0	0	10.83	0.59	0.97	0.78	NO	7	Physical	NO	one large particle on sediment surface, coarse sand over DM.
100n	a	7/11/94	9:16	St 1 ON 2	2	4	> 4	4	1.61	11.43	15.39	3.96	13.41	14.61	DM > Pen	0	0	0	7.78	0.46	0.55	0.505	NO	3	Physical	NO	coarse grain sand over clay fraction, bivalve in coarser grains.
100n	c	7/11/94	9:18	St 1	<-1	>4	2 to 3	0	0	8.57	11.66	3.09	10.12	11.8	DM > Pen	0	0	0	10.90	0.6	0.83	0.715	NO	2	Physical	NO	coarse sand, granules, pebble, and cobble size grains over clays.
100s	a	7/11/94	11:01	St 1 ON 3	2	>4	> 4	12	0.84	19.66	20.04	0.38	19.85	19.40	DM > Pen	0	0	0	10.74	0.72	0.84	0.78	NO	7	IND	NO	two distict disposal events, stage II survived and reestablished, oxidized sediment over historic DM, feeding void at depth
100s	b	7/17/94	10:31	St 1	2	>4	> 4	3	0.96	15.94	16.77	0.83	16.36	16.81	DM > Pen	0	0	0	6.88	0.36	0.64	0.5	NO	2	Physical	NO	evidence of multiple disposal events, some reworking of shallow DM.
100s	c	7/17/94	10:32	St 1 ON 3	2	>4	> 4	2	0.92	12.27	13.23	0.96	12.75	13.23	DM > Pen	0	0	0	5.59	0.32	0.48	0.4	NO	6	Physical	NO	thin layer of coarse sand over oxidized sediment over DM, evidence of feeding voids.
100s	d	7/17/94	10:30	St 1 ON 3	3	>4	> 4	0	0	8.65	9.79	1.14	9.22	9.79	DM > Pen	0	0	0	7.36	0.37	0.7	0.535	NO	6	Physical	NO	oxidized sediment over DM, small feeding void viesble.
100w	b	7/11/94	12:50	St 1 ON 3	2	>4	> 4	4	1.06	12.32	13.46	1.14	12.89	13.5	DM > Pen	0	0	0	11.78	0.76	0.93	0.845	NO	7	IND	NO	several large clumps of reduced sediment on surface, camera discharge.
100w	c	7/11/94	12:51	St 1	2	>4	> 4	4	1.23	9.16	11.1	1.94	10.13	11.1	DM > Pen	0	0	0	7.86	0.38	0.76	0.57	NO	2	Physical	NO	clump of reduced DM on surface, camera discharge, mud/sand/mud.
100w	d	7/11/94	12:53	St 1	2	>4	> 4	3	0.81	8.44	8.86	0.42	8.65	8.61	DM > Pen	0	0	0	18.45	1.18	1.48	1.33	NO	3	Biogenic	NO	oxidized sediment over DM.
150e	a	7/11/94	11:21	St 1	2	>4	> 4	2	0.8	15.57	16.79	1.22	16.18	16.83	DM > Pen	0	0	0	12.96	0.8	1.05	0.925	NO	3	Physical	NO	medium sand layer over reworked DM
150e	b	7/11/94	11:22	St 1	2	>4	3 to 4	2	0.55	3.8	5.27	1.47	4.54	4.6	DM > Pen	0	0	0	21.51	1.39	1.69	1.54	NO	4	Physical	NO	camera causing background disturbence.
150e	d	7/17/94	10:52	St 1	2	>4	> 4	0	0	11.26	11.30	0.04	11.28	11.3	DM > Pen	0	0	0	6.77	0.45	0.53	0.49	NO	2	IND	NO	evidence of burrow and/or feeding void in DM.
150n	a	7/17/94	10:46	St 1 ON 3	2	>4	> 4	0	0	9.36	9.92	0.56	9.64	9.68	DM > Pen	0	0	0	16.62	1.08	1.31	1.195	NO	7	IND	NO	medium sand over DM, evidence of feeding voids.
150n	b	7/17/94	10:47	St 1 ON 3	2	>4	> 4	1	0.96	10.32	11.99	1.67	11.16	11.79	DM > Pen	0	0	0	31.12	1.12	3.39	2.255	NO	9	Physical	NO	large collapsing burrow, feeding void, medium sand over DM.
150n	c	7/11/94	9:08	St 1 ON 3	2	>4	> 4	0	0	15.07	17.05	1.98	16.06	17.1	DM > Pen	0	0	0	15.11	0.92	1.06	0.99	NO	7	Physical	NO	oxidized sediment over DM, relic feeding void.
150n	d	7/11/94	9:10	St 1 ON 3	2	>4	3 to 4	7	1.02	8.52	9.26	0.74	8.89	8.97	DM > Pen	0	0	0	41.62	1.76	4.38	3.07	NO	10	Physical	NO	coarse grains transported to the surface.
150s	a	7/11/94	11:12	St 1	2	>4	> 4	3	0.59	11.22	13.96	2.74	12.59	13.96	DM > Pen	0	0	0	16.06	0.59	1.73	1.16	NO	3	Physical	NO	fine sand over two layers of DM.
150s	b	7/11/94	11.12	St 1 ON 3	2	>4	> 4	3	1.39	8.94	10.46	1.52	9.70	10.38	DM > Pen	0	0	0	5.3	0.3	0.46	0.38	NO	6	Physical	NO	three distinct strata, thin fine sand layer over DM.
150s	c	7/11/94	11:14	St 1	1	>4	> 4	0	0	6.03	7.59	1.56	6.81	7.59	DM > Pen	0	0	0	27.9	1.14	2.87	2.005	NO	4	Physical	NO	large clumps of clay from camera frame in picture.
150w	a	7/11/94	12:24	St 1	3	>4	3 to 4	0	0	1.73	3	1.27	2.37	3.08	DM > Pen	0	0	0	IND	IND	IND	IND	NO	IND	IND	NO	coarse grained surface layer viesble.
150w	b	7/11/94	12:43	St 1	2	>4	> 4	0	0	8.31	8.52	0.21	8.42	8.14	DM > Pen	0	0	0	13.8	0.51	1.48	0.995	NO	3	Biogenic	NO	clumps of reduced sediment incorporated into surface layer.
150w	d	7/11/94	12:46	St 1	2	>4	> 4	3	1.4	10.55	11.05	0.50	10.80	11.14	DM > Pen	0	0	0	15.61	0.93	1.35	1.14	NO	3	Biogenic	NO	sand over DM.
ctr	a	7/11/94	10.11	St 1	2	>4	> 4	0	0	13.75	14.43	0.68	14.09	14.85	DM > Pen	0	0	0	7.01	0.38	0.63	0.505	NO	2	Physical	NO	medium sand layer over fresh DM.
ctr	f	7/11/94	10:35	St 1	<-1	>4	> 4	0	0	8.1	11.94	3.84	10.02	11.98	DM > Pen	0	0	0	14.57	0.89	1.18	1.035	NO	3	Physical	NO	coarse sand, cobble, and pebble over dark DM.
ctr	g	7/11/94	10:40	Indet	<-1	>4	< -1	0	0	2.66	12.07	9.41	7.37	11.94	DM > Pen	0	0	0	IND	IND	IND	IND	NO	IND	Physical	NO	camera penetrated pile of cobble, and coarse grained sand.

Appendix B, Table 3
REMOTS® Results

July 1994 REMOTS® Data for the CLIS Reference Areas

Station	Rep	Date	Time	Successional Stage	Grain Size (phi) Min	Grain Size (phi) Max	Grain Size (phi) Maj Mode	Mud Clasts Number	Mud Clasts Avg Dia	Camera Penetration Min	Camera Penetration Max	Camera Penetration Range	Camera Penetration Mean	Dredged Material Thickness Mean	Dredged Material Thickness Penetration	Redox Rebound Thickness Min	Redox Rebound Thickness Max	Redox Rebound Thickness Mean	Area	Apparent RPD Thickness Min	Apparent RPD Thickness Max	Apparent RPD Thickness Mean	Methane	OSI	Surface Disturbance	Low DO	Comments
2500W																											
STA 1	a	7/16/94	1:48	St III	3	>4	>4	2	0.32	5.5	8.92	3.43	7.21	0	NO DM	0	0	0	19.71	1.16	1.71	1.43	NO	7	Physical	NO	well sorted no disturbances.
STA 1	b	7/16/94	1:49	St I ON St III	3	>4	>4	7	0.52	11.43	12.67	1.24	12.05	0	NO DM	0	0	0	10.13	0.64	0.84	0.74	NO	8	Physical	NO	fine sand over clay.
STA 1	c	7/16/94	1:49	St II ON St III	2	>4	>4	7	0.52	5.54	10.4	4.86	7.97	0	NO DM	0	0	0	6.26	0.32	0.6	0.46	NO	6	Physical	NO	feeding voids, burrows, and bivalves.
STA 1	d	7/16/94	1:50	St I -> II	2	>4	>4	4	1.18	10.32	12.19	1.87	11.25	0	NO DM	0	0	0	9.33	0.48	0.92	0.7	NO	3	Physical	NO	ambient bottom
STA 2	a	7/16/94	1:24	St II -> St III	2	>4	>4	8	0.48	11.79	13.51	1.71	12.65	0	NO DM	0	0	0	9.64	0.64	0.78	0.7	NO	5	Physical	NO	oxidized sediment over darker mud, evidence of burrows and bivalves.
STA 2	b	7/16/94	1:25	St I	2	>4	>4	0	0	7.01	10.24	3.23	8.63	0	NO DM	0	0	0	7.1	0.4	0.64	0.52	NO	2	Physical	YES	surface layers recently disturbed, possibly by trawl.
STA 2	c	7/16/94	1:26	St III	3	>4	>4	5	0.76	4.94	8.01	3.07	6.47	0	NO DM	0	0	0	7.06	0.36	0.68	0.52	NO	6	Physical	NO	worms viasble, shell frags, dark mud.
STA 2	d	7/16/94	1:27	St III	3	>4	>4	4	0.48	8.25	11.71	3.47	9.98	0	NO DM	0	0	0	4.36	0.2	0.44	0.32	NO	6	Physical	NO	area suffered a recent disturbance, burrows evident.
STA 3	a	7/16/94	1:31	St I ON St III	4	>4	>4	0	0	12.27	13.03	0.76	12.65	0	NO DM	0	0	0	5.68	0.32	0.52	0.42	NO	6	Physical	NO	surface near barren, recovering from a disturbance.
STA 3	b	7/16/94	1:32	St II ON St III	2	>4	>4	6	0.36	11.47	11.75	0.28	11.61	0	NO DM	0	0	0	8.71	0.36	0.92	0.64	NO	6	IND	NO	fine grained sediment inundated with burrows.
STA 3	c	7/16/94	1:33	St II ON St III	2	>4	>4	6	1	8.65	10.4	1.75	9.52	0	NO DM	0	0	0	7.87	0.4	0.76	0.58	NO	6	Physical	NO	fine grained sediment, evidence of worms and bivalves.
STA 3	d	7/16/94	1:34	St II ON St III	2	>4	>4	7	0.76	8.33	10.04	1.71	9.18	0	NO DM	0	0	0	10.07	0.68	0.8	0.74	NO	8	Physical	NO	area is recovering from a disturbance.
STA 4	a	7/16/94	1:54	St I -> II	2	>4	>4	5	1.2	10.36	11.51	1.16	10.94	0	NO DM	0	0	0	9.77	0.56	0.88	0.72	NO	3	Physical	NO	ambient bottom
STA 4	b	7/16/94	1:55	St II ON St III	2	>4	>4	5	1.87	8.29	10.08	1.79	9.18	0	NO DM	0	0	0	7.06	0.48	0.56	0.52	NO	6	Physical	NO	feeding voids, bivalve on surface.
STA 4	c	7/16/94	1:55	St II ON St III	2	>4	>4	11	1.28	9.08	10.44	1.35	9.76	0	NO DM	0	0	0	5.2	0.28	0.48	0.38	NO	8	Physical	NO	area experienced a disturbance recently.
4500E																											
STA1	a	7/16/94	2:41	St III	2	>4	>4	2	1.36	10.52	11.23	0.72	10.88	0	NO DM	0	0	0	9.77	0.8	0.64	0.72	NO	8	Physical	NO	feeding voids and burrows.
STA1	b	7/16/94	2:41	St III	2	>4	>4	0	0	9.6	10.88	0.88	10.24	0	NO DM	0	0	0	8.74	0.48	0.8	0.64	NO	6	IND	NO	hard packed basement layer, reworked top layer, sharp line of demarcation.
STA1	c	7/16/94	2:42	St III	2	>4	>4	0	0	7.41	9.36	1.95	8.39	0	NO DM	0	0	0	21.29	1.24	1.87	1.55	NO	8	Physical	NO	oxidized sediment over mud, burrows and surface tubes evident.
STA 2	b	7/16/94	2:35	St II ON St III	2	>4	>4	6	1.27	11.87	12.19	0.32	12.03	0	NO DM	0	0	0	9.8	0.6	0.84	0.72	NO	6	IND	NO	surface tubes, bivalves, and feeding voids.
STA 2	c	7/16/94	3:00	St II ON St III	2	>4	>4	5	1.43	7.09	7.93	0.84	7.51	0	NO DM	0	0	0	10.28	0.6	0.92	0.76	NO	7	IND	NO	feeding void near surface, burrows, and bivalves.
STA 2	d	7/16/94	11:22	St I -> II	2	>4	>4	0	0	8.67	9.23	0.56	8.95	0	NO DM	0	0	0	9.51	0.52	0.85	0.69	NO	3	IND	NO	area near barren, stage I tubes on surface with small bivalve.
STA 2	e	7/16/94	11:23	St II -> St III	2	>4	>4	2	0.93	7.86	9.68	1.81	8.77	0	NO DM	0	0	0	15.29	0.93	1.29	1.11	NO	6	Physical	NO	early stage III tubes on surface, bivalve in frame.
STA 3	b	7/16/94	2:29	St III	2	>4	>4	8	1.09	9.72	10.4	0.68	10.06	0	NO DM	0	0	0	6.53	0.36	0.6	0.48	NO	6	Physical	NO	ambient bottom, feeding void.
STA 3	c	7/16/94	2:30	St II ON St III	2	>4	>4	1	2.39	11.12	11.56	0.44	11.33	0	NO DM	0	0	0	13.66	0.84	1.2	1.02	NO	7	IND	NO	worm tubes, burrows, and bivalves.
STA 3	d	7/16/94	11:17	St II	2	>4	>4	0	0	9.23	10.57	1.34	9.9	0	NO DM	0	0	0	10.09	0.57	0.89	0.73	NO	4	Physical	NO	small burrows, voids, and bivalves present.
STA 3	e	7/16/94	11:18	St III	2	>4	>4	4	0.69	10.2	10.89	0.69	10.55	0	NO DM	0	0	0	12.3	0.77	1.01	0.89	NO	7	Biogenic	NO	surface tubes visable, small void in left frame.
STA 4	a	7/16/94	2:23	St III	2	>4	>4	8	1.24	11.2	12.58	1.39	11.89	0	NO DM	0	0	0	8.44	0.4	0.84	0.82	NO	6	Physical	NO	numerous shallow burrows, fine sand over mud, clasts probably camera discharge.
STA 4	b	7/16/94	2:24	St III	2	>4	>4	2	1.47	6.40	10.82	4.42	8.71	0	NO DM	0	0	0	9.47	0.64	0.76	0.7	NO	6	Physical	NO	area suffered a recent disturbance, perhaps due to camera.
STA 4	c	7/16/94	2:25	St II ON St III	2	>4	>4	4	0.96	4.68	5.88	1.2	5.28	0	NO DM	0	0	0	8.44	0.32	0.92	0.82	NO	6	Physical	NO	bottom worked, bivalves present, burrows and voids.
STA 4	d	7/16/94	11:12	St I ON St III	2	>4	>4	0	0	9.88	10.08	0.2	9.98	0	NO DM	0	0	0	17.94	1.21	1.38	1.3	NO	7	IND	NO	burrow in right frame.
STA 4	e	7/16/94	11:12	St I ON St III	2	>4	>4	0	0	11.05	11.74	0.69	11.4	0	NO DM	0	0	0	8.13	0.45	0.73	0.59	NO	8	Physical	NO	shallow feeding void.
CLIS-REF																											
STA1	a	7/17/94	12:59	St III	2	>4	>4	0	0	11.37	11.81	0.44	11.59	0	NO DM	0	0	0	27.12	1.77	2.14	1.96	NO	8	IND	NO	large borrows, feeding voids at depth, gastropod on surface.
STA1	b	7/17/94	1:00	St III	2	>4	>4	5	0.81	8.47	9.96	1.49	9.21	0	NO DM	0	0	0	38.03	2.5	2.98	2.74	NO	9	Biogenic	NO	large burrow, feeding void, surface tubes.
STA1	c	7/17/94	1:01	St II -> St III	2	>4	>4	2	0.82	10.46	11.41	0.82	10.94	0	NO DM	0	0	0	26.55	1.65	2.21	1.93	NO	7	Physical	NO	ambient bottom, small void on right.
STA1	d	7/17/94	1:02	St I ON St III	2	>4	>4	3	0.96	12.53	13.49	0.96	13.01	0	NO DM	0	0	0	22.8	1.29	1.97	1.63	NO	8	IND	NO	ambient bottom, large collapsing burrow on right, surface tubes and bivalves.
STA 2	a	7/17/94	12:52	St I ON St III	2	>4	>4	0	0	9.88	10.49	0.61	10.18	0	NO DM	0	0	0	21.52	1.38	1.74	1.56	NO	8	Biogenic	NO	evidence of burrows and feeding voids at depth.
STA 2	e	7/17/94	12:53	St II ON St III	2	>4	>4	0	0	10.52	10.97	0.44	10.75	0	NO DM	0	0	0	25.5	1.13	2.58	1.85	NO	6	IND	YES	evidence of bivalves, remains of a burrow and feeding voids, clump of reduced
STA 2	f	7/17/94	12:54	St III	2	>4	>4	9	0.89	11.93	13.06	1.13	12.5	0	NO DM	0	0	0	36.63	2.1	3.19	2.64	NO	9	Physical	NO	evidence of feeding voids, strongly oxidized streak in center frame.
STA 3	a	7/17/94	1:12	St I -> II	2	>4	>4	0	0	6.18	7.99	1.81	7.09	0	NO DM	0	0	0	17.02	0.84	1.61	1.22	NO	4	Physical	NO	area may be recovering from a disturbance, trawl etc. no voids or burrows.
STA 3	b	7/17/94	1:13	St I ON St III	2	>4	>4	1	0.89	7.59	7.87	0.28	7.73	0	NO DM	0	0	0	11.54	0.68	0.96	0.82	NO	7	IND	NO	possible recovery area, one small void located.
STA 3	c	7/17/94	1:14	St I -> II	2	>4	>4	0	0	8.19	8.47	0.29	8.33	0	NO DM	0	0	0	10.63	0.56	0.96	0.76	NO	4	IND	NO	possible recovery area, little surface bio., bivalves.
STA 4	a	7/16/94	3:37	St II -> St III	2	>4	>4	3	1	7.71	7.91	0.2	7.81	0	NO DM	0	0	0	8.9	0.56	0.72	0.64	NO	5	IND	NO	surface tubes, bivalves, and shallow burrows.
STA 4	b	7/16/94	3:38	St II -> St III	2	>4	>4	4	1.16	9.16	10.49	1.33	9.82	0	NO DM	0	0	0	8.96	0.44	0.84	0.64	NO	5	Physical	NO	shallow burrows, bivalves, and surface tubes.
STA 4	c	7/16/94	3:39	IND	2	>4	>4	4	1.21	5.34	8.23	2.89	6.79	0	NO DM	0	0	0	IND	IND	IND	IND	NO	IND	Physical	YES	area disturbed by camera at previous replicate locations, fluid mud on surface, no RPD or biologics
STA 5	a	7/17/94	1:07	St II -> St III	2	>4	>4	4	0.64	6.79	7.43	0.64	7.11	0	NO DM	0	0	0	13.71	0.84	1.12	0.98	NO	6	IND	NO	evidence of feeding and burrows, bivalves near surface.
STA 5	b	7/17/94	1:06	St II -> St III	2	>4	>4	3	1.24	8.96	10	1.04	9.48	0	NO DM	0	0	0	19.96	0.88	1.97	1.43	NO	6	Physical	NO	ambient bottom, limited burowing, bivalves on surface.
STA 5	c	7/16/94	3:18	IND	2	>4	>4	3	1.71	1.88	3.25	1.57	2.47	0	NO DM	0	0	0	IND	IND	IND	IND	NO	IND	Physical	NO	difficulty in distinguishing, prism tilted

