Monitoring Survey at the Mark Island Disposal Site
July 2002

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13. ABSTRACT

This report presents the results of a DAMOS monitoring survey conducted by Science Applications International Corporation (SAIC) in July 2002 at the Mark Island Disposal Site (MIDS) near Jonesport, Maine. The objectives of this survey were to document the distribution of recently deposited dredged material on the seafloor and assess the physical sediment characteristics and benthic community status within the disposal site. Dredging of the U.S. Coast Guard dock facilities in Moosabec Reach was performed during the winter of 2001/2002 and dredged material was placed near the center of MIDS. A monitoring survey was completed under the DAMOS program to evaluate the impacts of dredged material placement. As part of the July 2002 field effort, a precision bathymetric and side-scan sonar survey was performed to assess the distribution of the recently deposited sediment. In addition, a REMOTS® (Remote Ecological Monitoring of the Seafloor) sediment-profile imaging survey was conducted to further delineate the spatial distribution of dredged material on the seafloor and assess the benthic recolonization status over the disposal site relative to two nearby reference areas.

Due to the small volume of sediments placed at MIDS, comparisons between sequential bathymetric surveys (July 2002 vs. March 2000) did not detect a discrete disposal mound on the seafloor. However, differences in sediment composition provided sufficient contrast in bottom texture for side-scan sonar to detect evidence of multiple dredged material disposal events within MIDS. Benthic habitat conditions within MIDS were comparable to the ambient sediment at both the outer and reference area stations, with relatively deep RPD depths and a considerable presence of Stage III organisms. Overall OSI values of +6.3 (inner disposal site stations), +7.7 (outer stations), and +7 (reference area stations) were calculated during the 2002 survey, and were indicative of undisturbed benthic habitat conditions. Slightly higher median OSI values at the outer and reference area stations reflect moderately deeper RPD depths and a high frequency of advanced Stage III activity. Comparison of six corresponding stations in March 2000 and July 2002 REMOTS® data indicated a slight increase in overall OSI values from +6 in 2000 to +6.5 in 2002. However, these values are comparable and suggest that undisturbed benthic habitat conditions have prevailed over much of the surveyed MIDS area despite the recent placement of dredged material. Comparisons between individual stations suggest dredged material placement may have actually stimulated productivity by providing an input of organic matter (a food source for primary consumers), as reflected in higher OSI values at certain stations displaying the addition of dredged material since the 2000 survey.

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EXECUTIVE SUMMARY

The Disposal Area Monitoring System (DAMOS), managed by the New England District (NAE) of the US Army Corps of Engineers, conducts detailed monitoring studies to detect and minimize any physical, chemical, and biological impacts associated with dredging and dredged material disposal activities in New England. This report presents the results of a DAMOS monitoring survey conducted by Science Applications International Corporation (SAIC) in July 2002 at the Mark Island Disposal Site (MIDS) near Jonesport, Maine. The objectives of this survey were to document the distribution of recently deposited dredged material on the seafloor and assess the physical sediment characteristics and benthic community status within the disposal site.

Dredging of the US Coast Guard dock facilities in Moosabec Reach was performed during the winter of 2001/2002. A total estimated volume of 4,300 m^3 of dredged material was deposited at MIDS, a small 500 m × 500 m area of seafloor situated in the mouth of Chandler Bay in eastern Maine. A monitoring survey was completed under the DAMOS program to evaluate the impacts of dredged material placement. As part of the July 2002 field effort, a precision bathymetric and side-scan sonar survey was performed to assess the distribution of the recently deposited sediment. In addition, a REMOTS® (Remote Ecological Monitoring of the Seafloor) sediment-profile imaging survey was conducted to further delineate the spatial distribution of dredged material on the seafloor and assess the benthic recolonization status over the disposal site relative to two nearby reference areas.

The baseline assessment performed at the MIDS in March 2000 under the DAMOS program was used to determine the potential impacts of placing small volumes of sediment within this area of seafloor. The comparison of the March 2000 and July 2002 bathymetric data indicated no acoustically detectable mound (i.e., >20 cm) due to the small volume of material disposed. However, the side-scan sonar mosaic detected evidence of discrete disposal events within the MIDS. These disposal event features correspond well with both the disposal locations recorded on barge logs and REMOTS® survey data indicating the distribution of dredged material on the substrate.

The REMOTS® results agreed relatively well with the bathymetric and side-scan results over MIDS and indicated that the small dredged material deposit was contained within the confines of the disposal site. The REMOTS® images allowed measurement of relatively thin (i.e., less than 20 cm) dredged material layers that were not detected through the bathymetric depth differencing. Dredged material was evident in 5 of the 25 inner disposal site stations and was composed of primarily fine-grained sediment (silt). Dredged material thicknesses ranged from greater than the penetration depth of the sediment-profile camera to discrete dredged material layers observed in the profile images at these stations.

As anticipated, benthic recolonization over the surface of the relatively thin dredged material layer at MIDS was advanced due to minimal benthic disturbance and the ability of Stage III organisms (advanced, deeper dwelling infauna) to migrate up through the thin layers (<10 cm) of fresh dredged material. Stage III activity occurred at the majority of the inner disposal site stations. The average depth of the apparent Redox-Potential Discontinuity (RPD) over the inner stations of the MIDS (2.8 cm) was considered indicative of moderate to well-oxygenated surface sediments at the time of the July 2002 survey. Overall mean RPD depths at the six inner stations corresponding to the six stations sampled in 2000 within MIDS were slightly shallower in 2002 than in the March 2000 survey (3.1 cm) and likely reflect a slightly higher sediment oxygen demand (SOD) associated with the recent placement of dredged material.

Advanced Stage III activity was more prevalent at the outer and reference area stations. The overall mean RPD depths at the outer and reference areas (3.4 cm and 2.9 cm, respectively) were slightly deeper than those observed at the inner disposal site stations, but were likewise indicative of moderate to well-oxygenated surface sediments.

Benthic habitat conditions within MIDS were comparable to the ambient sediment at both the outer and reference area stations, with relatively deep RPD depths and a considerable presence of Stage III organisms. Overall OSI values of +6.3 (inner disposal site stations), +7.7 (outer stations), and +7 (reference area stations) were calculated during the July 2002 survey, and were indicative of undisturbed benthic habitat conditions. Slightly higher median OSI values at the outer and reference area stations reflect moderately deeper RPD depths and a high frequency of advanced Stage III activity. Comparison of the six corresponding stations in March 2000 and July 2002 REMOTS® data indicated a slight increase in overall OSI values from +6 in 2000 to +6.5 in 2002. However, these values are comparable and suggest that undisturbed benthic habitat conditions have prevailed over much of the surveyed MIDS area despite the recent placement of dredged material. Comparisons between individual stations suggest dredged material placement may have actually stimulated productivity by providing an input of organic matter (a food source for primary consumers), as reflected in higher OSI values at certain stations displaying the addition of dredged material since the March 2000 survey.

1.0 INTRODUCTION

In 1977, the New England District (NAE) of the US Army Corps of Engineers established the Disposal Area Monitoring System (DAMOS) to monitor the environmental impacts associated with the subaqueous disposal of sediments dredged from harbors, inlets, and bays in the New England region. The DAMOS Program conducts detailed monitoring studies to detect and minimize any physical, chemical, and biological impacts of dredging and dredged material disposal activities. DAMOS monitoring helps to ensure that any effects of sediment deposition on the marine environment are confined to designated seafloor areas and are of limited duration. A flexible, tiered monitoring protocol (Germano et al. 1994) is applied in the long-term management of dredged material disposal at open-water sites along the coast of New England. Three regional dredged material disposal sites exist off the coast of Maine (i.e., Cape Arundel Disposal Site [CADS], Portland Disposal Site [PDS], and Rockland Disposal Site [RDS]). Currently, RDS in West Penobscot Bay is the only active site generally available for dredging projects Downeast (Morris 1996).

The costs associated with transporting relatively small volumes of dredged material by barge from the Downeast rivers or harbors to RDS often outweigh the benefits of the dredging operation. As a result, investigations of alternative disposal techniques (i.e., intertidal mudflat construction) using the sediments removed from these bodies of water have commenced (Ray 1999). In addition, the feasibility of dredged material disposal at several historically used or new open-water sites along the coast of eastern Maine has also been examined (Figure 1-1).

1.1 Background

The coast of Maine has 5,600 kilometers (3,480 miles) of tidally influenced shoreline, with many small, shallow harbors. These harbors are usually quite close to open water, but protected from heavy seas by large bedrock islands or submerged reefs. At the headwaters of many embayments, there are relatively short, shallow rivers that provide drainage to the coastal mountain range.

Maine's Washington County is located along the Atlantic Seacoast and extends from the coastal community of Steuben to the Canadian border. Washington County's coast with numerous islands, bays and harbors resulted from a regional depression during the glacial period when the sea encroached on the land and extended far inland into the existing river valleys. The greatest rise and fall of tides on the shores of the continental United States occur along the Washington County coast, where 5.5 m tidal variations are common (Mainerec.com 2001). Moosabec Reach is a narrow waterway protected from the open

