Monitoring Cruise at the
Central Long Island Sound Disposal Site
September 1997 and March 1998

Disposal Area Monitoring System DAMOS

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13 Monitoring surveys were conducted at the Central Long Island Sound Disposal Site (CLIS) in September 1997 and March 1998. Field operations were concentrated over the CLIS 95/96 Mound Complex and the historic New Haven 1993 Mound (NHAV 93), and nearby reference areas. The September 1997 field effort consisted of precision bathymetric and REMOTS sediment-profile imaging surveys to examine the disposal mound morphology, stability, composition and rates of benthic recolonization. The March 1998 field effort consisted of a follow-up survey to examine benthos during winter conditions, and a side-scan sonar survey over one of the reference areas (CLIS REF). At the time of the September 1997 survey, the CLIS 95/96 Mound Complex was the newest bottom feature at the disposal site. It is an example of a medium-sized, capped dredged material disposal mound, a product of deposition during the 1995-96 (66,400 m^3) and 1996-97 (255,700 m^3) disposal seasons. The material deposited during the 1996-97 disposal coalesced with the pre-existing CLIS 95 Mound to form a single feature deemed the CLIS 95/96 Mound Complex. The CLIS 95/96 Mound Complex is a regular-shaped, moderate-sized bottom feature on the CLIS seafloor. No bathymetric data documenting the interim stages of development of the mound were available. However, the compact nature of the deposit, the CDM to UDM ratio, and the results of the REMOTS survey over the 95/96 Mound suggest the UDM deposit was completely capped. A well-developed benthic community (Stage III) was found to be widespread over the CLIS 95/96 Mound Complex. Comparisons between REMOTS images collected over CLIS 95/96 and the CLIS reference areas (2500W, 4500E, and CLIS REF), showed no significant differences in RPD depths or Organism Sediment Index (OSI) values. Examination of benthic habitat conditions at the historic NHAV 93 Mound in September of 1997 showed RPD depths similar to those of July 1996, but displayed less Stage III organisms, suggesting a decline in the benthic community. The surficial sediments are susceptible to environmental stress due to elevated oxygen demand of these sediments resulting in impacts to the benthic community during seasonal hypoxic events when bottom water dissolved oxygen decreased to levels between 5.0 $mg \cdot l^{-1}$ and 3.0 $mg \cdot l^{-1}$. Results of a March 1998 survey indicated a general improvement in benthic habitat quality with an increase in the number of Stage III organisms resulting in higher OSI values. Given the cyclical pattern of recovery and decline, relating to seasonal hypoxia, several benthic cycles may occur before a reduction in organic sediment and consequent recovery of the benthic population occurs. CLIS REF was investigated in September 1997 and March 1998 to examine an area of benthic disturbance noted in the 1996 survey. In 1997, one area indicated a physically disturbed layer. Further REMOTS and side-scan sonar surveys were conducted in March 1998 and found no obvious signs of benthic disturbance. Indications of recent trawling activity were found and determined to be the most likely cause of the anomalous conditions noted in July 1996 and September 1997.

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As part of the Disposal Area Monitoring System (DAMOS) Program, monitoring surveys were conducted by Science Applications International Corporation (SAIC) at the Central Long Island Sound Disposal Site (CLIS) in September 1997 and March 1998. Field operations were concentrated over the CLIS 95/96 Mound Complex and the historic New Haven 1993 Mound (NHAV 93), as well as at nearby reference areas. The September 1997 field effort consisted of precision bathymetric and REMOTS® sediment-profile imaging surveys. These techniques were employed to examine the disposal mound morphology, stability, composition, and rates of benthic recolonization. The March 1998 field effort consisted of a follow-up sediment-profile imaging survey to examine the benthos during winter conditions, as well as a side-scan sonar survey over one of the CLIS reference areas (CLIS REF).

At the time of the September 1997 survey, the CLIS 95/96 Mound Complex was the newest bottom feature at the disposal site. It is an example of a medium-sized, capped, dredged material disposal mound. CLIS 95/96 is a product of dredged material deposition during the 1995-96 and 1996-97 disposal seasons. An estimated barge volume of 66,400 m^3 was deposited at the CDA 95 buoy position between October 1995 and March 1996, resulting in the formation of the CLIS 95 Mound. In September 1996, the CDA buoy was placed 120 m west of the new CLIS 95 Mound, and a secondary disposal point (Point A) was selected approximately 120 m northwest of the CLIS 95 Mound to accommodate a small capping project that occurred during the disposal season at CLIS. An estimated barge volume of 255,700 m^3 of dredged material was deposited in close proximity to the CDA 96 buoy and Point A during the 1996/97 disposal season. The resulting sediment deposit coalesced with the pre-existing CLIS 95 Mound to form a single bottom feature deemed the CLIS 95/96 Mound Complex.

The September 1997 survey indicated that the sediment placed at Point A merged with the CDA 96 deposit, as well as with the CLIS 95 Mound, to become the CLIS 95/96 Mound Complex, a regular-shaped, moderate-sized bottom feature on the CLIS seafloor. No bathymetric data documenting the interim stages of development were available. However, the compact nature of the deposit, the CDM to UDM ratio, and the results of the REMOTS® sediment-profile imaging survey over the CLIS 95/96 Mound Complex suggest the UDM deposit was completely capped. A well-developed benthic community (Stage III) was found to be widespread over the CLIS 95/96 Mound Complex. Comparisons between REMOTS® images collected over CLIS 95/96 and the CLIS reference areas (2500W, 4500E, and CLIS-REF) showed no significant differences in RPD depths or OSI values.

In addition to the survey operations performed over the CLIS 95/96 Mound Complex, benthic habitat conditions on the surface of the historic NHAV 93 Mound were examined. Although RPD depths were comparable to the previous monitoring survey of July 1996, the images collected over the NHAV 93 Mound in September 1997 displayed less Stage III activity, suggesting a decline in the benthic community. The benthic community inhabiting the surficial sediments of the NHAV 93 Mound is generally more susceptible to environmental stress, due to the high apparent organic content and corresponding elevated oxygen demand of these sediments. As a result, the benthic community is impacted during seasonal hypoxic events when bottom water dissolved oxygen concentrations decrease to levels between 5.0 $mg \cdot l^{-1}$ and 3.0 $mg \cdot l^{-1}$. The results of the REMOTS® sediment-profile imaging survey indicated the benthic community was continuing to recover as expected, though impeded by the annual Sound-wide hypoxia events.

The results of a follow-up survey over NHAV 93 in March 1998 indicated a general improvement in benthic habitat quality, as increased near-bottom dissolved oxygen conditions apparently reduced environmental stress levels for the benthos. An increase in the number of Stage III organisms was detected at multiple stations, resulting in higher Organism Sediment Index (OSI) values. However, given the cyclical pattern of recovery and decline closely related to the onset and severity of seasonal hypoxia in the region, several benthic population cycles may occur at the mound as chemical and biological processes gradually reduce the level of organic carbon in the sediment. Barring a dramatic disturbance, complete benthic recovery should be achieved within the next few years, as continued chemical oxidation and increased biological activity dissipate the organic load within the sediment deposits.

The CLIS REF reference area was subjected to a detailed investigation in September 1997 and March 1998 to examine an area of apparent benthic disturbance. In July 1996, one replicate sediment-profile image obtained from Station 9 at CLIS-REF displayed an anomalous pocket of low reflectance, fine-grained material resembling non-ambient material and a physically disturbed surface layer. In 1997, one of six replicate images collected at the location of the 1996 disturbance displayed a physically disturbed surface layer and a chaotic sediment fabric. To further investigate the area, a nine-station REMOTS® survey and a five-lane side-scan sonar survey were conducted in early March 1998. No major areas of benthic disturbance were detected in the side-scan sonar record, and no obvious signs of further benthic disturbance were noted in the additional REMOTS® images. However, indications of recent trawling activity were found, and determined to be the most likely cause for the anomalous conditions noted in July 1996 and September 1997.

1.0 INTRODUCTION

1.1 Background

The New England District (NAE) of the U.S. Army Corps of Engineers regulates coastal dredging operations from Eastport, Maine, to Byram, Connecticut. In 1977, the Disposal Area Monitoring System (DAMOS) Program was developed in response to the recognized need for the managed disposal of the volumes of sediments dredged from the ports and harbors of the northeastern United States. The DAMOS Program currently oversees the use of ten closely monitored open water disposal sites along the New England coast. These sites are utilized for the cost-effective and environmentally sound disposal of dredged sediments removed from waterways within the New England and New York Districts (Long Island, Westchester County).

The Central Long Island Sound Disposal Site (CLIS) is one of four regional dredged material disposal sites located in the waters of Long Island Sound. CLIS covers a 6.86 km^2 (2 nmi^2) area and is centered at 41°08.902' N, 72°52.823' W, (NAD 83), (41°08.900' N, 72°52.850' W [NAD 27]; Morris 1996). It is located approximately 10.89 km (5.6 nmi) south of South End Point, East Haven, Connecticut (Figure 1-1). Historically, CLIS has been one of the most active disposal sites in the New England region. Sediments deposited at CLIS have been dredged from New Haven, Bridgeport, Stamford, and Norwalk Harbors, as well as other adjacent coastal areas.

Before dredging operations commence, the proposed project sediments are subjected to comprehensive testing in order to determine their physical and chemical properties, as well as evaluate potential biological impacts. Sediments originating from most of coastal New England are often classified as suitable for unconfined open water disposal. This material may be deposited at open water disposal sites or utilized as part of beneficial use projects. However, the sediments dredged from industrialized harbors or waterways tend to contain a variety of contaminants associated with urbanization (i.e., trace metals, organic compounds, etc.; NOAA 1991). Sediments with elevated contaminant levels require special handling techniques and are classified as unacceptably contaminated dredged material (UDM; Fredette 1994). If determined to be the best course of action, this material may be transported to an open water disposal site and placed on the seafloor at a pre-determined location. This UDM deposit would then be completely covered with a layer of capping dredged material (CDM) to isolate the contaminants from the marine environment.

During the 1978–79 disposal season at CLIS, subaqueous capping was introduced as a dredged material management approach with the formation of the Stamford-New Haven mounds (STNH-N and STNH-S; SAI 1979). As a result of the operational success of the 1979 capping project, many capped mounds have been developed over the CLIS seafloor.

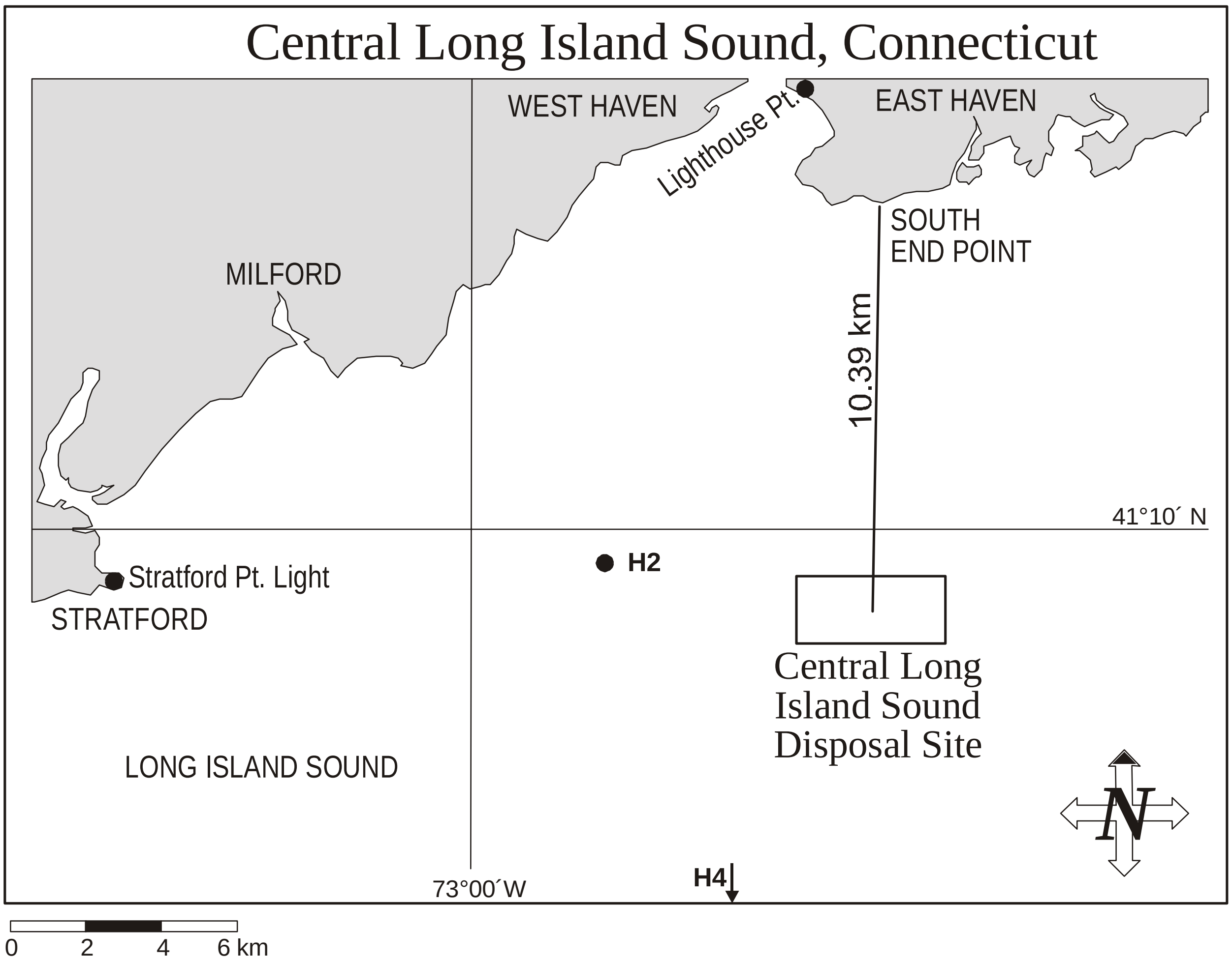


Figure 1-1. Location of the Central Long Island Sound Disposal Site and shore station benchmarks. In addition, the Connecticut Department of Environmental Protection Water Quality Monitoring Stations H2 and H4 are shown to indicate their locations relative to CLIS.

Science Applications International Corporation (SAIC) conducted a monitoring survey at CLIS from 10 to 15 September 1997 as part of the DAMOS Program. The field efforts were concentrated over the newly completed CLIS 95/96 Mound Complex to document the formation of the bottom feature and subsequent benthic recovery. The field activity included precision bathymetry and REMOTS® sediment-profile imaging over the project mound. In addition, sediment-profile imaging surveys were conducted over the historic New Haven 1993 (NHAV 93) Mound and the CLIS reference areas. A follow-on survey consisting of side-scan sonar and sediment-profile imaging was performed on 3 March 1998 over CLIS REF; supplemental sediment-profile imaging surveys also were conducted over the CLIS 95/96 Mound Complex and the NHAV 93 Mound.

1.2 CLIS 95/96 Mound Complex

At the time of the September 1997 surveys, the CLIS 95/96 Mound Complex was the newest feature on the CLIS seafloor. This bottom feature was the result of the recent deposition of dredged sediments at the CDA 96 buoy and Point A (an alternate disposal point), which coalesced into the pre-existing CLIS 95 Mound.

The CLIS 95 Mound was a small, capped mound that was encompassed by material placed at CLIS during the 1996-97 disposal season. In September 1995, the CDA buoy was deployed at 41°08.662' N, 72°53.015' W (NAD 83), (41°08.660' N, 72°53.042' W [NAD 27]) approximately 450 m southwest of the historic NHAV 74 Mound apex (Figure 1-2). An estimated barge volume of 16,300 m^3 of UDM dredged from Milford and Bridgeport Harbors was deposited in close proximity to the CDA 95 buoy, forming a small mound. Capping operations commenced on 30 October 1995 and continued through 4 March 1996. A total of 50,100 m^3 of CDM generated from dredging projects in the West River and Bridgeport Harbor was used to completely isolate the UDM deposit (Figure 1-3). The end result was a small, stable mound yielding a CDM to UDM ratio of 3.1:1.0 (Morris 1998a).

In September 1996, the CDA 96 buoy was deployed at 41°08.672' N, 72°53.106' W (NAD 83), (41°08.666' N, 72°53.133' W [NAD 27]) approximately 127 m west of the CLIS 95 Mound apex (Figure 1-2). An estimated barge volume of 42,028 m^3 of UDM dredged from West Cove and United Illuminating was deposited in close proximity to the CDA 96 buoy (Figure 1-3; Appendix A1). Capping operations commenced on 17 October 1996 and continued through 13 March 1997. A total of 178,868 m^3 of CDM generated from dredging projects in the West River and Bridgeport Harbor was used to completely isolate the UDM deposit (Figure 1-3; Appendix A2).

Due to logistical issues within the various dredging and disposal operations utilizing CLIS during the 1996-97 disposal season, an alternative disposal point was selected to accommodate capping projects that had begun later in the disposal season. Rather than place

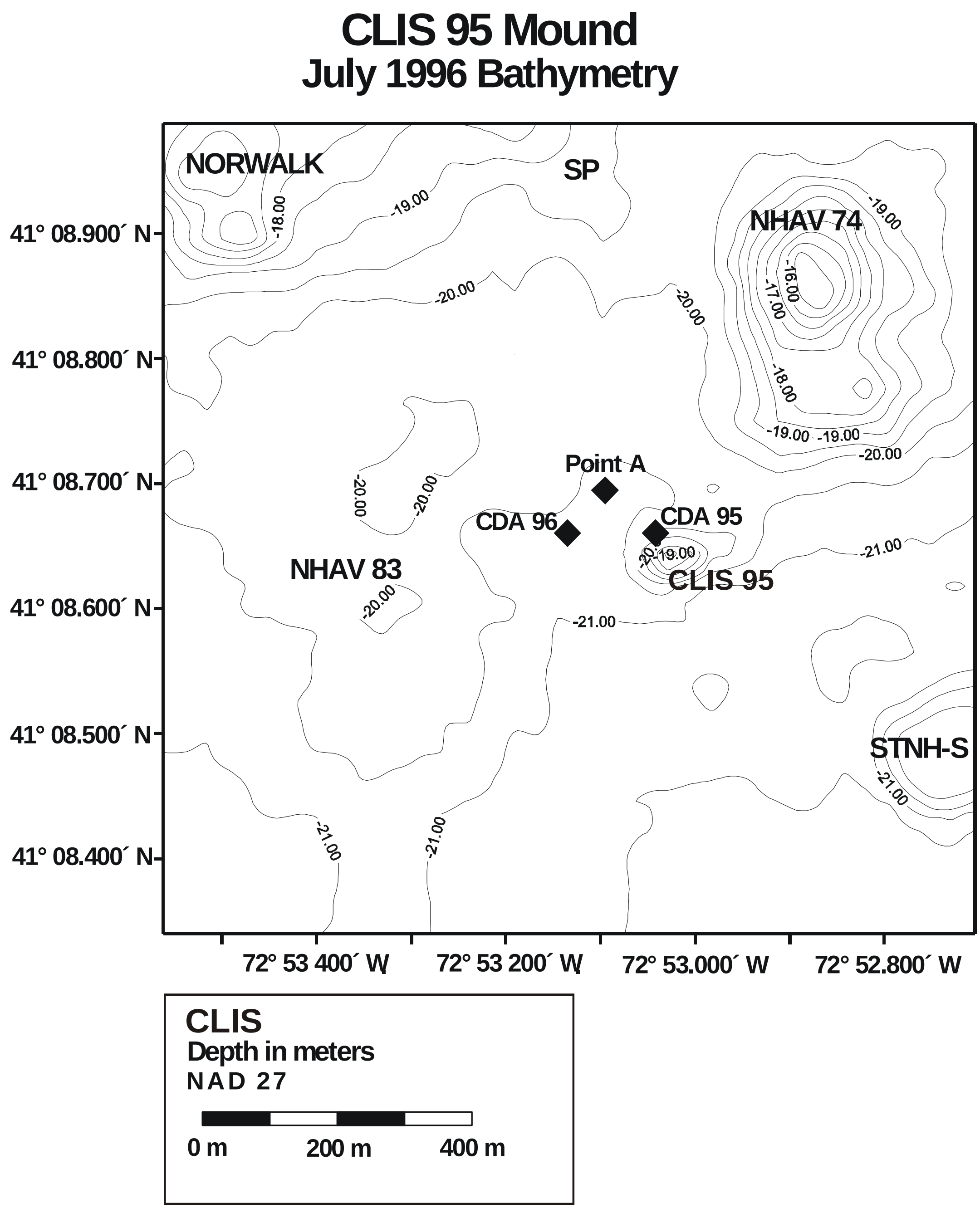


Figure 1-2. July 1996 bathymetry with plotted DAMOS disposal buoy positions for the 1995-96 and 1996-97 disposal seasons

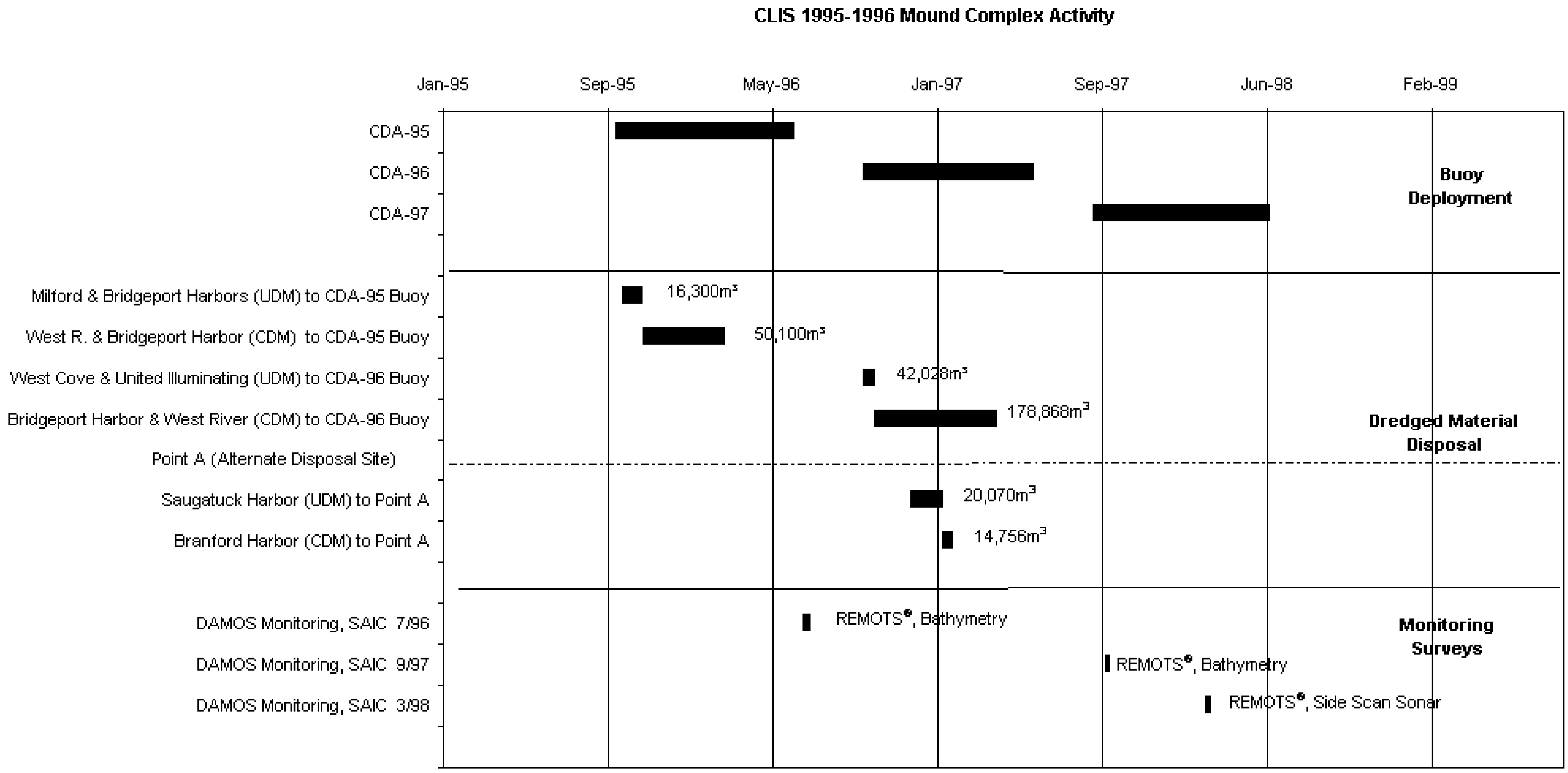


Figure 1-3. Timeline showing dredged material disposal activity at the Central Long Island Sound Disposal Site over the 1995-96 and 1996-97 disposal seasons and environmental monitoring activity from September 1996 to March 1998.

UDM on the apex of a developing mound, the material was directed to a point on the inner side of the mound complex to enhance its containment and minimize its lateral spread. In addition, the alternate disposal point prevented the development of alternating layers of UDM and CDM within the CDA 96 deposit. Point A was located at 41°08.701' N, 72°53.068' W NAD 83, (41°08.695' N, 72°53.095' W [NAD 27]) approximately 76 m northeast of the CDA 96 buoy and 92 m northwest of the CLIS 95 position, but no disposal buoy was deployed at this location (Figure 1-2).

From 11 December 1996 to 28 January 1997, an estimated barge volume of 20,070 m^3 of UDM dredged mostly from the Saugatuck Harbor was deposited at Point A (Figure 1-3; Appendix A3). The UDM deposit was then capped with a total of 14,756 m^3 of CDM from Branford Harbor (Figure 1-3; Appendix A4). After 12 February 1997, CDM was directed back to the CDA 96 buoy position with cap material deposited in the area through 20 April (Figure 1-3; Appendix A2). Because of the close proximity of Point A to the CDA 96 buoy, considerable overlap of the CDM was expected. The material disposed at Point A merged with the sediments at the CDA 96 buoy and the existing CLIS 95 Mound to become the CLIS 95/96 complex, a moderate-sized disposal mound.

1.3 NHAV 93 Mound

The NHAV 93 Mound was developed during the 1993–94 disposal season as part of a large-scale confined aquatic disposal (CAD) project. The management strategy of controlling the deposition of small to moderate volumes of dredged material over a ten-year period resulted in the formation of a ring of disposal mounds on the CLIS seafloor. Upon completion in 1992, this network of disposal mounds formed an artificial containment cell capable of accepting a large volume of UDM, limiting the lateral spread of the deposit, and facilitating efficient capping operations.

In 1993, approximately 590,000 m^3 of UDM dredged from the inner New Haven Harbor was deposited within the containment cell and capped to a thickness of 0.5 m to 1.0 m by 569,000 m^3 of CDM (Morris et al. 1996). The completed CAD mound was found to be broad, stable, adequately capped, and exhibiting a CDM to UDM ratio of 0.96:1.0. In the past, CDM to UDM ratios have varied from 2:1 to 6:1 when initiating a capping operation on a flat or gently sloping area of seafloor. Using the containment cell to limit the spread of UDM on the seafloor resulted in the formation of the first capped mound composed of a smaller volume of CDM than the initial UDM deposit. In addition, the completed NHAV 93 Mound formed a distinct, broad and flat mound complex as the project sediments merged with the smaller seven mounds at the perimeter (Morris and Tufts 1997).

The development of the CLIS 95/96 Mound Complex represents the continuation of this successful management strategy. By constructing networks of disposal mounds with small to moderate volumes of dredged material, numerous artificial containment cells will be formed, and the overall site capacity can be maximized (Morris et al. 1996). The formation of the CLIS 95/96 Mound Complex southwest of the historic NHAV 74 Mound continues the formation of a second artificial containment structure on the CLIS seafloor.

1.4 CLIS Reference Areas

As part of the DAMOS monitoring protocols, reference area data are collected to provide a baseline against which the results from the dredged material disposal mounds are compared. These areas are utilized due to their reflection of ambient conditions within the central Long Island Sound region. On occasion, indications of natural (hypoxia) or anthropogenic (trawling activity) disturbances are found within the confines of the CLIS reference areas.

During the July 1996 survey, one replicate REMOTS® photograph collected over CLIS REF documented the presence of a limited quantity of dark, organically enriched sediment within a 300 m radius of the central reference point (Morris 1998a). CLIS REF has been used for comparison with CLIS sediments since the inception of the DAMOS Program in 1977 and has consistently been free of anthropogenic disturbances. Due to the long history of use as a CLIS reference area, this disturbance warranted further investigation. During the September 1997 survey activity, six replicate REMOTS® photographs were collected at the location of the anomalous sediment. One of the replicates images obtained in September 1997 also appeared to display non-ambient sediment, or possible dredged material. As a result, the area was investigated further during the March 1998 field effort.

1.5 Seasonal Hypoxia

The effects of seasonal hypoxia on DAMOS monitoring results have been well documented at CLIS and the Western Long Island Sound Disposal Site (WLIS) over the past few years (Morris 1997, Morris 1998a, Morris 1998b, and Murray and Saffert 1999). The seasonal reduction in available oxygen (O_2) begins to degrade benthic habitat conditions in late July and August, with impacts being detectable in the benthos well into September. The duration and severity of the hypoxia event often plays a major role in the interpretation of environmental monitoring data pertaining to benthic recolonization status and overall condition of the benthic community.

A comprehensive water quality monitoring program sponsored by the Connecticut Department of Environmental Protection (CTDEP) has been used to provide information regarding the onset and duration of seasonal hypoxia relative to the timing of DAMOS monitoring surveys in Long Island Sound. These data usually show dissolved oxygen concentrations approaching 12.0 $mg \cdot l^{-1}$ in mid-March, followed by a gradual, but steady reduction in available oxygen as the waters of Long Island Sound become warmer throughout the spring and summer. Typically, bottom water dissolved oxygen concentrations below 3.0 mg·l^{-1} are detected in August before rebounding in September and October to levels protective of most marine life (≥5.0 mg·l^{-1}; LISS 1990).

The March 1998 monitoring cruise provided an opportunity to collect sediment-profile photographs over the CLIS project mounds and the reference areas during a period of the year when dissolved oxygen concentrations are traditionally at their highest. These data would then be used to compare winter conditions in the surface sediments to the pre-hypoxia (July) and post-hypoxia (August/September) conditions monitored during the summer months.

1.6 Objectives and Predictions

The specific objectives of the September 1997 monitoring cruise at CLIS were:

1) conduct a bathymetric survey capable of delineating the footprint of the new dredged material deposits at CDA 96 and Point A, while documenting any topographic changes at the CLIS 95 Mound;

2) assess the benthic recolonization status over the CLIS 95/96 Mound Complex and the NHAV 93 Mound, relative to three reference areas surrounding CLIS; and

3) further examine the apparent benthic disturbance identified at CLIS REF during the July 1996 survey.

The September 1997 field effort tested the following predictions:

- The dredged material deposited during the 1996–97 disposal season will result in a medium-sized disposal mound, conical or bimodal in shape and completely capped.

- The sediments of the CLIS 95/96 Mound Complex are expected to be supporting a solid Stage I population with some progression into Stage II or Stage III assemblages.

- The surface sediments of the NHAV 93 should be supporting mature benthic assemblages with Stage I, II, and III individuals present in relative abundance.

- Due to the timing of survey relative to the seasonal hypoxia event within the central Long Island Sound region, benthic conditions over both the disposal mounds and reference areas will not show marked improvement relative to the July 1996 survey.

The March 1998 survey was conducted to:

1) evaluate the aerial extent of disturbed sediments at CLIS REF; and

2) collect additional sediment-profile imaging data over the NHAV 93 Mound and the CLIS 95/96 Mound Complex to compare benthic habitat conditions at CLIS in the winter months (higher dissolved oxygen concentrations) versus the summer months (lower dissolved oxygen concentrations).

The March 1998 survey tested the following predictions:

- The physical disturbances found at CLIS REF should be localized and temporary, with no detectable dredged material deposits found; and

- the colder bottom waters in March should provide ample dissolved oxygen to support benthic infaunal populations, contributing to increased numbers of Stage III organisms. However, decreased bioturbational activity by the infauna within the surface sediments at this time of the year will hinder a significant increase in the depth of oxygen penetration (RPD) into the near surface sediments.

2.0 METHODS

2.1 September 1997 Survey Operations

2.1.1 Bathymetric Survey Area

In order to fulfill the objectives of the 1997 CLIS monitoring survey, a precision bathymetric survey was performed over the CLIS 95/96 Mound Complex. The September 1997 bathymetric survey covered a 1200 × 1200 m area, centered at 41°08.992' N, 72°53.245' W (NAD 83; 41°08.990' N, 72°53.272' W [NAD 27]). A total of 49 survey lanes, oriented east-west and spaced at 25 m intervals, were occupied to delineate the seafloor topography within the area of interest (Figure 2-1). Detailed bathymetric charts were generated for the 1.44 km^2 survey area, as well as an area of concentrated analysis over the CLIS 95/96 Mound Complex to accurately quantify mound height and lateral spread of dredged material.

2.1.2 Navigation

In an effort to provide optimal comparisons with historic data sets, bathymetric data were collected with the use of SAIC's Integrated Navigation and Data Acquisition System (INDAS). 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 data to an accuracy of ±3 m in the horizontal control of North American Datum of 1927 (NAD 27). 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) (Figure 1-1). A detailed description of the navigation system and its operation can be found in the DAMOS Navigation and Bathymetry Reference Report (Murray and Selvitelli 1996).

In order to maximize the efficiency of sediment-profile imaging survey operations at CLIS, Differential Global Positioning System (DGPS) data, in conjunction with SAIC's Portable Integrated Navigation and Survey System (PINSS), were used to position the survey vessel over the September 1997 and March 1998 sampling stations. A Magnavox 4200D GPS receiver interfaced with a Magnavox MX50R differential beacon receiver provided DGPS positioning data to PINSS in the horizontal control of North American Datum of 1983 (NAD 83) to an accuracy of ±5 m. The Coast Guard differential beacon broadcasting from Montauk Point, Long Island, New York (293 kHz) was utilized for satellite corrections due to its geographic position relative to CLIS.

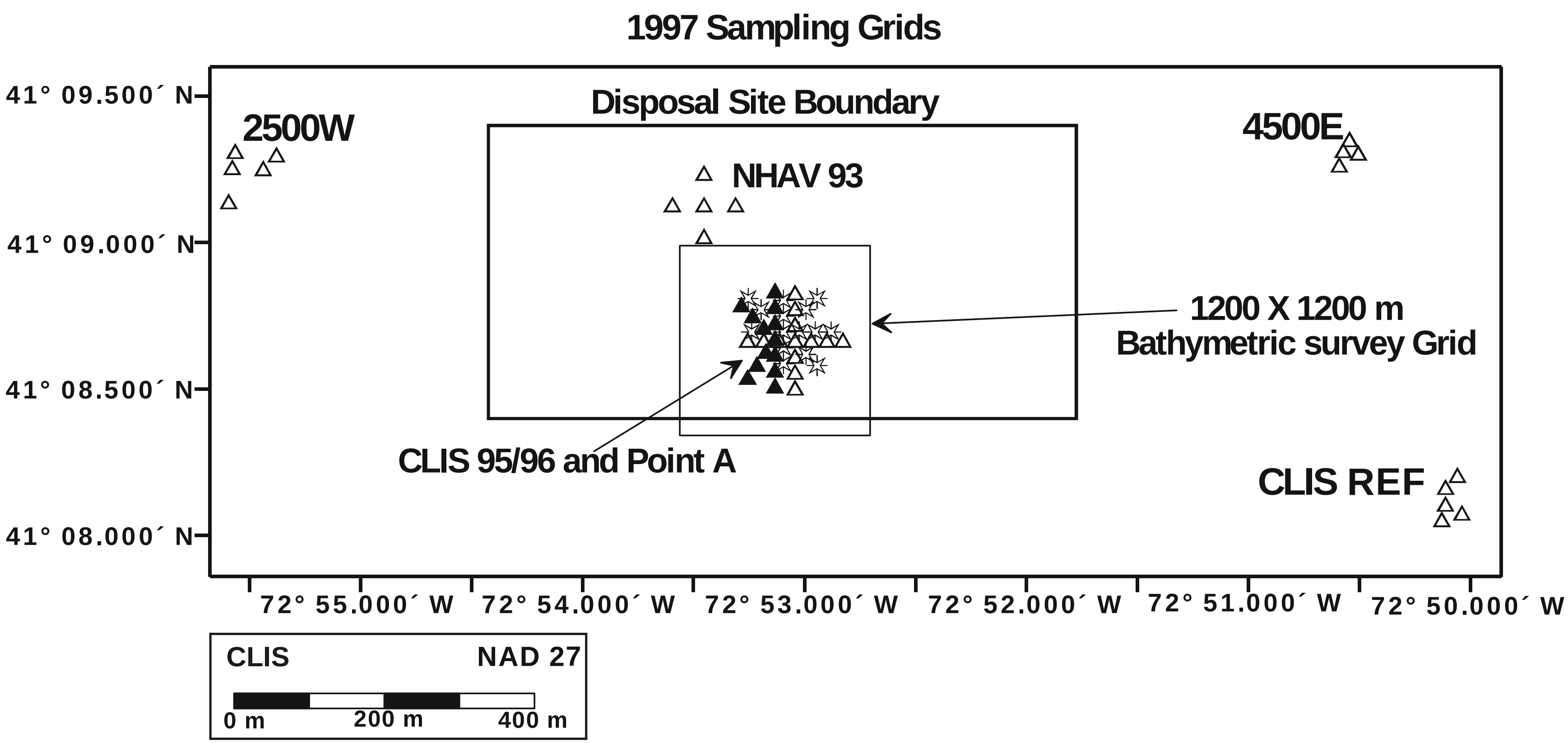


Figure 2-1. Chart of the 1200 × 1200 m bathymetric survey area and REMOTS® stations relative to the Central Long Island Sound Disposal Site boundaries

The target REMOTS® station locations were calculated in NAD 27, then converted to NAD 83 for real-time navigation using the U.S. Army Topographic Engineering Center's CORPSCON version 3.01. The actual positions of the REMOTS® replicate photographs were later reconverted to NAD 27 with CORPSCON for DAMOS database entry and reporting within this document.

2.1.3 Bathymetric Data Collection and Processing

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.) as described in the DAMOS Navigation and Bathymetry Reference Report (Murray and Selvitelli 1996). Depth values transmitted to INDAS were adjusted for transducer depth. The acoustic returns of the fathometer are generally accurate to 0.05% of the water depth measured. However, comparisons between sequential bathymetric surveys can reliably detect changes in depth of 20 cm or greater due to the accumulation of errors introduced by the positioning system, vertical motion of the survey vessel, changes in sound velocity through the water column, the slope of the bottom, and tidal corrections.

To reduce the effects of these errors, observed tidal data obtained through the National Oceanographic and Atmospheric Administration (NOAA), Ocean and Lake Levels Division's (OLLD) National Water Level Observation Network were applied to the raw bathymetric soundings. Data from NOAA tide station 8467150 in Bridgeport Harbor, Bridgeport, CT were used for tidal calculations for the September 1997 survey over CLIS. The NOAA 6-minute tide data were downloaded in the vertical datum of Mean Lower Low Water (MLLW) and corrected to local time. Tidal differences based on the entrance to New Haven Harbor, New Haven, CT, were applied to minimize time and height offsets.

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 intervals to account for any pycnoclines, rapid changes in density that create distinct layers within the water column. Sound velocity correction factors were then calculated using the bin-averaged values.

The bathymetric data were analyzed using SAIC's Hydrographic Data Analysis System (HDAS), version 1.03. Raw bathymetric data were imported into HDAS, corrected for sound velocity, and standardized to mean lower low water using the NOAA observed tides. The bathymetric data were then used to construct depth models of the surveyed area. A detailed discussion of the bathymetric analysis technique is provided in the DAMOS Bathymetry and Navigation Reference Report (Murray and Selvitelli 1996).

2.1.4 REMOTS® Sediment-Profile Imaging

Remote Ecological Monitoring of the Seafloor (REMOTS®) is a benthic sampling technique used to detect and map the distribution of thin (<20 cm) dredged material layers, map benthic disturbance gradients, and monitor the process of benthic recolonization at dredged material disposal mounds. This is a reconnaissance survey technique used for rapid collection, interpretation and mapping of data on physical and biological seafloor characteristics. The DAMOS Program has used this technique for routine disposal site monitoring for over 20 years. The REMOTS® hardware consists of a Benthos Model 3731 sediment-profile camera designed to obtain undisturbed, vertical cross-section photographs (*in situ* profiles) of the upper 15 to 20 cm of the seafloor (Figure 2-2). Computer-aided analysis of each REMOTS® image yields a suite of standard measured parameters, including sediment grain size major mode, camera prism penetration depth (an indirect measure of sediment bearing capacity/density), small-scale surface boundary roughness, depth of the apparent redox potential discontinuity (RPD, a measure of sediment aeration), infaunal successional stage, and Organism-Sediment Index (a summary parameter reflecting overall benthic habitat quality). Standard REMOTS® image acquisition and analysis methods are described fully in Rhoads and Germano (1982; 1986) and in the recent DAMOS Contribution No. 128 (SAIC 2001) and therefore not repeated herein.

The REMOTS® sampling grids established over the CLIS 95/96 Mound Complex consisted of three cross-shaped patterns intersecting at the central disposal points for CLIS 96, Point A, and CLIS 95. Three replicate photographs were collected at each of 13 stations established over the CLIS 95 and CLIS 96 deposits, with a total of 14 stations occupied around the Point A sediment deposit (Figure 2-3). This sampling configuration was used for maximize spatial coverage over the disposal mound complex, as well as for consistency with the usual DAMOS sampling procedures. Due to the close proximity of the three disposal points, the sampling scheme was adjusted to eliminate overlap of individual stations.

A standard 13-station cross-grid was established over the CLIS 95 Mound with sampling locations extending 300 m to the north, south, east, and west. Stations (denoted by black squares in Figure 2-3) were spaced at 100 m intervals with the grid centered at 41°08.662′ N, 72°53.015′ W (NAD 83), duplicating the July 1996 survey grid (Figure 2-3; Table 2-1). A modified 13-station sampling grid was employed to characterize the CLIS 96 sediment deposit. Based on a center of 41°08.672´ N, 72°53.106´ W (NAD 83) and 100 m spacing, the CLIS 96 stations (denoted by red triangles) extended 300 m to the north, south, southwest, and northwest (Figure 2-3; Table 2-1). An additional 15 stations (denoted by blue circles) were distributed around the center for Point A (41°08.701´ N, 72°53.068´ W; NAD 83) to serve as fill in areas that lacked adequate coverage. Station placement was based on a 100 m spacing interval with coverage extending 200 m north, south, and west, as well as 300 m northeast, east, and southeast (Figure 2-3; Table 2-1).