APPENDIX C

RAW SEDIMENT CHEMISTRY RESULTS

Appendix C, Table 1
Raw Sediment Chemistry Results

STATION	TOC (mg/L)	TOC (%)	GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)	FINES (silt+clay (%))
NHAV93-1	24000	2.4	0.0	27.6	38.2	34.2	72.4
NHAV93-2	26000	2.6	0.0	29.2	38.8	32.0	70.8
NHAV93-3	25000	2.5	1.3	33.4	35.7	29.6	65.3
NHAV93-4	28000	2.8	0.0	29.5	36.2	34.3	70.5
NHAV93-5	24000	2.4	0.0	28.1	41.0	30.9	71.9
NHAV93-6	26000	2.6	0.0	26.5	39.3	34.2	73.5
NHAV93-7	26000	2.6	1.3	30.9	38.0	29.9	67.9
NHAV93-8	12000	1.2	1.2	27.7	39.1	32.1	71.2
NHAV93-9	24000	2.4	0.0	28.3	43.0	28.8	71.8
NHAV93-10	15000	1.5	0.0	34.4	38.9	26.7	65.6
NHAV93-11	27000	2.7	0.0	25.6	40.1	34.3	74.4
AVERAGE	**23360**	**2.3**	**0.3**	**29.2**	**38.9**	**31.5**	**70.5**

Appendix C, Table 2
Raw Sediment Chemistry Results

LOW MOLECULAR WEIGHT PAHs (ppm)	NHAV93 MOUND													
	NH-1	NH-2	NH-3	NH-4	NH-5	NH-6	NH-7	NH-8	NH-9	NH-10	NH-11	NHAV93 AVERAGE		
Naphthalene	J 0.086	J 0.073	0.140	J 0.089	J 0.110	0.120	J 0.078	0.160	0.120	0.140	J 0.088	**0.109**	**+/-**	**0.029**
1-Methylnaphthalene	< 0.069	< 0.068	< 0.074	< 0.071	< 0.076	< 0.075	< 0.062	< 0.047	< 0.072	< 0.057	< 0.064	**0.067**	**+/-**	**0.009**
2-Methylnaphthalene	< 0.056	< 0.056	< 0.060	< 0.058	< 0.061	< 0.061	< 0.051	< 0.038	0.059	< 0.046	< 0.052	**0.054**	**+/-**	**0.007**
Biphenyl	0.120	0.120	J 0.130	0.130	0.140	0.140	J 0.110	J 0.088	0.130	0.110	0.130	**0.123**	**+/-**	**0.015**
2,6-Dimethylnapthalene	J 0.090	J 0.090	J 0.092	J 0.093	J 0.110	J 0.110	< 0.059	< 0.044	J 0.099	< 0.054	J 0.100	**0.086**	**+/-**	**0.023**
Acenaphthene	< 0.056	< 0.056	< 0.060	< 0.058	< 0.061	< 0.061	< 0.051	< 0.038	< 0.059	< 0.046	< 0.052	**0.054**	**+/-**	**0.007**
Acenaphthylene	0.082	0.081	J 0.078	0.084	0.090	0.094	0.200	J 0.044	0.095	J 0.054	0.100	**0.091**	**+/-**	**0.040**
Fluorene	< 0.043	< 0.043	J 0.051	< 0.044	< 0.047	< 0.047	J 0.043	J 0.053	J 0.050	J 0.043	0.040	**0.046**	**+/-**	**0.004**
Phenanthrene	0.220	0.210	0.210	0.240	0.260	0.230	0.480	0.190	0.280	0.210	0.280	**0.255**	**+/-**	**0.080**
1-Methylphenanthrene	< 0.021	< 0.021	< 0.023	< 0.022	< 0.023	< 0.023	< 0.019	< 0.014	< 0.022	< 0.017	< 0.020	**0.020**	**+/-**	**0.003**
Anthracene	J 0.060	J 0.051	J 0.078	J 0.071	J 0.071	J 0.090	0.140	0.091	0.100	0.100	J 0.072	**0.084**	**+/-**	**0.024**
2,3,5-Trimethylnaphthalene	< 0.032	< 0.032	< 0.034	< 0.033	< 0.035	J 0.033	J 0.027	J 0.021	< 0.033	J 0.025	J 0.028	**0.030**	**+/-**	**0.004**
TOTAL LMW PAHs	**0.935**	**0.901**	**1.030**	**0.993**	**1.084**	**1.084**	**1.320**	**0.828**	**1.119**	**0.902**	**1.026**	**1.020**	**+/-**	**0.135**
HIGH MOLECULAR WEIGHT PAHs (ppm)														
Fluoranthene	0.430	0.400	0.530	0.440	0.450	0.670	1.300	0.510	0.640	0.500	0.530	**0.582**	**+/-**	**0.253**
Pyrene	0.460	0.430	0.570	0.520	0.460	0.680	1.900	0.470	0.680	0.470	0.560	**0.655**	**+/-**	**0.422**
Benzo(a)anthracene	0.210	0.190	0.240	0.210	0.240	0.290	0.680	0.200	0.310	0.250	0.250	**0.279**	**+/-**	**0.138**
Chrysene	0.250	0.260	0.280	0.290	0.310	0.360	0.870	0.230	0.390	0.320	0.300	**0.351**	**+/-**	**0.178**
Benzo(b)fluoranthene	0.260	0.270	0.280	0.240	0.270	0.320	0.780	0.180	0.370	0.230	0.280	**0.316**	**+/-**	**0.161**
Benzo(k)fluoranthene	0.220	J 0.230	0.260	0.270	J 0.260	0.320	0.770	0.210	0.320	0.220	0.290	**0.306**	**+/-**	**0.159**
Benzo(a)pyrene	0.260	0.250	0.300	0.260	0.280	0.320	0.870	0.200	0.360	0.220	0.300	**0.329**	**+/-**	**0.185**
Benzo(e)pyrene	0.260	0.240	J 0.260	0.240	0.250	0.290	0.680	0.170	0.310	0.210	0.270	**0.289**	**+/-**	**0.135**
Benzo(g,h,i)perylene	0.210	0.230	0.240	0.220	J 0.220	0.230	0.740	0.160	0.270	0.210	0.220	**0.268**	**+/-**	**0.159**
Dibenz(a,h)anthracene	< 0.060	< 0.060	< 0.065	0.062	< 0.066	< 0.066	J 0.150	< 0.041	< 0.063	< 0.050	< 0.056	**0.067**	**+/-**	**0.028**
Indeno(1,2,3-cd)pyrene	0.210	0.250	0.270	0.220	0.210	0.250	0.660	0.160	0.300	0.210	0.240	**0.271**	**+/-**	**0.134**
Perylene	J 0.140	J 0.150	0.130	J 0.160	J 0.170	J 0.140	0.260	J 0.070	J 0.120	J 0.046	J 0.140	**0.139**	**+/-**	**0.055**
TOTAL HMW PAHs	**2.970**	**2.960**	**3.425**	**3.132**	**3.186**	**3.936**	**9.660**	**2.601**	**4.133**	**2.936**	**3.436**	**3.852**	**+/-**	**1.978**
TOTAL PAHs	**3.905**	**3.861**	**4.455**	**4.125**	**4.270**	**5.020**	**10.980**	**3.429**	**5.252**	**3.838**	**4.462**	**4.872**	**+/-**	**2.094**

Appendix C, Table 3
Raw Sediment Chemistry Results

METAL (ppm)		NHAV93 MOUND NH-1	NH-2	NH-3	NH-4	NH-5	NH-6	NH-7	NH-8	NH-9	NH-10	NH-11	AVERAGE
ALUMINUM	(Al)	19000	13000	11000	16000	21000	23000	11000	6300	18000	7600	12700	**14418 +/- 5422**
ARSENIC	(As)	8.4	8.3	8	8.7	8.1	8.3	6.1	3.6	7.9	5	7.7	**7.3 +/- 1.7**
CADMIUM	(Cd)	< 1.06	< 1.1	< 1.1	< 0.72	< 0.76	< 0.71	< 0.71	< 0.65	< 0.92	< 0.72	< 1.3	**0.89 +/- 0.22**
CHROMIUM	(Cr)	90	81	69	87	97	93	110	29	74	39	77	**77 +/- 24**
COPPER	(Cu)	100	100	91	110	110	110	290	42	96	55	97	**109 +/- 64**
IRON	(Fe)	26000	24000	21000	25000	27000	29000	19000	11000	25000	14000	23000	**22182 +/- 5546**
MERCURY	(Hg)	0.53	0.52	0.32	0.48	0.56	0.32	0.21	< 0.13	1.1	0.25	1.5	**0.54 +/- 0.41**
NICKEL	(Ni)	25	23	21	24	28	29	29	11	24	13	24	**23 +/- 6**
LEAD	(Pb)	63	53	48	60	61	70	100	23	62	30	52	**57 +/- 20**
ZINC	(Zn)	180	170	150	180	200	200	230	70	170	90	170	**165 +/- 47**

Appendix C, Table 4
Raw Sediment Chemistry Results

STATION	TOC (mg/L)	TOC (%)	GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)	FINES (silt+clay (%))
MQR-1	25000	2.5	0.0	19.7	53.0	27.2	80.2
MQR-2	11000	1.1	3.1	60.4	23.7	12.7	36.4
MQR-3	20000	2	4.6	66.0	20.7	8.7	29.4
MQR-4	27000	2.7	0.0	32.3	42.6	25.2	67.8
MQR-5	23000	2.3	0.0	18.1	49.8	32.1	81.9
MQR-6	22000	2.2	0.0	40.1	41.5	18.3	59.8
MQR-7	22000	2.2	0.0	32.7	44.7	22.6	67.3
MQR-8	13000	1.3	0.0	67.2	22.0	10.8	32.8
MQR-9	11000	1.1	0.0	73.2	17.1	9.7	26.8
MQR-10	15000	1.5	0.0	64.3	23.2	12.6	35.8
MQR-11	13000	1.3	0.0	57.9	27.1	15.1	42.2
AVERAGE	**18364**	**1.8**	**0.7**	**48.4**	**33.2**	**17.7**	**50.9**

Appendix C, Table 5
Raw Sediment Chemistry Results

LOW MOLECULAR WEIGHT PAHs (ppm)	MQR MOUND											
	MQR-1	**MQR-2**	**MQR-3**	**MQR-4**	**MQR-5**	**MQR-6**	**MQR-7**	**MQR-8**	**MQR-9**	**MQR-10**	**MQR-11**	**MQR AVERAGE**
Naphthalene	J 0.079	J 0.043	0.110	0.120	J 0.082	J 0.070	0.130	0.057	0.250	0.065	J 0.046	**0.096 +/- 0.059**
1-Methylnaphthalene	< 0.066	< 0.040	0.039	< 0.066	< 0.066	< 0.048	< 0.059	< 0.037	J 0.061	< 0.041	< 0.046	**0.052 +/- 0.012**
2-Methylnaphthalene	*< 0.054*	*< 0.033*	*< 0.032*	*< 0.053*	*< 0.053*	*< 0.039*	*< 0.048*	*< 0.030*	*J 0.081*	*< 0.034*	*< 0.037*	**0.045 +/- 0.015**
Biphenyl	0.140	0.073	0.081	0.120	0.120	0.094	0.110	J 0.066	0.077	0.080	0.080	**0.095 +/- 0.024**
2,6-Dimethylnapthalene	J 0.071	< 0.038	J 0.039	J 0.066	J 0.053	J 0.045	J 0.110	< 0.034	0.094	J 0.041	< 0.043	**0.058 +/- 0.025**
Acenaphthene	< 0.054	< 0.033	0.130	< 0.053	< 0.053	< 0.039	< 0.048	0.030	J 0.073	J 0.044	J 0.046	**0.055 +/- 0.028**
Acenaphthylene	J 0.075	< 0.014	0.057	J 0.120	J 0.066	0.070	0.120	J 0.030	0.044	0.057	J 0.040	**0.063 +/- 0.033**
Fluorene	J 0.042	J 0.028	J 0.057	J 0.049	< 0.041	0.030	J 0.063	< 0.023	0.083	J 0.047	J 0.034	**0.045 +/- 0.018**
Phenanthrene	0.260	0.160	0.160	0.400	0.240	0.210	0.320	0.110	0.440	0.180	0.470	**0.268 +/- 0.123**
1-Methylphenanthrene	J 0.042	J 0.015	0.044	J 0.049	0.070	< 0.015	< 0.018	J 0.016	0.094	J 0.023	J 0.014	**0.036 +/- 0.027**
Anthracene	J 0.071	J 0.046	0.074	0.140	J 0.058	0.073	0.140	0.048	0.160	0.059	0.130	**0.091 +/- 0.043**
2,3,5-Trimethylnaphthalene	< 0.031	J 0.018	J 0.025	0.041	J 0.029	J 0.027	0.110	< 0.017	0.110	J 0.023	J 0.023	**0.041 +/- 0.035**
TOTAL LMW PAHs	**0.985**	**0.541**	**0.848**	**1.277**	**0.931**	**0.760**	**1.276**	**0.498**	**1.567**	**0.694**	**1.009**	**0.944 +/- 0.329**
HIGH MOLECULAR WEIGHT PAHs (ppm)												
Fluoranthene	0.630	0.270	0.440	0.900	0.510	0.600	0.840	0.280	0.660	0.440	1.100	**0.606 +/- 0.259**
Pyrene	0.630	0.310	0.560	1.000	0.530	0.650	0.900	0.300	0.720	0.460	1.100	**0.651 +/- 0.263**
Benzo(a)anthracene	*0.250*	*0.130*	*0.270*	*0.450*	*0.220*	*0.330*	*0.400*	*0.160*	*0.300*	*0.270*	*0.520*	**0.300 +/- 0.119**
Chrysene	0.340	0.180	0.320	0.520	0.300	0.360	0.500	0.190	0.340	0.370	0.560	**0.362 +/- 0.124**
Benzo(b)fluoranthene	0.320	J 0.120	0.340	0.520	0.280	0.300	0.390	0.180	0.300	0.260	0.420	**0.312 +/- 0.110**
Benzo(k)fluoranthene	0.320	J 0.110	0.320	0.550	0.270	0.310	0.400	0.170	0.260	0.250	0.420	**0.307 +/- 0.121**
Benzo(a)pyrene	0.320	0.140	0.370	0.610	0.310	0.360	0.410	0.190	0.330	0.300	0.540	**0.353 +/- 0.135**
Benzo(e)pyrene	0.290	0.110	0.300	0.460	0.250	0.290	0.380	0.150	0.270	0.240	0.360	**0.282 +/- 0.099**
Benzo(g,h,i)perylene	0.310	J 0.083	0.290	0.510	0.280	0.320	0.390	0.150	0.270	0.230	0.390	**0.293 +/- 0.117**
Dibenz(a,h)anthracene	J 0.066	< 0.035	J 0.066	J 0.100	J 0.058	J 0.060	J 0.070	< 0.032	J 0.056	J 0.057	J 0.080	**0.062 +/- 0.019**
Indeno(1,2,3-cd)pyrene	0.300	J 0.081	0.240	0.470	0.280	0.270	0.360	0.130	0.220	0.210	0.380	**0.267 +/- 0.111**
Perylene	0.190	J 0.061	0.110	0.170	0.180	0.130	J 0.140	J 0.062	0.088	0.120	0.170	**0.129 +/- 0.046**
TOTAL HMW PAHs	**3.966**	**1.630**	**3.626**	**6.260**	**3.468**	**3.980**	**5.180**	**1.994**	**3.814**	**3.207**	**6.040**	**3.924 +/- 1.460**
TOTAL PAHs	**4.951**	**2.171**	**4.474**	**7.537**	**4.399**	**4.740**	**6.456**	**2.492**	**5.381**	**3.901**	**7.049**	**4.868 +/- 1.701**

Appendix C, Table 6
Raw Sediment Chemistry Results

METAL (ppm)		MQR MOUND											
		MQR-1	MQR-2	MQR-3	MQR-4	MQR-5	MQR-6	MQR-7	MQR-8	MQR-9	MQR-10	MQR-11	AVERAGE
ALUMINUM	**(Al)**	19000	6400	7100	15000	18000	12000	11000	6600	6800	10000	12000	**11264 +/- 4523**
ARSENIC	**(As)**	10	3.5	2.9	7.5	9.3	5.5	5.8	3.2	2.7	4.8	5.3	**5.5 +/- 2.5**
CADMIUM	**(Cd)**	< 0.79	< 0.56	< 4.2	< 0.74	< 0.77	< 0.74	< 0.91	< 0.52	< 0.37	< 0.54	< 0.91	**1.00 +/- 1.07**
CHROMIUM	**(Cr)**	93	29	65	73	74	45	110	25	19	36	40	**55 +/- 30**
COPPER	**(Cu)**	110	50	120	96	89	81	160	45	39	41	52	**80 +/- 39**
IRON	**(Fe)**	28000	11000	11000	22000	27000	17000	17000	10000	8800	14000	16000	**16527 +/- 6647**
MERCURY	**(Hg)**	0.58	0.16	0.27	0.29	0.43	0.65	0.98	0.19	< 0.12	0.63	0.24	**0.41 +/- 0.27**
NICKEL	**(Ni)**	26	10	12	23	24	16	20	17	7.2	12	13	**16.4 +/- 6.2**
LEAD	**(Pb)**	58	24	33	50	52	29	58	49	21	25	24	**38 +/- 15**
ZINC	**(Zn)**	190	67	92	150	170	110	170	76	48	74	93	**113 +/- 49**

Appendix C, Table 7
Raw Sediment Chemistry Results

STATION	TOC (mg/L)	TOC (%)	GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)	FINES (silt+clay (%))
CLIS-REF 1	20000	2	2.1	49.2	36.3	12.4	48.7
CLIS-REF 2	19000	1.9	1.3	46.2	36.0	16.5	52.5
CLIS-REF 3	21000	2.1	1.6	36.9	39.5	22.0	61.5
AVERAGE	**20000**	**2**	**1.7**	**44.1**	**37.3**	**17.0**	**54.2**
4500E-1	22000	2.2	0.6	23.1	46.3	30.6	76.9
4500E-2	22000	2.2	0.0	34.5	37.8	27.7	65.5
4500E-3	23000	2.3	1.9	44.7	39.1	14.2	53.3
4500E-4	20000	2	0.0	23.2	46.4	30.4	76.8
AVERAGE	**21750**	**2.2**	**0.5**	**31.4**	**42.4**	**25.7**	**68.1**
2500W-1	21000	2.1	0.0	25.9	43.0	31.2	74.2
2500W-2	22000	2.2	0.0	14.5	55.0	30.5	85.5
2500W-3	25000	2.5	1.7	44.3	37.9	16.1	54.0
2500W-4	22000	2.2	0.0	15.3	52.2	32.4	84.6
AVERAGE	**22500**	**2.3**	**0.4**	**25.0**	**47.0**	**27.6**	**74.6**