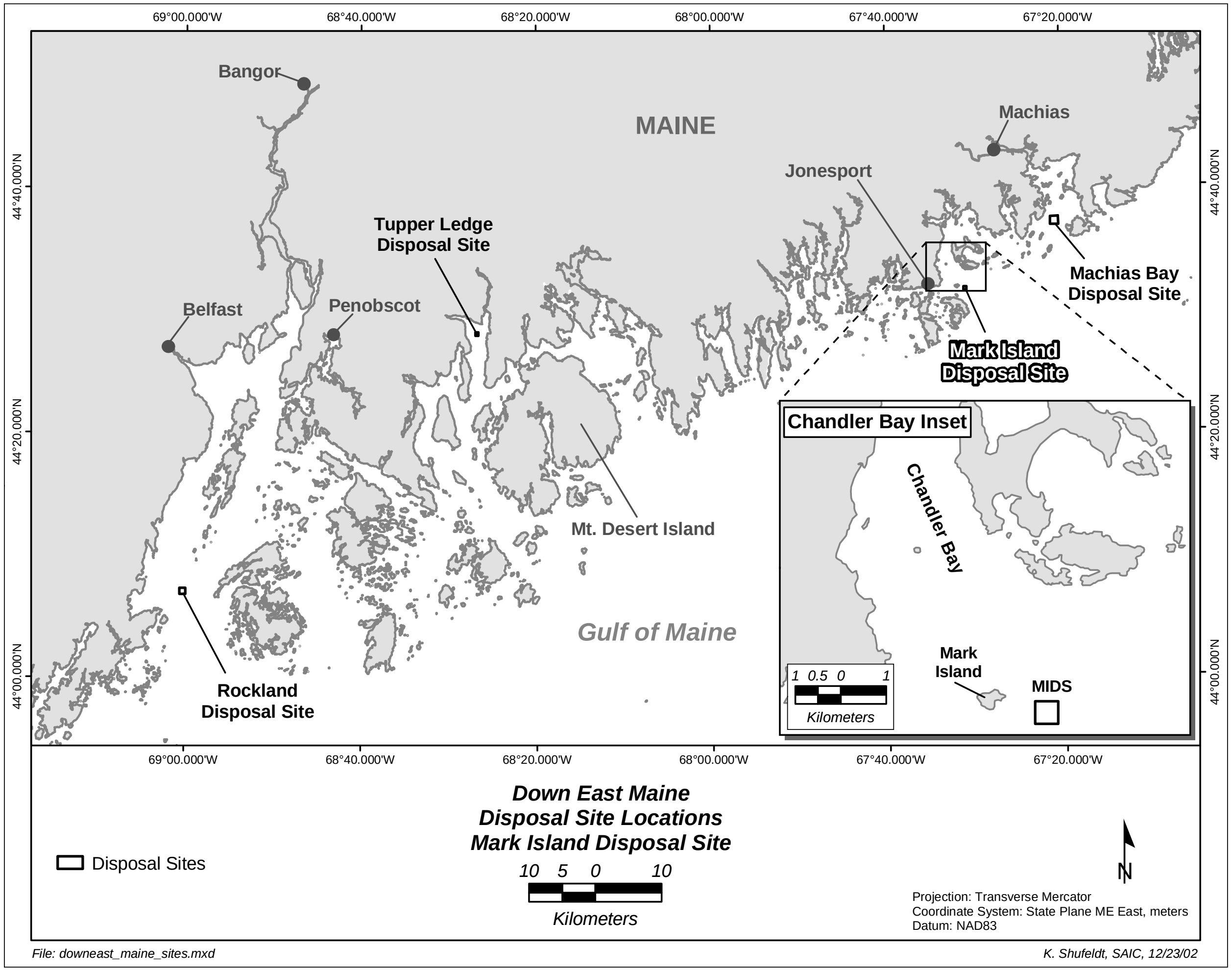


Figure 1-1. Location of the Mark Island Disposal Site relative to the coast of eastern Maine

ocean by a rocky island complex to the south. It serves as a thoroughfare between Wohoa Bay to the west and Chandler Bay to the east. The area surrounding Moosabec Reach is sparsely populated with little to no industrial influence. The nearby town of Jonesport, the largest port in the area, is home to a few marinas and boating facilities. The region supports a commercial lobster fishing fleet that dominates the use of the regional waters for much of the year. However, a small recreational fleet including pleasure craft and tourist excursion vessels is also known to visit these waters in the summer months.

1.2 Mark Island Disposal Site

The Mark Island Disposal Site (MIDS) is a small (500 m × 500 m) site situated in the mouth of Chandler Bay east of Mark Island in eastern Maine (Figures 1-1 and 1-2). This site was investigated in the winter of 2000 for the potential intermittent use for disposal of small volumes of sediment to be dredged from various marine facilities in Moosabec Reach and other nearby harbors. The baseline assessment performed at MIDS in March 2000 was used to determine the potential impact of placing small volumes of sediment within this area of seafloor (SAIC 2000). The bathymetric survey conducted for this effort confirmed that the area was depositional in nature, with a smooth, gently sloping seafloor in the southern portion of the survey area (Figure 1-3). However, a large rock reef was mapped in the northeastern portion of the proposed disposal area, prompting a shift in the disposal site boundary 250 m south from its original proposed location to avoid the reef. Based upon the findings of the March 2000 survey, the center of MIDS was established at 44°31.698´ N, 67°31.070´ W (NAD 83) (Figure 1-2).

The 0.25 km^2 area surveyed in July 2002 is located approximately 1.85 km northeast of Seguin Island, between West Black Rock and Mark Island (Figure 1-2). The area is relatively well-protected from the effects of winds and ocean swells, due to the presence of large islands/land masses to the west and north and a number of shallow rocks and ledges (e.g., The Black Rocks, Little Breaking Ledge) to the east and south. The reported tidal range of 4 m in the area causes water depths to vary between roughly 28 m to 33 m within a tidal cycle. This site was last used for disposal of material dredged from Pig Island Gut in 1966.

Dredging operations in Moosabec Reach for the US Coast Guard Base, Jonesport, ME were conducted from 17 December 2001 to 10 January 2002 (Figure 1-4). A total estimated barge volume of approximately 4,300 m^3 of sediment was placed at the Mark Island Disposal Site (Appendix A). A total of 18 small-volume disposal events were completed by pocket barges, which contained an average volume of 238 m^3 of sediment per barge (Figure 1-4). Placement of sediment at MIDS represents the first use of the site in approximately 35 years.

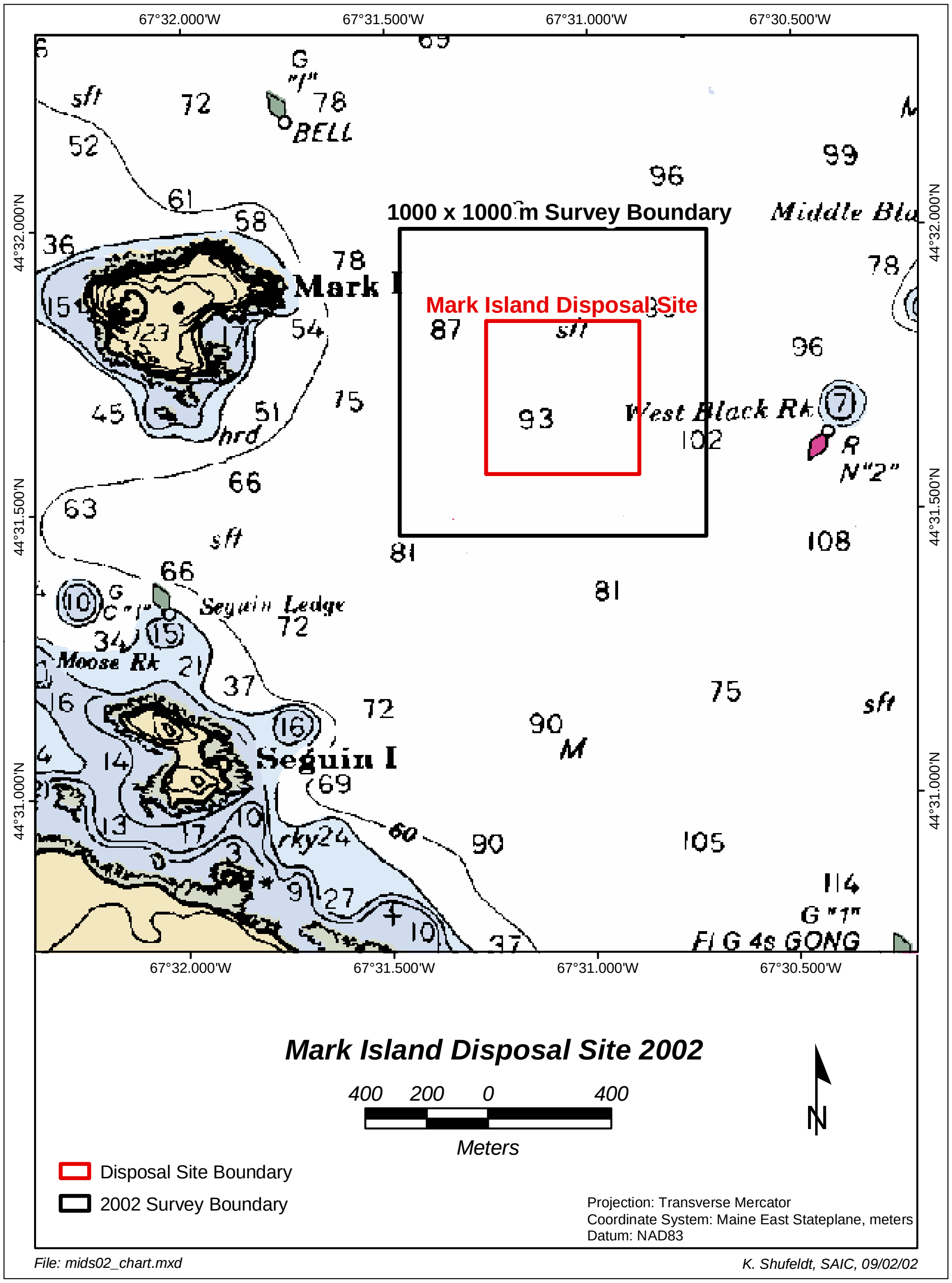


Figure 1-2. Detail of NOAA Chart No. 13326 showing the location of the Mark Island Disposal Site in Chandler Bay

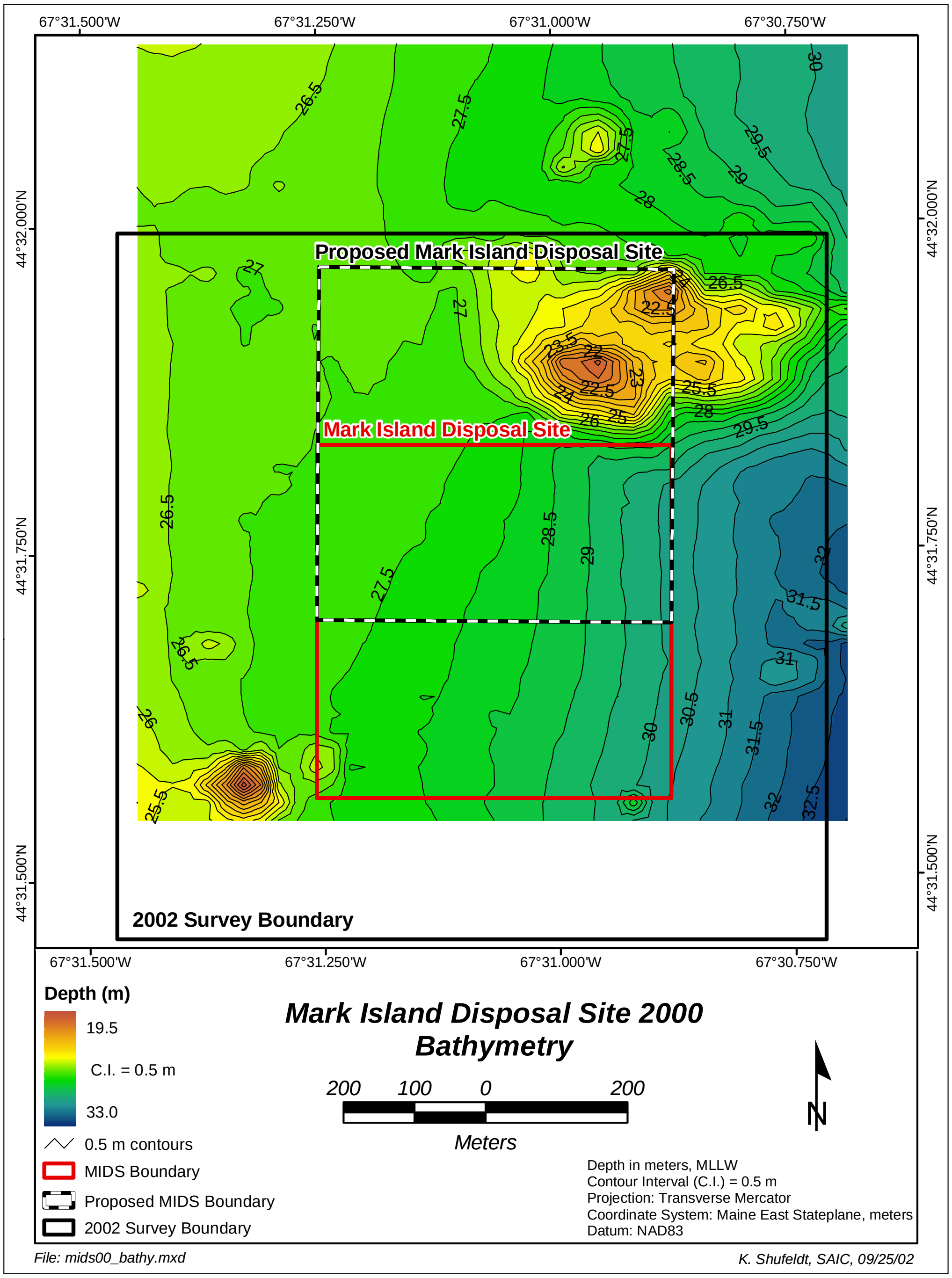


Figure 1-3. Map showing the locations of the proposed and current 500 × 500 m disposal site boundaries over the chart of the March 2000 bathymetry at the Mark Island Disposal Site