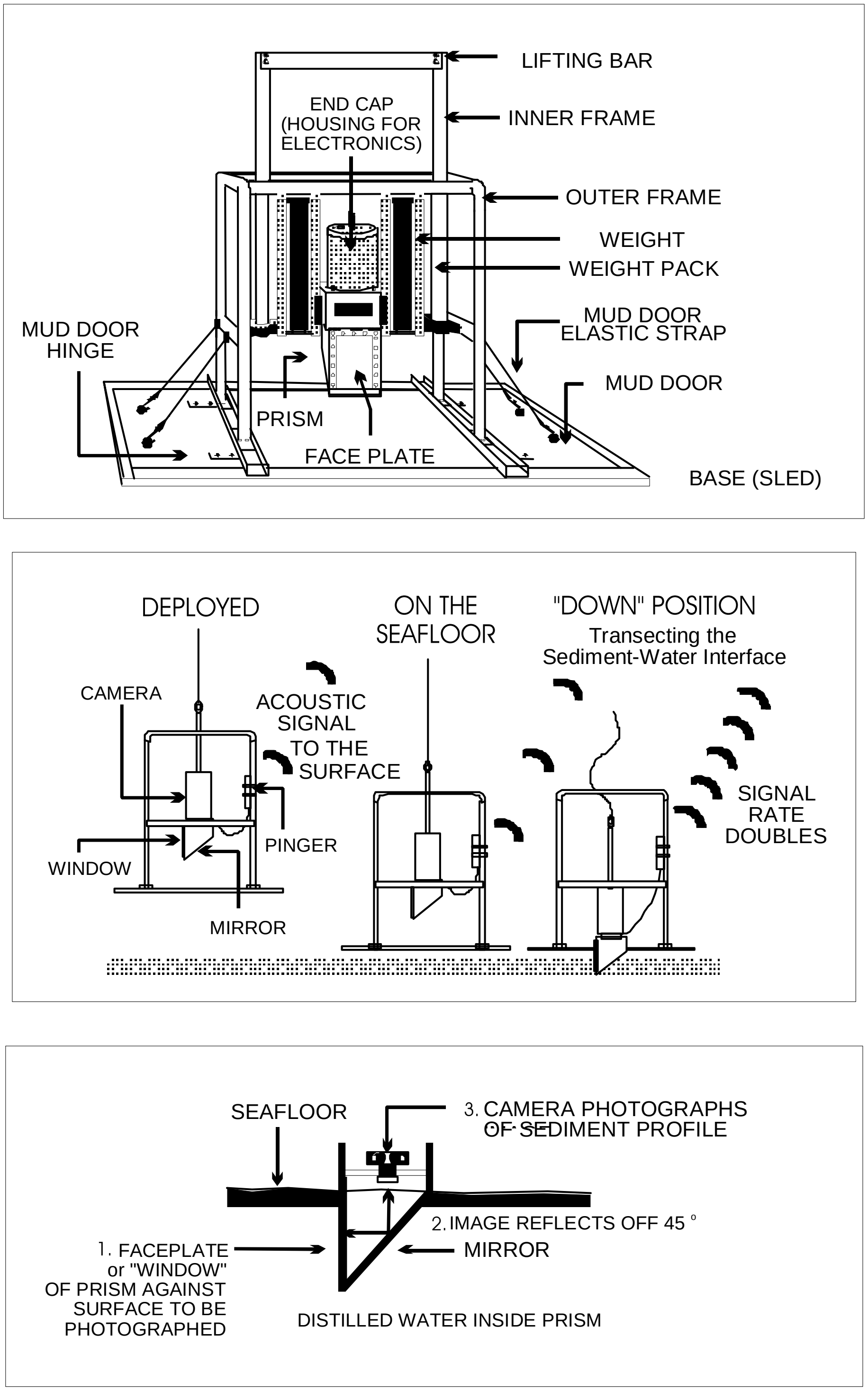


Figure 2-2. Schematic diagram of Benthos, Inc. Model 3731 REMOTS® sediment-profile camera and sequence of operation on deployment

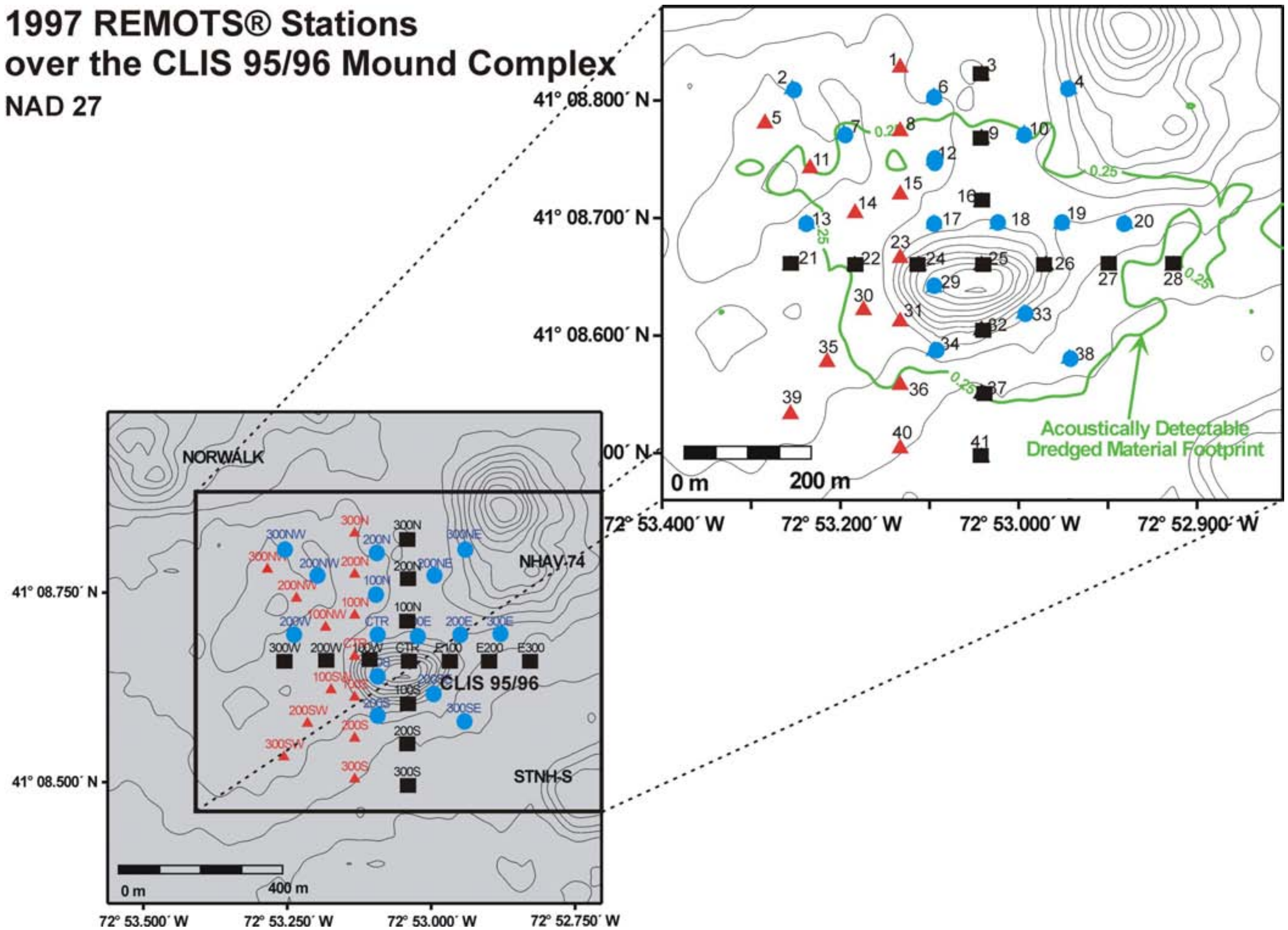


Figure 2-3. REMOTS® sediment-profile imaging stations established over the CLIS 95 Mound (black squares), as well as the CLIS 96 (red triangles) and Point A (blue circles) sediment deposits, plotted over a depth difference comparison between the July 1996 and September 1997 surveys.

Table 2-1. REMOTS® Sampling Locations over the CLIS 95/96 Mound Complex September 1997 and March 1998. Coordinates are shown for both NAD 1927 and NAD 1983.

September 1997

CLIS 95/96 REMOTS® Stations NAD 1927					CLIS 95/96 REMOTS® Stations NAD 1983				
Area	Station	Station	Latitude	Longitude	Area	Station	Station	Latitude	Longitude
	CTR	23	41° 08.666´ N	72° 53.133´ W		CTR	23	41° 08.672´ N	72° 53.106´ W
	100N	15	41° 08.720´ N	72° 53.133´ W		100N	15	41° 08.726´ N	72° 53.106´ W
	200N	8	41° 08.774´ N	72° 53.133´ W		200N	8	41° 08.780´ N	72° 53.106´ W
	300N	1	41° 08.828´ N	72° 53.133´ W		300N	1	41° 08.834´ N	72° 53.106´ W
CLIS 96	100S	31	41° 08.612´ N	72° 53.133´ W	CLIS 96	100S	31	41° 08.618´ N	72° 53.106´ W
SURVEY	200S	32	41° 08.558´ N	72° 53.133´ W	SURVEY	200S	32	41° 08.564´ N	72° 53.106´ W
41° 08.666´ N	300S	40	41° 08.504´ N	72° 53.133´ W	41° 08.672´ N	300S	40	41° 08.510´ N	72° 53.106´ W
72° 53.133´ W	100NW	14	41° 08.704´ N	72° 53.184´ W	72° 53.106´ W	100NW	14	41° 08.710´ N	72° 53.156´ W
	200NW	11	41° 08.742´ N	72° 53.234´ W		200NW	11	41° 08.748´ N	72° 53.207´ W
	300NW	5	41° 08.781´ N	72° 53.285´ W		300NW	5	41° 08.786´ N	72° 53.257´ W
	100SW	30	41° 08.622´ N	72° 53.174´ W		100SW	30	41° 08.628´ N	72° 53.147´ W
	200SW	35	41° 08.577´ N	72° 53.215´ W		200SW	35	41° 08.583´ N	72° 53.188´ W
	300SW	39	41° 08.533´ N	72° 53.256´ W		300SW	39	41° 08.539´ N	72° 53.229´ W
	CTR	17	41° 08.695´ N	72° 53.095´ W		CTR	17	41° 08.701´ N	72° 53.068´ W
	100N	12	41° 08.749´ N	72° 53.095´ W		100N	12	41° 08.755´ N	72° 53.068´ W
	200N	6	41° 08.803´ N	72° 53.095´ W		200N	6	41° 08.809´ N	72° 53.068´ W
Point A 96	100S	29	41° 08.641´ N	72° 53.095´ W	Point A 96	100S	29	41° 08.647´ N	72° 53.068´ W
SURVEY	200S	34	41° 08.587´ N	72° 53.095´ W	SURVEY	200S	34	41° 08.593´ N	72° 53.068´ W
41° 08.695´ N	100E	18	41° 08.695´ N	72° 53.024´ W	41° 08.701´ N	100E	18	41° 08.701´ N	72° 52.996´ W
72° 53.095´ W	200E	19	41° 08.695´ N	72° 52.952´ W	72° 53.068´ W	200E	19	41° 08.701´ N	72° 52.925´ W
	300E	20	41° 08.695´ N	72° 52.881´ W		300E	20	41° 08.701´ N	72° 52.853´ W
	200SE	33	41° 08.619´ N	72° 52.994´ W		200SE	33	41° 08.624´ N	72° 52.967´ W
	300SE	38	41° 08.580´ N	72° 52.943´ W		300SE	38	41° 08.586´ N	72° 52.916´ W
	200W	13	41° 08.695´ N	72° 53.238´ W		200W	13	41° 08.701´ N	72° 53.211´ W
	200NW	7	41° 08.771´ N	72° 53.196´ W		200NW	7	41° 08.777´ N	72° 53.169´ W
	300NW	2	41° 08.810´ N	72° 53.254´ W		300NW	2	41° 08.815´ N	72° 53.227´ W
	200NE	10	41° 08.771´ N	72° 52.994´ W		200NE	10	41° 08.777´ N	72° 52.967´ W
	300NE	4	41° 08.810´ N	72° 52.943´ W		300NE	4	41° 08.815´ N	72° 52.916´ W
	CTR	25	41° 08.660´ N	72° 53.042´ W		CTR	25	41° 08.666´ N	72° 53.015´ W
	100N	16	41° 08.714´ N	72° 53.042´ W		100N	16	41° 08.720´ N	72° 53.015´ W
	200N	9	41° 08.768´ N	72° 53.042´ W		200N	9	41° 08.774´ N	72° 53.015´ W
CLIS 95	300N	3	41° 08.822´ N	72° 53.042´ W	CLIS 95	300N	3	41° 08.828´ N	72° 53.015´ W
SURVEY	100S	32	41° 08.605´ N	72° 53.042´ W	SURVEY	100S	32	41° 08.611´ N	72° 53.015´ W
41° 08.660´ N	200S	37	41° 08.551´ N	72° 53.042´ W	41° 08.660´ N	200S	37	41° 08.557´ N	72° 53.015´ W
72° 53.042´ W	300S	41	41° 08.497´ N	72° 53.042´ W	72° 53.015´ W	300S	41	41° 08.503´ N	72° 53.015´ W
	100E	26	41° 08.660´ N	72° 52.970´ W		100E	26	41° 08.666´ N	72° 52.943´ W
	200E	27	41° 08.660´ N	72° 52.899´ W		200E	27	41° 08.666´ N	72° 52.872´ W
	300E	28	41° 08.660´ N	72° 52.827´ W		300E	28	41° 08.666´ N	72° 52.800´ W
	100W	24	41° 08.660´ N	72° 53.113´ W		100W	24	41° 08.666´ N	72° 53.086´ W
	200W	22	41° 08.660´ N	72° 53.184´ W		200W	22	41° 08.666´ N	72° 53.157´ W
	300W	21	41° 08.660´ N	72° 53.256´ W		300W	21	41° 08.666´ N	72° 53.229´ W

March 1998

CLIS 95/96 REMOTS® Stations NAD 1927					CLIS 95/96 REMOTS® Stations NAD 1983				
Area	Station	Station	Latitude	Longitude	Area	Station	Station	Latitude	Longitude
	CTR	23	41° 08.666´ N	72° 53.133´ W		CTR	23	41° 08.672´ N	72° 53.106´ W
CLIS 96	100N	15	41° 08.720´ N	72° 53.133´ W	CLIS 96	100N	15	41° 08.726´ N	72° 53.106´ W
	100S	31	41° 08.612´ N	72° 53.133´ W		100S	31	41° 08.618´ N	72° 53.106´ W
	CTR	25	41° 08.660´ N	72° 53.042´ W		CTR	25	41° 08.666´ N	72° 53.015´ W
	100N	16	41° 08.714´ N	72° 53.042´ W		100N	16	41° 08.720´ N	72° 53.015´ W
CLIS 95	100S	32	41° 08.605´ N	72° 53.042´ W	CLIS 95	100S	32	41° 08.611´ N	72° 53.015´ W
	100E	26	41° 08.660´ N	72° 52.970´ W		100E	26	41° 08.666´ N	72° 52.943´ W
	100W	24	41° 08.660´ N	72° 53.113´ W		100W	24	41° 08.666´ N	72° 53.086´ W

A total of 41 REMOTS® stations were established over the CLIS 95/96 Mound Complex as part of the September 1997 survey. Given the close proximity of these stations and the distribution of fresh dredged material in the active area of disposal, a secondary numbering system was developed for the CLIS 95/96 survey grid to facilitate more efficient presentation of results for the individual stations (Figure 2-3). For the purposes of this report the stations were numbered 1 through 41 to minimize the references to the grid center (i.e., CLIS 96, CLIS 95, Point A).

In an effort to assess the benthic habitat conditions over the NHAV 93 Mound, the five-station REMOTS® grid established as part of the July 1996 survey to facilitate long term monitoring was re-occupied. The survey was centered at 41° 09.127´ N, 72° 53.426´ W (NAD 83) with stations spaced 200 m to the north, south, east, and west (Figure 2-1; Table 2-2).

Sediment-profile imaging data from three reference areas (2500W, 4500E, and CLIS REF) were used for comparison of ambient central Long Island Sound sediments relative to the sediments deposited at CLIS through disposal operations. Reference area stations are usually selected at random and placed within a 300 m radius of the reference area center point. Five randomly selected stations were established over reference area 2500W (41°09.260′ N, 72°55.542′ W [NAD 83]) while both reference area 4500E (41°09.260′ N, 72 50.538′ W [NAD 83]) and reference area CLIS REF (41°08.085′ N, 72°50.109′ W [NAD 83]) were sampled at four randomly selected stations (Figure 2-1; Table 2-3). Three replicate images were collected at each station.

The location of a fifth REMOTS® station at CLIS REF, Station 14 (41°08.100′ N, 72°50.112′ W [NAD 83]), was selected with the intent to further investigate anomalous sediment conditions detected in July 1996 (Table 2-3). Six replicate images were collected within a tight sampling radius (25 m) in order to evaluate the composition of sediment in close proximity to the area sampled in July 1996. These data would be compared to both the 1996 results and to nearby stations occupied in 1997 to aid in determining if non-ambient sediments were present at CLIS REF.

2.2 March 1998 Survey Operations

2.2.1 Sediment-Profile Imaging

Based on the findings of the September 1997 survey, additional REMOTS® images were collected at CLIS REF in March 1998 to further investigate an area of benthic disturbance. A tightly spaced (20 m) cross-grid centered at 41°08.106´ N, 72°50.089´ W (Station 9, Replicate A from 1996) was established at CLIS REF (Figure 2-4).

Table 2- 2. REMOTS® Sampling Locations over the NHAV 93 Mound September 1997 and March 1998. Coordinates are shown for both NAD 1927 and NAD 1983

September 1997

NHAV 93 REMOTS® Stations NAD 1927				NHAV 93 REMOTS® Stations NAD 1983			
Area	Station	Latitude	Longitude	Area	Station	Latitude	Longitude
NHAV 1993	CTR	41° 09.122 ´ N	72° 53.453 ´ W	NHAV 1993	CTR	41° 09.128 ´ N	72° 53.426 ´ W
MOUND	200N	41° 09.230 ´ N	72° 53.453 ´ W	MOUND	200N	41° 09.236 ´ N	72° 53.426 ´ W
41° 09.122´ N	200S	41° 09.014 ´ N	72° 53.453 ´ W	41° 09.128´ N	200S	41° 09.020 ´ N	72° 53.426 ´ W
72° 53.453´ W	200E	41° 09.122 ´ N	72° 53.310 ´ W	72° 53.426´ W	200E	41° 09.128 ´ N	72° 53.283 ´ W
	200W	41° 09.122 ´ N	72° 53.596 ´ W		200W	41° 09.128 ´ N	72° 53.569 ´ W

March 1998

NHAV 93 REMOTS® Stations NAD 1927				NHAV 93 REMOTS® Stations NAD 1983			
Area	Station	Latitude	Longitude	Area	Station	Latitude	Longitude
NHAV 1993	CTR	41° 09.122 ´ N	72° 53.453 ´ W	NHAV 1993	CTR	41° 09.128 ´ N	72° 53.426 ´ W
MOUND	200N	41° 09.230 ´ N	72° 53.453 ´ W	MOUND	200N	41° 09.236 ´ N	72° 53.426 ´ W
41° 09.122´ N	200S	41° 09.014 ´ N	72° 53.453 ´ W	41° 09.128´ N	200S	41° 09.020 ´ N	72° 53.426 ´ W
72° 53.453´ W	200E	41° 09.122 ´ N	72° 53.310 ´ W	72° 53.426´ W	200E	41° 09.128 ´ N	72° 53.283 ´ W
	200W	41° 09.122 ´ N	72° 53.596 ´ W		200W	41° 09.128 ´ N	72° 53.569 ´ W

Table 2-3. REMOTS® Sampling Locations over the CLIS Reference Areas September 1997 and March 1998. Coordinates are shown for both NAD 1927 and NAD 1983.

September 1997

Reference Area REMOTS® Stations NAD 1927				Reference Area REMOTS® Stations NAD 1983			
Area	Station	Latitude	Longitude	Area	Station	Latitude	Longitude
	STA 1	41° 09.249 ´ N	72° 55.579 ´ W		STA 1	41° 09.255 ´ N	72° 55.552 ´ W
2500W	STA 2	41° 09.245 ´ N	72° 55.439 ´ W	2500W	STA 2	41° 09.251 ´ N	72° 55.412 ´ W
41° 09.254´ N	STA 3	41° 09.132 ´ N	72° 55.594 ´ W	41° 09.260´ N	STA 3	41° 09.138 ´ N	72° 55.567 ´ W
72° 55.569´ W	STA 4	41° 09.304 ´ N	72° 55.566 ´ W	72° 55.542´ W	STA 4	41° 09.310 ´ N	72° 55.538 ´ W
	STA 5	41° 09.292 ´ N	72° 55.380 ´ W		STA 5	41° 09.298 ´ N	72° 55.353 ´ W
	STA 6	41° 09.257 ´ N	72° 50.590 ´ W		STA 6	41° 09.263 ´ N	72° 50.563 ´ W
4500E	STA 7	41° 09.307 ´ N	72° 50.572 ´ W	4500E	STA 7	41° 09.313 ´ N	72° 50.545 ´ W
41° 09.254´ N	STA 8	41° 09.298 ´ N	72° 50.504 ´ W	41° 09.260´ N	STA 8	41° 9.304 ´ N	72° 50.477 ´ W
72° 50.565´ W	STA 9	41° 09.344 ´ N	72° 50.544 ´ W	72° 50.538´ W	STA 9	41° 09.3503´ N	72° 50.517 ´ W
	STA 10	41° 08.157 ´ N	72° 50.111 ´ W		STA 10	41° 08.163 ´ N	72° 50.083 ´ W
CLISREF	STA 11	41° 08.047 ´ N	72° 50.128 ´ W	CLISREF	STA 11	41° 08.053 ´ N	72° 50.101 ´ W
41° 08.085´ N	STA 12	41° 08.070 ´ N	72° 50.038 ´ W	41° 08.091´ N	STA 12	41° 08.075 ´ N	72° 50.010 ´ W
72° 50.109´ W	STA 13	41° 08.198 ´ N	72° 50.057 ´ W	72° 50.082´ W	STA 13	41° 08.204 ´ N	72° 50.030 ´ W
	STA 14	41° 08.100 ´ N	72° 50.112 ´ W		STA 14	41° 08.106 ´ N	72° 50.085 ´ W

March 1998

CLIS-REF 1998 REMOTS® Stations NAD 1927				CLIS-REF 1998 REMOTS® Stations NAD 1983			
Area	Station	Latitude	Longitude	Area	Station	Latitude	Longitude
	CTR(9A)	41° 08.100 ´ N	72° 50.116 ´ W		CTR(9A)	41° 08.106 ´ N	72° 50.089 ´ W
CLISREF	20W	41° 08.100 ´ N	72° 50.130 ´ W	CLISREF	20W	41° 08.106 ´ N	72° 50.103 ´ W
41° 08.085´ N	40W	41° 08.100 ´ N	72° 50.145 ´ W	41° 08.091´ N	40W	41° 08.106 ´ N	72° 50.117 ´ W
72° 50.109´ W	20N	41° 08.111 ´ N	72° 50.116 ´ W	72° 50.082´ W	20N	41° 08.117 ´ N	72° 50.089 ´ W
	40N	41° 08.122 ´ N	72° 50.116 ´ W		40N	41° 08.127 ´ N	72° 50.089 ´ W
	20E	41° 08.100 ´ N	72° 50.102 ´ W		20E	41° 08.106 ´ N	72° 50.074 ´ W
	40E	41° 08.100 ´ N	72° 50.087 ´ W		40E	41° 08.106 ´ N	72° 50.060 ´ W
	20S	41° 08.089 ´ N	72° 50.116 ´ W		20S	41° 08.095 ´ N	72° 50.089 ´ W
	40S	41° 08.078 ´ N	72° 50.116 ´ W		40S	41° 08.084 ´ N	72° 50.089 ´ W

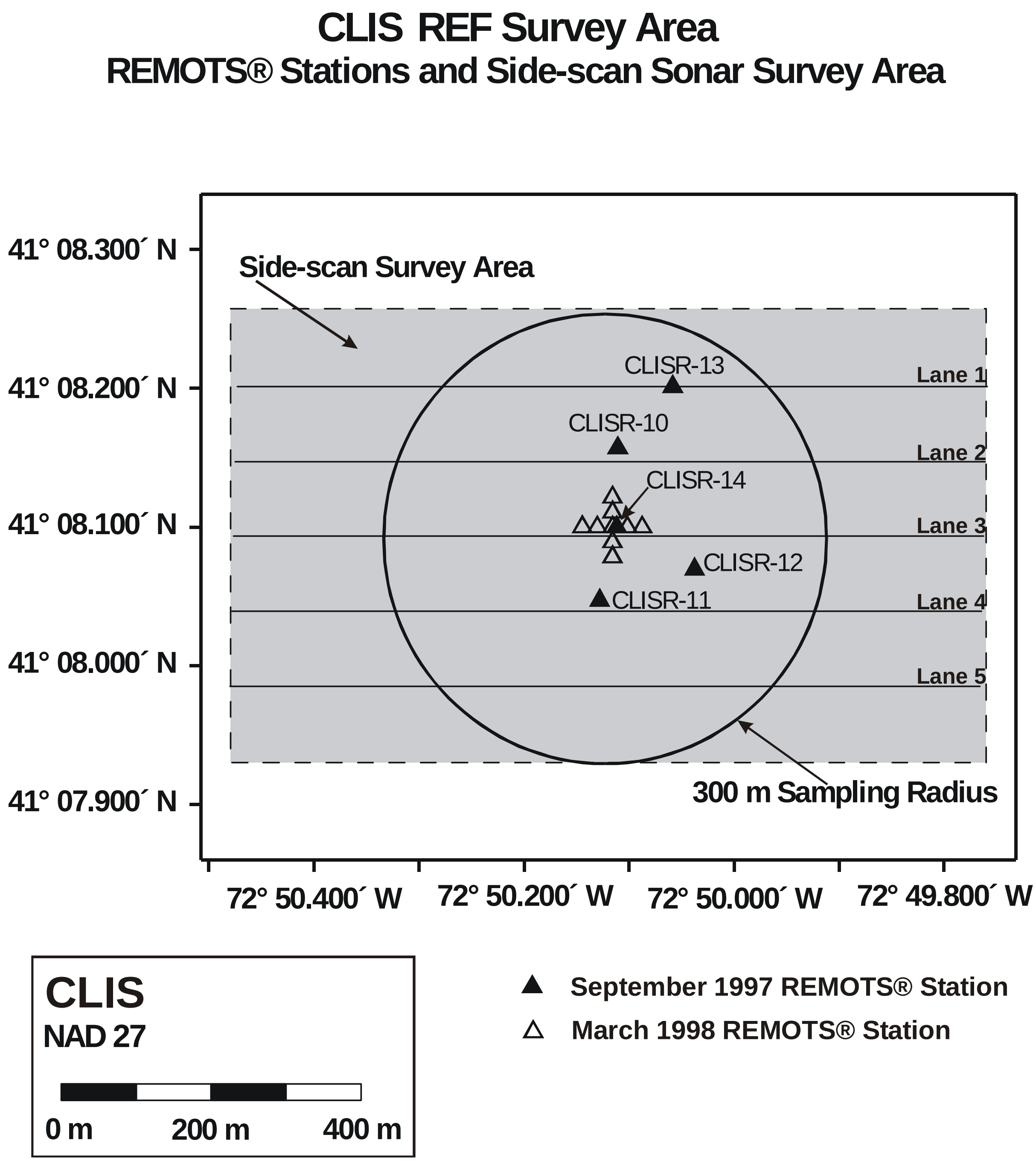


Figure 2-4. REMOTS® sediment-profile imaging stations established over CLIS REF in September 1997, as well as the REMOTS® sampling grid and 600 × 1000 m side-scan survey area occupied in March 1998

The 9-station survey grid consisted of four arms extending 40 m to the north, east, south, and west (Table 2-3). Three replicate images were collected at each station and analyzed, then compared to both the September 1997 and July 1996 results.

In addition, the March 1998 survey activity provided an opportunity to evaluate benthic conditions at CLIS and the reference areas during winter conditions (colder water temperatures and high dissolved oxygen concentrations) relative to summer conditions (warmer water temperatures and lower dissolved oxygen concentrations). The five REMOTS® stations over the NHAV 93 Mound, as well as eight stations over the CLIS 95/96 Mound Complex were reoccupied (Tables 2-1 and 2-2). Once again, three replicate images were obtained at each station and analyzed to assess benthic habitat quality in comparison to the summer months.

2.2.1 Side-Scan Sonar

Side-scan sonar was employed at CLIS REF to supplement the March 1998 sediment-profile imaging survey. Side-scan sonar is a tool that uses relative strength of acoustic reflection to distinguish differences in density in the sediment or from various objects on the seafloor. A towfish equipped with two side-looking transducers is towed through the water column by a survey vessel. Towfish height, or altitude, is tightly controlled to produce favorable incident angles to the seafloor and yield a clean acoustic record. The transducers emit and receive acoustic pulses in rapid succession, transmit the data via a tow cable to a topside unit that creates an acoustic image from the sonar data. When utilizing lower sonar frequencies (100 kHz –300 kHz), side-scan systems are capable of detecting discrete deposits of sediment over an ambient bottom.

During the March 1998 field effort, an EdgeTech DF1000 digital side-scan sonar system was utilized to collect acoustic reflection data over CLIS REF. The DF1000 towfish was directly controlled by a topside digital control unit (DCU) that regulated the power output and range scale settings for the side scan system. The sonar data were transmitted to an EdgeTech 260-TH topside paper recorder via a 100 m Kevlar tow cable to produce real-time imagery of collected side-scan sonar data. An EdgeTech model 380 recorder was also integrated into the system to electronically record the side-scan data onto 8 mm DAT tapes for archive and post processing purposes.

A 600 × 1000 m side-scan survey centered at 41° 08.204´ N, 72° 50.473´ W (NAD 27) (41°08.210′ N, 72°50.446′ W [NAD 83]) was completed over the reference area. The survey consisted of 5 lanes oriented east-west, and spaced at 100 m intervals (Figure 2-4). The towfish transmitted acoustic pulses at a frequency of 100 kHz to aid in determining if non-ambient sediment was present at CLIS REF. The position and altitude of the towfish were calculated in real-time by PINSS based on cable scope (layback) and speed of the survey vessel. This information was embedded within the digital side-scan sonar data to allow for the geo-referencing of each acoustic return.

3.0 RESULTS

3.1 September 1997 Survey

3.1.1 CLIS 95/96 Mound Complex

3.1.1.1 Precision Bathymetry

The 1200 × 1200 m precision bathymetric survey at CLIS was conducted to monitor changes in bottom topography and long-term stability of the sediment mounds occupying the most active region of the disposal site. This survey yielded a bathymetric chart of the 1.44 km^2 area with a minimum depth of 15.5 m over the historic NHAV 74 Mound and a maximum depth of 22 m just outside the disposal site boundary in the southeast corner of the survey area (Figure 3-1). A depth of 16 m was detected over the apex of the CLIS 95/96 Mound Complex, sloping downward to a depth of 20 m around the base of this bottom feature.

As anticipated, the sediment deposited at the CDA 96 buoy coalesced with the pre-existing CLIS 95 Mound. As a result, it is important to establish the prior dimensions of the CLIS 95 Mound in order to define the extent of the new dredged material deposit. The CLIS 95 Mound was constructed with an estimated barge volume of 66,400 m^3 of dredged material (16,300 m^3 UDM and 50,100 m^3 CDM) deposited at the CDA 95 buoy from 2 October 1995 through 4 March 1996. The bathymetric chart of this area, based on a July 1996 survey, is scaled to match the 1.44 km^2 1997 survey area and displays a sediment mound approximately 150 m wide along its north-south axis with a minimum depth of 17.25 m at the apex (Figure 3-2).

The mound resulting from dredged material deposition during the 1996-97 disposal season was composed of an estimated total barge volume of 255,700 m^3 of dredged material (62,097 m^3 UDM and 193,624 m^3 CDM) deposited at the CDA 96 buoy and Point A. Depth difference calculations with data collected during the July 1996 survey indicate the deposition of new material formed a sediment deposit with a maximum height of nearly 4.25 m (Figure 3-3). The apex of the CDA 96 deposit was located approximately 100 m east-southeast of the CDA 96 buoy position, with the majority of the sediment volume apparently placed to the east and southeast of the buoy.

Depth difference calculations based on comparisons between the September 1997 and July 1994 bathymetric surveys confirmed that deposition of material during the 1995-96 and 1996-97 disposal seasons had formed a single bottom feature on the CLIS seafloor with a height of 4.75 m (Figure 3-4). The diameter of the mound complex was approximately 700 m with a wide, flat dredged material apron encompassing the entire mound. A relatively wide apron of fresh dredged material existed around the entire CLIS 95/96 Mound

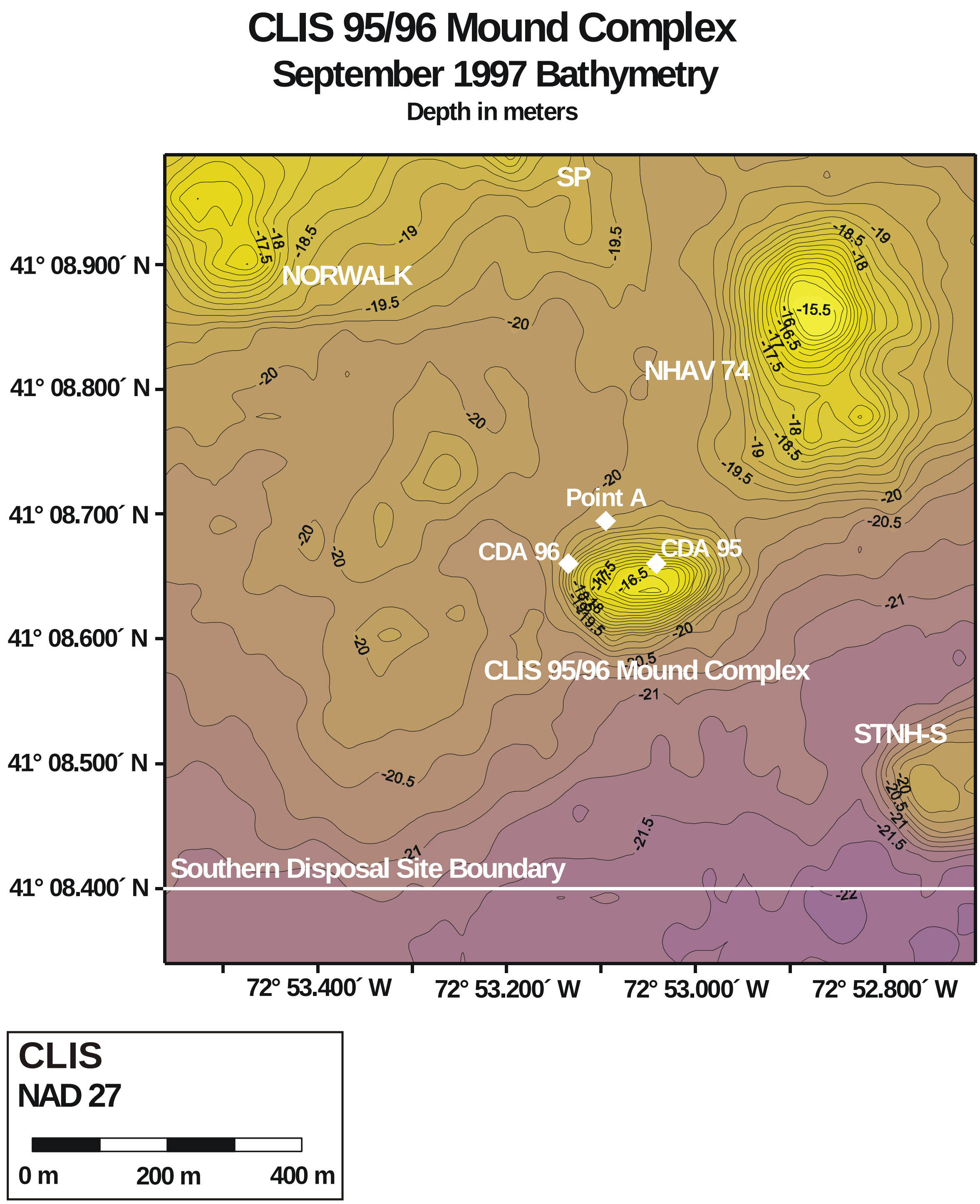


Figure 3-1. Bathymetric chart of the September 1997 1200 × 1200 m survey area relative to the southern boundary of the Central Long Island Sound Disposal Site, 0.25 m contour interval

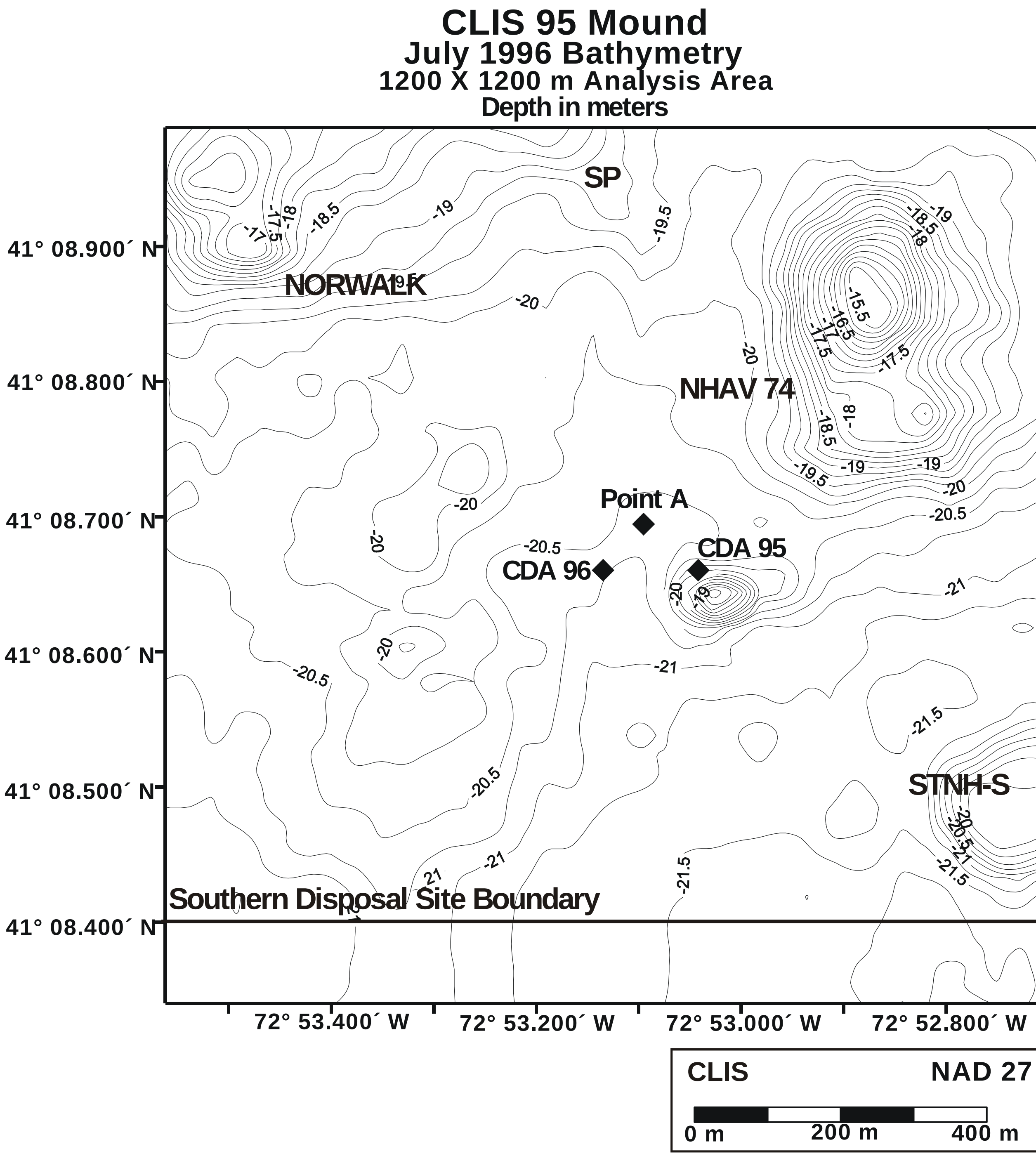


Figure 3- 2. Bathymetric chart of the 1200 × 1200 m analysis area based on the July 1996 survey, relative to the southern boundary of the Central Long Island Sound Disposal Site, 0.25 m contour interval

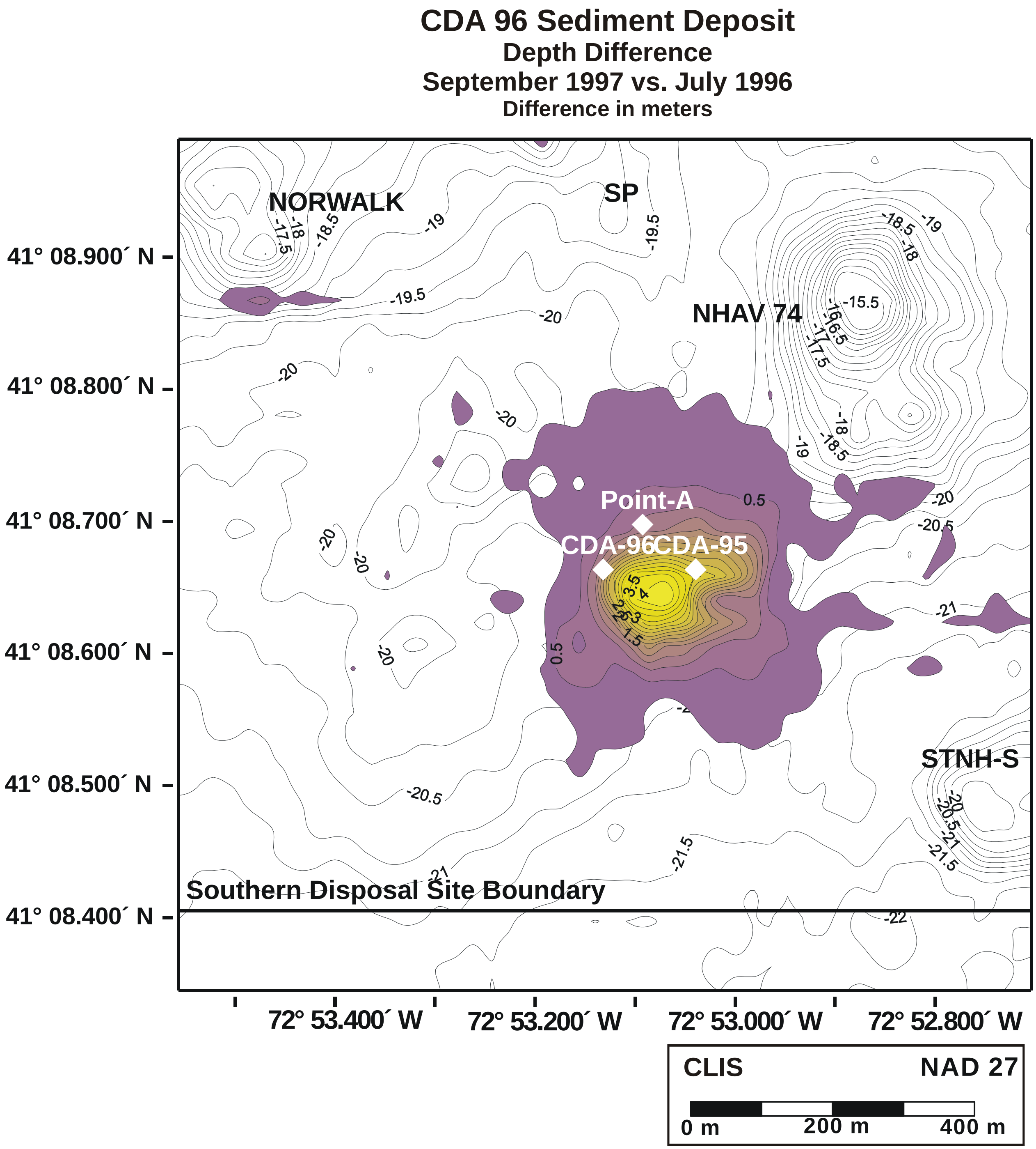


Figure 3-3. Depth difference comparison of the September 1997 bathymetric data versus the July 1996 bathymetric data showing the CDA 96 deposit plotted over 1997 bathymetry, 0.25 m contour interval

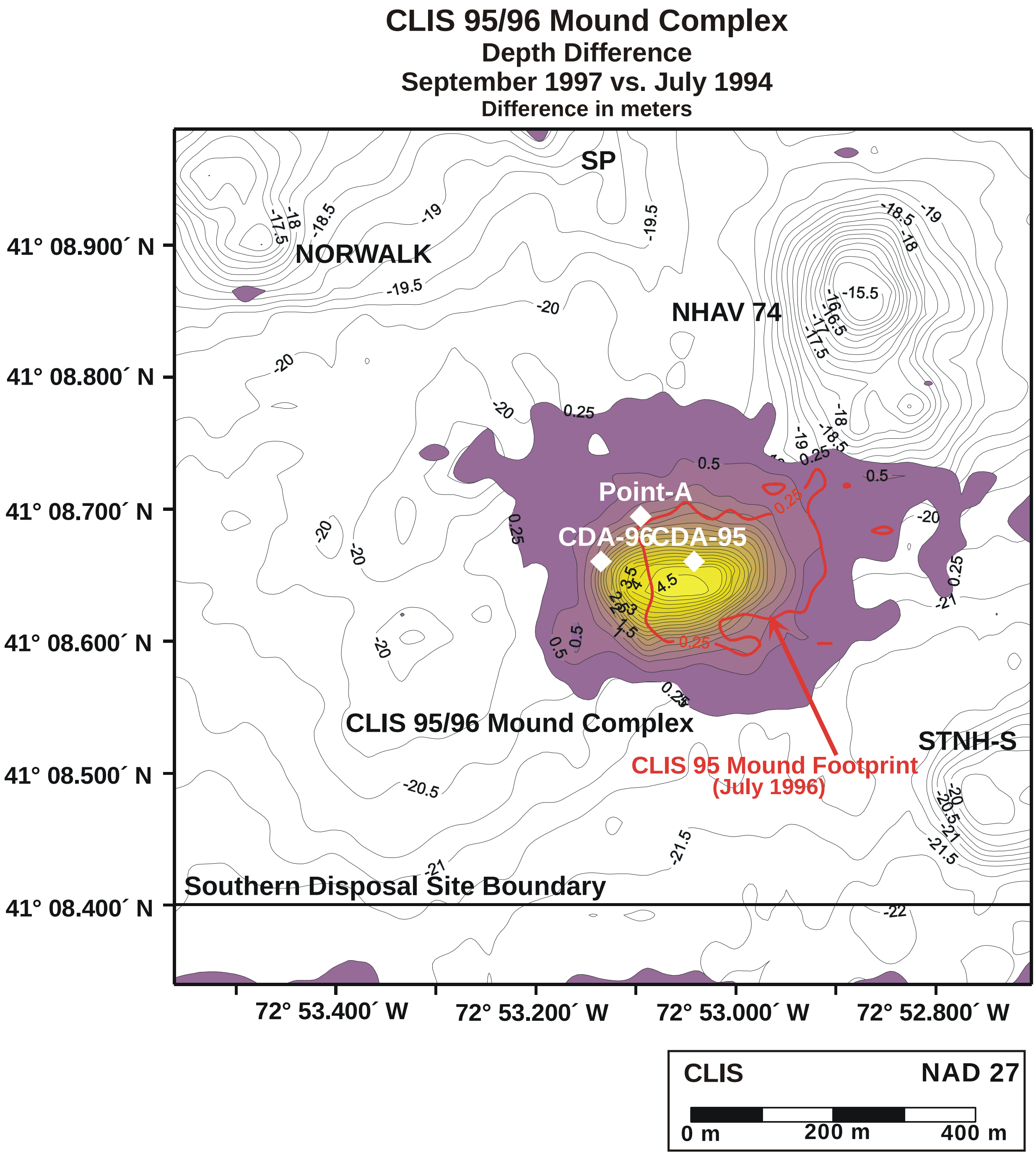


Figure 3-4. Depth difference comparison of the September 1997 bathymetric data versus the July 1994 bathymetric data showing total apparent dredged material accumulation at the CLIS 95/96 Mound Complex, 0.25 m contour interval. The original CLIS 95 Mound footprint is presented in red.