Appendix C, Table 8
Raw Sediment Chemistry Results

LOW MOLECULAR WEIGHT PAHs (ppm)	4500E REFERENCE AREA					2500W REFERENCE AREA					CLIS-REF REFERENCE AREA			
	4500E-1	4500E-2	4500E-3	4500E-4	4500E AVERAGE	2500W-1	2500W-2	2500W-3	2500W-4	2500W AVERAGE	CLIS-1	CLIS-2	CLIS-3	CLIS REF AVERAGE
Naphthalene	J 0.049	J 0.059	J 0.053	J 0.059	0.075 +/- 0.005	J 0.081	J 0.110	J 0.075	J 0.094	0.090 +/- 0.016	J 0.045	J 0.052	J 0.042	0.046 +/- 0.005
1-Methylnaphthalene	0.046	< 0.047	< 0.053	0.063	0.052 +/- 0.008	< 0.062	0.083	< 0.063	< 0.069	0.069 +/- 0.010	< 0.060	< 0.055	< 0.052	0.056 +/- 0.004
2-Methylnaphthalene	< 0.038	< 0.038	< 0.043	< 0.051	0.043 +/- 0.006	< 0.050	< 0.067	< 0.051	< 0.056	0.056 +/- 0.008	< 0.048	0.045	< 0.042	0.045 +/- 0.003
Biphenyl	0.084	0.085	0.096	0.120	0.096 +/- 0.017	0.110	0.150	0.130	0.120	0.128 +/- 0.017	0.110	0.100	0.100	0.103 +/- 0.006
2,6-Dimethylnapthalene	0.043	J 0.035	< 0.050	< 0.059	0.047 +/- 0.010	< 0.058	J 0.062	< 0.059	< 0.064	0.061 +/- 0.003	< 0.056	< 0.052	< 0.048	0.052 +/- 0.004
Acenaphthene	< 0.038	< 0.038	< 0.043	< 0.051	0.043 +/- 0.006	< 0.050	< 0.067	< 0.051	< 0.056	0.056 +/- 0.008	< 0.048	< 0.045	< 0.042	0.045 +/- 0.003
Acenaphthylene	0.061	0.059	J 0.060	J 0.067	0.062 +/- 0.004	0.081	0.100	0.083	J 0.056	0.080 +/- 0.018	J 0.037	J 0.035	J 0.042	0.038 +/- 0.004
Fluorene	< 0.029	< 0.029	< 0.033	< 0.039	0.033 +/- 0.005	< 0.039	< 0.052	< 0.040	< 0.043	0.044 +/- 0.006	< 0.037	J 0.014	< 0.032	0.028 +/- 0.012
Phenanthrene	0.130	0.140	0.130	0.130	0.133 +/- 0.005	0.150	0.220	0.170	0.130	0.168 +/- 0.039	0.120	0.140	0.120	0.127 +/- 0.012
1-Methylphenanthrene	0.014	< 0.014	J 0.017	J 0.020	0.016 +/- 0.003	< 0.019	< 0.025	J 0.028	< 0.021	0.023 +/- 0.004	< 0.018	< 0.017	< 0.016	0.017 +/- 0.001
Anthracene	J 0.040	J 0.038	J 0.040	J 0.043	0.040 +/- 0.002	J 0.054	J 0.078	J 0.055	J 0.043	0.058 +/- 0.015	J 0.034	J 0.041	J 0.035	0.037 +/- 0.004
2,3,5-Trimethylnaphthalene	< 0.021	< 0.022	< 0.025	0.029	0.024 +/- 0.004	< 0.029	< 0.038	0.029	< 0.032	0.032 +/- 0.004	< 0.028	< 0.026	< 0.024	0.026 +/- 0.002
TOTAL LMW PAHs	0.593	0.604	0.643	0.731	0.643 +/- 0.063	0.783	1.052	0.834	0.784	0.863 +/- 0.128	0.641	0.622	0.595	0.619 +/- 0.023
HIGH MOLECULAR WEIGHT PAHs (ppm)														
Fluoranthene	0.270	0.280	0.270	0.280	0.275 +/- 0.006	0.320	0.400	0.340	0.260	0.330 +/- 0.058	0.230	0.260	0.200	0.230 +/- 0.030
Pyrene	0.320	0.330	0.300	0.300	0.313 +/- 0.015	0.430	0.480	0.470	0.360	0.435 +/- 0.054	0.260	0.290	0.260	0.270 +/- 0.017
Benzo(a)anthracene	0.150	0.140	0.150	0.170	0.153 +/- 0.013	0.190	0.230	0.210	0.160	0.198 +/- 0.030	J 0.130	0.120	0.120	0.123 +/- 0.006
Chrysene	0.200	0.200	0.180	0.190	0.193 +/- 0.010	0.240	0.350	0.260	0.200	0.263 +/- 0.063	0.160	0.160	0.150	0.157 +/- 0.006
Benzo(b)fluoranthene	0.210	0.220	0.210	0.250	0.223 +/- 0.019	0.260	0.350	0.250	J 0.220	0.270 +/- 0.056	J 0.170	J 0.170	J 0.150	0.163 +/- 0.012
Benzo(k)fluoranthene	0.210	0.190	0.190	J 0.210	0.200 +/- 0.012	0.220	0.320	0.260	J 0.220	0.255 +/- 0.047	J 0.150	J 0.180	J 0.140	0.157 +/- 0.021
Benzo(a)pyrene	0.230	0.210	0.200	0.250	0.223 +/- 0.022	0.280	0.380	0.280	0.230	0.293 +/- 0.063	0.190	J 0.170	J 0.160	0.173 +/- 0.015
Benzo(e)pyrene	0.200	0.200	0.180	0.220	0.200 +/- 0.016	0.240	0.340	0.250	0.210	0.260 +/- 0.056	0.180	0.150	0.150	0.160 +/- 0.017
Benzo(g,h,i)perylene	0.230	0.210	0.200	0.240	0.220 +/- 0.018	0.270	0.350	0.260	0.220	0.275 +/- 0.054	J 0.170	J 0.160	0.160	0.163 +/- 0.006
Dibenz(a,h)anthracene	< 0.040	J 0.047	< 0.046	< 0.055	0.047 +/- 0.006	< 0.054	J 0.078	J 0.063	< 0.060	0.064 +/- 0.010	< 0.052	< 0.048	< 0.045	0.048 +/- 0.004
Indeno(1,2,3-cd)pyrene	0.210	0.200	0.190	0.230	0.208 +/- 0.017	0.260	0.330	0.240	0.210	0.260 +/- 0.051	J 0.160	J 0.140	0.150	0.150 +/- 0.010
Perylene	J 0.075	J 0.073	J 0.070	J 0.083	0.075 +/- 0.006	J 0.070	J 0.110	J 0.075	J 0.064	0.080 +/- 0.021	J 0.056	J 0.055	J 0.055	0.055 +/- 0.001
TOTAL HMW PAHs	2.345	2.300	2.186	2.478	2.327 +/- 0.121	2.834	3.718	2.958	2.414	2.981 +/- 0.544	1.908	1.903	1.740	1.850 +/- 0.096
TOTAL PAHs	2.938	2.904	2.829	3.209	2.970 +/- 0.166	3.617	4.770	3.792	3.198	3.844 +/- 0.666	2.549	2.525	2.335	2.470 +/- 0.117

Appendix C, Table 9
Raw Sediment Chemistry Results

METAL (ppm)		4500E REFERENCE AREA					2500W REFERENCE AREA					CLIS-REF REFERENCE AREA			
		4500E-1	4500E-2	4500E-3	4500E-4	AVERAGE	2500W-1	2500W-2	2500W-3	2500W-4	AVERAGE	CLIS-1	CLIS-2	CLIS-3	AVERAGE
ALUMINUM	(Al)	19000	22000	21000	22000	**21000 +/- 1414**	22000	31000	21000	20000	**23500 +/- 5066**	19000	19000	22000	**20000 +/- 1732**
ARSENIC	(As)	9.1	8	8.1	7.4	**8.2 +/- 0.70**	7.9	12	9.2	9.4	**9.6 +/- 1.7**	8.1	7.5	8.5	**8.0 +/- 0.5**
CADMIUM	(Cd)	1.2	0.77	1.2	1	**1.04 +/- 0.20**	1.5	2.4	1.2	0.85	**1.49 +/- 0.66**	< 0.99	1.2	1.4	**1.20 +/- 0.21**
CHROMIUM	(Cr)	67	60	61	56	**61 +/- 5**	71	100	71	64	**77 +/- 16**	52	51	57	**53 +/- 3**
COPPER	(Cu)	61	51	52	46	**53 +/- 6**	72	95	70	66	**76 +/- 13**	41	41	43	**42 +/- 1**
IRON	(Fe)	26000	26000	25000	23000	**25000 +/- 1414**	28000	41000	28000	27000	**31000 +/- 6683**	25000	26000	26000	**25667 +/- 577**
MERCURY	(Hg)	0.24	0.22	1.8	0.24	**0.63 +/- 0.78**	0.26	0.28	0.37	0.33	**0.31 +/- 0.05**	0.2	0.18	0.23	**0.20 +/- 0.03**
NICKEL	(Ni)	25	26	23	21	**24 +/- 2**	26	37	25	25	**28 +/- 6**	24	24	24	**24 +/- 0**
LEAD	(Pb)	47	32	35	36	**38 +/- 7**	38	53	40	36	**42 +/- 8**	34	32	33	**33 +/- 1**
ZINC	(Zn)	140	130	130	120	**130 +/- 8**	150	210	150	140	**163 +/- 32**	120	120	130	**123 +/- 6**

APPENDIX D

CHEMISTRY DATA NORMALIZED TO TOC

Appendix D, Table 1
Chemistry Data Normalized to TOC

LOW MOLECULAR WEIGHT PAHs (ppm/%TOC)	NHAV93 MOUND													
	NH-1	NH-2	NH-3	NH-4	NH-5	NH-6	NH-7	NH-8	NH-9	NH-10	NH-11	NHAV93 AVERAGE		
Naphthalene	J 0.036	J 0.028	0.056	J 0.032	J 0.046	0.046	J 0.030	0.133	0.050	0.093	J 0.033	**0.053**	**+/-**	**0.032**
1-Methylnaphthalene	< 0.029	< 0.026	< 0.030	< 0.025	< 0.032	< 0.029	< 0.024	< 0.039	< 0.030	< 0.038	< 0.024	**0.030**	**+/-**	**0.005**
2-Methylnaphthalene	< 0.023	< 0.022	< 0.024	< 0.021	< 0.025	< 0.023	< 0.020	< 0.032	0.025	< 0.031	< 0.019	**0.024**	**+/-**	**0.004**
Biphenyl	0.050	0.046	J 0.052	0.046	0.058	0.054	J 0.042	J 0.073	0.054	0.073	0.048	**0.054**	**+/-**	**0.010**
2,6-Dimethylnapthalene	J 0.038	J 0.035	J 0.037	J 0.033	J 0.046	J 0.042	< 0.023	< 0.037	J 0.041	< 0.036	J 0.037	**0.037**	**+/-**	**0.006**
Acenaphthene	< 0.023	< 0.022	< 0.024	< 0.021	< 0.025	< 0.023	< 0.020	< 0.032	< 0.025	< 0.031	< 0.019	**0.024**	**+/-**	**0.004**
Acenaphthylene	0.034	0.031	J 0.031	0.030	0.038	0.036	0.077	J 0.037	0.040	J 0.036	0.037	**0.039**	**+/-**	**0.013**
Fluorene	< 0.018	< 0.017	J 0.020	< 0.016	< 0.020	< 0.018	J 0.017	J 0.044	J 0.021	J 0.029	0.015	**0.021**	**+/-**	**0.008**
Phenanthrene	0.092	0.081	0.084	0.086	0.108	0.088	0.185	0.158	0.117	0.140	0.104	**0.113**	**+/-**	**0.034**
1-Methylphenanthrene	< 0.009	< 0.008	< 0.009	< 0.008	< 0.010	< 0.009	< 0.007	< 0.012	< 0.009	< 0.011	< 0.007	**0.009**	**+/-**	**0.001**
Anthracene	J 0.025	J 0.020	J 0.031	J 0.025	J 0.030	J 0.035	0.054	0.076	0.042	0.067	J 0.027	**0.039**	**+/-**	**0.019**
2,3,5-Trimethylnaphthalene	< 0.013	< 0.012	< 0.014	< 0.012	< 0.015	J 0.013	J 0.010	J 0.018	< 0.014	J 0.017	J 0.010	**0.013**	**+/-**	**0.002**
TOTAL LMW PAHs	**0.390**	**0.347**	**0.412**	**0.355**	**0.452**	**0.417**	**0.508**	**0.690**	**0.466**	**0.601**	**0.380**	**0.456**	**+/-**	**0.107**
HIGH MOLECULAR WEIGHT PAHs (ppm/%TOC)														
Fluoranthene	0.179	0.154	0.212	0.157	0.188	0.258	0.500	0.425	0.267	0.333	0.196	**0.261**	**+/-**	**0.114**
Pyrene	0.192	0.165	0.228	0.186	0.192	0.262	0.731	0.392	0.283	0.313	0.207	**0.286**	**+/-**	**0.162**
Benzo(a)anthracene	0.088	0.073	0.096	0.075	0.100	0.112	0.262	0.167	0.129	0.167	0.093	**0.124**	**+/-**	**0.056**
Chrysene	0.104	0.100	0.112	0.104	0.129	0.138	0.335	0.192	0.163	0.213	0.111	**0.155**	**+/-**	**0.071**
Benzo(b)fluoranthene	0.108	0.104	0.112	0.086	0.113	0.123	0.300	0.150	0.154	0.153	0.104	**0.137**	**+/-**	**0.059**
Benzo(k)fluoranthene	0.092	J 0.088	0.104	0.096	J 0.108	0.123	0.296	0.175	0.133	0.147	0.107	**0.134**	**+/-**	**0.060**
Benzo(a)pyrene	0.108	0.096	0.120	0.093	0.117	0.123	0.335	0.167	0.150	0.147	0.111	**0.142**	**+/-**	**0.068**
Benzo(e)pyrene	0.108	0.092	J 0.104	0.086	0.104	0.112	0.262	0.142	0.129	0.140	0.100	**0.125**	**+/-**	**0.049**
Benzo(g,h,i)perylene	0.088	0.088	0.096	0.079	J 0.092	0.088	0.285	0.133	0.113	0.140	0.081	**0.117**	**+/-**	**0.059**
Dibenz(a,h)anthracene	< 0.025	< 0.023	< 0.026	0.022	< 0.028	< 0.025	J 0.058	< 0.034	< 0.026	< 0.033	< 0.021	**0.029**	**+/-**	**0.010**
Indeno(1,2,3-cd)pyrene	0.088	0.096	0.108	0.079	0.088	0.096	0.254	0.133	0.125	0.140	0.089	**0.118**	**+/-**	**0.050**
Perylene	J 0.058	J 0.058	0.052	J 0.057	J 0.071	J 0.054	0.100	J 0.058	J 0.050	J 0.031	J 0.052	**0.058**	**+/-**	**0.017**
TOTAL HMW PAHs	**1.238**	**1.138**	**1.370**	**1.119**	**1.328**	**1.514**	**3.715**	**2.168**	**1.722**	**1.957**	**1.273**	**1.686**	**+/-**	**0.753**
TOTAL PAHs	**1.627**	**1.485**	**1.782**	**1.473**	**1.779**	**1.931**	**4.223**	**2.858**	**2.188**	**2.559**	**1.653**	**2.142**	**+/-**	**0.861**

Appendix D, Table 2
Chemistry Data Normalized to TOC

METAL		NHAV93 MOUND NH-1	NH-2	NH-3	NH-4	NH-5	NH-6	NH-7	NH-8	NH-9	NH-10	NH-11	AVERAGE
ALUMINUM	(Al)	7916.67	5000.00	4400.00	5714.29	8750.00	8846.15	4230.77	5250.00	7500.00	5066.67	4703.70	**6125.30 +/- 1769.18**
ARSENIC	(As)	3.50	3.19	3.20	3.11	3.38	3.19	2.35	3.00	3.29	3.33	2.85	**3.13 +/- 0.31**
CADMIUM	(Cd)	0.44	0.42	0.44	0.26	0.32	0.27	0.27	0.54	0.38	0.48	0.48	**0.39 +/- 0.10**
CHROMIUM	(Cr)	37.50	31.15	27.60	31.07	40.42	35.77	42.31	24.17	30.83	26.00	28.52	**32.30 +/- 5.94**
COPPER	(Cu)	41.67	38.46	36.40	39.29	45.83	42.31	111.54	35.00	40.00	36.67	35.93	**45.74 +/- 22.06**
IRON	(Fe)	10833.33	9230.77	8400.00	8928.57	11250.00	11153.85	7307.69	9166.67	10416.67	9333.33	8518.52	**9503.58 +/- 1262.26**
MERCURY	(Hg)	0.22	0.20	0.13	0.17	0.23	0.12	0.08	0.11	0.46	0.17	0.56	**0.22 +/- 0.15**
NICKEL	(Ni)	10.42	8.85	8.40	8.57	11.67	11.15	11.15	9.17	10.00	8.67	8.89	**9.72 +/- 1.20**
LEAD	(Pb)	26.25	20.38	19.20	21.43	25.42	26.92	38.46	19.17	25.83	20.00	19.26	**23.85 +/- 5.77**
ZINC	(Zn)	75.00	65.38	60.00	64.29	83.33	76.92	88.46	58.33	70.83	60.00	62.96	**69.59 +/- 10.15**