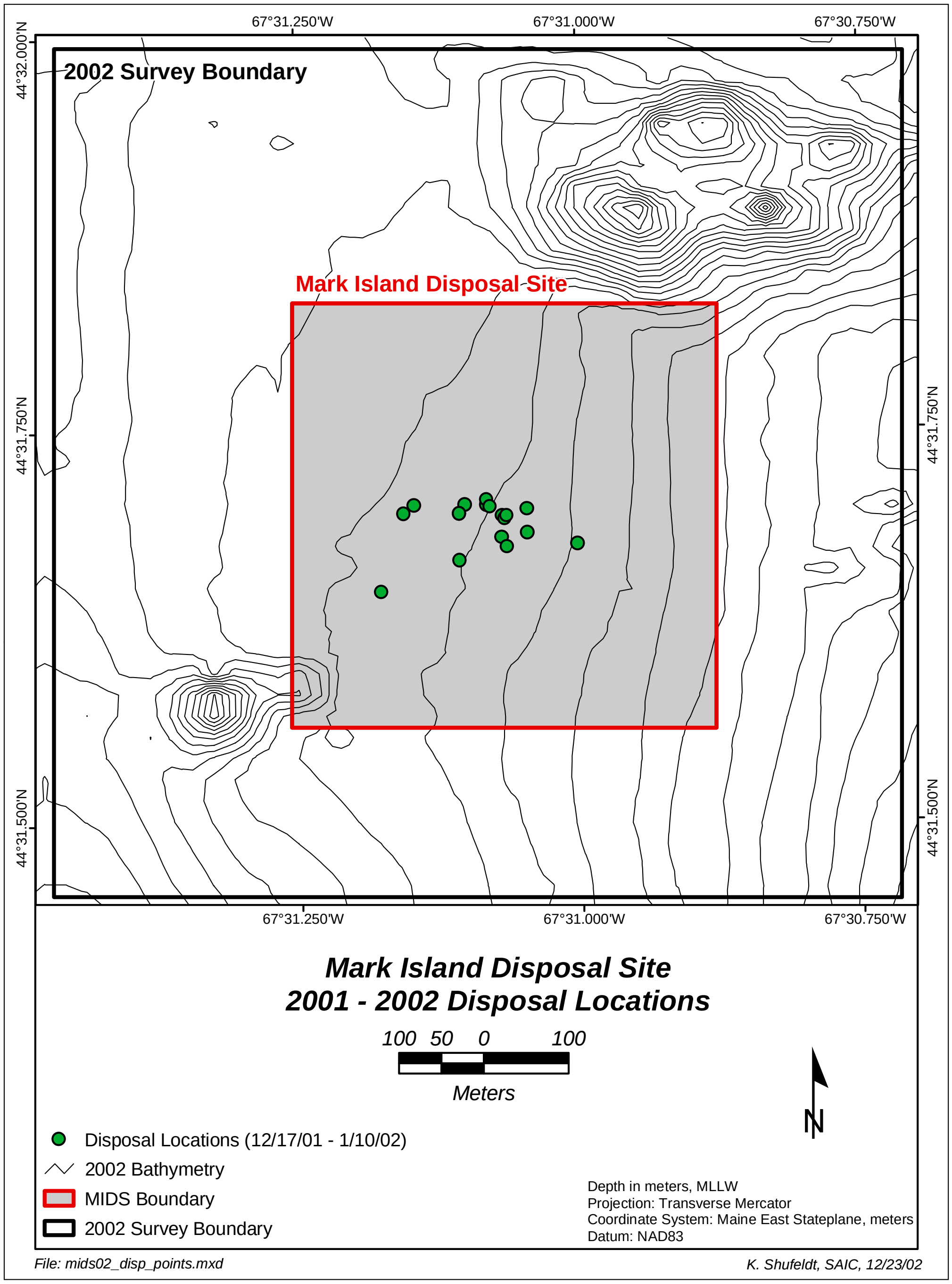


Figure 1-4. Map showing the December 2001 through January 2002 reported dredged material disposal locations over the MIDS 2002 survey boundary

1.3 Survey Objectives and Predictions

In July 2002, the DAMOS Program conducted an environmental survey of the Mark Island Disposal Site. The specific objectives of the July 2002 survey effort were to:

1) Document the distribution of recently placed dredged material on the seafloor within MIDS

2) Assess benthic community status and physical nature of the sediments within the confines of MIDS relative to existing seafloor conditions at two nearby reference areas

The July 2002 field effort tested the following predictions:

1) The estimated barge volume of 4,300 m^3 of sediment deposited at MIDS during the winter of 2001/2002 should be detectable on the seafloor, but may not exist as a discrete dredged material disposal mound; and

2) Recolonization of the relatively small amount of disposed sediment should be in a Stage II and Stage III successional status over most of the deposit due to vertical migration of infaunal organisms through the recently placed sediment.

To address the first objective, a hydrographic survey consisting of precision bathymetry and side-scan sonar was conducted over MIDS. It was predicted that the relatively small volume of material placed at the site would not likely be detectable using bathymetry, but that mapping its distribution with side-scan sonar and sediment-profile imaging would be possible. Therefore, the REMOTS® sediment-profile imaging survey was performed to delineate the distribution of historic dredged material and also to assess the benthic recolonization status over the disposal site relative to the nearby reference areas.

2.0 METHODS

The following section will provide an overview of the methods employed during the July 2002 environmental monitoring survey at MIDS. Field operations were conducted aboard the *M/V Beavertail* from 3 to 5 July 2002 and consisted of REMOTS® sediment-profile imaging, single-beam bathymetry and side-scan sonar. The disposal site was surveyed to assess the distribution of recently disposed sediment as well as the benthic community status and physical nature of the sediments.

2.1 Navigation

During the field operations, differentially-corrected Global Positioning System (DGPS) data in conjunction with Coastal Oceanographic's HYPACK® navigation and survey software were used to provide real-time positioning of the survey vessel to an accuracy of $\pm$5 m. A Trimble DSMPro GPS receiver was used to obtain raw satellite data and provide vessel position information in the horizontal control of North American Datum of 1983 (NAD 83). The GPS receiver has an integrated differential beacon receiver to improve the overall accuracy of the satellite data to the necessary tolerances. The US Coast Guard differential beacon broadcasting from Penobscot, Maine (290 kHz) was utilized for real-time satellite corrections due to its geographic position relative to MIDS.

The DGPS data were ported to Coastal Oceanographic's HYPACK® data acquisition software for position logging and helm display. REMOTS® sampling stations and bathymetric survey lanes were determined before the commencement of the field operations and stored in a project database. During the field operations, individual stations were selected and displayed by the navigation system in order to position the survey vessel over the correct geographic coordinates. The position of the vessel during the acquisition of each REMOTS® image was logged with a time stamp in Universal Time Coordinated (UTC) and a text identifier to facilitate Quality Control (QC) and rapid input into a Geographic Information System (GIS) database.

2.2 Bathymetric Data Acquisition and Analysis

2.2.1 Bathymetric Data Acquisition

Bathymetric data were collected over a 1000 $\times$ 1000 m area surrounding MIDS to examine seafloor topography and assess the distribution of recently disposed sediment within the disposal site boundary (Figure 2-1). The bathymetric survey was centered at

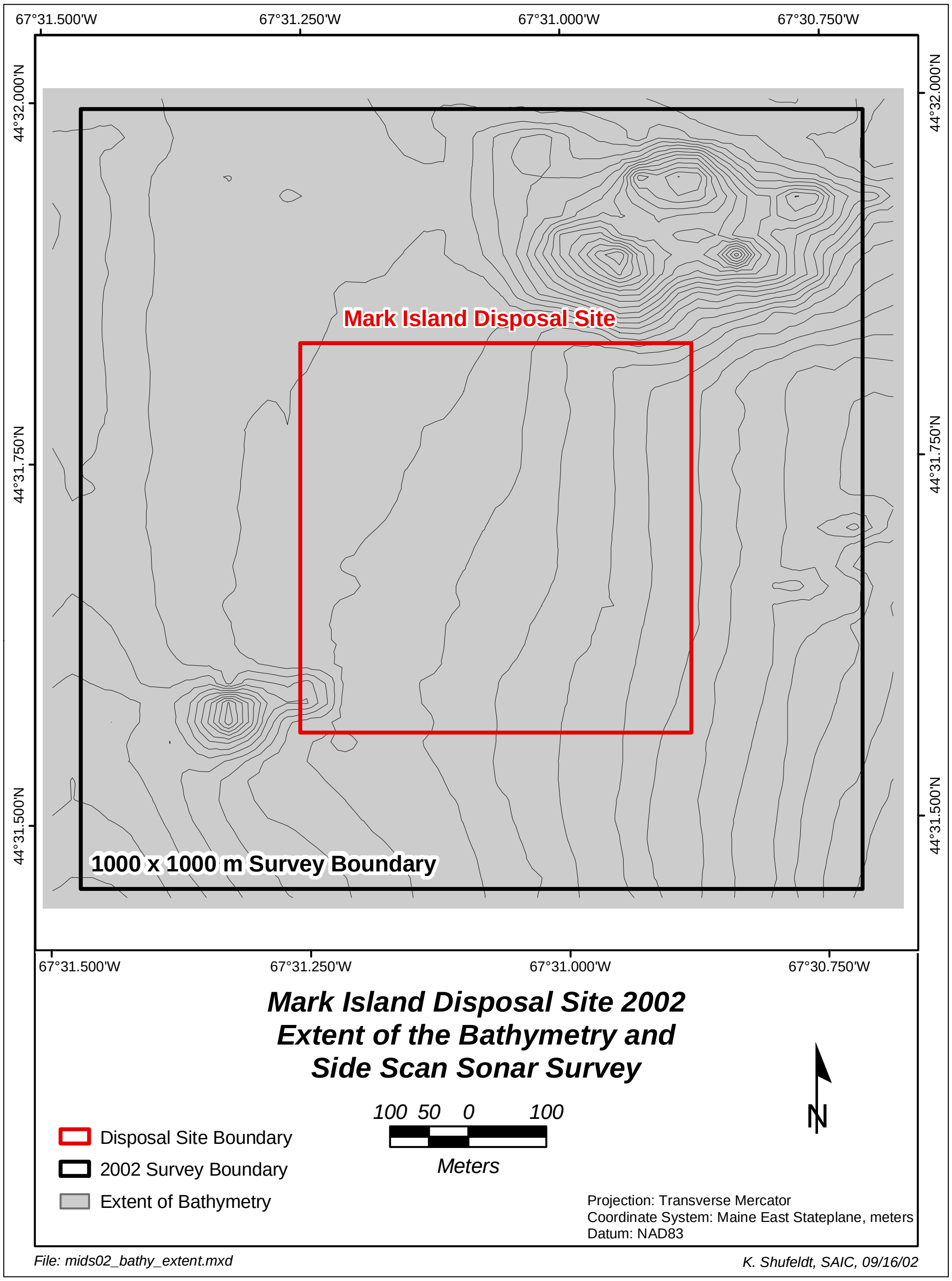


Figure 2-1. Map showing the MIDS boundary, the 1000 × 1000 m side-scan and bathymetric survey area surrounding MIDS

coordinates 44°31.725´ N, 67°31.093´ W (NAD 83) and consisted of a total of 21 survey lanes spaced at 50 m intervals and oriented north/south.

