Monitoring Survey at the Central Long Island Sound Disposal Site
June 2004

Disposal Area Monitoring System DAMOS

D A M O S

DISPOSAL AREA MONITORING SYSTEM

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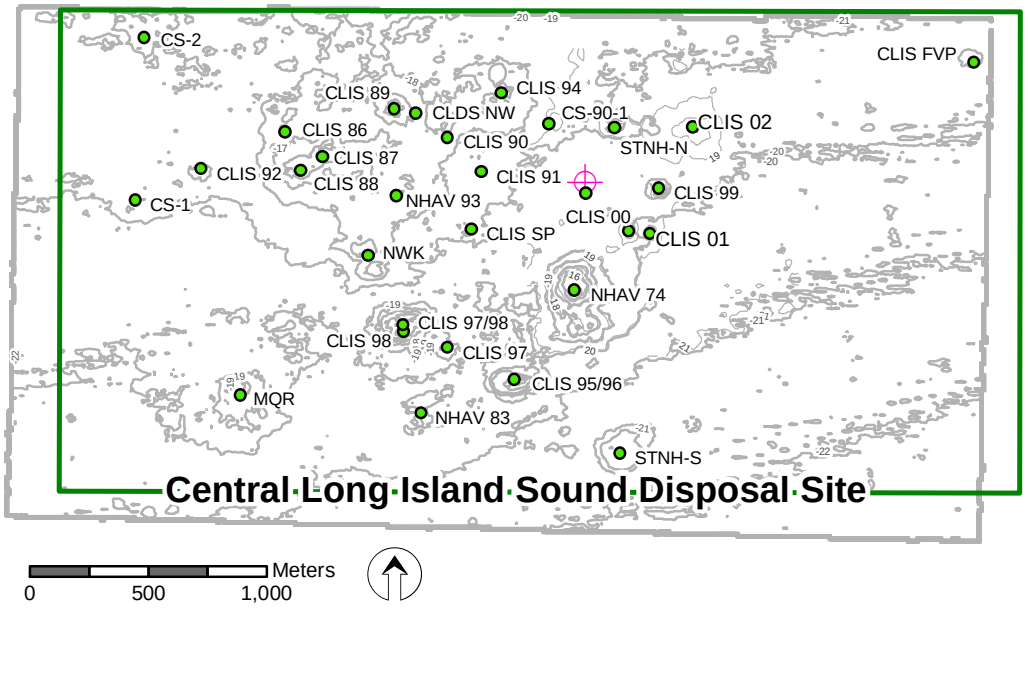

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13. ABSTRACT

The Central Long Island Sound Disposal Site (CLDS) was monitored as part of the Disposal Area Monitoring System (DAMOS) on 17-18 and 28-29 June 2004. The 2004 field effort consisted of bathymetric and sediment-profile imaging (SPI) surveys designed to characterize seafloor topography, evaluate the physical distribution of dredged material around recent and historic disposal events and to assess whether the algal/detrital layer observed in the September 2003 survey had persisted or reoccurred in 2004.

Between the September 2003 and the June 2004 survey, approximately 426,000 m^3 of dredged material was placed at CLDS at the location of the CDA 03 buoy. The 2004 bathymetric survey indicated the formation of a new mound, CLIS 03, which had an approximate base diameter of 400 m and an approximate height of 1.5 m above the surrounding sea floor. The September 2003 SPI survey noted the presence of a rust-colored surface layer of what appeared to be degraded phytoplankton (phytodetritus) at all stations. A surface layer of tan or rust-colored sediment, similar to the layer observed in 2003, was observed consistently in the 2004 SPI images at both the reference area and the CLDS stations. Given the differences in apparent concentration and appearance of the two layers, and the relatively rapid rates at which organic matter is known to be consumed at the sediment surface in temperate estuaries like Long Island Sound, it was considered unlikely that the 2004 layer was the same as the 2003 layer (i.e., unlikely that the 2003 layer had persisted over the 9 months between surveys). Rather, it was deemed more likely that the 2004 layer was of more recent origin, resulting from one or more phytoplankton blooms that had occurred in the weeks or months preceding the 2004 survey. The results of both the 2003 and 2004 SPI surveys indicate that these pulses of organic matter to the sediment surface were processed rapidly and efficiently under aerobic conditions, and no significant changes in RPD depths or localized zones of elevated sediment oxygen demand (SOD) were observed. In both years, the algal/detrital layer did not appear to have a negative impact on benthic recolonization at CLDS.

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EXECUTIVE SUMMARY

A monitoring survey was conducted in June 2004 at the Central Long Island Disposal Site (CLDS) as part of the Disposal Area Monitoring System (DAMOS). The 2004 field effort consisted of bathymetric and sediment-profile imaging surveys designed to document changes in seafloor topography, evaluate the physical distribution of dredged material, and assess whether the algal/detrital layer observed in the September 2003 survey had persisted or reoccurred in 2004.

The June 2004 bathymetric survey was performed over a 1.44 km^2 area in the northeast portion of CLDS. The survey area encompassed the region where disposal occurred during the 2003-2004 disposal season, overlapping partially with the 2003 survey. The 2004 bathymetric results indicated the formation of a new mound, CLIS 03, at the location of the CDA 03 buoy, approximately 300 m west of the CLIS 99 Mound. It was formed by the disposal of approximately 426,000 m^3 of material during the 2003-2004 disposal season. The base of the mound was approximately 400 m in diameter with two peaks that rose approximately 1.5 m above the surrounding seafloor. The two peaks were aligned in an east-west direction, approximately 150 m apart. This mound was positioned to further the ongoing development of confined aquatic disposal (CAD) cells within CLDS.

The previous CLDS SPI survey (September 2003) noted the ubiquitous occurrence of a thin, rust-colored surface layer of what appeared to be degraded phytoplankton (phytodetritus). This layer was observed at all three reference areas, as well as at each of the five disposal mounds that were surveyed. It was hypothesized that this layer had resulted from mass settling of phytoplankton cells following a Sound-wide phytoplankton bloom that had occurred roughly 18 to 20 days before the SPI survey.

The objective of the 2004 SPI survey was to assess whether the phytodetrital layer had persisted or reoccurred in 2004 by collecting images at 15 stations within CLDS that had not been subject to recent disposal activity and 15 stations located among the three CLDS reference stations (5 stations at each reference). The historic CLIS 95/96 Mound Complex was chosen for the SPI survey within CLDS because it was not likely to have experienced any recent disposal and previous SPI surveys had shown the mound to be completely recovered from past disposal activities.

A surface layer of tan or rust-colored sediment, similar to the layer observed in 2003, was observed consistently in the 2004 SPI images at both the reference area stations and the CLIS 95/96 Mound stations. As in 2003, it was hypothesized that the orange hue was at least in part due to the presence of elevated levels of phytodetritus on the sediment surface and in the upper 1 to 2 cm of the sediment column. The ubiquitous

presence of this rust-colored layer in both 2003 and 2004 suggests that its origin or cause(s) were regional in nature, as opposed to site-specific or disposal-related phenomena.

In the September 2003 survey, the phytodetrital layer appeared more distinct and concentrated. In the June 2004 survey, the layer was more diffuse and appeared to have been mixed downward to a greater extent than the one observed in 2003. Given the relatively rapid rates at which organic matter is known to be consumed at the sediment surface in temperate estuaries like Long Island Sound, it was considered unlikely that the 2004 layer was the same as the 2003 layer (i.e., unlikely that the 2003 layer had persisted over the 9 months between surveys). Rather, it was deemed more likely that the 2004 layer was of more recent origin, resulting from one or more phytoplankton blooms that had occurred in the weeks or months preceding the 2004 survey.

The results of both the 2003 and 2004 SPI surveys indicate that these pulses of organic matter to the sediment surface were processed rapidly and efficiently under aerobic conditions, and no significant changes in RPD depths or localized zones of elevated sediment oxygen demand (SOD) were observed. In both years, the algal/detrital layer did not appear to have a negative impact on benthic recolonization at CLDS.

1.0 INTRODUCTION

A monitoring survey was conducted at the Central Long Island Sound Disposal Site in June 2004 as part of the U.S. Army Corps of Engineers (USACE) New England District (NAE) Disposal Area Monitoring System (DAMOS). DAMOS is a comprehensive monitoring and management program designed and conducted to address environmental concerns associated with use of open-water disposal sites throughout the New England region. An introduction to the DAMOS Program and the Central Long Island Sound Disposal Site, including a brief description of previous dredged material disposal activities and previous monitoring surveys, is provided below.

1.1 Overview of the DAMOS Program

The DAMOS Program features a tiered management protocol designed to ensure that any potential adverse environmental impacts associated with dredged material disposal activities are promptly identified and addressed (Germano et al. 1994). For over 25 years, the DAMOS Program has collected and evaluated disposal site data throughout New England. Based on these data, patterns of physical, chemical, and biological responses of seafloor environments to dredged material disposal activity have been documented (Fredette and French 2004).

DAMOS monitoring surveys are designed to test hypotheses related to expected physical and ecological response patterns following placement of dredged material on the seafloor at established disposal sites. Thus, the data collected during DAMOS monitoring surveys serve as hypothesis tests, providing answers to strategic management questions. The results of each monitoring survey are evaluated to determine the next step in the disposal site environmental management process.

Two primary goals of DAMOS monitoring surveys have been to document the physical location of dredged material placed on the seafloor and to evaluate the environmental impact of placement of the dredged material. Sequential bathymetric measurements are made to characterize the height and extent of discrete dredged material deposits or mounds created at disposal sites, and sediment-profile imaging (SPI) surveys are performed to support evaluation of seafloor (benthic) habitat conditions and recovery over time. Each type of data collection activity is conducted periodically at disposal sites and the response of the animal-sediment system is evaluated. The conditions found after a specific set of disposal operations are compared to this long-term data set (Germano et al. 1994). DAMOS monitoring surveys may also feature additional types of data collection activities, such as side-scan sonar and sediment coring, as deemed appropriate to achieve specific survey objectives.

1.2 Introduction to the Central Long Island Sound Disposal Site

The Central Long Island Sound Disposal Site (CLDS, historically referred to as CLIS) is one of four regional dredged material disposal sites located in the waters of Long Island Sound (Figure 1-1). CLDS is situated approximately 10.4 km south of South End Point, East Haven, Connecticut. The Central Long Island Sound Disposal Site, centered at 41° 08.906' N, 72° 53.072' W (NAD 83), occupies a 3.70 km x 1.85 km (6.86 km^2) area on the seafloor (Figure 1-1).

Initially, the management strategy at CLDS involved the controlled placement of small to moderate volumes of sediment to form individual disposal mounds. These mounds have been monitored individually to assess stability, thickness of dredged material, and benthic recolonization status relative to previous survey results and in comparison to nearby reference areas. This management strategy was later modified to promote the development of multiple rings of disposal mounds on the CLDS seafloor. The rings are developed to form containment cells that can subsequently be used for large-scale confined aquatic disposal (CAD) operations. The containment cells aid in limiting the lateral spread of unacceptably contaminated dredged material (UDM) (Fredette, 1994). The first sediment deposit placed within a CAD cell developed at CLDS was the New Haven 93 (NHAV 93) Mound. Two additional containment cells are being developed for future CAD use by continued placement of disposal mounds in rings (SAIC 2003).

The Central Long Island Sound Disposal Site is characterized in general by a sloping bathymetry (Figure 1-2). Water depths along the northwest edge of the study area are shallower, approximately 18 m MLLW, increasing in a southeasterly direction to approximately 22 m MLLW along the southeast boundary of the study area. The shallowest depth recorded during the multi-beam bathymetric survey in 2000 was 13.9 m, which occurred over the CLIS 97/98 Mound Complex (SAIC 2002b).

Multiple dredged material disposal mounds have been identified within CLDS (Figure 1-2). A brief description of selected mounds and their origin is provided below. In general, the CDA disposal buoy is used to identify the current disposal location within the disposal site. It is typically deployed for a six-month period, with initial deployment in the fall and recovery in the spring of the following year. The location of the buoy for each disposal season is driven by the effort to form a ring of disposal mounds for the development of containment cells and is therefore dependent on the amount of material disposed and the morphology of the mound created during the prior disposal season.

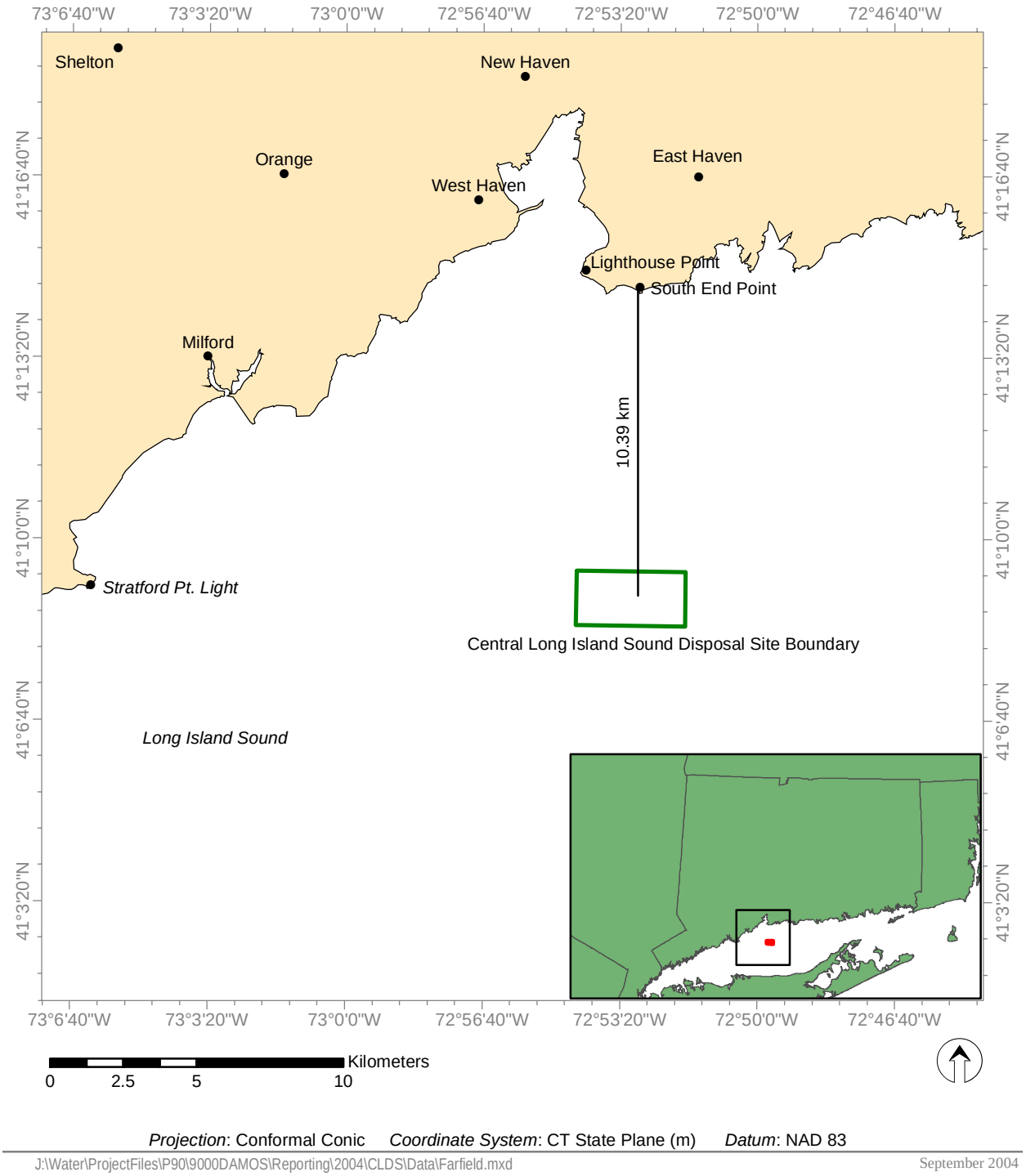

Figure 1-1. Location of the Central Long Island Sound Disposal Site

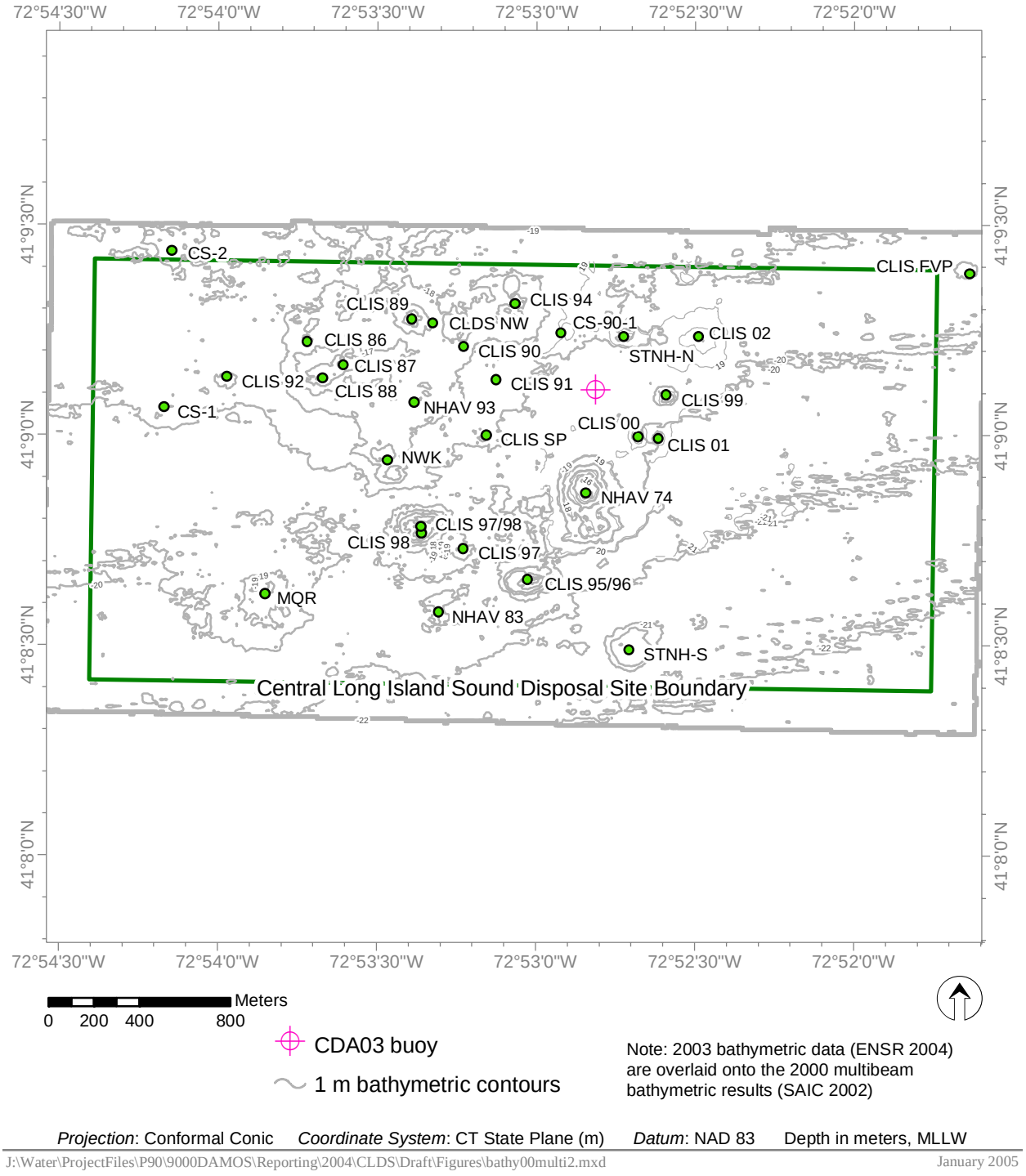

Figure 1-2. CLDS with disposal mounds and buoy indicated

Disposal site boundaries have been established to provide a management objective for placement of dredged material on the seafloor. Barge operators are given specific coordinates (and often visible lighted buoys) within the disposal boundaries to navigate to and release their cargo of dredged material. In practice, it is expected that barge disposal will occur in a cluster around the buoy location and that some dredged material will be lost in the water column during release. The Clean Water Act Section 404 (b)(1) provides guidelines for the discharge of dredged material and defines the "discharge point" as the point within the disposal site (the bottom surface area and any overlying volume of water) at which the dredged material is released. The Marine Protection, Research and Sanctuaries Act Section 102 defines the release zone as a locus of points 100 m around the barge from beginning to end of the discharge. Monitoring objectives recognize that the site boundary is a target area for release at the water's surface, and that during descent and placement some dredged material may extend across the boundary on the seafloor.

1.3 Historic Dredged Material Disposal Activity

CLDS has been used regularly as a regional disposal site for over 60 years, receiving over 5.2 million m^3 of dredged material. The CLIS 95/96 Mound Complex, developed from multiple disposal events during the 1995–1996 and 1996–1997 disposal seasons, is one of many mounds present on the seafloor of CLDS and was selected as a study area for the 2004 SPI survey. In 1995-1996, 16,000 m^3 of unacceptably-contaminated dredged material (UDM) was placed at the CDA 95 buoy, and was capped with 50,000 m^3 of capping dredged material (CDM), forming the CLIS 95 Mound. Subsequent monitoring surveys indicated that the deposit was stable and had been completely capped by the material disposed during the 1996 – 1997 disposal season (Morris 1998). Approximately 256,000 m^3 of dredged material was placed at the nearby CDA 96 buoy during the 1996-1997 disposal season, which coalesced with the CLIS 95 Mound and resulted in the formation of a moderate-sized bottom feature on the seafloor (SAIC 2002a). The 1996 – 1997 disposal season was the last time that any dredged material is known to have been placed over the CLIS 95/96 Mound Complex; this is further confirmed by the results of recent monitoring surveys showing complete benthic recovery and absence of fresh dredged material deposits (SAIC 2002b; ENSR 2004a).

1.4 Previous CLDS Monitoring Events

Monitoring surveys have been conducted at CLDS since the early 1970s. A summary of the monitoring surveys performed since 1995 is presented in Table 1-1. The most recent monitoring survey conducted at CLDS was in September 2003 and included a single-beam bathymetric survey and sediment-profile imaging survey (ENSR 2004a). The 2003 bathymetric survey confirmed the formation of two new mounds, CLIS 01 and

Table 1-1

Overview of Monitoring Activity at CLDS

Date	Purpose of Survey	Bathymetry Area (mxm)	# SPI Stations	Additional Studies	Contribution No.
9/1995	Monitoring	NHAV93: 1600x1600 CLIS94: 1000x1000	NHAV93 (13), CLIS94 (13) FVP (13), REF (13)	Geotechnical Coring	118
7/1996	Precision bathymetry	2100x2100	CLIS95 (13), NHAV93 (5) CLIS94 (5), REF (13)	DO, Hypoxia	120
9/1997	Monitoring	1200x1200	CLIS95/96 (41), NHAV93 (5), REF (14)		135
3/1998	Benthic Monitoring		CLIS95/96 (8), NHAV93 (5), REF (9)	Sidescan 600mx1000m	135
9/1999	Monitoring	1000x1000	CLIS97/98 & CLIS95/96 (57) NHAV93 (5), FVP (13) MQR (13), REF (13)		139
9/2000	Precision Bathymetric Baseline	2100x4100			139
6/2001	Monitoring	1000x1000	CLIS99 (10), CLIS00: 15) CLIS97/98 (21) NHAV93 (5), REF (13)		142
9/2003	Monitoring	1300x1000	CLIS00 (15), CLIS99 (10) NHAV93 (5), MQR (13) CLIS95/96 (25), REF (14)		159

CLIS 02, which were created, respectively, during the 2001-2002 and 2002-2003 disposal seasons. The 2003 SPI survey was performed at two slightly older mounds, CLIS 99 and CLIS 00, as well as three historic mounds, CLIS 95/96, NHAV 93 and MQR. In general, the SPI results indicated that benthic recovery had occurred as expected, with conditions at all the mounds comparable to those at the reference areas and indicative of an undisturbed or only a slightly disturbed benthic environment (ENSR 2004a).

A unique finding from the 2003 SPI survey was the detection of a thin, rust-colored layer on the sediment surface at all stations, including reference stations (Figure 1-3). The color of this material suggested the presence of degrading phytoplankton (phaeopigments or phytodetritus). It was hypothesized that this detrital layer had resulted from the mass settling of phytoplankton cells onto the sediment surface, following a Sound-wide bloom detected by satellite imagery 18 to 20 days before the SPI survey. The influx of fresh organic material apparently acted to stimulate Stage I activity at the sediment-water interface, as evidenced by a highly bioturbated surface and the presence of numerous recumbent tubes of Stage I polychaete worms in the pigmented surface layer (Figure 1-3). It was recommended that a follow-up SPI survey be conducted in 2004 to determine the fate of the rust-colored layer and assess the impact on the benthic community.

1.5 Recent Dredged Material Disposal Activity

Since the September 2003 survey, approximately 426,000 m^3 of dredged material has been placed at the CDA 03 buoy located at 41º 09.072' N, 72º 52.814' W (Figure 1-4, Table 1-2). The dredged material deposited at CDA 03 originated primarily from New Haven Harbor (355,000 m^3). One disposal event, indicated on Figure 1-4, appears to have occurred outside of CLDS, however, it is likely that disposal coordinates were incorrectly reported, as the disposal trip narrative for this disposal event indicated disposal approximately 25 m from the buoy. A detailed record of barge disposal activity at CLDS for the period from September 2003 to June 2004, including the origin of dredged material, the volume deposited, the disposal location, and the associated chemical analysis data, is provided in Appendix A.