Appendix D, Table 3
Chemistry Data Normalized to TOC

LOW MOLECULAR WEIGHT PAHs (ppm/%TOC)	MQR MOUND											
	MQR-1	MQR-2	MQR-3	MQR-4	MQR-5	MQR-6	MQR-7	MQR-8	MQR-9	MQR-10	MQR-11	MQR AVERAGE
Naphthalene	J 0.032	J 0.039	0.055	0.044	J 0.036	J 0.032	0.059	0.044	0.227	0.043	J 0.035	**0.059 +/- 0.057**
1-Methylnaphthalene	< 0.026	< 0.036	0.020	< 0.024	< 0.029	< 0.022	< 0.027	< 0.028	J 0.055	< 0.027	< 0.035	**0.030 +/- 0.010**
2-Methylnaphthalene	< 0.022	< 0.030	< 0.016	< 0.020	< 0.023	< 0.018	< 0.022	< 0.023	J 0.074	< 0.023	< 0.028	**0.027 +/- 0.016**
Biphenyl	0.056	0.066	0.041	0.044	0.052	0.043	0.050	J 0.051	0.070	0.053	0.062	**0.053 +/- 0.009**
2,6-Dimethylnapthalene	J 0.028	< 0.035	J 0.020	J 0.024	J 0.023	J 0.020	J 0.050	< 0.026	0.085	J 0.027	< 0.033	**0.034 +/- 0.019**
Acenaphthene	< 0.022	< 0.030	0.065	< 0.020	< 0.023	< 0.018	< 0.022	0.023	J 0.066	J 0.029	J 0.035	**0.032 +/- 0.017**
Acenaphthylene	J 0.030	< 0.013	0.029	J 0.044	J 0.029	0.032	0.055	J 0.023	0.040	0.038	J 0.031	**0.033 +/- 0.011**
Fluorene	J 0.017	J 0.025	J 0.029	J 0.018	< 0.018	0.014	J 0.029	< 0.018	0.075	J 0.031	J 0.026	**0.027 +/- 0.017**
Phenanthrene	0.104	0.145	0.080	0.148	0.104	0.095	0.145	0.085	0.400	0.120	0.362	**0.163 +/- 0.111**
1-Methylphenanthrene	J 0.017	J 0.014	0.022	J 0.018	0.030	< 0.007	< 0.008	J 0.012	0.085	J 0.015	J 0.011	**0.022 +/- 0.022**
Anthracene	J 0.028	J 0.042	0.037	0.052	J 0.025	0.033	0.064	0.037	0.145	0.039	0.100	**0.055 +/- 0.037**
2,3,5-Trimethylnaphthalene	< 0.012	J 0.016	J 0.013	0.015	J 0.013	J 0.012	0.050	< 0.013	0.100	J 0.015	J 0.018	**0.025 +/- 0.027**
TOTAL LMW PAHs	**0.394**	**0.492**	**0.424**	**0.473**	**0.405**	**0.345**	**0.580**	**0.383**	**1.425**	**0.463**	**0.776**	**0.560 +/- 0.310**
HIGH MOLECULAR WEIGHT PAHs (ppm/TOC)												
Fluoranthene	0.252	0.245	0.220	0.333	0.222	0.273	0.382	0.215	0.600	0.293	0.846	**0.353 +/- 0.198**
Pyrene	0.252	0.282	0.280	0.370	0.230	0.295	0.409	0.231	0.655	0.307	0.846	**0.378 +/- 0.197**
Benzo(a)anthracene	0.100	0.118	0.135	0.167	0.096	0.150	0.182	0.123	0.273	0.180	0.400	**0.175 +/- 0.090**
Chrysene	0.136	0.164	0.160	0.193	0.130	0.164	0.227	0.146	0.309	0.247	0.431	**0.210 +/- 0.091**
Benzo(b)fluoranthene	0.128	J 0.109	0.170	0.193	0.122	0.136	0.177	0.138	0.273	0.173	0.323	**0.177 +/- 0.066**
Benzo(k)fluoranthene	0.128	J 0.100	0.160	0.204	0.117	0.141	0.182	0.131	0.236	0.167	0.323	**0.172 +/- 0.064**
Benzo(a)pyrene	0.128	0.127	0.185	0.226	0.135	0.164	0.186	0.146	0.300	0.200	0.415	**0.201 +/- 0.087**
Benzo(e)pyrene	0.116	0.100	0.150	0.170	0.109	0.132	0.173	0.115	0.245	0.160	0.277	**0.159 +/- 0.057**
Benzo(g,h,i)perylene	0.124	J 0.075	0.145	0.189	0.122	0.145	0.177	0.115	0.245	0.153	0.300	**0.163 +/- 0.063**
Dibenz(a,h)anthracene	J 0.026	< 0.032	J 0.033	J 0.037	J 0.025	J 0.027	J 0.032	< 0.025	J 0.051	J 0.038	J 0.062	**0.035 +/- 0.012**
Indeno(1,2,3-cd)pyrene	0.120	J 0.074	0.120	0.174	0.122	0.123	0.164	0.100	0.200	0.140	0.292	**0.148 +/- 0.059**
Perylene	0.076	J 0.055	0.055	0.063	0.078	0.059	J 0.064	J 0.048	0.080	0.080	0.131	**0.072 +/- 0.023**
TOTAL HMW PAHs	**1.586**	**1.482**	**1.813**	**2.319**	**1.508**	**1.809**	**2.355**	**1.534**	**3.467**	**2.138**	**4.646**	**1.779 +/- 1.091**
TOTAL PAHs	**1.980**	**1.974**	**2.237**	**2.791**	**1.913**	**2.155**	**2.935**	**1.917**	**4.892**	**2.601**	**5.422**	**2.339 1.401**

Appendix D, Table 4
Chemistry Data Normalized to TOC

METAL		MQR MOUND											
		MQR-1	MQR-2	MQR-3	MQR-4	MQR-5	MQR-6	MQR-7	MQR-8	MQR-9	MQR-10	MQR-11	AVERAGE
ALUMINUM	**(Al)**	7600.00	5818.18	3550.00	5555.56	7826.09	5454.55	5000.00	5076.92	6181.82	6666.67	9230.77	**6178.23 +/- 1576.17**
ARSENIC	**(As)**	4.00	3.18	1.45	2.78	4.04	2.50	2.64	2.46	2.45	3.20	4.08	**2.98 +/- 0.82**
CADMIUM	**(Cd)**	0.32	0.51	2.10	0.27	0.33	0.34	0.41	0.40	0.34	0.36	0.70	**0.55 +/- 0.53**
CHROMIUM	**(Cr)**	37.20	26.36	32.50	27.04	32.17	20.45	50.00	19.23	17.27	24.00	30.77	**28.82 +/- 9.35**
COPPER	**(Cu)**	44.00	45.45	60.00	35.56	38.70	36.82	72.73	34.62	35.45	27.33	40.00	**42.79 +/- 12.93**
IRON	**(Fe)**	11200.00	10000.00	5500.00	8148.15	11739.13	7727.27	7727.27	7692.31	8000.00	9333.33	12307.69	**9034.11 +/- 2081.04**
MERCURY	**(Hg)**	0.23	0.15	0.14	0.11	0.19	0.30	0.45	0.15	0.11	0.42	0.18	**0.22 +/- 0.12**
NICKEL	**(Ni)**	10.40	9.09	6.00	8.52	10.43	7.27	9.09	13.08	6.55	8.00	10.00	**8.95 +/- 2.02**
LEAD	**(Pb)**	23.20	21.82	16.50	18.52	22.61	13.18	26.36	37.69	19.09	16.67	18.46	**21.28 +/- 6.57**
ZINC	**(Zn)**	76.00	60.91	46.00	55.56	73.91	50.00	77.27	58.46	43.64	49.33	71.54	**60.24 +/- 12.57**

Appendix D, Table 5
Chemistry Data Normalized to TOC

LOW MOLECULAR WEIGHT PAHs (ppm/%TOC)	4500E REFERENCE AREA					2500W REFERENCE AREA					CLIS-REF REFERENCE AREA			
	4500E-1	4500E-2	4500E-3	4500E-4	4500E AVERAGE	2500W-1	2500W-2	2500W-3	2500W-4	2500W AVERAGE	CLIS-1	CLIS-2	CLIS-3	CLIS REF AVERAGE
Naphthalene	J 0.022	J 0.027	J 0.023	J 0.030	**0.025 +/- 0.003**	J 0.039	J 0.050	J 0.030	J 0.043	**0.040 +/- 0.008**	J 0.023	J 0.027	J 0.020	**0.023 +/- 0.004**
1-Methylnaphthalene	0.021	< 0.021	< 0.023	0.032	**0.024 +/- 0.005**	< 0.030	0.038	< 0.025	< 0.031	**0.031 +/- 0.005**	< 0.030	< 0.029	< 0.025	**0.028 +/- 0.003**
2-Methylnaphthalene	< 0.017	< 0.017	< 0.019	< 0.026	**0.020 +/- 0.004**	< 0.024	< 0.030	< 0.020	< 0.025	**0.025 +/- 0.004**	< 0.024	0.024	< 0.020	**0.023 +/- 0.002**
Biphenyl	0.038	0.039	0.042	0.060	**0.045 +/- 0.010**	0.052	0.068	0.052	0.055	**0.057 +/- 0.008**	0.055	0.053	0.048	**0.052 +/- 0.004**
2,6-Dimethylnapthalene	0.020	J 0.016	< 0.022	< 0.030	**0.022 +/- 0.006**	< 0.028	J 0.028	< 0.024	< 0.029	**0.027 +/- 0.002**	< 0.028	< 0.027	< 0.023	**0.026 +/- 0.003**
Acenaphthene	< 0.017	< 0.017	< 0.019	< 0.026	**0.020 +/- 0.004**	< 0.024	< 0.030	< 0.020	< 0.025	**0.025 +/- 0.004**	< 0.024	< 0.024	< 0.020	**0.023 +/- 0.002**
Acenaphthylene	0.028	0.027	J 0.026	J 0.034	**0.029 +/- 0.003**	0.039	0.045	0.033	J 0.025	**0.036 +/- 0.008**	J 0.019	J 0.018	J 0.020	**0.019 +/- 0.001**
Fluorene	< 0.013	< 0.013	< 0.014	< 0.020	**0.015 +/- 0.003**	< 0.019	< 0.024	< 0.016	< 0.020	**0.019 +/- 0.003**	< 0.019	J 0.007	< 0.015	**0.014 +/- 0.006**
Phenanthrene	0.059	0.064	0.057	0.065	**0.061 +/- 0.004**	0.071	0.100	0.068	0.059	**0.075 +/- 0.018**	0.060	0.074	0.057	**0.064 +/- 0.009**
1-Methylphenanthrene	0.006	< 0.006	J 0.007	J 0.010	**0.008 +/- 0.002**	< 0.009	< 0.011	J 0.011	< 0.010	**0.010 +/- 0.001**	< 0.009	< 0.009	< 0.008	**0.009 +/- 0.001**
Anthracene	J 0.018	J 0.017	J 0.017	J 0.022	**0.019 +/- 0.002**	J 0.026	J 0.035	J 0.022	J 0.020	**0.026 +/- 0.007**	J 0.017	J 0.022	J 0.017	**0.018 +/- 0.003**
2,3,5-Trimethylnaphthalene	< 0.010	< 0.010	< 0.011	0.015	**0.011 +/- 0.002**	< 0.014	< 0.017	0.012	< 0.015	**0.014 +/- 0.002**	< 0.014	< 0.014	< 0.011	**0.013 +/- 0.001**
TOTAL LMW PAHs	**0.270**	**0.275**	**0.280**	**0.366**	**0.297 +/- 0.046**	**0.373**	**0.478**	**0.334**	**0.356**	**0.395 +/- 0.064**	**0.321**	**0.327**	**0.283**	**0.310 +/- 0.024**
HIGH MOLECULAR WEIGHT PAHs (ppm/%TOC)														
Fluoranthene	0.123	0.127	0.117	0.140	**0.127 +/- 0.010**	0.152	0.182	0.136	0.118	**0.147 +/- 0.027**	0.115	0.137	0.095	**0.116 +/- 0.021**
Pyrene	0.145	0.150	0.130	0.150	**0.144 +/- 0.009**	0.205	0.218	0.188	0.164	**0.194 +/- 0.024**	0.130	0.153	0.124	**0.135 +/- 0.015**
Benzo(a)anthracene	0.068	0.064	0.065	0.085	**0.071 +/- 0.010**	0.090	0.105	0.084	0.073	**0.088 +/- 0.013**	J 0.065	0.063	0.057	**0.062 +/- 0.004**
Chrysene	0.091	0.091	0.078	0.095	**0.089 +/- 0.007**	0.114	0.159	0.104	0.091	**0.117 +/- 0.030**	0.080	0.084	0.071	**0.079 +/- 0.007**
Benzo(b)fluoranthene	0.095	0.100	0.091	0.125	**0.103 +/- 0.015**	0.124	0.159	0.100	J 0.100	**0.121 +/- 0.028**	J 0.085	J 0.089	J 0.071	**0.082 +/- 0.009**
Benzo(k)fluoranthene	0.095	0.086	0.083	J 0.105	**0.092 +/- 0.010**	0.105	0.145	0.104	J 0.100	**0.114 +/- 0.021**	J 0.075	J 0.095	J 0.067	**0.079 +/- 0.014**
Benzo(a)pyrene	0.105	0.095	0.087	0.125	**0.103 +/- 0.016**	0.133	0.173	0.112	0.105	**0.131 +/- 0.031**	0.095	J 0.089	J 0.076	**0.087 +/- 0.010**
Benzo(e)pyrene	0.091	0.091	0.078	0.110	**0.093 +/- 0.013**	0.114	0.155	0.100	0.095	**0.116 +/- 0.027**	0.090	0.079	0.071	**0.080 +/- 0.009**
Benzo(g,h,i)perylene	0.105	0.095	0.087	0.120	**0.102 +/- 0.014**	0.129	0.159	0.104	0.100	**0.123 +/- 0.027**	J 0.085	J 0.084	0.076	**0.082 +/- 0.005**
Dibenz(a,h)anthracene	< 0.018	J 0.021	< 0.020	< 0.028	**0.022 +/- 0.004**	< 0.026	J 0.035	J 0.025	< 0.027	**0.028 +/- 0.005**	< 0.026	< 0.025	< 0.021	**0.024 +/- 0.002**
Indeno(1,2,3-cd)pyrene	0.095	0.091	0.083	0.115	**0.096 +/- 0.014**	0.124	0.150	0.096	0.095	**0.116 +/- 0.026**	J 0.080	J 0.074	0.071	**0.075 +/- 0.004**
Perylene	J 0.034	J 0.033	J 0.030	J 0.042	**0.035 +/- 0.005**	J 0.033	J 0.050	J 0.030	J 0.029	**0.036 +/- 0.010**	J 0.028	J 0.029	J 0.026	**0.028 +/- 0.001**
TOTAL HMW PAHs	**1.066**	**1.045**	**0.950**	**1.239**	**1.076 +/- 0.120**	**1.350**	**1.690**	**1.183**	**1.097**	**1.330 +/- 0.262**	**0.954**	**1.002**	**0.829**	**0.928 +/- 0.089**
TOTAL PAHs	**1.335**	**1.320**	**1.230**	**1.605**	**1.372 +/- 0.166**	**1.722**	**2.168**	**1.517**	**1.454**	**1.725 +/- 0.326**	**1.275**	**1.329**	**1.112**	**1.238 +/- 0.113**

Appendix D, Table 6
Chemistry Data Normalized to TOC

METAL		4500E REFERENCE AREA					2500W REFERENCE AREA					CLIS-REF REFERENCE AREA			
		4500E-1	4500E-2	4500E-3	4500E-4	AVERAGE	2500W-1	2500W-2	2500W-3	2500W-4	AVERAGE	CLIS-1	CLIS-2	CLIS-3	AVERAGE
ALUMINUM	(Al)	8636.36	10000.00	9130.43	11000.00	**9691.70 +/- 1038.50**	10476.19	14090.91	8400.00	9090.91	**10514.50 +/- 2535.74**	9500.00	10000.00	10476.19	**9992.06 +/- 488.14**
ARSENIC	(As)	4.14	3.64	3.52	3.70	**3.75 +/- 0.27**	3.76	5.45	3.68	4.27	**4.29 +/- 0.82**	4.05	3.95	4.05	**4.01 +/- 0.06**
CADMIUM	(Cd)	0.55	0.35	0.52	0.50	**0.48 +/- 0.09**	0.71	1.09	0.48	0.39	**0.67 +/- 0.31**	0.50	0.63	0.67	**0.60 +/- 0.09**
CHROMIUM	(Cr)	30.45	27.27	26.52	28.00	**28.06 +/- 1.71**	33.81	45.45	28.40	29.09	**34.19 +/- 7.89**	26.00	26.84	27.14	**26.66 +/- 0.59**
COPPER	(Cu)	27.73	23.18	22.61	23.00	**24.13 +/- 2.41**	34.29	43.18	28.00	30.00	**33.87 +/- 6.74**	20.50	21.58	20.48	**20.85 +/- 0.63**
IRON	(Fe)	11818.18	11818.18	10869.57	11500.00	**11501.48 +/- 447.18**	13333.33	18636.36	11200.00	12272.73	**13860.61 +/- 3300.81**	12500.00	13684.21	12380.95	**12855.05 +/- 720.53**
MERCURY	(Hg)	0.11	0.10	0.78	0.12	**0.28 +/- 0.34**	0.12	0.13	0.15	0.15	**0.14 +/- 0.01**	0.10	0.09	0.11	**0.10 +/- 0.01**
NICKEL	(Ni)	11.36	11.82	10.00	10.50	**10.92 +/- 0.82**	12.38	16.82	10.00	11.36	**12.64 +/- 2.95**	12.00	12.63	11.43	**12.02 +/- 0.60**
LEAD	(Pb)	21.36	14.55	15.22	18.00	**17.28 +/- 3.11**	18.10	24.09	16.00	16.36	**18.64 +/- 3.75**	17.00	16.84	15.71	**16.52 +/- 0.70**
ZINC	(Zn)	63.64	59.09	56.52	60.00	**59.81 +/- 2.94**	71.43	95.45	60.00	63.64	**72.63 +/- 15.95**	60.00	63.16	61.90	**61.69 +/- 1.59**

APPENDIX E

CHEMISTRY DATA NORMALIZED TO FINE-GRAINED MATERIAL

Appendix E, Table 1
Chemistry Data Normalized to Fine-Grained Material

LOW MOLECULAR WEIGHT PAHs (ppm/%TOC)	NHAV93 MOUND													
	NH -1	NH -2	NH -3	NH -4	NH -5	NH -6	NH -7	NH -8	NH -9	NH -10	NH -11	NHAV93 AVERAGE		
Naphthalene	J 0.0012	J 0.0010	0.0021	J 0.0013	J 0.0015	0.0016	J 0.0011	0.0022	0.0017	0.0021	J 0.0012	**0.0016**	**+/-**	**0.0004**
1-Methylnaphthalene	< 0.0010	< 0.0010	< 0.0011	< 0.0010	< 0.0011	< 0.0010	< 0.0009	< 0.0007	< 0.0010	< 0.0009	< 0.0009	**0.0009**	**+/-**	**0.0001**
2-Methylnaphthalene	< 0.0008	< 0.0008	< 0.0009	< 0.0008	< 0.0008	< 0.0008	< 0.0008	< 0.0005	0.0008	< 0.0007	< 0.0007	**0.0008**	**+/-**	**0.0001**
Biphenyl	0.0017	0.0017	J 0.0020	0.0018	0.0019	0.0019	J 0.0016	J 0.0012	0.0018	0.0017	0.0017	**0.0017**	**+/-**	**0.0002**
2,6-Dimethylnapthalene	J 0.0012	J 0.0013	J 0.0014	J 0.0013	J 0.0015	J 0.0015	< 0.0009	< 0.0006	J 0.0014	< 0.0008	J 0.0013	**0.0012**	**+/-**	**0.0003**
Acenaphthene	< 0.0008	< 0.0008	< 0.0009	< 0.0008	< 0.0008	< 0.0008	< 0.0008	< 0.0005	< 0.0008	< 0.0007	< 0.0007	**0.0008**	**+/-**	**0.0001**
Acenaphthylene	0.0011	0.0011	J 0.0012	0.0012	0.0013	0.0013	0.0029	J 0.0006	0.0013	J 0.0008	0.0013	**0.0013**	**+/-**	**0.0006**
Fluorene	< 0.0006	< 0.0006	J 0.0008	< 0.0006	< 0.0007	< 0.0006	J 0.0006	J 0.0007	J 0.0007	J 0.0007	0.0005	**0.0007**	**+/-**	**0.0001**
Phenanthrene	0.0030	0.0030	0.0032	0.0034	0.0036	0.0031	0.0071	0.0027	0.0039	0.0032	0.0038	**0.0036**	**+/-**	**0.0012**
1-Methylphenanthrene	< 0.0003	< 0.0003	< 0.0004	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0002	< 0.0003	< 0.0003	< 0.0003	**0.0003**	**+/-**	**0.0000**
Anthracene	J 0.0008	J 0.0007	J 0.0012	J 0.0010	J 0.0010	J 0.0012	0.0021	0.0013	0.0014	0.0015	J 0.0010	**0.0012**	**+/-**	**0.0004**
2,3,5-Trimethylnaphthalene	< 0.0004	< 0.0005	< 0.0005	< 0.0005	< 0.0005	J 0.0004	J 0.0004	J 0.0003	< 0.0005	J 0.0004	J 0.0004	**0.0004**	**+/-**	**0.0001**
TOTAL LMW PAHs	**0.0129**	**0.0127**	**0.0158**	**0.0141**	**0.0151**	**0.0147**	**0.0194**	**0.0116**	**0.0156**	**0.0138**	**0.0138**	**0.0145**	**+/-**	**0.0021**
HIGH MOLECULAR WEIGHT PAHs (ppm/%TOC)														
Fluoranthene	0.0059	0.0056	0.0081	0.0062	0.0063	0.0091	0.0191	0.0072	0.0089	0.0076	0.0071	**0.0083**	**+/-**	**0.2525**
Pyrene	0.0064	0.0061	0.0087	0.0074	0.0064	0.0093	0.0280	0.0066	0.0095	0.0072	0.0075	**0.0094**	**+/-**	**0.4220**
Benzo(a)anthracene	0.0029	0.0027	0.0037	0.0030	0.0033	0.0039	0.0100	0.0028	0.0043	0.0038	0.0034	**0.0040**	**+/-**	**0.1379**
Chrysene	0.0035	0.0037	0.0043	0.0041	0.0043	0.0049	0.0128	0.0032	0.0054	0.0049	0.0040	**0.0050**	**+/-**	**0.1784**
Benzo(b)fluoranthene	0.0036	0.0038	0.0043	0.0034	0.0038	0.0044	0.0115	0.0025	0.0052	0.0035	0.0038	**0.0045**	**+/-**	**0.1612**
Benzo(k)fluoranthene	0.0030	J 0.0032	0.0040	0.0038	J 0.0036	0.0044	0.0113	0.0029	0.0045	0.0034	0.0039	**0.0044**	**+/-**	**0.1585**
Benzo(a)pyrene	0.0036	0.0035	0.0046	0.0037	0.0039	0.0044	0.0128	0.0028	0.0050	0.0034	0.0040	**0.0047**	**+/-**	**0.1850**
Benzo(e)pyrene	0.0036	0.0034	J 0.0040	0.0034	0.0035	0.0039	0.0100	0.0024	0.0043	0.0032	0.0036	**0.0041**	**+/-**	**0.1349**
Benzo(g,h,i)perylene	0.0029	0.0032	0.0037	0.0031	J 0.0031	0.0031	0.0109	0.0022	0.0038	0.0032	0.0030	**0.0038**	**+/-**	**0.1587**
Dibenz(a,h)anthracene	< 0.0008	< 0.0008	< 0.0010	0.0009	< 0.0009	< 0.0009	J 0.0022	< 0.0006	< 0.0009	< 0.0008	< 0.0008	**0.0010**	**+/-**	**0.0285**
Indeno(1,2,3-cd)pyrene	0.0029	0.0035	0.0041	0.0031	0.0029	0.0034	0.0097	0.0022	0.0042	0.0032	0.0032	**0.0039**	**+/-**	**0.1342**
Perylene	J 0.0019	J 0.0021	0.0020	J 0.0023	J 0.0024	J 0.0019	0.0038	J 0.0010	J 0.0017	J 0.0007	J 0.0019	**0.0020**	**+/-**	**0.0548**
TOTAL HMW PAHs	**0.0410**	**0.0418**	**0.0525**	**0.0444**	**0.0443**	**0.0536**	**0.1423**	**0.0365**	**0.0576**	**0.0448**	**0.0462**	**0.0550**	**+/-**	**0.0296**
TOTAL PAHs	**0.0539**	**0.0545**	**0.0682**	**0.0585**	**0.0594**	**0.0683**	**0.1617**	**0.0482**	**0.0731**	**0.0585**	**0.0600**	**0.0695**	**+/-**	**0.0314**