During the bathymetric survey, HYPACK® was interfaced with an Odom Hydrotrac® survey echosounder, as well as the Trimble DGPS. The Hydrotrac® uses a narrow-beam (3°), 208-kHz transducer to make discrete depth measurements and produce a continuous analog record of the seafloor. The Hydrotrac® transmitted approximately 10 digital depth values per second (depending on water depth) to the data acquisition system. Within HYPACK®, the time-tagged position and depth data were merged to create continuous depth records along the actual survey track. These records were viewed in near real time to ensure adequate coverage of the survey area.

2.2.2 Bathymetric Data Processing

The bathymetric data were fully edited and processed using the HYPACK® data processing modules. Raw position and sounding data were edited as necessary to remove or correct questionable values, apply sound velocity and draft corrections, and reduce the depth soundings to the vertical datum of Mean Lower Low Water (MLLW) using observed tides obtained from the National Oceanic and Atmospheric Administration (NOAA).

During bathymetric survey data acquisition, an assumed and constant water column sound velocity was entered into the Odom echosounder. To account for the variable speed of sound through the water column, a Seabird Instruments, Inc. SEACAT SBE 19-01 conductivity, temperature, and depth (CTD) probe was used to obtain sound velocity profiles at the start and end of each field survey day. An average sound velocity was calculated for each day from the water column profile data, and then entered into a HYPACK® sound velocity correction table. Using the assumed sound velocity entered into the echosounder and the computed sound velocity from the CTD casts, HYPACK® then computed and applied the required sound velocity corrections to all of the sounding records.

Observed tide data were obtained from the NOAA tide station in Eastport, ME (Station number 8410140) through the National Water Level Observation Network. The NOAA six-minute tide data were downloaded in the MLLW datum and corrected for tidal offsets. A tide gauge mooring was deployed at the start of the survey in close proximity to the survey boundary to document water levels over the survey area and aid in applying correctors to the NOAA data. Based on the comparison between the NOAA tide data and the local tide gauge, a height corrector was calculated for the Mark Island data. Best fit between the NOAA observed data and the moored tide gauge data indicated a twelve-minute time offset and a height correction of 0.67 (Figure 2-2).

2.2.3 Bathymetric Data Analysis

The purpose of the bathymetric analysis was to identify any unique seafloor features and detect any topographic changes since the March 2000 survey. Because single-beam bathymetric survey data typically cover only a small percentage of the total seafloor area (approximately 5%), the analysis relies on interpolating between the discrete survey data points to generate a three-dimensional seafloor surface model.

After the bathymetric data were fully edited and reduced to MLLW, cross-check comparisons on overlapping data were performed in order to verify the proper application of the correctors and to evaluate the consistency of the data set. Once the data were verified, they were then processed through the HYPACK® Sort routine in order to thin the survey data and reduce the overall size of the dataset. Because of the rapid rate at which a survey echosounder can generate data (approximately ten depths per second), the along-track data density for a single-beam survey tends to be very high (multiple soundings per meter). In most cases, these data sets contain many redundant data points that can be eliminated without any effect on the overall quality of the data. The Sort routine examines the full dataset along each survey line and then extracts only the representative soundings based on a user-specified distance interval or search radius. The output from the Sort routine is a merged ASCII-xyz file that may contain anywhere from 2 to 10% of the original data set. These greatly reduced, but still representative, data sets are far more efficient to use in the subsequent modeling and analysis routines.

The 2002 MIDS bathymetric survey data were gridded through the ESRI® ArcMap software module to generate a depth model for the entire survey area, using a grid cell size of 25 × 25 m. The same system was used to generate a depth model for the March 2000 bathymetric survey data. The July 2002 and March 2000 models were mathematically compared within ArcMap, producing a dataset of calculated depth differences. Using this method, any depth differences are related to changes in seafloor topography between the dates of the compared survey grids. Prior to the 2002 survey, the disposal site boundary was shifted 250 m to the south (Figure 1-3) to avoid enclosing the rock reef located to the northeast of the site. As a result, the depth difference calculations were conducted within a 970 × 830 m area of overlap between the July 2002 bathymetry (northern portion) and the March 2000 bathymetry (southern portion).

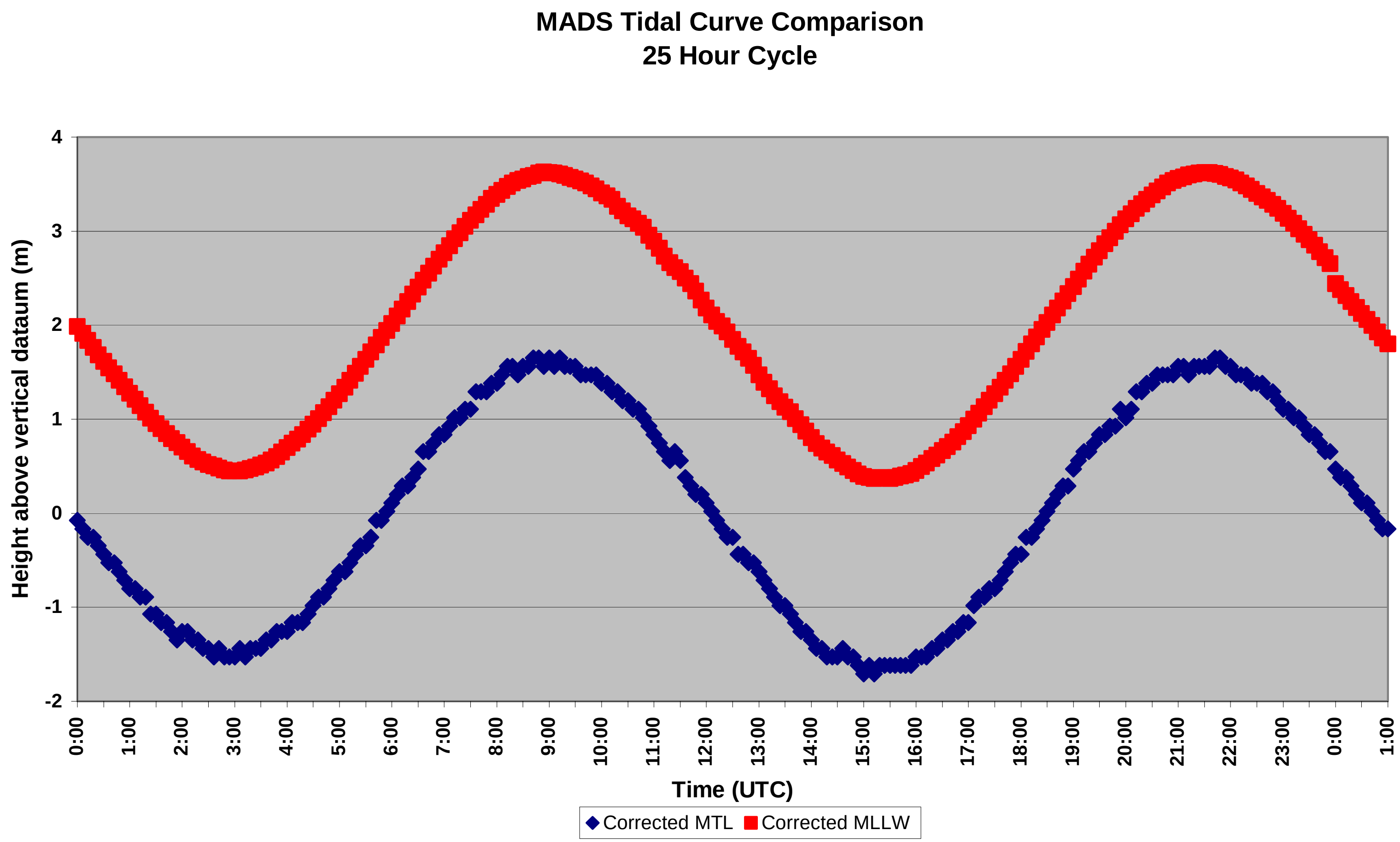


Figure 2-2. Tidal datum, phase, and height comparisons of the water levels recorded on site versus the adjusted NOAA observed tidal data for MIDS

2.3 Side-Scan Sonar Data Acquisition and Analysis

Side-scan sonar is a swath data type that provides an acoustic representation of the seafloor, yielding information on sediment type, bottom targets, and generalized seafloor characteristics by detecting the back-scattered signals emitted from a towed transducer housed in a towfish. Side-scan data provide information on size of an object, height above the seafloor, and its horizontal distance from the towfish. Dense objects (e.g., rocks and firm sediment) reflect strong signals and appear as dark areas on the side-scan records. Conversely, areas characterized by soft features (e.g., muddy sediments), which absorb sonar energy, appear as lighter areas in the side-scan records.

2.3.1 Side-Scan Sonar Data Acquisition

The area covered in the side-scan sonar survey was centered on MIDS and measured 1000 × 1000 m (Figure 2-1). The side-scan sonar survey consisted of 11 survey lanes oriented north/south and spaced at 100 m intervals to provide a full mosaic of the bottom features and assess the distribution of the dredged material deposit within the disposal site. The position of the towfish was calculated in real-time by a HYPACK® navigation package, based on cable scope (layback) and speed of the survey vessel. This information was embedded within the digital side-scan sonar data to allow for the geo-referencing of each acoustic return.

Side-scan sonar imagery data was acquired with an EdgeTech DF1000 side-scan sonar towfish, interfaced with a PC-based Triton-Elics ISIS® sonar acquisition system. The DF1000 operates at frequencies of 100 and 500 kHz and the range-scale was set to 100 m throughout the survey. The DF1000 side-scan fish was towed behind the survey vessel with a double-armored coaxial tow cable. The ISIS® system recorded acoustic data from the towfish and position information from the navigation system, and displayed real-time imagery on a PC monitor. With the lanes spaced at 100 m intervals and side-scan range scale set to 100 m, over 200% bottom coverage was obtained during the side-scan operations.