Complex, as the acoustically detectable footprint (thickness greater than 20 cm) of the new sediment deposit extended approximately 250 m to the north, east, southeast, and southwest from the apex. It is likely that this mound apron extended an estimated 100 m to 200 m beyond the 0.25 m contour presented in Figure 3-4 in layers too thin to be detected acoustically. As a result, it appears much of the pre-existing CLIS 95 Mound was covered with a layer of fresh dredged material during the 96-97 disposal season. (Figure 3-4).

Consolidation over the pre-existing CLIS 95 Mound cannot be directly measured from this data set due to the placement of fresh dredged material over the majority of the CDA 95 deposit (Figure 3-4). However, it is likely that some consolidation has occurred, as the deposition of new material would cause the compression of dredged material layers and expedite pore water extrusion in the underlying material.

3.1.1.2 REMOTS® Sediment-profile Imaging

As previously described, the REMOTS® survey was originally established as three separate grids (CDA 96, Point A, and CLIS 95) for survey planning convenience and to conform to standard DAMOS survey practice, one grid centered on each disposal point. However, due to the size of the dredged material footprint and apparent placement of fresh dredged material over the majority of the pre-existing CLIS 95 Mound, the data are presented together to characterize the surface of the entire bottom feature. A complete set of REMOTS® results for the September 1997 survey over the CLIS 95/96 Mound Complex are presented in Appendix B1.

Sediment Grain Size and Stratigraphy

Fresh dredged material composed primarily of low reflectance silt and clay was detected and measured at every REMOTS® station over the CLIS 95/96 Mound Complex. The thickness of fresh dredged material was determined to be greater than the penetration depth of the sediment-profile camera at the majority of the REMOTS® stations sampled (Figure 3-5; Table 3-1). However, variability among replicate images collected from the outermost stations indicated fresh dredged material existed in thin layers beyond the acoustically detectable margins of the disposal mound complex. These discrete layers of fresh dredged material over recent or historic dredged material were noted at several of the peripheral stations within the sampling grid.

Alternating bands of darker and lighter sediment within the profile images suggested the presence of CDA 96 or Point A CDM deposits overlying pre-existing CLIS 95 material (Figure 3-6A). Fresh dredged material over a light gray, biologically reworked sediment was detected at multiple stations on the periphery, indicating a pre-existing layer of historic dredged material from one of the four surrounding disposal mounds (NHAV 74, NHAV 83, NORWALK, STNH-S; Figure 3-6B).

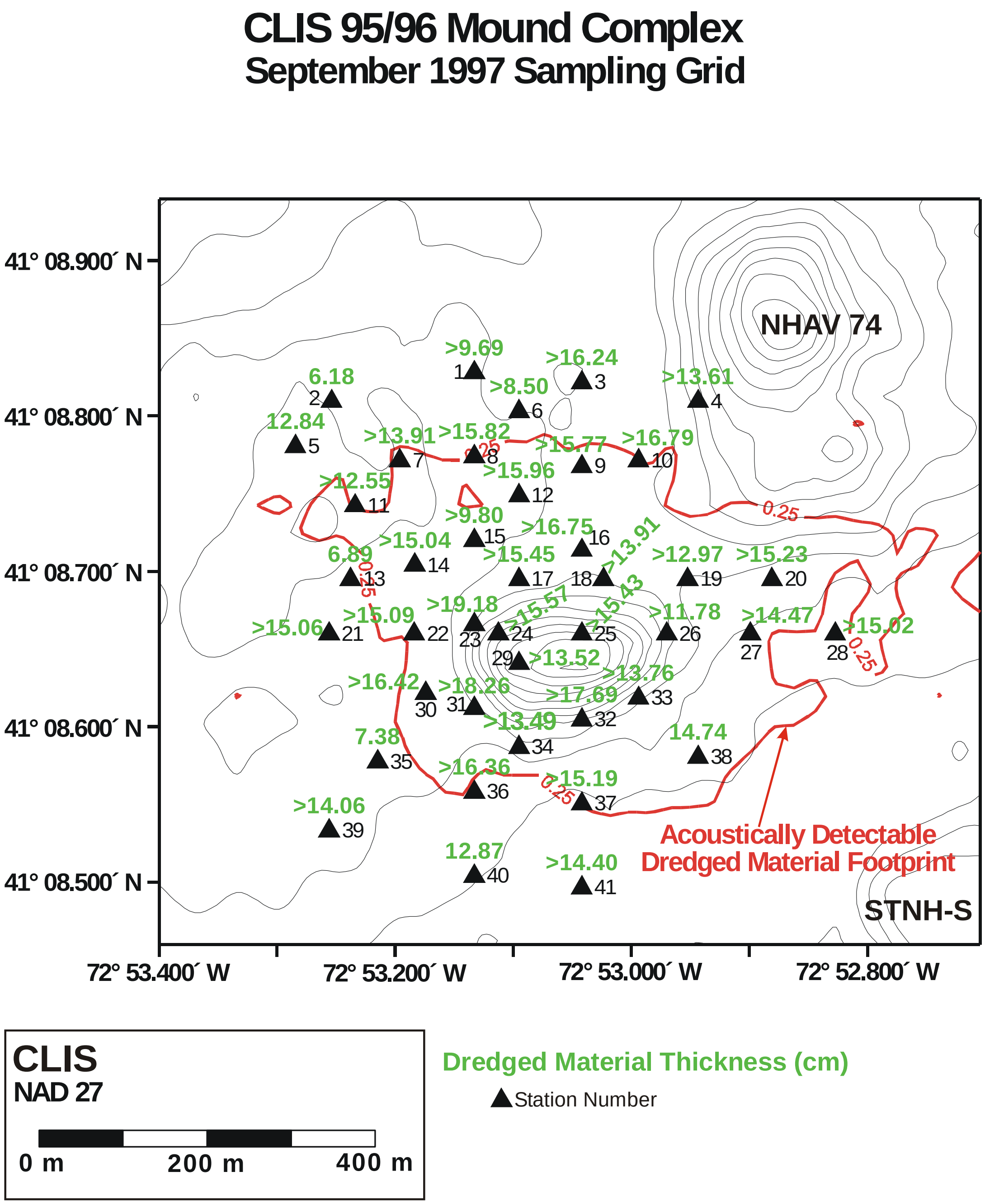
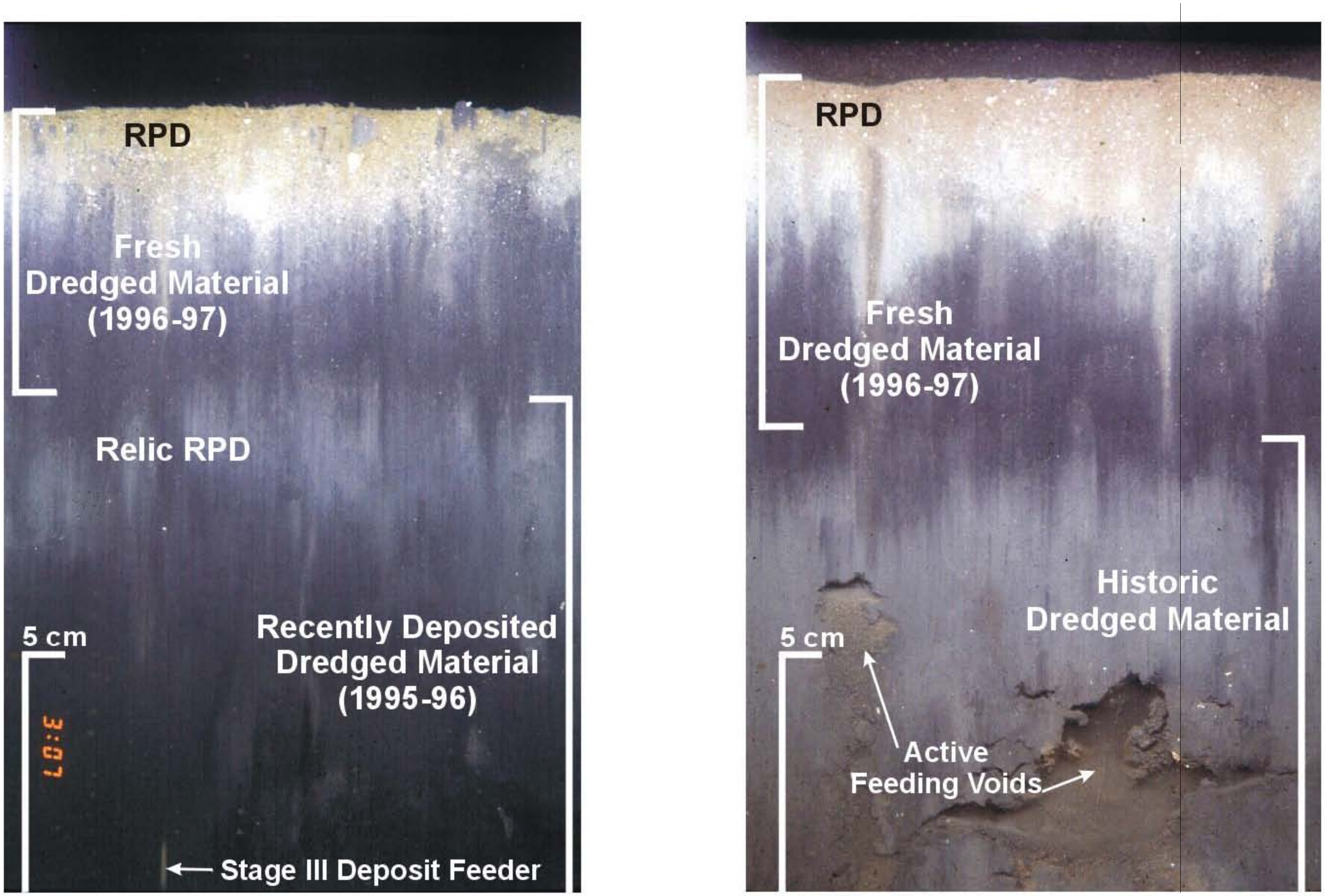


Figure 3-5. Chart of fresh dredged material thickness values over the CLIS 95/96 Mound Complex as detected by REMOTS® sediment-profile imaging, relative to the acoustically detectable dredged material footprint (red). A greater than sign indicates that the thickness of the dredged material layer was greater than the penetration depth of the sediment-profile camera.



A **B**

Figure 3-6. REMOTS® images collected from Stations 35 (A) and 6 (B) displaying layers of fresh dredged material over recent (1995-96) dredged material and fresh dredged material over historic dredged material, respectively

Table 3-1. Summary of REMOTS® Results for Stations over the CLIS 95/96 Mound Complex, September 1997

Station	Camera Penetration Mean (cm)	Dredged Material Thickness Mean* (cm)	Number of Reps w/ Fresh Dredged Material	RPD Mean (cm)	Successional Stages Present	Highest Stage Present	Grain Size Major Mode (Phi)	Methane Present	OSI Mean	OSI Median	Boundary Roughness Mean (cm)
1	11.55	>9.69	3	2.71	I, III	ST_I_ON_III	>4	NO	7.00	7	1.64
2	13.23	6.18	3	3.26	I	ST_I	>4	NO	6.00	6	0.62
3	16.25	>16.24	3	2.74	I, III	ST_I_ON_III	>4	NO	7.67	9	0.49
4	15.17	>13.61	3	1.40	I, III	ST_I_ON_III	>4	NO	5.00	4	0.55
5	16.32	12.84	3	2.38	I, III	ST_I_ON_III	>4	NO	7.33	9	0.78
6	18.47	>8.50	3	2.89	I, III	ST_I_ON_III	>4	NO	6.67	5	0.56
7	16.28	>13.91	3	3.45	I, III	ST_III	>4	NO	8.67	9	1.12
8	17.01	>15.82	3	3.69	I	ST_I	>4	NO	6.33	7	0.42
9	15.97	>15.77	3	4.21	I, III	ST_I_ON_III	>4	NO	8.00	8	1.13
10	19.29	>16.79	3	1.62	I	ST_I	>4	NO	3.50	3.5	0.63
11	12.34	>12.55	3	5.23	I, III	ST_III	>4	NO	9.33	10	1.68
12	15.56	>15.96	3	2.15	I, III	ST_I_ON_III	>4	NO	9.00	9	0.57
13	14.98	6.89	3	1.59	I, III	ST_I_ON_III	>4	NO	5.00	4	0.64
14	16.58	>15.04	3	3.85	I	ST_I	>4	NO	6.67	7	0.69
15	15.05	>9.80	3	2.84	I, III	ST_I_ON_III	>4	NO	6.67	7	0.62
16	16.75	>16.75	3	2.44	I, III	ST_I_ON_III	>4	NO	6	5	0.44
17	17.49	>15.45	3	2.34	I	ST_I	>4	NO	4.33	4	0.55
18	17.68	>13.91	3	2.55	I	ST_I	>4	NO	4.67	4	0.48
19	13.25	>12.97	3	3.76	I	ST_I	4 to 3	NO	5.50	5.5	0.80
20	16.52	>15.23	3	2.45	I, III	ST_I_ON_III	>4	NO	7.00	7	1.21
21	15.06	>15.06	3	3.49	I, III	ST_I_ON_III	>4	NO	10.00	10	0.70
22	15.04	>15.09	3	3.02	I, III	ST_I_ON_III	>4	NO	8.00	9	0.82
23	19.13	>19.18	3	2.15	I, III	ST_III	>4	NO	4.50	4.5	0.61
24	15.70	>15.57	3	2.60	I, III	ST_I_ON_III	>4	NO	6.33	7	1.88
25	15.31	>15.43	3	3.09	I, III	ST_I_ON_III	>4	NO	7.00	6	0.61
26	11.65	>11.78	3	2.62	I	ST_I	4 to 3	NO	5.00	5	1.31
27	14.47	>14.47	3	4.39	I, III	ST_I_ON_III	>4	NO	8.33	7	0.64
28	15.07	>15.02	3	3.36	I, III	ST_I_ON_III	>4	NO	8.67	9	0.88
29	13.29	>13.52	3	2.15	I	ST_I	>4	NO	4.50	4.5	1.09
30	16.45	>16.42	3	2.49	I, III	ST_I_ON_III	>4	NO	6.33	5	0.57
31	18.43	>18.26	3	2.91	I, III	ST_I_ON_III	>4	NO	6.67	6	0.66
32	17.74	>17.69	3	3.60	I	ST_I	>4	NO	6.67	7	0.38
33	18.21	>13.76	3	3.11	I, III	ST_I_ON_III	>4	NO	7.00	7	0.53
34	14.56	>13.49	3	2.87	I, III	ST_III	>4	NO	8.00	9	2.27
35	17.79	7.38	3	2.27	I, III	ST_III	>4	NO	7.33	8	0.77
36	16.37	>16.36	3	2.17	I, III	ST_I_ON_III	4 to 3	NO	5.67	4	0.59
37	15.21	>15.19	3	3.22	I, III	ST_I_ON_III	>4	NO	9.67	10	0.53
38	16.13	14.74	3	4.65	I, III	ST_I_ON_III	>4	NO	10.67	11	1.06
39	17.94	>14.06	3	2.77	I, III	ST_I_ON_III	>4	NO	7.67	8	0.77
40	16.21	12.87	3	2.50	I	ST_I	>4	NO	4.67	5	0.76
41	14.23	>14.40	3	4.13	I, III	ST_I_ON_III	>4	NO	8.50	8.5	0.86
AVG	15.85	>13.99	3	2.95					6.87	6.84	0.83
MIN	11.55	6.18	3	1.40					3.50	3.5	0.38
MAX	19.29	>19.18	3	5.23					10.67	11	2.27

*** Values shown are means for n = 3 replicate images obtained and analyzed at each station.**
If dredged material exceeded the prism penetration depth, then the mean value shown is a minimum estimate of dredged material layer thickness (indicated by the > sign).

Similar to the CLIS Reference Areas, the physical REMOTS® parameters for the CLIS 95/96 Mound Complex showed a major modal grain size of >4 phi for most stations, indicative of silts and clays in the surface layers (Tables 3-1 and 3-2). Many replicate images displayed varying amounts of sand within the surficial sediment layers. The amount of fine sand detected at Stations 19, 26, and 36 resulted in the stations being classified as 4 to 3 phi (Figure 3-7A). One replicate image obtained from Station 26 displayed an abundance of pebbles at the sediment-water interface; likely representing a product of recent dredged material placement rather than a lag deposit (Figure 3-7B).

Replicate-averaged mean camera penetration depths over the CLIS 95/96 Mound Complex ranged from 11.6 cm at Station 1 to 19.3 cm at Station 10, with little correlation to boundary roughness values (Table 3-1). Boundary roughness across the mound complex ranged from 0.4 cm at Station 32 to 2.3 cm at Station 34, with the primary cause for surface roughness being physical disturbance mainly due to the recent CDM deposition.

Benthic Community Assessment

Three parameters were used to assess the benthic recolonization status of the project mounds relative to the CLIS reference areas. The apparent Redox Potential Discontinuity (RPD) depth, infaunal successional status, and the Organism-Sediment Index (OSI) were mapped on station location plots to outline the biological conditions at each station (Figures 3-8 and 3-9).

The replicate-averaged RPD depths over CLIS 95/ 96 ranged from 1.4 cm at Station 4 to 5.2 cm at Station 11, with no distinct pattern in the RPD depths across the mound complex (Figure 3-8; Table 3-1). The overall average RPD for the CLIS 95/96 Mound Complex was 2.95 cm, which is relatively deep for a recently placed dredged material deposit. In fact, the average RPD for CLIS 95/96 actually exceeded the average RPD at the CLIS reference areas (2.4 cm). No methane or low dissolved oxygen was noted at any station over the CLIS 95/96 Mound Complex, but redox rebound intervals were relatively abundant during the September 1997 survey.

Redox rebound intervals, areas showing evidence of intermittent or seasonal oxidation below the oxidized surface layer, were noted at approximately half of the stations over the CLIS 95/96 Mound Complex. The presence of redox rebound intervals within a new sediment deposit indicates a recent reduction in bottom water dissolved oxygen concentrations.

Table 3-2. Summary of REMOTS® Results for the Stations Occupied over the CLIS Reference Areas, September 1997

Reference Area	Station	Camera Penetration Mean (cm)	Dredged Material Thickness Mean (cm)	Number of Reps w/ Fresh Dredged Material	RPD Mean (cm)	Successional Stages Present	Highest Stage Present	Grain Size Major Mode (Phi)	Methane Present	OSI Mean	OSI Median	Boundary Roughness Mean (cm)
2500W	1	13.78	0	0	1.98	I	ST_I	>4	NO	4.33	4	2.48
	2	14.60	0	0	1.76	I	ST_I	>4	NO	4.00	4	0.82
	3	13.68	0	0	2.91	I, III	ST_I_ON_III	>4	NO	9.67	10	1.75
	4	15.52	0	0	1.57	I, III	ST_III	>4	NO	3.50	3.5	0.91
	5	14.73	0	0	2.38	I	ST_I	>4	NO	4.67	5	0.78
4500E	6	14.09	0	0	1.97	I, III	ST_III	>4	NO	8.00	8	0.49
	7	14.37	0	0	2.38	I, III	ST_I_ON_III	>4	NO	5.67	5	0.43
	8	13.09	0	0	2.70	I, III	ST_III	>4	NO	7.67	8	0.78
	9	12.08	0	0	3.07	I, III	ST_III	>4	NO	8.33	10	0.39
CLIS REF	10	12.12	0	0	3.36	I, III	ST_I_ON_III	>4	NO	8.33	9	0.40
	11	10.99	0	0	2.46	I, III	ST_I_ON_III	>4	NO	6.50	6.5	0.58
	12	10.79	0	0	2.40	I	ST_I	>4	NO	4.67	5	0.98
	13	10.90	0	0	1.67	I, III	ST_I_ON_III	>4	NO	8.00	8	1.02
	14 (9A-1996)	10.91	0	0	2.34	I, III	ST_I_ON_III	>4	NO	6.75	9	0.65
AVG		12.97	0.00	0.00	2.35					6.43	6.79	0.89
MIN		10.79	0.00	0.00	1.57					3.50	3.50	0.39
MAX		15.52	0.00	0.00	3.36					9.67	10.00	2.48

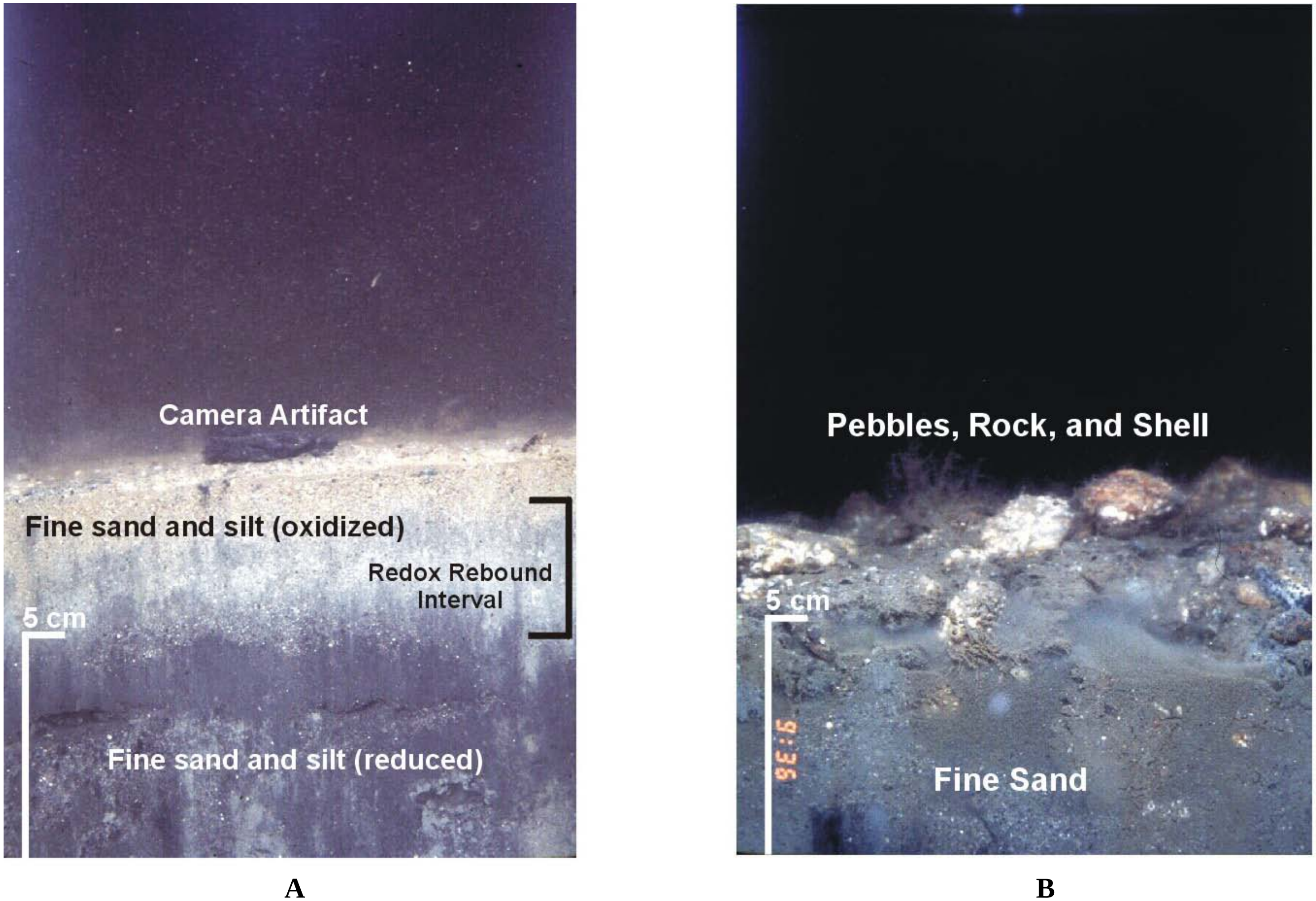


Figure 3-7. REMOTS® images collected from Stations 19 (A) and 26 (B) displaying layers of fresh dredged material composed of fine sand within a silt matrix or fine sand and pebble at the sediment-water interface

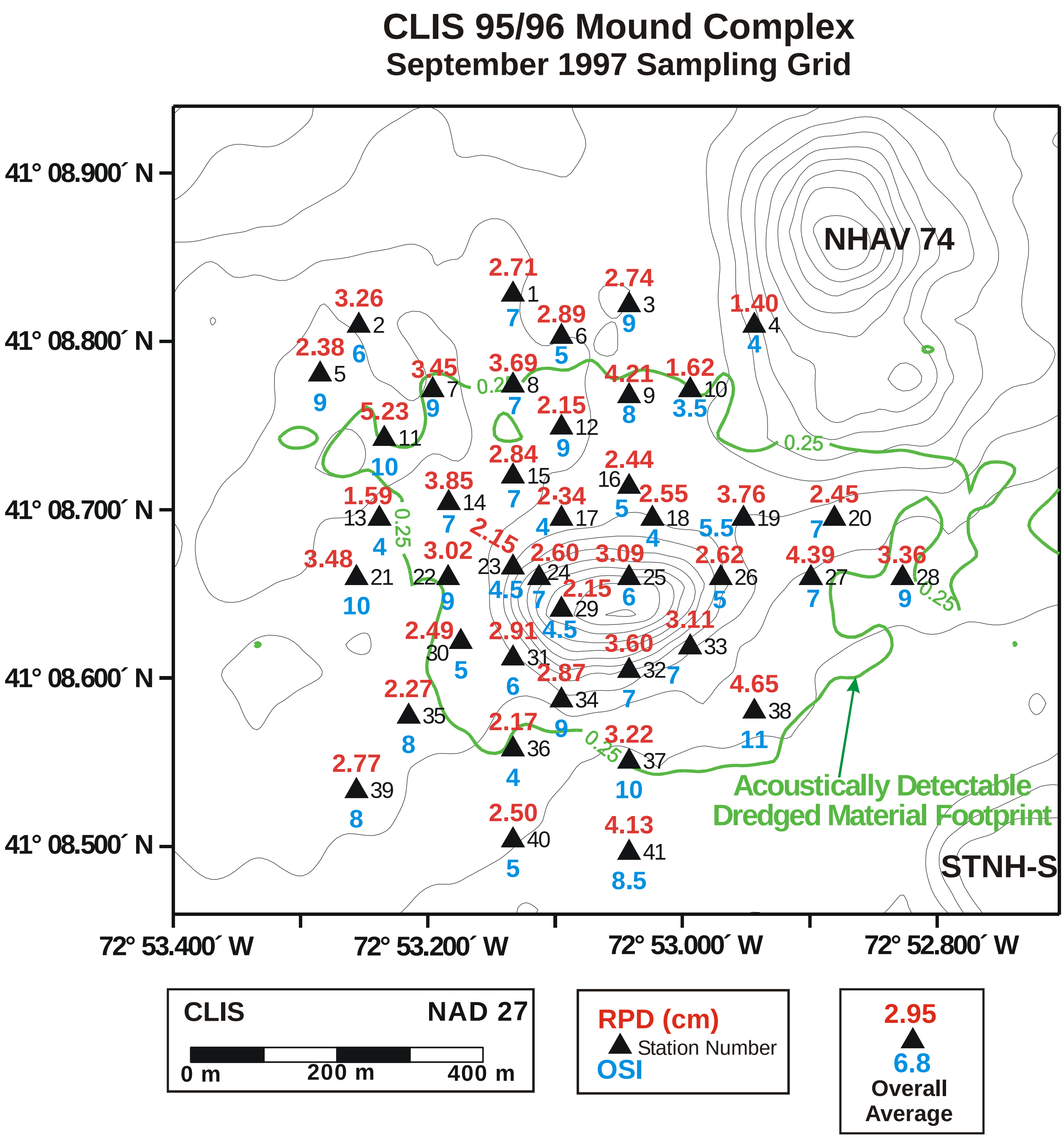


Figure 3-8. Chart of replicate-averaged RPD depths (red) and median OSI values (blue) detected over the CLIS 95/96 Mound Complex, relative to the acoustically detectable dredged material footprint (green)

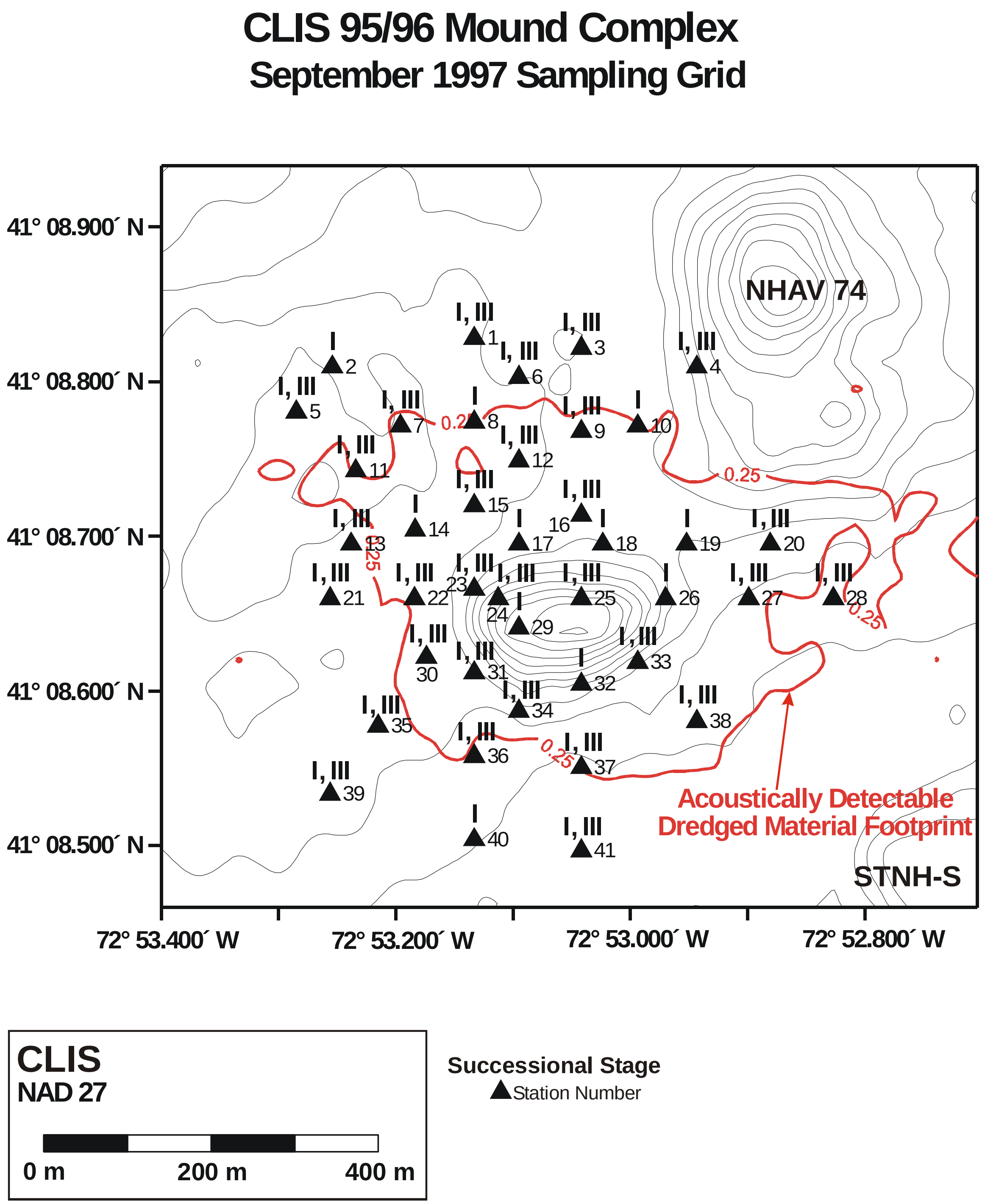


Figure 3-9. Chart of successional stage status for the REMOTS® stations established over the CLIS 95/96 Mound Complex, relative to the acoustically detectable dredged material footprint (red)

Given the timing of the 1997 survey over CLIS, the development of redox rebound intervals is likely related to the onset of seasonal hypoxia in the central Long Island Sound region. The recent reductions in the depth of oxygenation were most frequently detected at stations on the flanks of the mound complex. In addition, relic RPDs were observed in multiple replicate images collected over the mound apron and used as an indicator of dredged material layering (e.g., Figure 3-6A).

The successional stage status of the CLIS 95/96 Mound Complex was well within expectations for a new sediment deposit, displaying a solid Stage I population with advancement to Stage III at 30 of the 41 stations (Figure 3-9; Table 3-1). The Stage I individuals at the sediment-water interface likely represent new recruitment into the benthos, as the deposition of additional material over the CLIS 95 deposit during the 1996-97 disposal season covered the populations that were detected during the July 1996 survey (Figure 3-10A). The Stage III organisms detected at the stations established near the center of the mound complex also represent a new population. However, the errant polychaetes comprising the Stage III population inhabiting the apron sediments are probably resident infauna that were able to migrate up through relatively thin layers of new dredged material (10 cm) to reestablish a connection with the sediment-water interface and maintain a supply of oxygen from the bottom waters (Figure 3-10B).

With the advanced successional stage status and relatively deep RPD depths, median OSI values were correspondingly high over the surface of the CLIS 95/96 Mound Complex. The OSI values ranged from +3.5 at Station 10 to +11 at Station 38, with an overall average median value of +6.8 that was identical to the reference area average median value (Figure 3-8; Tables 3-1 and 3-2). At five months post-disposal, these findings suggest the benthic environment was recovering quite well from the recent disturbance and should continue to progress as expected over the next few years.

3.1.2 NHAV 93 Mound

The NHAV 93 Mound represents the first confined aquatic disposal (CAD) mound developed on the CLIS seafloor. Benthic recovery over the surface of this mound has been closely monitored since July 1994. Since its completion, the NHAV 93 Mound has displayed a cyclical pattern of benthic recovery and decline, suggesting an increased susceptibility to regional disturbance (i.e., seasonal hypoxia) relative to the CLIS reference areas and surrounding disposal mounds (Morris 1998a). Due to the origin of the CDM and lack of toxicity in a well-oxygenated environment, the instability in the benthic habitat is likely related to labile organics within the deposited sediment and sediment oxygen demand (Morris and Tufts 1997).

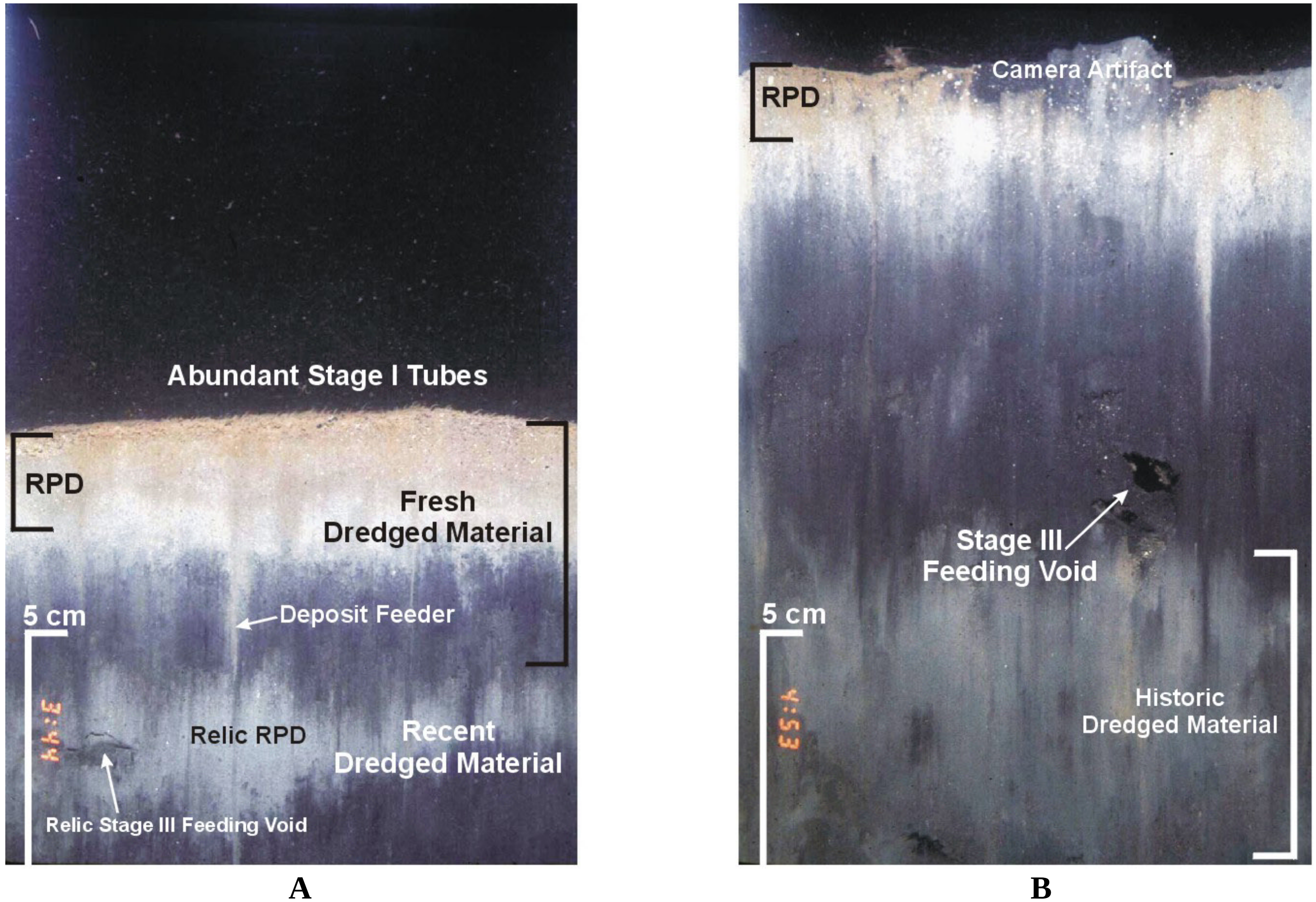


Figure 3-10. REMOTS® images collected from Stations 38 (A) and 11 (B) over the CLIS 95/96 Mound Complex displaying examples of recolonization within thin layers of fresh dredged material. Station 38 shows abundant Stage I pioneering polychaetes at the sediment-water interface, while Station 11 displays a Stage III feeding void at depth within the surface layer of fresh dredged material.

The September 1997 REMOTS® survey over the NHAV 93 Mound represents the fourth monitoring effort that has focused on recolonization status of this capped mound. In addition, the images collected over the surface of NHAV 93 provide additional information on the presence or absence of erosion at the sediment-water interface. Complete REMOTS® results for the NHAV 93 Mound are available in Appendix B2.