Appendix E, Table 2
Chemistry Data Normalized to Fine-Grained Material

METAL		NHAV93 MOUND											
		NH-1	NH-2	NH-3	NH-4	NH-5	NH-6	NH-7	NH-8	NH-9	NH-10	NH-11	AVERAGE
ALUMINUM	**(Al)**	262.43	183.62	168.45	226.95	292.07	312.93	162.00	88.48	250.70	115.85	170.70	**203.11 +\- 71.69**
ARSENIC	**(As)**	0.12	0.12	0.12	0.12	0.11	0.11	0.09	0.05	0.11	0.08	0.10	**0.10 +\- 0.02**
CADMIUM	**(Cd)**	< 0.01	< 0.02	< 0.02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.02	< **0.01 +\- 0.00**
CHROMIUM	**(Cr)**	1.24	1.14	1.06	1.23	1.35	1.27	1.62	0.41	1.03	0.59	1.03	**1.09 +\- 0.34**
COPPER	**(Cu)**	1.38	1.41	1.39	1.56	1.53	1.50	4.27	0.59	1.34	0.84	1.30	**1.56 +\- 0.95**
IRON	**(Fe)**	359.12	338.98	321.59	354.61	375.52	394.56	279.82	154.49	348.19	213.41	309.14	**313.59 +\- 72.50**
MERCURY	**(Hg)**	0.01	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.02	0.00	0.02	**0.01 +\- 0.01**
NICKEL	**(Ni)**	0.35	0.32	0.32	0.34	0.39	0.39	0.43	0.15	0.33	0.20	0.32	**0.32 +\- 0.08**
LEAD	**(Pb)**	0.87	0.75	0.74	0.85	0.85	0.95	1.47	0.32	0.86	0.46	0.70	**0.80 +\- 0.29**
ZINC	**(Zn)**	2.49	2.40	2.30	2.55	2.78	2.72	3.39	0.98	2.37	1.37	2.28	**2.33 +\- 0.66**

Appendix E, Table 3
Chemistry Data Normalized to Fine-Grained Material

LOW MOLECULAR WEIGHT PAHs (ppm/%TOC)	MQR MOUND											
	MQR-1	MQR-2	MQR-3	MQR-4	MQR-5	MQR-6	MQR-7	MQR-8	MQR-9	MQR-10	MQR-11	MQR AVERAGE
Naphthalene	J 0.0010	J 0.0012	0.0037	0.0018	J 0.0010	J 0.0012	0.0019	0.0017	0.0093	0.0018	J 0.0011	**0.0023 +/- 0.0024**
1-Methylnaphthalene	< 0.0008	< 0.0011	0.0013	< 0.0010	< 0.0008	< 0.0008	< 0.0009	< 0.0011	J 0.0023	< 0.0011	< 0.0011	**0.0011 +/- 0.0004**
2-Methylnaphthalene	< 0.0007	< 0.0009	< 0.0011	< 0.0008	< 0.0006	< 0.0007	< 0.0007	< 0.0009	J 0.0030	< 0.0009	< 0.0009	**0.0010 +/- 0.0007**
Biphenyl	0.0017	0.0020	0.0028	0.0018	0.0015	0.0016	0.0016	J 0.0020	0.0029	0.0022	0.0019	**0.0020 +/- 0.0005**
2,6-Dimethylnapthalene	J 0.0009	< 0.0010	J 0.0013	J 0.0010	J 0.0006	J 0.0008	J 0.0016	< 0.0010	0.0035	J 0.0011	< 0.0010	**0.0013 +/- 0.0008**
Acenaphthene	< 0.0007	< 0.0009	0.0044	< 0.0008	< 0.0006	< 0.0007	< 0.0007	0.0009	J 0.0027	J 0.0012	J 0.0011	**0.0013 +/- 0.0012**
Acenaphthylene	J 0.0009	< 0.0004	0.0019	J 0.0018	J 0.0008	0.0012	0.0018	J 0.0009	0.0016	0.0016	J 0.0009	**0.0013 +/- 0.0005**
Fluorene	J 0.0005	J 0.0008	J 0.0019	J 0.0007	< 0.0005	0.0005	J 0.0009	< 0.0007	0.0031	J 0.0013	J 0.0008	**0.0011 +/- 0.0008**
Phenanthrene	0.0032	0.0044	0.0054	0.0059	0.0029	0.0035	0.0048	0.0034	0.0164	0.0050	0.0111	**0.0060 +/- 0.0041**
1-Methylphenanthrene	J 0.0005	J 0.0004	0.0015	J 0.0007	0.0009	< 0.0003	< 0.0003	J 0.0005	0.0035	J 0.0006	J 0.0003	**0.0009 +/- 0.0009**
Anthracene	J 0.0009	J 0.0013	0.0025	0.0021	J 0.0007	0.0012	0.0021	0.0015	0.0060	0.0016	0.0031	**0.0021 +/- 0.0015**
2,3,5-Trimethylnaphthalene	< 0.0004	J 0.0005	J 0.0009	0.0006	J 0.0004	J 0.0005	0.0016	< 0.0005	0.0041	J 0.0006	J 0.0005	**0.0010 +/- 0.0011**
TOTAL LMW PAHs	**0.0123**	**0.0149**	**0.0288**	**0.0188**	**0.0114**	**0.0127**	**0.0190**	**0.0152**	**0.0585**	**0.0194**	**0.0239**	**0.0213 +/- 0.0134**
HIGH MOLECULAR WEIGHT PAHs (ppm/%TOC)												
Fluoranthene	0.0079	0.0074	0.0150	0.0133	0.0062	0.0100	0.0125	0.0085	0.0246	0.0123	0.0261	**0.0131 +/- 0.2593**
Pyrene	0.0079	0.0085	0.0190	0.0147	0.0065	0.0109	0.0134	0.0091	0.0269	0.0128	0.0261	**0.0142 +/- 0.2626**
Benzo(a)anthracene	0.0031	0.0036	0.0092	0.0066	0.0027	0.0055	0.0059	0.0049	0.0112	0.0075	0.0123	**0.0066 +/- 0.1187**
Chrysene	0.0042	0.0049	0.0109	0.0077	0.0037	0.0060	0.0074	0.0058	0.0127	0.0103	0.0133	**0.0079 +/- 0.1235**
Benzo(b)fluoranthene	0.0040	J 0.0033	0.0116	0.0077	0.0034	0.0050	0.0058	0.0055	0.0112	0.0073	0.0100	**0.0068 +/- 0.1096**
Benzo(k)fluoranthene	0.0040	J 0.0030	0.0109	0.0081	0.0033	0.0052	0.0059	0.0052	0.0097	0.0070	0.0100	**0.0066 +/- 0.1205**
Benzo(a)pyrene	0.0040	0.0038	0.0126	0.0090	0.0038	0.0060	0.0061	0.0058	0.0123	0.0084	0.0128	**0.0077 +/- 0.1352**
Benzo(e)pyrene	0.0036	0.0030	0.0102	0.0068	0.0031	0.0048	0.0056	0.0046	0.0101	0.0067	0.0085	**0.0061 +/- 0.0989**
Benzo(g,h,i)perylene	0.0039	J 0.0023	0.0099	0.0075	0.0034	0.0054	0.0058	0.0046	0.0101	0.0064	0.0092	**0.0062 +/- 0.1167**
Dibenz(a,h)anthracene	J 0.0008	< 0.0010	J 0.0022	J 0.0015	J 0.0007	J 0.0010	J 0.0010	< 0.0010	J 0.0021	J 0.0016	J 0.0019	**0.0013 +/- 0.0189**
Indeno(1,2,3-cd)pyrene	0.0037	J 0.0022	0.0082	0.0069	0.0034	0.0045	0.0053	0.0040	0.0082	0.0059	0.0090	**0.0056 +/- 0.1111**
Perylene	0.0024	J 0.0017	0.0037	0.0025	0.0022	0.0022	J 0.0021	J 0.0019	0.0033	0.0034	0.0040	**0.0027 +/- 0.0459**
TOTAL HMW PAHs	**0.0495**	**0.0448**	**0.1233**	**0.0923**	**0.0423**	**0.0666**	**0.0770**	**0.0608**	**0.1423**	**0.0896**	**0.1431**	**0.0847 +/- 0.0373**
TOTAL PAHs	**0.0617**	**0.0596**	**0.1522**	**0.1112**	**0.0537**	**0.0793**	**0.0959**	**0.0760**	**0.2008**	**0.1090**	**0.1670**	**0.1060 +/- 1.7005**

Appendix E, Table 4
Chemistry Data Normalized to Fine-Grained Material

METAL		MQR MOUND											
		MQR-1	MQR-2	MQR-3	MQR-4	MQR-5	MQR-6	MQR-7	MQR-8	MQR-9	MQR-10	MQR-11	AVERAGE
ALUMINUM	(Al)	236.91	175.82	241.50	221.24	219.78	200.67	163.45	201.22	253.73	279.33	284.36	**225.27 +\- 38.88**
ARSENIC	(As)	0.12	0.10	0.10	0.11	0.11	0.09	0.09	0.10	0.10	0.13	0.13	**0.11 +\- 0.02**
CADMIUM	(Cd)	< 0.01	< 0.02	< 0.14	< 0.01	< 0.01	< 0.01	< 0.01	< 0.02	< 0.01	< 0.02	< 0.02	< **0.03 +\- 0.04**
CHROMIUM	(Cr)	1.16	0.80	2.21	1.08	0.90	0.75	1.63	0.76	0.71	1.01	0.95	**1.09 +\- 0.46**
COPPER	(Cu)	1.37	1.37	4.08	1.42	1.09	1.35	2.38	1.37	1.46	1.15	1.23	**1.66 +\- 0.87**
IRON	(Fe)	349.13	302.20	374.15	324.48	329.67	284.28	252.60	304.88	328.36	391.06	379.15	**329.09 +\- 42.39**
MERCURY	(Hg)	0.01	0.00	0.01	0.00	0.01	0.01	0.01	0.01	0.00	0.02	0.01	**0.01 +\- 0.00**
NICKEL	(Ni)	0.32	0.27	0.41	0.34	0.29	0.27	0.30	0.52	0.27	0.34	0.31	**0.33 +\- 0.07**
LEAD	(Pb)	0.72	0.66	1.12	0.74	0.63	0.48	0.86	1.49	0.78	0.70	0.57	**0.80 +\- 0.28**
ZINC	(Zn)	2.37	1.84	3.13	2.21	2.08	1.84	2.53	2.32	1.79	2.07	2.20	**2.22 +\- 0.38**

Appendix E, Table 5
Chemistry Data Normalized to Fine-Grained Material

LOW MOLECULAR WEIGHT PAHs (ppm/%TOC)	4500E REFERENCE AREA					2500W REFERENCE AREA					CLIS-REF REFERENCE AREA			
	4500E-1	4500E-2	4500E-3	4500E-4	4500E AVERAGE	2500W-1	2500W-2	2500W-3	2500W-4	2500W AVERAGE	CLIS-1	CLIS-2	CLIS-3	CLIS REF AVERAGE
Naphthalene	J 0.0006	J 0.0009	J 0.0010	J 0.0008	0.0008 +/- 0.0002	J 0.0011	J 0.0013	J 0.0014	J 0.0011	0.0012 +/- 0.0001	J 0.0009	J 0.0010	J 0.0007	0.0009 +/- 0.0002
1-Methylnaphthalene	0.0006	< 0.0007	< 0.0010	0.0008	0.0008 +/- 0.0002	< 0.0008	0.0010	< 0.0012	< 0.0008	0.0009 +/- 0.0002	< 0.0012	< 0.0010	< 0.0008	0.0010 +/- 0.0002
2-Methylnaphthalene	< 0.0005	< 0.0006	< 0.0008	< 0.0007	0.0006 +/- 0.0001	< 0.0007	< 0.0008	< 0.0009	< 0.0007	0.0008 +/- 0.0001	< 0.0010	0.0009	< 0.0007	0.0008 +/- 0.0002
Biphenyl	0.0011	0.0013	0.0018	0.0016	0.0014 +/- 0.0003	0.0015	0.0018	0.0024	0.0014	0.0018 +/- 0.0005	0.0023	0.0019	0.0016	0.0019 +/- 0.0003
2,6-Dimethylnapthalene	0.0006	J 0.0005	< 0.0009	< 0.0008	0.0007 +/- 0.0002	< 0.0008	J 0.0007	< 0.0011	< 0.0008	0.0008 +/- 0.0002	< 0.0011	< 0.0010	< 0.0008	0.0010 +/- 0.0002
Acenaphthene	< 0.0005	< 0.0006	< 0.0008	< 0.0007	0.0006 +/- 0.0001	< 0.0007	< 0.0008	< 0.0009	< 0.0007	0.0008 +/- 0.0001	< 0.0010	< 0.0009	< 0.0007	0.0008 +/- 0.0002
Acenaphthylene	0.0008	0.0009	J 0.0011	J 0.0009	0.0009 +/- 0.0001	0.0011	0.0012	0.0015	J 0.0007	0.0011 +/- 0.0004	J 0.0008	J 0.0007	J 0.0007	0.0007 +/- 0.0000
Fluorene	< 0.0004	< 0.0004	< 0.0006	< 0.0005	0.0005 +/- 0.0001	< 0.0005	< 0.0006	< 0.0007	< 0.0005	0.0006 +/- 0.0001	< 0.0008	J 0.0003	< 0.0005	0.0005 +/- 0.0002
Phenanthrene	0.0017	0.0021	0.0024	0.0017	0.0020 +/- 0.0004	0.0020	0.0026	0.0031	0.0015	0.0023 +/- 0.0007	0.0025	0.0027	0.0020	0.0024 +/- 0.0004
1-Methylphenanthrene	0.0002	< 0.0002	J 0.0003	J 0.0003	0.0002 +/- 0.0001	< 0.0003	< 0.0003	J 0.0005	< 0.0002	0.0003 +/- 0.0001	< 0.0004	< 0.0003	< 0.0003	0.0003 +/- 0.0001
Anthracene	J 0.0005	J 0.0006	J 0.0008	J 0.0006	0.0006 +/- 0.0001	J 0.0007	J 0.0009	J 0.0010	J 0.0005	0.0008 +/- 0.0002	J 0.0007	J 0.0008	J 0.0006	0.0007 +/- 0.0001
2,3,5-Trimethylnaphthalene	< 0.0003	< 0.0003	< 0.0005	0.0004	0.0004 +/- 0.0001	< 0.0004	< 0.0004	0.0005	< 0.0004	0.0004 +/- 0.0001	< 0.0006	< 0.0005	< 0.0004	0.0006 +/- 0.0001
TOTAL LMW PAHs	0.0077	0.0092	0.0121	0.0095	0.0096 +/- 0.0018	0.0106	0.0123	0.0154	0.0093	0.0119 +/- 0.0027	0.0132	0.0118	0.0097	0.0116 +/- 0.0018
HIGH MOLECULAR WEIGHT PAHs (ppm/%TOC)														
Fluoranthene	0.0035	0.0043	0.0051	0.0036	0.0041 +/- 0.0058	0.0043	0.0047	0.0063	0.0031	0.0046 +/- 0.0577	0.0047	0.0050	0.0033	0.0043 +/- 0.0300
Pyrene	0.0042	0.0050	0.0056	0.0039	0.0047 +/- 0.0150	0.0058	0.0056	0.0087	0.0043	0.0061 +/- 0.0645	0.0053	0.0055	0.0042	0.0050 +/- 0.0173
Benzo(a)anthracene	0.0020	0.0021	0.0028	0.0022	0.0023 +/- 0.0126	0.0026	0.0027	0.0039	0.0019	0.0028 +/- 0.0299	J 0.0027	0.0023	0.0020	0.0023 +/- 0.0058
Chrysene	0.0026	0.0031	0.0034	0.0025	0.0029 +/- 0.0096	0.0032	0.0041	0.0048	0.0024	0.0036 +/- 0.0634	0.0033	0.0030	0.0024	0.0029 +/- 0.0058
Benzo(b)fluoranthene	0.0027	0.0034	0.0039	0.0033	0.0033 +/- 0.0189	0.0035	0.0041	0.0046	J 0.0026	0.0037 +/- 0.0560	J 0.0035	J 0.0032	J 0.0024	0.0031 +/- 0.0115
Benzo(k)fluoranthene	0.0027	0.0029	0.0036	J 0.0027	0.0030 +/- 0.0115	0.0030	0.0037	0.0048	J 0.0026	0.0035 +/- 0.0473	J 0.0031	J 0.0034	J 0.0023	0.0029 +/- 0.0208
Benzo(a)pyrene	0.0030	0.0032	0.0038	0.0033	0.0033 +/- 0.0222	0.0038	0.0044	0.0052	0.0027	0.0040 +/- 0.0629	0.0039	J 0.0032	J 0.0026	0.0032 +/- 0.0153
Benzo(e)pyrene	0.0026	0.0031	0.0034	0.0029	0.0030 +/- 0.0163	0.0032	0.0040	0.0046	0.0025	0.0036 +/- 0.0560	0.0037	0.0029	0.0024	0.0030 +/- 0.0173
Benzo(g,h,i)perylene	0.0030	0.0032	0.0038	0.0031	0.0033 +/- 0.0183	0.0036	0.0041	0.0048	0.0026	0.0038 +/- 0.0545	J 0.0035	J 0.0030	0.0026	0.0030 +/- 0.0058
Dibenz(a,h)anthracene	< 0.0005	J 0.0007	< 0.0009	< 0.0007	0.0007 +/- 0.0062	< 0.0007	J 0.0009	J 0.0012	< 0.0007	0.0009 +/- 0.0102	< 0.0011	< 0.0009	< 0.0007	0.0009 +/- 0.0035
Indeno(1,2,3-cd)pyrene	0.0027	0.0031	0.0036	0.0030	0.0031 +/- 0.0171	0.0035	0.0039	0.0044	0.0025	0.0036 +/- 0.0510	J 0.0033	J 0.0027	0.0024	0.0028 +/- 0.0100
Perylene	J 0.0010	J 0.0011	J 0.0013	J 0.0011	0.0011 +/- 0.0056	J 0.0009	J 0.0013	J 0.0014	J 0.0008	0.0011 +/- 0.0207	J 0.0011	J 0.0010	J 0.0009	0.0010 +/- 0.0006
TOTAL HMW PAHs	0.0305	0.0351	0.0410	0.0323	0.0347 +/- 0.0046	0.0382	0.0435	0.0548	0.0285	0.0412 +/- 0.0109	0.0392	0.0362	0.0283	0.0346 +/- 0.0056
TOTAL PAHs	0.0382	0.0443	0.0531	0.0418	0.0444 +/- 0.1657	0.0487	0.0558	0.0702	0.0378	0.0531 +/- 0.6656	0.0523	0.0481	0.0380	0.0461 +/- 0.1172