1.6 Survey Objectives

The June 2004 CLDS survey was designed to document the distribution of dredged material associated with recent dredged material disposal activity and further assess the impact of the algal/detrital layer observed in the summer of 2003. Survey objectives included documentation of the distribution of dredged material around the 2003/2004 disposal location using single-beam bathymetry and assessment of the persistence or

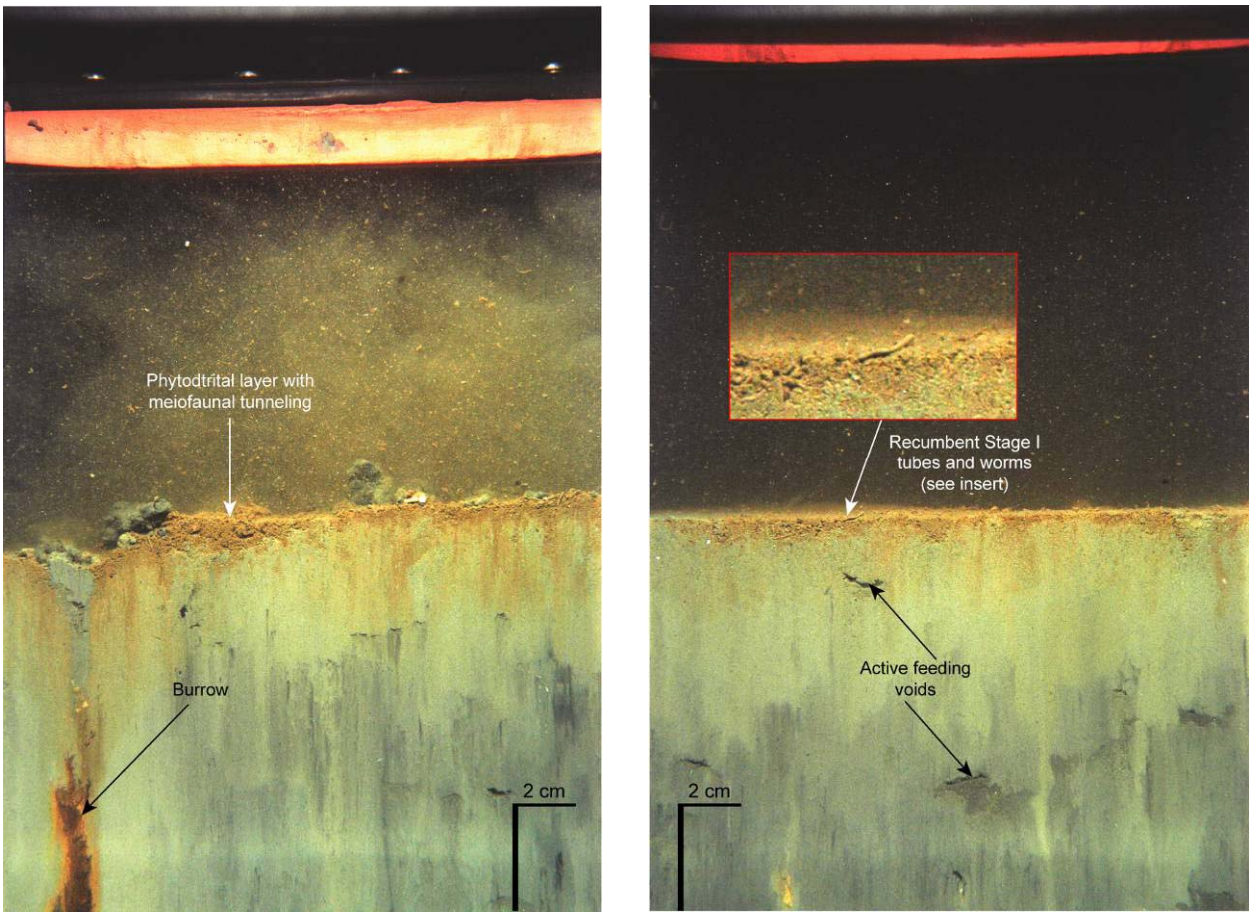

Figure 1-3. Sediment-profile images illustrating the rust-colored layer of phytodetritus observed at the sediment surface at both reference area and disposal mound stations in the September 2003 survey. Station REF 2500W 2B (left): Note that the rust-colored phytodetritus has been brought down into the large burrow on the left, and the near-surface phytodetrital layer shows extensive meiofaunal tunneling. Station REF 4500E 1A (right): The inset shows broken and recumbent tubes of Stage I worms on the rust-colored phytodetrital layer at the sediment surface (ENSR 2004a).

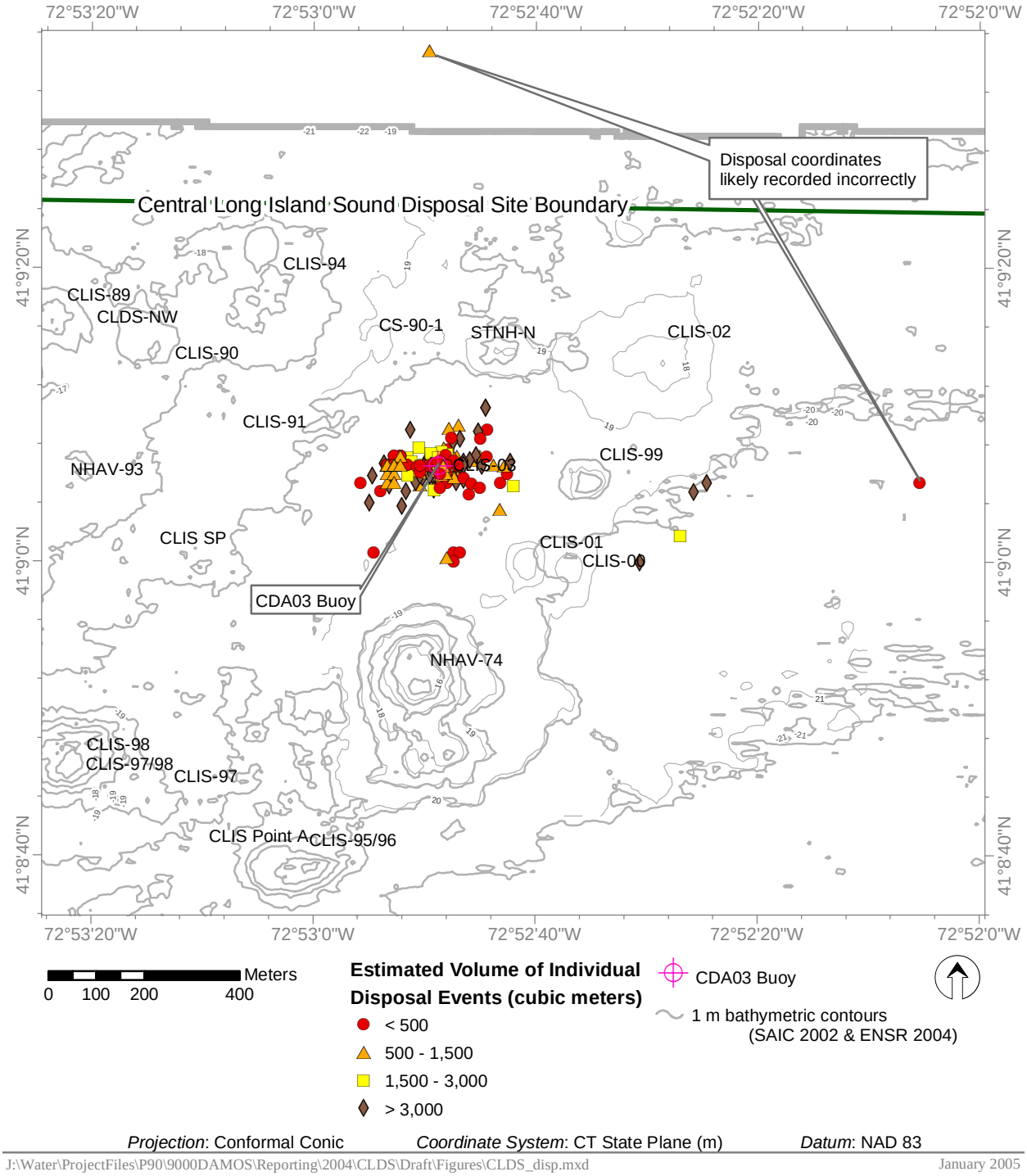

Figure 1-4. CLDS with recent reported dredged material disposal locations indicated

Table 1-2

Overview of Recent Disposal Activity at CLDS

Source Project	Estimated Scow Volume Disposed (m^3)
	2003/2004 Season
Pine Orchard Yacht & Country Club	14,144
Bridgeport Harbor/Lou's Boat Basin	11,174
Conn. River/Conn. DEP	1,988
East Branch of Norwalk River/Norman Bloom Marina	2,523
Gwenmor Marina	1,147
Harbor Point Marina	841
New Haven Harbor/COE	240,599
New Haven Harbor (misc. projects)	114,784
Norwalk Harbor (misc. projects)	8,563
Southport Harbor/Pequot Yacht Club	19,343
West River Channel/Guilford Yacht Club	6,652
West River/Guilford Harbor	4,587
Season Total	426,347

reoccurrence of the algal/detrital layer observed in the summer of 2003 using sediment-profile imaging (SPI).

In order to accomplish the objectives of the SPI survey, images were collected from the three CLDS reference areas (CLISREF, 2500W and 4500E) as well as from an area within CLDS that had not been subject to recent disposal activity. The historic CLIS 95/96 Mound Complex was chosen for the SPI survey within CLDS because it was not likely to have experienced any recent disposal activity (i.e. within the past 5 to 7 years) and previous SPI surveys have shown this mound to be completely recovered from past disposal activities.

The design of the June 2004 survey allowed assessment of the following expectations:

- The placement of 426,000 m^3 of dredged material at the CDA 03 buoy during the 2003/2004 disposal season will result in an observable disposal mound.
- An algal/detrital layer similar to that observed in the summer 2003 survey may be visible but is not be expected to have any detrimental effect on the benthic community in 2004.

2.0 METHODS

A team of investigators from ENSR International, Ocean Surveys, Inc., CR Environmental, and Germano and Associates performed the June 2004 survey at CLDS. The bathymetric survey was conducted 17-18 June 2004 to assess dredged material distribution at CLDS. The sediment-profile imaging (SPI) survey was conducted 28-29 June 2004 to further assess the presence of any algal/detrital layers. Field activities are summarized in Table 2-1 and an overview of the methods used to collect, process, and analyze the survey data is provided below. A more detailed description of methodology and the related terminology can be found in ENSR (2004b).

2.1 Navigation and On-Board Data Acquisition

Positional data, comprised of horizontal positioning (x- and y-dimensional data) and time (t-dimensional data), were collected using a Trimble 4000 series Global Positional System (GPS) receiver interfaced with a Trimble Probeacon differential beacon receiver. This system received and processed satellite and land-based beacon data and provided real-time vessel position, typically to sub-meter accuracy. Coastal Oceanographics, Inc. HYPACK® hydrographic survey software was used to acquire, integrate, and store all positional data from the DGPS as well as bathymetric and station data. The HYPACK® software also displayed real-time vessel position, bathymetric data, and SPI stations over a background electronic chart of the study area, thus enabling survey scientists to review and evaluate survey data on a real-time basis.

2.2 Bathymetry

Bathymetric surveys provide measurements of water depth that, when processed, can be used to map the seafloor topography. The processed data can also be compared with previous surveys to track changes in the size and location of seafloor features. This technique is the primary tool in the DAMOS Program for mapping the distribution of dredged material at disposal sites.

2.2.1 Bathymetric Data Collection

The 2004 single-beam bathymetric survey was designed to cover a 1200 x 1200 m area, representing approximately 1.44 km^2 of the northeast portion of CLDS (Figure 2-1). The survey area encompassed the region where disposal occurred during the 2003-2004 disposal season, overlapping partially with the 2003 survey. The bathymetric survey was conducted 17-18 June 2004 aboard the R/V *Parker*. A total of 49 survey lines, each 25 m apart, were occupied as part of the survey (Figure 2-1). Additional tie-lines were occupied perpendicular to the main survey lines to assess data quality.

Table 2-1

June 2004 CLDS Field Activities Summary

Survey Type	Date	Summary
Bathymetry	17 – 18 June 2004	Area: 1200 x 1200 m Lines: 49 Spacing: 25 m
Sediment-Profile Imaging	28 – 29 June 2004	Stations: 30 CLIS 95/96: 15 2500W Reference: 5 4500E Reference: 5 CLIS REF: 5

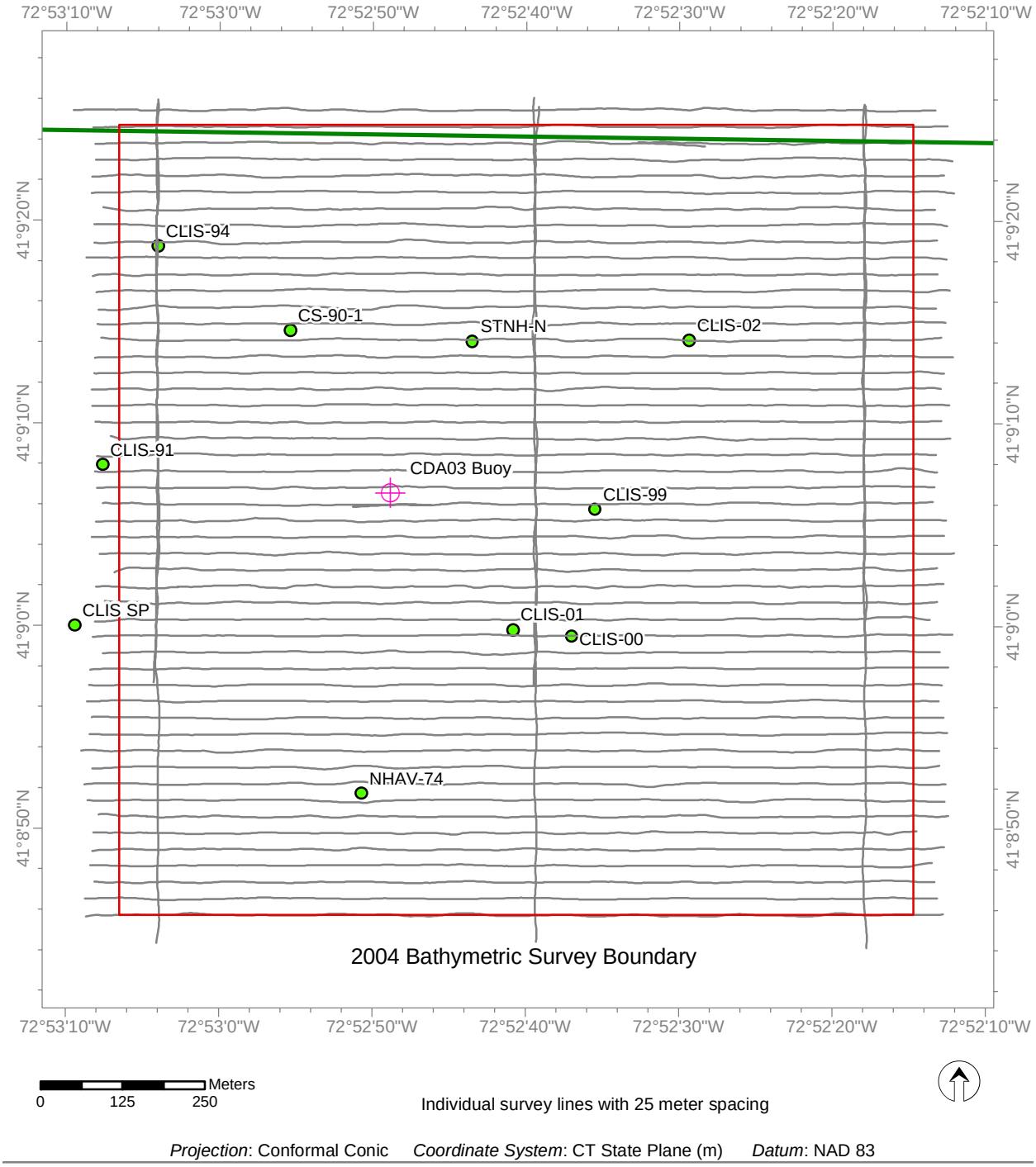

Figure 2-1. Bathymetric survey lines at CLDS, June 2004

Bathymetric data were collected using an Innerspace Model 448 Echo Sounder outfitted with an 8º transducer, which achieved an accuracy of approximately 3 cm in CLDS water depths. Data were collected at a rate of 17 to 18 soundings per second at boat speeds of 4 to 4.5 knots, resulting in soundings spaced at less than 0.2 meter intervals along each survey transect line. Calibration procedures were conducted on-site prior to data collection as well as at the conclusion of each survey day. The average speed of sound through the water column was obtained from a full depth cast of a CTD profiler. Additional calibration information was obtained from a bar check. Tidal elevations were recorded in meters and were referenced to Mean Low Water (MLW) based on water level data obtained from the National Oceanic and Atmospheric Administration (NOAA) tide station in New Haven, CT. Bathymetric data were recorded by means of a high-resolution trace on a thermal printer in addition to the digital data stored within Hypack®. Hypack® managed data acquisition and storage of data from the echosounder and the Trimble DGPS. In addition, Hypack® recorded depth, vessel heave, heading, position, and time along each survey transect line.

2.2.2 Bathymetric Data Processing

The bathymetric data were processed using the HYPACK® software program and included corrections for tidal conditions, local speed of sound, and spurious data points. Tidal correction consisted of transforming the raw measurements of depth below the transducer to seafloor elevation measurements relative to MLW using the locally collected tidal elevation data. Heave data supplied by the vessel's motion reference unit (MRU) was incorporated into the raw data to minimize the effects of vessel motion. The bathymetric data were also reviewed for spurious data points (clearly unrealistic measurements resulting from signal interference), and these points were removed.

2.2.3 Bathymetric Data Analysis

Bathymetric data were analyzed to gain a better understanding of the existing conditions at the site and to document changes in seafloor topography in comparison with previous surveys. The corrected bathymetric data were analyzed using a combination of the contouring and surface plotting software program, Surfer® 8.0 and the GIS-based software package ArcView® 8.3. Using Surfer®, the processed CLDS 2004 data were gridded to a cell size of 25 m^2, consistent with the bathymetric grid created for the previous (September 2003) survey (ENSR 2004a). Once gridded, bathymetric contour lines were generated and displayed using ArcView®.

Surfer® was also used to calculate a depth-difference grid based on the September 2003 and June 2004 bathymetric data sets. The boundaries of the depth-difference grid

were defined by the region where the two bathymetric surveys overlapped. This grid was calculated by subtracting the June 2004 interpolated depth estimates from the September 2003 depth estimates at each point throughout the grid. The resulting depth differences were contoured and displayed using ArcView®.

2.3 Sediment-Profile Imaging

Sediment-profile imaging (SPI) is a monitoring technique used to provide data on the physical characteristics of the seafloor as well as the status of the benthic biological community. The technique involves deploying an underwater camera system that photographs a cross section of the sediment-water interface. Computer-aided analysis of the resulting images provides a set of standard measurements that can be compared between different locations and different surveys. The DAMOS Program has successfully used this technique for over 20 years to map the distribution of disposed dredged material and to monitor benthic recolonization at disposal sites. For a detailed discussion of SPI methodology, see ENSR (2004b).

2.3.1 SPI Data Acquisition

The 2004 SPI survey design included 30 stations: 15 stations located within CLDS and 15 stations distributed within three reference areas (Table 2-2, Figure 2-2). The 15 stations located within CLDS were randomly located within a 300-m radius of the center of the CLIS 95/96 Mound Complex. The CLIS 95/96 Mound Complex was chosen for the SPI survey within CLDS because it was not likely to have experienced any recent disposal activity (i.e. within the past 5 to 7 years) and previous SPI surveys have shown this mound to be completely recovered from past disposal activities. Three previously established reference areas, located west of the disposal site (REF 2500W), east of the disposal site (REF 4500E), and southeast of the disposal site (CLIS REF), were also surveyed to provide a basis of comparison between CLDS sediment conditions and the ambient sediment conditions in Central Long Island Sound. Five reference stations were selected randomly within a 300-m radius of the centers of each of the three references areas (REF 2500W, REF 4500E, and CLIS REF) (Table 2-2, Figure 2-2).

The sediment-profile imaging survey was conducted 28 – 29 June 2004 aboard the F/V *Shanna Rose*. At each station, the vessel was positioned at the target coordinates and the camera was deployed within a defined station tolerance of 10 m. Three replicate sediment-profile images were collected at each of the 30 stations for characterization of small-scale (i.e. within-station) spatial variability.

Table 2-2

CLDS Sediment-Profile Image Target Sampling Locations

Area	Station	Latitude (N)	Longitude (W)
CLDS	CLDS04-01	41° 08.710'	72° 53.226'
	CLDS04-02	41° 08.789'	72° 52.969'
	CLDS04-03	41° 08.812'	72° 53.049'
	CLDS04-04	41° 08.637'	72° 52.829'
	CLDS04-05	41° 08.594'	72° 52.942'
	CLDS04-06	41° 08.586'	72° 53.127'
	CLDS04-07	41° 08.656'	72° 53.012'
	CLDS04-08	41° 08.721'	72° 52.956'
	CLDS04-09	41° 08.651'	72° 52.884'
	CLDS04-10	41° 08.697'	72° 52.833'
	CLDS04-11	41° 08.745'	72° 52.846'
	CLDS04-12	41° 08.644'	72° 53.043'
	CLDS04-13	41° 08.631'	72° 53.038'
	CLDS04-14	41° 08.676'	72° 52.857'
	CLDS04-15	41° 08.644'	72° 53.147'
Reference	2500W-01	41° 09.379'	72° 55.454'
	2500W-02	41° 09.182'	72° 55.565'
	2500W-03	41° 09.099'	72° 55.524'
	2500W-04	41° 09.337'	72° 55.684'
	2500W-05	41° 09.151'	72° 55.674'
	4500E-01	41° 09.159'	72° 50.447'
	4500E-02	41° 09.317'	72° 50.592'
	4500E-03	41° 09.204'	72° 50.692'
	4500E-04	41° 09.344'	72° 50.581'
	4500E-05	41° 09.273'	72° 50.602'
	CLISREF-01	41° 08.121'	72° 49.995'
	CLISREF-02	41° 08.117'	72° 49.979'
	CLISREF-03	41° 08.036'	72° 49.940'
	CLISREF-04	41° 08.212'	72° 49.941'
	CLISREF-05	41° 08.053'	72° 49.926'

Note: All coordinates NAD83

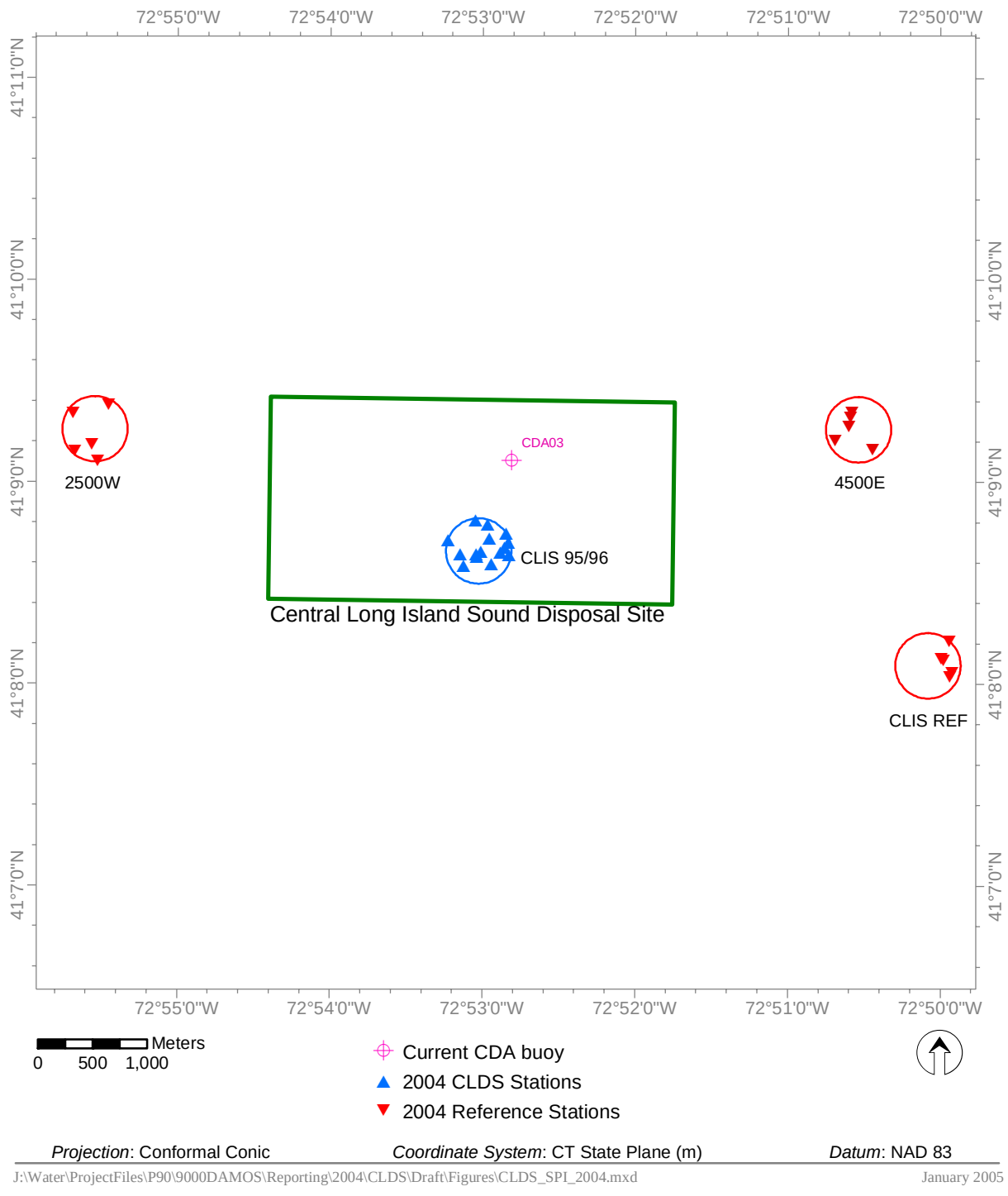

Figure 2-2. CLDS with target SPI stations indicated

Acquisition of high-resolution SPI images was accomplished using an Ocean Imaging Model 3731 pressure housing system with a Nikon D100 digital single-lens reflex camera. The camera was mounted inside the pressure housing and sat atop a wedge-shaped prism with a front faceplate and a back mirror. The mirror was mounted at a 45° angle to reflect the profile of the sediment-water interface. As the prism penetrated the seafloor, a trigger activated a time-delay circuit that fired an internal strobe to obtain a cross-sectional image of the upper 15 to 20 cm of the sediment column. The camera remained on the seafloor for approximately 20 seconds to ensure that a successful image had been obtained.

Two types of adjustments to the SPI system are typically made in the field: 1) physical adjustments to the frame stop collars and/or adding/subtracting lead weights to the frame to control penetration in harder or softer sediments, and 2) electronic software adjustments to the Nikon D100 to control camera settings. Each image was assigned a unique time stamp in the digital file attributes by the camera's data logger and cross-checked with the time stamp in the navigational system's computer data file. In addition, the field crew kept redundant written sample logs. Images were downloaded periodically to verify successful sample acquisition or to assess what type of sediment/depositional layer was present at a particular station. Digital image files were re-named with the appropriate station name immediately after downloading on deck as a further quality assurance step.

Test exposures of the Kodak® Color Separation Guide (Publication No. Q-13) were made on deck at the beginning and end of each survey to verify that all internal electronic systems were working to design specifications and to provide a color standard against which final images could be checked for proper color balance. After deployment of the camera at each station, the frame counter was checked to ensure that the requisite number of replicates had been obtained. In addition, a prism penetration depth indicator on the camera frame was checked to verify that the optical prism had actually penetrated the bottom to a sufficient depth. If images were missed or the penetration depth was insufficient, the camera frame stop collars were adjusted and/or weights were added or removed, and additional replicate images were taken. Changes in prism weight amounts, the presence or absence of mud doors, and frame stop collar positions were recorded for each replicate image.

2.3.2 SPI Data Analysis

Computer-aided analysis of each image was performed to provide measurement of the following standard set of parameters:

- *Sediment Type*—The sediment grain size major mode and range were estimated visually from the images using a grain-size comparator at a similar scale. Results were reported using the phi scale. Conversion to other grain-size scales is provided in Appendix B. The presence and thickness of disposed dredged material was also assessed by inspection of the images.

- *Penetration Depth*—The depth to which the camera penetrates into the seafloor was measured to provide an indication of the sediment density or bearing capacity. The penetration depth can range from a minimum of 0 cm (i.e., no penetration on hard substrates) to a maximum of 20 cm (full penetration on very soft substrates).