3.1.2.1 Sediment Grain Size and Stratigraphy

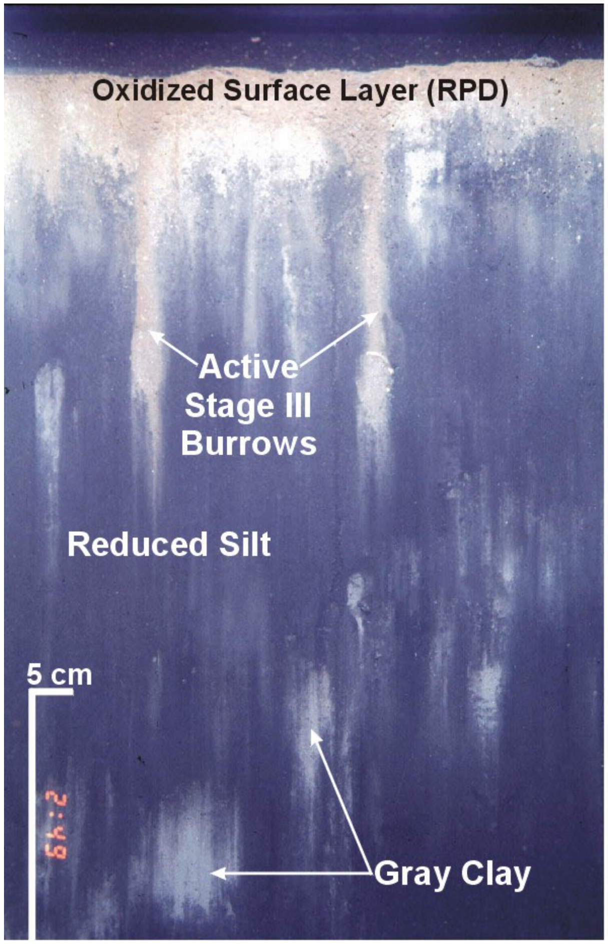
Physical REMOTS® parameters indicated surface sediments at every station were composed primarily of low reflectance silts and clays having a grain size major mode of >4 phi (Figure 3-11). No lag deposits or significant coarsening of surface dredged material (i.e., no loss of fine-grained sediment) due to winnowing was noted in any replicate.

Historic dredged material was detected in layers exceeding the penetration depth of the sediment-profile camera at all stations (Table 3-3). Replicate-averaged camera penetration depths ranged from 14.7 cm at Station 200S to 16.8 cm at Station 200W (Table 3-3). Boundary roughness values ranged from 0.5 cm to 1.1 cm. The primary cause of boundary roughness was classified as physical disturbance. Neither grain size nor surface roughness data showed any distinct spatial patterns over the NHAV 93 Mound during the September 1997 survey.

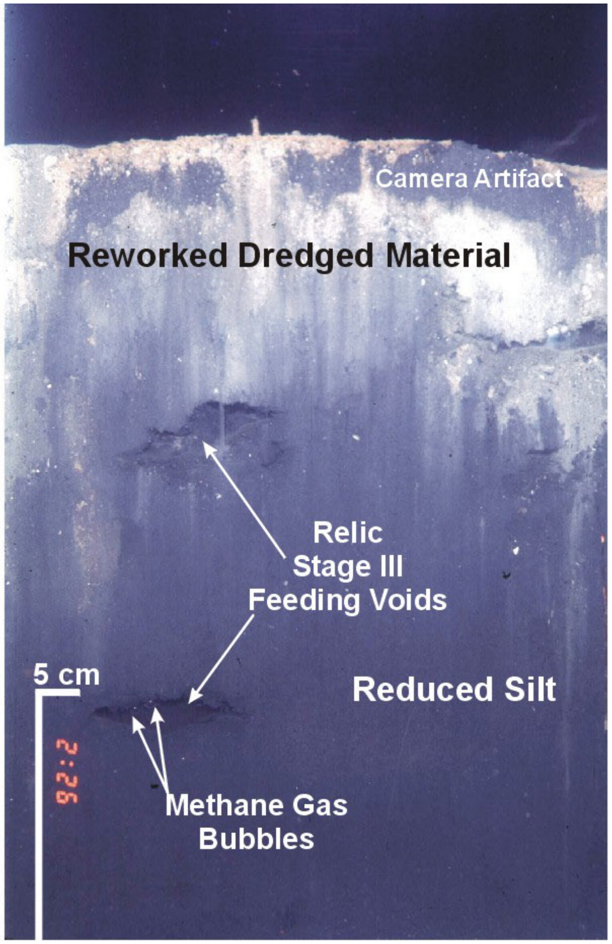
3.1.2.2 Benthic Community Assessment

Replicate-averaged RPD depths over the NHAV 93 Mound were generally consistent with the findings for the CLIS Reference Areas, ranging from 1.6 cm at 200S to 3.0 cm at CTR (Figure 3-12; Table 3-3). The overall average RPD for NHAV 93 was 2.2 cm, comparable to the composite value of 2.4 cm for the CLIS Reference Areas (Table 3-2). Low sediment dissolved oxygen conditions were not observed in any of the replicate sediment-profile images. However, sediment methane was found in replicates photographs collected at Stations 200E and CTR (Figure 3-11B). In addition, redox rebound intervals were noted at four of the five stations occupied over the NHAV 93 Mound.

Only stations 200N and CTR showed any evidence of Stage III activity, while the remainder of the NHAV 93 stations were classified as Stage I (Figure 3-13; Table 3-3). Both the low abundance of Stage III organisms and the presence of sediment methane in multiple replicate photographs impacted the OSI values calculated for this historic mound. Median OSI values for the NHAV 93 Mound ranged from +2.5 to +8, with an overall average OSI of +4.9. These values were lower than the CLIS reference areas, which displayed an overall average median value of +6.8.



A



B

Figure 3-11. REMOTS® images collected from Stations 200W (A) and CTR (B) over the NHAV 93 Mound displaying low reflectance, fine-grained sediment found throughout the survey area. In addition, pockets of gray clay were detected at depth at 200W and methane gas bubbles were visible at depth at CTR.

Table 3-3. Summary of REMOTS® Results for Stations over the NHAV 93 Mound, September 1997

Station	Camera Penetration Mean (cm)	Dredged Material Thickness Mean* (cm)	Number of Reps w/ Fresh Dredged Material	RPD Mean (cm)	Successional Stages Present	Highest Stage Present	Grain Size Major Mode (Phi)	Methane Present	OSI Mean	OSI Median	Boundary Roughness Mean (cm)
CTR	16.10	>15.80	3	2.60	I, III	ST_I_ON_III	>4	YES	5.67	5	1.09
200N	16.19	>16.06	3	2.97	I, III	ST_I_ON_III	>4	NO	8.00	8	0.62
200S	14.77	>14.71	3	1.60	I	ST_I	>4	NO	2.50	2.5	1.07
200E	15.32	>15.20	3	2.23	I	ST_I	>4	YES	4.00	5	0.53
200W	16.84	>16.80	3	1.63	I	ST_I	>4	NO	3.67	4	0.73
AVG	15.84	>15.71	3.00	2.21					4.77	4.90	0.81
MIN	14.77	>14.71	3.00	1.60					2.50	2.50	0.53
MAX	16.84	>16.80	3.00	2.97					8.00	8.00	1.09

*** Values shown are means for n = 3 replicate images obtained and analyzed at each station.**
If dredged material exceeded the prism penetration depth, then the mean value shown is a minimum estimate of dredged material layer thickness (indicated by the > sign).

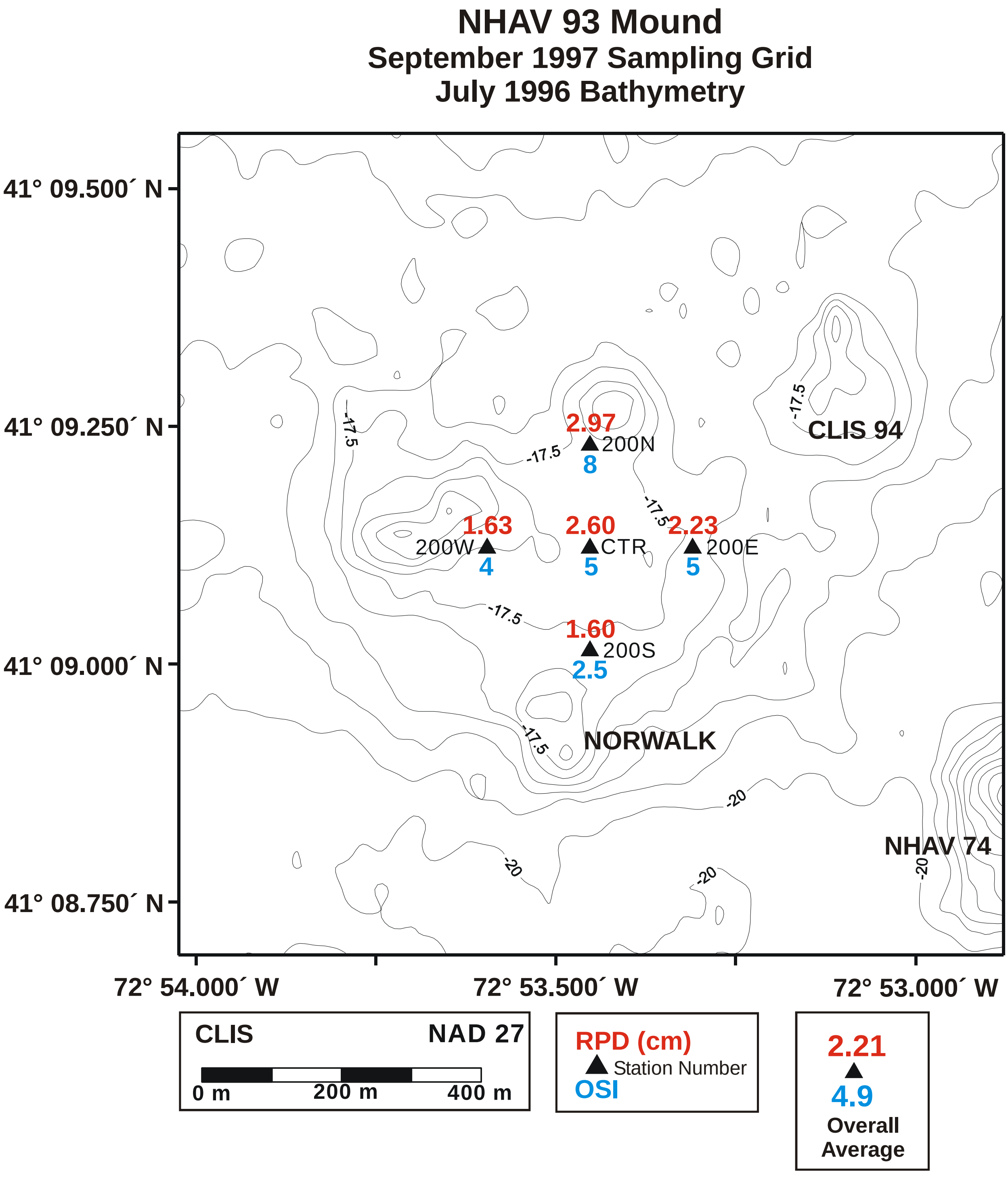


Figure 3-12. Chart of replicate-averaged RPD depths (red) and median OSI values (blue) detected over the NHAV 93 Mound

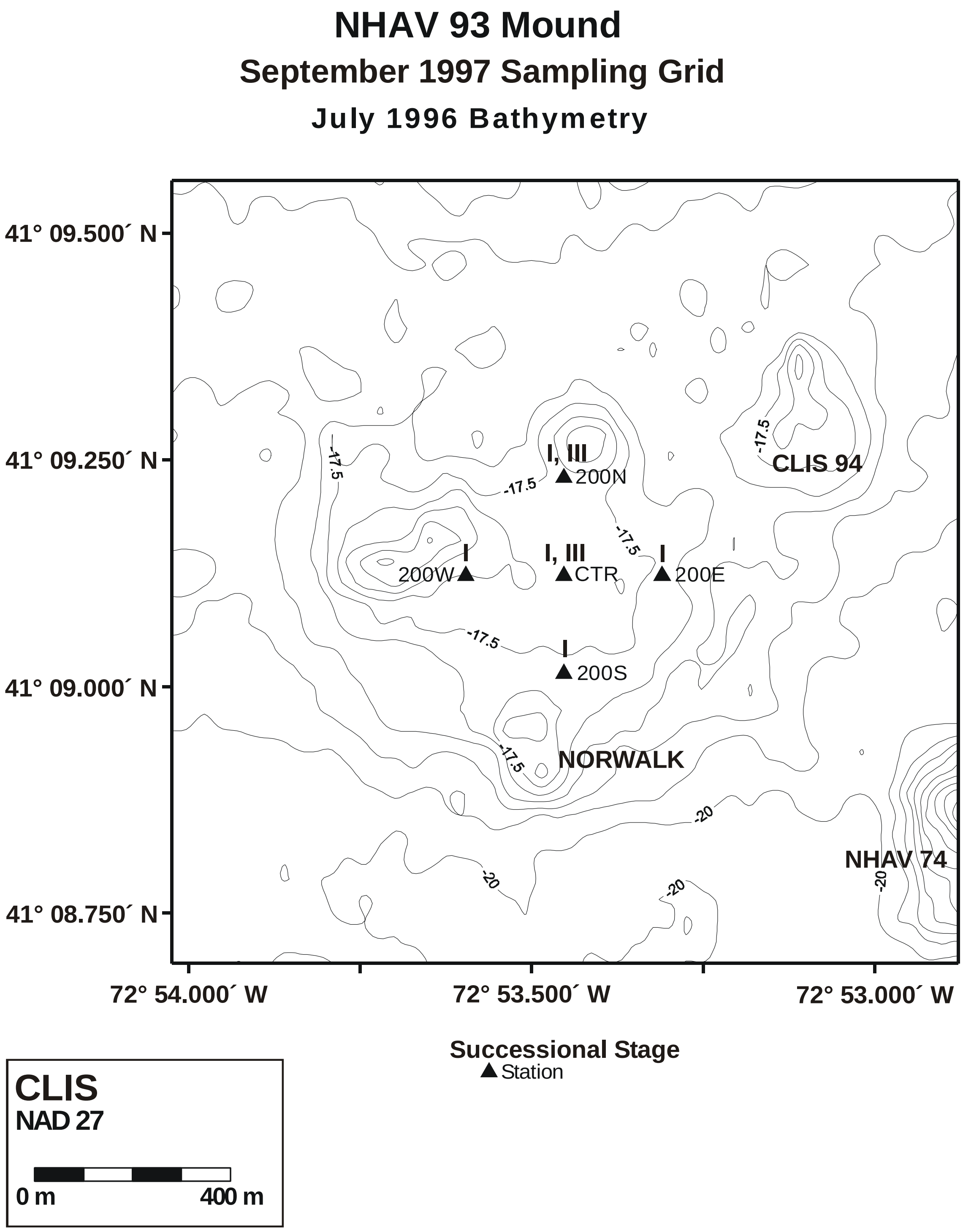


Figure 3-13. Chart of successional stage status for the REMOTS® stations established over the NHAV 93 Mound

Overall, the REMOTS® sediment-profile imaging results indicate that the NHAV 93 Mound was still recovering from the impact of dredged material disposal. However, the September 1997 survey may be documenting a decline in benthic habitat conditions due to high sediment oxygen demand within the sediments and low bottom water dissolved oxygen concentrations.

3.1.3 CLIS Reference Areas

3.1.3.1 Sediment Grain Size and Stratigraphy

A complete set of REMOTS® image analysis results for the survey over the three CLIS reference areas (2500W, 4500E and CLIS REF) is provided in Appendix B3. All of the replicate images obtained from the CLIS reference areas were characterized as displaying ambient sediment. However, one replicate image collected from Station 14 (former 1996 Station 9A) displayed a disturbed surface layer, with fluidized mud at the sediment-water interface (Figure 3-14A). Each of the reference area images displayed a consistent major modal grain size of >4 phi, indicating a seafloor comprised of fine-grained sediment (silt/clay) with no dredged material or non-ambient sediment present. Replicate-averaged camera penetration ranged from 10.8 to 15.5 cm, with an overall average 13 cm for the reference areas (Table 3-2).

Boundary roughness values were low for most stations sampled, ranging from 0.4 to 2.5 cm (average 0.9 cm), with biological activity at the sediment-water interface being the predominant cause of surface roughness. The higher boundary roughness values were measured at Stations 1 and 3 over reference area 2500W and were likely related to burrowing activity of resident macrofauna (i.e., juvenile lobster, demersal fish; Figure 3-14B).

3.1.3.2 Benthic Community Assessment

Replicate-averaged RPD depths at the three CLIS reference areas ranged from 1.6 cm to 3.4 cm, with an overall average of 2.35 cm (Table 3-2). These results are generally consistent with the depth of oxygenation detected during the previous July 1996 survey. No indications of low dissolved oxygen or methane gas were noted in the reference area sediments. However, redox rebound intervals were identified in several reference area photographs, indicating a recent reduction in water column dissolved oxygen concentrations and a decrease in the depth of oxygen penetration into the sediment.

The successional stage status at most reference stations was slightly lower relative to the conditions found during the July 1996 survey, with the greatest difference detected at 2500W. Two of the five stations occupied within 2500W displayed evidence of recent Stage III activity, with the remaining three stations were classified as Stage I only (Table 3-2).

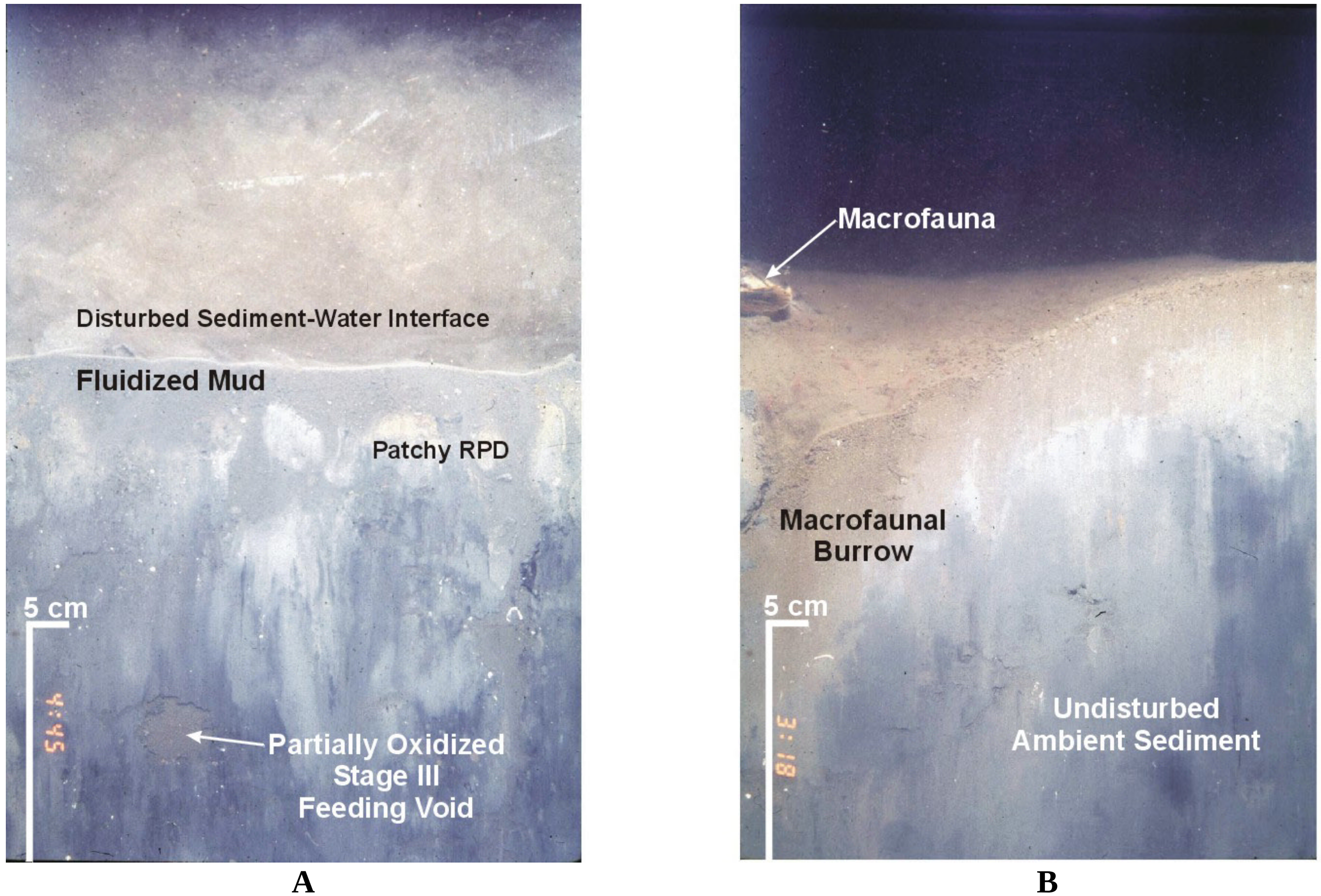


Figure 3-14. REMOTS® images collected from CLIS REF Station 14 (A) and 2500W Station 1 (B) during the September 1997 survey displaying an area of surface disturbance at CLIS REF and a large macrofaunal burrow at the sediment-water interface, respectively

Stage III activity was noted at every station within 4500E and four of the five stations sampled at CLIS REF. Megafaunal (potentially juvenile lobster) burrows were also observed at a depth of 15 to 20 cm in multiple replicates collected from all three reference areas. Median OSI values for the reference area stations ranged from +3.5 to +10, with the lowest composite value calculated for 2500W (+5.3) due the low abundance of Stage III organisms. OSI values of +6 or higher (indicative of undisturbed benthic habitat conditions) were present at one of five 2500W stations, three of four 4500E stations, and four of five CLIS REF stations sampled. The composite OSI value for the CLIS reference areas was +6.8 during the September 1997 survey, which was only slightly below the value of +7 calculated for the same areas in July 1996.

3.2 March 1998 Survey

3.2.1 CLIS REF Investigation

3.2.1.1 REMOTS® Sediment-profile imaging

As previously described, the March 1998 sediment-profile imaging survey over CLIS REF consisted of a series of nine stations established near the center of the reference area (Figure 2-4). These stations were used to further examine a physical disturbance detected at the sediment-water interface in July 1996 and September 1997. The data obtained from this supplemental survey are summarized in Table 3-4, with a complete set of image analysis results presented in Appendix B4.

Sediment Grain Size and Stratigraphy

A total of 27 replicate images were collected over CLIS REF during the March 1998 survey. Although there was a small degree of variability among replicates, all the images displayed fine-grained (>4 phi) sediment consisting of a 2-3 cm layer of tan, oxygenated silt overlying a slightly mottled, gray (hypoxic) sediment at depth (Figure 3-15). There were no obvious signs of a major physical disturbance at the sediment-water interface or input of non-ambient sediment observed in any REMOTS® image. However, average boundary roughness measurements were noticeably higher in comparison to the September 1997 data for CLIS REF, ranging from 0.5 cm at Station 20N to 2.6 at Station 20E (Table 3-4).

The center of the survey grid, which was the original area of concern, appeared to have recovered from the disturbances noted in previous surveys. A well-defined sediment-water interface and RPD were present in all three replicates. Sediment color and texture were consistent with the surrounding stations, and no residual effects from the benthic disturbance were apparent.

Table 3-4. Summary of REMOTS® Results for Stations Occupied over CLIS REF, March 1998

Reference Area	Station	Camera Penetration Mean (cm)	Dredged Material Thickness Mean (cm)	Number of Reps w/ Fresh Dredged Material	RPD Mean (cm)	Successional Stages Present	Highest Stage Present	Grain Size Major Mode (Phi)	Methane Present	OSI Mean	OSI Median	Boundary Roughness Mean (cm)
CLIS REF	CTR	8.23	0	0	2.04	I, III	ST_I_ON_III	>4	NO	5.67	5	0.76
	20N	9.80	0	0	2.06	I, III	ST_I_ON_III	>4	NO	6.00	5	0.51
	20S	9.47	0	0	1.93	I, III	ST_III	>4	NO	8.00	8	1.46
	20E	10.42	0	0	1.58	I, III	ST_III	>4	NO	6.33	7	2.64
	20W	8.29	0	0	1.56	I, III	ST_III	>4	NO	6.33	7	1.13
	40N	9.29	0	0	2.07	I	ST_I	>4	NO	4.33	4	0.97
	40S	9.68	0	0	2.42	I, III	ST_III	>4	NO	9.00	9	0.55
	40E	7.29	0	0	1.83	I, III	ST_III	>4	NO	7.00	8	2.06
	40W	7.24	0	0	1.94	I, III	ST_III	>4	NO	6.67	8	1.18
AVG		8.86	0.00	0.00	1.94					6.59	6.78	1.25
MIN		7.24	0.00	0.00	1.56					4.33	4.00	0.51
MAX		10.42	0.00	0.00	2.42					9.00	9.00	2.64

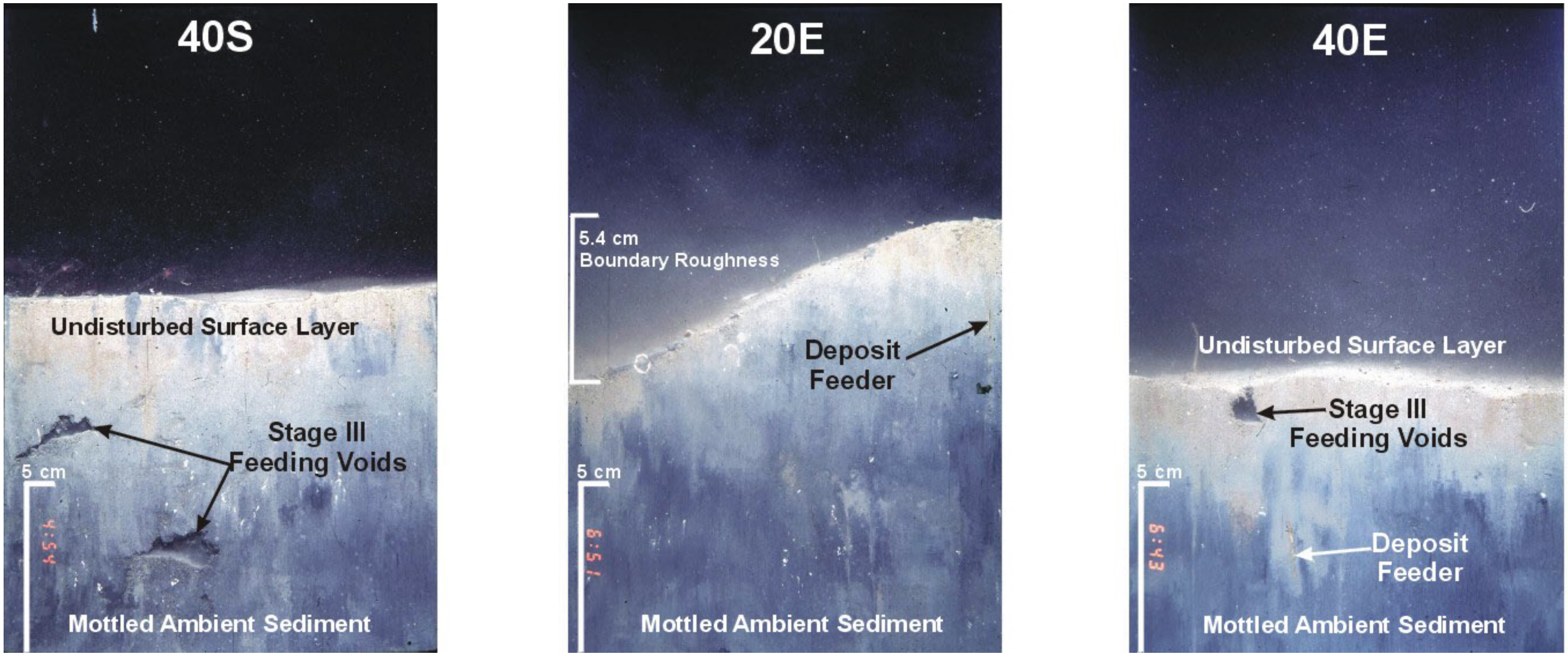


Figure 3-15. REMOTS® images collected from CLIS REF during the March 1998 survey as examples of undisturbed, oxidized surface layers with mottled gray silt and clay at depth, and varying levels of Stage III activity. The high boundary roughness displayed at Station 20E is likely due to natural processes at CLIS REF during the winter months.

Benthic Community Assessment

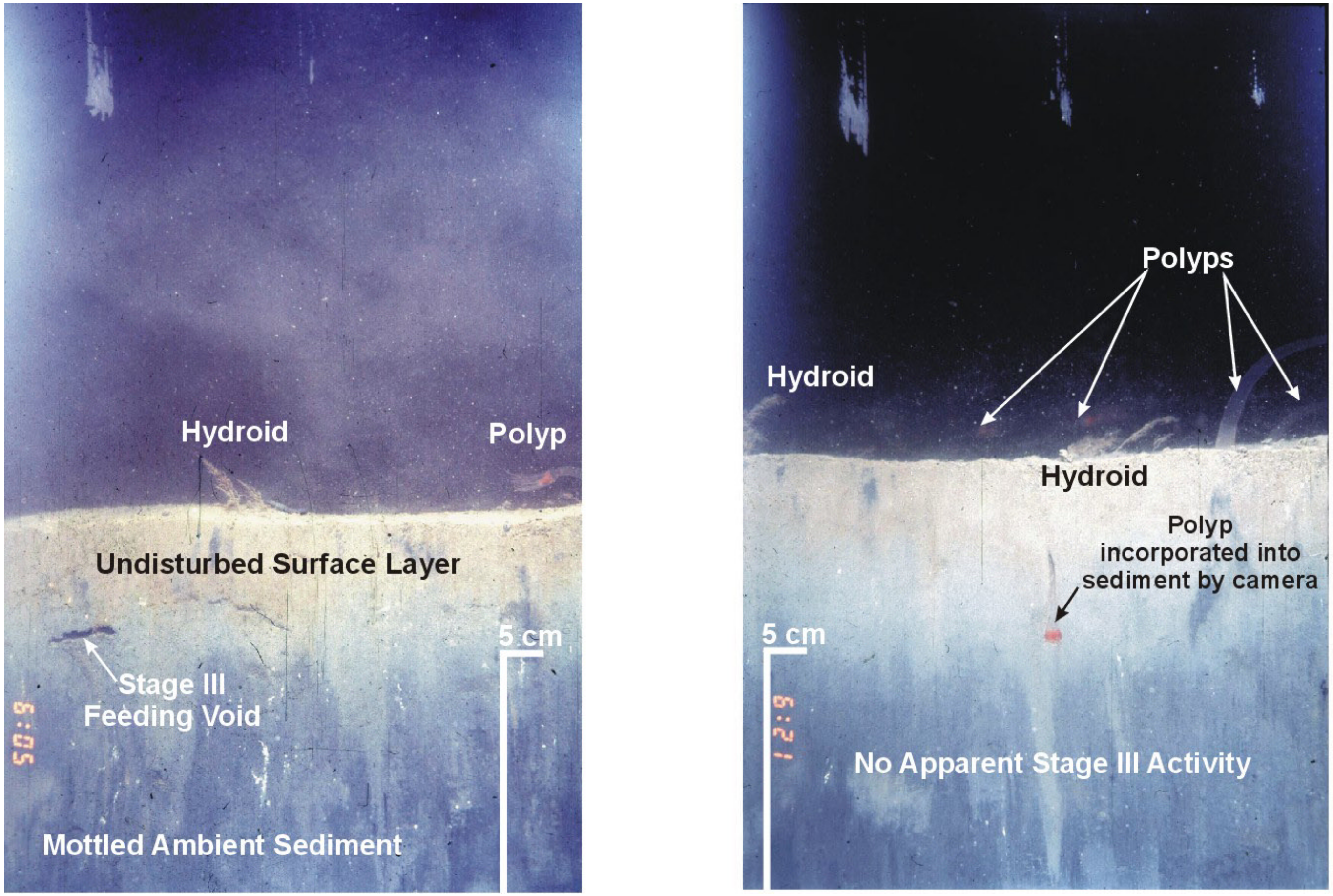
Replicate-averaged RPD depths at CLIS REF ranged from 1.6 to 2.4 cm during the March 1998 survey, with an overall average of 1.9 cm, indicating a reduction in the depth of oxygenation relative to the average RPD value of 2.4 cm during the September 1997 survey (Tables 3-2 and 3-4). Despite the difference in the thickness of the oxidized layer, no low dissolved oxygen conditions, methane gas, or redox rebounds were detected in any replicate photograph.

Although RPD depths were somewhat shallower at CLIS-REF in March 1998 compared to September 1997, evidence of Stage III activity was present at eight of the nine stations (Figures 3-15 and 16a; Table 3-4). Stage I individuals were present at the sediment-water interface in every replicate photograph. In addition, large polyps, representing the sessile, pre-adult stage of development of a species of hydrozoan were found in many of the replicate images (Figure 3-16B).

3.2.1.2 Side-Scan Sonar

The March 1998 side-scan survey did not detect any large, discrete mounds of deposited sediment within the 0.6 km^2 survey area. The bottom at CLIS REF was found to be regular and flat, with the only prominent features being strong, linear sedimentary furrows (Figure 3-17). Previously identified in side-scan sonar and sub-bottom profile data acquired by the U.S. Geological Survey (USGS), the furrows were reported to have an average width of 9.2 m and average relief of 0.4 m. In addition to the large-scale features described above, a variety of small-scale features were also detected within the confines of CLIS REF.

Represented as thin, faint lines in the side-scan record, multiple sets of trawl door scars were imaged within the survey area (Figure 3-17). This suggests CLIS REF is subjected to commercial fishing activity on a periodic basis, which may account for the benthic disturbances detected in July 1996 and September 1997. In addition, a number of small sonar contacts were detected within the survey area established over CLIS REF. The majority of these targets were 5-10 m in diameter and often corresponded to the naturally occurring sedimentary furrows (Figure 3-17). Given that these targets lacked the acoustic signature that is characteristic of deposited sediments, the sonar contacts could represent schools of fish gathering within the seafloor depressions.



A **B**

Figure 3-16. REMOTS® images collected from Stations CTR (A) and 20N (B) over CLIS REF during the March 1998 surveys displaying undisturbed surface layers; mottled, ambient sediment at depth, and hydrozoan polyps at the sediment-water interface

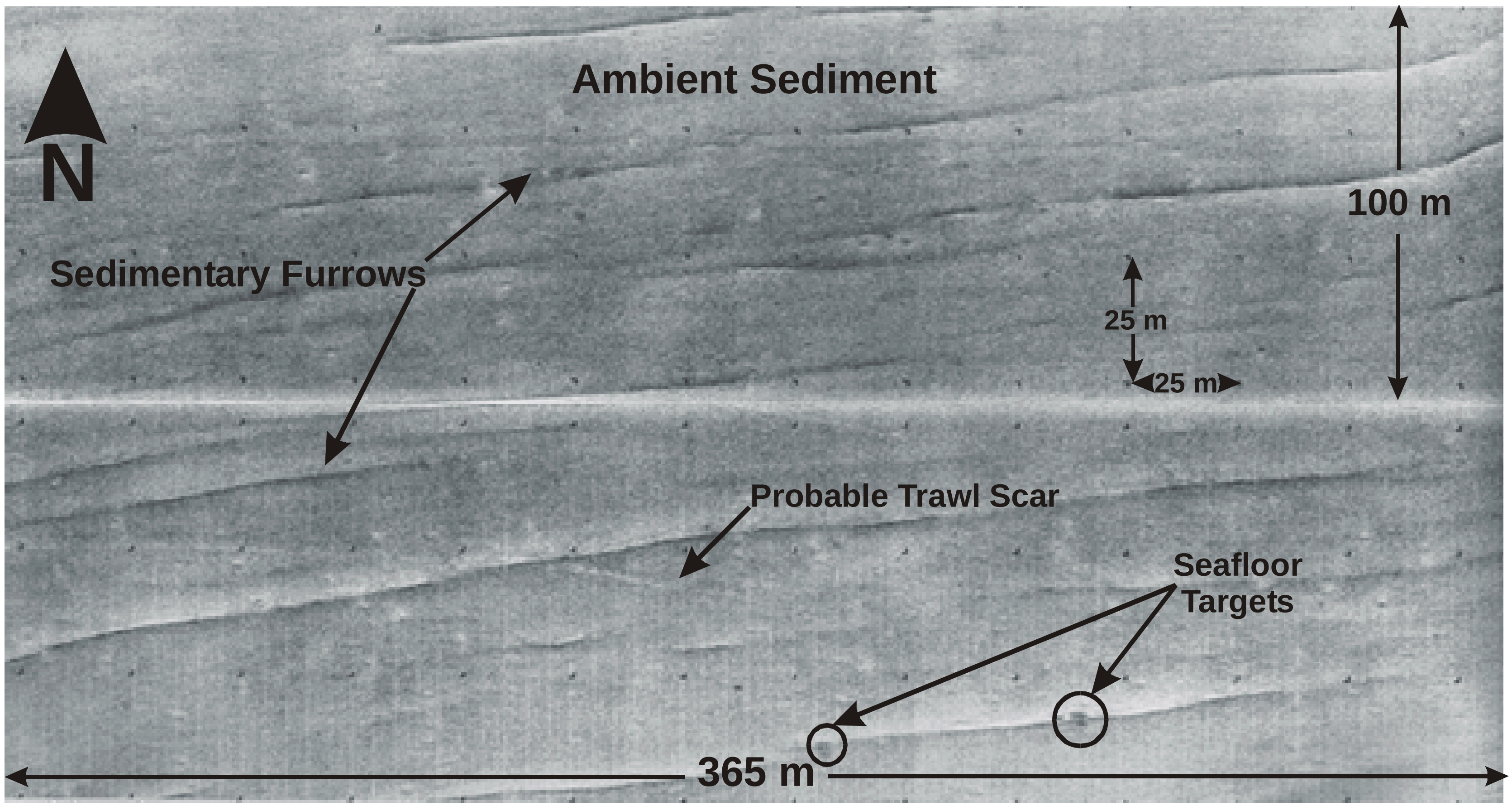


Figure 3-17. Side-scan sonar image (with the water column removed) obtained for an area of seafloor near the center of CLIS REF showing ambient sediment throughout, with various types of seafloor features identified

3.2.2 CLIS 95/96 Mound Complex

A subset of REMOTS® stations that were established over the CLIS 95/96 Mound Complex for the September 1997 survey were reoccupied in March 1998 to evaluate benthic habitat conditions over the sediment deposit during the winter months. In addition, the images were useful in examining the impacts of new dredged material placement activity associated with the 1997-98 disposal season on a recovering area of seafloor. The data obtained from this field effort are summarized in Table 3-5, with a complete set of image analysis results for the March 1998 survey provided in Appendix B5.

3.2.2.1 Sediment Grain Size and Stratigraphy

A total of eight stations concentrated near the center of the CLIS 95/96 Mound Complex were sampled in March 1998, with varying numbers of replicate images analyzed. Layers of fresh dredged material from the on-going 1997-98 disposal activity were detected over the recently placed (1996-97 disposal season) material at Stations 16, 17, 26, and 31. This new layer of sediment was the direct result of recent dredged material deposition at the CDA 97 buoy approximately 200 m to the northwest, and the formation of an overlapping mound apron. A distinct relic RPD was still readily visible approximately 9-10 cm below the new layer of dredged material, which marks the surficial sediment layer detected in September (Figures 3-18A and 3-18B).

The major modal grain size of this new material was >4 phi, indicating a silt/clay composition. Replicate-averaged camera penetration depths over the bottom feature ranged from 9.5 cm at Station 25 to a full 20 cm at Station 15. Boundary roughness measurements were slightly higher over the interior portions of the mound complex relative to the September field effort, with an average value of 1.1 cm calculated for the March survey.

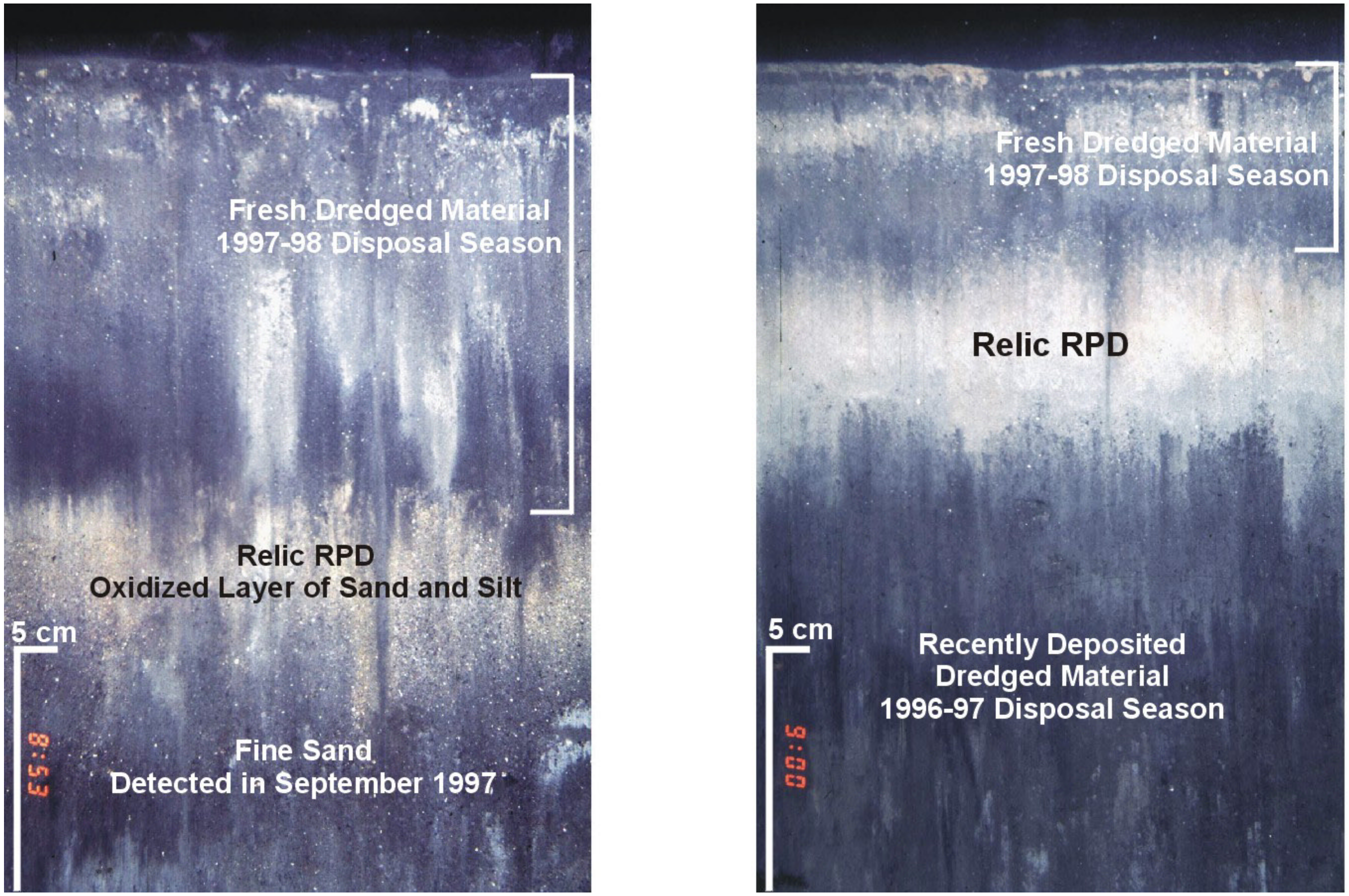
3.2.2.2 Benthic Recolonization

Replicate-averaged RPD depths ranged from 0 cm at Station 23 to 3.84 cm over Station 26, with an overall average of 1.92 cm for the March 1998 stations (Figure 3-19; Table 3-5). The majority of the stations sampled displayed RPD depths that were equivalent to the values for CLIS REF. However, the one analyzable replicate image collected from Station 26 displayed no apparent RPD at the sediment-water interface (Figure 3-18A). Similar conditions were detected at Station 31 as a thin, diffusional RPD of 0.3 cm was detected at the sediment-water interface (Figure 3-18B). This lack of a distinct RPD in these photographs is likely a product of the recent benthic disturbance resulting from dredged material input rather than a degradation of conditions within an existing sediment deposit. No methane gas or redox rebound layers were detected in any replicate image.