2.3.2 Side-Scan Sonar Data Processing

Individual survey lines were played back in ISIS® and converted to a format for use in the Delph Map mosaicing program. Upon playback of the side-scan records, adjustments were made to the time-varying-gain (TVG) of the return signal and portions of the records corresponding to water column were removed. As each line was completed in ISIS® they were imported into Delph Map to check for processing accuracy during the file conversion from one program to the other. Upon processing completion of all of the side-scan survey lines, a mosaic was generated in Delph Map to check for coverage gaps between survey lines. After the mosaic was completed it was saved and exported out of Delph Map as a geo-referenced Tiff file. This Tiff image was then imported into a Geographic Information System (GIS) environment as a geo-referenced data source that is capable of being compared with various existing and future data sets from the corresponding area.

2.4 REMOTS® Sediment-Profile Imaging

REMOTS® (Remote Ecological Monitoring of the Seafloor) sediment-profile imaging is a benthic sampling technique used to detect and map the distribution of thin (<20 cm) dredged material layers, delineate benthic disturbance gradients, and monitor the process of benthic recolonization following physical seafloor disturbance. This is a reconnaissance survey technique used for rapid collection, interpretation and mapping of data on physical and biological seafloor characteristics. The DAMOS Program has used this technique for routine disposal site monitoring for over 20 years.

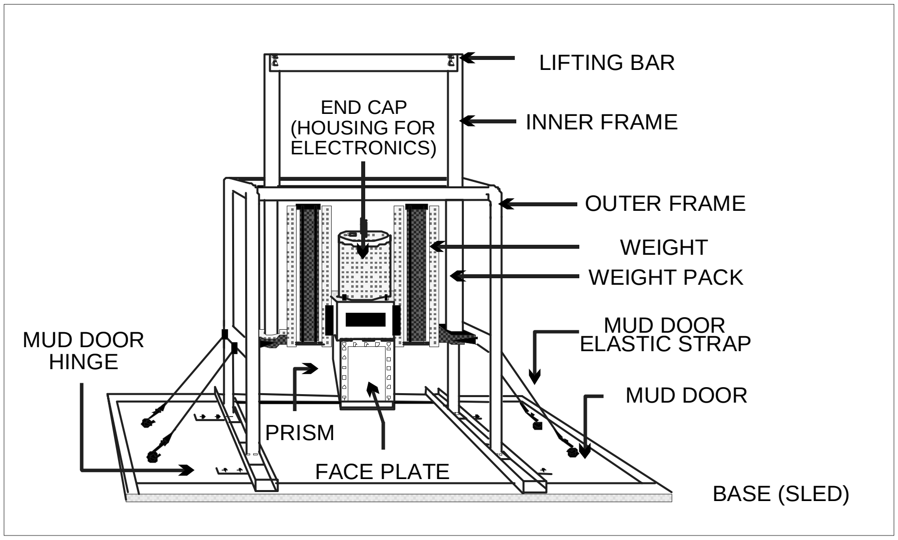
The REMOTS® hardware consists of a Benthos Model 3731 sediment-profile camera designed to obtain undisturbed, vertical cross-section photographs (in situ profiles) of the upper 15 to 20 cm of the seafloor (Figure 2-3). Computer-aided analysis of each REMOTS® image yields a suite of standard measured parameters, including sediment grain size major mode, camera prism penetration depth (an indirect measure of sediment bearing capacity/density), small-scale surface boundary roughness, depth of the apparent redox potential discontinuity (RPD, a measure of sediment aeration), infaunal successional stage, and Organism-Sediment Index (OSI, a summary parameter reflecting overall benthic habitat quality).

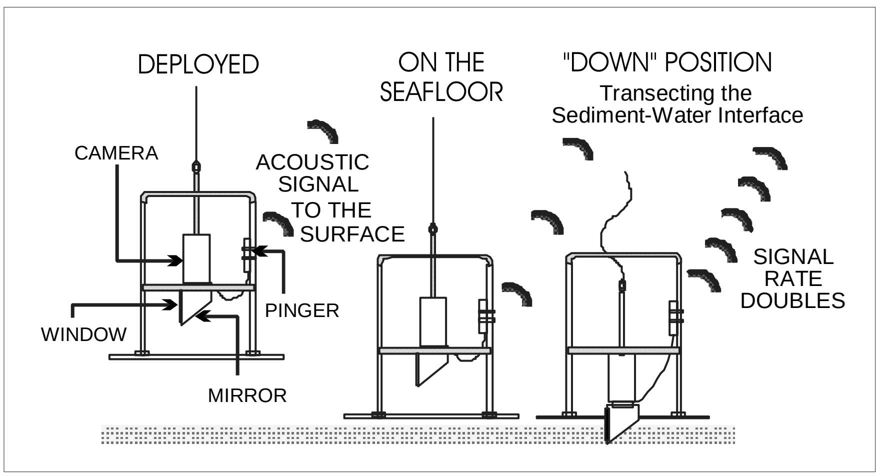
Organism-Sediment Index values may range from –10 (azoic with low sediment dissolved oxygen and/or presence of methane gas in the sediment) to +11 (healthy, aerobic environment with deep RPD depths and advanced successional stages). The OSI values are calculated using values assigned for the apparent RPD depth, successional status, and indicators of methane or low oxygen. Because the OSI is calculated using apparent RPD depths and successional stages, indeterminate apparent RPD depths and/or successional stages lead to indeterminate OSI values. REMOTS® image acquisition and analysis methods are described fully in Rhoads and Germano (1982; 1986) and in the recent DAMOS Contribution No. 128 (SAIC 2001).

The REMOTS® survey performed over MIDS as part of the July 2002 field effort consisted of a 25-station rectangular sampling grid within the 500 × 500 m disposal boundary, with an additional eight stations distributed outside the disposal site boundary (denoted as inner and outer stations in Table 2-1). The REMOTS® images collected from these stations were used to assess benthic community status and the physical nature of the recently deposited sediments within and surrounding the disposal site. The sampling grid was centered at the location of Station S occupied in the March 2000 baseline survey at coordinates 44°31.726´ N, 67°31.069´ W, now located within the current 500 m × 500 m disposal site boundary (Table 2-1; Figure 2-4). Given the shift in the survey area center relative to March 2000, 6 of the 25 stations (Stations 01, 03, 05, 11, 13, and 15) coincided with the position of stations previously occupied during the baseline survey effort.

The inner sampling grid consisted of five rows of stations evenly spaced from center Station 13 corresponding to the location of Station S in March 2000 (two rows to the north of the center, two rows to the south of the center and a row of five at the center). The outer REMOTS® sampling grid was composed of four stations positioned 375 m to the north, east, south, and west of Station 13 near the center of the disposal site, while the remaining four stations were placed 500 m to the northeast, southeast, southwest, and northwest of Station 13. All 25 stations established over MIDS were successfully sampled during the July 2002 survey.

Reference areas are typically sampled during DAMOS monitoring surveys to provide a comparative assessment of the environmental conditions existing on the ambient seafloor. Ten sediment-profile imaging stations were randomly distributed over two reference areas (NEREF and SREF) in close proximity to MIDS to provide a basis of comparison with conditions within the ambient sediment of Chandler Bay (Table 2-2; Figure 2-4). Five randomly selected stations were occupied within a 300 m radius of the center of reference area NEREF (44°32.266´ N, 67°30.488´ W), and an additional five stations were randomly occupied within a 300 m radius of the center of SREF (44°27.617´ N, 68°26.271´ W; Table 2-2; Figure 2-4). At each of the disposal site and reference area REMOTS® stations occupied in the July 2002 survey, the camera was lowered into the seafloor multiple times to obtain at least three replicate images of suitable quality for subsequent analysis.





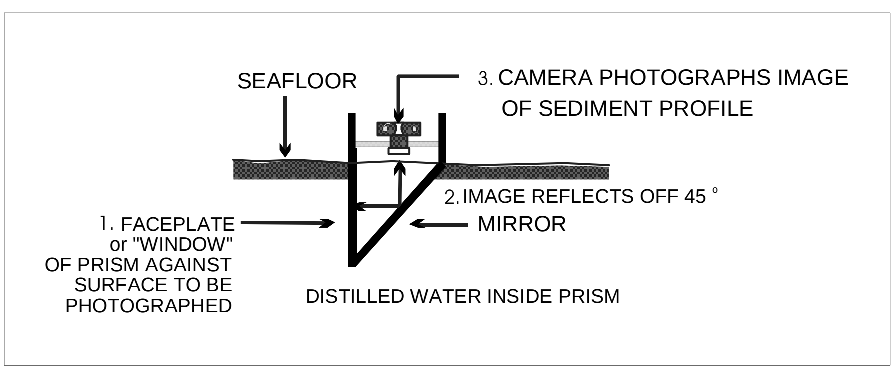


Figure 2-3. Schematic diagram of Benthos Inc. Model 3731 REMOTS® sediment-profile camera and sequence of operation on deployment

Table 2-1.

REMOTS® Station Locations over the Mark Island Disposal Site

Area	Station	Latitude (NAD 83)	Longitude (NAD 83)
Inner Stations	1	44° 31.835´ N	67° 31.219´ W
	2	44° 31.834´ N	67° 31.140´ W
	3	44° 31.833´ N	67° 31.068´ W
	4	44° 31.833´ N	67° 30.992´ W
	5	44° 31.832´ N	67° 30.917´ W
	6	44° 31.781´ N	67° 31.219´ W
	7	44° 31.780´ N	67° 31.144´ W
	8	44° 31.779´ N	67° 31.069´ W
	9	44° 31.779´ N	67° 30.993´ W
	10	44° 31.778´ N	67° 30.918´ W
	11	44° 31.727´ N	67° 31.220´ W
	12	44° 31.726´ N	67° 31.145´ W
	13	44° 31.725´ N	67° 31.069´ W
	14	44° 31.725´ N	67° 30.994´ W
	15	44° 31.724´ N	67° 30.918´ W
	16	44° 31.673´ N	67° 31.221´ W
	17	44° 31.672´ N	67° 31.146´ W
	18	44° 31.671´ N	67° 31.070´ W
	19	44° 31.671´ N	67° 30.995´ W
	20	44° 31.670´ N	67° 30.919´ W
	21	44° 31.619´ N	67° 31.222´ W
	22	44° 31.618´ N	67° 31.147´ W
	23	44° 31.617´ N	67° 31.071´ W
	24	44° 31.617´ N	67° 30.996´ W
	25	44° 31.616´ N	67° 30.920´ W
Outer Stations	N375	44° 31.928´ N	67° 31.066´ W
	E375	44° 31.723´ N	67° 30.786´ W
	S375	44° 31.523´ N	67° 31.073´ W
	W375	44° 31.728´ N	67° 31.352´ W
	NE500	44° 31.914´ N	67° 30.799´ W
	SE500	44° 31.532´ N	67° 30.806´ W
	SW500	44° 31.537´ N	67° 31.339´ W
	NW500	44° 31.919´ N	67° 31.333´ W