- *Surface Boundary Roughness*—Surface boundary roughness is a measure of the vertical relief of features at the sediment-water interface in the sediment-profile image. Surface boundary roughness was determined by measuring the vertical distance between the highest and lowest points of the sediment-water interface. The surface boundary roughness (sediment surface relief) measured over the width of sediment-profile images typically ranges from 0.02 to 3.8 cm, and may be related to physical structures (e.g., ripples, rip-up structures, mud clasts) or biogenic features (e.g., burrow openings, fecal mounds, foraging depressions). Biogenic roughness typically changes seasonally and is related to the interaction of bottom turbulence and bioturbational activities.

- *Apparent Redox Potential Discontinuity (RPD) Depth*— RPD provides a measure of the integrated time history of the balance between near surface oxygen conditions and biological reworking of sediments. Sediment particles exposed to oxygenated waters oxidize and lighten in color to brown or light grey. As the particles are moved downwards by biological activity or buried, they are exposed to reduced oxygen concentrations in subsurface pore waters and their oxic coating slowly reduces, changing the color to dark grey or black. When biological activity is high the RPD depth increases; when it is low or absent, the RPD depth decreases. The RPD depth was measured by assessing color and reflectance boundaries within the images.

- *Infaunal Successional Stage*—Infaunal successional stage is a measure of the biological community inhabiting the seafloor. Current theory holds that organism-sediment interactions in fine-grained sediments follow a predictable sequence of development after a major disturbance (such as dredged material disposal), and this sequence has been divided subjectively into three stages (Rhoads and Germano 1982, 1986). Successional stage was assigned by assessing which types of species or organism-related activities were apparent in the images.

- *Organism-Sediment Index (OSI)*—OSI is a summary parameter incorporating the apparent mean RPD depth, successional stage, and presence of methane or low oxygen and reflects the seafloors' response to natural or anthropogenic disturbance (Revelas et al. 1987; Table 2-3). An OSI threshold of +6 is used to evaluate the degree of benthic habitat disturbance along the continuum from highly disturbed (OSI value of -10) to undisturbed (OSI value of +11). In general, OSI values of +6 and below are indicative of a moderately to highly disturbed habitat.

Additional components of the SPI analysis included calculation of means and ranges for the parameters listed above and mapping of individual values.

Table 2-3.

Organisms-Sediment Index (OSI) Terms and Formulation

Parameter	Index Value
A. Mean RPD Depth (choose one)	
0.00 cm	0
0.01 – 0.75 cm	1
0.76 – 1.50 cm	2
1.51 – 2.25 cm	3
2.26 – 3.00 cm	4
3.01 – 3.75 cm	5
> 3.75 cm	6
B. Successional Stage (choose one)	
Azoic	-4
Stage I	1
Stage I – II	2
Stage II	3
Stage II – III	4
Stage III	5
Stage I on III	5
Stage II on III	5
C. Chemical Parameters (choose all that apply)	
Methane Present	-2
No/Low Dissolved Oxygen	-4
Calculation of Organism-Sediment Index (OSI)	
OSI = Total of above indices (A+B+C)	
Range of possible OSI values is -10 to +11	

3.0 RESULTS

3.1 Bathymetry

The June 2004 bathymetric survey results for CLDS were consistent with earlier survey results. The natural seafloor slopes from the northwest to the southeast across the survey area (a subset of the disposal site), with depths ranging from approximately 18 m in the northwest to 21 m in the southeast. (Figure 3-1, depths reported as MLW).

3.1.1 CLIS 03 Mound

A new mound, designated as CLIS 03, formed at the location of the CDA 03 buoy, approximately 300 m west of the CLIS 99 Mound (Figure 3-1). This new mound was formed from the disposal of approximately 426,000 m^3 of material during the 2003-2004 disposal season. The base of the mound was approximately 400 m in diameter with two peaks that rose approximately 1.5 m above the surrounding seafloor. The two peaks were aligned in an east-west direction, approximately 150 m apart. The minimum water depth at the apex of the two peaks was approximately 17.5 m and the surrounding water depths averaged about 19 m, indicating that the mound was approximately 1.5 m above the surrounding seafloor.

3.1.2 Historic Mounds

Nine historic mounds were evident within the 2004 survey area. The most distinct mound was the NAV 74 Mound, which was approximately 4 meters above the surrounding seafloor. The CLIS 91 Mound and CLIS SP Mound were approximately 0.5 m in height, the STNH-N Mound was approximately 1 m in height, and the CLIS 94 Mound was approximately 1.5 m in height. The CLIS 99 and CLIS 00 Mounds, first identified during the 2001 survey, and the CLIS 01 and CLIS 02 Mounds, first identified during the September 2003 survey, were all approximately 0.5 m in height. The CS-90-1 Mound was no longer evident (Figure 3-1).

3.1.3 Comparison with Previous Bathymetry

The overlapping bathymetric data from the 2004 survey (Figure 3-1) and the 2003 survey (Figure 3-2) were used to generate a depth-difference map (Figure 3-3). The depth-difference map was plotted at 0.25 m contour intervals. The most significant feature was the newly formed disposal mound, CLIS 03, which was about 1.5 m above

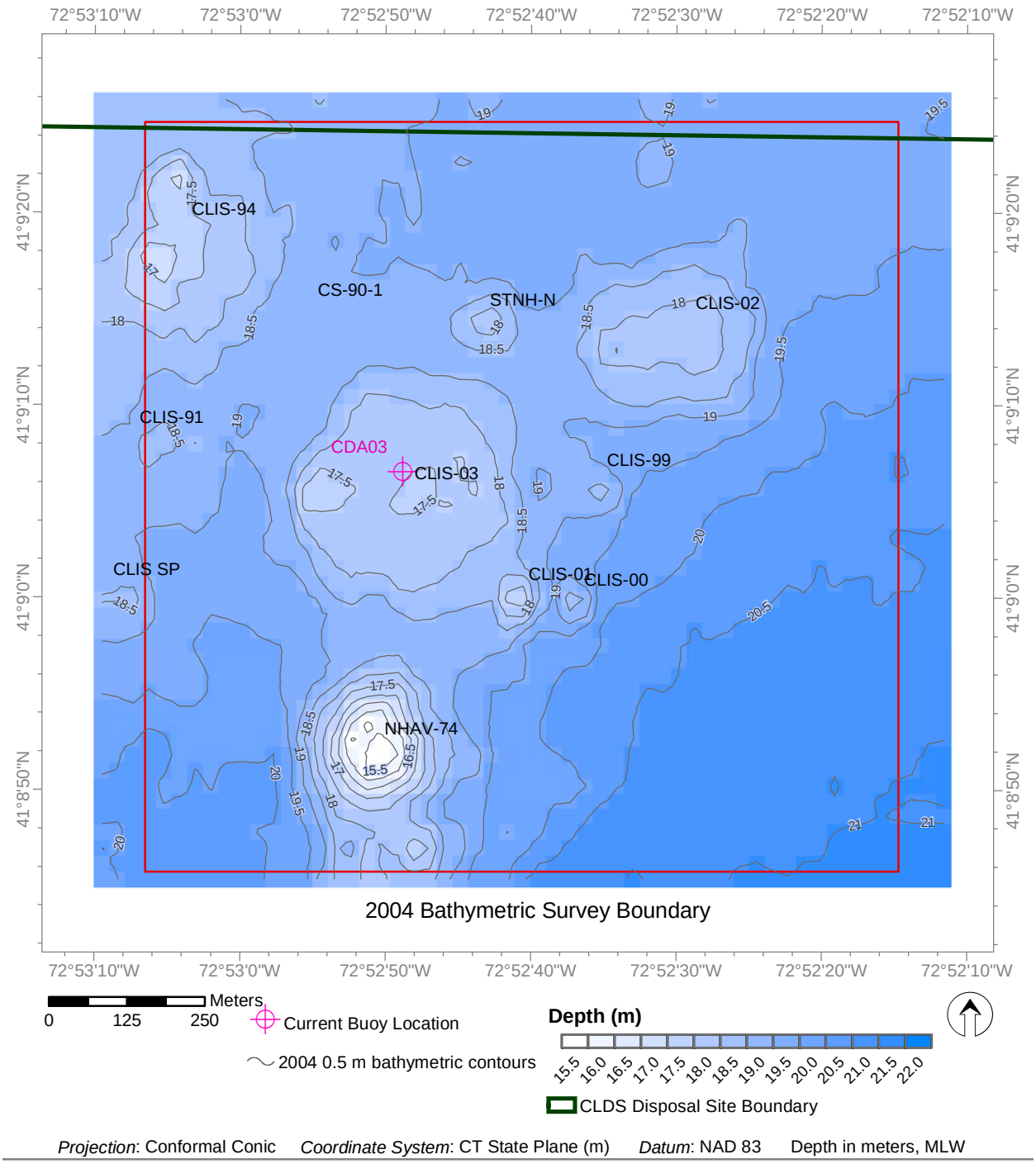

Figure 3-1. Bathymetric contour map of CLDS survey area, June 2004 (0.5-m contour interval).

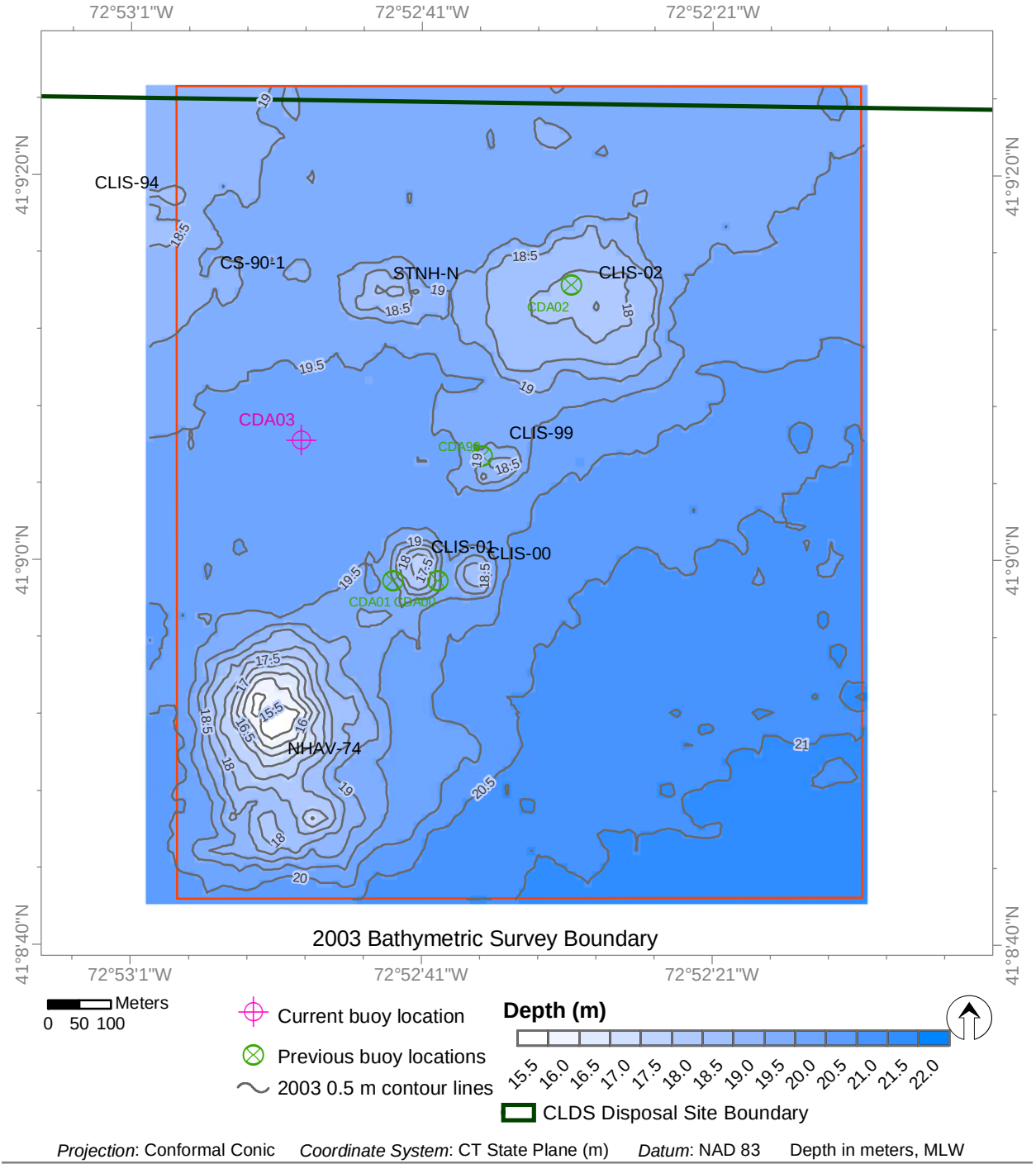

Figure 3-2. Bathymetric contour map of CLDS survey area, September 2003 (0.5-m contour interval).

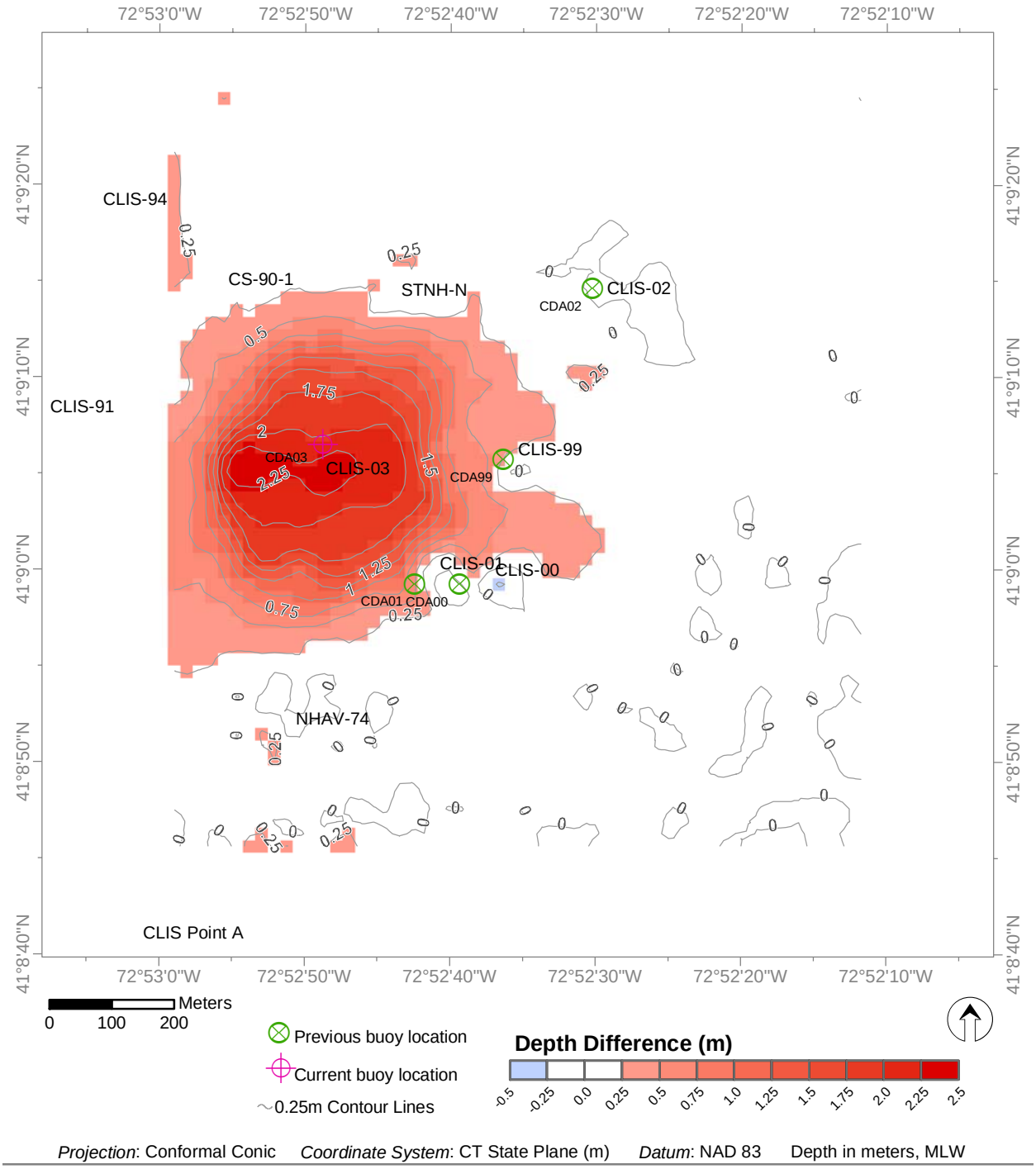

Figure 3-3. Depth difference contour map of CLDS survey area, September 2003 vs. June 2004 survey results (0.25-m contour interval).

the surrounding seafloor. The mound extended 200 to 300 m to the north and east of the CDA03 buoy, wholly or partially encompassing the smaller mounds in this area.

3.2 Sediment-Profile Imaging

The previous SPI survey of September 2003 noted the ubiquitous occurrence of a thin, rust-colored surface layer of what appeared to be degraded phytoplankton (phaeopigments or phytodetritus). This layer was observed in every image at all three reference areas, as well as at each of the five CLDS disposal mounds that were surveyed (Figure 1-3). The results of the June 2004 SPI survey were evaluated to assess whether such a phytodetrital layer remained visible at the sediment surface within CLDS or at the reference areas. A complete set of results for the SPI image analysis is presented in Appendix B; these results are presented and discussed below.

3.2.1 Reference Areas

Sediment Physical Characteristics

Surface sediments at all three of the reference areas consisted of silt-clay having a major modal grain size of >4 phi (Table 3-1; Figure 3-4). This is consistent with the results of previous DAMOS surveys showing that the central basin of Long Island Sound in the vicinity of CLDS is dominated by relatively soft, muddy sediments (SAIC 2003; ENSR 2004a). There was only a small amount of small-scale surface relief observed across the field-of-view of the images: the average boundary roughness values at the reference area stations ranged between 0.3 and 0.9 cm and were judged to be of both physical and biological origin.

The overall average (i.e., for all three reference areas combined) prism penetration depth was 16.0 cm, with a relatively narrow range of values between 14.3 and 17.1 cm (Table 3-1). Such values are near the high end of the potential range (0 to 20 cm) and reflect the homogeneous nature of the relatively soft, biogenically-reworked mud at all of the reference area stations (Table 3-1; Figure 3-4). There were no dredged material layers, sedimentary methane, or apparent low dissolved oxygen conditions observed at the reference area SPI stations from the June 2004 survey.

Biological Conditions and Benthic Recolonization Status

The sediment occurring at and just below the sediment-water interface (SWI) was characterized by a tan or subtle orange color at all of the reference area stations (Figure 3-4). This relatively thin layer of orange or rust-colored sediment was most distinct and

Table 3-1
Summary of SPI Results for CLDS Reference Stations, June 2004

Area	Station	Mean Prism Penetration Depth (cm)	Grain Size Major Mode (phi)	Boundary Roughness (cm)	Mean RPD Depth (cm)	Successional Stages present (no. of replicates)	Mean Number of Feeding Voids	Median OSI	Methane present?	Low DO?
2500W	1	16.1	>4	0.4	2.6	I on III (3)	3	9	No	No
	2	16.6	>4	0.6	2.7	I on III (3)	5	9	No	No
	3	16.2	>4	0.6	2.8	I on III (3)	4	9	No	No
	4	14.9	>4	0.9	3.1	I on III (3)	4	10	No	No
	5	16.9	>4	0.5	3.7	I on III (3)	3	11	No	No
4500E	1	16.7	>4	0.6	4.4	I on III (3)	4	11	No	No
	2	16.3	>4	0.7	3.5	I on III (2), III (1)	4	10	No	No
	3	17.0	>4	0.4	4.6	I on III (3)	3	11	No	No
	4	16.9	>4	0.7	3.8	I on III (3)	2	11	No	No
	5	17.1	>4	0.9	3.6	I on III (3)	5	10	No	No
CLIS REF	1	14.6	>4	0.6	5.3	I on III (3)	3	11	No	No
	2	14.3	>4	0.7	5.7	I on III (3)	1	11	No	No
	3	15.6	>4	0.3	5.6	I on III (3)	4	11	No	No
	4	15.2	>4	0.5	5.3	I on III (3)	3	11	No	No
	5	15.6	>4	0.6	4.8	I on III (3)	3	11	No	No
Average		16.0		0.6	4.1		3	NA		
Median		NA		NA	NA		NA	11		
Minimum		14.3		0.3	2.6		1	9		
Maximum		17.1		0.9	5.7		5	11		

NA = Not Applicable

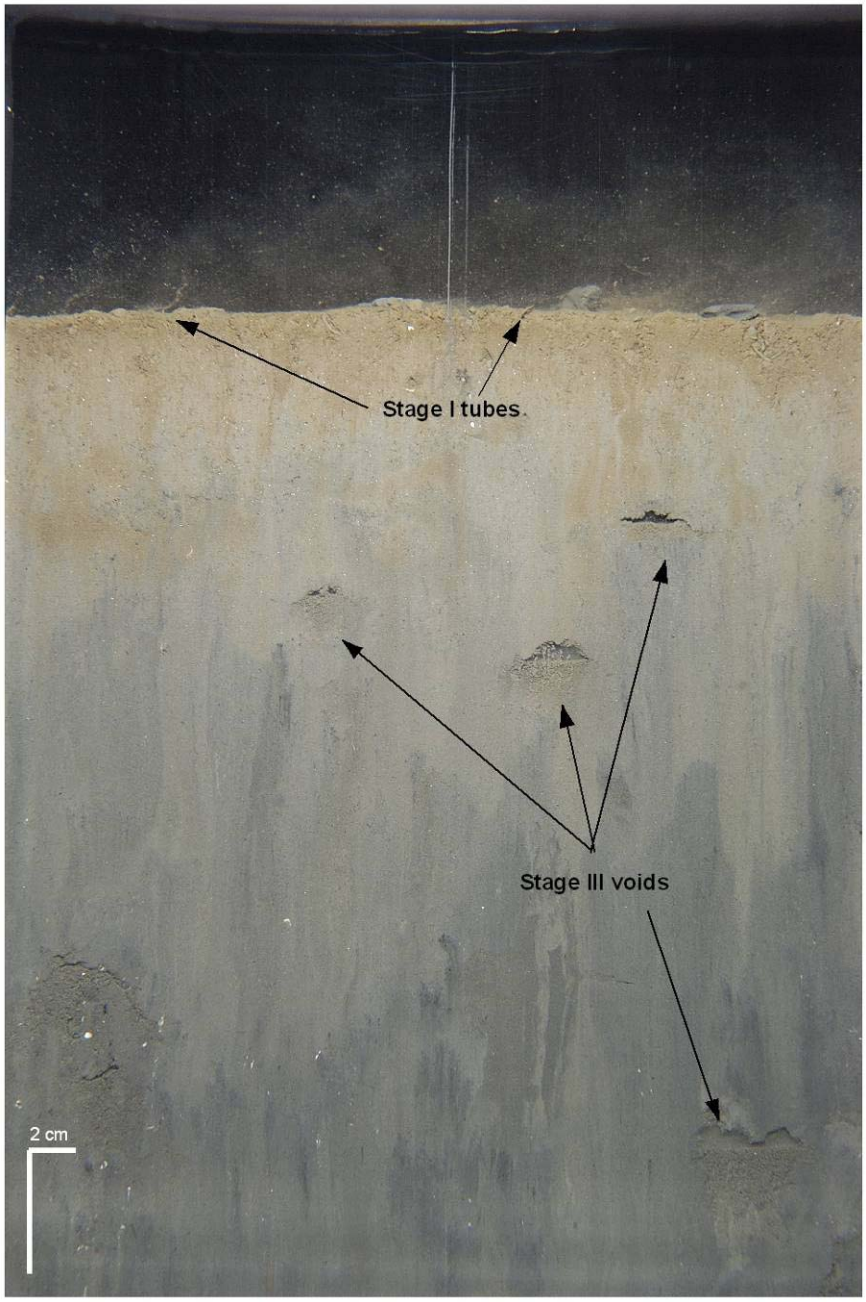

Figure 3-4. SPI image from Station 2500W 02 A typifying the seafloor conditions observed at all three reference areas in the June 2004 and past surveys. The sediment surface lacks significant small-scale relief, and the profile shows soft, homogenous, gray silt-clay containing small shell fragments. The sediment at and just below the sediment-water interface (SWI) has a tan/rust color, in subtle contrast to the underlying light-gray sediment. Stage I tubes are visible at the SWI, and there are several active Stage III feeding voids at depth.

most consistently observed in the upper 1 to 2 cm of the sediment column (Figure 3-5). It is likely that some of the orange hue was imparted to the sediment surface by the presence of settled phytoplankton detritus and associated phaeopigments. Similar to the 2003 survey, this thin, colored layer at and just below the SWI exhibited a flocculent or more granular texture, attributed to extensive biological reworking (e.g., meiofaunal tunneling and feeding) within this narrow zone (microhabitat) of organic matter enrichment (Figure 3-5).

The mean apparent RPD depths at the reference areas ranged from 2.6 cm (2500W 1) to 5.7 cm (CLISREF 2), with an overall mean of 4.1 cm (Table 3-1, Figure 3-6). These values are typical of early summer ambient bottom conditions in those areas of central Long Island Sound not experiencing hypoxia. While these values are all considered indicative of a normal or healthy degree of sediment aeration, the greatest RPD depths were observed most consistently at CLISREF and the shallowest at 2500W (Figure 3-6).

Infaunal successional stages were dominated by Stage I-III assemblages at all of the reference area stations (Table 3-1; Figure 3-7). Evidence of Stage I included both upright/intact and broken/recumbent tubes at the sediment surface, while active, subsurface feeding voids were evidence of Stage III (Figures 3-4 and 3-5). Three or more feeding voids, on average, were visible in the images at the majority of stations (Table 3-1). Median OSI values at the reference area stations ranged from +9 to +11, indicative of undisturbed benthic habitat conditions on the ambient bottom of central LIS at the time of the survey in June 2004 (Table 3-1). The spatial distribution of OSI values among the reference areas reflect the somewhat shallower RPD depths at 2500W and the greater RPD depths at CLISREF (Figure 3-8).

3.2.2 CLIS 95/96 Mound Complex

Sediment Physical Characteristics

Older dredged material was observed at all of the stations over the CLIS 95/96 Mound Complex in the June 2004 survey, similar to the results of the previous SPI survey of September 2003 (Table 3-2; Figure 3-9). The average thickness of the dredged material layer was greater than the penetration depth of the sediment-profile camera at each of the 15 stations (Figures 3-9 and 3-10). The sediment comprising the dredged material was predominantly silt-clay (grain size major mode of >4 phi) at all of the stations (Table 3-2 and Figure 3-10, left). At a number of stations (particularly 02, 03, 06, 07, 08, 10, 14 and 15), there was a significant component of fine to medium sand that was either mixed with the silt-clay or occurred in distinct layers (Figure 3-10, right).