Appendix E, Table 6
Chemistry Data Normalized to Fine-Grained Material

METAL	4500E REFERENCE AREA					2500W REFERENCE AREA					CLIS-REF REFERENCE AREA			
	4500E-1	4500E-2	4500E-3	4500E-4	AVERAGE	2500W-1	2500W-2	2500W-3	2500W-4	AVERAGE	CLIS-1	CLIS-2	CLIS-3	AVERAGE
ALUMINUM (Al)	247.07	335.88	394.00	286.46	**315.85 +\- 63.51**	296.50	362.57	388.89	236.41	**321.09 +\- 68.54**	390.1	361.9	357.7	**369.9 +\- 17.6**
ARSENIC (As)	0.12	0.12	0.15	0.10	**0.12 +\- 0.02**	0.11	0.14	0.17	0.11	**0.13 +\- 0.03**	0.2	0.1	0.1	**0.1 +\- 0.0**
CADMIUM (Cd)	0.02	0.01	0.02	0.01	**0.02 +\- 0.00**	0.02	0.03	0.02	0.01	**0.02 +\- 0.01**	0.0	0.0	0.0	**0.0 +\- 0.0**
CHROMIUM (Cr)	0.87	0.92	1.14	0.73	**0.92 +\- 0.17**	0.96	1.17	1.31	0.76	**1.05 +\- 0.24**	1.1	1.0	0.9	**1.0 +\- 0.1**
COPPER (Cu)	0.79	0.78	0.98	0.60	**0.79 +\- 0.15**	0.97	1.11	1.30	0.78	**1.04 +\- 0.22**	0.8	0.8	0.7	**0.8 +\- 0.1**
IRON (Fe)	338.10	396.95	469.04	299.48	**375.89 +\- 73.91**	377.36	479.53	518.52	319.15	**423.64 +\- 91.63**	513.3	495.2	422.8	**477.1 +\- 47.9**
MERCURY (Hg)	0.00	0.00	0.03	0.00	**0.01 +\- 0.02**	0.00	0.00	0.01	0.00	**0.00 +\- 0.00**	0.0	0.0	0.0	**0.0 +\- 0.0**
NICKEL (Ni)	0.33	0.40	0.43	0.27	**0.36 +\- 0.07**	0.35	0.43	0.46	0.30	**0.39 +\- 0.08**	0.5	0.5	0.4	**0.4 +\- 0.1**
LEAD (Pb)	0.61	0.49	0.66	0.47	**0.56 +\- 0.09**	0.51	0.62	0.74	0.43	**0.57 +\- 0.14**	0.7	0.6	0.5	**0.6 +\- 0.1**
ZINC (Zn)	1.82	1.98	2.44	1.56	**1.95 +\- 0.37**	2.02	2.46	2.78	1.65	**2.23 +\- 0.49**	2.5	2.3	2.1	**2.3 +\- 0.2**

APPENDIX F

PREDREDGING SEDIMENT CHEMISTRY RESULTS

Appendix F, Table 1

Total Organic Carbon (TOC) and Grain Size Results for the NHAV 93 Mound CDM

STATION	% TOC	%GRAVEL	%SAND	% FINES (silt + clay)
OUTER FEDERAL CHANNEL				
E	0.6	N/A	N/A	95
F	0.64	N/A	N/A	97
G	0.4	N/A	N/A	97
H	0.68	N/A	N/A	99
I	0.76	N/A	N/A	98
J	0.5	N/A	N/A	77
AVERAGE	**0.60**	**N/A**	**N/A**	**93.83**
NORTHEAST PETROLEUM				
T1	3.4	0	9.5	90.54
T2	3.6	0	10.7	89.3
B1	4.8	0	10.3	89.7
B2	3.1	0	8.35	91.65
B3	2.6	0	7.82	92.18
B3	0.9	0	12.6	87.4
B3	0.07	0	97.7	2.3
B4	3.2	0	11.4	88.6
B4	1.6	0	6.82	93.18
B5	3.5	0	7.43	92.57
B5	2	0	10.4	89.6
B6	2.2	0	11.2	88.8
B7	0.46	0	69.7	26.7
B8	0.26	1.67	74.5	21.6
AVERAGE	**2.26**	**0.12**	**24.89**	**74.68**
WYATT INC.				
B1 (Arco berth)	3.8	12.7	67.6	19.3
B2 (Arco berth)	3.4	8.98	70.2	21.6
B3 (Arco berth)	4.8	18.4	56.3	26.9
B4 (Pink Tank berth)	2	11.3	72.6	16.9
B4-A (Pink Tank berth)	3.9	0	69.5	30.8
B5 (Pink Tank berth)	3.1	3.43	68.3	28.3
B6 (Pink Tank berth)	0.64	0.5	87.1	12.3
A1 (Pink Tank berth)	4.3	0	34.1	65.9
AVERAGE	**3.24**	**6.91**	**65.71**	**27.76**
LEX/ATLANTIC GATEWAY				
B2	N/A	0	63.21	36.79
B3	N/A	0	40.38	59.62
B4	N/A	0	18.55	81.45
B5	N/A	0	93.22	6.78
B6B	N/A	0	90.32	9.68
AB3	N/A	0	58.14	41.86
B11	N/A	0	97.22	2.78
B12	N/A	0	86.96	13.04
B13	N/A	0	60.47	39.53
AVERAGE		**0**	**67.61**	**32.39**
CAP SUMMARY				
AVERAGE	**2.03**	**2.34**	**52.74**	**57.14**
RANGE				
MIN VALUE	**0.07**	**0**	**6.82**	**2.3**
MAX VALUE	**4.8**	**18.4**	**97.7**	**99**

Appendix F, Table 2A

Outer Federal Channel Raw PAH Results for the NHAV 93 Mound CDM

Low Molecular Weight PAHs (ppm)	OUTER FEDERAL CHANNEL							
	E	F	G	H	I	J	AVERAGE	RANGE
Napthalene	0.030	< 0.020	0.140	0.480	0.060	0.050	**0.130 +/- 0.161**	**0.020 - 0.480**
1-Methylnapthalene	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**	**N/A**
2-Methylnapthalene	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**	**N/A**
Biphenyl	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**	**N/A**
2,6-Dimethylnapthalene	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**	**N/A**
Acenapthene	< 0.050	< 0.020	< 0.050	0.260	< 0.060	< 0.030	**0.078 +/- 0.082**	**0.020 - 0.260**
Acenapthylene	< 0.050	< 0.020	< 0.050	< 0.050	< 0.060	< 0.030	**0.043 +/- 0.014**	**0.020 - 0.060**
Fluorene	< 0.050	< 0.020	0.080	0.470	< 0.060	< 0.030	**0.118 +/- 0.158**	**0.020 - 0.470**
Phenanthrene	0.070	0.110	0.360	1.070	0.180	0.210	**0.333 +/- 0.342**	**0.070 - 1.070**
1-Methylphenanthrene	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**	**N/A**
Anthracene	< 0.050	0.030	0.080	0.220	< 0.060	0.060	**0.083 +/- 0.063**	**0.030 - 0.220**
TOTAL LMW PAHs	**0.300**	**0.220**	**0.760**	**2.550**	**0.480**	**0.410**	**0.787 +/- 0.884**	**0.220 - 2.550**
High Molecular Weight PAHs (ppm)								
Fluoranthene	0.160	0.540	0.830	0.940	0.430	0.350	**0.542 +/- 0.270**	**0.160 - 0.940**
Pyrene	0.160	0.580	0.780	0.930	0.430	0.370	**0.542 +/- 0.257**	**0.160 - 0.930**
Benzo(a)anthracene	0.060	0.390	0.280	0.310	0.190	0.150	**0.230 +/- 0.109**	**0.060 - 0.390**
Chrysene	0.060	0.290	0.380	0.300	0.190	0.140	**0.227 +/- 0.108**	**0.060 - 0.380**
Benzo(b)fluoranthene	< 0.050	0.290	0.340	0.370	0.130	0.160	**0.223 +/- 0.117**	**0.050 - 0.370**
Benzo(k)fluoranthene	< 0.050	0.250	0.320	0.350	0.130	0.110	**0.202 +/- 0.112**	**0.050 - 0.350**
Benzo(a)pyrene	< 0.050	0.270	0.310	0.350	0.130	0.130	**0.207 +/- 0.109**	**0.050 - 0.350**
Benzo(e)pyrene	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**	**N/A**
Benzo(g,h,i)perylene	< 0.050	0.190	0.30	0.290	< 0.060	< 0.030	**0.124 +/- 0.100**	**0.030 - 0.290**
Dibenzo(a,h)anthracene	< 0.050	< 0.020	< 0.050	< 0.050	< 0.060	< 0.030	**0.043 +/- 0.014**	**0.020 - 0.060**
Indeno(1,2,3-cd)pyrene	< 0.050	0.310	< 0.050	< 0.050	< 0.060	< 0.030	**0.092 +/- 0.098**	**0.030 - 0.310**
Perylene	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**	**N/A**
TOTAL HMW PAHs	**0.740**	**3.130**	**3.340**	**3.940**	**1.810**	**1.500**	**2.410 +/- 1.241**	**0.740 - 3.940**
TOTAL PAHs	**1.040**	**3.350**	**4.100**	**6.490**	**2.290**	**1.910**	**3.197 +/- 1.940**	**1.040 - 6.490**

Appendix F, Table 2B

Northeast Petroleum Raw PAH Results for the NHAV 93 Mound CDM

Low Molecular Weight PAHs (ppm)	NORTHEAST PETROLEUM															
	T1	T2	B1	B2	B3	B3	B3	B4	B4	B5	B5	B6	B7	B8	AVERAGE	RANGE
Napthalene	ND	ND	ND	ND	ND	0.060	ND	0.120	0.140	0.040	0.600	ND	ND	ND	0.192 +/- 0.232	0.040 - 0.600
1-Methylnapthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- -	0.000 - 0.000
2-Methylnapthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- -	0.000 - 0.000
Biphenyl	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- -	0.000 - 0.000
2,6-Dimethylnapthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- -	0.000 - 0.000
Acenapthene	ND	0.240	ND	ND	ND	ND	ND	ND	ND	0.140	ND	ND	ND	ND	0.190 +/- 0.071	0.140 - 0.240
Acenapthylene	ND	ND	ND	ND	0.030	ND	ND	ND	0.090	ND	ND	ND	ND	ND	0.060 +/- 0.042	0.030 - 0.090
Fluorene	ND	0.230	ND	ND	ND	ND	ND	ND	0.140	ND	0.080	ND	ND	ND	0.150 +/- 0.075	0.080 - 0.230
Phenanthrene	ND	0.940	ND	ND	0.060	ND	ND	0.090	0.280	0.130	0.070	ND	ND	ND	0.262 +/- 0.342	0.060 - 0.940
1-Methylphenanthrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- -	0.000 - 0.000
Anthracene	ND	ND	ND	ND	0.040	ND	ND	ND	0.060	0.460	ND	ND	ND	ND	0.187 +/- 0.237	0.040 - 0.460
TOTAL LMW PAHs	ND	1.410	ND	ND	0.130	0.060	ND	0.210	0.710	0.770	0.750	ND	ND	ND	0.577 +/- 0.480	0.060 - 1.410
High Molecular Weight PAHs (ppm)																
Fluoranthene	0.430	4.660	ND	ND	0.110	0.440	ND	1.600	3.130	2.300	1.270	0.900	ND	ND	1.649 +/- 1.488	0.110 - 4.660
Pyrene	0.310	2.540	ND	ND	ND	0.260	ND	1.000	2.300	1.460	0.780	0.550	ND	ND	1.150 +/- 0.876	0.260 - 2.540
Benzo(a)anthracene	ND	0.250	ND	ND	0.030	ND	ND	0.130	0.240	0.140	0.080	0.090	ND	ND	0.137 +/- 0.082	0.030 - 0.250
Chrysene	0.140	ND	ND	ND	ND	0.140	ND	ND	0.050	ND	ND	ND	ND	ND	0.110 +/- 0.052	0.050 - 0.140
Benzo(b)fluoranthene	ND	0.210	ND	ND	0.450	0.050	ND	0.170	0.380	0.120	0.130	0.120	ND	ND	0.204 +/- 0.139	0.050 - 0.450
Benzo(k)fluoranthene	ND	0.220	ND	ND	0.580	0.070	ND	0.240	0.520	0.210	0.170	0.150	ND	ND	0.270 +/- 0.181	0.070 - 0.580
Benzo(a)pyrene	ND	0.270	ND	ND	ND	0.100	ND	0.310	0.490	ND	0.220	0.150	ND	ND	0.257 +/- 0.138	0.100 - 0.490
Benzo(e)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- -	0.000 - 0.000
Benzo(g,h,i)perylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- -	0.000 - 0.000
Dibenzo(a,h)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	0.050	ND	ND	ND	ND	ND	0.050 +/- -	0.050 - 0.050
Indeno(1,2,3-cd)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- -	0.000 - 0.000
Perylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- -	0.000 - 0.000
TOTAL HMW PAHs	0.880	8.150	ND	ND	1.170	1.060	ND	3.450	7.160	4.230	2.650	1.960	ND	ND	3.412 +/- 2.665	0.880 - 8.150
TOTAL PAHs	0.880	9.560	ND	ND	1.300	1.120	ND	3.660	7.870	5.000	3.400	1.960	ND	ND	3.861 +/- 3.096	0.880 - 9.560

Appendix F, Table 2C

Wyatt, Inc. Raw PAH Results for the NHAV 93 Mound CDM

Low Molecular Weight PAHs (ppm)	WYATT, INC.													
	B1	B2	B3	B4	B4-A	B5	B6	A1	AVERAGE			RANGE		
Napthalene	ND	ND	ND	ND	0.410	ND	ND	ND	0.410	+/-	-	0.410	-	0.410
1-Methylnapthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	+/-	-	0.000	-	0.000
2-Methylnapthalene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A			N/A		
Biphenyl	ND	ND	ND	ND	ND	ND	ND	ND	ND	+/-	-	0.000	-	0.000
2,6-Dimethylnapthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	+/-	-	0.000	-	0.000
Acenapthene	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*	*+/-*	*-*	*0.000*	*-*	*0.000*
Acenapthylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	+/-	-	0.000	-	0.000
Fluorene	ND	ND	ND	ND	ND	ND	ND	ND	ND	+/-	-	0.000	-	0.000
Phenanthrene	ND	0.110	0.180	0.300	0.800	0.530	ND	0.160	0.347	+/-	0.268	0.110	-	0.800
1-Methylphenanthrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	+/-	-	0.000	-	0.000
Anthracene	ND	ND	0.190	ND	0.070	ND	ND	0.060	0.107	+/-	0.072	0.060	-	0.190
TOTAL LMW PAHs	-	0.110	0.370	0.300	1.280	0.530	-	0.220	0.468	+/-	0.422	0.110	-	1.280
High Molecular Weight PAHs (ppm)														
Fluoranthene	1.310	0.540	1.090	2.870	8.700	3.220	1.440	1.350	2.565	+/-	2.639	0.540	-	8.700
Pyrene	ND	0.510	0.970	2.510	6.950	2.690	1.210	6.510	3.050	+/-	2.638	0.510	-	6.950
Benzo(a)anthracene	*ND*	*ND*	*0.510*	*0.140*	*0.170*	*0.130*	*0.070*	*5.370*	*1.065*	*+/-*	*2.115*	*0.070*	*-*	*5.370*
Chrysene	1.440	0.340	0.520	1.680	2.880	2.290	0.970	0.770	1.361	+/-	0.889	0.340	-	2.880
Benzo(b)fluoranthene	2.880	0.880	2.010	2.790	2.360	4.340	1.730	7.450	3.055	+/-	2.040	0.880	-	7.450
Benzo(k)fluoranthene	3.710	0.080	2.580	0.290	0.170	0.350	0.180	0.560	0.990	+/-	1.372	0.080	-	3.710
Benzo(a)pyrene	ND	ND	0.210	0.400	0.600	0.480	0.290	0.650	0.438	+/-	0.172	0.210	-	0.650
Benzo(e)pyrene	ND	ND	ND	ND	0.300	ND	ND	ND	0.300	+/-	-	0.300	-	0.300
Benzo(g,h,i)perylene	ND	ND	ND	0.310	ND	0.720	0.070	2.100	0.800	+/-	0.907	0.070	-	2.100
Dibenzo(a,h)anthracene	ND	ND	0.430	0.540	0.840	0.700	0.340	0.870	0.620	+/-	0.218	0.340	-	0.870
Indeno(1,2,3-cd)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	+/-	-	0.000	-	0.000
Perylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	+/-	-	0.000	-	0.000
TOTAL HMW PAHs	9.340	2.350	8.320	11.530	22.970	14.920	6.300	25.630	12.670	+/-	8.084	2.350	-	25.630
TOTAL PAHs	9.340	2.460	8.690	11.830	24.250	15.450	6.300	25.850	13.021	+/-	8.341	2.460	-	25.850

Appendix F, Table 3A

Outer Federal Channel Raw Metals Concentrations for the NHAV 93 Mound CDM

	OUTER FEDERAL CHANNEL							
METALS (ppm)	E	F	G	H	I	J	AVERAGE	RANGE
ARSENIC (As)	< 0.03	12.60	3.90	1.40	1.50	1.90	**3.56 +\- 4.20**	**0.03 - 12.60**
CADMIUM (Cd)	4.20	1.10	3.90	1.10	0.76	0.62	**1.95 +\- 1.50**	**0.62 - 4.20**
CHROMIUM (Cr)	320.00	220.00	278.00	318.00	162.00	151.00	**241.50 +\- 68.70**	**151.00 - 320.00**
COPPER (Cu)	260.00	340.00	258.00	420.00	149.00	153.00	**263.33 +\- 96.36**	**149.00 - 420.00**
MERCURY (Hg)	0.19	0.22	0.24	0.24	0.28	0.38	**0.26 +\- 0.06**	**0.19 - 0.38**
NICKEL (Ni)	36.00	76.00	96.00	181.00	60.00	63.00	**85.33 +\- 46.42**	**36.00 - 181.00**
LEAD (Pb)	90.00	100.00	80.00	98.00	106.00	112.00	**97.67 +\- 10.42**	**80.00 - 112.00**
ZINC (Zn)	101.00	440.00	117.00	218.00	321.00	334.00	**255.17 +\- 121.76**	**101.00 - 440.00**