Table 3-5. Summary of REMOTS® Results for Stations over the CLIS 95/96 Mound Complex, March 1998

Station	Camera Penetration Mean (cm)	Dredged Material Thickness Mean* (cm)	Number of Reps w/ Fresh Dredged Material	RPD Mean (cm)	Successional Stages Present	Highest Stage Present	Grain Size Major Mode (Phi)	Methane Present	OSI Mean	OSI Median	Boundary Roughness Mean (cm)
15	20.00	>19.98	1	N/A	INDET	INDET	>4	NO	INDET	INDET	0.00
16	17.27	>17.56	3	1.60	I	ST_I	>4	NO	3.50	3.5	2.67
23	19.09	>19.01	2	0.00	I	ST_I	>4	NO	-3.00	-3	0.45
24	9.53	>9.64	3	2.46	I	ST_I	>4	NO	5.00	5	2.28
25	15.97	>15.89	1	2.37	I	ST_I	>4	NO	5.00	5	1.44
26	14.41	>14.51	1	3.84	I	ST_I	>4	NO	7.00	7	0.05
31	17.21	>17.21	2	0.30	I	ST_I	>4	NO	2.00	2	0.55
32	18.95	>19.05	1	2.89	I, III	ST_III	>4	NO	9.00	9	1.58
AVG	16.55	>16.60		1.92					4.07	4.07	1.13
MIN	9.53	>9.64		0.00					-3.00	-3	0.00
MAX	20.00	>19.98		3.84					9.00	9	2.67

* **Values shown are means for n = 3 replicate images obtained and analyzed at each station.**
If dredged material exceeded the prism penetration depth, then the mean value shown is a minimum estimate of dredged material layer thickness (indicated by the > sign).



A **B**

Figure 3-18. REMOTS® images collected from Stations 26 (A) and 31 (B) over the CLIS 95/96 Mound Complex during the March 1998 surveys displaying thin layers of fresh dredged material from the 1997-98 disposal season over recent (1996-97) dredged material. Relic RPDs are easily distinguishable between the various layers of deposited sediment.

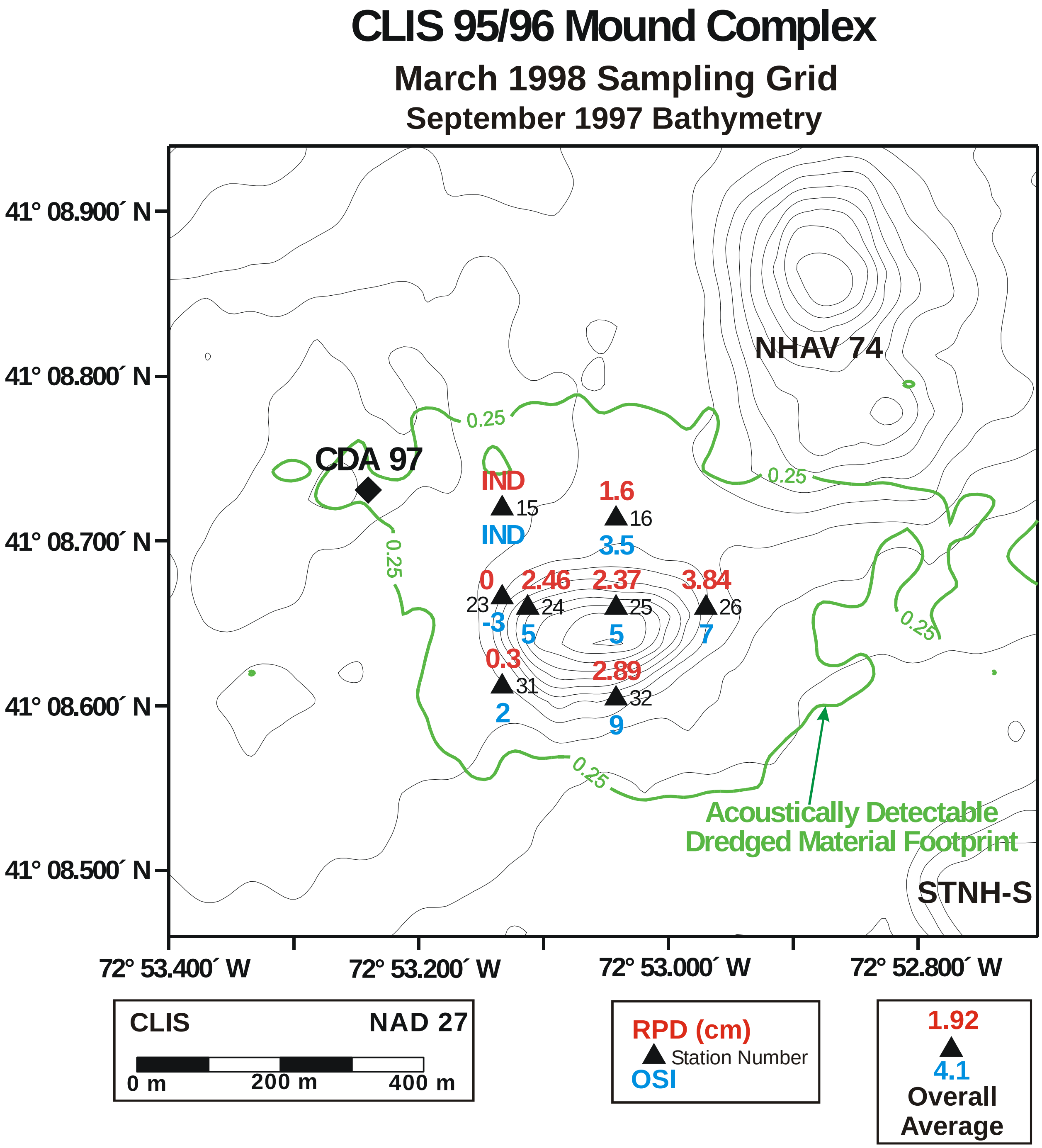


Figure 3-19. Chart of replicate-averaged RPD depths (red) and median OSI values (blue) detected at stations occupied over the CLIS 95/96 Mound Complex during the March 1998, relative to the acoustically detectable dredged material footprint (green).

The successional stage status was predominantly Stage I over most of the stations sampled (Figure 3-20; Table 3-5). A Stage III deposit feeder was imaged in the one photograph obtained from Station 32. The effects of the recent benthic disturbance over CLIS 95/96 and the lack of Stage III activity impacted the median OSI values calculated for Stations 23 (-3) and 31 (+2), as well as reduced the overall average OSI value for the mound (+4.1; Figure 3-19). Apart from Stations 23 and 31, the remainder of the stations displayed moderate OSI values ranging from +3.5 to +9, reflecting deeper RPD depths. In general, the OSI values calculated for Stations 15, 16, 24, 25, 26, and 32 were comparable to the data obtained from CLIS REF, despite the on-going nearby sediment disposal (Tables 3-4 and 3-5).

3.2.3 NHAV 93 Mound

The March 1998 REMOTS® survey over the NHAV 93 Mound represents the fifth monitoring effort focused on the recolonization status of this capped mound. The data generated as part of the winter survey are summarized in Table 3-6, with a complete set of REMOTS® image analysis results presented in Appendix B6.

3.2.3.1 Sediment Grain Size and Stratigraphy

As in the September survey, the replicate images collected over NHAV 93 indicated the surface sediments were composed primarily of low reflectance silts and clays. The major modal grain size classification was >4 phi at every station, with no lag deposits or significant coarsening of surface dredged material detected. Once again, historic dredged material was detected and classified as greater than the penetration depth of the sediment-profile camera in all replicate images. The replicate-averaged mean camera penetration was similar to the summer survey, ranging from 13.9 cm at Station 200E to 17.24 cm at Station 200W (Table 3-6). Boundary roughness values ranged from 0.3 cm to 1.0 cm, with the primary cause of boundary roughness related to biological activity at the sediment-water interface.

3.2.1.1 Benthic Community Assessment

Replicate-averaged RPD depths over the NHAV 93 Mound were somewhat lower relative to the September 1997 results, but still consistent with the findings at CLIS REF. The RPD depths over NHAV 93 ranged from 1.6 cm at Station 200N to 2.2 cm at Station CTR, with an overall average of 1.8 cm (Figure 3-21; Table 3-6). No indications of low dissolved oxygen or redox rebound intervals were noted in any photograph. The sediment methane that was detected at Stations 200E and CTR in September 1997 was not present in the March photographs (Figure 3-22A).

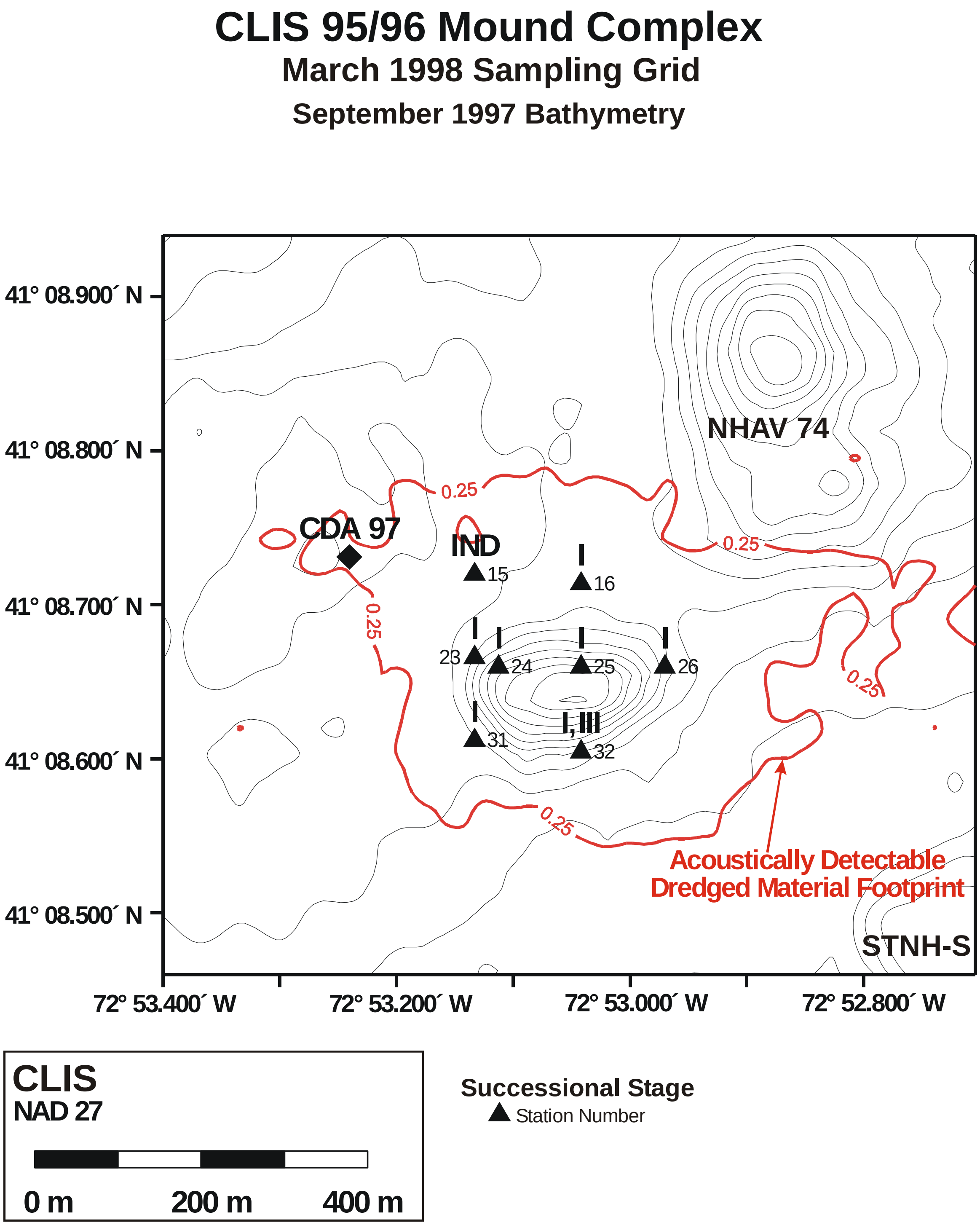


Figure 3-20. Chart of successional stage status for the REMOTS® stations occupied over the CLIS 95/96 Mound Complex during the March 1998 survey, relative to the acoustically detectable dredged material footprint (red)

Table 3-6. Summary of REMOTS® Results for Stations over the NHAV 93 Mound, March 1998

Station	Camera Penetration Mean (cm)	Dredged Material Thickness Mean* (cm)	Number of Reps w/ Fresh Dredged Material	RPD Mean (cm)	Successional Stages Present	Highest Stage Present	Grain Size Major Mode (Phi)	Methane Present	OSI Mean	OSI Median	Boundary Roughness Mean (cm)
CTR	15.52	>15.47	2	2.15	I	ST_I	>4	NO	4.50	4.5	0.33
200N	15.80	>15.75	2	1.62	I, III	ST_I_ON_III	>4	NO	5.50	5.5	0.58
200S	15.76	>15.63	3	1.62	I, III	ST_III	>4	NO	5.50	5.5	0.81
200E	13.85	>13.90	3	1.75	I	ST_I	>4	NO	4.00	4	1.14
200W	17.30	>17.24	3	2.06	I, III	ST_I_ON_III	>4	NO	7.00	8	0.75
AVG	15.65	>15.60		1.84					5.30	5.50	0.72
MIN	13.85	>13.90		1.62					4.00	4	0.33
MAX	17.30	>17.24		2.15					7.00	8	1.14

* **Values shown are means for n = 3 replicate images obtained and analyzed at each station.**
If dredged material exceeded the prism penetration depth, then the mean value shown is a minimum estimate of dredged material layer thickness (indicated by the > sign).

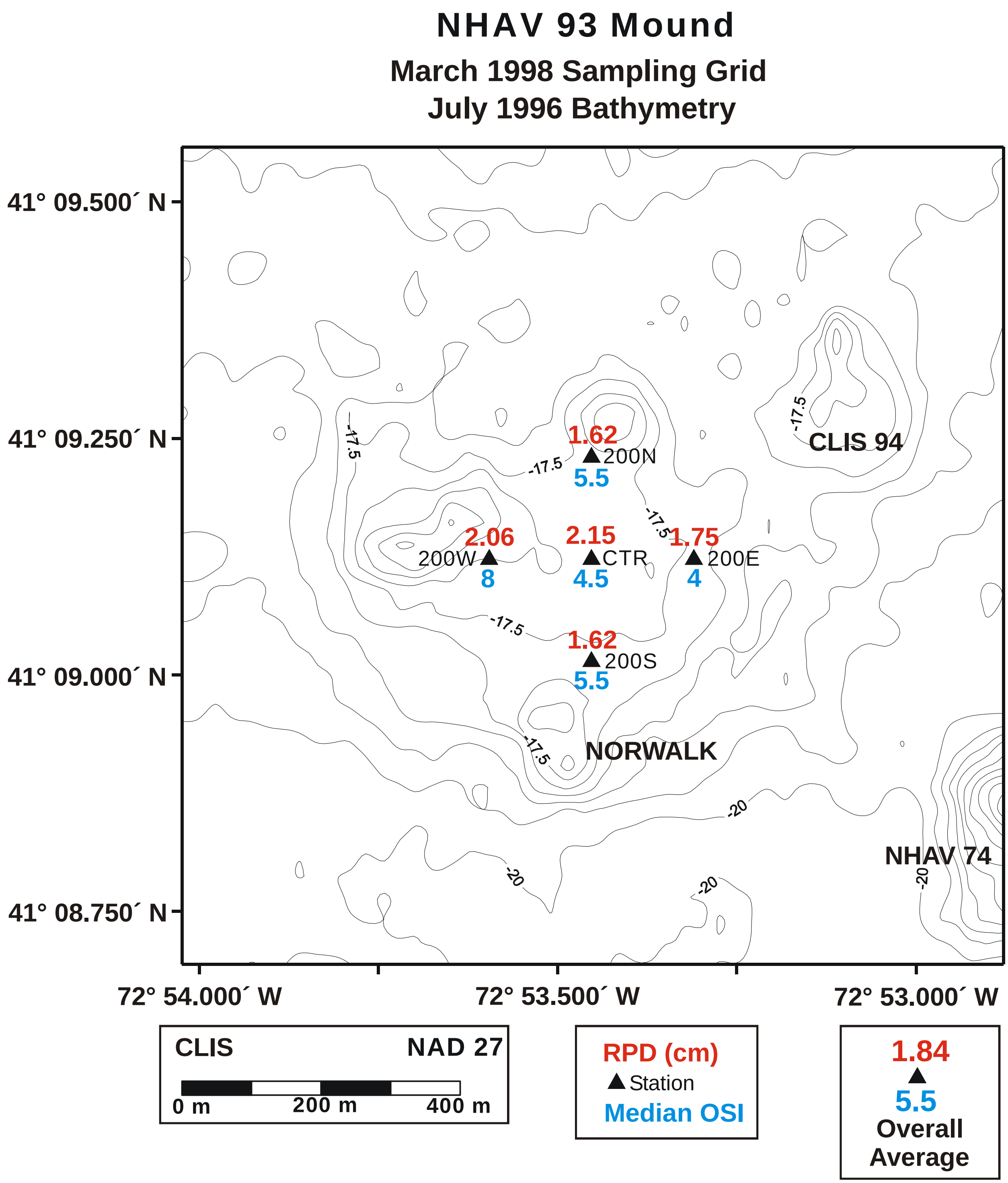
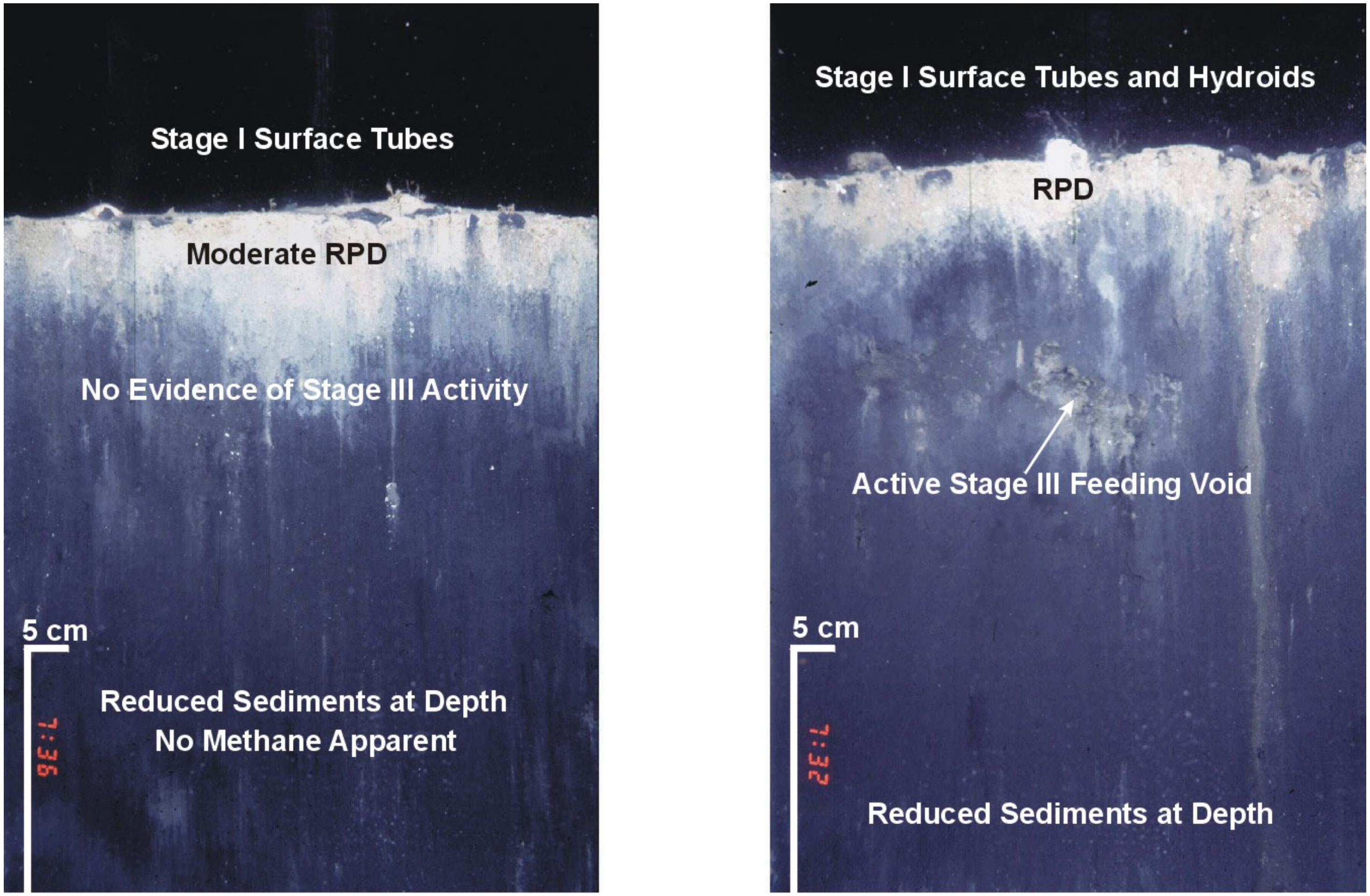


Figure 3-21. Chart of replicate-averaged RPD depths (red) and median OSI values (blue) detected over the NHAV 93 Mound in March 1998



A **B**

Figure 3-22. REMOTS® images collected from Stations CTR (A) and 200S (B) over the NHAV 93 Mound during the March 1998 survey showing improved benthic habitat conditions, relative to the September 1997 survey

Stage III organisms were slightly more abundant, relative to the September survey, as one additional station displayed evidence of an advanced successional stage (Figure 3-23; Table 3-6). As in September 1997, Station 200N was supporting a Stage III population, but the remaining stations continued to display variability in benthic habitat conditions over time. Station 200S displayed the largest improvement relative to September by supporting an advanced successional stage in multiple replicate images, resulting in a three-point increase in the median OSI value (Figure 3-22B). Station-to-station comparisons of OSI values for the remainder of the survey grid showed minor variations between the March and September data. In general, there was a small increase (0.6 points) in the composite OSI value for NHAV 93 during winter conditions, as the average value for the mound was +5.5.

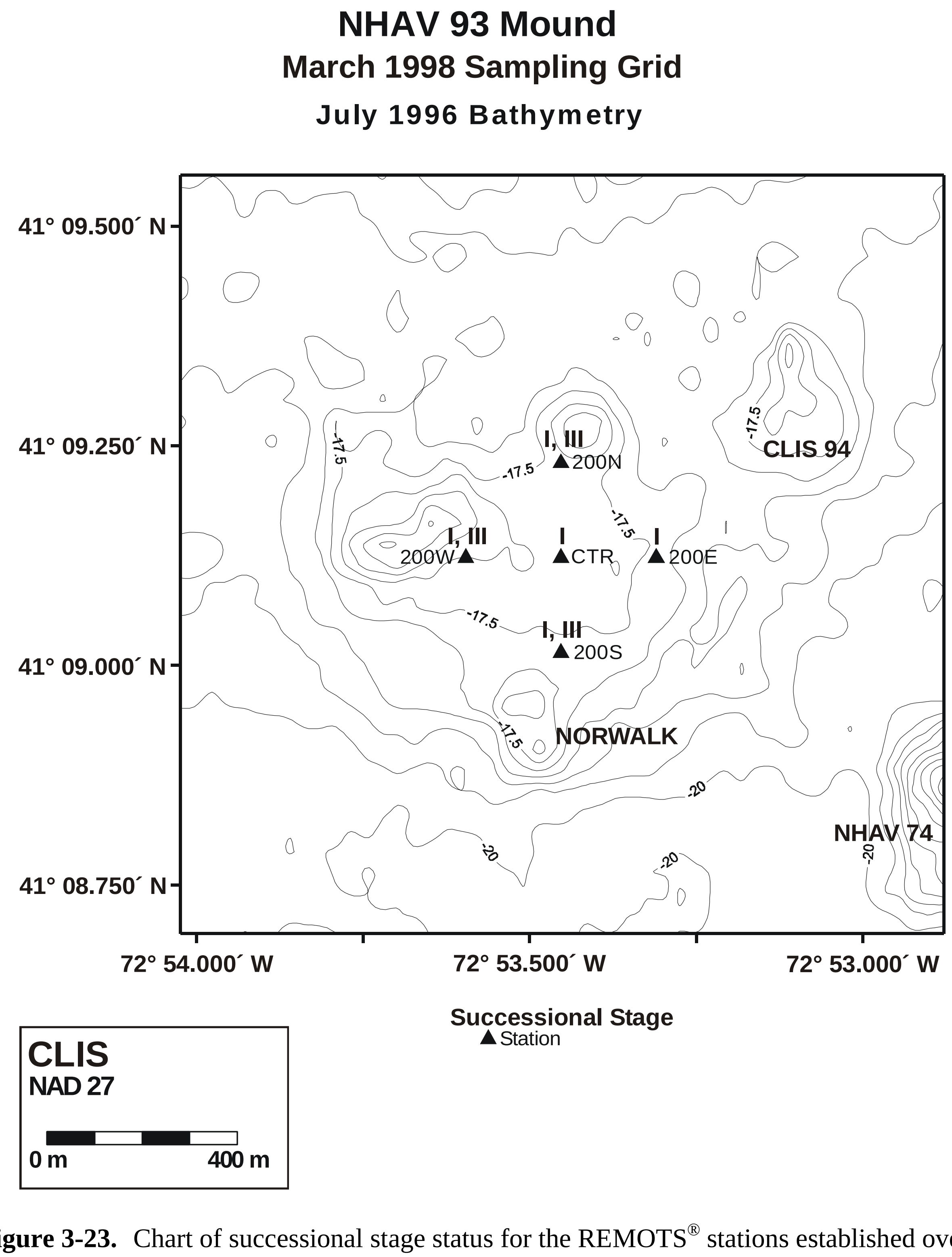


Figure 3-23. Chart of successional stage status for the REMOTS® stations established over the NHAV 93 Mound in March 1998

4.0 DISCUSSION

4.1 September 1997 Survey

One objective of the September 1997 survey was to evaluate the changes in seafloor topography resulting from the deposition of dredged material at the CDA 96 buoy and a nearby, secondary disposal point (Point A) during the 1996-97 disposal season. Depth difference calculations based on successive bathymetric surveys showed that this material formed a deposit having a maximum height of nearly 4.25 m at its apex, centered approximately 100 m east-southeast of the CDA 96 buoy position. The material placed at Point A and the CDA 96 buoy coalesced on the seafloor with the existing CLIS 95 Mound to form a single new bottom feature called the CLIS 95/96 Mound Complex. Bathymetric survey results showed that this feature was roughly circular, with a height of 4.75 m at its apex and a diameter of about 700 m.

Using a ring of disposal mounds to create a bowl-like bathymetric feature on the seafloor, and subsequently placing dredged material within the confines of such a "containment cell," represent a DAMOS management strategy originally demonstrated with the successful construction of the NHAV 93 Mound (Fredette 1994; Morris et al. 1996). The CLIS 95/96 Mound Complex serves to begin closing a second artificial containment cell on the CLIS seafloor (labeled as Cell A in Figure 4-1). This containment cell can be used in the future to limit the lateral spread on the seafloor of unacceptably-contaminated dredged material (UDM), which can then be covered with a layer of cleaner, capping dredged material (CDM).

In September 1997, the CDA 97 buoy was placed to the northwest of the CLIS 95/96 Mound Complex to create a new disposal mound (CLIS 97) that will continue closing containment Cell A (Figure 4-1). Upon completion, this containment cell will offer a dredged material capacity of well over one million cubic meters. Dependent upon the volume of material disposed and the morphology of the CLIS 97 Mound, it is recommended that future placement operations be directed to several points north and east of the NHAV 74 Mound (Figure 4-1). The development of discrete mounds in this region will begin the formation of a third containment cell at CLIS (labeled as Cell B in Figure 4-1).

A second objective of the September 1997 monitoring survey was to evaluate benthic recolonization over the CLIS 95/96 Mound Complex and assess benthic habitat conditions over the now historic NHAV 93 Mound, relative to conditions at the three reference areas (2500W, 4500E, and CLIS REF) surrounding the disposal site. DAMOS monitoring surveys in Long Island Sound typically are performed during the summer, several months following the end of each disposal season, to allow the benthic infaunal population to become

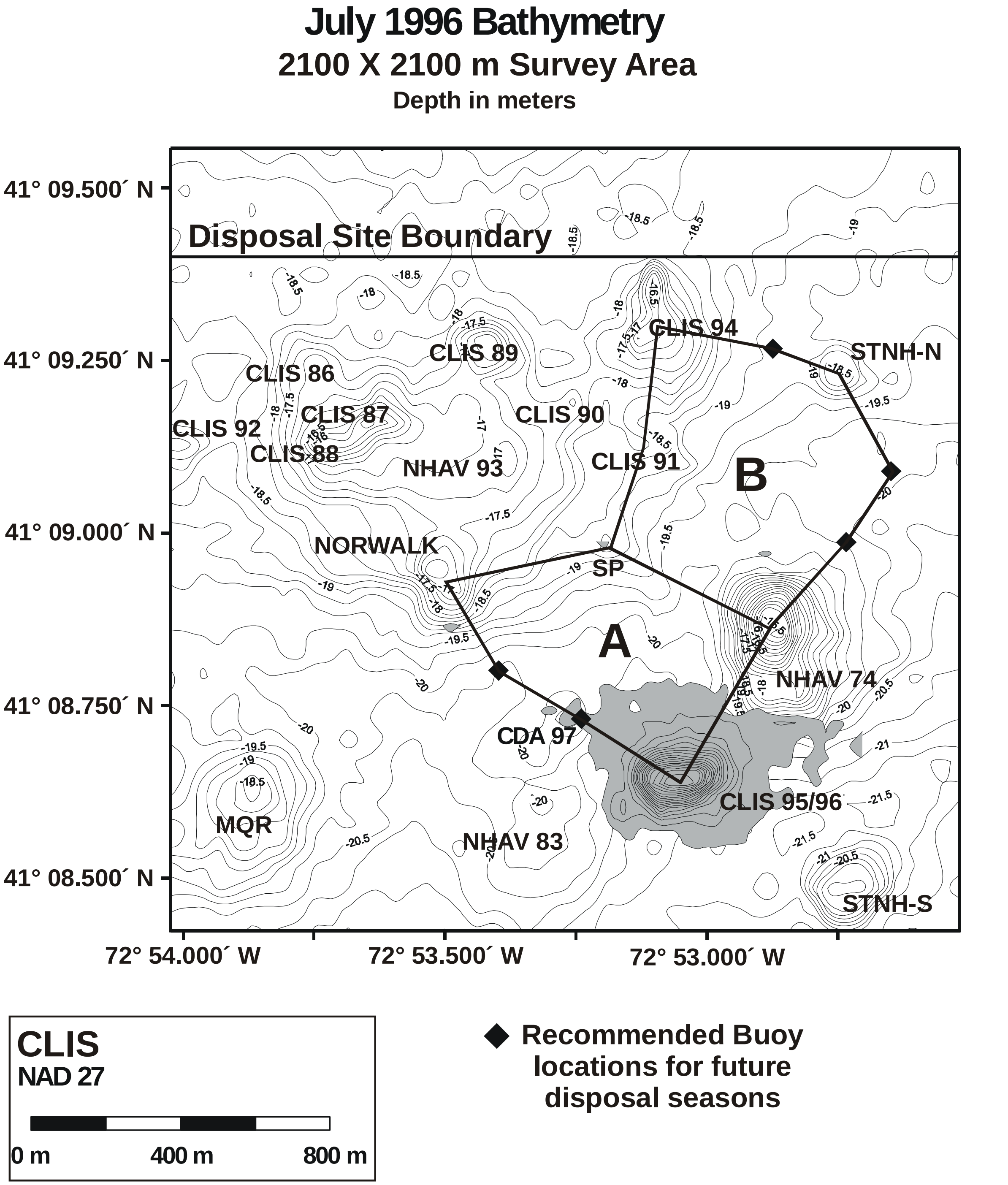


Figure 4-1. Bathymetric chart of the July 1996 2100 × 2100 m survey area overlaid with the latest changes in seafloor topography and suggested points for future disposal to facilitate the completion of a second and third artificial containment cell on the CLIS seafloor

established within the new sediment deposits. In addition, this practice allows warmer bottom water temperatures (17 to 21°C) to promote increased bioturbation by the recovering benthic community, increasing the depth of oxygenation in the sediment and improving habitat conditions. However, the bottom waters of western and central Long Island Sound also are known to experience significant declines in dissolved oxygen during the summer, which can complicate the interpretation of monitoring data collected during or after the passage of a seasonal hypoxia event.

Dredged material placement operations in the vicinity of the CDA 96 buoy were completed on 20 April 1997, allowing four months for a new benthic infaunal population to establish itself in the surficial sediments of CLIS 95/96 Mound Complex before the September monitoring survey. As the most recent bottom feature within the disposal site, the mound complex displayed evidence of rapid benthic recolonization, with Stage I organisms observed at every station, and evidence of Stage III activity at 73% of the stations sampled. The majority of the Stage III individuals inhabiting the CLIS 95/96 Mound Complex in September were probably the product of recruitment into this competition-free space. However, given the detection of dredged material layering on the apron of the sediment deposit, many of the errant polychaetes detected at the outer stations probably migrated up into the relatively thin layer of fresh dredged material to exploit the new food source.

Dissolved oxygen concentrations of $\geq 5.0\ mg \cdot l^{-1}$ are thought to be protective of most Long Island Sound marine life, while concentrations defined as hypoxic ($<3.0\ mg \cdot l^{-1}$) can cause organism stress or mortality (LISS 1990). Bottom water dissolved oxygen concentrations at CTDEP Stations H2 and H4 located near CLIS (see Figure 1-1) never reached hypoxic levels, but remained at approximately $4.0\ mg \cdot l^{-1}$ for a period of four weeks preceding the September 1997 DAMOS monitoring survey (Figure 4-2, bottom panel). Despite the timing of the REMOTS® sampling relative to the seasonal reduction in dissolved oxygen, RPD depths were found to be well developed over most of the CLIS 95/96 Mound Complex. These relatively deep RPD depths are attributed to intense bioturbation by the recovering benthic infauna during the months of May, June, and July, which served to incorporate oxygen-rich bottom water into the sediment. Redox rebound intervals were found to be widespread over the CLIS 95/96 Mound Complex in September, indicating a shallowing trend in RPD depths and confirming the recent reduction in near-bottom water dissolved oxygen concentrations. The mean redox rebound depths ranged from 3.3 to 9 cm, suggesting RPD depths were much deeper at many stations during the spring and early summer, relative to the September survey.

Due to the active sediment aeration by benthic organisms in the months preceding the September 1997 survey, the median OSI values calculated for the majority of the stations over the CLIS 95/96 mound complex remained high, despite the apparent decreasing levels of oxygen in the sediment. As a result, the September 1997 data indicate that benthic habitat

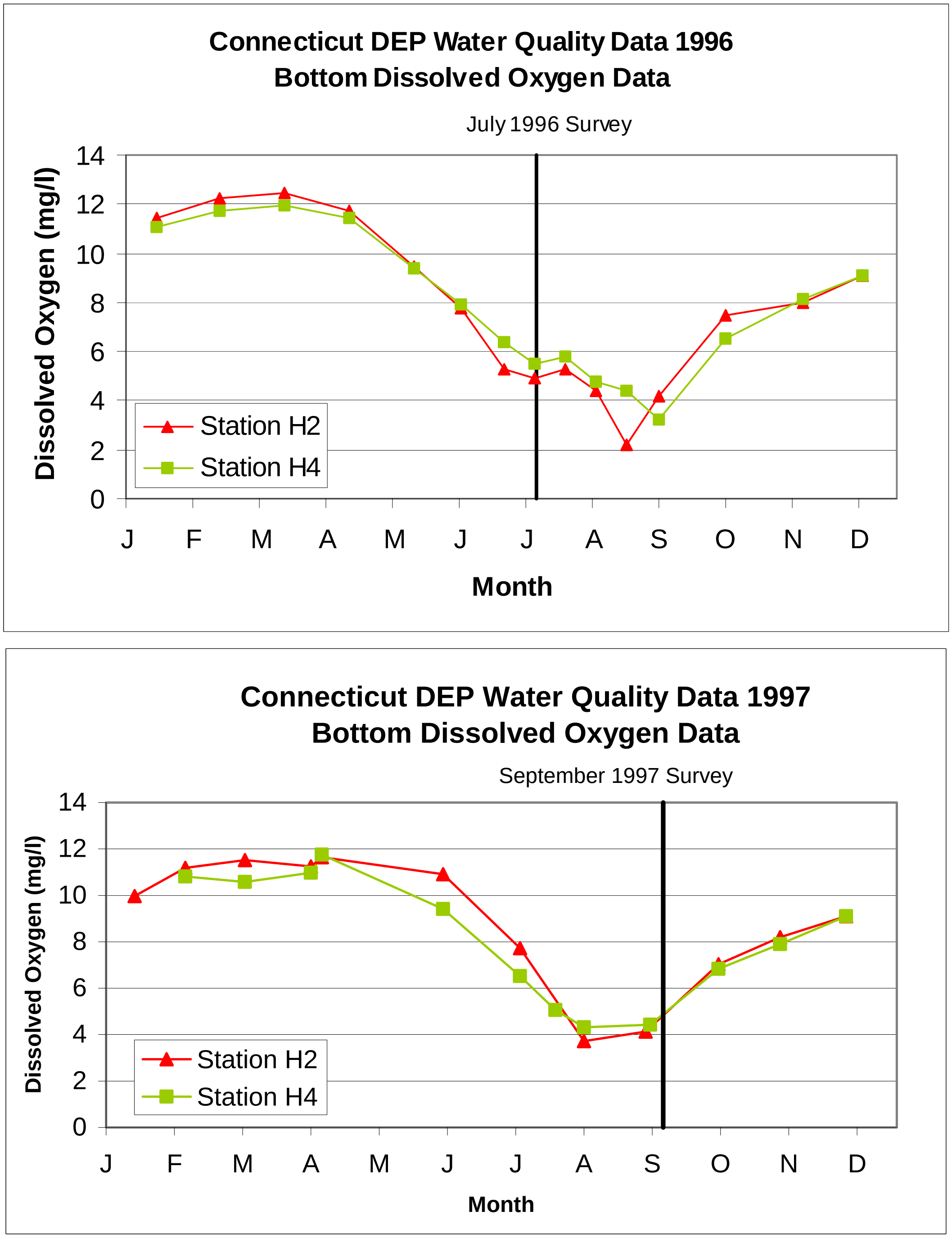


Figure 4-2. Observed changes in bottom water dissolved oxygen concentrations at the Connecticut Department of Environmental Protection (CTDEP) water quality sampling stations H2 and H4 for 1996 (top panel) and 1997 (bottom panel).

quality was not adversely effected by the added stress induced by the seasonal reduction in available oxygen. Almost five months following the end of the 1996-97 disposal season, 28 of the 41 stations (68%) at the newly formed CLIS 95/96 Mound Complex had mean OSI values greater than +6 (considered indicative of undisturbed benthic habitat quality). These results reflect the presence of an advanced successional stage and relatively deep RPD depths at the majority of stations. The average median OSI value of +6.8 for the CLIS 95/96 Mound Complex was, in fact, identical to the composite value for the CLIS reference areas.

Recently deposited dredged material like that comprising the CLIS 95/96 Mound Complex often supports higher population densities of recolonizing benthic organisms by providing a concentrated food source within a competition-free space, relative to ambient sediments (Germano et al. 1994). Fresh dredged material often possesses a higher inorganic nutrient (N, P, Si, Fe, etc.) and organic material (bioavailable carbon) content, in comparison to the more depleted ambient sediments surrounding the disposal site (Rhoads and Germano 1986). As a result, disposal mounds composed of sediments with higher nutrients and organic detritus tend to promote faster recolonization and increased bioturbation, as seen in the September 1997 survey results for the CLIS 95/96 Mound Complex.

While higher nutrients and organic carbon content generally have a stimulatory effect on benthic communities, it is also possible for dredged material to be over-enriched with respect to these parameters. Elevated sediment oxygen demand associated with microbial decomposition of high concentrations of organic matter can make an area of seafloor more susceptible to disturbance during periods of time when bottom water dissolved oxygen concentrations are low (seasonal hypoxic events). As oxygen levels in overlying waters decrease, the benthic community becomes stressed and less able to maintain an aerobic sedimentary environment (Diaz and Rosenberg 1995; Ritter and Montagna 1999). Microbial-mediated oxidation of organic matter will continue in the sediment until the supply of molecular oxygen is exhausted, causing a rapid decrease in RPD depths that is often observed in sediment-profile images as a redox rebound layer.

The NHAV 93 Mound is an example of a dredged material deposit that is highly enriched in organic matter, fostering increased sediment oxygen demand as the organic material decomposes over time (Morris and Tufts 1997). Over the years, benthic recolonization near the center of the NHAV 93 Mound has shown a cyclical recovery and decline roughly corresponding to the onset and severity of seasonal hypoxia in the near-bottom waters of the central Long Island Sound region. Due to the high apparent oxygen demand of the NHAV 93 Mound sediments, the resident benthic community appears to be more susceptible to hypoxia-induced stress. It is hypothesized that the combined effects of high existing sediment oxygen demand and seasonal hypoxia are persistent obstacles to the development of a stable benthic infaunal population. Another objective of the September

1997 survey, therefore, was to test this hypothesis by examining the recolonization status of the NHAV 93 Mound.

The NHAV 93 disposal mound in the September 1997 survey continued to display benthic habitat quality below that of the CLIS reference areas and a strong relationship with the seasonal hypoxia cycle in Long Island Sound. The presence of methane gas bubbles in several of the 1997 REMOTS® images served to confirm the continued presence of high levels of labile organic matter within the NHAV 93 dredged material and anoxic conditions in the subsurface sediments. A decline in benthic habitat conditions was detected at four of the five stations over NHAV 93 in 1997, relative to the results of the preceding REMOTS® survey of July 1996. Although there was no appreciable difference in the replicate-averaged RPD depths between the 1997 and 1996 surveys, the number of stations displaying evidence of Stage III activity decreased. The lower abundance of Stage III organisms caused median OSI values to drop 4-points at Stations CTR and 200W, 2-points at 200E, and 0.5-point at 200S.

While the majority of the stations over the NHAV 93 Mound showed evidence of declining conditions, Station 200N showed a marked improvement over the previous surveys. Station 200N was originally one of three areas of concern (200N, CTR, and 400S) discovered during the July 1994 REMOTS® survey due to the appearance of dark sulphidic sediments and thin, diffusional RPDs (Morris and Tufts 1997). During the July 1996 survey, only Stage I activity and a relatively shallow average RPD depth of 1.37 cm was noted at this station (Morris 1998). However, the September 1997 data indicate Station 200N had the deepest average RPD depth, the highest number of replicates with Stage III activity (2), and the highest median OSI value of any station over the NHAV 93 Mound. It is possible that a sufficient amount of organic material has been consumed within the dredged material at this station to decrease the oxygen demand and allow a stable benthic population to become established. Based on these findings and the similar composition of material, the remainder of the NHAV 93 Mound is expected to follow this pattern.