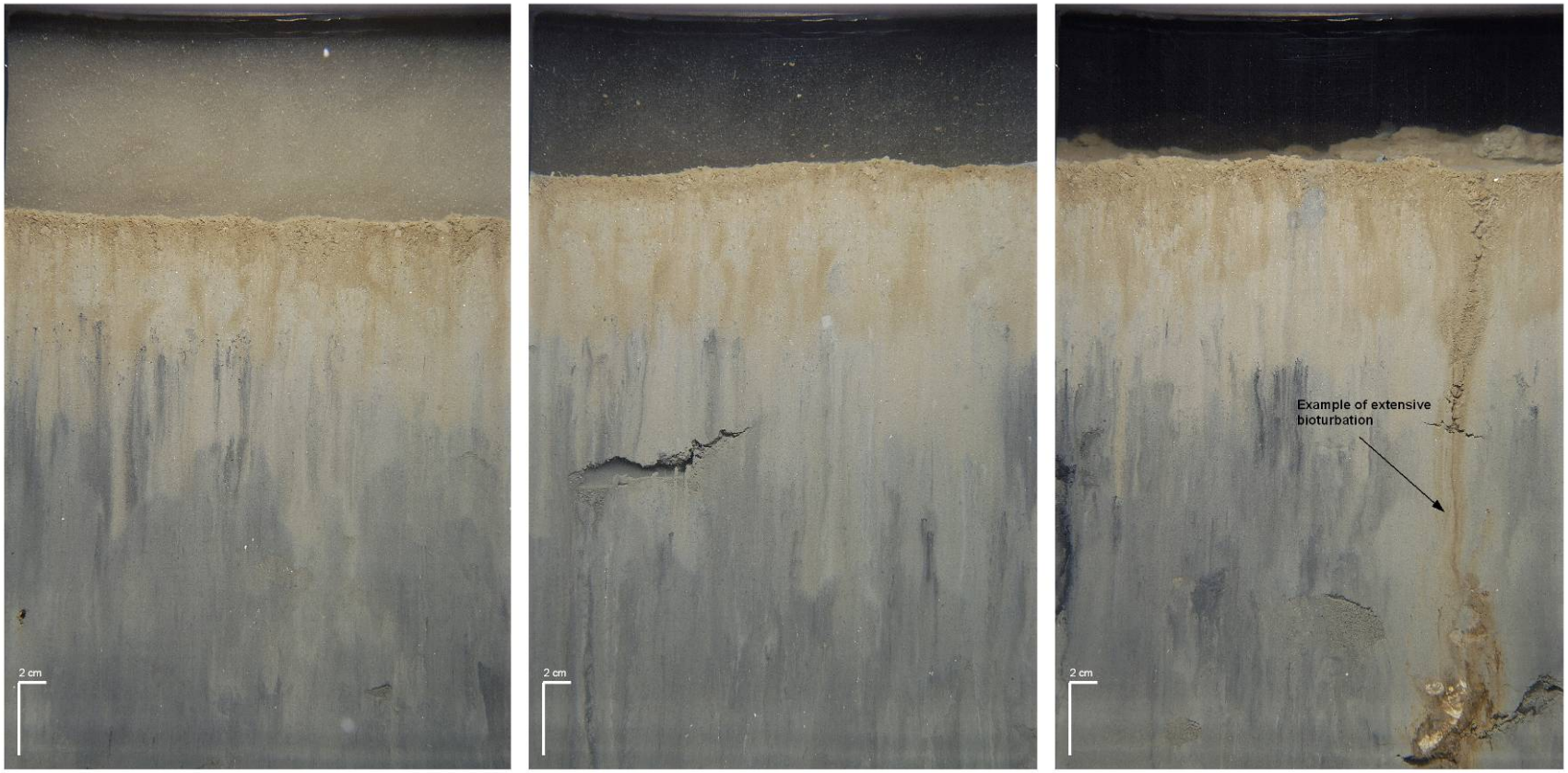

Figure 3-5. Three example SPI images from reference area stations showing a layer of rust-colored sediment at and just below the SWI. Station 4500E 02 A (left), Station 2500W 05 D (center) and Station 4500E 03 C (right) all exhibit a flocculent texture in the upper 1 to 2 cm of the sediment column, attributed to extensive biological reworking of the rust-colored surface layer. Bioturbation also has served to mix some of the surface sediment downward, resulting in the observed discontinuous patches and/or downward-reaching "fingers" of reddish sediment below the SWI. In the image to the right, an organism has brought some of the oxidized surface sediment down into its subsurface burrow. Stage I surface tubes and active sub-surface feeding voids are visible in all three images (Stage I on III).

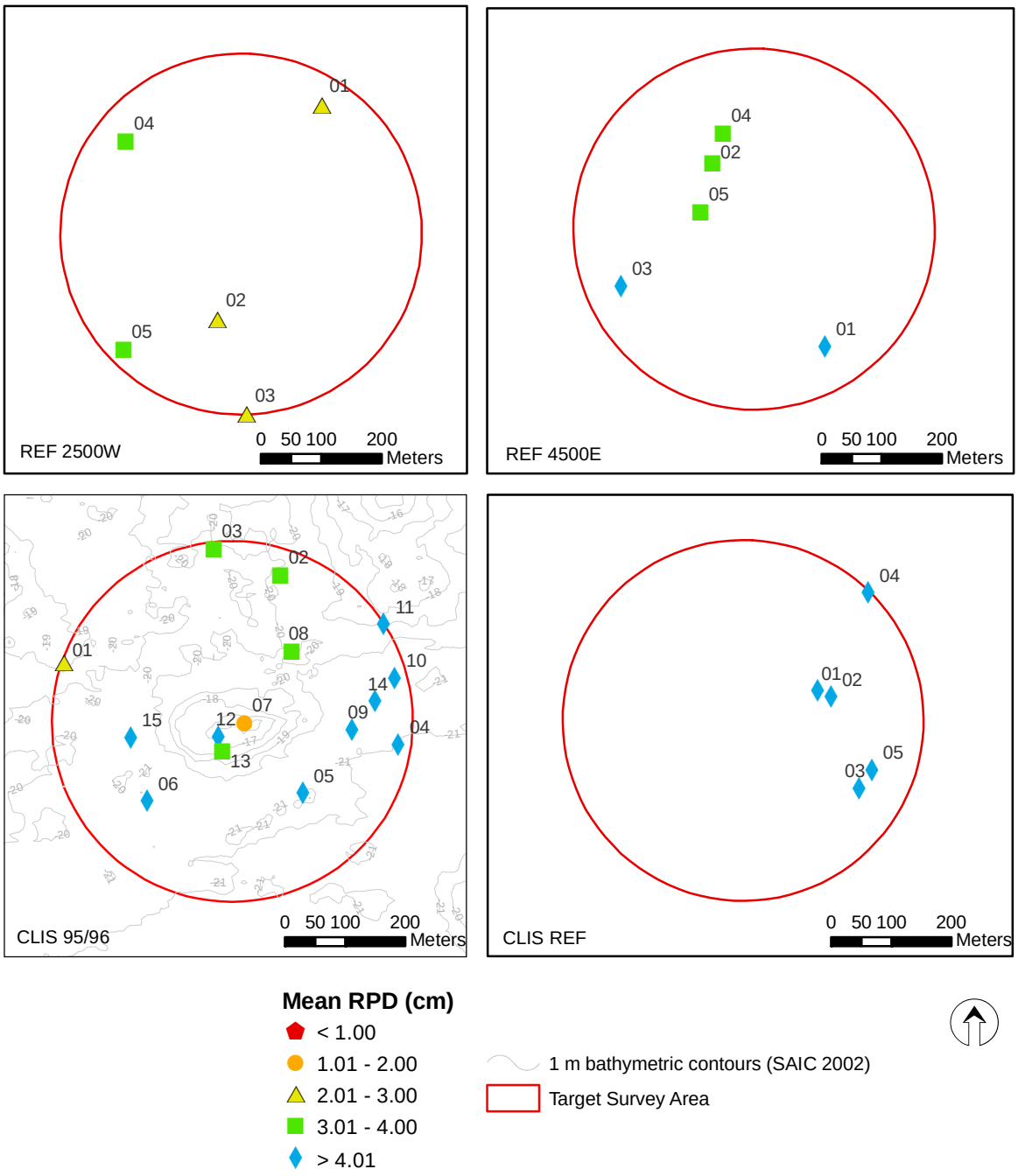

Figure 3-6. Map of mean apparent RPD depths at the reference area and CLIS 95/96 Mound stations, June 2004

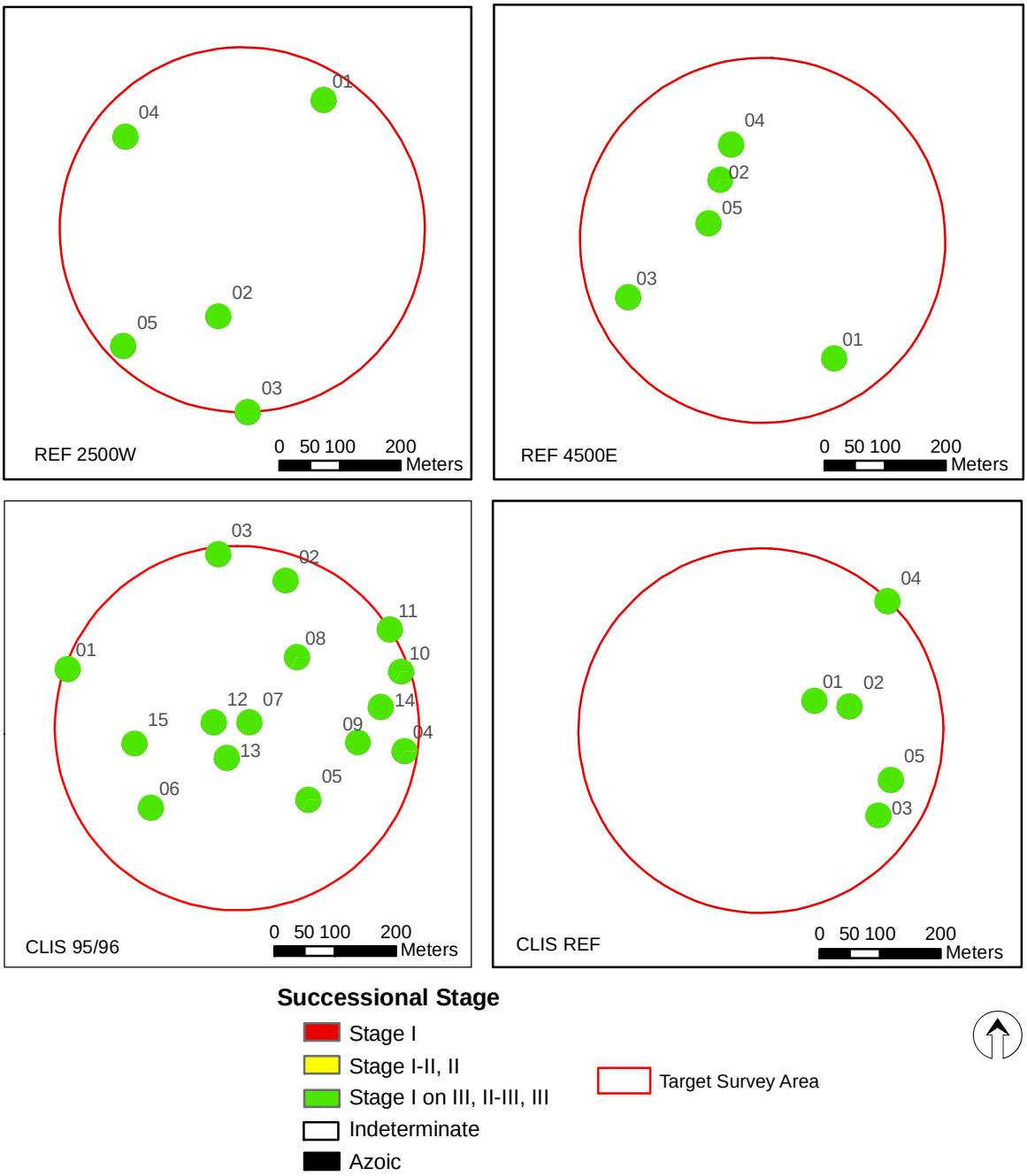

Figure 3-7. Map of infaunal successional stages at the reference area and CLIS 95/96 Mound stations, June 2004

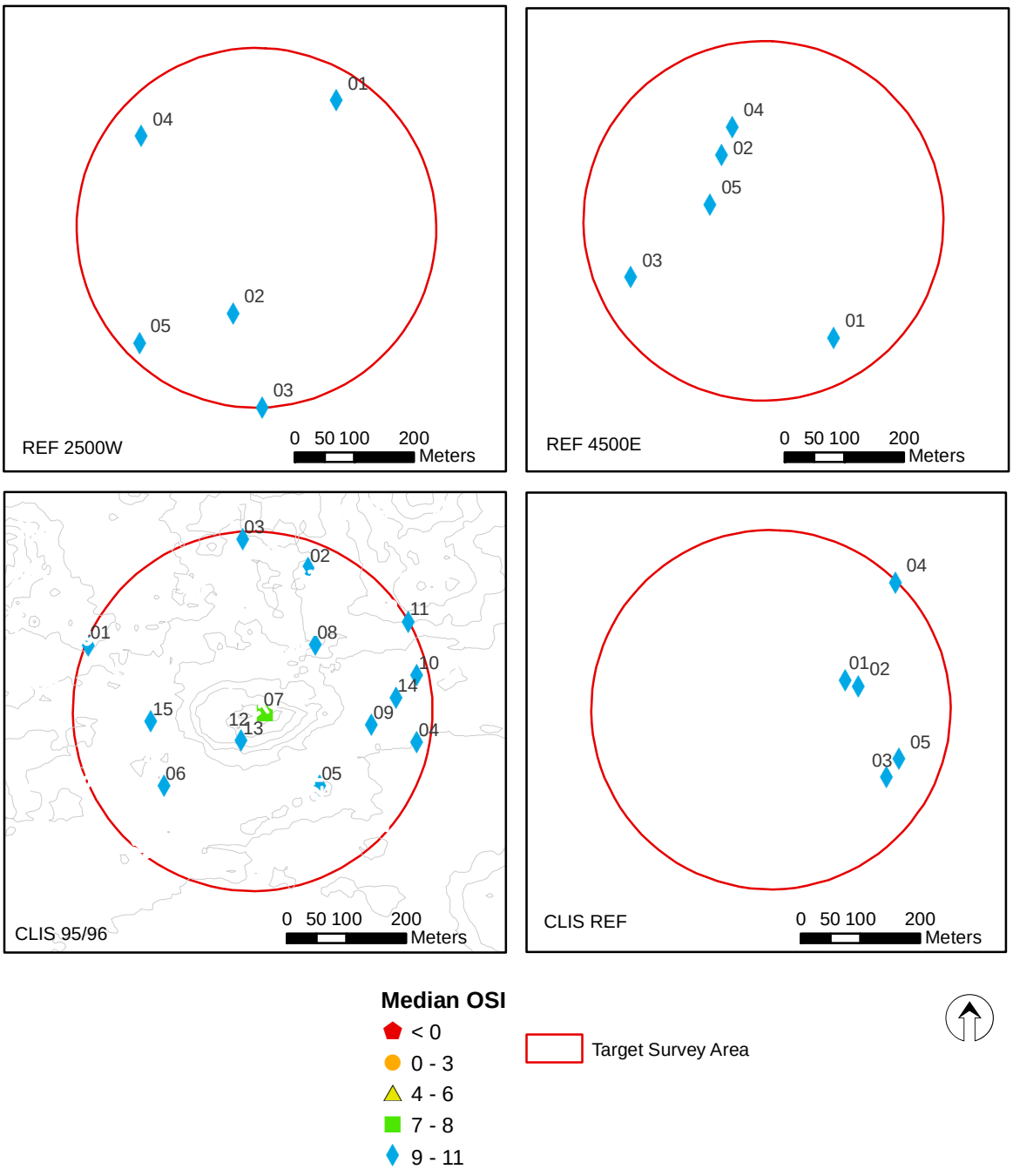

Figure 3-8. Map of median OSI values at the reference area and CLIS 95/96 Mound stations, June 2004

Table 3-2
Summary of SPI Results for CLDS Stations, June 2004

Area	Station	Mean Prism Penetration Depth (cm)	Mean DM thickness (cm)	Grain Size Major Mode (phi)	Boundary Roughness (cm)	Mean RPD Depth (cm)	Successional Stages present (no. of replicates)	Mean Number of Feeding Voids	Median OSI	Methane present?	Low DO?
CLIS	CLDS04 01	14.9	> 14.9	> 4	0.5	2.6	I on III (3)	2	9	Yes	No
95/96	CLDS04 02	14.3	> 14.3	> 4	0.6	3.4	I on III (3)	3	10	No	No
Mound	CLDS04 03	13.3	> 13.3	> 4	1.1	3.6	I on III (3)	2	11	No	No
Complex	CLDS04 04	16.8	> 16.8	> 4	1.0	4.3	I on III (2), III (1)	4	11	No	No
	CLDS04 05	20.2	> 20.2	> 4	0.5	4.2	I on III (2), III (1)	3	11	No	No
	CLDS04 06	12.5	> 12.5	> 4	1.1	5.1	I on III (3)	3	11	No	No
	CLDS04 07	10.9	> 10.9	> 4	2.2	1.7	I on III (2), II to III (1)	2	7	No	No
	CLDS04 08	14.5	> 14.5	> 4	0.9	3.9	I on III (3)	2	11	No	No
	CLDS04 09	17.2	> 17.2	> 4	0.6	5.3	I on III (3)	2	11	No	No
	CLDS04 10	14.7	> 14.7	> 4	1.1	4.8	I on III (2), III (1)	4	11	No	No
	CLDS04 11	14.5	> 14.5	> 4	0.6	4.8	I on III (3)	4	11	No	No
	CLDS04 12	10.5	> 10.5	> 4	1.3	4.2	I on III (3)	1	10.5	No	No
	CLDS04 13	13.3	> 13.3	> 4	0.5	3.2	I on III (3)	3	10	No	No
	CLDS04 14	15.4	> 15.4	> 4	0.9	4.6	I on III (3)	1	11	No	No
	CLDS04 15	14.7	> 14.7	> 4	0.8	4.0	I on III (3)	3	11	No	No
Average		14.5	> 14.5		0.9	4.0		3	NA		
Median		NA	NA		NA	NA		NA	11		
Minimum		10.5	> 10.5		0.5	1.7		1	7		
Maximum		20.2	> 20.2		2.2	5.3		4	11		

NA = Not Applicable

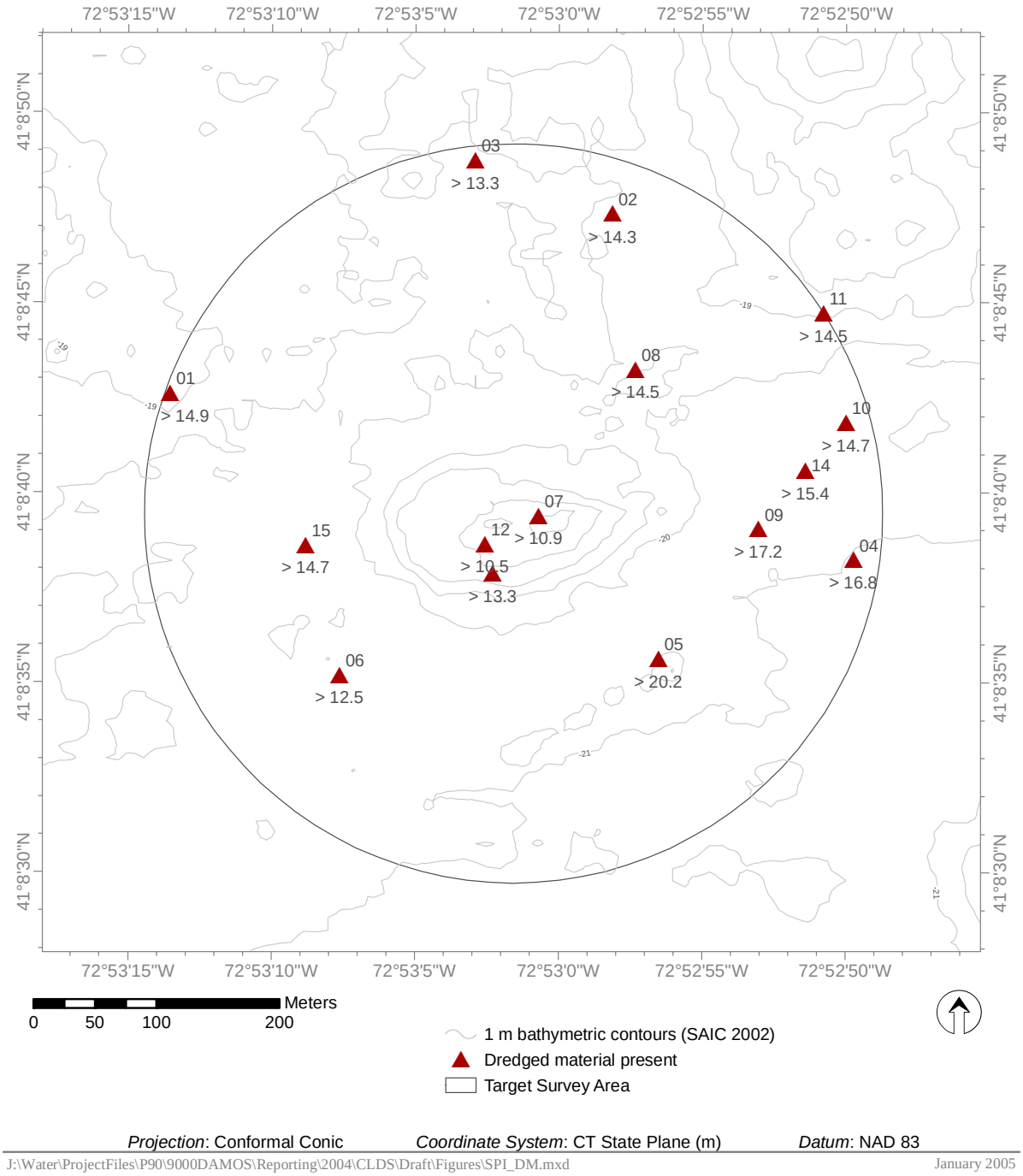

Figure 3-9. Map showing the average thickness of the surface dredged material layer at each SPI station over the CLIS 95/96 Mound Complex. A "greater than" sign indicates the dredged material layer extended from the sediment surface to below the imaging (i.e., penetration) depth of the sediment-profile camera.

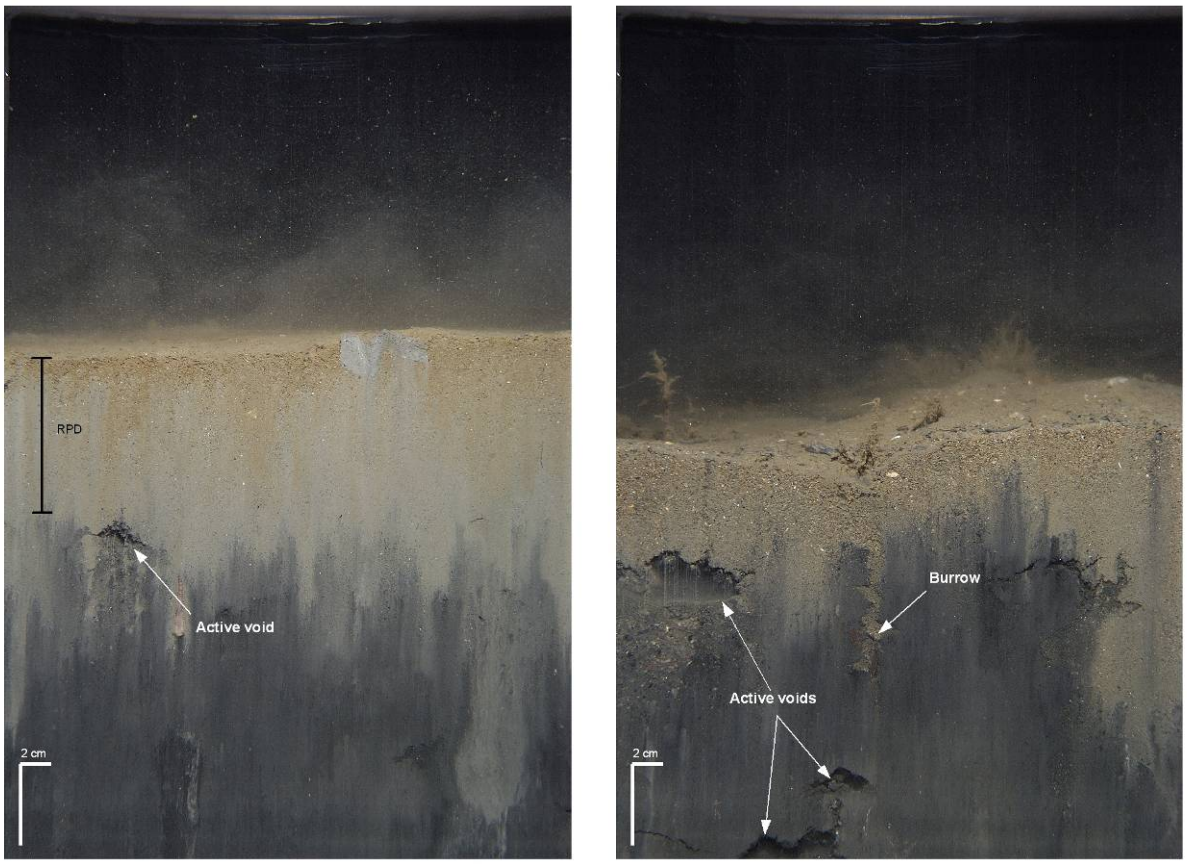

Figure 3-10. SPI images from Stations CLDS04 13 A (left) and CLDS04 07 A (right) at the CLIS 95/96 Mound showing dredged material extending from the sediment surface to below the imaging depth of the SPI camera (i.e., DM thickness > penetration). The dredged material in both images is distinguished by its darker reflectance at depth, indicating higher inventories of organic matter and the presence of reduced sulfides, compared to ambient sediments. Both images also show evidence of extensive surface and sub-surface biological activity, including well-developed RPDs, Stage I tubes, and numerous active Stage III feeding voids and burrows.

Given the somewhat coarser and more heterogeneous nature of the older dredged material comprising the surface of the CLIS 95/96 Mound Complex, there was both a lower mean and a wider range of camera penetration depths (mean = 14.5 cm, range 10.5 to 20.3 cm) compared with the reference areas (Table 3-2). Similarly, there was slightly more small-scale surface relief over the mound, as seen in the higher overall mean and higher minimum and maximum boundary roughness values (Table 3-2). The higher organic matter content in the sediments below the apparent RPD was indicated both by their darker appearance compared with reference and the observation of a few methane bubbles in a single image at Station 01 (Figure 3-11). Aside from this single image, neither methane nor low dissolved oxygen conditions were observed in the sediment at any other station.

Biological Conditions and Benthic Recolonization Status

Similar to observations at the reference stations, the sediment at and just below the SWI over the CLIS 95/96 Mound Complex appeared tan or rust-colored compared to underlying light-to-dark gray or black sediments (Figure 3-12). The orange hue was at least in part due to the presence of elevated levels of phytodetritus on the sediment surface and in the upper 1 to 2 cm of the sediment column.