Appendix F, Table 3B

Northeast Petroleum Raw Metals Concentrations for the NHAV 93 Mound CDM

	NORTHEAST PETROLEUM															
METALS (ppm)	T1	T2	B1	B2	B3	B3	B3	B4	B4	B5	B5	B6	B7	B8	AVERAGE	RANGE
ARSENIC (As)	0.60	0.61	1.01	1.05	1.17	0.39	0.43	0.89	0.75	1.40	1.13	1.35	NA	NA	**0.90 +\- 0.34**	**0.39 - 1.40**
CADMIUM (Cd)	ND	ND	ND	0.07	0.51	ND	ND	ND	ND	1.22	0.86	ND	NA	NA	**0.66 +\- 0.49**	**0.07 - 1.22**
CHROMIUM (Cr)	71.40	61.20	71.30	92.80	128.00	5.56	32.00	73.40	91.50	1.56	101.00	72.50	NA	NA	**66.85 +\- 37.62**	**1.56 - 128.00**
COPPER (Cu)	107.00	92.70	100.00	60.20	73.40	46.30	4.08	130.00	54.20	98.40	64.70	88.10	NA	NA	**76.59 +\- 33.43**	**4.08 - 130.00**
MERCURY (Hg)	0.09	0.10	0.14	0.10	0.04	0.01	0.09	0.14	0.18	0.20	0.11	0.09	NA	NA	**0.11 +\- 0.05**	**0.01 - 0.20**
NICKEL (Ni)	18.70	19.90	25.10	24.10	32.40	6.27	10.90	25.70	23.40	40.30	24.80	22.70	NA	NA	**22.86 +\- 8.83**	**6.27 - 40.30**
LEAD (Pb)	69.90	61.00	75.00	77.30	122.00	10.70	29.00	78.40	81.00	144.00	98.70	73.90	NA	NA	**76.74 +\- 35.70**	**10.70 - 144.00**
ZINC (Zn)	156.00	159.00	182.00	188.00	235.00	16.20	57.20	166.00	306.00	919.00	543.00	149.00	4.22	7.62	**220.59 +\- 244.71**	**4.22 - 919.00**

Appendix F, Table 3C

Wyatt, Inc. Raw Metals Concentrations for the NHAV 93 Mound CDM

METALS (ppm)	B1	B2	B3	B4	B4-A	B5	B6	A1	AVERAGE	RANGE
	WYATT, INC.	(Arco berth)			(Pink Tank berth)					
ARSENIC (As)	ND	ND	ND	ND	ND	ND	ND	ND	**ND +\- -**	**0.00 - 0.00**
CADMIUM (Cd)	ND	ND	2.54	2.18	3.51	2.87	0.60	1.20	**2.15 +\- 1.08**	**0.60 - 3.51**
CHROMIUM (Cr)	89.10	44.80	87.00	64.70	101.00	77.20	23.50	10.90	**62.28 +\- 32.75**	**10.90 - 101.00**
COPPER (Cu)	148.00	67.00	144.00	190.30	206.00	171.00	68.60	ND	**142.13 +\- 55.26**	**67.00 - 206.00**
MERCURY (Hg)	ND	ND	ND	ND	ND	ND	ND	ND	**ND +\- -**	**0.00 - 0.00**
NICKEL (Ni)	45.40	21.10	26.50	19.80	29.90	25.10	8.46	8.19	**23.06 +\- 12.02**	**8.19 - 45.40**
LEAD (Pb)	168.00	59.30	105.00	113.00	131.00	106.00	4.48	24.40	**88.90 +\- 55.19**	**4.48 - 168.00**
ZINC (Zn)	ND	139.00	214.00	149.00	265.00	213.00	82.80	61.90	**160.67 +\- 74.04**	**61.90 - 265.00**

Appendix F, Table 3D

Lex/Atlantic Gateway Raw Metals Concentrations for the NHAV 93 Mound CDM

	LEX/ATLANTIC GATEWAY										
METALS (ppm)	B2	B3	B4	B5	B6B	AB3	B11	B12	B13	AVERAGE	RANGE
ARSENIC (As)	6.70	2.60	2.10	3.00	4.80	3.00	2.10	6.20	3.00	**3.72 +/- 1.74**	**2.10 - 6.70**
CADMIUM (Cd)	1.80	1.90	0.90	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	1.40	**0.72 +/- 0.79**	**0.10 - 1.90**
CHROMIUM (Cr)	46.70	124.90	47.40	6.00	6.40	15.20	4.50	6.30	53.00	**34.49 +/- 39.53**	**4.50 - 124.90**
COPPER (Cu)	170.00	150.90	200.00	5.60	5.30	11.70	5.60	3.70	11.30	**62.68 +/- 84.17**	**3.70 - 200.00**
MERCURY (Hg)	0.21	0.13	0.15	0.05	< 0.02	0.02	< 0.02	0.02	0.53	**0.13 +/- 0.17**	**0.02 - 0.53**
NICKEL (Ni)	16.20	20.90	16.90	3.40	6.80	11.80	6.40	4.40	16.00	**11.42 +/- 6.36**	**3.40 - 20.90**
LEAD (Pb)	90.80	94.90	72.10	1.70	2.00	4.60	2.10	4.60	49.10	**35.77 +/- 40.93**	**1.70 - 94.90**
ZINC (Zn)	191.30	182.30	148.30	10.70	15.60	35.90	6.40	4.40	152.00	**82.99 +/- 82.65**	**4.40 - 191.30**

Appendix F, Table 4A

Outer Federal Channel PAHs Normalized to TOC

Low Molecular Weight PAHs (ppm)	OUTER FEDERAL CHANNEL							
	E	F	G	H	I	J	AVERAGE	RANGE
Napthalene	0.050	0.031	0.350	0.706	0.079	0.100	**0.219 +/- 0.265**	**0.031 - 0.706**
1-Methylnapthalene	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**	**N/A**
2-Methylnapthalene	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**	**N/A**
Biphenyl	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**	**N/A**
2,6-Dimethylnapthalene	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**	**N/A**
Acenapthene	< 0.083	< 0.031	< 0.125	0.382	< 0.079	< 0.060	**0.127 +/- 0.129**	**0.031 - 0.382**
Acenapthylene	< 0.083	< 0.031	< 0.125	< 0.074	< 0.079	< 0.060	**0.075 +/- 0.031**	**0.031 - 0.125**
Fluorene	< 0.083	< 0.031	0.200	0.691	< 0.079	< 0.060	**0.191 +/- 0.252**	**0.031 - 0.691**
Phenanthrene	0.117	0.172	0.900	1.574	0.237	0.420	**0.570 +/- 0.568**	**0.117 - 1.574**
1-Methylphenanthrene	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**	**N/A**
Anthracene	< 0.083	0.047	0.200	0.324	< 0.079	0.120	**0.142 +/- 0.103**	**0.047 - 0.324**
TOTAL LMW PAHs	**0.500**	**0.344**	**1.900**	**3.750**	**0.632**	**0.820**	**1.324 +/- 1.311**	**0.344 - 3.750**
High Molecular Weight PAHs (ppm)								
Fluoranthene	0.267	0.844	2.075	1.382	0.566	0.700	**0.972 +/- 0.654**	**0.267 - 2.075**
Pyrene	0.267	0.906	1.950	1.368	0.566	0.740	**0.966 +/- 0.606**	**0.267 - 1.950**
Benzo(a)anthracene	0.100	0.609	0.700	0.456	0.250	0.300	**0.403 +/- 0.228**	**0.100 - 0.700**
Chrysene	0.100	0.453	0.950	0.441	0.250	0.280	**0.412 +/- 0.294**	**0.100 - 0.950**
Benzo(b)fluoranthene	< 0.083	0.453	0.850	0.544	0.171	0.320	**0.404 +/- 0.278**	**0.083 - 0.850**
Benzo(k)fluoranthene	< 0.083	0.391	0.800	0.515	0.171	0.220	**0.363 +/- 0.265**	**0.083 - 0.800**
Benzo(a)pyrene	< 0.083	0.422	0.775	0.515	0.171	0.260	**0.371 +/- 0.254**	**0.083 - 0.775**
Benzo(e)pyrene	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**	**N/A**
Benzo(g,h,i)perylene	< 0.083	0.297	0.750	0.426	< 0.079	< 0.060	**0.283 +/- 0.272**	**0.060 - 0.750**
Dibenzo(a,h)anthracene	< 0.083	< 0.031	< 0.125	< 0.074	< 0.079	< 0.060	**0.075 +/- 0.031**	**0.031 - 0.125**
Indeno(1,2,3-cd)pyrene	< 0.083	0.484	< 0.125	< 0.074	< 0.079	< 0.060	**0.151 +/- 0.165**	**0.060 - 0.484**
Perylene	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**	**N/A**
TOTAL HMW PAHs	**1.233**	**4.891**	**9.100**	**5.794**	**2.382**	**3.000**	**4.400 +/- 2.840**	**1.233 - 9.100**
TOTAL PAHs	**1.733**	**5.234**	**11.000**	**9.544**	**3.013**	**3.820**	**5.724 +/- 3.730**	**1.733 - 11.000**

Appendix F, Table 4B

Northeast Petroleum PAHs Normalized to TOC

Low Molecular Weight PAHs (ppm)	NORTHEAST PETROLEUM															
	T1	T2	B1	B2	B3	B3	B3	B4	B4	B5	B5	B6	B7	B8	AVERAGE	RANGE
Napthalene	ND	ND	ND	ND	ND	0.067	ND	0.038	0.088	0.011	0.300	ND	ND	ND	0.101 +/- 0.115	0.011 - 0.300
1-Methylnapthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- ND	0.000 - 0.000
2-Methylnapthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- ND	0.000 - 0.000
Biphenyl	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- ND	0.000 - 0.000
2,6-Dimethylnapthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- ND	0.000 - 0.000
Acenapthene	ND	0.067	ND	ND	ND	ND	ND	ND	ND	0.040	ND	ND	ND	ND	0.053 +/- 0.019	0.040 - 0.067
Acenapthylene	ND	ND	ND	ND	0.012	ND	ND	ND	0.056	ND	ND	ND	ND	ND	0.034 +/- 0.032	0.012 - 0.056
Fluorene	ND	0.064	ND	ND	ND	ND	ND	ND	0.088	ND	0.040	ND	ND	ND	0.064 +/- 0.024	0.040 - 0.088
Phenanthrene	ND	0.261	ND	ND	0.023	ND	ND	0.028	0.175	0.037	0.035	ND	ND	ND	0.093 +/- 0.101	0.023 - 0.261
1-Methylphenanthrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- ND	0.000 - 0.000
Anthracene	ND	ND	ND	ND	0.015	ND	ND	ND	0.038	0.131	ND	ND	ND	ND	0.061 +/- 0.062	0.015 - 0.131
TOTAL LMW PAHs	ND	0.392	ND	ND	0.050	0.067	ND	0.066	0.444	0.220	0.375	ND	ND	ND	0.230 +/- 0.173	0.050 - 0.444
High Molecular Weight PAHs (ppm)																
Fluoranthene	0.126	1.294	ND	ND	0.042	0.489	ND	0.500	1.956	0.657	0.635	0.409	ND	ND	0.679 +/- 0.598	0.042 - 1.956
Pyrene	0.091	0.706	ND	ND	ND	0.289	ND	0.313	1.438	0.417	0.390	0.250	ND	ND	0.487 +/- 0.422	0.091 - 1.438
Benzo(a)anthracene	ND	0.069	ND	ND	0.012	ND	ND	0.041	0.150	0.040	0.040	0.041	ND	ND	0.056 +/- 0.045	0.012 - 0.150
Chrysene	0.041	ND	ND	ND	ND	0.156	ND	ND	0.031	ND	ND	ND	ND	ND	0.076 +/- 0.069	0.031 - 0.156
Benzo(b)fluoranthene	ND	0.058	ND	ND	0.173	0.056	ND	0.053	0.238	0.034	0.065	0.055	ND	ND	0.091 +/- 0.073	0.034 - 0.238
Benzo(k)fluoranthene	ND	0.061	ND	ND	0.223	0.078	ND	0.075	0.325	0.060	0.085	0.068	ND	ND	0.122 +/- 0.098	0.060 - 0.325
Benzo(a)pyrene	ND	0.075	ND	ND	ND	0.111	ND	0.097	0.306	ND	0.110	0.068	ND	ND	0.128 +/- 0.089	0.068 - 0.306
Benzo(e)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- ND	0.000 - 0.000
Benzo(g,h,i)perylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- ND	0.000 - 0.000
Dibenzo(a,h)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	0.031	ND	ND	ND	ND	ND	0.031 +/- 0.000	0.031 - 0.031
Indeno(1,2,3-cd)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- ND	0.000 - 0.000
Perylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- ND	0.000 - 0.000
TOTAL HMW PAHs	0.259	2.264			0.450	1.178		1.078	4.475	1.209	1.325	0.891			1.459 +/- 1.266	0.259 - 4.475
TOTAL PAHs	0.259	2.656			0.500	1.244		1.144	4.919	1.429	1.700	0.891			1.638 +/- 1.414	0.259 - 4.919

Appendix F, Table 4C

Wyatt, Inc. PAHs Normalized to TOC

Low Molecular Weight PAHs (ppm)	WYATT, INC.									
	B1	B2	B3	B4	B4-A	B5	B6	A1	AVERAGE	RANGE
Napthalene	ND	ND	ND	ND	0.105	ND	ND	ND	0.105 +/- 0.000	0.105 - 0.105
1-Methylnapthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- ND	ND - ND
2-Methylnapthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- ND	ND - ND
Biphenyl	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- ND	ND - ND
2,6-Dimethylnapthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- ND	ND - ND
Acenapthene	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- ND	ND - ND
Acenapthylene	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- ND	ND - ND
Fluorene	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- ND	ND - ND
Phenanthrene	ND	0.032	0.038	0.150	0.205	0.171	ND	0.037	0.106 +/- 0.079	0.032 - 0.205
1-Methylphenanthrene	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- ND	ND - ND
Anthracene	ND	ND	0.040	ND	0.018	ND	ND	0.014	0.024 +/- 0.014	0.014 - 0.040
TOAL LMW PAHs	ND	0.032	0.077	0.150	0.328	0.171	ND	0.051	0.135 +/- 0.109	0.032 - 0.328
High Molecular Weight PAHs (ppm)										
Fluoranthene	0.345	0.159	0.227	1.435	2.231	1.039	2.250	0.314	1.000 +/- 0.884	0.159 - 2.250
Pyrene	ND	0.150	0.202	1.255	1.782	0.868	1.891	1.514	1.094 +/- 0.713	0.150 - 1.891
Benzo(a)anthracene	ND	ND	0.106	0.070	0.044	0.042	0.109	1.249	0.270 +/- 0.480	0.042 - 1.249
Chrysene	0.379	0.100	0.108	0.840	0.738	0.739	1.516	0.179	0.575 +/- 0.485	0.100 - 1.516
Benzo(b)fluoranthene	0.758	0.259	0.419	1.395	0.605	1.400	2.703	1.733	1.159 +/- 0.815	0.259 - 2.703
Benzo(k)fluoranthene	0.976	0.024	0.538	0.145	0.044	0.113	0.281	0.130	0.281 +/- 0.325	0.024 - 0.976
Benzo(a)pyrene	ND	ND	0.044	0.200	0.154	0.155	0.453	0.151	0.193 +/- 0.138	0.044 - 0.453
Benzo(e)pyrene	ND	ND	ND	ND	0.077	ND	ND	ND	0.077 +/- 0.000	0.077 - 0.077
Benzo(g,h,i)perylene	ND	ND	ND	0.155	ND	0.232	0.109	0.488	0.246 +/- 0.169	0.109 - 0.488
Dibenzo(a,h)anthracene	ND	ND	0.090	0.270	0.215	0.226	0.531	0.202	0.256 +/- 0.148	0.090 - 0.531
Indeno(1,2,3-cd)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- ND	0.000 - 0.000
Perylene	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- ND	0.000 - 0.000
TOTAL HMW PAHs	2.458	0.691	1.733	5.765	5.890	4.813	9.844	5.960	4.644 +/- 2.939	0.691 - 9.844
TOTAL PAHs	2.458	0.724	1.810	5.915	6.218	4.984	9.844	6.012	4.746 +/- 2.957	0.724 - 9.844

Appendix F, Table 4D

Outer Federal Channel Metals Normalized to TOC

METALS (ppm)	OUTER FEDERAL CHANNEL E	F	G	H	I	J	AVERAGE	RANGE
ARSENIC (As)	0.05	19.69	9.75	2.06	1.97	3.80	**6.22 +/- 7.39**	**0.05 - 19.69**
CADMIUM (Cd)	7.00	1.72	9.75	1.62	1.00	1.24	**3.72 +/- 3.72**	**1.00 - 9.75**
CHROMIUM (Cr)	533.33	343.75	695.00	467.65	213.16	302.00	**425.81 +/- 174.96**	**213.16 - 695.00**
COPPER (Cu)	433.33	531.25	645.00	617.65	196.05	306.00	**454.88 +/- 177.82**	**196.05 - 645.00**
MERCURY (Hg)	0.32	0.34	0.60	0.35	0.37	0.76	**0.46 +/- 0.18**	**0.32 - 0.76**
NICKEL (Ni)	60.00	118.75	240.00	266.18	78.95	126.00	**148.31 +/- 85.18**	**60.00 - 266.18**
LEAD (Pb)	150.00	156.25	200.00	144.12	139.47	224.00	**168.97 +/- 34.64**	**139.47 - 224.00**
ZINC (Zn)	168.33	687.50	292.50	320.59	422.37	668.00	**426.55 +/- 210.85**	**168.33 - 687.50**

Appendix F, Table 4E

Northeast Petroleum Metals Normalized to TOC

	NORTHEAST PETROLEUM															
METALS (ppm)	T1	T2	B1	B2	B3	B3	B3	B4	B4	B5	B5	B6	B7	B8	AVERAGE	RANGE
ARSENIC (As)	0.18	0.17	0.21	0.34	0.45	0.43	6.16	0.28	0.47	0.40	0.57	0.61	NA	NA	**0.86 +/- 1.68**	**0.17 - 6.16**
CADMIUM (Cd)	ND	ND	ND	0.02	0.19	ND	ND	ND	ND	0.35	0.43	ND	NA	NA	**0.25 +/- 0.18**	**0.02 - 0.43**
CHROMIUM (Cr)	21.00	17.00	14.85	29.94	49.23	6.18	457.14	22.94	57.19	0.45	50.50	32.95	NA	NA	**63.28 +/- 125.29**	**0.45 - 457.14**
COPPER (Cu)	31.47	25.75	20.83	19.42	28.23	51.44	58.29	40.63	33.88	28.11	32.35	40.05	NA	NA	**34.20 +/- 11.70**	**19.42 - 58.29**
MERCURY (Hg)	0.03	0.03	0.03	0.03	0.01	0.01	1.23	0.04	0.11	0.06	0.05	0.04	NA	NA	**0.14 +/- 0.34**	**0.01 - 1.23**
NICKEL (Ni)	5.50	5.53	5.23	7.77	12.46	6.97	155.71	8.03	14.63	11.51	12.40	10.32	NA	NA	**21.34 +/- 42.43**	**5.23 - 155.71**
LEAD (Pb)	20.56	16.94	15.63	24.94	46.92	11.89	414.29	24.50	50.63	41.14	49.35	33.59	NA	NA	**62.53 +/- 111.62**	**11.89 - 414.29**
ZINC (Zn)	45.88	44.17	37.92	60.65	90.38	18.00	817.14	51.88	191.25	262.57	271.50	67.73	9.17	29.31	**142.68 +/- 212.64**	**9.17 - 817.14**