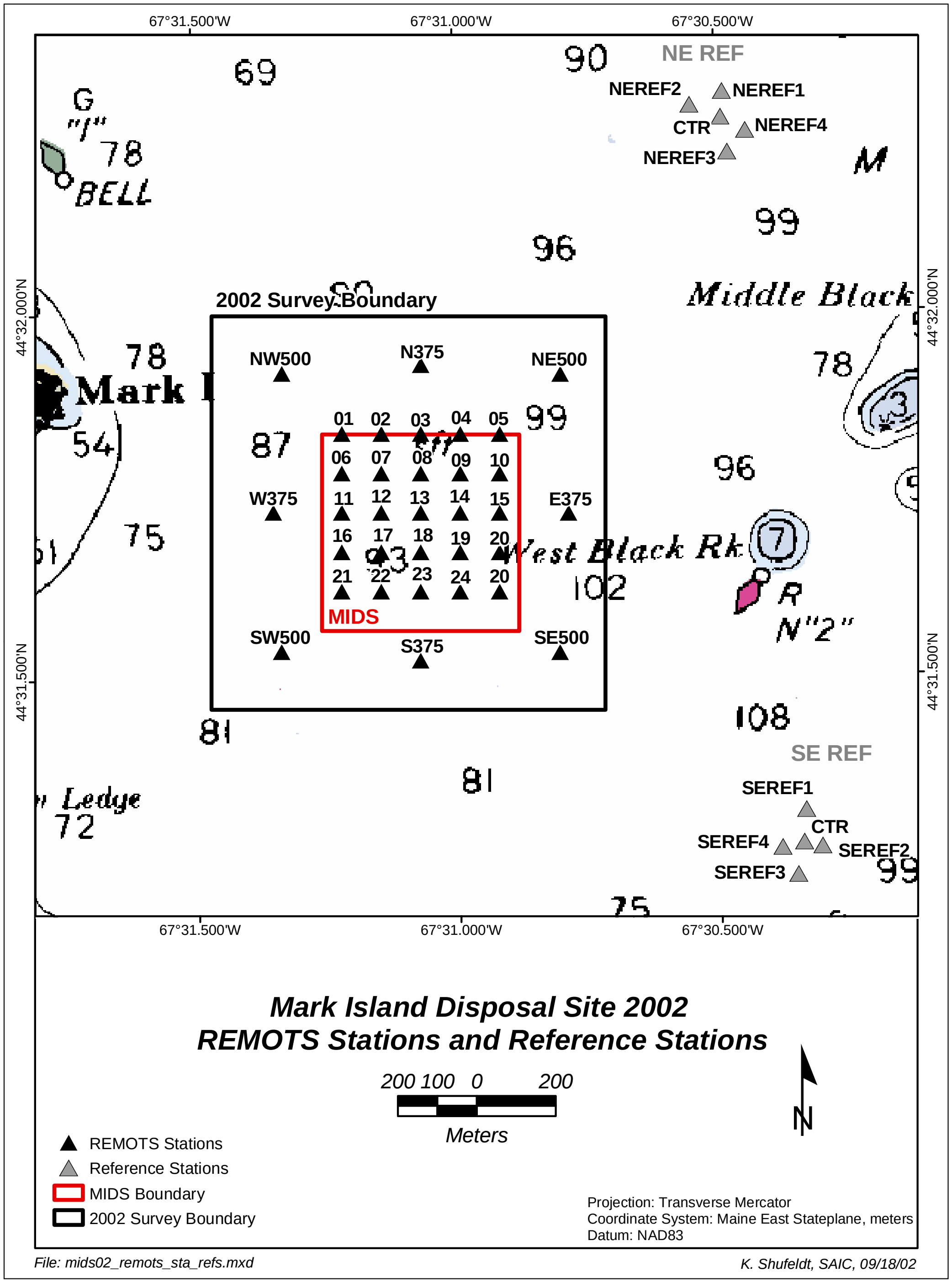


Figure 2-4. Map showing the REMOTS® stations occupied at MIDS and nearby reference areas (NEREF and SEREF) over NOAA Chart No. 13326

Table 2-2.

REMOTS® Station Locations over the Mark Island Reference Areas

Area	Station	Latitude (NAD 83)	Longitude (NAD 83)
Northeast Reference	NEREF-CTR	44° 32.265´ N	67° 30.488´ W
	NE REF1	44° 32.300´ N	67° 30.484´ W
	NE REF2	44° 32.282´ N	67° 30.546´ W
	NE REF3	44° 32.217´ N	67° 30.474´ W
	NE REF4	44° 32.246´ N	67° 30.440´ W
South Reference	SREF-CTR	44° 31.214´ N	67° 31.070´ W
	SREF1	44° 31.238´ N	67° 31.096´ W
	SREF2	44° 31.206´ N	67° 31.124´ W
	SREF3	44° 31.189´ N	67° 31.080´ W
	SREF4	44° 31.160´ N	67° 31.034´ W

3.0 RESULTS

3.1 Bathymetry

As part of the July 2002 monitoring effort, a bathymetric survey was performed over a 1 km^2 survey area encompassing MIDS. Within the survey area, the depth ranged from 20.5 m over the rock reef in the northeast of MIDS to 34 m in the southeast corner of the survey area. Both of these areas of seafloor are located outside the 0.25 km^2 disposal site boundary (Figure 3-1).

The largest bottom feature within the survey area was the rock reef located in the northeast corner of the survey area, outside the disposal site (Figure 3-1). The reef measured approximately 500 m along its E-W axis. The largest and shallowest outcrop in the reef was located in the southwest corner of the reef with a depth of 20.5 m at its apex. This outcrop was approximately 7 m above the seafloor within the adjacent MIDS.

A smaller rock outcrop was distinguishable in the southwest corner of the survey, also outside the MIDS boundary (Figure 3-1). The outcrop was oval shaped with the E-W axis measuring 180 m and the N-S axis measuring 120 m. The depth at the apex was 22 m, approximately 5 m above the adjacent MIDS seafloor.

The natural seafloor within the disposal site boundary was relatively flat and featureless, sloping gradually from a minimum depth of 27.5 m in the west to a maximum depth of 30.5 m in the east (Figure 3-1). As anticipated, the depth difference comparison between the March 2000 and July 2002 bathymetric surveys indicated no detectable changes in seafloor topography following the placement of 4,300 m^3 of sediment within the disposal site. Given that this is a minimal volume, the resulting change in seafloor topography would be below the detectable threshold for a bathymetric survey (i.e., $<$20 cm thick).

3.2 Side-Scan Sonar

A complete 100 kHz image mosaic, representing 200% side-scan bottom coverage, was created for the entire MIDS survey area (Figure 3-2). In the mosaic, darker areas represent stronger acoustic returns (higher reflectance) and indicate harder seafloor surface materials such as boulders or bedrock. The lighter areas of the mosaic represent weaker acoustic returns (low reflectance) and indicate softer seafloor surface material such as silt and clay. Although some resolution was lost when creating the small-scale mosaic over a

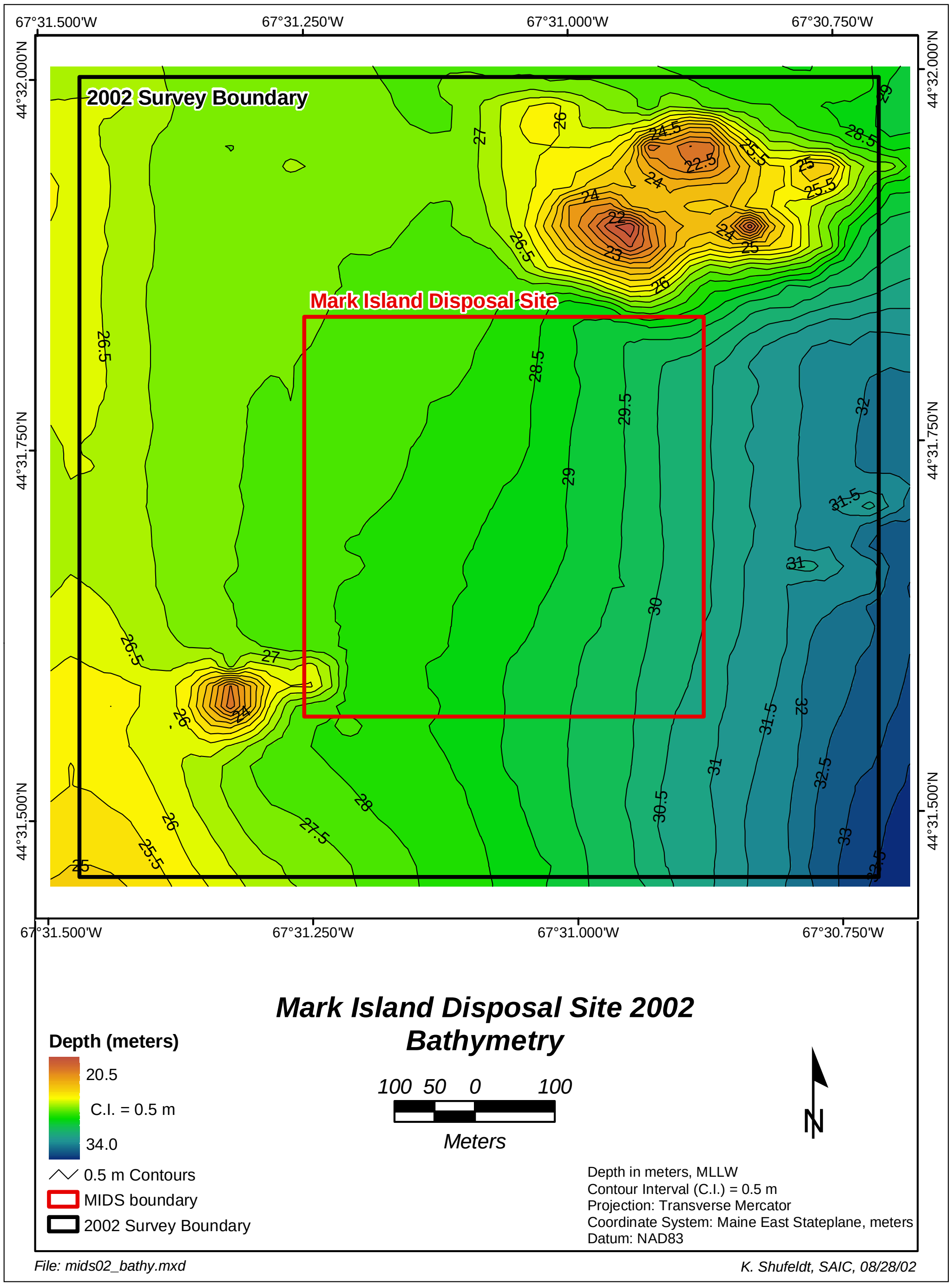


Figure 3-1. Bathymetric chart of the July 2002 survey area over the Mark Island Disposal Site, 0.5 m contour interval