The overall mean apparent RPD depth at the CLIS 95/96 Mound Complex was 4.0 cm, and average RPD depths greater than 3.0 cm were measured at all of the stations except 01 and 07 (Table 3-2; Figures 3-6 and 3-10 through 3-12). Infaunal succession was advanced at all of the stations, with abundant evidence of the presence of Stage III organisms either alone or, more typically, in combination with Stage I opportunists at the sediment surface (Table 3-2; Figures 3-10 and 3-12). Median OSI values were uniformly high at this mound, with an overall median of +11 and a range of values from +7 to +11 at individual stations (Table 3-2; Figure 3-8). Based on these OSI values, the 95/96 Mound Complex was in an advanced state of recolonization, comparable to CLDS reference area conditions.

3.2.3 Comparison to Reference Area Conditions

A surface layer of tan or rust-colored sediment was observed consistently in the SPI images at both the reference area stations and CLIS 95/96 Mound stations, suggesting that the origin or cause of this layer were regional in nature, as opposed to a more site-specific or disposal-related phenomena. In addition to sharing this rust-colored surface feature, overall benthic conditions at the reference area and CLIS 95/96 Mound stations were broadly comparable: surface sediments in both areas were predominantly silt-clay, with well-developed RPD depths and Stage I infauna inhabiting the sediment surface, as

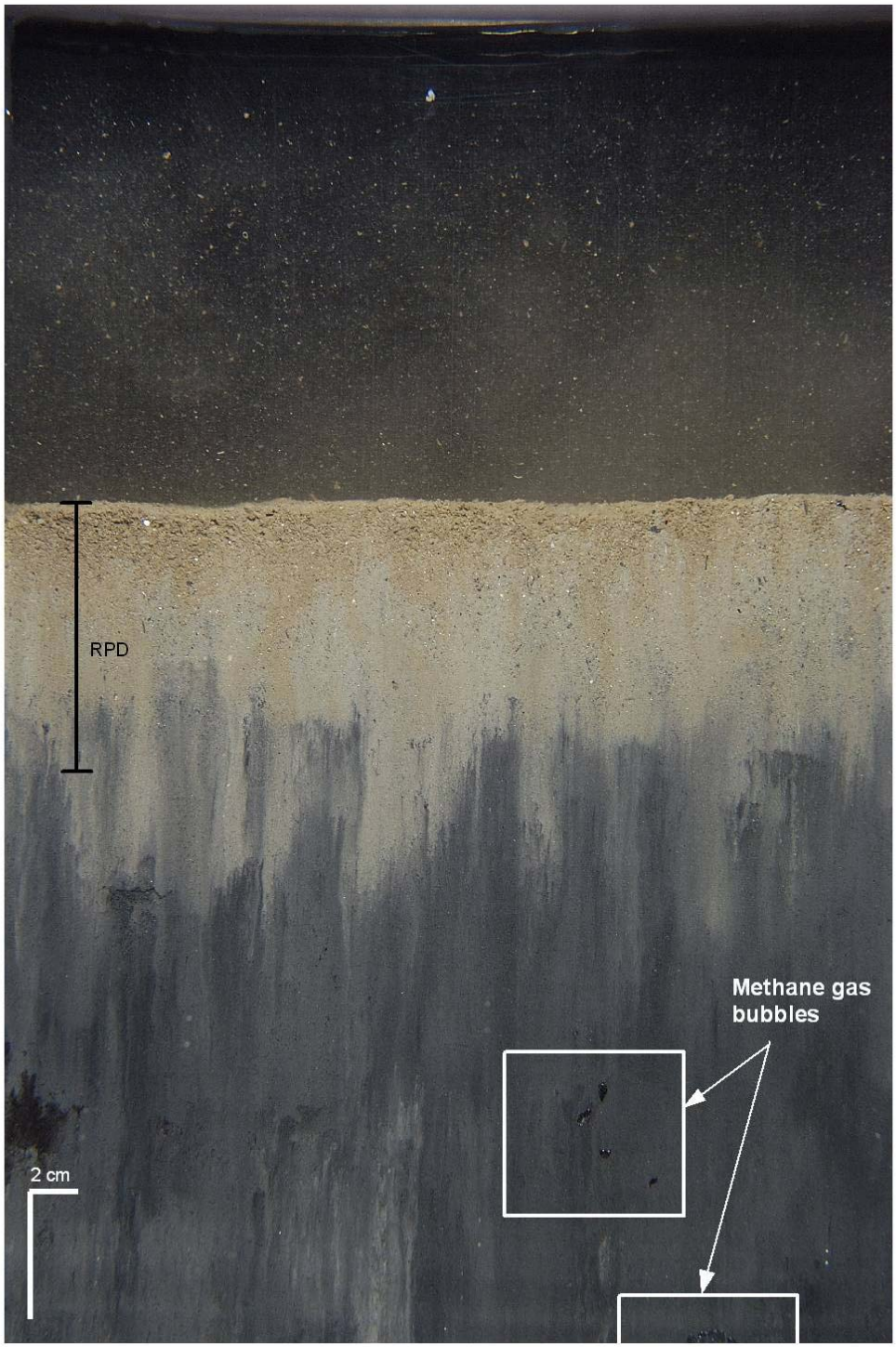

Figure 3-11. SPI image from Station CLDS04 01 A showing dredged material with a moderately well-developed RPD (2.7 cm) and methane gas being produced at depth (several bubbles in lower right corner).

Figure 3-12. SPI images from Stations CLDS04 06 A (left) and CLDS04 03 C (right) illustrating the transition in sediment color from tan/rust at and just below the SWI, to light grey above the apparent RPD, to dark grey or black at depth below the apparent RPD. In both images, the RPD is well-developed (5.3 cm (left) and 3.8 cm (right)), and the sediment surface appears to have a grainier texture due to intensive biological reworking (e.g., tunneling and fecal pellet production). An extensive feeding void complex/burrow is visible in the black subsurface sediment in the left image. Several active, subsurface feeding voids are visible in the right image. Note the oxidized sediment that has been subducted and comprises the floor of the feeding void at right.

well as ample evidence of an abundant subsurface community of larger-bodied, deposit-feeding, Stage III taxa. All the images collected at both the reference area and CLIS 95/96 Mound stations were assigned an advanced successional stage designation consisting of Stage III, Stage I on III, or Stage II going to III (Tables 3-1 and 3-2; Figure 3-7).

3.2.4 Comparison to Previous Survey Results

The tan, rust-colored layer observed at all three references areas, as well as at the 95/96 Mound Complex in 2004 was similar, but not identical, to the layer observed in the previous survey of September 2003. In the September 2003 survey, the layer appeared to be more distinct, with the rust color concentrated within the upper 1 or 2 cm of the sediment column. In the June 2004 survey, the layer was more diffuse and appeared to have been mixed downward to a greater extent within the upper sediment column compared to the appearance of the 2003 layer (Figures 3-13 and 3-14).

Further comparison of the June 2004 survey results with previous survey results show a slight but steady increase in mean RPD depths and corresponding OSI values at both the reference areas and the CLIS 95/96 Mound Complex. Historic OSI data from the reference areas and the CLIS 95/96 Mound Complex show that the median OSI values exceeded +6 and the average RPD depths were greater than 2.0 cm (Table 3-3). These results, together with the consistent observation of an advanced successional status (dominance of Stage III) over the CLIS 95/96 Mound Complex in all of the post-disposal monitoring surveys conducted to date, show that this mound recovered completely from the disturbance of disposal activity and has maintained conditions comparable to those at the reference areas (Table 3-3).

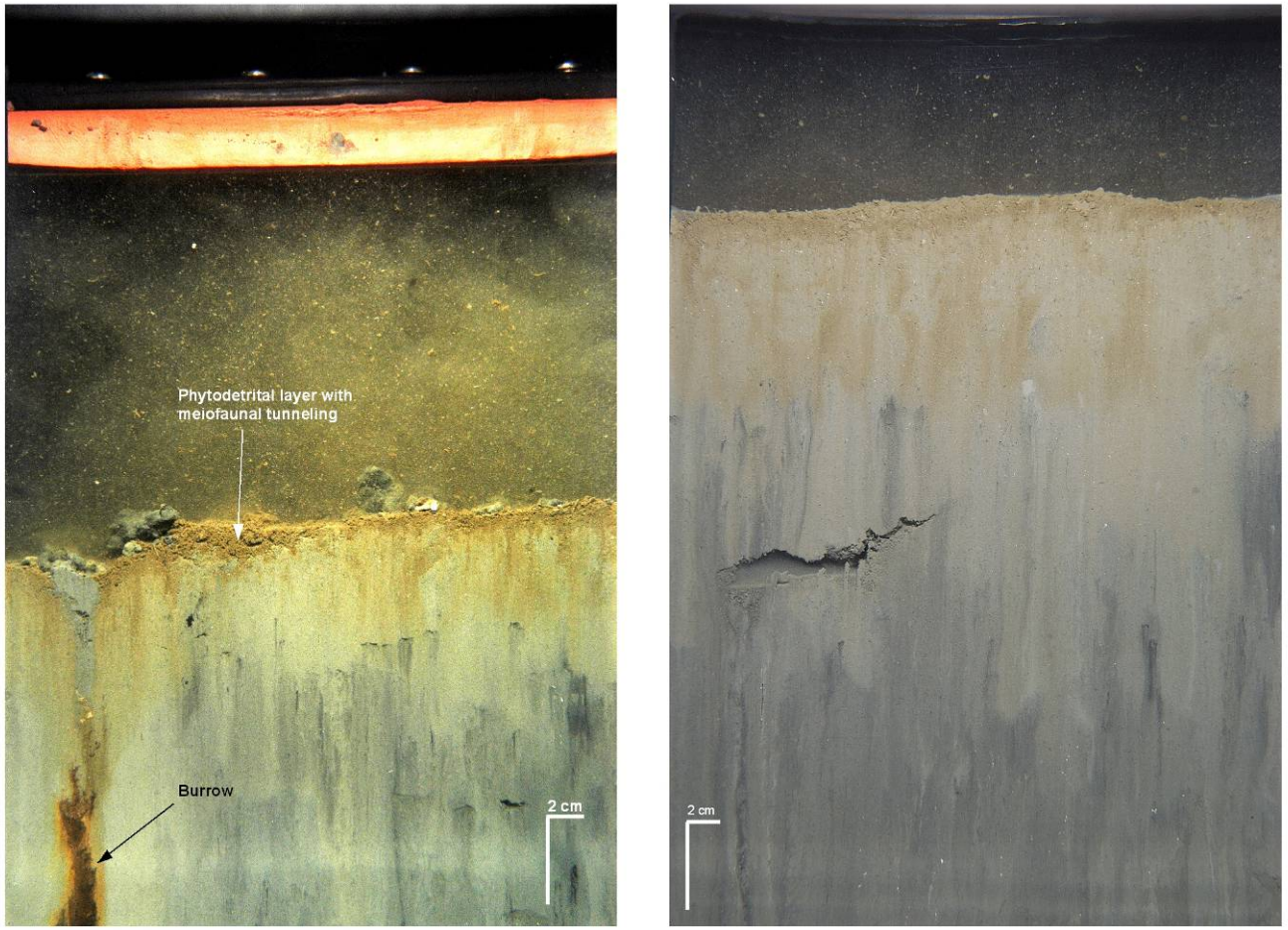

Figure 3-13. Comparison of images from reference area 2500W in September 2003 (left, Station 2 B1) and June 2004 (right, Station 05 D). Both show the presence of tan to rust-colored sediment at and just below the SWI, but in 2003 this surface layer appeared to have a more reddish/orange hue and was more concentrated within the upper 1 cm of the sediment column.

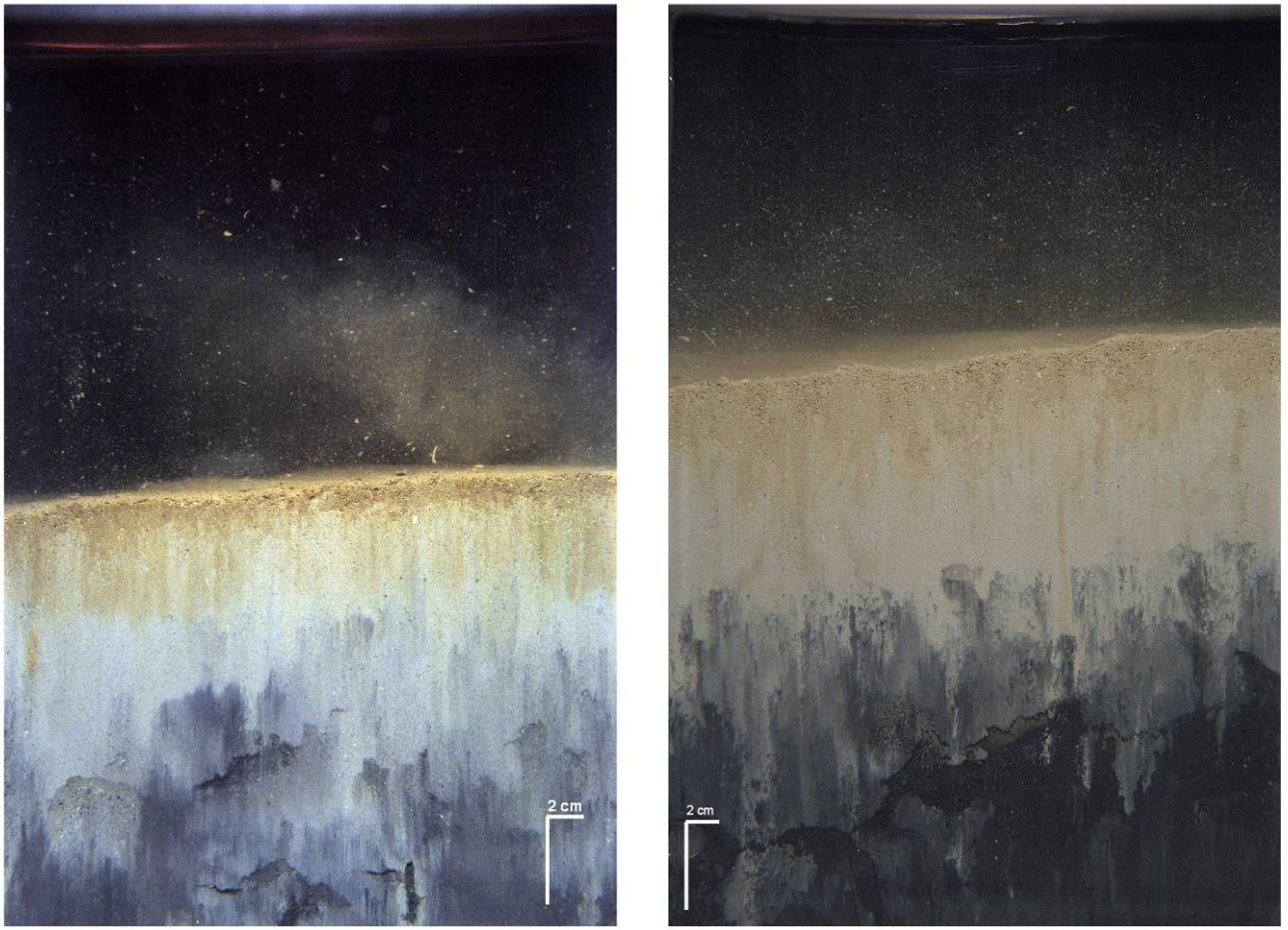

Figure 3-14. Comparison of images from the same general location of the CLIS 95/96 Mound: Station R8C7 94 B1 in September 2003 (left) and Station CLDS04 06 A in June 2004 (right). Both show the presence of tan to rust-colored sediment at and just below the SWI, but in 2003 this surface layer appeared to have a more reddish/orange hue and was more concentrated within the upper 1 cm of the sediment column.

Table 3-3
Comparison of Sediment Biological Conditions at the CLIS 95/96 Mounds and CLDS Reference Areas
Based on SPI Surveys Between 1997 and 2004

Area	Year*	Average RPD, in cm (range)	Median OSI (range)
CLIS95/96	1999	2.9 (2.2 to 4.1)	+9 (+5 to +11)
	2003	3.3 (2.0 to 4.0)	+10 (+7 to +11)
	2004	4.0 (1.7 to 5.3)	+11 (+7 to +11)
Reference	1997	2.4 (1.6 to 3.4)	+7.25 (+3.5 to+10)
	1999	3.3 (1.5 to 4.7)	+9 (+6 to +11)
	2001	3.1 (2.3 to 3.9)	+9 (+ 4 to +10)
	2003	3.0 (1.7 to 4.6)	+9.5 (+8 to +11)
	2004	4.1 (2.6 to 5.7)	+11 (+9 to +11)

*June 2001, September 1999 and September 1997 CLDS data from SAIC (2002a, 2002b, 2003); September 2003 CLDS data from ENSR (2004a)

4.0 DISCUSSION

The objectives of the June 2004 survey at CLDS included characterization of the seafloor topography of the study area, documentation of dredged material distribution, and assessment of the persistence or reoccurrence of the algal/detrital layer observed in the summer of 2003. These objectives were accomplished using bathymetric and SPI techniques.

4.1 Dredged Material Distribution

The June 2004 bathymetric survey at CLDS was intended to assess the seafloor topography of a portion of the site where dredged material had been deposited since the last survey in 2003. A new mound, CLIS 03, was observed approximately 300 m west of the CLIS 99 Mound. The relatively large mound was formed primarily from the disposal of approximately 426,000 m^3 of material during the 2003-2004 disposal season. The depth-difference map indicated that the detectable apron of the newly formed mound extended into previously formed mounds CLIS 99, CLIS 00, CLIS 01, STNH-N and CS-90-1. These historic mounds were partially encompassed into the CLIS 03 Mound, and were less distinct in the bathymetric data. The CS-90-1 Mound was wholly encompassed into the CLIS 03 Mound, and was no longer evident in the 2004 bathymetry data.

The management strategy at CLDS involves the disposal of small to moderate volumes of dredged material in rings to form containment cells. In September 2004, the CDA buoy was deployed in the southwestern quadrant of CLDS. Dredged material deposited during the 2004/2005 disposal season will likely form another discrete mound in this area.

Dredged material greater than the penetration depth of the camera prism was found in the majority of SPI images from the CLIS 95/96 Mound Complex. It was determined that the dredged material present over the CLIS 95/96 Mound Complex was old and not the result of recent disposal events. Ambient sediment was only detected in one replicate at two stations over the CLIS 95/96 Mound Complex.

4.2 Biological Conditions and Benthic Recolonization

The primary objective of the June 2004 SPI survey at CLDS was to determine whether the algal/detrital layer observed in the previous survey of September 2003 had persisted or reoccurred. The 2004 images from both the reference area and CLIS 95/96 Mound Complex showed that the sediment at and just below the SWI had a tan or rust color that was distinct from the underlying gray-colored sediment. This layer was similar, but not identical to the layer observed in the 2003 survey. In the September

2003 survey, the layer appeared to be more distinct, with the rust color concentrated within the upper 1 or 2 cm of the sediment column. In the June 2004 survey, the layer was more diffuse, with rust-colored sediment mixed downward to a greater extent within the upper sediment column (Figures 3-13 and 3-14).

The surface layers observed in both the September 2003 and June 2004 SPI surveys appeared to have a coarser and/or more flocculent texture than the underlying sediment (e.g., Figures 3-5 and 3-12). This is attributed to stimulation of bacterial decomposition processes and meiofaunal burrowing, feeding, and fecal pellet production. Such stimulation undoubtedly occurred in September 2003, resulting in the high densities of small polychaete tubes observed within the phytodetritus layer. This represents an expected and relatively short-term response of the benthos to a natural episodic event, as opposed to an indication of an adverse impact or retrograde successional pattern. The rapidly sedimented organic matter creates a relatively thin zone (i.e., microhabitat) of enhanced food supply, intense biogenic reworking, and increased benthic consumption and production. Rhoads et al. (1977) noted that such biogenic reworking of surface sediments in LIS is highest in the fall, when both water temperatures and faunal densities remain high. In the weeks following the September 2003 survey, therefore, it is reasonable to assume that significant consumption and degradation of the original phytodetrital layer occurred, making it less likely that this layer would persist over the nine months preceding the June 2004 follow-up survey.

It has been demonstrated that phytoplankton and other organic matter deposited on the sediment surface undergoes direct consumption and microbial degradation on time scales much shorter than the nine months between the two SPI surveys. Webb and Montagna (1993) demonstrated that surface-dwelling meiofauna transferred a minimum of 83% of sedimented chlorophyll *a* below the sediment-water interface in 10 days. Germano (1983) likewise found that meiofauna were significantly more important than subsurface deposit-feeding macrofauna in reworking organic matter, and a typical assemblage of Stage I organisms from LIS was capable of turning over 90% of the sediment surface in eight hours. Other investigators have shown that pulses of phytodetritus and other organic matter that settle to the bottom can greatly stimulate growth and production rates of opportunistic, surface-dwelling benthic taxa (Maughan and Oviatt 1993; Marsh and Tenore 1990). Furthermore, in studies involving the weekly addition of organic matter (wastewater solids) to mesocosms over a three month period, Maughan and Oviatt (1993) found that organic carbon generally did not build up in surface sediments but rather was rapidly consumed by increased numbers of opportunistic species feeding predominantly at the sediment-water interface.

It is therefore likely that the phytodetrital layer observed in June 2004 was not the result of the September 2003 layer persisting through time, but rather was due to a phytoplankton bloom that had occurred more recently than the bloom that produced the September 2003 layer. A review of satellite imagery for the time period prior to the June 2004 SPI survey revealed a phytoplankton bloom which began 16 days prior to the survey and persisted for approximately eight days (RUCOOL 2004) . In general, phytoplankton blooms and subsequent sinking of algal detritus to the bottom are common phenomena in LIS, particularly in the western portion in response to historically elevated nutrient inputs (Parker and O'Reilly 1991). Anderson and Taylor (2001) observed phytoplankton blooms recurring every few weeks in western LIS in response to episodic rainfall events and resulting nutrient pulses. They further noted that chlorophyll-rich particles appeared to be rapidly sedimented in this region.

The reddish or tan coloration of the top 1 to 3 cm of sediment in 2003 and 2004 can also be attributed at least in part to the presence of ferric hydroxide coatings on the sediment particles comprising this layer; such coatings would have been created under aerobic pore-water conditions (i.e., a positive redox state) existing in the upper part of the sediment column at the time of or sometime prior to the September 2003 and June 2004 surveys. Such coloration, therefore, may to varying degrees simply represent the normal appearance of muddy, aerobic surface sediments in much of central LIS. In general, the oxidized surface layer of fine-grained marine sediments has been variously described as having brown, olive-brown (i.e., tan), or brown-green coloration (Rhoads and Germano 1982; Revsbech et al. 1979; Bull and Williamson 2001; Lyle 1983; Nilsson and Rosenberg 1997; 2000).

It is not possible to state unequivocally that the layer with enhanced phaeopigments that was present in June 2004 was not simply a result of the September 2003 layer persisting over the intervening nine month period. Given that other studies have shown relatively rapid consumption/degradation of phytodetritus at the sediment-water interface, and that phytoplankton blooms occur frequently in LIS, it seems more likely that the layers were the result of separate bloom events. If this were in fact the case, the subtle difference in the appearance of the layers between 2003 and 2004 could be due to the density of the phytoplankton bloom or the level of benthic activity following deposition of the phytodetritus. Regardless of the possible differences in the 2003 and 2004 phytoplankton blooms, the results of both SPI surveys indicate that the pulses of organic matter to the sediment surface were processed rapidly and efficiently under aerobic conditions: no significant changes in RPD depths or localized zones of elevated sediment oxygen demand (SOD) were observed in the profile images.

5.0 CONCLUSIONS

The June 2004 bathymetric survey at CLDS provided a means to observe the recently formed CLIS 03 Mound and evaluate the status of older mounds in the survey area. The 2004 SPI survey allowed for assessment of the persistence/reoccurrence of the algal/detrital layer observed in the summer of 2003 and further evaluation of benthic conditions at the CLIS 95/96 Mound Complex. The presence of a newly formed thin algal/detrital layer at the sediment surface does not appear to have resulted in any negative impacts on sediment geochemistry or benthic recolonization processes at CLDS.

The 2004 survey was designed to assess the following expectations:

- The placement of 426,000 m^3 of dredged material at the CDA 03 buoy during the 2003/2004 disposal season will result in an observable disposal mound.
- An algal/detrital layer similar to the one observed in the summer 2003 survey may be visible at the sediment surface but is not expected to have a detrimental effect on the benthic community in 2004.

Following the disposal of 426,000 m^3 of dredged material during the 2003/2004 disposal season a new mound was formed, as expected, within the CLDS boundary.

The 2004 images from both the reference area and disposal mound stations showed that the sediment at and just below the SWI had a tan or rust color that was distinct from the underlying gray-colored sediment. Although generally similar to the phytodetrital layer that was observed during the 2003 survey, it was less distinct and appeared to have been mixed downward to a greater extent. It is considered more likely that the two layers resulted from settling of two separate phytoplankton blooms than from persistence through time of the signal from the first bloom of 2003. The subtle difference in the appearance of these two layers between the September 2003 and June 2004 surveys is attributed to the density of the phytoplankton bloom and subsequent settling and processing of phytodetritus prior to each survey. The results of both the 2003 and 2004 SPI surveys indicate that these two distinct pulses of organic matter to the sediment surface were being processed rapidly and efficiently under aerobic conditions, and thus not negatively impacting the benthic recolonization process.

The three CLDS reference areas and the CLIS 95/96 Mound Complex continue to exhibit well-established benthic communities. An infaunal community comprised of both surface-dwelling opportunists (Stage I) and sub-surface deposit-feeders (Stage III) has been observed consistently in both the reference and disposal mound areas. By all

measures, conditions over the surface of the CLIS 95/96 Mound Complex were comparable to those observed in the reference areas. Similar to the results of previous monitoring surveys (1999 and 2003), the June 2004 results continue to provide evidence of a complete recovery of the benthic community over the surface of the CLIS 95/96 Mound.

Based on the findings of the 2004 CLDS survey, the following recommendations are proposed:

- R1) A bathymetry survey at the location of the CDA04 buoy should be conducted to evaluate the topography of the seafloor and determine if a new mound has formed;

- R2) Periodic SPI monitoring should be performed over the newly created CLIS 03 Mound and the previously created CLIS 01 and CLIS 02 Mounds (ENSR 2004a) to confirm that a normal pattern of benthic recolonization is occurring.