The CTDEP water quality data indicate that near-bottom dissolved oxygen concentrations at stations H2 and H4 ranged from 5.0 $mg \cdot l^{-1}$ to 5.75 $mg \cdot l^{-1}$ at the time of the July 1996 survey (Figure 4-2, top panel). In contrast with the July 1996 survey, which occurred well before any effects of hypoxia were experienced in the central Long Island Sound region, the September 1997 survey occurred after relatively low dissolved oxygen concentrations of 4.0 $mg \cdot l^{-1}$ had persisted for several weeks (Figure 4-2, bottom panel). The decline in benthic habitat conditions at the NHAV 93 mound in September 1997 compared to July 1996 appears to be due to the timing of the two surveys relative to the onset of regional hypoxia, rather than an issue related to chemical contamination. The lack of adverse effects due to chemical contamination was demonstrated in 1994, when testing of NHAV 93 surface sediments using the standard 10-day acute amphipod test failed to detect any significant toxicity (Morris and Tufts 1997).

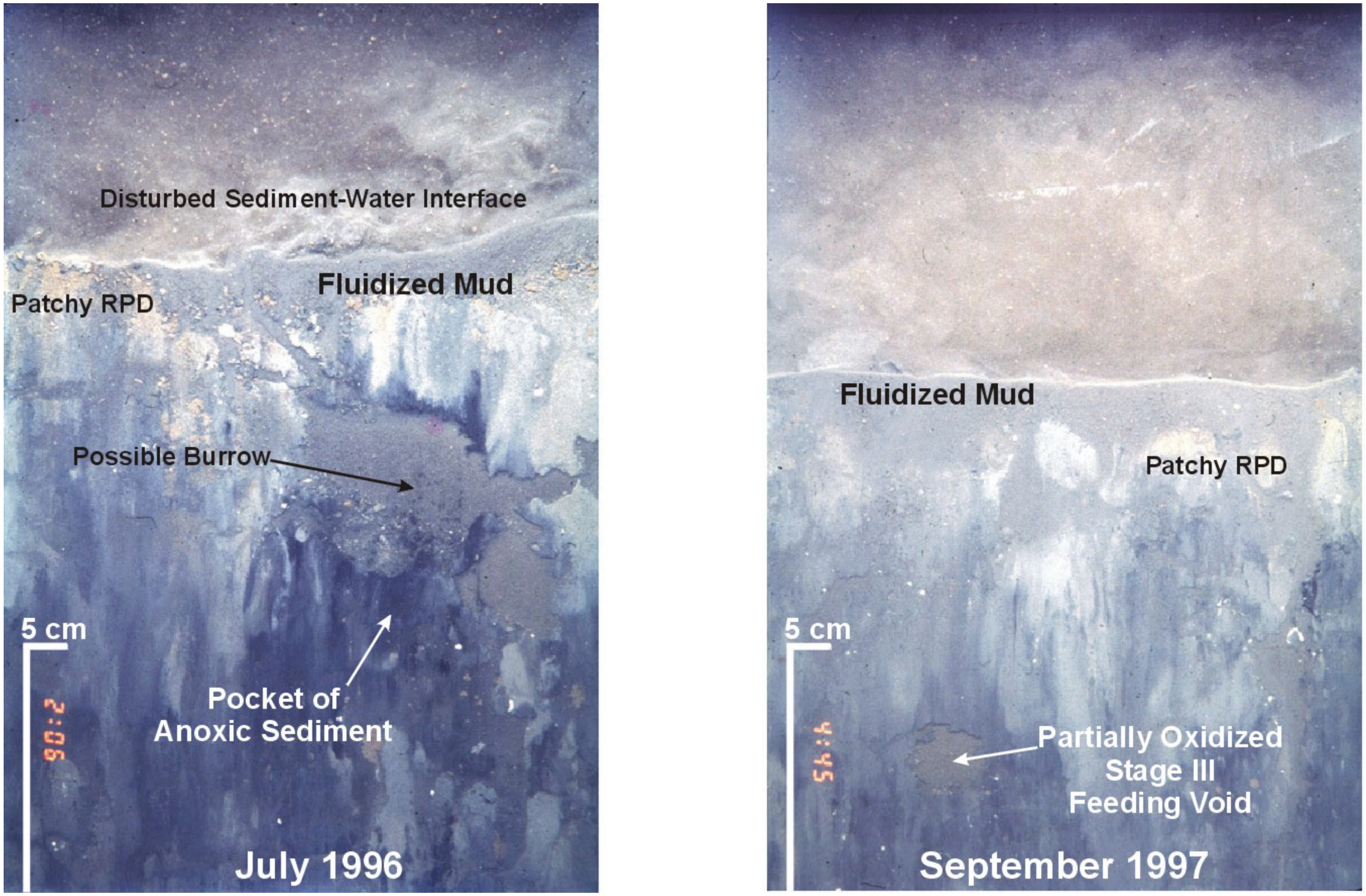
The September 1997 results suggest that portions of the NHAV 93 Mound will continue to undergo benthic population cycles over the next few years, as the level of organic carbon is gradually reduced by chemical and biological processes. Eventually, the organic load within the surficial sediments should be reduced to a point where sediment oxygen demand will no longer be an obstacle to the development of a stable benthic infaunal population.

A final objective of the September 1997 field effort was to examine a specific area within CLIS REF for the presence of non-ambient material (Morris 1998a). One of the replicate sediment-profile images obtained at Station 14 in the September 1997 survey displayed characteristics similar to those observed at Station 9A in July 1996, with a disturbed surface layer, fluidized mud and a chaotic sediment fabric (Figure 4-3). These results prompted the additional study performed in March 1998.

4.2 March 1998 Survey

The REMOTS® images collected at CLIS REF in March 1998 did not show any indications of sediment disturbance, or any evidence of recent or historic input of non-ambient material, over the area where such features had been observed in the previous surveys of 1996 and 1997. All of the replicate images obtained in March 1998 displayed ambient sediment, with an intact sediment-water interface and uniform sediment fabric. A tan, oxidized surface layer was detected in all photographs, with a mottled gray, reduced sediment horizon at depth. The March 1998 side-scan sonar survey likewise failed to detect any areas of benthic disturbance or dredged material input, suggesting that the conditions observed in the July 1996 and September 1997 sediment-profile images were highly localized and temporary.

Although the side-scan sonar survey did not detect any large-scale sediment deposits, a variety of features were discovered on the seafloor at CLIS REF. In particular, several distinct linear depressions were observed as dominant features of the CLIS REF seafloor (Figure 3-17). These features were later identified as naturally occurring sedimentary furrows in the central Long Island Sound seafloor. These furrows are oriented along a west-southwest to east-northeast axis and are the product of sediment transport within the central Long Island sound region driven by tidal and storm-induced, near-bottom currents (Poppe et al. 1998). These features are located in a depositional environment with normally weak bottom-current regimes, which suggests they are only intermittently active (Knebel et al. 1999; Signell 1998). Due to the compression of the digital data used to produce the side-scan sonar image, the furrows appear to be quite narrow and comparable to trawl door scars on the seafloor. However, these features are common throughout central Long Island Sound, with an average width of 9.2 m and approximately 0.4 m of relief. Multiple small to moderate sized targets corresponding to the locations of the furrows were also noted in the side-scan



A B

Figure 4-3. REMOTS® images collected near the center of CLIS REF in July 1996 (A) and September 1997 (B) displaying similarity in conditions related to recent benthic disturbances record. Based on the acoustic reflection, these targets may represent small schools of fish (i.e., scup, Atlantic Croaker, drum fish) congregating or feeding near the seafloor within the confines of the furrows.

In addition to the furrows, several small-scale linear features were also detected on the seafloor at CLIS REF. These smaller, linear features were often found in pairs, indicative of trawl door scars on the bottom (Figure 3-17). The CTDEP confirms that this area of Long Island Sound is subject to trawling activity for both baitfish (i.e., skate) used to support lobster fishing activity and market fish (i.e., flounder), but the trawling is subject to various restrictions. The disturbed surface layers identified in the sediment-profile images from July 1996 and September 1997 may have been caused by the action of trawl doors scraping off the oxidized surface layer and overturning the reduced underlying sediment. The failure to detect any areas of disturbed sediment near the center of CLIS REF during the March 1998 survey suggests these impacts to the seafloor are minor and highly localized, allowing the benthic environment to recover quickly. As inshore trawling continues to occur in the central Long Island Sound region, it is likely that sediment disturbance similar to that seen in 1996 and 1997 may occasionally be observed in sediment-profile images collected during DAMOS monitoring surveys.

In addition to the evaluation of conditions at CLIS REF, the March 1998 survey provided an opportunity to collect additional sediment-profile imaging data from several stations over the NHAV 93 Mound and CLIS 95/96 Mound Complex. The March 1998 data were used to evaluate the effects of higher bottom water dissolved oxygen concentrations on sediment oxygen demand and benthic habitat quality. As illustrated in Figure 4-2, dissolved oxygen concentrations in the near-bottom waters of central Long Island Sound are typically at their highest during the winter and early spring, due to the presence of a well mixed water column and very low temperatures.

All of the replicate REMOTS® images collected over the CLIS 95/96 Mound Complex in March 1998 showed a layer of fresh dredged material at the sediment surface (Figure 3-18). This fresh material emanated from the on-going disposal activity at the CDA 97 buoy, located about 300 m northwest of the center of the REMOTS® station grid. Because the deposition of this dredged material represents a very recent physical disturbance at the sediment surface, the REMOTS® results for March 1998 showed a general decrease in Stage III activity and shallower RPD depths compared to the September 1997 survey. Not surprisingly, the OSI values at six of the eight stations were lower in March than September. The two stations (Stations 26 and 32) that had higher OSI values in March 1998 were located the farthest away from the CDA 97 buoy position (Figure 3-19). Station 26 actually showed a decline in Stage III activity, but an increase in the replicate-averaged RPD depth relative to the 1997 survey. Station 32 displayed an more advanced successional stage but a decreased RPD depth in comparison to the September data.

Unaffected by any recent dredged material placement activity, the NHAV 93 Mound showed a minor increase in Stage III activity in March 1998. The absence of any methane bubbles in the March 1998 sediment-profile images suggested a decrease in methane production in the subsurface sediments, reflecting slower microbial activity at this cold time of year. Despite the presence of abundant oxygen in the overlying water, the overall average RPD depth in March 1998 (1.8 cm) was slightly lower than in September 1997 (2.2 cm). The persistence of relatively shallow RPD depths at this mound is attributed to the continued high organic content of the sediment.

There was some variability in the OSI values between September 1997 and March 1998 for the five NHAV 93 Mound stations. Three of the stations showed slight declines in habitat quality due to shallower RPD depths in March. However, a strong improvement in OSI at two stations was the basis for a 0.6-point increase in the overall average OSI value for NHAV 93. Stations 200S and 200W showed the most improvement in benthic habitat quality, with a 3-point and 4-point increase in average OSI values, respectively. The increase in OSI values was primarily based upon the detection of Stage III organisms at these two stations, where only Stage I had been observed in September 1997. Overall, the results of March 1998 REMOTS® survey indicate that the NHAV 93 Mound was continuing to experience inter-annual variability in benthic habitat quality, related to both high apparent sediment oxygen demand and the cyclic recovery and decline of the benthic community in response to seasonal fluctuations in bottom water oxygen levels.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The September 1997 survey over CLIS delineated the areal extent and initial benthic recolonization status of the dredged material deposit formed during the 1995-96 and 1996-97 disposal seasons. In addition, monitoring of the NHAV 93 Mound documented the continued benthic habitat recovery process over this capped mound.

During the 1996-97 disposal season, an estimated total barge volume of 62,100 m^3 of UDM followed by 193,600 m^3 of CDM was deposited at the CDA 96 buoy position and at a nearby point (Point A). The compact nature of the ensuing deposit on the seafloor, the relatively high CDM to UDM ratio (3.1:1.0), and the results of the September 1997 REMOTS® survey showing rapid benthic recolonization of this mound suggest that the UDM was completely capped and isolated from the marine environment.

The dredged material placed at CLIS during the 1996-97 disposal season coalesced with the pre-existing CLIS 95 Mound to form a single bottom feature on the CLIS seafloor, called the CLIS 95/96 Mound Complex. This feature is an example of a medium-sized, capped dredged material disposal mound. Formed by the deposition of material at multiple disposal points over multiple years, the September 1997 survey demonstrated that the CLIS 95/96 Mound Complex was roughly circular, with a height of 4.75 m at its apex and a diameter of 700 m.

Formation of the CLIS 95/96 Mound Complex begins to close a second artificial containment cell on the CLIS seafloor. During the 1997-98 disposal season, the CDA 97 buoy will be located to the northwest of the CLIS 95/96 Mound Complex to continue creating this new containment cell. Once complete, the cell will offer a dredged material capacity of well over 1 million cubic meters. It is recommended that future placement of small to moderate volumes of dredged material be directed to points north and east of the NHAV 74 Mound to facilitate the formation of a third artificial containment cell at CLIS.

The REMOTS® sediment-profile imaging survey conducted in September 1997 indicated that the CLIS 95/96 Mound Complex had relatively well-developed RPD depths and had been rapidly recolonized by a benthic community consisting of both Stage I and Stage III organisms. Overall benthic habitat quality over this dredged material deposit, as reflected in the REMOTS® OSI values, was comparable to that at the nearby CLIS reference areas. The dredged material comprising the CLIS 95/96 Mound Complex likely contained a higher organic content than surrounding ambient sediments, providing an attractive food source for recolonizing benthic organisms.

In March 1998, it was found that benthic habitat quality had declined over the CLIS 95/96 Mound Complex, as a result of recent physical disturbance associated with placement of dredged material at the nearby CDA 97 buoy. Periodic monitoring of the surface sediments over the CLIS 95/96 Mound Complex is recommended for the next several years to verify that benthic habitat quality remains comparable to that on the ambient seafloor.

In contrast to the CLIS 95/96 Mound Complex, the NHAV 93 Mound is composed of sediment with unusually high levels of organic matter. This higher organic content increases sediment oxygen demand and makes the resident benthic community more susceptible to stress during periods when low dissolved oxygen concentrations occur in the overlying water. Over the years, benthic recolonization near the center of the NHAV 93 Mound has shown a cyclical recovery and decline roughly corresponding to the onset and severity of seasonal hypoxia in the near-bottom waters of the central Long Island Sound region.

The REMOTS® surveys of September 1997 and March 1998 showed that benthic habitat quality continued to be variable over the NHAV 93 Mound. In September 1997, there was a reduction in the abundance of Stage III organisms relative to the preceding survey of July 1996, and the presence of sediment methane in a few REMOTS® images confirmed the continued presence of high levels of labile organic matter. The decline in habitat quality was attributed to the effects of seasonal hypoxia; near-bottom dissolved oxygen concentrations were depressed to levels of 4.0 $mg \cdot l^{-1}$ for approximately four weeks before the September 1997 survey. In March 1998, when near-bottom dissolved oxygen concentrations were high, there was increased Stage III activity that resulted in an increase in the average OSI value for this mound.

Overall, the survey results indicate a continuation of the cyclical pattern of recovery and decline at the NHAV 93 Mound. Several cycles will likely occur within the benthic population over the next few years as chemical and biological processes gradually reduce the level of organic carbon in the sediment. Barring a dramatic disturbance, complete benthic recovery should eventually be achieved as oxidation and on-going biological activity act to reduce the organic load within the sediment. It is recommended that monitoring efforts over the NHAV 93 Mound continue until the high organic load is reduced and the benthic community stabilizes.

Trawling activity at CLIS REF appears to be the most likely cause of the seafloor disturbance observed in REMOTS® images collected during the July 1996 and September 1997 surveys. More intensive REMOTS® surveying in March 1998 found no evidence of seafloor disturbance where it had been observed earlier. Further, side-scan sonar surveying detected trawl scars that represent a probable cause for the earlier observations.

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Index

Appendix A1
Summary of UDM Disposal at the CDA 96 Disposal Buoy

Appendix A1
Summary of UDM Disposal at the CDA 96 Disposal Buoy

permittee	project	disparea	dispdate	wtd	xtd	ytd	ztd	latdeg	latmin	longdeg	longmin	cyvol
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	14-Oct-96	0	26545.3	43996.1	0	41	8.669	72	53.087	5,000
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	14-Oct-96	0	26545.3	43996.3	0	41	8.695	72	53.08	5,000
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	14-Oct-96	0	26545.5	43996.1	0	41	8.664	72	53.112	3,500
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	16-Oct-96	0	26545.6	43996.1	0	41	8.662	72	53.124	4,500
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	16-Oct-96	0	26545.5	43996.2	0	41	8.677	72	53.108	4,500
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	16-Oct-96	0	26545.5	43996	0	41	8.652	72	53.116	4,800
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	17-Oct-96	0	26545.2	43996	0	41	8.659	72	53.079	4,000
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	17-Oct-96	0	26545.5	43996	0	41	8.652	72	53.116	5,000
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	17-Oct-96	0	26545.7	43995.3	0	41	8.557	72	53.167	5,000
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	17-Oct-96	0	26545.3	43996.2	0	41	8.682	72	53.084	5,000
WEST COVE MARINA	WEST RIVER WEST HAV CT	CLIS	25-Oct-96	0	26545.6	43996	0	41	8.649	72	53.128	400
WEST COVE MARINA	WEST RIVER WEST HAV CT	CLIS	26-Oct-96	0	26545.3	43996.1	0	41	8.669	72	53.087	350
WEST COVE MARINA	WEST RIVER WEST HAV CT	CLIS	26-Oct-96	0	26545.5	43996.2	0	41	8.677	72	53.108	400
WEST COVE MARINA	WEST RIVER WEST HAV CT	CLIS	27-Oct-96	0	26545.5	43996	0	41	8.652	72	53.116	400
WEST COVE MARINA	WEST RIVER WEST HAV CT	CLIS	28-Oct-96	0	26545.4	43996.5	0	41	8.718	72	53.084	400
WEST COVE MARINA	WEST RIVER WEST HAV CT	CLIS	29-Oct-96	0	26545.4	43996.5	0	41	8.718	72	53.084	400
WEST COVE MARINA	WEST RIVER WEST HAV CT	CLIS	29-Oct-96	0	26545.6	43996	0	41	8.649	72	53.128	400
WEST COVE MARINA	WEST RIVER WEST HAV CT	CLIS	31-Oct-96	0	26545.5	43996.1	0	41	8.664	72	53.112	450
WEST COVE MARINA	WEST RIVER WEST HAV CT	CLIS	31-Oct-96	0	26545.6	43996.1	0	41	8.662	72	53.124	400
DOUGLAS & SANDRA CAMPBELL	FIVE MILE RIVER DARIEN CT	CLIS	05-Oct-96	0	0	0	0	41	8.66	72	53.13	500
DOUGLAS & SANDRA CAMPBELL	FIVE MILE RIVER DARIEN CT	CLIS	05-Oct-96	0	0	0	0	41	8.665	72	53.133	600
DOUGLAS & SANDRA CAMPBELL	FIVE MILE RIVER DARIEN CT	CLIS	23-Oct-96	0	0	0	0	41	8.665	72	53.129	600
DOUGLAS & SANDRA CAMPBELL	FIVE MILE RIVER DARIEN CT	CLIS	23-Oct-96	0	0	0	0	41	8.665	72	53.133	600
DOUGLAS & SANDRA CAMPBELL	FIVE MILE RIVER DARIEN CT	CLIS	21-Oct-96	0	0	0	0	41	8.666	72	53.103	500
DOUGLAS & SANDRA CAMPBELL	FIVE MILE RIVER DARIEN CT	CLIS	24-Oct-96	0	0	0	0	41	8.665	72	53.133	600
DOUGLAS & SANDRA CAMPBELL	FIVE MILE RIVER DARIEN CT	CLIS	25-Oct-96	0	0	0	0	41	8.666	72	53.13	500
WM & DEBORAH NIGHTINGALE	FIVE MILE RIVER DARIEN CT	CLIS	24-Oct-96	0	0	0	0	41	8.665	72	53.133	600
WM & DEBORAH NIGHTINGALE	FIVE MILE RIVER DARIEN CT	CLIS	25-Oct-96	0	0	0	0	41	8.666	72	53.13	500
WILLIAM&DEBORAH NIGHTINGALE	FIVE MILE RIVER DARIEN CT	CLIS	17-Dec-96	0	0	0	0	41	8.695	72	53.095	70
									total UDM yards^3			54,970
									total UDM meters^3			42,028

Appendix A2
Summary of CDM Deposition at the CDA 96 Disposal Buoy

Appendix A2

Summary of CDM Deposition at the CDA 96 Disposal Buoy

permittee	project	disparea	dispdate	wtd	xtd	ytd	ztd	latdeg	latmin	longdeg	longmin	cyvol
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	17-Oct-96	0	26545.3	43996.2	0	41	8.682	72	53.084	5,000
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	18-Oct-96	0	26545.3	43996	0	41	8.656	72	53.091	5,000
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	18-Oct-96	0	26545.5	43996.4	0	41	8.703	72	53.1	5,000
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	18-Oct-96	0	26545.5	43996	0	41	8.652	72	53.116	5,000
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	18-Oct-96	0	26545.5	43996	0	41	8.652	72	53.116	5,000
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	20-Oct-96	0	26545.5	43996.1	0	41	8.664	72	53.112	5,000
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	20-Oct-96	0	26545.3	43996.1	0	41	8.669	72	53.087	5,000
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	20-Oct-96	0	26545.3	43996	0	41	8.656	72	53.091	5,000
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	21-Oct-96	0	26545.6	43996.1	0	41	8.662	72	53.124	5,000
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	21-Oct-96	0	26545.3	43996.1	0	41	8.669	72	53.087	5,000
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	21-Oct-96	0	26545.5	43996	0	41	8.652	72	53.116	5,000
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	21-Oct-96	0	26545.4	43996	0	41	8.654	72	53.104	5,000
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	22-Oct-96	0	26545.3	43996.1	0	41	8.669	72	53.087	5,000
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	22-Oct-96	0	26545.5	43996.1	0	41	8.664	72	53.112	5,000
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	22-Oct-96	0	26545.4	43996.1	0	41	8.667	72	53.1	5,000
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	22-Oct-96	0	26545.5	43996.1	0	41	8.664	72	53.112	5,000
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	22-Oct-96	0	26545.4	43996	0	41	8.654	72	53.104	4,700
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	23-Oct-96	0	26545.5	43996.1	0	41	8.664	72	53.112	5,000
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	23-Oct-96	0	26545.5	43996	0	41	8.652	72	53.116	4,700
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	23-Oct-96	0	26545.5	43996	0	41	8.652	72	53.116	4,500
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	24-Oct-96	0	26545.6	43996.2	0	41	8.675	72	53.12	4,700
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	24-Oct-96	0	26545.4	43995.9	0	41	8.641	72	53.107	4,000
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	24-Oct-96	0	26545.6	43995.8	0	41	8.624	72	53.136	4,700
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	24-Oct-96	0	26545.5	43995.9	0	41	8.639	72	53.12	4,700
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	25-Oct-96	0	26545.3	43995.8	0	41	8.631	72	53.099	4,500
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	25-Oct-96	0	26545.6	43995.9	0	41	8.636	72	53.132	4,500
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	25-Oct-96	0	26545.6	43996	0	41	8.649	72	53.128	4,500
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	25-Oct-96	0	26545.5	43996	0	41	8.652	72	53.116	4,500
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	26-Oct-96	0	26545.4	43995.9	0	41	8.641	72	53.107	4,500
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	26-Oct-96	0	26545.5	43995.1	0	41	8.537	72	53.15	4,500
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	26-Oct-96	0	26545.6	43996.2	0	41	8.675	72	53.12	4,500
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	27-Oct-96	0	26545.4	43996.1	0	41	8.667	72	53.1	4,700
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	27-Oct-96	0	26545.6	43996.1	0	41	8.662	72	53.124	4,700
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	27-Oct-96	0	26545.3	43996.1	0	41	8.669	72	53.087	3,500
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	28-Oct-96	0	26545.5	43996	0	41	8.652	72	53.116	4,700
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	28-Oct-96	0	26545.3	43996.1	0	41	8.669	72	53.087	3,000
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	31-Oct-96	0	26545.4	43995.9	0	41	8.641	72	53.107	3,000
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	01-Nov-96	0	26673.4	44005.3	0	41	6.737	73	8.424	1,000
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	01-Nov-96	0	26545.4	43996	0	41	8.654	72	53.104	2,500
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	01-Nov-96	0	26545.5	43996	0	41	8.652	72	53.116	4,000
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	02-Nov-96	0	26545.5	43996	0	41	8.652	72	53.116	3,400
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	02-Nov-96	0	26545.4	43996.1	0	41	8.667	72	53.1	3,800
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	02-Nov-96	0	26545.4	43996.1	0	41	8.667	72	53.1	4,000
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	02-Nov-96	0	26545.4	43996.1	0	41	8.667	72	53.1	4,000
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	03-Nov-96	0	26545.3	43995.9	0	41	8.644	72	53.095	3,000
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	03-Nov-96	0	26545.5	43996	0	41	8.652	72	53.116	3,600
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	03-Nov-96	0	26545.5	43996	0	41	8.652	72	53.116	3,600
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	04-Nov-96	0	26545.3	43996.2	0	41	8.682	72	53.084	2,400
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	04-Nov-96	0	26545.5	43996.1	0	41	8.664	72	53.112	3800
UNITED ILLUMINATING	BRIDGEPORT HARBOR	CLIS	04-Nov-96	0	26545.4	43996.1	0	41	8.667	72	53.1	3,800
WEST COVE MARINA	WEST RIVER	CLIS	09-Jan-97	0	26545.5	43996	0	41	8.652	72	53.116	450
WEST COVE MARINA	WEST COVE	CLIS	10-Jan-97	0	26545.3	43996	0	41	8.656	72	53.091	400
WEST COVE MARINA	WEST COVE	CLIS	11-Jan-97	0	26545.5	43996.1	0	41	8.664	72	53.112	450
WEST COVE MARINA	WEST COVE	CLIS	13-Jan-97	0	26545.5	43996	0	41	8.652	72	53.116	400
WEST COVE MARINA	WEST COVE	CLIS	13-Jan-97	0	26545.4	43996.3	0	41	8.692	72	53.092	400
WEST COVE MARINA	WEST COVE	CLIS	15-Jan-97	0	26545.4	43996.3	0	41	8.692	72	53.092	400
WEST COVE MARINA	WEST COVE	CLIS	15-Jan-97	0	26545.5	43996	0	41	8.652	72	53.116	400
WEST COVE MARINA	WEST COVE	CLIS	17-Jan-97	0	26545.5	43996	0	41	8.652	72	53.116	450
WEST COVE MARINA	WEST COVE	CLIS	18-Jan-97	0	26545.5	43996	0	41	8.652	72	53.116	450
WEST COVE MARINA	WEST COVE	CLIS	19-Jan-97	0	26545.5	43996.1	0	41	8.664	72	53.112	450
WEST COVE MARINA	WEST COVE	CLIS	19-Jan-97	0	26545.5	43996	0	41	8.652	72	53.116	450
WEST COVE MARINA	WEST COVE	CLIS	21-Jan-97	0	26545.5	43996	0	41	8.652	72	53.116	400
WEST COVE MARINA	WEST COVE	CLIS	21-Jan-97	0	26545.5	43996	0	41	8.652	72	53.116	400
WEST COVE MARINA	WEST COVE	CLIS	22-Jan-97	0	26545.5	43996	0	41	8.652	72	53.116	450
WEST COVE MARINA	WEST COVE	CLIS	23-Jan-97	0	26545.5	43996	0	41	8.652	72	53.116	400
WEST COVE MARINA	WEST COVE	CLIS	26-Jan-97	0	26545.5	43996	0	41	8.652	72	53.116	400
WEST COVE MARINA	WEST COVE	CLIS	26-Jan-97	0	26545.5	43996.1	0	41	8.664	72	53.112	400
WEST COVE MARINA	WEST COVE	CLIS	27-Jan-97	0	26545.5	43996	0	41	8.652	72	53.116	400
WEST COVE MARINA	WEST COVE	CLIS	28-Jan-97	0	26545.5	43996.3	0	41	8.69	72	53.104	400
WEST COVE MARINA	WEST COVE	CLIS	28-Jan-97	0	26545.5	43996.3	0	41	8.69	72	53.104	400
WEST COVE MARINA	WEST COVE	CLIS	31-Jan-97	0	26545.5	43996	0	41	8.652	72	53.116	450
RIVERSIDE YACHT CLUB	RIVERSIDE YACHT CL	CLIS	19-Apr-97	0	26829.1	43973.5	0	0	0	0	0	400
RIVERSIDE YACHT CLUB	RIVERSIDE YACHT CL	CLIS	20-Apr-97	0	26829.2	43973.7	0	0	0	0	0	450
RIVERSIDE YACHT CLUB	RIVERSIDE YACHT CL	CLIS	20-Mar-97	0	26545.4	43996.4	0	0	0	0	0	700
RIVERSIDE YACHT CLUB	RIVERSIDE YACHT CL	CLIS	19-Mar-97	0	26545.5	43996.3	0	0	0	0	0	700
RIVERSIDE YACHT CLUB	RIVERSIDE YACHT CL	CLIS	18-Mar-97	0	26545.4	43996.2	0	0	0	0	0	900
RIVERSIDE YACHT CLUB	RIVERSIDE YACHT CL	CLIS	17-Mar-97	0	26545.4	43996.3	0	0	0	0	0	800
RIVERSIDE YACHT CLUB	RIVERSIDE YACHT CL	CLIS	15-Apr-97	0	26829.1	43973.7	0	0	0	0	0	450
RIVERSIDE YACHT CLUB	RIVERSIDE YACHT CL	CLIS	14-Apr-97	0	26829	43973.6	0	0	0	0	0	400
RIVERSIDE YACHT CLUB	RIVERSIDE YACHT CL	CLIS	14-Apr-97	0	26829.1	43973.7	0	0	0	0	0	450
RIVERSIDE YACHT CLUB	RIVERSIDE YACHT CL	CLIS	13-Apr-97	0	26829.2	43973.5	0	0	0	0	0	400
RIVERSIDE YACHT CLUB	RIVERSIDE YACHT CL	CLIS	12-Apr-97	0	26829.2	43973.6	0	0	0	0	0	400
RIVERSIDE YACHT CLUB	RIVERSIDE YACHT CL	CLIS	12-Apr-97	0	26829.2	43973.7	0	0	0	0	0	450
RIVERSIDE YACHT CLUB	RIVERSIDE YACHT CL	CLIS	11-Apr-97	0	26829.2	43973.6	0	0	0	0	0	250
RIVERSIDE YACHT CLUB	RIVERSIDE YACHT CL	CLIS	16-Mar-97	0	26545.4	43996.2	0	0	0	0	0	800
RIVERSIDE YACHT CLUB	RIVERSIDE YACHT CL	CLIS	15-Mar-97	0	26545.5	43996.3	0	0	0	0	0	800
RIVERSIDE YACHT CLUB	RIVERSIDE YACHT CL	CLIS	14-Mar-97	0	26545.4	43996.3	0	0	0	0	0	900
RIVERSIDE YACHT CLUB	RIVERSIDE YACHT CL	CLIS	13-Mar-97	0	26545.3	43996.3	0	0	0	0	0	900
									total UDM yards^3			233,950
									total UDM meters^3			178,868

Appendix A3
Summary of UDM Disposal at Disposal Point A

Appendix A3

Summary of UDM Disposal at the Disposal Point A

permittee	project	disparea	dispdate	wtd	xtd	ytd	ztd	latdeg	latmin	longdeg	longmin	cyvol
POST ROAD BOAT YARD	POST ROAD BOAT YARD	CLIS	11-Dec-96	0	26545.4	43996.3	0	41	8.692	72	53.092	450
POST ROAD BOAT YARD	POST ROAD BOAT YARD	CLIS	12-Dec-96	0	26545.4	43996.3	0	41	8.692	72	53.092	850
POST ROAD BOAT YARD	POST ROAD BOAT YARD	CLIS	15-Dec-96	0	26545.4	43996.5	0	41	8.718	72	53.084	450
POST ROAD BOAT YARD	POST ROAD BOAT YARD	CLIS	16-Dec-96	0	26545.4	43996.6	0	41	8.731	72	53.08	450
POST ROAD BOAT YARD	POST ROAD BOAT YARD	CLIS	17-Dec-96	0	26545.4	43996.4	0	41	8.705	72	53.088	450
POST ROAD BOAT YARD	POST ROAD BOAT YARD	CLIS	18-Dec-96	0	26545.4	43996.3	0	41	8.692	72	53.092	800
POST ROAD BOAT YARD	POST ROAD BOAT YARD	CLIS	18-Dec-96	0	26545.8	43996.6	0	41	8.721	72	53.129	400
POST ROAD BOAT YARD	POST ROAD BOAT YARD	CLIS	20-Dec-96	0	26545.4	43996.3	0	41	8.692	72	53.092	800
POST ROAD BOAT YARD	POST ROAD BOAT YARD	CLIS	21-Dec-96	0	26545.4	43996.4	0	41	8.705	72	53.088	800
POST ROAD BOAT YARD	POST ROAD BOAT YARD	CLIS	22-Dec-96	0	26545.4	43996.2	0	41	8.68	72	53.096	700
POST ROAD BOAT YARD	POST ROAD BOAT YARD	CLIS	24-Dec-96	0	26545.4	43996.4	0	41	8.705	72	53.088	450
SAUGATUCK HARBOR YACHT CLUB	SAUGATUCK HARBOR YACHT CLUB	CLIS	23-Dec-96	0	26545.4	43996.3	0	41	8.692	72	53.092	600
SAUGATUCK HARBOR YACHT CLUB	SAUGATUCK HARBOR YACHT CLUB	CLIS	27-Dec-96	0	26545.4	43996.4	0	41	8.705	72	53.088	600
SAUGATUCK HARBOR YACHT CLUB	SAUGATUCK HARBOR YACHT CLUB	CLIS	28-Dec-96	0	26545.4	43996.3	0	41	8.692	72	53.092	500
SAUGATUCK HARBOR YACHT CLUB	SAUGATUCK HARBOR YACHT CLUB	CLIS	29-Dec-96	0	26545.3	43996.2	0	41	8.682	72	53.084	650
SAUGATUCK HARBOR YACHT CLUB	SAUGATUCK HARBOR YACHT CLUB	CLIS	30-Dec-96	0	26545.4	43996.3	0	41	8.692	72	53.092	500
SAUGATUCK HARBOR YACHT CLUB	SAUGATUCK HARBOR YACHT CLUB	CLIS	02-Jan-97	0	26545.4	43996.2	0	41	8.68	72	53.096	600
SAUGATUCK HARBOR YACHT CLUB	SAUGATUCK HARBOR YACHT CLUB	CLIS	03-Jan-97	0	26545.3	43996.4	0	41	8.708	72	53.076	650
SAUGATUCK HARBOR YACHT CLUB	SAUGATUCK HARBOR YACHT CLUB	CLIS	04-Jan-97	0	26545.4	43996.4	0	41	8.705	72	53.088	500
SAUGATUCK HARBOR YACHT CLUB	SAUGATUCK HARBOR YACHT CLUB	CLIS	06-Jan-97	0	26545.4	43996.3	0	41	8.692	72	53.092	500
SAUGATUCK HARBOR YACHT CLUB	SAUGATUCK HARBOR YACHT CLUB	CLIS	07-Jan-97	0	26545.4	43996.2	0	41	8.68	72	53.096	500
SAUGATUCK HARBOR YACHT CLUB	SAUGATUCK HARBOR YACHT CLUB	CLIS	09-Jan-97	0	26545.4	43996.3	0	41	8.692	72	53.092	500
SAUGATUCK HARBOR YACHT CLUB	SAUGATUCK HARBOR YACHT CLUB	CLIS	09-Jan-97	0	26545.5	43996.3	0	41	8.69	72	53.104	500
SAUGATUCK HARBOR YACHT CLUB	SAUGATUCK HARBOR YACHT CLUB	CLIS	10-Jan-97	0	26545.4	43996.3	0	41	8.692	72	53.092	500
SAUGATUCK HARBOR YACHT CLUB	SAUGATUCK HARBOR YACHT CLUB	CLIS	12-Jan-97	0	26545.4	43996.4	0	41	8.705	72	53.088	500
SAUGATUCK HARBOR YACHT CLUB	SAUGATUCK HARBOR YACHT CLUB	CLIS	13-Jan-97	0	26545.4	43996.3	0	41	8.692	72	53.092	500
SAUGATUCK HARBOR YACHT CLUB	SAUGATUCK HARBOR YACHT CLUB	CLIS	14-Jan-97	0	26545.4	43996.1	0	41	8.667	72	53.1	600
SAUGATUCK HARBOR YACHT CLUB	SAUGATUCK HARBOR YACHT CLUB	CLIS	15-Jan-97	0	26545.4	43996.3	0	41	8.692	72	53.092	700
SAUGATUCK HARBOR YACHT CLUB	SAUGATUCK HARBOR YACHT CLUB	CLIS	17-Jan-97	0	26545.3	43996.4	0	41	8.708	72	53.076	700
SAUGATUCK HARBOR YACHT CLUB	SAUGATUCK HARBOR YACHT CLUB	CLIS	18-Jan-97	0	26545.3	43996.3	0	41	8.695	72	53.08	700
SAUGATUCK HARBOR YACHT CLUB	SAUGATUCK HARBOR YACHT CLUB	CLIS	19-Jan-97	0	26545.3	43996.3	0	41	8.695	72	53.08	600
SAUGATUCK HARBOR YACHT CLUB	SAUGATUCK HARBOR YACHT CLUB	CLIS	20-Jan-97	0	26545.4	43996.4	0	41	8.705	72	53.088	700
SAUGATUCK HARBOR YACHT CLUB	SAUGATUCK HARBOR YACHT CLUB	CLIS	21-Jan-97	0	26545.4	43996.5	0	41	8.718	72	53.084	500
SAUGATUCK HARBOR YACHT CLUB	SAUGATUCK HARBOR YACHT CLUB	CLIS	22-Jan-97	0	26545.3	43996.2	0	41	8.682	72	53.084	700
SAUGATUCK HARBOR YACHT CLUB	SAUGATUCK HARBOR YACHT CLUB	CLIS	23-Jan-97	0	26545.4	43996.2	0	41	8.68	72	53.096	700
SAUGATUCK HARBOR YACHT CLUB	SAUGATUCK HARBOR YACHT CLUB	CLIS	24-Jan-97	0	26545.5	43996.3	0	41	8.69	72	53.104	700
SAUGATUCK HARBOR YACHT CLUB	SAUGATUCK HARBOR YACHT CLUB	CLIS	25-Jan-97	0	26545.5	43996.4	0	41	8.703	72	53.1	850
SAUGATUCK HARBOR YACHT CLUB	SAUGATUCK HARBOR YACHT CLUB	CLIS	27-Jan-97	0	26545.4	43996.3	0	41	8.692	72	53.092	850
SAUGATUCK HARBOR YACHT CLUB	SAUGATUCK HARBOR YACHT CLUB	CLIS	28-Jan-97	0	26545.4	43996.2	0	41	8.68	72	53.096	850
BELLE HAVEN CLUB	CAPTAIN HARBOR	CLIS	19-Dec-96	0	26545.3	43996.4	0	41	8.708	72	53.076	400
BELLE HAVEN CLUB	CAPTAIN HARBOR	CLIS	21-Dec-96	0	26545.4	43996.5	0	41	8.718	72	53.084	300
BELLE HAVEN CLUB	CAPTAIN HARBOR	CLIS	22-Dec-96	0	26545.4	43996.4	0	41	8.705	72	53.088	400
BELLE HAVEN CLUB	CAPTAIN HARBOR	CLIS	27-Dec-96	0	26545.3	43996.3	0	41	8.695	72	53.08	400
BELLE HAVEN CLUB	CAPTAIN HARBOR	CLIS	28-Dec-96	0	26545.4	43996.3	0	41	8.692	72	53.092	300
BELLE HAVEN CLUB	CAPTAIN HARBOR	CLIS	29-Dec-96	0	26545.5	43996.3	0	41	8.69	72	53.104	300
BELLE HAVEN CLUB	CAPTAIN HARBOR	CLIS	30-Dec-96	0	26545.5	43996.4	0	41	8.703	72	53.1	300
									total UDM yards^3			26,250
									total UDM meters^3			20,070

Appendix A4
Summary of CDM Deposition at Disposal Point A

Appendix A4
Summary of CDM Deposition at the Disposal Point A

permittee	project	disparea	dispdate	wtd	xtd	ytd	ztd	latdeg	latmin	longdeg	longmin	cyvol
BRUCE & JOHNSON MARINA	BRANFORD HARBOR	CLIS	29-Jan-97	0	26545.4	43996.4	0	41	8.705	72	53.088	900
BRUCE & JOHNSON MARINA	BRANFORD HARBOR	CLIS	30-Jan-97	0	26545.4	43996.3	0	41	8.692	72	53.092	900
BRUCE & JOHNSON MARINA	BRANFORD HARBOR	CLIS	30-Jan-97	0	26545.4	43996.3	0	41	8.692	72	53.092	800
BRUCE & JOHNSON MARINA	BRANFORD HARBOR	CLIS	31-Jan-97	0	26545.5	43996.4	0	41	8.703	72	53.100	900
BRUCE & JOHNSON MARINA	BRANFORD HARBOR	CLIS	01-Feb-97	0	26545.4	43996.3	0	41	8.692	72	53.092	850
BRUCE & JOHNSON MARINA	BRANFORD HARBOR	CLIS	01-Feb-97	0	26545.3	43996.2	0	41	8.682	72	53.084	900
BRUCE & JOHNSON MARINA	BRANFORD HARBOR	CLIS	02-Feb-97	0	26545.3	43996.4	0	41	8.708	72	53.076	900
BRUCE & JOHNSON MARINA	BRANFORD HARBOR	CLIS	03-Feb-97	0	26545.5	43996.3	0	41	8.690	72	53.104	850
BRUCE & JOHNSON MARINA	BRANFORD HARBOR	CLIS	03-Feb-97	0	26545.5	43996.6	0	41	8.728	72	53.093	450
BRUCE & JOHNSON MARINA	BRANFORD HARBOR	CLIS	04-Feb-97	0	26545.0	43996.6	0	41	8.740	72	53.032	450
BRUCE & JOHNSON MARINA	BRANFORD HARBOR	CLIS	04-Feb-97	0	26545.3	43996.3	0	41	8.695	72	53.080	700
BRUCE & JOHNSON MARINA	BRANFORD HARBOR	CLIS	05-Feb-97	0	26545.3	43996.3	0	41	8.695	72	53.080	800
BRUCE & JOHNSON MARINA	BRANFORD HARBOR	CLIS	06-Feb-97	0	26545.4	43996.3	0	41	8.692	72	53.092	850
BRUCE & JOHNSON MARINA	BRANFORD HARBOR	CLIS	06-Feb-97	0	26545.4	43996.3	0	41	8.692	72	53.092	450
BRUCE & JOHNSON MARINA	BRANFORD HARBOR	CLIS	07-Feb-97	0	26545.4	43996.3	0	41	8.692	72	53.092	750
BRUCE & JOHNSON MARINA	BRANFORD HARBOR	CLIS	08-Feb-97	0	26545.4	43996.3	0	41	8.692	72	53.092	850
BRUCE & JOHNSON MARINA	BRANFORD HARBOR	CLIS	08-Feb-97	0	26545.3	43996.3	0	41	8.695	72	53.080	600
BRUCE & JOHNSON MARINA	BRANFORD HARBOR	CLIS	09-Feb-97	0	26545.4	43996.2	0	41	8.680	72	53.096	600
BRUCE & JOHNSON MARINA	BRANFORD HARBOR	CLIS	10-Feb-97	0	26545.3	43996.3	0	41	8.695	72	53.080	700
BRUCE & JOHNSON MARINA	BRANFORD HARBOR	CLIS	10-Feb-97	0	26545.0	43996.3	0	41	8.702	72	53.043	450
BRUCE & JOHNSON MARINA	BRANFORD HARBOR	CLIS	11-Feb-97	0	26545.4	43996.3	0	41	8.692	72	53.092	900
BRUCE & JOHNSON MARINA	BRANFORD HARBOR	CLIS	11-Feb-97	0	26545.4	43996.2	0	41	8.680	72	53.096	900
BRUCE & JOHNSON MARINA	BRANFORD HARBOR	CLIS	11-Feb-97	0	26545.2	43996.3	0	41	8.697	72	53.068	450
BRUCE & JOHNSON MARINA	BRANFORD HARBOR	CLIS	12-Feb-97	0	26545.4	43996.3	0	41	8.692	72	53.092	600
BRUCE & JOHNSON MARINA	BRANFORD HARBOR	CLIS	12-Feb-97	0	26545.4	43996.0	0	41	8.654	72	53.104	450
BRUCE & JOHNSON MARINA	BRANFORD HARBOR	CLIS	09-Feb-97	0	26545.4	43996.3	0	0	0	0	0	450
BRUCE & JOHNSON MARINA	BRANFORD HARBOR	CLIS	08-Feb-97	0	26545.4	43996.3	0	0	0	0	0	450
BRUCE & JOHNSON MARINA	BRANFORD HARBOR	CLIS	06-Feb-97	0	26545.4	43996.3	0	0	0	0	0	450
									total UDM yards³			19,300
									total UDM meters³			14,756