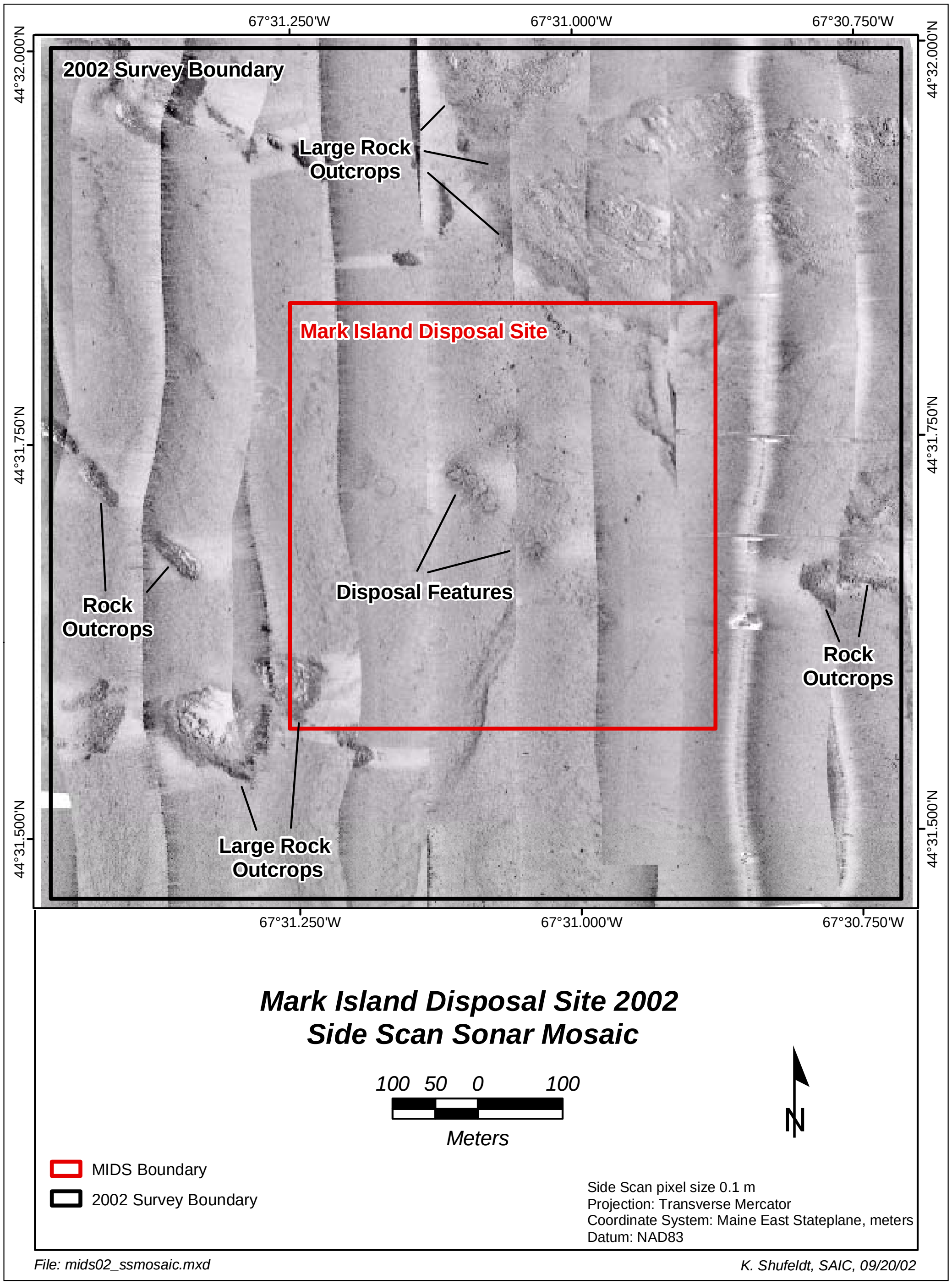


Figure 3-2. Map showing the side-scan sonar mosaic (100 kHz) over the 2002 Mark Island survey area

large area, the survey provided a useful overview of the site and enabled a broad seafloor characterization of the entire survey area.

Based on the full area mosaic, the majority of the survey area was characterized by low reflectance, weaker acoustic returns that are indicative of softer, lower density ambient bottom sediments comprised of silt and clay (Figure 3-2). However, several higher-reflectance features were prominent in the side-scan sonar mosaic, such as bedrock outcrops and disposal features created by pocket barges. Although detected in the individual survey lanes, small individual targets (i.e., lobster traps and small boulders) were not apparent in the mosaic.

Just outside the northeastern and southwestern limits of the disposal site boundary, two prominent rock outcrops are evident on the mosaic. The northeastern reef is composed of three to four individual outcrops, and its total measurement based on sonar returns was 520 m (E-W) by 260 m (N-S) (Figure 3-3A). The southwestern reef is composed of two distinct outcrops and measures 180 m (E-W) by 130 m (N-S) (Figure 3-3B). Based on the significant acoustic shadowing associated with these features, they appear to rise steeply above the surrounding seafloor. Several other smaller rock outcrops can also be discerned within the survey area (Figure 3-2).

Although a distinct disposal mound could not be identified with the bathymetry data, disposal features were evident in the side-scan sonar mosaic (Figure 3-4). These features appeared as higher-reflectance individual rings or series of rings along a line. The acoustic return of these circular features was darker and more concentrated when compared to the surrounding seafloor. It signified both the small-scale bottom disturbance associated with the impact of the sediment placed on the seafloor and the contrast in surface texture between the dredged material deposit and ambient sediments. These disposal features were typical of the type of features produced by pocket-type disposal barges. Similar disposal features have been seen in side-scan sonar and multibeam bathymetry surveys performed at other disposal sites (DeAngelo and Murray 1997; SAIC 2002; Valentine et al. 1996).

3.3 REMOTS® Sediment-Profile Imaging

The REMOTS® results were primarily used to assess the distribution of dredged material and monitor the subsequent recovery of the benthic infaunal community. The complete set of REMOTS® image analysis results for both the disposal site and the reference areas stations is provided in Appendix B; these results are summarized in Tables 3-1 through 3-3.

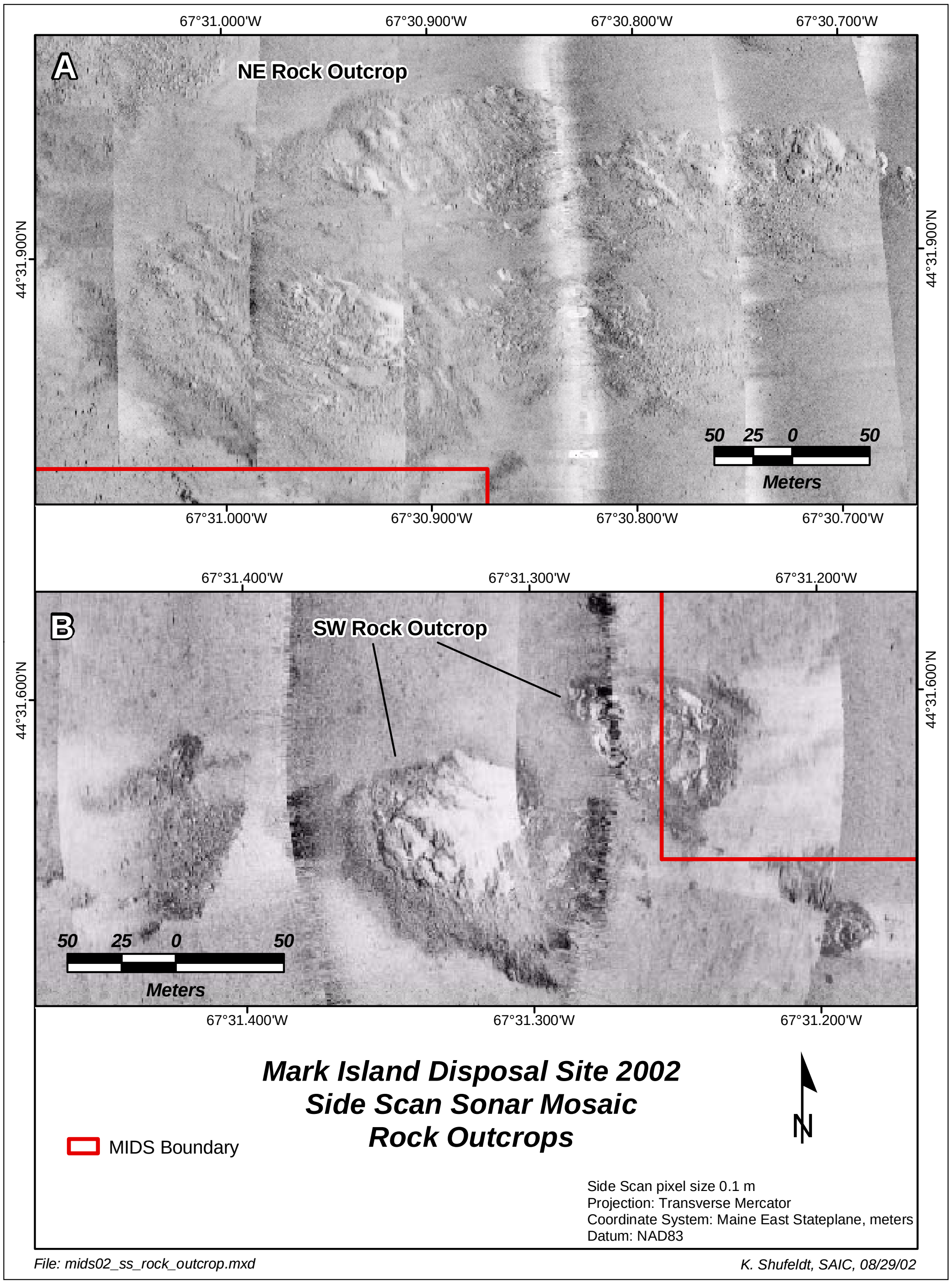


Figure 3-3. Side-scan sonar graphics showing the two largest rock outcrops at the Mark Island Disposal Site in detail