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Appendix A

Disposal Barge Log Summary and Chemical Analysis Results for CLDS September 2003 to June 2004

Project Name: BRIDGEPORT HARBOR
Permittee: LOU'S BOAT BASIN
Permit Number: 199701986

Disposal Date	Volume (yd3)	Volume (m3)	Disposal Latitude	Disposal Longitude	Distance from Buoy	Direction from Buoy
10/6/2003	200	153	41.151500	-72.868167	0.7 nm	ESE
10/7/2003	400	306	41.150167	-72.881833	0.7 nm	
10/8/2003	400	306	41.151667	-72.880000		
10/9/2003	300	229	41.151667	-72.879833		
10/10/2003	200	153	41.151500	-72.878667		
10/11/2003	300	229	41.151667	-72.879667		
10/13/2003	400	306	41.150167	-72.879833		
10/14/2003	300	229	41.151667	-72.879833		
10/16/2003	400	306	41.151333	-72.881667		
10/17/2003	300	229	41.150167	-72.879667		
10/18/2003	500	382	41.150000	-72.879833		
10/19/2003	400	306	41.151667	-72.878500		
10/20/2003	200	153	41.152500	-72.879000		
4/27/2004	900	688	41.151650	-72.880133	50 ft	S
4/29/2004	800	612	41.151867	-72.880233	20 ft	N
4/30/2004	500	382	41.151817	-72.880017	10 ft	NE
5/4/2004	600	459	41.151917	-72.880167	40 ft	NE
5/5/2004	615	470	41.151883	-72.880233	70 ft	NE
5/7/2004	700	535	41.151750	-72.880050	20 ft	S
5/11/2004	800	612	41.151683	-72.880033	20 ft	N
5/12/2004	900	688	41.151817	-72.880100	20 ft	N
5/13/2004	900	688	41.152000	-72.880233	100 ft	N
5/14/2004	475	363	41.151650	-72.880050	5 ft	S
5/19/2004	700	535	41.151817	-72.880167	20 ft	N
5/25/2004	850	650	41.151883	-72.880067	10 ft	NE
5/26/2004	850	650	41.151800	-72.880200	10 ft	NE
5/27/2004	725	554	41.151817	-72.879983	75 ft	E
Total Dredged Material Volume:	14,615	11,173				

Project Name: NEW HAVEN HARBOR
Permittee: GULF OIL L.P.
Permit Number: 199902909

Disposal Date	Volume (yd3)	Volume (m3)	Disposal Latitude	Disposal Longitude	Distance from Buoy	Direction from Buoy
11/26/2003	900	688	41.151817	-72.880200	50 ft	
12/3/2003	1300	994	41.151817	-72.880333		
12/4/2003	1500	1147	41.151817	-72.880133		
12/16/2003	1500	1147	41.151817	-72.880233		
12/17/2003	1500	1147	41.151817	-72.880333		
12/19/2003	800	612	41.151817	-72.880233		
12/19/2003	1500	1147	0.000000	0.000000		
1/3/2004	600	459	41.151817	-72.880233		
1/5/2004	1200	917	41.166000	-72.882033		
1/5/2004	1500	1147	41.150083	-72.880000		
1/9/2004	1500	1147	41.151667	-72.880400	100 ft	
1/9/2004	0	0	41.151817	-72.880233	50 ft	N
1/10/2004	1500	1147	41.151817	-72.878567	90 ft	W
1/11/2004	1000	765	41.152533	-72.879950	120 ft	W
1/14/2004	1300	994	41.152000	-72.880100		
1/20/2004	1500	1147	41.151817	-72.880100	100 ft	
1/21/2004	1500	1147	41.151817	-72.880000	50 ft	
1/24/2004	1200	917	41.151817	-72.880167	10 ft	
1/25/2004	1300	994	41.151817	-72.880300	30 ft	
1/26/2004	1200	917	41.151600	-72.879817	30 ft	W
1/31/2004	600	459	41.152333	-72.882000	120 ft	W
2/1/2004	1300	994	41.151667	-72.873167	150 ft	SW
4/20/2004	700	535	41.151833	-72.880000	90 ft	E
4/22/2004	650	497	41.151800	-72.880750	60 ft	W
4/26/2004	500	382	41.151667	-72.880000	60 ft	E
4/27/2004	500	382	41.151700	-72.880667	60 ft	W
4/29/2004	300	229	41.151833	-72.880000	60 ft	SW
5/4/2004	650	497	41.151817	-72.880667	75 ft	SW
Total Dredged Material Volume:	29,500	22,555				

Project Name: NORWALK HARBOR
Permittee: VILLAGE CREEK HARBOR ASSOC.
Permit Number: 200100183

Disposal Date	Volume (yd3)	Volume (m3)	Disposal Latitude	Disposal Longitude	Distance from Buoy	Direction from Buoy
12/30/2003	700	535	41.151817	-72.880233		
1/3/2004	700	535	41.151817	-72.880233		
1/4/2004	700	535	41.151833	-72.880233		
1/6/2004	700	535	41.151717	-72.880233		
Total Dredged Material Volume:	2,800	2,140				

Project Name: CONN. RIVER
Permittee: CONN DEP
Permit Number: 200100278

Disposal Date	Volume (yd3)	Volume (m3)	Disposal Latitude	Disposal Longitude	Distance from Buoy	Direction from Buoy
10/3/2003	1300	994	41.152583	-72.879717	75 ft	
10/6/2003	1300	994	41.151917	-72.879333	75 ft	
Total Dredged Material Volume:	2,600	1,988				

Project Name: SOUTHPORT HARBOR
Permittee: PEQUOT YACHT CLUB
Permit Number: 200100514

Disposal Date	Volume (yd3)	Volume (m3)	Disposal Latitude	Disposal Longitude	Distance from Buoy	Direction from Buoy
10/3/2003	600	459	41.152117	-72.879967	50 ft	N
10/5/2003	600	459	41.151267	-72.879450	75 ft	S
10/7/2003	700	535	41.151800	-72.879750	120 ft	E
1/7/2003	720	550	41.151733	-72.880117	50 ft	NE
10/8/2003	725	554	41.152150	-72.880083	60 ft	NE
10/9/2003	700	535	41.151967	-72.880333	100 ft	N
10/11/2003	725	554	41.151567	-72.880133	100 ft	S
10/14/2003	730	558	41.151900	-72.880233	10 ft	W
10/17/2003	720	550	41.151817	-72.880050	25 ft	E
10/18/2003	720	550	41.151683	-72.880167	10 ft	E
10/23/2003	775	593	41.151833	-72.880083	25 ft	E
10/24/2003	775	593	41.151817	-72.880367	100 ft	W
10/24/2003	800	612	41.151817	-72.880133		
10/28/2003	720	550	41.151833	-72.880250		
10/30/2003	820	627	41.151883	-72.880100		
10/31/2003	790	604	41.151817	-72.880083		
11/1/2003	800	612	41.151783	-72.880200		
11/2/2003	800	612	41.151817	-72.880233		
11/3/2003	800	612	41.151817	-72.880233		
11/5/2003	800	612	41.151817	-72.880067		
11/6/2003	775	593	41.151817	-72.880333		
11/7/2003	825	631	41.151733	-72.880000		
11/9/2003	800	612	41.151800	-72.880167		
11/10/2003	800	612	41.151733	-72.880233		
11/11/2003	700	535	41.151733	-72.880133		
11/11/2003	780	596	41.151617	-72.880233		
11/14/2003	650	497	0.000000	0.000000		
11/16/2003	800	612	41.151700	-72.880233		
11/17/2003	800	612	41.151750	-72.880233		
11/18/2003	800	612	41.151667	-72.880233		
11/19/2003	800	612	0.000000	0.000000		
11/22/2003	750	573	41.151700	-72.880167		
11/23/2003	800	612	41.151817	-72.880233		
12/27/2003	400	306	41.151817	-72.880167		
Total Dredged Material Volume:	25,300	19,346				

Project Name: WEST RIVER CHANNEL
Permittee: GUILFORD YACHT CLUB
Permit Number: 200101571

Disposal Date	Volume (yd3)	Volume (m3)	Disposal Latitude	Disposal Longitude	Distance from Buoy	Direction from Buoy
2/5/2004	500	382	41.151400	-72.880167	150 ft	W
2/5/2004	0	0	41.151667	-72.880167	30 ft	W
2/8/2004	500	382	41.151833	-72.880333	30 ft	W
Total Dredged Material Volume:	1,000	764				

Project Name: WEST RIVER/GUILFORD HARBOR
Permittee: GUILFORD YACHT CLUB
Permit Number: 200101572

Disposal Date	Volume (yd3)	Volume (m3)	Disposal Latitude	Disposal Longitude	Distance from Buoy	Direction from Buoy
3/27/2004	350	268	41.151500	-72.882167		
4/3/2004	300	229	41.151833	-72.881000		
4/4/2004	350	268	41.151833	-72.881000		
4/6/2004	400	306	41.151833	-72.881333		
4/7/2004	400	306	41.151833	-72.881333		
Total Dredged Material Volume:	1,800	1,377				

Project Name: GWENMOR MARINA
Permittee: NORWALK HARBORVIEW CONDO ASSOC
Permit Number: 200102259

Disposal Date	Volume (yd3)	Volume (m3)	Disposal Latitude	Disposal Longitude	Distance from Buoy	Direction from Buoy
10/29/2003	300	229	41.151817	-72.880233		
10/30/2003	300	229	41.151783	-72.879917		
10/31/2003	300	229	41.151817	-72.880233		
11/4/2003	300	229	41.151817	-72.880233		
11/6/2003	300	229	41.151817	-72.880233		
Total Dredged Material Volume:	1,500	1,145				

Project Name: HARBOR POINT MARINA
Permittee: HARBOR POINT MARINA
Permit Number: 200102331

Disposal Date	Volume (yd3)	Volume (m3)	Disposal Latitude	Disposal Longitude	Distance from Buoy	Direction from Buoy
5/17/2004	400	306	41.151667	-72.880167	30 ft	S
5/18/2004	400	306	41.152000	-72.879000	50 ft	N
5/19/2004	300	229	41.151833	-72.880000		
Total Dredged Material Volume:	1,100	841				

Project Name: EAST BRANCH OF NORWALK RIVER
Permittee: NORMAN BLOOM MARINA
Permit Number: 200102523

Disposal Date	Volume (yd3)	Volume (m3)	Disposal Latitude	Disposal Longitude	Distance from Buoy	Direction from Buoy
10/2/2003	300	229	41.151667	-72.880317	20 ft	N
10/3/2003	300	229	41.151817	-72.880233		
10/7/2003	300	229	41.151817	-72.880233		
10/8/2003	300	229	41.151817	-72.880233		
10/9/2003	300	229	41.151650	-72.879667	30 ft	S
10/11/2003	300	229	41.151817	-72.880233		
10/13/2003	300	229	41.151817	-72.880233		
10/20/2003	300	229	41.151817	-72.880233		
10/23/2003	300	229	41.151817	-72.880233		
10/25/2003	300	229	41.151750	-72.879733	20 ft	N
10/26/2003	300	229	41.151817	-72.880233		
Total Dredged Material Volume:	3,300	2,519				

Project Name: NORWALK HARBOR
Permittee: HILLARD BLOOM SHELLFISH
Permit Number: 200200687

Disposal Date	Volume (yd3)	Volume (m3)	Disposal Latitude	Disposal Longitude	Distance from Buoy	Direction from Buoy
11/8/2003	900	688	41.151000	-72.878667	50 ft	SE
11/9/2003	900	688	41.151667	-72.880167	20 ft	SSW
11/10/2003	500	382	41.152000	-72.880333	30 ft	WNW
Total Dredged Material Volume:	2,300	1,758				

Project Name: NORWALK HARBOR
Permittee: EAST NORWALK BOAT & YACHT CLUB
Permit Number: 200200688

Disposal Date	Volume (yd3)	Volume (m3)	Disposal Latitude	Disposal Longitude	Distance from Buoy	Direction from Buoy
11/22/2003	300	229	41.151817	-72.880233		
11/23/2003	300	229	41.151817	-72.880233		
11/24/2003	200	153	41.151817	-72.880233		
Total Dredged Material Volume:	800	611				

Project Name: NEW HAVEN HARBOR
Permittee: MAGELLAN TERMINAL HOLDINGS
Permit Number: 200201396

Disposal Date	Volume (yd3)	Volume (m3)	Disposal Latitude	Disposal Longitude	Distance from Buoy	Direction from Buoy
10/12/2003	1350	1032	41.152000	-72.879750	50 ft	
10/13/2003	1000	765	41.151817	-72.880233	50 ft	
10/17/2003	1000	765	41.151967	-72.879817	75 ft	
10/30/2003	1100	841	41.151833	-72.880267	75 ft	
11/26/2003	300	229	41.151817	-72.880100		
11/30/2003	1250	956	41.152000	-72.880233	50 ft	
12/4/2003	800	612	0.000000	0.000000		
12/8/2003	800	612	41.151750	-72.880333		
12/8/2003	1500	1147	41.151817	-72.880167		
12/9/2003	1500	1147	41.151817	-72.880233		
12/10/2003	500	382	41.151817	-72.880233		
12/13/2003	500	382	41.151817	-72.880233		
12/13/2003	1500	1147	41.151817	-72.880333		
12/16/2003	800	612	41.151817	-72.880167		
12/17/2003	1500	1147	41.151817	-72.880333		
12/20/2003	300	229	41.151817	-72.880333		
12/20/2003	1000	765	41.151733	-72.880167		
12/23/2003	400	306	0.000000	0.000000		
1/17/2004	500	382	41.151850	-72.880100		
1/31/2004	200	153	41.152333	-72.882000	120 ft	W
2/1/2004	200	153	41.151667	-72.873167	150 ft	SW
Total Dredged Material Volume:	18,000	13,764				

Project Name: NEW HAVEN HARBOR
Permittee: MAGELLAN TERMINAL HOLDINGS
Permit Number: 200201397

Disposal Date	Volume (yd3)	Volume (m3)	Disposal Latitude	Disposal Longitude	Distance from Buoy	Direction from Buoy
10/16/2003	1350	1032	41.151800	-72.880000	50 ft	
11/30/2003	500	382	41.151817	-72.880050		
12/16/2003	800	612	41.151817	-72.880167		
12/23/2003	400	306	0.000000	0.000000		
Total Dredged Material Volume:	3,050	2,332				

Project Name: NEW HAVEN HARBOR
Permittee: NEW HAVEN TERMINAL
Permit Number: 200201398

Disposal Date	Volume (yd3)	Volume (m3)	Disposal Latitude	Disposal Longitude	Distance from Buoy	Direction from Buoy
10/19/2003	900	688	41.159667	-72.880450	75 ft	
10/21/2003	1200	917	41.151833	-72.880300	75 ft	
10/22/2003	1200	917	41.151850	-72.880267	100 ft	
10/23/2003	1000	765	41.151833	-72.880267	75 ft	
10/24/2003	1200	917	41.151850	-72.880317	100 ft	
10/26/2003	1200	917	41.151833	-72.880250	75 ft	
10/28/2003	1500	1147	41.151950	-72.880033	100 ft	
11/1/2003	1500	1147	41.166333	-72.880233	100 ft	
11/3/2003	1350	1032	41.151967	-72.880117	75 ft	
11/5/2003	1500	1147	41.151817	-72.880567	75 ft	
11/6/2003	1500	1147	41.151667	-72.880400	75 ft	
11/7/2003	1000	765	41.151817	-72.880083	75 ft	
11/10/2003	1500	1147	41.151817	-72.880750	50 ft	
11/11/2003	1000	765	41.151783	-72.880167	20 ft	W
11/12/2003	1500	1147	41.151683	-72.879683	25 ft	SW
11/15/2003	1500	1147	41.151833	-72.880117	75 ft	
11/26/2003	200	153	41.151817	-72.880100		
12/10/2003	750	573	41.151817	-72.880233		
12/12/2003	1500	1147	41.151817	-72.880233		
12/13/2003	300	229	41.151817	-72.880233		
12/20/2003	300	229	41.151817	-72.880333		
12/20/2003	1000	765	41.151733	-72.880167		
12/27/2003	750	573	41.151867	-72.880100		
Total Dredged Material Volume:	25,350	19,381				

Project Name: NORWALK HARBOR
Permittee: ISHODA YACHT CLUB
Permit Number: 200201498

Disposal Date	Volume (yd3)	Volume (m3)	Disposal Latitude	Disposal Longitude	Distance from Buoy	Direction from Buoy
11/10/2003	400	306	41.152000	-72.880333	30 ft	WNW
11/12/2003	500	382	41.151833	-72.880167	20 ft	W
Total Dredged Material Volume:	900	688				

Project Name: BASIN & YACHT CLUB
Permittee: PINE ORCHARD YACHT & COUNTRY CLUB
Permit Number: 200201501

Disposal Date	Volume (yd3)	Volume (m3)	Disposal Latitude	Disposal Longitude	Distance from Buoy	Direction from Buoy
11/28/2003	900	688	41.152000	-72.879167	50 ft	N
12/4/2003	900	688	41.151833	-72.878833	50 ft	NE
4/15/2004	900	688	41.152000	-72.881167		
4/16/2004	950	726	41.151833	-72.881333		
4/17/2004	950	726	41.151833	-72.881500		
4/18/2004	900	688	41.151500	-72.881500		
4/19/2004	900	688	41.151667	-72.881500		
4/20/2004	950	726	41.151833	-72.881500		
4/21/2004	950	726	41.151833	-72.881500		
4/22/2004	900	688	41.151833	-72.881333		
4/23/2004	950	726	41.151833	-72.881500		
4/24/2004	900	688	41.151667	-72.881333		
4/26/2004	950	726	41.151500	-72.881333		
4/27/2004	950	726	41.151833	-72.881500		
4/28/2004	900	688	41.151833	-72.881333		
4/29/2004	900	688	41.151833	-72.881333		
4/30/2004	950	726	41.151833	-72.881333		
5/3/2004	950	726	41.151833	-72.881333		
5/4/2004	950	726	41.151833	-72.881333		
5/5/2004	900	688	41.151833	-72.881167		
Total Dredged Material Volume:	18,500	14,140				

Project Name: WEST RIVER CHANNEL
Permittee: GUILFORD YACHT CLUB
Permit Number: 200201571

Disposal Date	Volume (yd3)	Volume (m3)	Disposal Latitude	Disposal Longitude	Distance from Buoy	Direction from Buoy
1/18/2004	700	535	0.000000	0.000000		
1/20/2004	700	535	41.151817	-72.880033	50 ft	
1/21/2004	500	382	41.151817	-72.880267	25 ft	
1/23/2004	400	306	41.151817	-72.880233	20 ft	
1/25/2004	500	382	41.152350	-72.879883	90 ft	W
1/27/2004	400	306	41.151833	-72.880067	45 ft	W
2/10/2004	400	306	41.151583	-72.879583	10 ft	S
2/11/2004	400	306	41.151467	-72.879383	35 ft	S
2/12/2004	400	306	41.151400	-72.879167	30 ft	S
2/13/2004	400	306	41.151817	-72.879733	10 ft	N
2/16/2004	400	306	41.151817	-72.880483	70 ft	N
2/17/2004	400	306	41.151817	-72.880350	5 ft	S
2/17/2004	0	0	41.152033	-72.880033	30 ft	N
2/19/2004	400	306	41.151817	-72.880233	5 ft	N
2/20/2004	400	306	41.151867	-72.880333	25 ft	N
2/26/2004	400	306	41.151917	-72.879833	10 ft	N
Total Dredged Material Volume:	6,800	5,200				

Project Name: NEW HAVEN HARBOR
Permittee: PSEG POWER CONN LC
Permit Number: 200201650

Disposal Date	Volume (yd3)	Volume (m3)	Disposal Latitude	Disposal Longitude	Distance from Buoy	Direction from Buoy
11/18/2003	800	612	41.151817	-72.880233	55 ft	
11/20/2003	1500	1147	41.151817	-72.880417	75 ft	
11/21/2003	1500	1147	41.166333	-72.880400	50 ft	
11/22/2003	1500	1147	41.151867	-72.879850	10 ft	
11/24/2003	1500	1147	41.151817	-72.880400	75 ft	
11/25/2003	1500	1147	41.151667	-72.880333	75 ft	
11/28/2003	1500	1147	41.152050	-72.880133		
12/3/2003	500	382	41.151817	-72.880017		
12/27/2003	750	573	41.151867	-72.880100		
12/29/2003	600	459	41.151817	-72.880233		
1/3/2004	650	497	41.151817	-72.880233		
Total Dredged Material Volume:	12,300	9,405				

Project Name: NORWALK HARBOR
Permittee: HILLARD BLOOM SHELLFISH
Permit Number: 200201736

Disposal Date	Volume (yd3)	Volume (m3)	Disposal Latitude	Disposal Longitude	Distance from Buoy	Direction from Buoy
11/12/2003	400	306	41.151833	-72.880167	20 ft	W
11/15/2003	800	612	41.151667	-72.880000	30 ft	S
Total Dredged Material Volume:	1,200	918				

Project Name: NORWALK HARBOR
Permittee: BLOOM BROTHERS MARINA
Permit Number: 200202109

Disposal Date	Volume (yd3)	Volume (m3)	Disposal Latitude	Disposal Longitude	Distance from Buoy	Direction from Buoy
11/16/2003	500	382	41.151667	-72.880333	40 ft	W
11/17/2003	400	306	41.151500	-72.880000	30 ft	S
11/18/2003	400	306	41.151667	-72.880500	40 ft	W
11/21/2003	500	382	41.151667	-72.880167	20 ft	S
11/22/2003	400	306	41.151667	-72.880000	50 ft	SW
11/23/2003	500	382	41.151667	-72.880167	30 ft	WSW
11/24/2003	500	382	41.151833	-72.880333	40 ft	W
Total Dredged Material Volume:	3,200	2,446				

Project Name: WEST RIVER/GUILFORD HARBOR
Permittee: GUILFORD YACHT CLUB
Permit Number: 200301752

Disposal Date	Volume (yd3)	Volume (m3)	Disposal Latitude	Disposal Longitude	Distance from Buoy	Direction from Buoy
3/14/2004	350	268	41.152333	-72.879167	20 ft	N
3/15/2004	400	306	41.151833	-72.881500	576 ft	SSW
3/20/2004	400	306	41.152000	-72.881333		
3/21/2004	350	268	41.152000	-72.881167		
3/22/2004	400	306	41.151833	-72.881500		
3/23/2004	400	306	41.152000	-72.881167		
3/24/2004	400	306	41.152000	-72.881167		
3/26/2004	350	268	41.151833	-72.881167		
3/28/2004	400	306	41.152000	-72.881333		
3/29/2004	350	268	41.151833	-72.881500		
3/30/2004	400	306	41.151833	-72.881167		
Total Dredged Material Volume:	4,200	3,214				

Project Name: NEW HAVEN HARBOR
Permittee: COE NEW HAVEN HARBOR
Permit Number: 2003C0001

Disposal Date	Volume (yd3)	Volume (m3)	Disposal Latitude	Disposal Longitude	Distance from Buoy	Direction from Buoy
12/11/2003	4500	3440	41.151333	-72.873833	300 ft	E
12/11/2003	5000	3823	41.150667	-72.884667		
12/11/2003	0	0	41.151500	-72.873500	400 ft	E
12/12/2003	3800	2905	41.150500	-72.874167	200 ft	W
12/12/2003	4000	3058	41.150000	-72.875167	250 ft	W
12/12/2003	5400	4129	41.152917	-72.879028	150 ft	E
12/13/2003	4100	3135	41.152917	-72.879028	150 ft	E
12/13/2003	4700	3593	41.151333	-72.881028	150 ft	W
12/13/2003	5563	4253	41.151889	-72.879583	50 ft	E
12/14/2003	4700	3593	41.151111	-72.881945	150 ft	W
12/14/2003	5774	4415	41.152500	-72.880917	200 ft	SE
12/15/2003	4935	3773	41.151889	-72.878417	300 ft	E
12/15/2003	5353	4093	41.151817	-72.879667	100 ft	
12/16/2003	4100	3135	41.151817	-72.879933	150 ft	E
12/16/2003	4700	3593	41.151817	-72.880467	50 ft	W
12/16/2003	4900	3746	41.151817	-72.879833	200 ft	E
12/16/2003	4935	3773	41.152017	-72.879267		E
12/17/2003	3900	2982	41.152000	-72.880183	60 ft	NW
12/17/2003	5563	4253	41.151867	-72.881583	300 ft	W
12/18/2003	5500	4205	41.151933	-72.879417	200 ft	E
12/19/2003	1100	841	41.151450	-72.880667	200 ft	SW
12/19/2003	4400	3364	41.151667	-72.880417	50 ft	W
12/20/2003	1900	1453	41.151767	-72.880167	20 ft	SE
12/20/2003	5100	3899	41.151500	-72.880767	175 ft	NW
12/20/2003	0	0	41.151533	-72.881383	300 ft	W
12/21/2003	1965	1502	41.151433	-72.878333	480 ft	E
12/21/2003	5100	3899	41.152467	-72.879217	360 ft	NE
12/21/2003	5535	4232	41.151633	-72.881867	430 ft	W
12/22/2003	4935	3773	41.151600	-72.880333	35 ft	SW
12/22/2003	0	0	41.151717	-72.879867	100 ft	E
12/23/2003	5100	3899	41.151450	-72.881450	340 ft	SW
12/23/2003	0	0	41.151600	-72.880600	90 ft	W
12/23/2003	5774	4415	41.151500	-72.879767	150 ft	SE
12/24/2003	4500	3440	41.151750	-72.879883	95 ft	ESE
12/24/2003	4774	3650	41.151950	-72.880050	55 ft	NE
12/25/2003	5300	4052	41.151883	-72.880133	45 ft	SE
12/25/2003	5500	4205	41.151633	-72.880433	85 ft	SW
12/26/2003	5142	3931	41.151817	-72.879133	290 ft	E
12/26/2003	5300	4052	41.151817	-72.880933	190 ft	W
12/26/2003	0	0	41.151883	-72.880500	72 ft	W
12/27/2003	5100	3899	41.151750	-72.880500	80 ft	SW
12/27/2003	0	0	41.152333	-72.879683	225 ft	NE
12/28/2003	4523	3458	41.151917	-72.880517	75 ft	NW
12/28/2003	5143	3932	41.151750	-72.880667	120 ft	W
12/28/2003	5353	4093	41.152267	-72.879850	134 ft	NE
12/29/2003	4500	3440	41.151633	-72.880667	150 ft	W
12/29/2003	4728	3615	41.151750	-72.880350	35 ft	W
12/29/2003	5300	4052	41.151933	-72.880167	25 ft	NE
12/30/2003	3500	2676	41.152160	-72.880698	150 ft	W
12/30/2003	4938	3775	41.151050	-72.881133	350 ft	SW
12/30/2003	0	0	41.151833	-72.880050	48 ft	NE
12/30/2003	5335	4079	0.000000	0.000000		