Appendix F, Table 4F

Wyatt, Inc. Metals Normalized to TOC

METALS (ppm)	B1	B2 (Arco berth)	B3	B4	B4-A	B5 (Pink Tank berth)	B6	A1	AVERAGE	RANGE
					WYATT, INC.					
ARSENIC (As)	ND	ND	ND	ND	ND	ND	ND	ND	**ND +/- ND**	**0.00 - 0.00**
CADMIUM (Cd)	ND	ND	0.53	1.09	0.90	0.93	0.93	0.28	**0.78 +/- 0.31**	**0.28 - 1.09**
CHROMIUM (Cr)	23.45	13.18	18.13	32.35	25.90	24.90	36.72	2.53	**22.14 +/- 10.83**	**2.53 - 36.72**
COPPER (Cu)	38.95	19.71	30.00	95.15	52.82	55.16	107.19	ND	**57.00 +/- 32.76**	**19.71 - 107.19**
MERCURY (Hg)	ND	ND	ND	ND	ND	ND	ND	ND	**ND +/- ND**	**0.00 - 0.00**
NICKEL (Ni)	11.95	6.21	5.52	9.90	7.67	8.10	13.22	1.90	**8.06 +/- 3.65**	**1.90 - 13.22**
LEAD (Pb)	44.21	17.44	21.88	56.50	33.59	34.19	7.00	5.67	**27.56 +/- 17.85**	**5.67 - 56.50**
ZINC (Zn)	ND	40.88	44.58	74.50	67.95	68.71	129.38	14.40	**62.91 +/- 36.02**	**14.40 - 129.38**

Appendix F, Table 5A

Outer Federal Channel PAHs Normalized to Fines

Low Molecular Weight PAHs (ppm)	OUTER FEDERAL CHANNEL E	F	G	H	I	J	AVERAGE	RANGE
Napthalene	0.0003	< 0.0002	0.0014	0.0048	0.0006	0.0006	**0.0013 +/- 0.0018**	**0.0002 - 0.0048**
1-Methylnapthalene	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**	**N/A**
2-Methylnapthalene	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**	**N/A**
Biphenyl	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**	**N/A**
2,6-Dimethylnapthalene	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**	**N/A**
Acenapthene	*< 0.0005*	*< 0.0002*	*< 0.0005*	*0.0026*	*< 0.0006*	*< 0.0004*	***0.0008 +/- 0.0009***	***0.0002 - 0.0026***
Acenapthylene	< 0.0005	< 0.0002	< 0.0005	< 0.0005	< 0.0006	< 0.0004	**0.0005 +/- 0.0001**	**0.0002 - 0.0006**
Fluorene	< 0.0005	< 0.0002	0.0008	0.0047	< 0.0006	< 0.0004	**0.0012 +/- 0.0017**	**0.0002 - 0.0047**
Phenanthrene	0.0007	0.0011	0.0037	0.0108	0.0018	0.0027	**0.0035 +/- 0.0037**	**0.0007 - 0.0108**
1-Methylphenanthrene	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**	**N/A**
Anthracene	< 0.0005	0.0003	0.0008	0.0022	< 0.0006	0.0008	**0.0009 +/- 0.0007**	**0.0003 - 0.0022**
TOTAL LMW PAHs	**0.0032**	**0.0023**	**0.0078**	**0.0258**	**0.0049**	**0.0053**	**0.0082 +/- 0.0088**	**0.0023 - 0.0258**
High Molecular Weight PAHs (ppm)								
Fluoranthene	0.0017	0.0056	0.0086	0.0095	0.0044	0.0045	**0.0057 +/- 0.0029**	**0.0017 - 0.0095**
Pyrene	0.0017	0.0060	0.0080	0.0094	0.0044	0.0048	**0.0057 +/- 0.0028**	**0.0017 - 0.0094**
Benzo(a)anthracene	*0.0006*	*0.0040*	*0.0029*	*0.0031*	*0.0019*	*0.0019*	***0.0024 +/- 0.0012***	***0.0006 - 0.0040***
Chrysene	0.0006	0.0030	0.0039	0.0030	0.0019	0.0018	**0.0024 +/- 0.0012**	**0.0006 - 0.0039**
Benzo(b)fluoranthene	< 0.0005	0.0030	0.0035	0.0037	0.0013	0.0021	**0.0024 +/- 0.0013**	**0.0005 - 0.0037**
Benzo(k)fluoranthene	< 0.0005	0.0026	0.0033	0.0035	0.0013	0.0014	**0.0021 +/- 0.0012**	**0.0005 - 0.0035**
Benzo(a)pyrene	< 0.0005	0.0028	0.0032	0.0035	0.0013	0.0017	**0.0022 +/- 0.0012**	**0.0005 - 0.0035**
Benzo(e)pyrene	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**	**N/A**
Benzo(g,h,i)perylene	< 0.0005	0.0020	0.0031	0.0029	< 0.0006	< 0.0004	**0.0016 +/- 0.0012**	**0.0004 - 0.0031**
Dibenzo(a,h)anthracene	< 0.0005	< 0.0002	< 0.0005	< 0.0005	< 0.0006	< 0.0004	**0.0005 +/- 0.0001**	**0.0002 - 0.0006**
Indeno(1,2,3-cd)pyrene	< 0.0005	0.0032	< 0.0005	< 0.0005	< 0.0006	< 0.0004	**0.0010 +/- 0.0011**	**0.0004 - 0.0032**
Perylene	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**	**N/A**
TOTAL HMW PAHs	**0.0078**	**0.0323**	**0.0375**	**0.0398**	**0.0185**	**0.0195**	**0.0259 +/- 0.0126**	**0.0078 - 0.0398**
TOTAL PAHs	***0.0109***	***0.0345***	***0.0454***	***0.0656***	***0.0234***	***0.0248***	**0.0341 +/- 0.0193**	**0.0109 - 0.0656**

Appendix F, Table 5B

Northeast Petroleum PAHs Normalized to Fines

Low Molecular Weight PAHs (ppm)	NORTHEAST PETROLEUM														
	T1	T2	B1	B2	B3	B3	B3	B4	B4	B5	B5	B6	B7	B8	AVERAGE	RANGE
Napthalene	ND	ND	ND	ND	ND	0.0007	ND	0.0014	0.0015	0.0004	0.0067	ND	ND	ND	0.0021 +/- 0.0026	0.0004 - 0.0067
1-Methylnapthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- -	-
2-Methylnapthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- -	-
Biphenyl	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- -	-
2,6-Dimethylnapthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- -	-
Acenapthene	ND	0.0027	ND	ND	ND	ND	ND	ND	ND	0.0015	ND	ND	ND	ND	0.0021 +/- 0.0008	0.0015 - 0.0027
Acenapthylene	ND	ND	ND	ND	0.0003	ND	ND	ND	0.0010	ND	ND	ND	ND	ND	0.0006 +/- 0.0005	0.0003 - 0.0010
Fluorene	ND	0.0026	ND	ND	ND	ND	ND	ND	0.0015	ND	0.0009	ND	ND	ND	0.0017 +/- 0.0009	0.0009 - 0.0026
Phenanthrene	ND	0.0105	ND	ND	0.0007	ND	ND	0.0010	0.0030	0.0014	0.0008	ND	ND	ND	0.0029 +/- 0.0038	0.0007 - 0.0105
1-Methylphenanthrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- -	-
Anthracene	ND	ND	ND	ND	0.0004	ND	ND	ND	0.0006	0.0050	ND	ND	ND	ND	0.0020 +/- 0.0026	0.0004 - 0.0050
TOTAL LMW PAHs	ND	0.0158	ND	ND	0.0014	0.0007	ND	0.0024	0.0076	0.0083	0.0084	ND	ND	ND	0.0064 +/- 0.0053	0.0007 - 0.0158
High Molecular Weight PAHs (ppm)																
Fluoranthene	0.0048	0.0522	ND	ND	0.0012	0.0050	ND	0.0181	0.0336	0.0248	0.0142	0.0101	ND	ND	0.0182 +/- 0.0164	0.0012 - 0.0522
Pyrene	0.0034	0.0284	ND	ND	ND	0.0030	ND	0.0113	0.0247	0.0158	0.0087	0.0062	ND	ND	0.0127 +/- 0.0096	0.0030 - 0.0284
Benzo(a)anthracene	ND	0.0028	ND	ND	0.0003	ND	ND	0.0015	0.0026	0.0015	0.0009	0.0010	ND	ND	0.0015 +/- 0.0009	0.0003 - 0.0028
Chrysene	0.0015	ND	ND	ND	ND	0.0016	ND	ND	0.0005	ND	ND	ND	ND	ND	0.0012 +/- 0.0006	0.0005 - 0.0016
Benzo(b)fluoranthene	ND	0.0024	ND	ND	0.0049	0.0006	ND	0.0019	0.0041	0.0013	0.0015	0.0014	ND	ND	0.0022 +/- 0.0015	0.0006 - 0.0049
Benzo(k)fluoranthene	ND	0.0025	ND	ND	0.0063	0.0008	ND	0.0027	0.0056	0.0023	0.0019	0.0017	ND	ND	0.0030 +/- 0.0019	0.0008 - 0.0063
Benzo(a)pyrene	ND	0.0030	ND	ND	ND	0.0011	ND	0.0035	0.0053	ND	0.0025	0.0017	ND	ND	0.0028 +/- 0.0015	0.0011 - 0.0053
Benzo(e)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- -	-
Benzo(g,h,i)perylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- -	-
Dibenzo(a,h)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	0.0005	ND	ND	ND	ND	ND	0.0005 +/- -	0.0005 - 0.0005
Indeno(1,2,3-cd)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- -	-
Perylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- -	-
TOTAL HMW PAHs	ND	0.0913	ND	ND	0.0127	0.0121	ND	0.0389	0.0768	0.0457	0.0296	ND	ND	ND	0.0439 +/- 0.0304	0.0121 - 0.0913
TOTAL PAHs	ND	0.1071	ND	ND	0.0141	0.0128	ND	0.0413	0.0845	0.0540	0.0379	ND	ND	ND	0.0502 +/- 0.0350	0.0128 - 0.1071

Appendix F, Table 5C

Wyatt, Inc. PAHs Normalized to Fines

Low Molecular Weight PAHs (ppm)	WYATT, INC.									
	B1	B2	B3	B4	B4-A	B5	B6	A1	AVERAGE	RANGE
Napthalene	ND	ND	ND	ND	0.0133	ND	ND	ND	0.0133 +/- -	0.0133 - 0.0133
1-Methylnapthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- -	-
2-Methylnapthalene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Biphenyl	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- -	-
2,6-Dimethylnapthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- -	-
Acenapthene	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- -	-
Acenapthylene	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- -	-
Fluorene	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- -	-
Phenanthrene	ND	0.0051	0.0067	0.0178	0.0260	0.0187	ND	0.0024	0.0128 +/- 0.0094	0.0024 - 0.0260
1-Methylphenanthrene	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- -	-
Anthracene	ND	ND	0.0071	ND	0.0023	ND	ND	0.0009	0.0034 +/- 0.0032	0.0009 - 0.0071
TOTAL LMW PAHs	-	0.0051	0.0138	0.0178	0.0416	0.0187	-	0.0033	0.0167 +/- 0.0137	0.0033 - 0.0416
High Molecular Weight PAHs (ppm)										
Fluoranthene	0.0679	0.0250	0.0405	0.1698	0.2825	0.1138	0.1171	0.0205	0.1046 +/- 0.0886	0.0205 - 0.2825
Pyrene	ND	0.0236	0.0361	0.1485	0.2256	0.0951	0.0984	0.0988	0.1037 +/- 0.0683	0.0236 - 0.2256
Benzo(a)anthracene	ND	ND	0.0190	0.0083	0.0055	0.0046	0.0057	0.0815	0.0208 +/- 0.0302	0.0046 - 0.0815
Chrysene	0.0746	0.0157	0.0193	0.0994	0.0935	0.0809	0.0789	0.0117	0.0593 +/- 0.0371	0.0117 - 0.0994
Benzo(b)fluoranthene	0.1492	0.0407	0.0747	0.1651	0.0766	0.1534	0.1407	0.1131	0.1142 +/- 0.0454	0.0407 - 0.1651
Benzo(k)fluoranthene	0.1922	0.0037	0.0959	0.0172	0.0055	0.0124	0.0146	0.0085	0.0438 +/- 0.0672	0.0037 - 0.1922
Benzo(a)pyrene	ND	ND	0.0078	0.0237	0.0195	0.0170	0.0236	0.0099	0.0169 +/- 0.0068	0.0078 - 0.0237
Benzo(e)pyrene	ND	ND	ND	ND	0.0097	ND	ND	ND	0.0097 +/- -	0.0097 - 0.0097
Benzo(g,h,i)perylene	ND	ND	ND	0.0183	ND	0.0254	0.0057	0.0319	0.0203 +/- 0.0112	0.0057 - 0.0319
Dibenzo(a,h)anthracene	ND	ND	0.0160	0.0320	0.0273	0.0247	0.0276	0.0132	0.0235 +/- 0.0073	0.0132 - 0.0320
Indeno(1,2,3-cd)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- -	-
Perylene	ND	ND	ND	ND	ND	ND	ND	ND	ND +/- -	-
TOTAL HMW PAHs	0.4839	0.1088	0.3093	0.6822	0.7458	0.5272	0.5122	0.3889	0.4698 +/- 0.2033	0.1088 - 0.7458
TOTAL PAHs	0.4839	0.1139	0.3230	0.7000	0.7873	0.5459	0.5122	0.3923	0.4823 +/- 0.2120	0.1139 - 0.7873

Appendix F, Table 5D

Outer Federal Channel Metals Normalized to Fines

METALS (ppm)	OUTER FEDERAL CHANNEL E	F	G	H	I	J	AVERAGE	RANGE
ARSENIC (As)	0.000	0.130	0.040	0.014	0.015	0.025	**0.037 +/- 0.047**	**0.000 - 0.130**
CADMIUM (Cd)	0.044	0.011	0.040	0.011	0.008	0.008	**0.020 +/- 0.017**	**0.008 - 0.044**
CHROMIUM (Cr)	3.368	2.268	2.866	3.212	1.653	1.961	**2.555 +/- 0.698**	**1.653 - 3.368**
COPPER (Cu)	2.737	3.505	2.660	4.242	1.520	1.987	**2.775 +/- 0.990**	**1.520 - 4.242**
MERCURY (Hg)	0.002	0.002	0.002	0.002	0.003	0.005	**0.003 +/- 0.001**	**0.002 - 0.005**
NICKEL (Ni)	0.379	0.784	0.990	1.828	0.612	0.818	**0.902 +/- 0.499**	**0.379 - 1.828**
LEAD (Pb)	0.947	1.031	0.825	0.990	1.082	1.455	**1.055 +/- 0.214**	**0.825 - 1.455**
ZINC (Zn)	1.063	4.536	1.206	2.202	3.276	4.338	**2.770 +/- 1.517**	**1.063 - 4.536**

Appendix F, Table 5E

Northeast Petroleum Metals Normalized to Fines

	NORTHEAST PETROLEUM															
METALS (ppm)	T1	T2	B1	B2	B3	B3	B3	B4	B4	B5	B5	B6	B7	B8	AVERAGE	RANGE
ARSENIC (As)	0.007	0.007	0.011	0.011	0.013	0.004	0.187	0.010	0.008	0.015	0.013	0.015	NA	NA	**0.025 +/- 0.051**	**0.004 - 0.187**
CADMIUM (Cd)	ND	ND	ND	0.001	0.005	ND	ND	ND	ND	0.013	0.010	ND	NA	NA	**0.007 +/- 0.005**	**0.001 - 0.013**
CHROMIUM (Cr)	0.789	0.685	0.795	1.013	1.379	0.064	13.913	0.828	0.983	0.017	1.127	0.816	NA	NA	**1.868 +/- 3.813**	**0.017 - 13.913**
COPPER (Cu)	1.182	1.038	1.115	0.657	0.791	0.530	1.774	1.467	0.582	1.064	0.722	0.992	NA	NA	**0.993 +/- 0.370**	**0.530 - 1.774**
MERCURY (Hg)	0.001	0.001	0.002	0.001	0.000	0.000	0.037	0.002	0.002	0.002	0.001	0.001	NA	NA	**0.004 +/- 0.010**	**0.000 - 0.037**
NICKEL (Ni)	0.207	0.223	0.280	0.263	0.349	0.072	4.739	0.290	0.251	0.436	0.277	0.256	NA	NA	**0.637 +/- 1.295**	**0.072 - 4.739**
LEAD (Pb)	0.772	0.683	0.836	0.844	1.315	0.122	12.609	0.885	0.870	1.557	1.102	0.832	NA	NA	**1.869 +/- 3.400**	**0.122 - 12.609**
ZINC (Zn)	1.724	1.781	2.029	2.052	2.532	0.185	24.870	1.874	3.287	9.935	6.060	1.678	0.158	0.353	**4.180 +/- 6.490**	**0.158 - 24.870**

Appendix F, Table 5F

Wyatt, Inc. Metals Normalized to Fines

METALS (ppm)	B1	B2 (Arco berth)	B3	B4	B4-A	B5 (Pink Tank berth)	B6	A1	AVERAGE	RANGE
	WYATT, INC.									
ARSENIC (As)	ND	ND	ND	ND	ND	ND	ND	ND	**ND +/- -**	**0.000 - 0.000**
CADMIUM (Cd)	ND	ND	0.094	0.129	0.114	0.101	0.048	0.018	**0.084 +/- 0.042**	**0.018 - 0.129**
CHROMIUM (Cr)	4.617	2.074	3.234	3.828	3.279	2.728	1.911	0.165	**2.730 +/- 1.363**	**0.165 - 4.617**
COPPER (Cu)	7.668	3.102	5.353	11.260	6.688	6.042	5.577	ND	**6.527 +/- 2.516**	**3.102 - 11.260**
MERCURY (Hg)	ND	ND	ND	ND	ND	ND	ND	ND	**ND +/- -**	**0.000 - 0.000**
NICKEL (Ni)	2.352	0.977	0.985	1.172	0.971	0.887	0.688	0.124	**1.019 +/- 0.625**	**0.124 - 2.352**
LEAD (Pb)	8.705	2.745	3.903	6.686	4.253	3.746	0.364	0.370	**3.847 +/- 2.860**	**0.364 - 8.705**
ZINC (Zn)	ND	6.435	7.955	8.817	8.604	7.527	6.732	0.939	**6.716 +/- 2.696**	**0.939 - 8.817**

Appendix F, Table 5G

Lex/Atlantic Gateway Metals Normalized to Fines

	LEX/ATLANTIC GATEWAY										
METALS (ppm)	B2	B3	B4	B5	B6B	AB3	B11	B12	B13	AVERAGE	RANGE
ARSENIC (As)	0.182	0.044	0.026	0.442	0.496	0.072	0.755	0.475	0.076	**0.285 +/- 0.263**	**0.026 - 0.755**
CADMIUM (Cd)	0.049	0.032	0.011	0.015	0.010	0.002	0.036	0.008	0.035	**0.022 +/- 0.016**	**0.002 - 0.049**
CHROMIUM (Cr)	1.269	2.095	0.582	0.885	0.661	0.363	1.619	0.483	1.341	**1.033 +/- 0.585**	**0.363 - 2.095**
COPPER (Cu)	4.621	2.531	2.455	0.826	0.548	0.280	2.014	0.284	0.286	**1.538 +/- 1.490**	**0.280 - 4.621**
MERCURY (Hg)	0.006	0.002	0.002	0.007	0.002	0.000	0.007	0.002	0.013	**0.005 +/- 0.004**	**0.000 - 0.013**
NICKEL (Ni)	0.440	0.351	0.207	0.501	0.702	0.282	2.302	0.337	0.405	**0.614 +/- 0.649**	**0.207 - 2.302**
LEAD (Pb)	2.468	1.592	0.885	0.251	0.207	0.110	0.755	0.353	1.242	**0.874 +/- 0.782**	**0.110 - 2.468**
ZINC (Zn)	5.200	3.058	1.821	1.578	1.612	0.858	2.302	0.337	3.845	**2.290 +/- 1.522**	**0.337 - 5.200**