Appendix B1
REMOTS® Data from the CLIS 95/96 Mound Complex, September 1997

Appendix Table B1a

REMOTS® Data from the CLIS 95/96 Mound Complex, September 1997

Station Number	Grid Center	Station Location	Replicate	Date	Successional Stage	Grain Size (phi)			Mud Clasts	Camera Penetration				Dredged Material Thickness**			Redox Rebound Thickness		
						Min	Max	Maj. Mode	Count	Min	Max	Range	Mean	Min	Max	Mean	Min	Max	Mean
1	CLIS 96	300N	A	9/14/1997	ST_I_ON_III	4	>4	>4	0	14.1	15.91	1.81	15	12.19	16.29	15.06	0	0	0
1	CLIS 96	300N	C	9/14/1997	INDET	4	>4	>4	0	6.14	8.81	2.67	7.48	4.67	9.33	7.5	0	0	0
1	CLIS 96	300N	D	9/15/1997	ST_I	4	>4	>4	0	11.96	12.39	0.43	12.17	6	7	6.5	0	0	0
2	Point A	300NW	A	9/14/1997	ST_I	4	>4	>4	0	17.93	18.19	0.26	18.06	6.72	9.19	7.04	0	0	0
2	Point A	300NW	B	9/14/1997	ST_I	4	>4	>4	0	9.74	9.9	0.16	9.82	4.23	6.65	6.13	3.37	6.43	4.9
2	Point A	300NW	C	9/14/1997	ST_I	4	>4	>4	0	11.09	12.54	1.45	11.81	4.38	6.96	5.37	0	0	0
3	CLIS 95	300N	A	9/12/1997	ST_I_ON_III	4	>4	>4	0	19.39	19.89	0.49	19.64	14.74	19.94	19.55	2.29	5.15	3.72
3	CLIS 95	300N	D	9/15/1997	ST_I_ON_III	4	>4	>4	1	15.32	15.66	0.35	15.49	7.59	15.71	15.39	0	0	0
3	CLIS 95	300N	E	9/15/1997	ST_I	4	>4	>4	2	13.3	13.94	0.64	13.62	6.9	14.14	13.79	0	0	0
4	Point A	300NE	A	9/14/1997	ST_I_ON_III	4	>4	>4	0	14.79	15.07	0.28	14.93	7.54	15.45	14.97	1.9	4.41	3.15
4	Point A	300NE	B	9/14/1997	ST_I	4	>4	>4	1	15.97	16.97	1	16.47	8.2	16.97	16.35	0	0	0
4	Point A	300NE	D	9/15/1997	ST_I	4	>4	>4	0	13.93	14.31	0.38	14.12	9.33	14.6	9.5	0	0	0
5	CLIS 96	300NW	A	9/14/1997	ST_I_ON_III	4	>4	>4	0	15.65	16.22	0.57	15.93	15.7	16.22	15.81	0	0	0
5	CLIS 96	300NW	B	9/14/1997	ST_I_ON_III	4	>4	>4	0	15.13	16.53	1.4	15.83	15.18	16.89	15.76	0	0	0
5	CLIS 96	300NW	C	9/14/1997	ST_I	4	>4	>4	0	17.03	17.39	0.36	17.21	1.9	7.69	6.96	0	0	0
6	Point A	200N	B	9/14/1997	ST_I_ON_III	4	>4	>4	0	18.57	18.86	0.29	18.71	6.95	10.95	9	0	0	4
6	Point A	200N	C	9/14/1997	ST_I	4	>4	>4	0	18.76	19.81	1.05	19.29	9.67	11.86	11	0	0	0
6	Point A	200N	D	9/14/1997	ST_I	4	>4	>4	0	17.24	17.57	0.33	17.41	5.14	6.95	5.5	0	0	0
7	Point A	200NW	A	9/14/1997	ST_I	4	>4	>4	0	18.45	19.33	0.88	18.89	18.5	19.38	18.83	0	0	0
7	Point A	200NW	C	9/14/1997	ST_III	4	>4	>4	0	18.6	19.95	1.35	19.28	9.9	13.19	11.86	0	0	0
7	Point A	200NW	D	9/15/1997	ST_I_ON_III	4	>4	>4	0	10.1	11.24	1.14	10.67	7.72	11.35	11.04	4.2	7.83	6.02
8	CLIS 96	200N	D	9/15/1997	ST_I	4	>4	>4	0	18.57	19	0.43	18.79	14	16.1	15.5	0	0	0
8	CLIS 96	200N	E	9/15/1997	ST_I	4	>4	>4	0	15.24	15.64	0.39	15.44	7.65	15.64	15.25	0	0	0
8	CLIS 96	200N	F	9/15/1997	ST_I	4	>4	>4	0	16.57	17.01	0.44	16.79	16.47	17.3	16.7	0	0	0
9	CLIS 95	200N	D	9/15/1997	ST_I_ON_III	3	>4	>4	0	15.42	16.11	0.69	15.76	15.27	16.16	15.67	7.54	10.59	9.06
9	CLIS 95	200N	E	9/15/1997	ST_I	4	>4	>4	2	15.76	17.24	1.48	16.5	15.76	16.85	15.86	0	0	0
9	CLIS 95	200N	F	9/15/1997	INDET	4	>4	>4	1	15.02	16.25	1.23	15.64	15.12	16.25	15.77	0	0	0
10	Point A	200NE	A	9/15/1997	ST_I	4	>4	>4	0	18.1	19.57	1.47	18.84	11	12	11.5	1.85	5.55	3.7
10	Point A	200NE	D	9/15/1997	ST_I	4	>4	>4	0	19.38	19.67	0.28	19.52	19.48	19.95	19.59	2.7	4.69	3.7
10	Point A	200NE	E	9/15/1997	INDET	4	4	>4	0	19.44	19.57	0.13	19.51	14.6	19.52	19.27	0	0	0
11	CLIS 96	200NW	A	9/14/1997	ST_I_ON_III	4	>4	>4	0	16.58	16.79	0.21	16.68	16.58	17.15	16.54	0	0	0
11	CLIS 96	200NW	B	9/14/1997	ST_III	4	>4	>4	0	10.52	13.42	2.9	11.97	12.64	13.26	12.64	0	0	0
11	CLIS 96	200NW	C	9/14/1997	ST_I	4	>4	>4	0	7.41	9.33	1.92	8.37	7.41	9.48	8.47	0	0	0
12	Point A	100N	D	9/15/1997	ST_I_ON_III	4	>4	>4	0	17.58	18.01	0.43	17.8	13.41	18.1	17.73	0	0	0
12	Point A	100N	E	9/15/1997	INDET	4	>4	>4	0	14.41	14.41	0	14.41	14.69	15.35	15.02	1.75	5.12	3.44
12	Point A	100N	F	9/15/1997	INDET	4	>4	>4	1	13.84	15.12	1.28	14.48	14.64	15.54	15.13	3.18	5.74	4.46
13	Point A	200W	A	9/14/1997	ST_I_ON_III	4	>4	>4	0	16.58	17.25	0.67	16.92	3.14	8.81	7.19	2.54	5.96	4.25
13	Point A	200W	D	9/15/1997	ST_I	4	>4	>4	0	12.9	13.58	0.67	13.24	5.98	7.47	6.54	0	0	0
13	Point A	200W	E	9/15/1997	ST_I	4	>4	>4	0	14.51	15.08	0.57	14.79	6.19	7.73	6.94	2.23	7	4.62
14	CLIS 96	100NW	A	9/14/1997	ST_I	4	>4	>4	0	18.76	19.38	0.62	19.07	13.19	15.62	14.29	0	0	0
14	CLIS 96	100NW	C	9/14/1997	ST_I	4	>4	>4	0	16.99	17.96	0.97	17.47	16.73	18.06	17.4	0	0	0
14	CLIS 96	100NW	D	9/15/1997	ST_I	4	>4	>4	0	12.95	13.42	0.47	13.19	13.16	13.73	13.43	0	0	0
15	CLIS 96	100N	B	9/14/1997	ST_I	4	>4	>4	0	15.27	16.13	0.85	15.7	11.86	16.18	12.5	0	0	0
15	CLIS 96	100N	C	9/14/1997	ST_I_ON_III	4	>4	>4	0	19.34	19.9	0.55	19.62	6.23	9.15	7	0	0	0
15	CLIS 96	100N	D	9/14/1997	ST_I	4	>4	>4	0	9.6	10.05	0.45	9.82	5.23	10.45	9.89	0	0	0

continued

Appendix Table B1a (continued)

Station Number	Grid Center	Station Location	Replicate	Date	Apparent RPD Thickness Min	Max	Mean	Methane	OSI	Surface Roughness	Low DO	Comments
1	CLIS 96	300N	A	9/14/1997	2.1	5.76	3	0	9	PHYSICAL	NO	dem mud>pen;somemixing reduce/oxy clay?;shell frags
1	CLIS 96	300N	C	9/14/1997	NA	NA	NA	0	99	INDET	NO	pullout;dm>pen;clay smear on faceplate
1	CLIS 96	300N	D	9/15/1997	0.86	4.86	2.41	0	5	PHYSICAL	NO	dm mud>pen;reduced layer;relic rpd?stgIII activity;halo
2	Point A	300NW	A	9/14/1997	1.61	5.8	4.07	0	7	BIOGENIC	NO	dm>pen;dm mud;sand/clay mix at depth?relic rpd;void or pulldown
2	Point A	300NW	B	9/14/1997	0.36	3.26	2.58	0	5	BIOGENIC	NO	dm/old dm?;layered mud; relic rpd
2	Point A	300NW	C	9/14/1997	1.71	4.25	3.14	0	6	INDET	NO	dm/old dm?;layered dm mud; relic rpd;coarser material at depth?
3	CLIS 95	300N	A	9/12/1997	1.39	3.56	2.97	0	9	BIOGENIC	NO	DM>pen;layered historic dm;void at depth;forams near surface
3	CLIS 95	300N	D	9/15/1997	2.02	3.79	2.83	0	9	BIOGENIC	NO	dm >pen;historic layered dm;reduced;2 voids;stg I assem
3	CLIS 95	300N	E	9/15/1997	0.54	3.05	2.41	0	5	PHYSICAL	NO	dm>pen;historic layered dm mud;rpd extrapolated under wiper clast
4	Point A	300NE	A	9/14/1997	0.95	2.75	1.54	0	8	INDET	NO	dm mud>pen;reduced at depth;relic rpd collapsed void
4	Point A	300NE	B	9/14/1997	0.38	2.84	1.12	0	3	PHYSICAL	NO	dm mud>pen;reduced layered at depth;reduced wiper clast;silt on surface
4	Point A	300NE	D	9/15/1997	0.71	3.65	1.55	0	4	BIOGENIC	NO	dm mud>pen;relic rpd;reduced at depth;burrow/tube;silty surface
5	CLIS 96	300NW	A	9/14/1997	1.66	3.94	2.98	0	9	BIOGENIC	NO	dm/ambient bottom?;mud/clay;worm void at depth
5	CLIS 96	300NW	B	9/14/1997	0.78	7.56	2.47	0	9	PHYSICAL	NO	dm>pen;ambient bottom?mud/clay;pocket of red sand at depth;active oxy voids
5	CLIS 96	300NW	C	9/14/1997	1.35	2.18	1.7	0	4	BIOGENIC	NO	dm amb?; heterog. reducedmud/clay/sand? at depth;relic rpd; active voids?
6	Point A	200N	B	9/14/1997	2.81	5.24	3.82	0	11	INDET	NO	dm mud>pen;reduced layer older material?;burrow;voids;OXY halo
6	Point A	200N	C	9/14/1997	1.24	3.48	2.12	0	4	INDET	NO	dm mud>pen;reduced layer historic dm;relic rpd?oxy. pulldown
6	Point A	200N	D	9/14/1997	1.33	3.67	2.74	0	5	INDET	NO	dm mud>pen;reduced layer relic rpd?fractures at depth
7	Point A	200NW	A	9/14/1997	1.09	4.77	3.57	0	6	INDET	NO	dm>pen;layered;reduced at depth dm mud
7	Point A	200NW	C	9/14/1997	2.59	6.37	4.1	0	11	INDET	NO	dm/old dm/;layered reduced mud/clay;wiper smear;burrow; shrimp on surface;relic rpd
7	Point A	200NW	D	9/15/1997	0.62	3.52	2.67	0	9	PHYSICAL	NO	dm>pen;layered;reduced mud;light clay at depth;relic rpd?void;shell frags
8	CLIS 96	200N	D	9/15/1997	1.62	4.1	2.87	0	5	INDET	NO	reduced layer;relic rpd at depth?active void?forams near surface
8	CLIS 96	200N	E	9/15/1997	2.45	4.95	4.03	0	7	PHYSICAL	NO	dm mud>pen;reduced at depth;wiper clast
8	CLIS 96	200N	F	9/15/1997	2.11	6.52	4.18	0	7	INDET	NO	dm mud>pen;reduced at depth;worm;reduced wiper clast
9	CLIS 95	200N	D	9/15/1997	1.92	14.58	5.48	0	11	BIOGENIC	NO	dm mud>pen; deep rpd from feeding void?in layered reduced dm.;forams
9	CLIS 95	200N	E	9/15/1997	0.99	5.42	2.93	0	5	INDET	NO	dm mud >pen;historic reduced dm layers; reduced wiper clasts;forams near surface
9	CLIS 95	200N	F	9/15/1997	NA	NA	NA	0	99	PHYSICAL	NO	dm mud>pen;historic reduced dm layers; reduced wiper clast obscures surface;forams
10	Point A	200NE	A	9/15/1997	0.28	3.79	1.05	0	3	PHYSICAL	NO	dm mud>pen;reduced at depth;relic rpd;forams near surface;shear artifacts
10	Point A	200NE	D	9/15/1997	0.14	4.03	2.19	0	4	INDET	NO	dm mud>pen;layered S/M;reduced at depth;relic rpd;forams near surface
10	Point A	200NE	E	9/15/1997	NA	NA	NA	0	99	INDET	NO	reduced dm mud>pen; wiper clast?;obscures surface and rpd
11	CLIS 96	200NW	A	9/14/1997	2.23	3.89	3.23	0	10	INDET	NO	dm>pen;light clay;large voids/fractures S/M/S
11	CLIS 96	200NW	B	9/14/1997	2.02	6.06	4.09	0	11	PHYSICAL	NO	dm>pen;light clay/mud;large voids and burrows;erosion;nemertean?
11	CLIS 96	200NW	C	9/14/1997	7.41	9.33	8.37	0	7	PHYSICAL	NO	dm>pen;sandy clay?clay pulldown;worm casts on surface;collapsed void?
12	Point A	100N	D	9/15/1997	0.05	6.82	2.92	0	9	INDET	NO	dm mud>pen;deep rpd feeding voids near surface;oxid burrow;halo;silty surface
12	Point A	100N	E	9/15/1997	1.04	2.46	1.66	0	99	INDET	NO	dm mud>pen; wiper clast obscures surface rpd extrapol
12	Point A	100N	F	9/15/1997	0.66	2.46	1.87	0	99	INDET	NO	dm mud >pen;reduced fresh dm or wiper clast obscures surface;rpd extrapol
13	Point A	200W	A	9/14/1997	0.52	3.04	1.58	0	8	BIOGENIC	NO	layered mud;relic rpd;active void with pellets
13	Point A	200W	D	9/15/1997	0.52	1.86	1.25	0	3	INDET	NO	dm/old dm?;layered mud/clay;relic rpd;shell frag;tube
13	Point A	200W	E	9/15/1997	0.98	3.21	1.93	0	4	INDET	NO	dm/old dm?;layered reduced dm mud;shell frags;stg I tubes;collapsed voids?
14	CLIS 96	100NW	A	9/14/1997	2.54	5.85	3.88	0	7	BIOGENIC	NO	layered dmmud/clay;dense stgI assem.;relic rpd
14	CLIS 96	100NW	C	9/14/1997	1.58	5.05	3.97	0	7	BIOGENIC	NO	dm>pen;layered;reduced dm mud/clay;
14	CLIS 96	100NW	D	9/15/1997	0.57	5.91	3.7	0	6	INDET	NO	dm>pen;layered dm mud/clay;reduced at depth;collapsed voids or drag down right?
15	CLIS 96	100N	B	9/14/1997	1.41	2.81	2.22	0	4	INDET	NO	dm mud>pen;S/M;reduced;coarser surface particles;relic rpd at depth
15	CLIS 96	100N	C	9/14/1997	1.71	3.17	2.54	0	9	INDET	NO	dm mud>pen;reduced layer at depth;relic rpd.possible collapsed void
15	CLIS 96	100N	D	9/14/1997	2.71	4.57	3.77	0	7	INDET	NO	dm mud>pen;reduced at depth;no stgIII;deep rpd;no relic;minor wiper smear

Appendix Table B1b
REMOTS® Data from the CLIS 95/96 Mound Complex, September 1997

Station Number	Grid Center	Station Location		Date	Successional Stage	Grain Size (phi)			Mud Clasts	Camera Penetration				Dredged Material Thickness**			Redox Rebound Thickness		
						Min	Max	Maj. Mode	Count	Min	Max	Range	Mean	Min	Max	Mean	Min	Max	Mean
16	CLIS 95	100N	A	9/12/1997	ST_I	4	>4	>4	0	19.37	20.16	0.79	19.76	19.51	20.24	19.8	3.1	4.34	3.72
16	CLIS 95	100N	D	9/15/1997	ST_I	4	>4	>4	0	15.26	15.36	0.1	15.31	7.66	15.45	15.11	2.58	3.97	3.28
16	CLIS 95	100N	E	9/15/1997	ST_I_ON_II	3	>4	>4	0	14.98	15.41	0.43	15.19	7.51	15.69	15.35	0	0	0
17	Point A	CTR	A	9/14/1997	ST_I	4	>4	>4	0	16.48	16.64	0.15	16.56	4.22	17.03	16.44	0	0	0
17	Point A	CTR	B	9/14/1997	ST_I	4	>4	>4	0	16.93	17.99	1.06	17.46	17.03	17.84	17.42	0	0	0
17	Point A	CTR	C	9/14/1997	ST_I	4	>4	>4	0	18.24	18.69	0.45	18.46	12	15	12.5	0	0	0
18	Point A	100E	A	9/14/1997	ST_I	4	>4	>4	2	16.68	17.38	0.7	17.03	11.73	13.74	12	0	0	0
18	Point A	100E	B	9/14/1997	ST_I	4	>4	>4	0	18.44	19.14	0.7	18.79	4.67	19.39	18.72	0	0	0
18	Point A	100E	D	9/15/1997	ST_I	4	>4	>4	0	17.19	17.24	0.05	17.21	10.09	13.04	11.02	3.67	6.49	5.08
19	Point A	200E	A	9/14/1997	ST_I	2	>4	4 to 3	0	11.36	11.36	0	11.36	7.49	11	10.54	0	0	0
19	Point A	200E	B	9/14/1997	ST_I	4	>4	>4	0	18.94	19.9	0.95	19.42	15.12	20.3	19.54	2.5	3.5	3
19	Point A	200E	C	9/14/1997	INDET	3	>4	4 to 3	1	8.24	9.7	1.46	8.97	2.41	9.7	8.82	2.21	4.32	3.27
20	Point A	300E	A	9/14/1997	ST_I	4	>4	>4	0	17.64	18.14	0.5	17.89	13.57	18.19	15.71	0	0	0
20	Point A	300E	B	9/14/1997	ST_I_ON_II	4	>4	>4	0	14.17	16.23	2.06	15.2	13.02	15.08	14.46	0	0	0
20	Point A	300E	C	9/14/1997	ST_I	4	>4	>4	0	15.93	16.99	1.06	16.46	7.89	17.39	15.53	0	0	0
21	CLIS 95	300W	B	9/12/1997	ST_I_ON_II	4	>4	>4	1	16.99	17.95	0.96	17.47	6.7	18.09	17.54	4.74	9.57	7.15
21	CLIS 95	300W	C	9/12/1997	ST_I_ON_II	4	>4	>4	0	16.36	16.9	0.53	16.63	0.1	16.94	16.42	0	0	0
21	CLIS 95	300W	D	9/15/1997	ST_I_ON_II	3	>4	>4	1	10.77	11.39	0.62	11.08	4.28	11.34	11.13	0	0	0
22	CLIS 95	200W	B	9/12/1997	ST_I	3	>4	>4	2	16.92	17.98	1.06	17.45	4.61	18.46	17.36	0	0	0
22	CLIS 95	200W	D	9/15/1997	ST_I_ON_II	4	>4	4 to 3	0	11.54	12.06	0.53	11.8	3.56	12.21	11.79	0	0	0
22	CLIS 95	200W	E	9/15/1997	ST_I_ON_II	4	>4	>4	1	15.43	16.29	0.87	15.86	14.32	16.49	16.12	3.8	8.12	5.96
23	CLIS 96	CTR	A	9/14/1997	ST_I	4	>4	>4	0	17.2	18.24	1.04	17.72	17.36	18.24	17.71	0	0	0
23	CLIS 96	CTR	B	9/14/1997	ST_III	4	>4	>4	0	20.83	20.83	0	20.83	20.73	20.88	20.75	0	0	0
23	CLIS 96	CTR	C	9/14/1997	ST_I	4	>4	>4	0	18.45	19.22	0.78	18.83	10.21	20.47	19.08	0	0	0
24	CLIS 95	100W	A	9/12/1997	ST_I	4	>4	>4	1	16.58	18.65	2.07	17.62	16.44	18.94	17.54	0	0	0
24	CLIS 95	100W	B	9/12/1997	ST_I_ON_II	4	>4	>4	0	11.1	13.57	2.47	12.34	6.82	13.65	12.12	0	0	0
24	CLIS 95	100W	C	9/12/1997	ST_I	4	>4	>4	1	16.58	17.69	1.11	17.13	16.73	17.83	17.05	0	0	0
25	CLIS 95	CTR	A	9/12/1997	ST_I_ON_II	4	>4	>4	0	17.13	17.28	0.14	17.21	8.52	17.37	16.97	0	0	0
25	CLIS 95	CTR	C	9/12/1997	ST_I	4	>4	>4	0	18.42	19.14	0.72	18.78	9.76	19.52	19.18	4.79	6.65	5.72
25	CLIS 95	CTR	D	9/15/1997	ST_I	4	>4	>4	0	9.47	10.43	0.96	9.95	10.1	11.15	10.13	0	0	0
26	CLIS 95	100E	A	9/12/1997	INDET	4	>4	>4	3	13.65	15.38	1.73	14.52	10.14	15.81	14.88	0	0	0
26	CLIS 95	100E	B	9/12/1997	ST_I	4	>4	4 to 3	1	14.76	16.49	1.73	15.62	15.09	16.49	15.69	0	0	0
26	CLIS 95	100E	D	9/15/1997	ST_I	3	>4	4 to 3	0	4.57	5.05	0.48	4.81	4.33	5.34	4.76	0	0	0
27	CLIS 95	200E	A	9/12/1997	ST_I	4	>4	>4	0	16.77	17.11	0.34	16.94	16.87	17.4	17	4.86	10.06	7.46
27	CLIS 95	200E	B	9/12/1997	ST_I	4	>4	>4	0	15.09	15.52	0.43	15.31	4.66	15.72	15.23	4.52	7.07	5.79
27	CLIS 95	200E	C	9/12/1997	ST_I_ON_II	4	4	>4	0	10.58	11.73	1.15	11.15	10.86	12.21	11.18	0	0	0
28	CLIS 95	300E	A	9/12/1997	ST_I_ON_II	3	>4	>4	2	13.89	15.33	1.44	14.61	10.33	15.52	14.25	4.43	6.73	5.58
28	CLIS 95	300E	B	9/12/1997	ST_I	4	>4	>4	1	15.24	15.72	0.48	15.48	15.52	16.29	15.79	5.44	8.56	7
28	CLIS 95	300E	C	9/12/1997	ST_I_ON_II	3	>4	>4	2	14.76	15.48	0.71	15.12	14.71	15.48	15.03	4.95	7.31	6.13
29	Point A	100S	A	9/14/1997	INDET	2	>4	>4	0	13.37	13.73	0.36	13.55	13.68	14.25	13.73	0	0	0
29	Point A	100S	B	9/14/1997	ST_I	2	>4	>4	0	10.73	12.8	2.08	11.76	12.23	13.37	12.29	0	0	0
29	Point A	100S	C	9/14/1997	ST_I	3	>4	>4	0	14.15	14.97	0.83	14.56	14.15	15.18	14.53	0	0	0
30	CLIS 96	100SW	A	9/14/1997	ST_I	4	>4	>4	0	14.67	15.48	0.8	15.07	11.76	15.73	15.2	0	0	5
30	CLIS 96	100SW	B	9/14/1997	ST_I	3	>4	>4	0	17.42	17.78	0.35	17.6	8.69	17.93	17.63	3.23	4.19	3.71
30	CLIS 96	100SW	C	9/14/1997	ST_I_ON_II	4	>4	>4	0	16.41	16.97	0.56	16.69	12.63	17.07	16.43	0	0	0

continued

Appendix Table B1b (continued)

Station Number	Grid Center	Station Location		Date	Apparent RPD Thickness			Methane	OSI	Surface Roughnes s	Low DO	Comments
					Min	Max	Mean					
16	CLIS 95	100N	A	9/12/1997	0.99	2.41	1.63	0	4	BIOGENIC	NO	dm mud>pen;historic layers reduced dm;forams near surface
16	CLIS 95	100N	D	9/15/1997	2.39	3.16	2.78	0	5	BIOGENIC	NO	dm mud> pen; layers reduced dm mud
16	CLIS 95	100N	E	9/15/1997	0.86	4.31	2.9	0	9	PHYSICAL	NO	dm mud>pen;layers historic reduced dm;void;some shelll hash;chaotic fabric
17	Point A	CTR	A	9/14/1997	2.21	3.52	2.04	0	4	BIOGENIC	NO	dm mud>pen;reduced S/M;no relic rpd;stg I assem
17	Point A	CTR	B	9/14/1997	1.76	3.92	2.94	0	5	INDET	NO	dm mud>pen;reduced;reduced wiper clasts surface;relic rpd
17	Point A	CTR	C	9/14/1997	0.85	3.52	2.05	0	4	BIOGENIC	NO	dm mud>pen;layered reduced;pocket light clay;partial relic rpd
18	Point A	100E	A	9/14/1997	0.4	2.41	1.18	0	3	INDET	NO	dm mud>pen;reduced at depth;relic rpd?;reduced wiper clasts
18	Point A	100E	B	9/14/1997	3.17	6.38	4.43	0	7	INDET	NO	dm mud>pen;reduced ;layeredwiper clast pulldown
18	Point A	100E	D	9/15/1997	1.5	2.62	2.03	0	4	BIOGENIC	NO	dm/old dm; relic rpd.; dense stg I;void L.L
19	Point A	200E	A	9/14/1997	5.43	8.24	7.1	0	7	PHYSICAL	NO	dm>pen?;sand;coarse part. over light clay;no recent dm;deep rpd;shell;weed
19	Point A	200E	B	9/14/1997	1.5	2.5	2	0	4	PHYSICAL	NO	dm mud>pen;reduced at depth;pocketlight clay;stg I assem
19	Point A	200E	C	9/14/1997	0.95	3.32	2.19	0	99	PHYSICAL	NO	dm mud>pen;sand layer surface?reduced wiperclast.shell frags;poorly sorted
20	Point A	300E	A	9/14/1997	1.56	3.32	2.63	0	5	INDET	NO	dm mud>pen;relic rpd;layered;reduced at depth;stgI
20	Point A	300E	B	9/14/1997	0.65	3.87	2.27	0	9	PHYSICAL	NO	dm>pen layered reduced at depth;relic rpd;collapsed and active void;shell frags
20	Point A	300E	C	9/14/1997	NA	NA	NA	0	99	PHYSICAL	NO	dm mud>pen;layed reduced at depth;shallow rpd obscured by wiper clast;shell fragments
21	CLIS 95	300W	B	9/12/1997	2.11	4.98	3.65	0	10	BIOGENIC	NO	dm mdu>pen;historic dm reduced;voids at depth;reduced wiper clast smear;forams
21	CLIS 95	300W	C	9/12/1997	NA	NA	NA	0	99	PHYSICAL	NO	dm mud>pen;historic layered dm;stranded tube;burrow or void
21	CLIS 95	300W	D	9/15/1997	1.78	4.28	3.32	0	10	INDET	NO	dm mud>pen;histroic dm;large clay clast farfield;void?
22	CLIS 95	200W	B	9/12/1997	1.35	3.6	2.99	0	5	INDET	NO	dm mud>pen;historic dm layers;reduced wiper clasts;forams near surface
22	CLIS 95	200W	D	9/15/1997	2.26	4.47	3.56	0	10	INDET	NO	dmmud>pen;m/s/m historic dm reduced;shallow rpd;relic void?
22	CLIS 95	200W	E	9/15/1997	0.24	3.99	2.52	0	9	PHYSICAL	NO	dm >pen;historic layered dm reduced;oxy clay clasts
23	CLIS 96	CTR	A	9/14/1997	1.76	3.63	2.76	0	5	INDET	NO	dm>pen;light clay/reduced mud;void or pulldown;stg I tubes
23	CLIS 96	CTR	B	9/14/1997	NA	NA	NA	0	99	INDET	NO	overpen;dm>pen;reducedmud/clay;voids
23	CLIS 96	CTR	C	9/14/1997	0.88	3.01	1.53	0	4	INDET	NO	dm>pen;S/M;reduced homo. mud;shallow rpd;reduced wiper clast
24	CLIS 95	100W	A	9/12/1997	0.91	3.6	1.29	0	3	PHYSICAL	NO	dm>pen;chaotic layered historic dm;fresh dm?reduced at depth;worm;voids or fractures
24	CLIS 95	100W	B	9/12/1997	0.67	3.32	2.32	0	9	PHYSICAL	NO	dm>pen;historic mud/clay dm reduced/oxy;gastropods?
24	CLIS 95	100W	C	9/12/1997	2.69	5.58	4.2	0	7	PHYSICAL	NO	dm mud>pen;historic layered dm.oxy mud clast;stg I tube mat
25	CLIS 95	CTR	A	9/12/1997	1.77	3.4	2.53	0	9	BIOGENIC	NO	dm mud>pen;historic dm layers light clay;not reduced;voids;forams near surface
25	CLIS 95	CTR	C	9/12/1997	0.86	4.5	3.62	0	6	INDET	NO	dm>pen;historic dmlayers;reduced;slight overpen;wiper clasts?
25	CLIS 95	CTR	D	9/15/1997	2.44	4.16	3.11	0	6	INDET	NO	dm mud >pen;historic dm layers reduced; rocks with barnancles
26	CLIS 95	100E	A	9/12/1997	0.62	5.48	2.64	0	99	PHYSICAL	NO	dm mud>pen;historic dm reduced;reduced wiper clasts pulldown in rpd
26	CLIS 95	100E	B	9/12/1997	1.44	3.94	2.72	0	5	PHYSICAL	NO	dm mud>pen;historic dm reduced;reduced wiper clast?relic voids?
26	CLIS 95	100E	D	9/15/1997	1.2	3.27	2.49	0	5	PHYSICAL	NO	dm>pen;brown sand/silt/mud/gravel poorly sorted/ barnacles/molluscan shell armor
27	CLIS 95	200E	A	9/12/1997	3.03	6.58	5.01	0	7	BIOGENIC	NO	dm mud>pen;historic layered dm;relic voids or shear art.?
27	CLIS 95	200E	B	9/12/1997	3.32	4.42	3.91	0	7	PHYSICAL	NO	dm mud>pen;historic dm chaotic;reduced at depth
27	CLIS 95	200E	C	9/12/1997	1.87	5.86	4.25	0	11	PHYSICAL	NO	dm mud>pen;historic dm reduced at depth; large void?;burrow
28	CLIS 95	300E	A	9/12/1997	0.91	4.23	3.3	0	10	INDET	NO	dm mud>pen;m/s/m;layered historic dm;burrow;clay clastsin rpd
28	CLIS 95	300E	B	9/12/1997	1.97	4.71	4.07	0	7	PHYSICAL	NO	dm mud>pen;M/S/M;historic dm reduced sorted;wiper clast;shear artifact
28	CLIS 95	300E	C	9/12/1997	2.11	3.22	2.7	0	9	PHYSICAL	NO	dm mud>pen.historic layered dm m/s/m;wiper clasts active void;forams near surface
29	Point A	100S	A	9/14/1997	1.44	2.72	2.05	0	99	INDET	NO	dm>pen;S/M;reudec/light clay;many voids or fractures?;pebbles;shell stgI surface
29	Point A	100S	B	9/14/1997	1.19	3.01	2.37	0	5	PHYSICAL	NO	dm>pen;S/M;scour lagsand.shell;cobble on reduced;layered clay/mud;burrow or pullout
29	Point A	100S	C	9/14/1997	0.05	3.11	2.04	0	4	PHYSICAL	NO	dm>pen;S/M;shell frags;layered reduced dm; relic void?
30	CLIS 96	100SW	A	9/14/1997	1.44	2.31	1.9	0	4	INDET	NO	dm mud>pen;light clay;chaotic fabric;feeding halo;shell frags
30	CLIS 96	100SW	B	9/14/1997	1.34	2.99	2.49	0	5	INDET	NO	dm mud>pen;clay clasts in rpd; burrow at depth;chaotic fabric
30	CLIS 96	100SW	C	9/14/1997	2.12	4.39	3.08	0	10	PHYSICAL	NO	dm mud>pen;reduced layered mud/clay; oxy clay clasts in rpd

Appendix Table B1c
REMOTS® Data from the CLIS 95/96 Mound Complex, September 1997

Station Number	Grid Center	Station Location	Replicate	Date	Successional Stage	Grain Size (phi)			Mud Clasts	Camera Penetration				Dredged Material Thickness**			Redox Rebound Thickness		
						Min	Max	Maj. Mode	Count	Min	Max	Range	Mean	Min	Max	Mean	Min	Max	Mean
31	CLIS 96	100S	A	9/14/1997	ST_I	4	>4	>4	0	16.77	17.73	0.96	17.25	8.94	17.88	17.03	3.38	8.38	5.88
31	CLIS 96	100S	B	9/14/1997	ST_I	4	>4	>4	0	19.44	19.85	0.4	19.65	19.34	20.05	19.5	0	0	0
31	CLIS 96	100S	C	9/14/1997	ST_I_ON_II	4	>4	>4	0	18.08	18.69	0.61	18.38	14.04	18.89	18.25	0	0	0
32	CLIS 95	100S	A	9/12/1997	ST_I	4	>4	>4	0	16.46	16.94	0.48	16.7	16.12	17.03	16.54	0	0	0
32	CLIS 95	100S	B	9/12/1997	ST_I	4	>4	>4	0	16.8	17.42	0.62	17.11	16.79	17.56	17.05	0	0	0
32	CLIS 95	100S	C	9/12/1997	ST_I	4	>4	>4	2	19.38	19.43	0.05	19.4	19.09	19.95	19.47	0	0	0
33	Point A	200SE	A	9/14/1997	ST_I	4	>4	>4	0	18.39	19.27	0.88	18.83	6.89	19.38	18.85	0	0	0
33	Point A	200SE	B	9/14/1997	ST_I_ON_II	4	>4	>4	0	19.95	19.95	0	19.95	3.09	6.91	6.44	0	0	0
33	Point A	200SE	C	9/14/1997	ST_I	4	>4	>4	0	15.49	16.22	0.72	15.86	15.91	16.32	16	0	0	0
34	Point A	200S	A	9/14/1997	ST_I	4	>4	>4	0	12.63	17.48	4.85	15.05	6.62	17.58	14.93	0	0	0
34	Point A	200S	B	9/14/1997	ST_I_ON_II	4	>4	>4	0	14.95	15.1	0.15	15.03	14.9	15.35	15.12	0	0	0
34	Point A	200S	C	9/14/1997	ST_III	4	>4	>4	1	12.68	14.5	1.82	13.59	8.5	11.51	10.43	0	0	0
35	CLIS 96	200SW	A	9/14/1997	ST_I	4	>4	>4	0	18.03	18.23	0.2	18.13	6.72	9.28	7.04	3.84	6.46	5.15
35	CLIS 96	200SW	B	9/14/1997	ST_III	4	>4	>4	0	17.18	18.59	1.41	17.89	6.18	8.49	7.47	3.77	7.84	5.8
35	CLIS 96	200SW	C	9/14/1997	ST_I_ON_II	4	>4	>4	0	16.98	17.69	0.7	17.34	2.05	8.46	7.62	7.09	10.4	8.74
36	CLIS 96	200S	A	9/14/1997	ST_I	4	>4	4 to 3	0	17.83	18.53	0.71	18.18	13.74	18.59	18.2	0	0	3.5
36	CLIS 96	200S	B	9/14/1997	ST_I_ON_II	4	>4	4 to 3	0	14.9	15.35	0.46	15.13	11.57	15.5	15.18	0	0	0
36	CLIS 96	200S	C	9/14/1997	ST_I	4	>4	4 to 3	0	15.5	16.11	0.61	15.81	15.66	16.01	15.71	0	0	5
37	CLIS 95	200S	A	9/12/1997	ST_I_ON_II	4	>4	>4	0	14.69	15.31	0.62	15	11	15.41	14.97	3.7	5.6	4.65
37	CLIS 95	200S	B	9/12/1997	ST_I_ON_II	4	>4	>4	2	16.36	16.89	0.53	16.63	16.17	17.42	16.85	0	0	0
37	CLIS 95	200S	C	9/12/1997	ST_I_ON_II	4	>4	>4	2	13.78	14.21	0.43	14	13.59	14.21	13.76	0	0	0
38	Point A	300SE	A	9/14/1997	ST_I_ON_II	4	>4	>4	0	10.1	10.83	0.73	10.47	2.27	7.06	6.28	3.37	6.53	4.95
38	Point A	300SE	B	9/14/1997	ST_I_ON_II	4	>4	>4	0	19.53	20.26	0.73	19.9	14.66	20.16	19.83	4.4	9.28	6.84
38	Point A	300SE	C	9/14/1997	ST_I_ON_II	3	>4	>4	0	17.15	18.86	1.71	18.01	16.94	19.02	18.1	0	0	0
39	CLIS 96	300SW	A	9/14/1997	ST_I_ON_II	4	>4	>4	0	17.13	18.39	1.26	17.76	9.2	18.44	17.25	4	6	5
39	CLIS 96	300SW	C	9/14/1997	ST_I	4	>4	>4	0	17.64	18.49	0.86	18.07	6.42	9.74	7.21	3.32	7.7	5.51
39	CLIS 96	300SW	D	9/14/1997	ST_I_ON_II	4	>4	>4	0	17.89	18.09	0.2	17.99	4.47	18.14	17.72	0	0	0
40	CLIS 96	300S	D	9/15/1997	ST_I	4	>4	>4	0	14.9	15.4	0.5	15.15	9.02	12.22	11.83	0	0	0
40	CLIS 96	300S	E	9/15/1997	ST_I	4	>4	>4	0	17.48	17.83	0.36	17.66	13.14	13.92	13.35	0	0	0
40	CLIS 96	300S	F	9/15/1997	ST_I	4	>4	>4	0	15.13	16.53	1.41	15.83	9.39	13.92	13.44	0	0	0
41	CLIS 95	300S	D	9/15/1997	ST_I_ON_II	4	>4	>4	2	13.01	13.59	0.57	13.3	10.33	13.83	13.46	0	0	0
41	CLIS 95	300S	E	9/15/1997	ST_I	4	>4	>4	2	15.41	15.69	0.29	15.55	15.22	15.93	15.47	3.21	6.61	4.91
41	CLIS 95	300S	F	9/15/1997	ST_I	4	>4	>4	1	12.97	14.69	1.72	13.83	10.24	14.74	14.27	0	0	0

continued

Appendix Table B1c (continued)