12/31/2003	3500	2676	41.151730	-72.880741	150 ft	W
12/31/2003	3800	2905	41.151721	-72.880928	150 ft	W
12/31/2003	0	0	41.151803	-72.880560	180 ft	W
12/31/2003	0	0	41.151830	-72.880562	210 ft	W
12/31/2003	3900	2982	41.151803	-72.880560	195 ft	W
12/31/2003	4500	3440	41.151367	-72.880333	166 ft	SW
12/31/2003	4938	3775	41.151550	-72.879583	225 ft	SE
1/1/2004	3300	2523	41.151694	-72.880545	195 ft	W
1/1/2004	0	0	41.151959	-72.881004	165 ft	W
1/1/2004	3400	2599	41.152036	-72.879986	105 ft	W
1/1/2004	3600	2752	41.151760	-72.879974	180 ft	W
1/1/2004	0	0	41.151901	-72.880897	120 ft	W
1/1/2004	4900	3746	41.151633	-72.880417	60 ft	SW
1/1/2004	5300	4052	41.151833	-72.879583	175 ft	E
1/2/2004	3400	2599	41.151824	-72.880635	180 ft	W
1/2/2004	3500	2676	41.151769	-72.880487	180 ft	W
1/2/2004	3600	2752	41.152075	-72.880141	195 ft	W
1/2/2004	5300	4052	41.152850	-72.880550	375 ft	NW
1/3/2004	3200	2447	41.152055	-72.880398	180 ft	W
1/3/2004	3400	2599	41.151847	-72.880532		
1/3/2004	3500	2676	41.151642	-72.880979	210 ft	W
1/3/2004	3600	2752	41.151766	-72.880116	180 ft	W
1/3/2004	0	0	41.151968	-72.880208	255 ft	W
1/3/2004	4813	3680	41.151117	-72.881267	310 ft	SW
1/4/2004	3100	2370	41.151350	-72.880317		
1/6/2004	4500	3440	41.151750	-72.880417	50 ft	W
1/12/2004	4728	3615	41.151817	-72.880233		
1/12/2004	5700	4358	41.151817	-72.880000	75 ft	E
1/13/2004	5353	4093	41.151817	-72.880567	135 ft	W
1/12/2004	0	0	0.000000	-72.880233		
1/14/2004	4600	3517	41.151817	-72.880400	70 ft	W
Total Dredged Material Volume:	314,700	240,599				

Appendix B

Sediment-Profile Image Results for CLDS
June 2004 Survey

Table B-1
Grain Size Scale for Sediments

Phi (Φ) size	Size range (mm)	Size class (Wentworth class)
< -1	> 2	Gravel
0 to –1	1 to 2	Very coarse sand
1 to 0	0.5 to 1	Coarse sand
2 to 1	0.25 to 0.5	Medium sand
3 to 2	0.125 to 0.25	Fine sand
4 to 3	0.0625 to 0.125	Very fine sand
> 4	< 0.0625	Silt/clay

Table B-2
Sediment-Profile Image Results for Reference Stations at CLDS

Station	REP	Date	Time	Minimum Penetration Depth (cm)	Maximum Penetration Depth (cm)	Mean Penetration Depth (cm)	Penetration Area (sq.cm)	Boundary Roughness (cm)	Min Dredged Material Thickness (cm)	Max Dredged Material Thickness (cm)	Mean Dredged Material Thickness (cm)	Total Dredged Material Area	Minimum Grain Size (phi)	Maximum Grain Size (phi)	Major Mode Grain Size (phi)	Minimum RPD (cm)	Maximum RPD (cm)	Mean RPD (cm)	RPD Area	Void #	Void Minimum Depth (cm)	Void Maximum Depth (cm)	Void Average Depth (cm)	Mud Clast #	Mud Clast State	METHANE	Low DO	Successional Stage	OSI	COMMENT
2500W 01	A	6/29/2004	9:50:10	15.22	15.51	15.35	224.04	0.29	-	-	0.00	0.00	>4	1	>4	1.57	2.80	2.16	31.54	3	4.74	14.45	9.60	0	-	None	No	Stage I on III	8	Gray, shelly, silt/clay with tan RPD. Numerous shallow dwelling organisms and burrows. Buried mudclast with oxidized rind in upper left. Active voids in upper mi left and lower right. Burrow trace above voids at right. Several small tubes (at leas
2500W 01	B	6/29/2004	9:51:17	16.96	17.22	17.14	250.18	0.26	-	-	0.00	0.00	>4	2	>4	1.29	4.23	2.93	42.71	5	2.66	15.88	9.27	1	R	None	No	Stage I on III	9	Gray silt/clay with tan RPD. Reduced, artifactual mudclast in left-center SWI. Shallow burrows and two shallow feeding voids. Three active deep feeding voids. Nemertean at right. Nice tubes in left center SWI. Phytodetritus/phaeopigments in upper
2500W 01	C	6/29/2004	9:52:33	15.65	16.25	15.81	230.75	0.60	-	-	0.00	0.00	>4	2	>4	1.46	3.17	2.63	38.42	2	10.08	12.77	11.42	1	R	None	No	Stage I on III	9	Gray slightly shelly silt/clay with tan RPD and floccular layer of silt and planktonic seston at SWI. Phaeopigments visible in seston layer and are being incorporated into the sediments column. Numerous tubes and tube fragments at SWI. Oxidized small v
2500W 02	A	6/29/2004	10:06:47	16.74	16.99	16.85	245.91	0.26	-	-	0.00	0.00	>4	2	>4	2.34	3.54	3.21	46.87	6	3.40	14.25	8.82	3	R	None	No	Stage I on III	10	Gray silt/clay with shell fragments throughout the sediment column. Phaeopigments/planktonic seston at SWI and in upper 0.5-to 1 cm of sediment column. Feeding voids are well-formed and active with either oxidized halo or floored with oxidized sediment.
2500W 02	B	6/29/2004	10:07:58	15.54	16.22	15.85	231.25	0.69	-	-	0.00	0.00	>4	2	>4	1.69	3.14	2.25	32.85	3	9.62	12.45	11.04	2	R	None	No	Stage I on III	8	Gray silt with tan RPD and some planktonic seston/phaeopigments in upper 1 cm of sediment column. Burrow and feeding depression at far left with organism smeared in left hand side of photo. Two voids in lower right. Numerous small mud tubes intact and
2500W 02	C	6/29/2004	10:08:58	16.76	17.74	17.24	251.62	0.97	-	-	0.00	0.00	>4	2	>4	2.06	2.77	2.50	36.53	6	4.48	16.85	10.67	2	R	None	No	Stage I on III	9	Gray silt/clay with tan RPD. Some planktonic seston/phaeopigments in upper 1.5 cm of sediment column. Numerous active voids throughout the sediment column. Few small tubes and shallow burrow in upper far left. Mudclasts at SWI are artifacts Top 1 c
2500W 03	A	6/29/2004	10:23:13	14.79	15.37	15.07	219.98	0.57	-	-	0.00	0.00	>4	2	>4	3.34	4.20	3.57	52.08	2	6.03	8.65	7.34	0	-	None	No	Stage I on III	10	Gray silt/clay with tan RPD and orangish planktonic seston/phaeopigments at SWI. Possible old DM as there are faint laminations (4) related to porosity transitions as well as a thin band of light gray clay 10.1 cm below the SWI. Two active voids at righ
2500W 03	B	6/29/2004	10:24:09	16.08	16.56	16.31	238.09	0.49	-	-	0.00	0.00	>4	2	>4	1.06	2.51	1.85	26.98	6	4.51	14.97	9.74	2	R	None	No	Stage I on III	8	Gray silt/clay with tan RPD that contains planktonic seston/phaeopigments. Two shallow voids in upper right and four deep void/burrow complexes with oxidized sediment at depth. Mudclast at SWI is artifact. Thin band of reduced sediment underlies RPD.
2500W 03	C	6/29/2004	10:26:44	16.79	17.42	17.14	250.16	0.63	-	-	0.00	0.00	>4	2	>4	1.14	4.28	2.95	43.12	3	11.68	15.62	13.65	2	1O-1R	None	No	Stage I on III	9	Gray silt/clay with tan RPD that contains planktonic seston/phaeopigments. Three sediment-filled oxidized voids in lower center. Several small burrows in upper 4 cm of sediment column and long, oxidized burrow at right. A few small, thin polychaetes in

Table B-2
Sediment-Profile Image Results for Reference Stations at CLDS

Station	REP	Date	Time	Minimum Penetration Depth (cm)	Maximum Penetration Depth (cm)	Mean Penetration Depth (cm)	Penetration Area (sq.cm)	Boundary Roughness (cm)	Min Dredged Material Thickness (cm)	Max Dredged Material Thickness (cm)	Mean Dredged Material Thickness (cm)	Total Dredged Material Area	Minimum Grain Size (phi)	Maximum Grain Size (phi)	Major Mode Grain Size (phi)	Minimum RPD (cm)	Maximum RPD (cm)	Mean RPD (cm)	RPD Area	Void #	Void Minimum Depth (cm)	Void Maximum Depth (cm)	Void Average Depth (cm)	Mud Clast #	Mud Clast State	METHANE	Low DO	Successional Stage	OSI	COMMENT
2500W 04	A	6/29/2004	9:58:13	12.45	13.25	12.87	187.85	0.80	-	-	0.00	0.00	>4	2	>4	1.86	5.14	3.09	45.17	4	1.00	13.20	7.10	2	R	None	No	Stage I on III	10	Gray silt/clay with tan RPD that contains planktonic seston/phaeopigments. Large burrow with oxidized halo at left and smeared organism and void at right. Two shallow voids. RPD highly invaginated. Possible old Dm but it has been reworked (if present)
2500W 04	C	6/29/2004	10:00:39	14.77	15.28	14.94	218.08	0.51	-	-	0.00	0.00	>4	2	>4	0.60	2.97	2.26	32.96	4	3.54	14.62	9.08	3	R	None	No	Stage I on III	8	Gray silt/clay with some mottling at depth. Tan RPD that contains planktonic seston/phaeopigments and is highly invaginated. Two biogenic mounds at SWI. Classic "rocket" void and burrow in upper center. Large burrow/void complex at left and deep void
2500W 04	D	6/29/2004	11:09:24	16.11	17.51	16.97	247.64	1.40	-	-	0.00	0.00	>4	2	>4	3.26	4.11	3.89	56.72	3	9.80	17.48	13.64	0	-	None	No	Stage I on III	11	Gray silt/clay with tan RPD that contains planktonic seston/phaeopigments. Large void in lower right and burrow/void in lower left. Well developed oxidized burrow in upper right that likely leads to void complex in lower right. A few very small intac
2500W 05	A	6/29/2004	10:15:29	16.76	17.05	16.88	246.29	0.29	-	-	0.00	0.00	>4	2	>4	2.97	4.83	3.77	55.08	2	13.34	16.48	14.91	0	-	None	No	Stage I on III	11	Gray silt/clay with tan RPD that contains planktonic seston/phaeopigments. Two oxidized sediment filled voids at depth and several shall. Well-formed burrows. Oxidized halo adjacent to a void in lower left.
2500W 05	C	6/29/2004	11:03:45	16.11	16.65	16.36	238.81	0.54	-	-	0.00	0.00	>4	2	>4	2.54	3.63	3.28	47.88	5	3.26	15.79	9.52	2	R	None	No	Stage I on III	10	Gray silt/clay with tan RPD that contains planktonic seston/phaeopigments. Several large active voids with oxidized halos or oxidized sediment in subsurface sediment. Voids may be part of an interrelated complex. A few small tubes at SWI and several sh
2500W 05	D	6/29/2004	11:01:51	16.99	17.54	17.33	252.99	0.54	-	-	0.00	0.00	>4	2	>4	3.00	4.60	4.19	61.19	2	7.54	16.57	12.05	0	-	None	No	Stage I on III	11	Gray silt clay with tan RPD that contains planktonic seston/phaeopigments. Large void in mid left and smaller void in lower right corner. Numerous small tubes at SWI that are mantled with seston. Some ribbons of lighter colored clay-like material that
4500E 01	A	6/28/2004	13:45:06	16.88	17.31	17.12	249.85	0.43	-	-	0.00	0.00	>4	2	>4	3.94	4.94	4.59	67.01	5	3.46	16.36	9.91	0	-	None	No	Stage I on III	11	Gray silt with tan RPD that contains planktonic seston/phaeopigments. Several burrows and void with oxidized sediment at depth. Numerous small tubes at SWI and abundant tube fragments. Seston mantles tubes. Organism in burrow at lower left.
4500E 01	B	6/28/2004	13:46:04	16.82	17.71	17.46	254.88	0.89	-	-	0.00	0.00	>4	2	>4	2.77	4.71	3.79	55.32	5	7.85	17.39	12.62	3	R	None	No	Stage I on III	11	Gray silt with tan RPD that contains planktonic seston/phaeopigments. Mudclasts artifactual. Possible cryptic layering due to porosity differences. Animal and active voids in lower left. Oxidized sediment-filled voids in center. Numerous small tubes
4500E 01	C	6/28/2004	13:46:44	15.25	15.62	15.52	226.52	0.37	-	-	0.00	0.00	>4	2	>4	4.20	4.43	4.69	68.49	2	7.08	13.82	10.45	4	R	None	No	Stage I on III	11	Gray silt with tan RPD that contains planktonic seston/phaeopigments. Mudclasts artifactual. Two large polychaetes against window at left. Two oxidized sediment-filled voids - one in lower left and other in right center of frame. Several small mud tub
4500E 02	A	6/28/2004	14:05:27	15.65	16.05	15.87	231.62	0.40	-	-	0.00	0.00	>4	2	>4	2.74	3.83	3.02	44.02	2	13.26	15.82	14.54	0	-	None	No	Stage I on III	10	Gray silt with tan RPD that contains planktonic seston/phaeopigments. Oxidized burrow in lower left. Oxidized void in lower right and bottom center. Thin band of dark gray to black reduced organic particles under the RPD and is possibly relict DM - alt
4500E 02	B	6/28/2004	14:06:27	16.36	16.88	16.61	242.45	0.51	-	-	0.00	0.00	>4	2	>4	4.74	5.94	5.34	77.90	8	3.06	15.34	9.20	2	R	None	No	Stage I on III	11	Gray silt with tan RPD that contains planktonic seston/phaeopigments. Numerous large subsurface burrows and oxidized voids. RPD thickened by biogenic cycling and sediment column well-bioturbated. Several seston-mantled small mud tubes and shallow burro

Table B-2
Sediment-Profile Image Results for Reference Stations at CLDS

Station	REP	Date	Time	Minimum Penetration Depth (cm)	Maximum Penetration Depth (cm)	Mean Penetration Depth (cm)	Penetration Area (sq.cm)	Boundary Roughness (cm)	Min Dredged Material Thickness (cm)	Max Dredged Material Thickness (cm)	Mean Dredged Material Thickness (cm)	Total Dredged Material Area	Minimum Grain Size (phi)	Maximum Grain Size (phi)	Major Mode Grain Size (phi)	Minimum RPD (cm)	Maximum RPD (cm)	Mean RPD (cm)	RPD Area	Void #	Void Minimum Depth (cm)	Void Maximum Depth (cm)	Void Average Depth (cm)	Mud Clast #	Mud Clast State	METHANE	Low DO	Successional Stage	OSI	COMMENT
4500E 02	C	6/28/2004	14:07:21	16.02	17.11	16.41	239.53	1.09	-	-	0.00	0.00	>4	2	>4	Ind	Ind	2.21	Ind	1	15.11	15.57	15.34	3	R	None	No	Stage III	8	Gray silt/clay with a clearly disturbed surface. RPD has been physically removed by camera frame over most of cross-section and a thin coating of settled seston/detritus coats the SWI. Evidence of deep bioturbation and oxidized void in bottom center. A
4500E 03	A	6/28/2004	13:54:46	16.39	16.68	16.48	240.52	0.29	-	-	0.00	0.00	>4	1	>4	3.91	5.20	4.51	65.88	3	2.03	16.19	9.11	4	R	None	No	Stage I on III	11	Gray, mottled silt/clay with a tan RPD that contains planktonic seston/phaeopigments. Burrow and void complex at left that goes to depth of frame. Oxidized burrow halo at right. Several recumbent tubes in seston hash. Mudclasts are artifactual. Mino
4500E 03	B	6/28/2004	13:56:29	16.91	17.28	17.16	250.40	0.37	-	-	0.00	0.00	>4	1	>4	3.68	5.51	4.53	66.06	2	3.83	14.25	9.04	3	R	None	No	Stage I on III	11	Gray silt/clay with tan RPD that contains seston/phaeopigments. Thin bands of dark organic particles below RPD and traces of light gray clay indicating possible relict DM. Shallow void in upper left and oxidized active void in lower center. Several sha
4500E 03	C	6/28/2004	13:57:21	17.08	17.71	17.48	255.08	0.63	-	-	0.00	0.00	>4	1	>4	4.11	5.60	4.80	70.06	4	6.17	17.51	11.84	4	3O-1R	None	No	Stage I on III	11	Gray silt/clay with tan RPD that contains planktonic seston/phaeopigments. Several oxidized voids at depth and dragdown of an animal at right. A few oxidized mudclas at SWI that seemingly indicate past physical disturbance. Numerous intact and dissoc
4500E 04	A	6/28/2004	14:10:45	16.88	17.56	17.25	251.80	0.69	-	-	0.00	0.00	>4	2	>4	3.54	4.91	4.12	60.15	3	12.51	16.62	14.57	0	-	None	No	Stage I on III	11	Gray silt/clay with tan RPD that contains planktonic seston/phaeopigments. Two small active voids floored with oxidized sediment and one oxidized sediment filled void. A few halos of oxidized sediment can be seen in subsurface sediment throughout the se
4500E 04	B	6/28/2004	14:11:34	15.85	16.25	16.05	234.21	0.40	-	-	0.00	0.00	>4	2	>4	2.35	4.17	3.49	50.90	0	0	0	0	4	R	None	No	Stage I on III	10	Gray silt/clay with tan RPD that contains planktonic seston/phaeopigments. No voids in subsurface sediments but there are several oxidized halos that are on the flanks of voids and several oxidized burrows at depths >8 cm below the SWI. Mudclasts at SWI
4500E 04	C	6/28/2004	14:12:54	16.56	17.65	17.27	252.07	1.09	-	-	0.00	0.00	>4	2	>4	2.17	4.71	3.79	55.26	4	7.48	17.16	12.32	0	-	None	No	Stage I on III	11	Gray silt/clay with tan RPD that contains planktonic seston/phaeopigments. Several small active voids at depth within the sediment column that contain oxidized sediment. Several patches of oxidized sediment in subsurface from burrows or adjacent to void
4500E 05	A	6/28/2004	14:00:58	16.71	17.42	17.15	250.36	0.71	-	-	0.00	0.00	>4	2	>4	3.23	4.03	3.69	53.83	3	8.74	16.97	12.85	0	-	None	No	Stage I on III	10	Gray to dark gray silt/clay with tan RPD and planktonic seston/phaeopigments in RPD. Thin band of sulfate reduction/black sediments immediately below the RPD, looks like historic DM signature. Several subsurface burrows and a few small voids with the vo
4500E 05	B	6/28/2004	14:01:48	16.42	17.22	16.83	245.55	0.80	-	-	0.00	0.00	>4	2	>4	2.97	4.48	3.95	57.70	2	15.48	16.00	15.74	4	R	None	No	Stage I on III	11	Gray to dark gray silt/clay with tan RPD and planktonic seston/phaeopigments in RPD. Thin band of sulfate reduction/black organic sediments immediately below the RPD. Organic enrichment in upper sediment column. Mudclasts at the SWI are artifactual. T

Table B-2
Sediment-Profile Image Results for Reference Stations at CLDS

Station	REP	Date	Time	Minimum Penetration Depth (cm)	Maximum Penetration Depth (cm)	Mean Penetration Depth (cm)	Penetration Area (sq.cm)	Boundary Roughness (cm)	Min Dredged Material Thickness (cm)	Max Dredged Material Thickness (cm)	Mean Dredged Material Thickness (cm)	Total Dredged Material Area	Minimum Grain Size (phi)	Maximum Grain Size (phi)	Major Mode Grain Size (phi)	Minimum RPD (cm)	Maximum RPD (cm)	Mean RPD (cm)	RPD Area	Void #	Void Minimum Depth (cm)	Void Maximum Depth (cm)	Void Average Depth (cm)	Mud Clast #	Mud Clast State	METHANE	Low DO	Successional Stage	OSI	COMMENT
4500E 05	C	6/28/2004	14:02:46	16.76	17.94	17.32	252.82	1.17	-	-	0.00	0.00	>4	2	>4	2.37	3.49	3.30	48.22	9	7.54	15.77	11.65	0	-	None	No	Stage I on III	10	Gray to dark gray silt/clay with tan RPD and planktonic seston/phaeopigments in RPD. Thin band of sulfate reduction/black organic sediments immediately below the RPD. Organic enrichment in upper sediment column. Abundant small active voids with oxidize
CLDS04 Ref 1	A	6/28/2004	10:41:58	13.97	14.54	14.43	210.63	0.57	-	-	0.00	0.00	>4	2	>4	2.94	5.80	5.57	81.26	3	7.51	12.88	10.20	0	-	None	No	Stage I on III	11	Light to medium gray, bioturbated, silt/clay with tan RPD that contain minor amounts of planktonic seston. Numerous small oxidized voids and burrows in subsurface sediment. Several small polychaetes in upper 5 cm of sediment column and small, fine mud t
CLDS04 Ref 1	B	6/28/2004	10:49:15	13.62	14.25	13.95	203.52	0.63	-	-	0.00	0.00	>4	2	>4	4.20	6.03	5.18	75.55	6	6.40	13.97	10.18	0	-	None	No	Stage I on III	11	Light to medium gray, bioturbated, silt/clay with tan RPD that contain minor amounts of planktonic seston. Numerous small oxidized voids and burrows in subsurface sediment. Most of the voids contain oxidized sediments and a few oxidized halos w/o voids
CLDS04 Ref 1	C	6/28/2004	10:50:17	14.91	15.57	15.33	223.66	0.66	-	-	0.00	0.00	>4	2	>4	4.60	5.28	5.11	74.57	1	5.23	14.43	9.83	0	-	None	No	Stage I on III	11	Light to medium gray, well-bioturbated slightly sandy silt/clay. Tan RPD with some planktonic seston in RPD. Large burrow/void complex in center to bottom of frame. Evidence of large scale subsurface bioturbation based on patches of oxidized sediment a
CLDS04 Ref 2	A	6/28/2004	11:36:10	12.79	13.45	13.12	191.43	0.66	-	-	0.00	0.00	>4	2	>4	3.94	7.20	5.41	78.93	0	0.00	0.00	0.00	0	-	None	No	Stage I on III	11	Light to medium gray, well-bioturbated slightly sandy silt/clay. Tan RPD with some planktonic seston in RPD. Large burrow at right. No active subsurface voids but several oxidized burrow in deep subsurface and three polychaetes against faceplate in cen
CLDS04 Ref 2	B	6/28/2004	11:37:52	15.39	15.79	15.50	226.19	0.40	-	-	0.00	0.00	>4	2	>4	4.94	6.48	5.72	83.41	3	8.83	15.54	12.18	3	R	None	No	Stage I on III	11	Light to medium gray, well-bioturbated slightly sandy silt/clay. Tan RPD with some planktonic seston in RPD. Subsurface sediment extensively reworked. Void/burrow at mid right and large void and burrow complex in lower part of frame. Oxidized sediment
CLDS04 Ref 2	C	6/28/2004	11:39:23	13.71	14.71	14.42	210.38	1.00	-	-	0.00	0.00	>4	2	>4	5.37	6.28	5.98	87.23	1	7.43	8.43	7.93	0	-	None	No	Stage I on III	11	Light to medium gray, well-bioturbated slightly sandy silt/clay. Tan RPD with some planktonic seston in RPD. Subsurface sediment extensively reworked. Void/burrow at mid right with oxidized sediment filling. Numerous patches of oxidized sediment at de
CLDS04 Ref 3	A	6/28/2004	11:45:09	16.36	16.45	16.35	238.59	0.09	-	-	0.00	0.00	>4	2	>4	6.03	7.31	6.49	94.70	7	5.51	12.74	9.13	0	-	None	No	Stage I on III	11	Light to medium gray, well-bioturbated slightly sandy silt/clay. Tan RPD with some planktonic seston in RPD. Numerous oxidized voids in subsurface along with several shallow burroes within the RPD. Subsurface sediment is extensively reworked. A few sm
CLDS04 Ref 3	B	6/28/2004	11:45:46	15.34	15.79	15.47	225.82	0.46	-	-	0.00	0.00	>4	2	>4	4.23	6.45	5.39	78.59	3	6.45	13.65	10.05	0	-	None	No	Stage I on III	11	Light to medium gray silt/clay with tan RPD that contains some planktonic seston. Void in upper right center and lower left. The void at lower left is part of a reticyulated burro/void complext that runs from left to bottom center and contains oxidized

Table B-2
Sediment-Profile Image Results for Reference Stations at CLDS

Station	REP	Date	Time	Minimum Penetration Depth (cm)	Maximum Penetration Depth (cm)	Mean Penetration Depth (cm)	Penetration Area (sq.cm)	Boundary Roughness (cm)	Min Dredged Material Thickness (cm)	Max Dredged Material Thickness (cm)	Mean Dredged Material Thickness (cm)	Total Dredged Material Area	Minimum Grain Size (phi)	Maximum Grain Size (phi)	Major Mode Grain Size (phi)	Minimum RPD (cm)	Maximum RPD (cm)	Mean RPD (cm)	RPD Area	Void #	Void Minimum Depth (cm)	Void Maximum Depth (cm)	Void Average Depth (cm)	Mud Clast #	Mud Clast State	METHANE	Low DO	Successional Stage	OSI	COMMENT
CLDS04 Ref 3	C	6/28/2004	11:47:34	14.71	15.14	14.99	218.70	0.43	-	-	0.00	0.00	>4	2	>4	3.54	6.25	4.85	70.82	3	5.75	10.65	8.20	0	-	None	No	Stage I on III	11	Light to medium gray silt/clay with tan RPD that contains some planktonic seston. Oxidized sediment filled voids in center of frame and some patches of oxidized sediment/feeding lags at lower right. Subsurface sediment is mottled with patches of oxidize
CLDS04 Ref 4	A	6/28/2004	12:09:43	14.59	15.17	14.90	217.48	0.57	-	-	0.00	0.00	>4	2	>4	4.26	5.40	5.00	72.95	6	6.54	12.57	9.55	1	R	None	No	Stage I on III	11	Light to medium gray silt/clay with tan RPD that contains some planktonic seston. Numerous subsurface, oxidized sediment filled voids. Subsurface sediment is well-bioturbated and there are patches of oxidized sediment/feeding lags in addition to the act
CLDS04 Ref 4	E	6/28/2004	13:12:18	15.22	15.42	15.27	222.86	0.20	-	-	0.00	0.00	>4	2	>4	4.94	6.11	5.40	78.84	2	7.11	11.02	9.07	0	-	None	No	Stage I on III	11	Light to medium gray silt/clay with tan RPD that contains some planktonic seston. Void at left and void complex in center - both contain oxidized sediment. Polychaete in lower right. Patches of oxidized sediment in deeper portions of sediment column in
CLDS04 Ref 4	F	6/28/2004	13:13:20	14.94	15.62	15.43	225.16	0.69	-	-	0.00	0.00	>4	2	>4	4.63	5.63	5.39	78.68	1	7.48	9.20	8.34	1	R	None	No	Stage I on III	11	Light to medium gray silt/clay with tan RPD that contains some planktonic seston. Large, oxidized sediment-filled void at right that also contains some planktonic seston. Numerous patches of oxidized sediment at depth within the sediment couln - extensi
CLDS04 Ref 5	A	6/28/2004	12:01:58	15.94	16.54	16.13	235.43	0.60	-	-	0.00	0.00	>4	2	>4	3.37	4.97	4.16	60.68	3	13.17	16.11	14.64	0	-	None	No	Stage I on III	11	Light to medium gray silt/clay with tan RPD that contains some planktonic seston. Large active void complex at bottom of frame and oxidized burrow in lower center. Mud tubes at SWI. Ambient.
CLDS04 Ref 5	B	6/28/2004	12:02:46	15.02	15.82	15.39	224.53	0.80	-	-	0.00	0.00	>4	2	>4	4.86	6.37	5.80	84.67	4	5.85	12.11	8.98	3	R	None	No	Stage I on III	11	Light to medium gray silt/clay with tan RPD that contains some planktonic seston. Numerous subsurface voids that contain oxidized sediment, in addition, patches of oxidized sediment that are infaunal feedin lag deposites/or wall of voids/burrows. Mudcla
CLDS04 Ref 5	C	6/28/2004	12:04:32	15.14	15.51	15.32	223.54	0.37	-	-	0.00	0.00	>4	2	>4	3.40	5.46	4.32	63.02	1	6.00	9.88	7.94	1	R	None	No	Stage I on III	11	Light to medium gray silt/clay with tan RPD that contains some planktonic seston. Large void/burrow at right that contains oxidized sediment. Polychaete agains window in bottom center and numerous shallow burrows in upper 5 cm of sediment column. Reduc