Station Number	Grid Center	Station Location	Replicate	Date	Apparent RPD Thickness Min	Max	Mean	Methane	OSI	Surface Roughness	Low DO	Comments
31	CLIS 96	100S	A	9/14/1997	1.92	4.8	3.43	0	6	PHYSICAL	NO	dm>pen; layered mud/clay;chaotic fabric at depth;WIPER ARTIFACTS?
31	CLIS 96	100S	B	9/14/1997	2.17	3.23	2.65	0	5	INDET	NO	dm>pen;layered reduced mud/clay;shell frags.reduced mud balls in rpd(wiper?)
31	CLIS 96	100S	C	9/14/1997	2.17	3.23	2.65	0	9	PHYSICAL	NO	dm>pen;reduced dm mud/clay;feeding halo
32	CLIS 95	100S	A	9/12/1997	1.87	4.74	3.84	0	7	BIOGENIC	NO	dm mud>pen;historic layers reduced dm;stg Itubes
32	CLIS 95	100S	B	9/12/1997	1.72	5.17	3.76	0	7	INDET	NO	dm mud>pen;historic layers of reduced dm;clay wiper clast on surface
32	CLIS 95	100S	C	9/12/1997	1.2	4.88	3.21	0	6	INDET	NO	dm mud>pen;historic reduced layers dm;wiper clasts;forams near surface
33	Point A	200SE	A	9/14/1997	1.71	4.2	2.36	0	5	INDET	NO	dm>pen;reduced mud/clay at depth;rock with barnacles;stg I tubes
33	Point A	200SE	B	9/14/1997	1.4	3.78	2.81	0	9	INDET	NO	reduced mud/light clay at depth;voids;reduced wiper clast;relic rpd?
33	Point A	200SE	C	9/14/1997	3.37	5.18	4.15	0	7	PHYSICAL	NO	dm>pen;reduced mud over clay;void at depth or fractures;dense stg I
34	Point A	200S	A	9/14/1997	0.05	3.13	1.98	0	4	PHYSICAL	NO	dm>pen;sloping topo.;layered;reduced;dense stg I tubes
34	Point A	200S	B	9/14/1997	2.93	4.7	3.96	0	11	INDET	NO	dm>pen;layered reduced S/M;light clay at depth;active feeding void
34	Point A	200S	C	9/14/1997	1.01	3.59	2.68	0	9	PHYSICAL	NO	dm>pen;large clay clast wiper surface;relic rpd reduced layer over light clay
35	CLIS 96	200SW	A	9/14/1997	0.3	3.28	2.28	0	5	INDET	NO	dm/old dm;relic rpd;reduced;layered at depth;stg I assem
35	CLIS 96	200SW	B	9/14/1997	0.8	2.31	1.77	0	8	INDET	NO	dm/old dm;layered reduced dm;relic rpd;void;reduced wiper clast
35	CLIS 96	200SW	C	9/14/1997	2.21	3.72	2.76	0	9	INDET	NO	dm/old dm; S/M;reduced;layered;relic rpd;active voids;worm?
36	CLIS 96	200S	A	9/14/1997	1.7	2.37	2.05	0	4	INDET	NO	dm>pen;reduced at depth;S/M;forams near surface
36	CLIS 96	200S	B	9/14/1997	1.11	3.59	2.47	0	9	BIOGENIC	NO	dm>pen;reduced at depth;feeding voids;reduced wiper clasts surface
36	CLIS 96	200S	C	9/14/1997	2.53	4.39	2	0	4	BIOGENIC	NO	dm>pen;reduced;chaotic fabric at depth;dense stg I assem;active voids
37	CLIS 95	200S	A	9/12/1997	1.1	4.07	2.86	0	9	BIOGENIC	NO	dm>pen;chaotic fabric reduced at depth;voids and/or fractures
37	CLIS 95	200S	B	9/12/1997	0.96	3.97	3.05	0	10	INDET	NO	dm mud >pen; historic layered;reduced dm;voids/fractures?;wiper clayclasts
37	CLIS 95	200S	C	9/12/1997	3.25	4.21	3.74	0	10	BIOGENIC	NO	dmmud>pen;historic layered dm;dense stgI ;wiper clasts
38	Point A	300SE	A	9/14/1997	2.16	3.56	3.5	0	10	BIOGENIC	NO	dm>pen;layered dm/clay reduced at depth;relic rpd;dense stgI;void
38	Point A	300SE	B	9/14/1997	2.85	5.8	4.17	0	11	BIOGENIC	NO	dm>pen;relic rpd;reduced at depth;active void;reduced wiper clast;dense stg I
38	Point A	300SE	C	9/14/1997	4.51	8.76	6.29	0	11	PHYSICAL	NO	dm>pen;mud;clay/sand mix chaotic at depth;shell frags;dense stg I
39	CLIS 96	300SW	A	9/14/1997	1.6	2.51	2.1	0	8	PHYSICAL	NO	dm mud>pen;reduced at depth;collapsed and active voids;some shell frags
39	CLIS 96	300SW	C	9/14/1997	2.06	5.38	3.52	0	6	BIOGENIC	NO	dm/old dm;reduced at depth;layered;relic rpd;sand fracture at depth
39	CLIS 96	300SW	D	9/14/1997	0.4	3.97	2.68	0	9	PHYSICAL	NO	dm mud>pen;reduced;layered;relic rpd;feeding halo
40	CLIS 96	300S	D	9/15/1997	1.11	2.78	1.94	0	4	INDET	NO	dm/old dm?; layered dm reduced at depth;relic rpd
40	CLIS 96	300S	E	9/15/1997	0.86	3.23	2.69	0	5	INDET	NO	dm/old dm?;reduced dm;clay at depth;wiper clasts;relic rpd;forams near surface
40	CLIS 96	300S	F	9/15/1997	2.18	3.37	2.87	0	5	INDET	NO	dm mud/clay;rpd extrapolated under wiper clast;relic rpd
41	CLIS 95	300S	D	9/15/1997	3.44	5.45	4.56	0	11	BIOGENIC	NO	dm>pen;forams near surface; 12 cm relict RPD
41	CLIS 95	300S	E	9/15/1997	NA	NA	NA	0	99	INDET	NO	dm mud>pen; historic layers reduced dm; rpd obscured under wiper smear
41	CLIS 95	300S	F	9/15/1997	2.82	4.55	3.7	0	6	INDET	NO	dm mud>pen;historic layereddm;reduced;wiper clast smear;rpd extrapolated

Appendix B2
REMOTS® Data from the CLIS NHAV 93 Mound, September 1997

Appendix Table B 2
REMOTS® Data from the CLIS NHAV 93 Mound, September 1997

Station Location	Replicate	Date	Successional Stage	Grain Size (phi)			Mud Clasts	Camera Penetration				Dredged Material Thickness**			Redox Rebound Thickness			Apparent RPD Thickness		
				Min	Max	Maj. Mode	Count	Min	Max	Range	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
200E	A	9/12/1997	ST_I	4	>4	>4	0	15.83	16.02	0.19	15.92	11.94	16.26	15.7	2.28	3.6	2.94	0.29	4.13	2.64
200E	B	9/12/1997	ST_I	4	>4	>4	0	14.17	15.34	1.17	14.76	10.83	15.24	14.63	0	0	0	2.04	3.06	2.53
200E	C	9/12/1997	ST_I	4	>4	>4	0	15.15	15.39	0.24	15.27	15.19	15.58	15.26	0	0	0	1.8	3.35	1.51
200N	A	9/12/1997	ST_I_ON_III	4	>4	>4	0	16	16.58	0.59	16.29	12.14	16.58	16.2	1.91	3.66	2.78	1.32	4.68	3.53
200N	B	9/12/1997	ST_I	4	>4	>4	0	15.61	16	0.39	15.81	15.66	16.29	15.83	0	0	0	3.56	10	3.21
200N	C	9/12/1997	ST_I_ON_III	4	>4	>4	1	16.02	16.89	0.87	16.46	5	16.7	16.15	3.62	6.36	4.99	1.46	2.62	2.17
200S	A	9/12/1997	ST_I	4	>4	>4	1	13.11	14.76	1.65	13.93	13.25	15.19	14.36	0	0	0	0.05	3.16	1.84
200S	B	9/12/1997	INDET	4	>4	>4	0	15.53	16.7	1.17	16.12	15.53	16.31	15.75	0	0	0	1.02	1.75	1.36
200S	C	9/12/1997	ST_I	4	>4	>4	0	14.08	14.47	0.39	14.27	6.7	14.51	14.02	0	0	0	NA	NA	NA
200W	A	9/12/1997	ST_I	4	>4	>4	0	18.16	18.5	0.34	18.33	18.16	18.79	18.45	0	0	0	0.73	6.55	2.16
200W	B	9/12/1997	ST_I	4	>4	>4	0	16.7	17.52	0.82	17.11	6.46	17.52	17.01	2.57	4.42	3.5	0.58	2.18	1.65
200W	C	9/12/1997	ST_I	4	>4	>4	0	14.56	15.58	1.02	15.07	11.12	15.53	14.93	0	0	0	0.92	3.16	1.09
CTR	A	9/12/1997	ST_I	4	>4	>4	0	15.43	15.86	0.43	15.65	15.43	16.05	15.5	0	0	0	0.24	3.85	1.8
CTR	B	9/12/1997	ST_I_ON_III	4	>4	>4	0	15.48	16.34	0.87	15.91	15.33	16.49	16.13	0	0	0	1.11	4.95	3.54
CTR	C	9/12/1997	ST_I	4	>4	>4	1	15.77	17.74	1.97	16.75	15.43	17.78	15.78	3.7	7.02	5.36	1.39	3.75	2.45

continued

Appendix Table B 2 (continued)

Station Location	Replicate	Date	Methane	OSI	Surface Roughness	Low DO	Comments
200E	A	9/12/1997	0	5	INDET	NO	dm mud>pen;historic dm reduced;pulldown or burrow?;stranded tube
200E	B	9/12/1997	0	5	INDET	NO	dm mud>pen;historic dm reduced;rpd extrapolated under wiper clast;weed
200E	C	9/12/1997	2	2	BIOGENIC	NO	dm mud>pen;historic dm reduced at depth;wiper clast pulldown;rpd extrapolated
200N	A	9/12/1997	0	10	INDET	NO	dm mud>pen;historic dm reduced at depth;oxy void or burrows?;forams near surface
200N	B	9/12/1997	0	6	BIOGENIC	NO	dm mud>pen;historic dm reduced at depth;rpd extrapol. under wiper clast smears
200N	C	9/12/1997	0	8	INDET	NO	dm mud>pen;historic dm reduced;wiper clast;stranded tube;active void?
200S	A	9/12/1997	0	4	INDET	NO	dm mud>pen;historic dm reduced;void or burrow?shallow rpd.small wiper clast?
200S	B	9/12/1997	0	99	INDET	NO	dm mud>pen;rpd extrapolated under wiper clast which obscures the surface
200S	C	9/12/1997	0	1	INDET	NO	dm mud>pen;historic dm reduced;shell frags;shallow rpd;hydroids
200W	A	9/12/1997	0	4	INDET	NO	dm mud>pen;historic dm reduced;relic oxid.dm mud clasts
200W	B	9/12/1997	0	4	PHYSICAL	NO	dm mud>pen;historic dm reduced;Nephys polychaete;reduced wiper clast pulldown;
200W	C	9/12/1997	0	3	INDET	NO	dm>pen;mud/light clay; large pull apart fracture;much less reduced than other reps
CTR	A	9/12/1997	0	4	BIOGENIC	NO	dm mud>pen;historic dm reduced at depth;collapsed oxy void
CTR	B	9/12/1997	2	8	INDET	NO	dm mud>pen;historic dm reduced at depth;voids active&relic;stranded tube
CTR	C	9/12/1997	0	5	PHYSICAL	NO	dm mud>pen;historic dm reduced;void;stranded tubes;shell frags

Appendix B3
REMOTS® Data from the CLIS Reference Areas, September 1997

Appendix Table B 3

REMOTS® Data from the CLIS Reference Areas, September 1997

Reference Area Station	Replicate	Date	Successional Stage	Grain Size (phi)			Mud Clasts	Camera Penetration				Dredged Material Thickness**			Redox Rebound Thickness			Apparent RPD Thickness			Methane	OSI
				Min	Max	Maj. Mode	Count	Min	Max	Range	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean		
2500W																						
STA1	A	9/12/1997	ST_I	4	>4	>4	0	8.93	13.69	4.76	11.31	0	0	0	0	0	0	1.6	3.74	2.67	0	5
STA1	B	9/12/1997	ST_I	4	>4	>4	0	15.93	16.22	0.29	16.07	0	0	0	0	0	0	1.07	2.43	1.53	0	4
STA1	C	9/12/1997	ST_I	4	>4	>4	2	12.77	15.15	2.38	13.96	0	0	0	3.01	4.86	3.94	0.39	3.06	1.75	0	4
STA2	A	9/12/1997	ST_I	4	>4	>4	1	13.91	14.3	0.39	14.11	0	0	0	3.43	5.72	4.57	0.43	2.95	1.56	0	4
STA2	B	9/12/1997	ST_I	4	>4	>4	0	13.82	14.64	0.82	14.23	0	0	0	3.29	5.99	4.64	1.21	3.24	2.46	0	5
STA2	C	9/12/1997	ST_I	4	>4	>4	0	14.83	16.09	1.26	15.46	0	0	0	0	0	0	0.97	2.51	1.25	0	3
STA3	A	9/12/1997	ST_I_ON_III	4	>4	>4	0	14.5	14.93	0.43	14.71	0	0	0	0	0	0	2.46	4.01	3.04	0	10
STA3	B	9/12/1997	ST_I_ON_III	4	>4	>4	0	14.93	15.56	0.63	15.24	0	0	0	3.58	6.38	4.98	0.14	5.56	3.18	0	10
STA3	C	9/12/1997	ST_I_ON_III	4	>4	>4	0	8.99	13.19	4.2	11.09	0	0	0	0	0	0	0.43	3.67	2.52	0	9
STA4	A	9/12/1997	ST_I	4	>4	>4	0	15.78	16.21	0.44	16	0	0	0	4.71	6.21	5.46	1.17	2.82	2.14	0	4
STA4	B	9/12/1997	ST_I	4	>4	>4	1	15.34	16.07	0.73	15.71	0	0	0	0	0	0	0.78	2.28	1	0	3
STA4	C	9/12/1997	ST_III	4	>4	>4	2	14.06	15.61	1.55	14.84	0	0	0	0	0	0	NA	NA	NA	0	99
STA5	A	9/12/1997	ST_I	4	>4	>4	0	14.15	14.99	0.83	14.57	0	0	0	0	0	0	2.27	3.53	2.84	0	5
STA5	B	9/12/1997	ST_I	4	>4	>4	1	14.64	15.65	1.02	15.14	0	0	0	0	0	0	0.72	2.61	1.66	0	4
STA5	C	9/12/1997	ST_I	4	>4	>4	1	14.25	14.73	0.48	14.49	0	0	0	0	0	0	1.64	5.22	2.63	0	5
4500E																						
STA6	A	9/12/1997	ST_I_ON_III	4	>4	>4	0	16.44	17.11	0.67	16.77	0	0	0	3.23	7.62	5.42	1.73	3.22	2.7	0	9
STA6	B	9/12/1997	ST_III	4	>4	>4	0	11.73	12.4	0.67	12.06	0	0	0	0	0	0	0.77	1.92	1.32	0	7
STA6	C	9/12/1997	ST_I_ON_III	4	>4	>4	0	13.36	13.51	0.14	13.43	0	0	0	0	0	0	0.87	2.55	1.88	0	8
STA7	A	9/12/1997	ST_I_ON_III	4	>4	>4	0	13.24	13.67	0.44	13.46	0	0	0	0	0	0	0.47	2.65	2.01	0	8
STA7	B	9/12/1997	ST_I	4	>4	>4	0	13.22	13.74	0.52	13.48	0	0	0	0	0	0	0.09	4.17	2.17	0	4
STA7	C	9/12/1997	ST_I	4	>4	>4	0	16.02	16.35	0.33	16.18	0	0	0	0	0	0	0.62	4.69	2.96	0	5
STA8	A	9/12/1997	ST_I	4	>4	>4	0	13.36	14.36	1	13.86	0	0	0	0	0	0	0.76	9.95	3.17	0	6
STA8	B	9/12/1997	ST_III	4	>4	>4	0	10.71	11.47	0.76	11.09	0	0	0	0	0	0	0.14	3.22	2.05	0	8
STA8	C	9/12/1997	ST_I_ON_III	4	>4	>4	0	14.03	14.6	0.57	14.31	0	0	0	0	0	0	0.14	3.74	2.88	0	9
STA9	A	9/12/1997	ST_I	4	>4	>4	0	11.75	12.08	0.33	11.92	0	0	0	0	0	0	1.2	2.7	1.7	0	4
STA9	B	9/12/1997	ST_III	4	>4	>4	2	10.62	10.9	0.28	10.76	0	0	0	0	0	0	0.43	5.88	3.39	0	10
STA9	C	9/12/1997	ST_I_ON_III	4	>4	>4	0	13.27	13.84	0.57	13.55	0	0	0	0	0	0	0.09	6.11	4.12	0	11
CLIS-REF																						
STA10	B	9/12/1997	ST_I	4	>4	>4	0	11.19	11.39	0.2	11.29	0	0	0	0	0	0	1.14	4.08	2.96	0	5
STA10	D	9/15/1997	ST_I_ON_III	4	>4	>4	0	10.84	11.29	0.45	11.07	0	0	0	0	0	0	1.69	6.52	4.39	0	11
STA10	E	9/15/1997	ST_I_ON_III	4	>4	>4	2	13.74	14.29	0.55	14.01	0	0	0	3.93	5.18	4.56	1.24	11.04	2.74	0	9
STA11	A	9/12/1997	ST_I	4	>4	>4	0	11.34	11.44	0.1	11.39	0	0	0	3.93	5.18	4.56	0.35	4.03	1.92	0	4
STA11	B	9/12/1997	ST_I_ON_III	4	>4	>4	0	9.71	10.21	0.5	9.96	0	0	0	0	0	0	0.55	7.61	2.99	0	9
STA11	C	9/12/1997	INDET	4	>4	>4	0	11.05	12.19	1.14	11.62	0	0	0	0	0	0	NA	NA	NA	0	99
STA12	A	9/12/1997	ST_I	4	>4	>4	0	10.15	11.35	1.2	10.75	0	0	0	3.13	5.97	4.55	0.15	3.93	2.87	0	5
STA12	B	9/12/1997	ST_I	4	>4	>4	0	10.05	10.65	0.6	10.35	0	0	0	3.33	5.22	4.28	0.55	3.73	2.42	0	5
STA12	C	9/12/1997	ST_I	4	>4	>4	0	10.7	11.84	1.15	11.27	0	0	0	0	0	0	0.05	2.84	1.92	0	4
STA13	A	9/12/1997	ST_I_ON_III	4	>4	>4	1	13.46	13.75	0.29	13.6	0	0	0	0	0	0	0.53	6.01	2.4	0	9
STA13	B	9/12/1997	ST_I_ON_III	4	>4	>4	0	9.09	10.91	1.82	10	0	0	0	0	0	0	0.14	2.21	1.09	0	7
STA13	C	9/12/1997	ST_I_ON_III	4	>4	>4	0	8.61	9.57	0.96	9.09	0	0	0	0	0	0	0.29	2.26	1.52	0	8
STA14	A	9/12/1997	INDET	4	>4	>4	0	11.82	12.08	0.26	11.95	11.82	12.08	11.95	0	0	0	NA	NA	NA	0	99
STA14	B	9/12/1997	ST_I_ON_III	4	>4	>4	0	9.52	10	0.48	9.76	0	0	0	1.54	5.15	3.34	0.14	3.89	2.43	0	9
STA14	C	9/12/1997	ST_I_ON_III	4	>4	>4	0	9.32	10	0.67	9.66	0	0	0	2.6	4.66	3.63	1.97	3.99	3.1	0	10
STA14	D	9/12/1997	ST_I	4	>4	>4	0	11.44	12.54	1.11	11.99	0	0	0	2.26	3.99	3.13	0.34	2.84	1.95	0	4
STA14	E	9/12/1997	ST_I	4	>4	>4	0	12.03	12.66	0.63	12.35	0	0	0	0	0	0	NA	NA	NA	0	99
STA14	F	9/12/1997	ST_I	4	>4	>4	0	9.38	10.1	0.73	9.74	0	0	0	0	0	0	0.89	2.86	1.89	0	4

continued

Appendix Table B 3 (continued)

Reference Area Station	Replicate	Date	Surface Roughness	Low DO	Comments
2500W					
STA1	A	9/12/1997	BIOGENIC	NO	silty mud/mud clay amb.;large burrow;razor clam shell?
STA1	B	9/12/1997	PHYSICAL	NO	silt/mud/clay amb.shear artifact;oxy halo;wiper smear on faceplate
STA1	C	9/12/1997	PHYSICAL	NO	siltly mud/clay pull apart fracture at depth;shell frag;wiper smear on faceplate
STA2	A	9/12/1997	INDET	NO	silty mud/clay amb.;reduced wiper clasts;fractures at depth?
STA2	B	9/12/1997	INDET	NO	silty mud/clay amd.;reduced wiper clasts;shell frags
STA2	C	9/12/1997	INDET	NO	silty mud/clay;claey wiper clast obscures surface;shear fracture at depth
STA3	A	9/12/1997	PHYSICAL	NO	silty mud/clay oxy or light;ambient bottom; void at left?
STA3	B	9/12/1997	BIOGENIC	NO	silt/clay amb.macrofaunal burrow;deep rpd;shell frags;pull apartfractures at depth
STA3	C	9/12/1997	BIOGENIC	NO	silty mud/clay amb.;voids or burrow edge;reworked sed;sloped surface
STA4	A	9/12/1997	BIOGENIC	NO	siltly mud/clay amb.;large burrow at depth
STA4	B	9/12/1997	PHYSICAL	NO	dm>pen;wiper clast at surface
STA4	C	9/12/1997	BIOGENIC	NO	silty mud/clay amb.;macrofaunal burrow with shell frags;large pullapart fracture
STA5	A	9/12/1997	BIOGENIC	NO	silty mud/clay amb.;wiper smear on faceplate;clay clast farfield
STA5	B	9/12/1997	BIOGENIC	NO	silt/clay ambient;pull apart fracture at depth;clay wiperclast?
STA5	C	9/12/1997	BIOGENIC	NO	silt/clay amb. wiper clast?relic voids?
4500E					
STA6	A	9/12/1997	BIOGENIC	NO	silty mud/clay amb. anemone;shell frags;well developed void
STA6	B	9/12/1997	INDET	NO	silt mud/clay amb;wiper clast/smear;rpd extraploted;shallow void?
STA6	C	9/12/1997	BIOGENIC	NO	silty mud/clay amb.;wiper clast;voids at depth
STA7	A	9/12/1997	BIOGENIC	NO	siltly mud/clay amb.;wiper clast;shell frags;voids
STA7	B	9/12/1997	BIOGENIC	NO	silty mud/clay amb.;featureless topo;shell frags
STA7	C	9/12/1997	INDET	NO	silty mud/clay amb.;wiper clast;shell;possible voids
STA8	A	9/12/1997	BIOGENIC	NO	silty mud/clay amb.;shell frags
STA8	B	9/12/1997	BIOGENIC	NO	silty mud/clay amb.;voids;wiper clast;shell frags
STA8	C	9/12/1997	BIOGENIC	NO	silty mud/clay amb.;feeding voids;shell frags;nucula?
STA9	A	9/12/1997	INDET	NO	silty mud/clay amb.;void anemone at depth?shell frags
STA9	B	9/12/1997	PHYSICAL	NO	silty mud/clay ambient;reduced at depth; void
STA9	C	9/12/1997	BIOGENIC	NO	silty mud/clay ambient;large void/burrow at depth;wiper clast
CLIS-REF					
STA10	B	9/12/1997	BIOGENIC	NO	silty mud/clay amient;collapsed void at depth?;featureless topography
STA10	D	9/15/1997	BIOGENIC	NO	silt mud/clay amb.;feeding halo;void or shear?
STA10	E	9/15/1997	PHYSICAL	NO	silty mud/clay;relic rpd;void or burrow;wiper clast
STA11	A	9/12/1997	BIOGENIC	NO	silty mud/clay amb.;featureless topography;reduced at depth;shell frags
STA11	B	9/12/1997	PHYSICAL	NO	silty mud/clay amb.;feeding void halo at left;shell frags
STA11	C	9/12/1997	PHYSICAL	NO	silty mud/clay ambient;wiper clasts;mollusc shell?
STA12	A	9/12/1997	BIOGENIC	NO	silty mud/clay ambient;reduced art depth;shell frags
STA12	B	9/12/1997	INDET	NO	silty mud/clay ambient;reduced at depth;shell frags
STA12	C	9/12/1997	INDET	NO	silt mud/clay ambient;reduced at depth shell frags; wiper smear
STA13	A	9/12/1997	INDET	NO	silty mud/clay ambient;feeding voids;shell frags
STA13	B	9/12/1997	INDET	NO	clay amb;surface layer of silt;anemone at depth;shell frags;wiper smear; RPD extrapolated
STA13	C	9/12/1997	INDET	NO	silty mud/clay amb.;rpd extrapol. under wiper clast smear;void?
STA14	A	9/12/1997	INDET	NO	DM>pen;pullout; disturbed floc.layer surface;oxy.burrows at depth?
STA14	B	9/12/1997	INDET	NO	silty mud/clay;dm at depth?collapsed voids; void at left;some wiper smear ove rpd
STA14	C	9/12/1997	BIOGENIC	NO	silty mud/clay ;shell pulldown
STA14	D	9/12/1997	INDET	NO	silty mud/clay amb;dm? sulfidic layer;reduced at depth;wiper clast smear rpd
STA14	E	9/12/1997	INDET	NO	amb mud;large wiper clast pulldown obscures RPD; wiper smear on faceplate
STA14	F	9/12/1997	BIOGENIC	NO	amb mud;tube at left;some layering;shell frags at depth;wiper smear; dm? in sulfidic layer at depth

Appendix B4
REMOTS® Data from the CLIS REF, March 1998

Appendix Table B 4
REMOTS® Data from the CLIS REF, March 1998

Reference Area Station	Replicate	Date	Successional Stage	Grain Size (phi)			Mud Clasts	Camera Penetration				Dredged Material Thickness**			Redox Rebound Thickness			Apparent RPD Thickness		
				Min	Max	Maj. Mode	Count	Min	Max	Range	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
20E	A	3/3/1998	ST_III	4	>4	>4	0	8.6	9.42	0.82	9.01	0	0	0	0	0	0	0.39	3.33	2.07
20E	B	3/3/1998	ST_I	4	>4	>4	0	10.29	12.03	1.74	11.16	0	0	0	0	0	0	0.82	2.03	1.72
20E	C	3/3/1998	ST_III	4	>4	>4	0	8.41	13.77	5.36	11.09	0	0	0	0	0	0	0.19	1.59	0.95
20N	A	3/3/1998	ST_I_ON_III	4	>4	>4	0	9.8	10.4	0.6	10.1	0	0	0	0	0	0	0.8	2.14	1.7
20N	B	3/3/1998	ST_I	4	>4	>4	0	9.75	10.35	0.6	10.05	0	0	0	0	0	0	1.09	3.43	2.46
20N	C	3/3/1998	INDET	4	>4	>4	0	7.96	8.71	0.75	8.33	0	0	0	0	0	0	0.1	2.44	1.69
20N	D	3/3/1998	ST_I	>4	>4	>4	0	10.68	10.77	0.1	10.72	0	0	0	0	0	0	0.48	3.09	2.37
20S	B	3/3/1998	ST_III	4	>4	>4	0	12.74	14.18	1.44	13.46	0	0	0	0	0	0	1.54	2.59	2.07
20S	D	3/3/1998	INDET	4	>4	>4	0	4.53	6.62	2.09	5.57	0	0	5.57	0	0	0	1.24	3.08	1.66
20S	E	3/3/1998	ST_I_ON_III	4	>4	>4	0	8.95	9.8	0.84	9.38	0	0	0	0	0	0	0.95	2.64	2.06
20W	A	3/3/1998	ST_III	4	>4	>4	0	8.26	8.5	0.24	8.38	0	0	0	0	0	0	0.72	1.93	1.35
20W	B	3/3/1998	ST_III	4	>4	>4	0	8.41	11.4	3	9.9	0	0	0	0	0	0	0.87	2.17	1.67
20W	C	3/3/1998	ST_I	4	>4	>4	0	6.52	6.67	0.14	6.59	0	0	0	0	0	0	0.58	3	1.65
40E	A	3/3/1998	ST_I	4	>4	>4	0	6.04	7.25	1.21	6.64	0	0	0	0	0	0	0.58	3.62	2.29
40E	B	3/3/1998	ST_III	4	>4	>4	0	8.31	8.89	0.58	8.6	0	0	0	0	0	0	0.68	2.08	1.58
40E	C	3/3/1998	ST_III	4	>4	>4	0	4.44	8.84	4.4	6.64	0	0	0	0	0	0	0.87	2.32	1.63
40N	A	3/3/1998	ST_I	4	>4	>4	0	10.48	11.35	0.87	10.92	0	0	0	0	0	0	1.01	3	2.06
40N	B	3/3/1998	ST_I	4	>4	>4	0	8.6	9.23	0.63	8.91	0	0	0	0	0	0	1.21	2.08	1.65
40N	C	3/3/1998	ST_I	4	>4	>4	0	7.34	8.74	1.4	8.04	0	0	0	0	0	0	0.53	3.33	2.49
40S	C	3/3/1998	ST_III	4	>4	>4	0	7.76	8.41	0.65	8.09	0	0	0	0	0	0	0.05	3.63	2.27
40S	E	3/3/1998	ST_I_ON_III	>4	>4	>4	0	11.04	11.49	0.45	11.27	0	0	0	0	0	0	1.69	3.63	2.56
40W	A	3/3/1998	ST_III	4	>4	>4	1	9.24	9.33	0.1	9.29	0	0	0	0	0	0	0.57	3.9	1.98
40W	B	3/3/1998	ST_I	4	>4	>4	1	3.38	4.29	0.91	3.83	0	0	3.83	0	0	0	1.5	2.5	2
40W	C	3/3/1998	ST_III	4	>4	>4	0	7.33	9.86	2.52	8.6	0	0	0	0	0	0	0.95	2.57	1.84
CTR	A	3/3/1998	ST_I	>4	>4	>4	0	9.25	10.65	1.39	9.95	0	0	0	0	0	0	0.5	3.33	2.28
CTR	C	3/3/1998	ST_I_ON_III	>4	>4	>4	0	7.91	8.61	0.7	8.26	0	0	0	0	0	0	1.69	3.43	2.48
CTR	D	3/3/1998	ST_I	4	>4	>4	0	6.37	6.57	0.2	6.47	0	0	6.47	0	0	0	0.2	2.49	1.36

continued

Appendix Table B 4 (continued)

Reference Area Station	Replicate	Date	Methane	OSI	Surface Roughness	Low DO	Comments
20E	A	3/3/1998	0	8	BIOGENIC	NO	ambient mud;darker horizons at depth;worm middepth; anemone?
20E	B	3/3/1998	0	4	INDET	NO	ambient mud;rpd extrapolated under wiper clast;anemone;shell hash
20E	C	3/3/1998	0	7	PHYSICAL	NO	ambient mud;sloping topo;some dark material;shell; feeding void?
20N	A	3/3/1998	0	8	PHYSICAL	NO	ambient mud;active void and worm burrow; wiper smearing
20N	B	3/3/1998	0	5	BIOGENIC	NO	ambient mud;hydroids and anemones (3)
20N	C	3/3/1998	0	99	PHYSICAL	NO	ambient mud; anemone in burrow; mud clast/rock farfield?
20N	D	3/3/1998	0	5	INDET	NO	ambient mud; patches of dark material at depth;possible void?
20S	B	3/3/1998	0	8	PHYSICAL	NO	ambient mud;feeding voidd; shell hash
20S	D	3/3/1998	0	99	PHYSICAL	NO	possible Dm?; burrow; shell lag; sulfidic?
20S	E	3/3/1998	0	8	PHYSICAL	NO	ambient mud;feeding void
20W	A	3/3/1998	0	7	BIOGENIC	NO	ambient mud;collapsed void under clay wiper smear;some dark material
20W	B	3/3/1998	0	8	PHYSICAL	NO	ambient mud;possible void;dark material middepth
20W	C	3/3/1998	0	4	PHYSICAL	NO	ambient mud; dark material;shell frags
40E	A	3/3/1998	0	5	INDET	NO	ambient mud;void at left;darker horizons.some shell hash;possible old dm?
40E	B	3/3/1998	0	8	INDET	NO	ambient mud; void?; rpd void is pulldown;tube farfield
40E	C	3/3/1998	0	8	PHYSICAL	NO	ambient mud/clay rpd; extrapolated under wiper smear;large void?shell lag
40N	A	3/3/1998	0	4	PHYSICAL	NO	ambient mud;rpd pulldown with shells;erosional?clasts farfield;possible dm?
40N	B	3/3/1998	0	4	PHYSICAL	NO	ambient mud;some dark horizon clay?relic rpd;possible dm?;shell hash
40N	C	3/3/1998	0	5	INDET	NO	ambient mud; darker horizon at depth;shell hash;sloping-erosional?possible dm?
40S	C	3/3/1998	0	9	INDET	NO	ambient;deep rpd; worm at depth; voids
40S	E	3/3/1998	0	9	BIOGENIC	NO	ambient mud;active feeding voids;shell hash;anemonones(2)
40W	A	3/3/1998	0	8	INDET	NO	ambient mud;dark material possible dm?;voids;clay clast;tube;anemone
40W	B	3/3/1998	0	4	PHYSICAL	NO	ambient mud; dark material possible Dm?wiper smears erosional?clasts/shell;scour
40W	C	3/3/1998	0	8	PHYSICAL	NO	ambient mud;feeding void; dark material possible dm?;shell frags;anemone
CTR	A	3/3/1998	0	5	INDET	NO	ambient mud;anemone; no voids
CTR	C	3/3/1998	0	9	INDET	NO	ambient mud; shell ; hydroids
CTR	D	3/3/1998	0	3	PHYSICAL	NO	possible Dm; relic void; anemone? shell lag; erosional

Appendix B5
REMOTS® Data from the CLIS95/96 Mound Complex, March 1998

Appendix Table B 5
REMOTS® Data from the CLIS 95/96 Mound Complex, March 1998

Station Number	Grid Center	Station Location	Replicate	Date	Successional Stage	Grain Size (phi)			Mud Clasts	Camera Penetration				Dredged Material Thickness**			Redox Rebound Thickness			Apparent RPD Thickness		
						Min	Max	Maj. Mode	Count	Min	Max	Range	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
15	CLIS 96	100N	C	3/3/1998	INDET	>4	>4	4 to 3	0	20	20	0	20	19.75	20.25	19.98	0	0	0	NA	NA	NA
16	CLIS 95	100N	A	3/3/1998	ST_I	4	>4	>4	0	12.5	19.49	6.99	15.99	6.68	19.29	17.12	0	0	0	0.15	4.03	1.82
16	CLIS 95	100N	B	3/3/1998	ST_I	4	>4	>4	0	19.08	19.29	0.2	19.18	19.03	19.34	19.18	5.15	9.03	7.09	1.38	2.04	1.38
16	CLIS 95	100N	C	3/3/1998	INDET	4	>4	>4	0	16.22	17.04	0.82	16.63	4.29	17.14	16.37	4.19	8.94	6.56	NA	NA	NA
23	CLIS 96	CTR	A	3/3/1998	INDET	4	>4	>4	0	19.24	19.54	0.3	19.39	19.29	19.54	19.37	0	0	0	NA	NA	NA
23	CLIS 96	CTR	B	3/3/1998	ST_I	4	>4	>4	0	18.49	19.09	0.6	18.79	13.97	19.14	18.64	0	0	0	0	0	0
24	CLIS 95	100W	A	3/3/1998	ST_I	4	>4	>4	0	6.79	10.21	3.42	8.5	7.04	10.56	8.64	0	0	0	1.89	3.32	2.49
24	CLIS 95	100W	B	3/3/1998	ST_I	>4	>4	>4	0	7.09	7.15	0.05	7.12	7.04	7.6	7.27	0	0	0	1.28	2.19	1.69
24	CLIS 95	100W	C	3/3/1998	ST_I	4	>4	>4	0	11.28	14.64	3.37	12.96	8.88	14.49	13	0	0	0	1.99	6.33	3.21
25	CLIS 95	CTR	C	3/3/1998	ST_I	4	>4	>4	0	15.26	16.69	1.44	15.97	8.42	16.89	15.89	0	0	4	0.87	3.42	2.37
26	CLIS 95	100E	A	3/3/1998	ST_I	4	>4	>4	0	14.39	14.44	0.05	14.41	7.35	14.8	14.51	0	0	0	1.22	4.95	3.84
31	CLIS 96	100S	B	3/3/1998	ST_I	4	>4	>4	0	18.74	18.94	0.2	18.84	7.18	19.19	18.86	0	0	0	0.2	0.5	0.2
31	CLIS 96	100S	C	3/3/1998	ST_I	4	>4	>4	0	15.12	16.03	0.9	15.57	15.42	15.87	15.56	0	0	0	0	0.8	0.4
32	CLIS 95	100S	A	3/3/1998	ST_III	4	>4	>4	0	18.16	19.74	1.58	18.95	18.27	19.95	19.05	0	0	0	2.3	3.42	2.89

continued

Appendix Table B 5 (continued)

Station Number	Grid Center	Station Location	Replicate	Date	Methane	OSI	Surface Roughness	Low DO	Comments
15	CLIS 96	100N	C	3/3/1998	0	99	INDET	NO	DGP; s/m overpen;layered dm.clay layer;relic rpd
16	CLIS 95	100N	A	3/3/1998	0	4	PHYSICAL	NO	DGP; s/m relic rpd;erosional?or recent physical disturb
16	CLIS 95	100N	B	3/3/1998	0	3	BIOGENIC	NO	DGP; s/m layered reduced dm;relic rpds(3)?
16	CLIS 95	100N	C	3/3/1998	0	99	PHYSICAL	NO	DGP; layered reduced dm;relic rpd;slight pullaway
23	CLIS 96	CTR	A	3/3/1998	0	99	INDET	NO	DGP; layered reduced dm;relic rpd?overpen
23	CLIS 96	CTR	B	3/3/1998	0	-3	INDET	YES	DGP; layered reduced on old dm; relic dm horizon;sulfidic at surface, flocculent
24	CLIS 95	100W	A	3/3/1998	0	5	PHYSICAL	NO	DGP; layered reduced dm;light rpd; sloping topo;possible burrow entrance?or large DM clast
24	CLIS 95	100W	B	3/3/1998	0	4	BIOGENIC	NO	DGP; layered;reduced dm; silty surface; relic rpd?
24	CLIS 95	100W	C	3/3/1998	0	6	BIOGENIC	NO	DGP; s/m relic rpd and voids?;layered reduced; large macro burrow
25	CLIS 95	CTR	C	3/3/1998	0	5	PHYSICAL	NO	DGp; S/M layered reduced dm/clay;hydroids;some wiper clasts but clear rpd;relic rpd
26	CLIS 95	100E	A	3/3/1998	0	7	BIOGENIC	NO	DGP; deep rpd;reduced ;some layering of coarser material at depth;relic voids;rpd
31	CLIS 96	100S	B	3/3/1998	0	2	BIOGENIC	NO	DGP;layered reduced dm over old dm horizon;4 relic rpds
31	CLIS 96	100S	C	3/3/1998	0	2	PHYSICAL	NO	DGP; layered reduced dm/old dm; clay layer at depth
32	CLIS 95	100S	A	3/3/1998	0	9	INDET	NO	GDP; deep rpd layered reduced dm/clay; relic voids?chaotic fabric

Appendix B6
REMOTS® Data from the CLIS NHAV 93 Mound, March 1998

Appendix Table B 6

REMOTS® Data from the CLIS NHAV 93 Mound, March 1998

Station Location	Replicate	Date	Successional Stage	Grain Size (phi) Min	Grain Size (phi) Max	Grain Size (phi) Maj. Mode	Mud Clasts Count	Camera Penetration Min	Camera Penetration Max	Camera Penetration Range	Camera Penetration Mean	Dredged Material Thickness** Min	Dredged Material Thickness** Max	Dredged Material Thickness** Mean	Redox Rebound Thickness Min	Redox Rebound Thickness Max	Redox Rebound Thickness Mean	Apparent RPD Thickness Min	Apparent RPD Thickness Max	Apparent RPD Thickness Mean	Methane	OSI
200E	A	3/3/1998	ST_I	4	>4	>4	0	13.52	14.49	0.97	14.01	10.15	14.54	14.15	0	0	0	1.22	2.04	1.62	0	4
200E	B	3/3/1998	ST_I	4	>4	>4	7	13.83	14.9	1.07	14.36	6.84	14.59	14.16	0	0	0	1.43	3.52	1.96	0	4
200E	C	3/3/1998	ST_I	4	>4	>4	0	12.5	13.88	1.38	13.19	10.2	13.72	13.39	0	0	0	1.07	2.3	1.66	0	4
200N	A	3/3/1998	ST_I_ON_III	4	>4	>4	0	15.93	16.51	0.59	16.22	15.97	16.41	15.99	0	0	0	0.87	1.99	1.41	0	7
200N	B	3/3/1998	ST_I	4	>4	>4	0	15.1	15.66	0.56	15.38	7.76	15.97	15.5	0	0	0	1.43	2.35	1.82	0	4
200S	A	3/3/1998	ST_I	4	>4	>4	0	14.9	15.56	0.66	15.23	5.81	15.71	15.17	0	0	0	0.51	2.17	0.8	0	3
200S	B	3/3/1998	ST_III	4	>4	>4	0	16.67	17.42	0.76	17.05	16.57	17.63	17.01	0	0	0	1.26	8.33	2.22	0	8
200S	C	3/3/1998	INDET	4	>4	>4	0	14.49	15.51	1.01	15	7.83	15.71	14.71	0	0	0	0.71	2.53	1.83	0	99
200W	A	3/3/1998	ST_I_ON_III	4	>4	>4	1	17.35	18.01	0.66	17.68	0.05	18.11	17.33	0	0	0	1.73	2.86	2.29	0	9
200W	B	3/3/1998	ST_I_ON_III	4	>4	>4	0	17.19	18.01	0.82	17.6	6.79	18.27	17.61	0	0	0	1.48	2.81	2.06	0	8
200W	C	3/3/1998	ST_I	4	>4	>4	0	16.22	16.99	0.77	16.61	16.43	16.99	16.79	0	0	0	1.22	2.45	1.83	0	4
CTR	A	3/3/1998	ST_I	4	>4	>4	0	15.86	16.06	0.2	15.96	15.5	16.11	15.88	0	0	0	1.52	2.42	1.9	0	4
CTR	C	3/3/1998	ST_I	4	>4	>4	0	14.85	15.3	0.45	15.08	15	15.45	15.06	0	0	0	1.06	3.08	2.39	0	5

continued

Appendix Table B 6 (continued)

Station Location	Replicate	Date	Surface Roughness	Low DO	Comments
200E	A	3/3/1998	INDET	NO	dm mud>pen;historic dm reduced;pulldown or burrow?;stranded tube
200E	B	3/3/1998	INDET	NO	dm mud>pen;historic dm reduced;rpd extrapolated under wiper clast;weed
200E	C	3/3/1998	BIOGENIC	NO	dm mud>pen;historic dm reduced at depth;wiper clast pulldown;rpd extrapolated
200N	A	3/3/1998	INDET	NO	dm mud>pen;historic dm reduced at depth;oxy void or burrows?;forams near surface
200N	B	3/3/1998	BIOGENIC	NO	dm mud>pen;historic dm reduced at depth;rpd extrapol. under wiper clast smears
200S	A	3/3/1998	INDET	NO	dm mud>pen;historic dm reduced;wiper clast;stranded tube;active void?
200S	B	3/3/1998	INDET	NO	dm mud>pen;historic dm reduced;void or burrow?shallow rpd.small wiper clast?
200S	C	3/3/1998	INDET	NO	dm mud>pen;rpd extrapolated under wiper clast which obscures the surface
200W	A	3/3/1998	INDET	NO	dm mud>pen;historic dm reduced;shell frags;shallow rpd;hydroids
200W	B	3/3/1998	INDET	NO	dm mud>pen;historic dm reduced;relic oxid.dm mud clasts
200W	C	3/3/1998	PHYSICAL	NO	dm mud>pen;historic dm reduced;Nephys polychaete;reduced wiper clast pulldown;
CTR	A	3/3/1998	INDET	NO	dm>pen;mud/light clay; large pull apart fracture;much less reduced than other reps
CTR	C	3/3/1998	BIOGENIC	NO	dm mud>pen;historic dm reduced at depth;collapsed oxy void