Table B-3
Sediment Profile Image Results for Mound CLIS 95/96

Station	REP	DATE	TIME	Minimum Penetration Depth (cm)	Maximum Penetration Depth (cm)	Mean Penetration Depth (cm)	Penetration Area (sq.cm)	Boundary Roughness (cm)	Min Dredged Material Thickness (cm)	Max Dredged Material Thickness (cm)	Mean Dredged Material Thickness (cm)	Total Dredged Material Area	Minimum Grain Size (phi)	Maximum Grain Size (phi)	Major Mode Grain Size (phi)	Minimum RPD (cm)	Maximum RPD (cm)	Mean RPD (cm)	RPD Area	Void #	Void Minimum Depth (cm)	Void Maximum Depth (cm)	Void Average Depth (cm)	Mud Clast #	Mud Clast State	METHANE	Low DO	Successional Stage	OSI	COMMENT
CLDS 04 01	A	6/28/2004	16:04:10	13.71	13.94	13.84	202.00	0.23	> 13.71	> 13.94	> 13.84	202.00	>4	2	>4	2.37	3.48	2.75	40.18	1	6.23	6.51	6.37	0	-	Yes	No	Stage I on III	7	Dark gray, relatively homogeneous silt/clay with tan RPD that contains planktonic seston/phaeopigments. Small void at left. Dominantly Stage I but deeper colonization occurring slowly. Methane in lower right center. Several small thin polychaetes in
CLDS 04 01	B	6/28/2004	16:05:42	15.08	15.31	15.23	222.22	0.23	> 15.08	> 15.31	> 15.23	222.22	>4	2	>4	2.17	3.74	2.74	40.01	2	4.43	6.00	5.21	1	Reduced	None	No	Stage I on III	9	Dark gray, relatively homogeneous silt/clay with tan RPD that contains planktonic seston/phaeopigments. Dominantly Stage I but deeper colonization occurring slowly. Mudclast dragdown at center. Relict RPD 9.2 cm below SWI. Two small active voids, one a
CLDS 04 01	C	6/28/2004	16:06:30	14.91	15.96	15.63	228.12	1.06	> 14.91	> 15.96	> 15.63	228.12	>4	2	>4	1.26	3.14	2.44	35.67	2	2.14	5.71	3.93	3	Reduced	None	No	Stage I on III	9	Dark gray, relatively homogeneous silt/clay with tan RPD that contains planktonic seston/phaeopigments. Dominantly Stage I but deeper colonization occurring slowly. Mudclast dragdown at center and right. Two small active voids, one at far left and one i
CLDS 04 02	A	6/28/2004	16:28:24	13.59	14.19	13.90	202.92	0.60	> 13.59	> 14.19	> 13.90	202.92	>4	1	>4	2.80	4.43	3.80	55.51	6	4.51	11.62	8.07	0	-	None	No	Stage I on III	11	Dark gray sandy silt/clay with tan RPD that contains planktonic seston/phaeopigments. Numerous subsurface active voids with oxidized sediment. Sand throughout the sediment column and occasionally concentrated as a feeding lag. A couple of recumbent t
CLDS 04 02	B	6/28/2004	16:30:09	13.94	14.37	14.18	206.90	0.43	> 13.94	> 14.37	> 14.18	206.90	>4	2	>4	0.83	4.17	3.09	45.16	2	2.23	14.05	8.14	4	Reduced	None	No	Stage I on III	10	Dark gray, slightly sandy silt/clay with tan RPD. Some planktonic seston/phaeopigments at SWI but not nearly the inventory of other stations. Shallow void in upper left and deep void in bottom center. Numerous small mud tubes at the SWI. Patchy subsu
CLDS 04 02	C	6/28/2004	16:41:28	14.51	15.31	14.97	218.43	0.80	> 14.51	> 15.31	> 14.97	218.43	>4	1	>4	2.03	4.54	3.20	46.69	2	4.00	7.88	5.94	1	Reduced	None	No	Stage I on III	10	Dark gray very sandy silt/clay with tan RPD. Amount of planktonic seston/phaeopigments at SWI less than other stations (exhaustion-reworking?). Large burrow/void complex at left center with active conveyoring of reduced subsurface sediment to SWI. Void
CLDS04 03	A	6/28/2004	16:49:25	12.57	13.82	12.98	189.44	1.26	> 12.57	> 13.82	> 12.98	189.44	>4	1	>4	3.03	4.54	3.94	57.50	1	9.65	12.71	11.18	0	-	None	No	Stage I on III	11	Dark gray very sandy silt/clay with tan RPD that contains planktonic seston/phaeopigments. Large void in lower left and well form burrow with oxidized walls in lower right. Several small polychaetes in upper 3 cm of sediment column. Polychaete and an
CLDS04 03	B	6/28/2004	16:52:26	11.94	13.37	12.94	188.90	1.43	> 11.94	> 13.37	> 12.94	188.90	>4	1	>4	0.77	4.08	2.98	43.51	2	3.68	5.66	4.67	2	Reduced	None	No	Stage I on III	9	Dark gray very sandy silt/clay. Two voids at upper right and remarkable sand lag from feeding activity. Anyone who does not think that infauna can effectively sort sediment needs to see this picture. Layering due to DM disposal and different sediment
CLDS04 03	C	6/28/2004	16:56:27	13.71	14.19	13.98	203.98	0.49	> 13.71	> 14.19	> 13.98	203.98	>4	1	>4	3.66	3.91	3.77	54.98	4	2.97	11.72	7.34	0	-	None	No	Stage I on III	11	Gray sandy silt clay with tan RPD that contains planktonic seston/phaeopigments. Prominent large, active, feeding voids that contain oxidized sediment of oxidized halos. Not as organically rich as other reps from this station. DM>P and DM is highly rew
CLDS04 04	A	6/28/2004	15:10:43	16.14	16.45	16.35	238.62	0.31	> 16.14	> 16.45	> 16.35	238.62	>4	2	>4	3.51	5.88	4.87	71.11	5	5.08	15.80	10.44	0	-	None	No	Stage I on III	11	Gray slightly sandy silt/clay with tan RPD that contains planktonic seston. Reworking of seston into sediment column in upper 5 cm. Numerous shallow burrows. Several active voids with oxidized sediment or oxidized halos. Slightly patchy, organic subsu
CLDS04 04	B	6/28/2004	15:11:35	16.11	17.45	16.77	244.80	1.34	> 16.11	> 17.45	> 16.77	244.80	>4	2	>4	1.54	3.71	2.73	39.91	2	4.43	15.08	9.75	1	Reduced	None	No	Stage III	9	Gray layered slightly sandy silt/clay. Large artifactual mudclast at left SWI that obscures RPD and RPD interpolated. Very large burrow/void complex with oxidized walls in center of frame. Deep oxidized burrow in lower left of frame. A couple of sma
CLDS04 04	C	6/28/2004	15:12:17	16.39	17.82	17.14	250.21	1.43	> 16.39	> 17.82	> 17.14	250.21	>4	2	>4	4.80	6.51	5.43	79.20	4	2.89	13.42	8.15	1	Reduced	None	No	Stage I on III	11	Gray, slightly sandy silt/clay with tan RPD that contains planktonic seston with phaeopigments. Dark band of organically enriched sediment at the bottom of the frame that is presumably DM. Scattered organic fragments in the sediment column. Small oxidi
CLDS04 05	A	6/28/2004	15:15:32	19.42	20.08	19.72	287.87	0.66	> 19.42	> 20.08	> 19.72	287.87	>4	2	>4	3.37	5.06	4.12	60.14	2	9.11	11.43	10.27	0	-	None	No	Stage I on III	11	Very soft, gray silt/clay. Pull away and RPD interpolated. Highly water rich and subsurface texture reflects the expressing of pore fluids during prism penetration. Two small voids one in center and one at left. Several shallow burrows and bivalve in
CLDS04 05	B	6/28/2004	15:16:24	19.51	19.88	19.67	287.12	0.37	> 19.51	> 19.88	> 19.67	287.12	>4	2	>4	3.89	4.83	4.29	62.60	4	7.80	19.74	13.77	1	Reduced	None	No	Stage I on III	11	Very soft, gray silt/clay. Pull away and RPD interpolated. Highly water rich and subsurface texture reflects the expressing of pore fluids during prism penetration. Patchy distribution of organics in subsurface sediment. Deep voids and numerous intact
CLDS 04 05	C	6/28/2004	15:17:07	20.91	21.28	21.09	307.81	0.37	> 20.91	> 21.28	> 21.09	307.81	>4	2	>4	Ind	Ind	Ind	Ind	2	12.28	20.53	16.41	0	-	None	No	Stage III	Ind	Slightly OP. Very soft, faintly layered silt/clay. Two very large, deep active burrows/voids at center and right. Possibly old DM based on very faint layering (likely). Oxidized burrow wall in background within lower void.
CLDS04 06	A	6/28/2004	15:51:34	12.74	14.22	13.60	198.44	1.48	> 12.74	> 14.22	> 13.60	198.44	>4	1	>4	4.88	5.37	5.34	77.99	1	8.31	12.08	10.20	0	-	None	No	Stage I on III	11	Compact dark gray to black. Sandy silt/clay with tan RPD that contains planktonic seston. Huge recumbent void complex/burrow that stretched across entire frame with multiple chambers. Dark high organic DM>P. Abundant infaunal fecal material and pellets
CLDS04 06	B	6/28/2004	15:52:17	13.20	13.88	13.60	198.50	0.68	> 13.20	> 13.88	> 13.60	198.50	>4	2	>4	4.28	5.80	5.63	82.23	5	2.54	13.28	7.91	1	Reduced	None	No	Stage I on III	11	Gray, compact, slightly sandy silt/clay. Large black artifactual mudclast in center. Several active voids in subsurface sediment. Relict RPD at bottom of frame. Tan-orange planktonic seston is not extensively reworked into upper sediment. Very differ

Table B-3
Sediment Profile Image Results for Mound CLIS 95/96

Station	REP	DATE	TIME	Minimum Penetration Depth (cm)	Maximum Penetration Depth (cm)	Mean Penetration Depth (cm)	Penetration Area (sq.cm)	Boundary Roughness (cm)	Min Dredged Material Thickness (cm)	Max Dredged Material Thickness (cm)	Mean Dredged Material Thickness (cm)	Total Dredged Material Area	Minimum Grain Size (phi)	Maximum Grain Size (phi)	Major Mode Grain Size (phi)	Minimum RPD (cm)	Maximum RPD (cm)	Mean RPD (cm)	RPD Area	Void #	Void Minimum Depth (cm)	Void Maximum Depth (cm)	Void Average Depth (cm)	Mud Clast #	Mud Clast State	METHANE	Low DO	Successional Stage	OSI	COMMENT
CLDS04 06	C	6/28/2004	15:55:13	9.62	10.80	10.18	148.64	1.17	> 9.62	> 10.80	> 10.18	148.64	>4	1	>4	3.20	5.31	4.31	62.94	2	7.40	10.71	9.06	0	-	None	No	Stage I on III	11	Light to dark mottled gray silt/clay with tan RPD that contains planktonic seston. Medium to coarse sand particles sprinkled throughout sediment column. Active voids in center and lower right. A few small mud tubes mantled with detritus and a few tube
CLDS04 07	A	6/28/2004	15:35:37	9.65	11.51	10.62	155.03	1.86	> 9.65	> 11.51	> 10.62	155.03	>4	0	3-2/>4	1.76	3.23	2.10	30.59	4	2.57	10.11	6.34	0	-	None	No	Stage I on III	8	Dark gray very sandy silt/clay with tan RPD that contains minimal amounts of planktonic seston relative to other stations. Entire sediment composed of DM that is not recently placed, but does not appear to be that old either. Large subsurface voids and
CLDS04 07	B	6/28/2004	15:37:05	10.97	13.34	11.88	173.43	2.37	> 10.97	> 13.34	> 11.88	173.43	>4	0	>4	0.01	4.82	1.36	19.78	1	3.66	4.48	4.07	1	Reduced	None	No	Stage I on III	7	Patchy light and dark gray very sandy silt/clay with disrupted RPD and minimal amounts of planktonic seston relative to other stations. Void at right. Epizoans at SWI along with numerous broken tubes of several types. Several polychaetes in subsurface
CLDS04 07	C	6/28/2004	15:37:52	9.48	11.74	10.33	150.75	2.26	> 9.48	> 11.74	> 10.33	150.75	>4	1	>4	1.34	2.54	1.61	23.46	0	0.00	0.00	0.00	0	-	None	No	Stage II -> III	7	Mottled light and dark gray silt with tan RPD that contains minimal planktonic seston relative to other stations. DM>P and chaotic texture in DM. Very thinly developed RPD. Surface disturbance probably from sampling and RPD was measured linearly from t
CLDS04 08	A	6/28/2004	16:13:41	14.54	15.57	15.07	219.91	1.03	> 14.54	> 15.57	> 15.07	219.91	>4	1	>4	3.14	4.57	4.22	61.57	3	8.14	15.11	11.63	0	-	None	No	Stage I on III	11	Light to medium gray silt clay with tan RPD and planktonic seston/phaeopigments. Relict RPD at bottom of frame and DM>P, with the DM being older and not recently deposited. Several large voids with oxidized sediment at center left. Maldanid polychaete
CLDS04 08	B	6/28/2004	16:14:52	12.91	14.14	13.72	200.21	1.23	> 12.91	> 14.14	> 13.72	200.21	>4	1	>4	2.97	3.86	3.14	45.86	2	3.11	9.14	6.13	0	-	None	No	Stage I on III	10	Mottled light and dark gray slightly sandy silt with tan RPD that contains planktonic seston/phaeopigments. Trace of relict RPD at bottom of frame and DM >P, with DM appearing to be older, reworked and not recently deposited. Weak stage 3 community pres
CLDS04 08	C	6/28/2004	16:17:16	14.25	14.68	14.57	212.59	0.43	> 14.25	> 14.68	> 14.57	212.59	>4	1	>4	3.66	4.63	4.28	62.50	1	11.54	11.85	11.70	2	Ox	None	No	Stage I on III	11	Medium to dark gray very sandy silt/clay with tan RPD that contains planktonic seston/phaeopigments. Relict RPD at bottom of frame and DM>P with the DM appearing to be older, partially reworked and not recently deposited. Small void and associated burro
CLDS04 09	A	6/28/2004	15:06:06	16.59	17.19	16.95	247.35	0.60	> 16.59	> 17.19	> 16.95	247.35	>4	2	>4	4.63	6.34	5.85	85.40	1	11.08	11.60	11.34	0	-	None	No	Stage I on III	11	Light to medium gray silt/clay with sandier layer near bottom of frame and possible relict RPD. Tan RPD with planktonic seston phaeopigments. Small void in lower right center. Deep RPD with numerous burrows. Bivalve at SWI. Nice pic.
CLDS04 09	B	6/28/2004	15:06:53	16.94	17.76	17.18	250.74	0.83	> 16.94	> 17.76	> 17.18	250.74	>4	2	>4	4.46	5.94	5.13	74.92	3	8.83	14.57	11.70	1	Reduced	None	No	Stage I on III	11	Light to medium gray silt/clay with sandier layer near bottom of frame and possible relict RPD. Tan RPD with planktonic seston phaeopigments. Two voids at left on at right. The sandy layer near the bottom of the frame is very similar to the character of
CLDS04 09	C	6/28/2004	15:07:49	17.25	17.65	17.54	256.05	0.40	> 17.25	> 17.65	> 17.54	256.05	>4	2	>4	4.68	5.20	5.04	73.57	3	10.23	16.82	13.52	3	Reduced	None	No	Stage I on III	11	Light to medium gray silt/clay with sandier layer near bottom of frame and possible relict RPD. Tan RPD with planktonic seston phaeopigments. The sandy layer near the bottom of the frame is very similar to the character of the old DM seen at CLDS04 08.
CLDS04 10	A	6/28/2004	14:54:30	14.77	15.48	15.08	220.08	0.71	> 14.77	> 15.48	> 15.08	220.08	>4	1	>4	3.43	4.83	4.59	67.05	4	8.91	11.71	10.31	0	-	None	No	Stage I on III	11	Medium to dark gray very sandy silt/clay with tan RPD that contains planktonic seston/phaeopigments. Two layers of DM and paleo-RPD at depth 10.9 cm below the SWI. Four small burrows/voids that are fringed with oxidized sediment. Dm appears older and n
CLDS04 10	B	6/28/2004	14:55:14	13.85	14.94	14.66	214.00	1.09	> 13.85	> 14.94	> 14.66	214.00	>4	1	>4	3.51	6.11	5.04	73.51	2	6.05	8.31	7.18	5	Reduced	None	No	Stage I on III	11	Medium to dark gray, layered sandy silt/clay with a tan RPD that contains planktonic seston/phaeopigments. DM>P with clear rhythmic layering of DM corresponding to individual deposition events. Sand-filled void in right center and void at far left that
CLDS04 10	C	6/28/2004	14:55:58	13.68	15.05	14.31	208.88	1.37	> 13.68	> 15.05	> 14.31	208.88	>4	1	>4	Ind	Ind	Ind	Ind	5	4.60	10.05	7.33	>5	Reduced	None	No	Stage III	Ind	Light gray to black sandy silt/clay with disturbed SWI from sampling. RPD is indeterminate due to sampling disturbance. Numerous subsurface voids/burrows most with oxidized sediment in some form. Organism in lower center. DM>P with layering in 3-4 cm
CLDS04 11	A	6/28/2004	16:20:57	14.62	15.05	14.84	216.61	0.43	12.97	14.22	13.11	191.27	>4	1	>4	3.74	6.03	4.81	70.16	5	5.54	13.85	9.70	0	-	None	No	Stage I on III	11	Medium to dark gray sandy silt/clay with planktonic seston in tan RPD. Upper unit of Dm is thick, 11.8 cm, but all DM appears to be older with established top-down colonization. Similar to CLDS04 10. Several voids in subsurface some show reduced sedi
CLDS04 11	B	6/28/2004	16:21:49	14.14	14.97	14.51	211.80	0.83	> 14.14	> 14.97	> 14.51	211.80	>4	1	>4	3.74	5.69	5.23	76.31	5	4.43	12.20	8.31	1	Reduced	None	No	Stage I on III	11	Medium to dark gray silt/clay, slightly sandy, with tan RPD that contains planktonic seston/phaieopigments. DM>P with top-down colonization. Deep RPD and several tubes at SWI. Reduced mudclast at right is a sampling artifact and dragged down. Numerous
CLDS04 11	C	6/28/2004	16:23:04	13.88	14.31	14.15	206.44	0.43	> 13.88	> 14.31	> 14.15	206.44	>4	1	>4	3.51	5.08	4.22	61.53	3	3.48	12.65	8.07	4	Reduced	None	No	Stage I on III	11	Medium to dark gray silt/clay, slightly sandy, with tan RPD that contains planktonic seston/phaeopigments. DM>P. Deep RPD and several tubes at SWI. Reduced mudclasts at SWI are sampling artifacts. Very large void in center and active void in upper lef
CLDS04 12	A	6/28/2004	15:40:44	7.68	8.54	8.08	117.99	0.86	> 7.68	> 8.54	> 8.08	117.99	>4	1	>4	Ind	Ind	Ind	Ind	2	4.71	8.45	6.58	0	-	None	No	Stage I on III	Ind	Light to dark gray mottled slightly sandy silt/clays. Shell debris at SWI mantled with planktonic seston and detritus. Epizoan on shell in background. DM>P and appears to amalgamation of compact silt/clays. Two subsurface feeding voids with oxidized s

Table B-3
Sediment Profile Image Results for Mound CLIS 95/96

Station	REP	DATE	TIME	Minimum Penetration Depth (cm)	Maximum Penetration Depth (cm)	Mean Penetration Depth (cm)	Penetration Area (sq.cm)	Boundary Roughness (cm)	Min Dredged Material Thickness (cm)	Max Dredged Material Thickness (cm)	Mean Dredged Material Thickness (cm)	Total Dredged Material Area	Minimum Grain Size (phi)	Maximum Grain Size (phi)	Major Mode Grain Size (phi)	Minimum RPD (cm)	Maximum RPD (cm)	Mean RPD (cm)	RPD Area	Void #	Void Minimum Depth (cm)	Void Maximum Depth (cm)	Void Average Depth (cm)	Mud Clast #	Mud Clast State	METHANE	Low DO	Successional Stage	OSI	COMMENT
CLDS04 12	B	6/28/2004	15:41:27	12.34	13.08	12.72	185.58	0.74	> 12.34	> 13.08	> 12.72	185.58	>4	1	>4	4.08	7.14	5.33	77.83	2	4.34	7.48	5.91	4	Reduced	None	No	Stage I on III	11	Medium to dark gray sandy silt/clay with tan RPD that contains planktonic seston. Artifactual reduced mudclast at SWI. DM>P with little layering. Two large voids with oxidized sediment in upper sediment column. Top-down colonization. A few small mud
CLDS04 12	C	6/28/2004	15:42:04	9.34	11.62	10.60	154.68	2.28	> 9.34	> 11.62	> 10.60	154.68	>4	1	>4	1.32	3.83	3.03	44.28	0	0.00	0.00	0.00	6	Reduced	None	No	Stage I on III	10	Light to medium gray sandy silt/clay with tan RPD that contains planktonic seston/phaeopigments. Dragdown and burrow at center. Nephtid at right and long thin polychaete at left. Numerous intact tubes and tube fragments at SWI. Patchy texture to subsu
CLDS04 13	A	6/28/2004	15:45:23	12.77	13.65	13.23	193.08	0.89	> 12.77	> 13.65	> 13.23	193.08	>4	1	>4	3.54	5.25	4.58	66.84	3	4.28	12.37	8.33	1	Reduced	None	No	Stage I on III	11	Dark gray sandy silt/clay with tan RPD that contains planktonic seston. DM>P and Dm organically enriched. Large active void in upper left, void in lower right, and far right. Polychaete next to void in upper left. Several shallow burrows. A few small
CLDS04 13	B	6/28/2004	15:46:28	13.34	13.91	13.65	199.25	0.57	> 13.34	> 13.91	> 13.65	199.25	>4	1	>4	2.94	4.34	3.02	Ind	1	4.86	6.14	5.50	2	Reduced	None	No	Stage I on III	10	Light to dark gray slightly sandy silt with tan RPD that contains some planktonic seston. Mudclasts smeared at SWI in right of frame obscuring RPD. RPD is representative linear measurements from left side of SWI. Large active void in upper right. Biog
CLDS04 13	C	6/28/2004	15:48:03	13.02	13.11	13.14	191.76	0.09	> 13.02	> 13.11	> 13.14	191.76	>4	1	>4	0.97	2.86	1.92	27.97	4	3.77	10.71	7.24	2	Reduced	None	No	Stage I on III	8	Light to dark gray sandy silt/clay with tan RPD that contains minor amounts of planktonic seston. DM>P with relict RPD 9 cm below SWI and some chaotic fabric in subsurface sediment. RPD thinly developed relative to other stations and reps, reason unclea
CLDS04 14	A	6/28/2004	14:59:53	15.05	16.14	15.61	227.85	1.08	> 15.05	> 16.14	> 15.61	227.85	>4	1	>4	2.63	4.37	3.71	54.09	1	14.34	15.42	14.88	0	-	None	No	Stage I on III	10	Light to dark gray, mottled sandy silt/clay. Thinly developed RPD in places with minor amounts of planktonic seston. Sandier towards bottom of frame and remnant chaotic fabric near bottom of frame. Several long oxidized infaunal burrows in upper 10 cm
CLDS04 14	B	6/28/2004	15:02:05	14.65	15.79	15.26	222.67	1.14	> 14.65	> 15.79	> 15.26	222.67	>4	1	>4	4.54	6.25	5.64	82.24	1	12.79	14.37	13.58	0	-	None	No	Stage I on III	11	Light to dark gray very sandy silt/clay with tan RPD that contains some planktonic seston that has been cycled. Sediment column increases in sand content near the bottom of the frame and possible relict RPD in lower right corner. Active void in lower ri
CLDS04 14	C	6/28/2004	15:02:57	15.17	15.68	15.45	225.51	0.51	> 15.17	> 15.68	> 15.45	225.51	>4	1	>4	3.66	5.45	4.48	65.39	2	6.26	15.48	10.87	2	Reduced	None	No	Stage I on III	11	Light gray sandy silt clay with tan RPD that contains minor amounts of planktonic seston. Void in upper left and lower right center of frame. Appear to very old DM>P that has been reworked and exhausted of its organic inventories. Some sand at depth
CLDS04 15	A	6/28/2004	15:58:57	13.02	14.05	13.65	199.19	1.03	> 13.02	> 14.05	> 13.65	199.19	>4	1	>4	3.51	6.20	4.74	69.17	1	7.60	9.77	8.68	1	Reduced	None	No	Stage I on III	11	Light gray sandy silt with tan RPD that contains planktonic seston. Chaotic fabric near bottom of frame with increasing sand content with depth. Likely a normally graded sequence of older DM. DM>P. Large void in mid-left with a sand lag at bottom void
CLDS04 15	B	6/28/2004	16:00:40	15.37	16.22	15.79	230.45	0.86	> 15.37	> 16.22	> 15.79	230.45	>4	1	>4	2.43	3.94	3.42	49.88	5	3.14	14.77	8.95	0	-	None	No	Stage I on III	10	Light gray sandy silt with tan RPD that contains planktonic seston. Voids in upper left lower left and lower right. Oxidized sediment in many of the voids. Linear band of dark, reduced sediment at depth that is interpreted to be DM. DM>P. Several sma
CLDS04 15	C	6/28/2004	16:01:20	14.34	14.82	14.59	212.95	0.49	> 14.34	> 14.82	> 14.59	212.95	>4	1	>4	2.54	4.60	3.89	56.73	3	3.74	8.48	6.11	1	Reduced	None	No	Stage I on III	11	Light to dark gray very sandy silt/clay with tan RPD that contains some planktonic seston that has been cycled. Sediment column increases in sand content near the bottom of the frame. DM>P and DM appears older. Two voids in upper right and one at mid