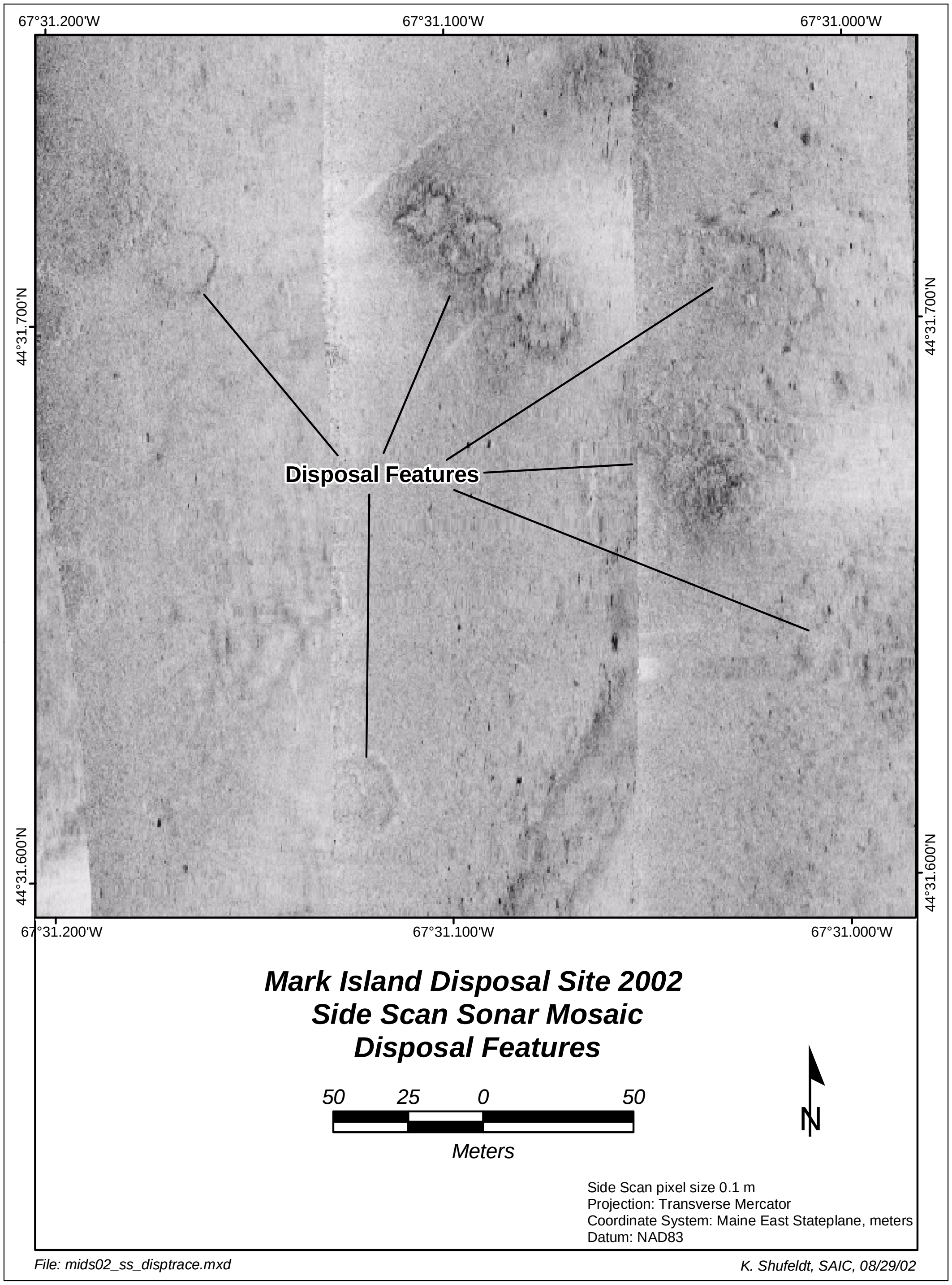


Figure 3-4. Map of the side-scan sonar mosaic showing detail of the disposal features on the Mark Island Disposal Site seafloor

Table 3-1.

REMOTS® Sediment-Profile Imaging Results Summary for the Inner Survey Stations at the Mark Island Disposal Site, July 2002

Station	Grain Size Major Mode (phi) # of Replicates	Camera Penetration Mean (cm)	Dredged Material Thickness Mean (cm)	Number Of Replicates with Dredged Material	Boundary Roughness Mean (cm)	Successional Stages Present	Highest Stage Present	RPD Mean (cm)	OSI Mean	OSI Median
1	> 4 phi (3)	13.96	0.00	0	0.87	I,III	ST I on III	3.62	7.33	7.0
2	> 4 phi (3)	13.26	0.00	0	1.48	I,INDET	ST I	4.70	6.50	6.5
3	> 4 phi (3)	14.45	0.00	0	1.69	I,III	ST I on III	3.20	7.33	6.0
4	> 4 phi (1), 4 to 3 phi (1), 3 to 2 phi (1)	8.07	0.00	0	3.51	I,III,INDET	ST I on III	4.16	8.50	8.5
5	4 to 3 phi (2), 0 to -1 phi (1)	3.59	0.00	0	0.94	I,INDET	ST I	2.42	5.00	5.0
6	> 4 phi (3)	12.51	0.00	0	1.84	I,III	ST I on III	3.20	7.00	6.0
7	> 4 phi (3)	12.05	0.00	0	2.65	I,INDET	ST I	3.53	6.50	6.5
8	> 4 phi (3)	12.53	0.00	0	3.25	I,III	ST I on III	2.46	7.33	9.0
9	> 4 phi (3)	12.89	0.00	0	1.16	I	ST I	3.40	6.00	7.0
10	> 4 phi (3)	14.32	0.00	0	1.04	I	ST I	2.84	5.33	5.0
11	> 4 phi (3)	15.70	9.52	2	1.01	I,III	ST I on III	1.74	8.00	8.0
12	> 4 phi (3)	12.67	0.00	0	1.10	I,III	ST I on III	2.69	6.33	6.0
13	> 4 phi (3)	16.92	12.70	3	1.24	I,III,INDET	ST I on III	0.84	5.00	5.0
14	> 4 phi (3)	14.67	0.00	0	2.50	I,III	ST I on III	1.95	5.33	4.0
15	> 4 phi (3)	13.36	0.00	0	1.73	I,III	ST I on III	1.64	7.67	8.0
16	> 4 phi (3)	11.42	0.00	0	1.78	I,III	ST I on III	3.11	7.00	6.0
17	> 4 phi (3)	16.05	>14.85	3	1.39	I,III	ST I on III	2.42	5.67	7.0
18	> 4 phi (3)	12.54	> 8.78	2	1.32	I	ST I	1.40	3.33	3.0
19	> 4 phi (3)	13.87	0.00	0	2.26	I,INDET	ST I	1.89	4.00	4.0
20	> 4 phi (3)	13.69	0.00	0	0.88	I,III	ST I on III	2.30	5.67	6.0
21	> 4 phi (3)	12.17	0.00	0	1.83	I	ST I	3.41	5.67	5.0
22	> 4 phi (3)	16.65	5.27	2	1.50	I,II,III	ST I on III	2.65	7.33	7.0
23	> 4 phi (3)	12.63	0.00	0	1.47	I,III	ST I on III	3.02	6.67	5.0
24	> 4 phi (3)	15.67	0.00	0	0.77	I,III	ST I on III	3.33	7.33	7.0
25	> 4 phi (3)	15.95	0.00	0	1.09	I,III	ST I on III	4.90	9.33	10.0
AVG		13.26		0.48	1.61			2.83	6.45	6.30
MAX		16.92		3	3.51			4.90	9.33	10.0
MIN		3.59		0	0.77			0.84	3.33	3.0

Table 3-2.

REMOTS® Sediment-Profile Imaging Results Summary for the Outer Survey Stations at the Mark Island Disposal Site, July 2002

Station	Grain Size Major Mode (phi) # of Replicates	Camera Penetration Mean (cm)	Dredged Material Thickness Mean (cm)	Number Of Replicates with Dredged Material	Boundary Roughness Mean (cm)	Successional Stages Present	Highest Stage Present	RPD Mean (cm)	OSI Mean	OSI Median
E375	> 4 phi (3)	14.36	0.00	0	2.56	I,III	ST I on III	3.87	8.67	11.0
N375	4 to 3 phi (2), 3 to 2 phi (1)	7.65	0.00	0	0.99	I,III	ST I on III	2.41	7.33	8.0
NE500	< -1 phi (3)	0.55	0.00	0	0.01	INDET	INDET	INDET	INDET	INDET
NW500	> 4 phi (3)	10.63	0.00	0	1.47	I,III	ST I on III	2.79	6.67	5.0
S375	> 4 phi (3)	16.51	0.00	0	1.05	I,III	ST I on III	4.72	8.00	7.0
SE500	> 4 phi (3)	11.64	0.00	0	1.12	I,III	ST I on III	3.42	7.33	7.0
SW500	> 4 phi (3)	15.95	0.00	0	1.58	I,III	ST I on III	3.58	8.67	10.0
W375	> 4 phi (3)	8.99	0.00	0	1.36	I,III	ST I on III	2.69	6.33	6.0
AVG		10.78			1.27			3.36	7.57	7.71
MAX		16.51			2.56			4.72	8.67	11.0
MIN		0.55			0.01			2.41	6.33	5.0

Table 3-3.

REMOTS® Sediment-Profile Imaging Results Summary from the Mark Island Disposal Site Reference Areas, July 2002

Station	Grain Size Major Mode (phi) # of Replicates	Camera Penetration Mean (cm)	Boundary Roughness Mean (cm)	Successional Stages Present	Highest Stage Present	RPD Mean (cm)	OSI Mean	OSI Median
NEREF CTR	> 4 phi (3)	7.52	1.36	I,III	ST I on III	1.90	6.67	8.0
NEREF1	> 4 phi (3)	12.39	0.87	I,III	ST I on III	2.69	7.67	8.0
NEREF2	> 4 phi (3)	14.45	1.41	I,III	ST I on III	3.16	7.00	6.0
NEREF3	4 to 3 phi (3)	6.46	0.75	I,III	ST I on III	2.16	7.00	8.0
NEREF4	4 to 3 phi (3)	7.27	1.20	I,III	ST I on III	2.98	7.00	6.0
SREF CTR	> 4 phi (3)	13.50	1.63	I,III	ST I on III	3.25	7.00	6.0
SREF1	> 4 phi (3)	14.79	2.17	I,III	ST I on III	3.30	10.00	10.0
SREF2	> 4 phi (3)	12.95	2.18	I,III	ST I on III	3.36	7.00	7.0
SREF3	> 4 phi (3)	13.78	1.52	I,III	ST I on III	2.65	6.33	6.0
SREF4	> 4 phi (3)	13.99	1.02	I,III	ST I on III	3.01	6.67	5.0
AVG		11.71	1.41			2.85	7.23	7.0
MAX		14.79	2.18			3.36	10.00	10.0
MIN		6.46	0.75			1.90	6.33	5.0

3.3.1 Mark Island Disposal Site

3.3.1.1 Dredged Material Distribution and Physical Sediment Characteristics

Dredged material was evident in the REMOTS® images at 5 of the 25 inner stations and appeared to be concentrated in the central and southwestern portions of the disposal site. Dredged material layers exceeded the penetration depth of the REMOTS® camera (i.e., dredged material layer thickness greater than prism penetration) within individual replicate images collected at Stations 13, 17, and 18, while discrete layers of dredged sediment were detected at Stations 11, 22, and in two replicate images of Station 13 (Table 3-1; Figures 3-5 and 3-6). The dredged material was predominantly low reflectance, fine-grained silt, with a grain size major mode of >4 phi (Table 3-1).

Ambient sediment (i.e., unaffected by dredged material disposal) consisting of tan over gray silt was evident at the remaining inner stations occupied over MIDS (Tables 3-1 and 3-2; Figure 3-5). There was no dredged material detected at any of the outer stations surrounding the disposal site. A major modal grain size of >4 phi was detected at most inner and outer ambient stations; however, a higher sand fraction along with shell hash resulted in larger grain size classifications at inner Stations 04 and 05 and outer Station N375 (grain size major modes of 4 to 3 and 3 to 2 phi; Tables 3-1 and 3-2; Figure 3-7). Hard bottom conditions prevailed at outer Station NE500 characterized by rocks, pebbles, and shell, and in one replicate of inner Station 05 where a mussel bed over sand was detected. White clay chips at depth were observed in the ambient sediment of several inner and outer stations (Figure 3-7). In addition, shell fragments and shell hash were observed at the sediment surface at numerous stations.

The penetration of the sediment-profile camera prism typically serves as a measure of sediment density or compaction. Mean camera penetration measurements for the inner stations varied from a shallow 3.6 cm at inner Station 5 to 16.9 cm at center Station 13 (average of 13.3 cm; Table 3-1). Outer station mean camera penetration measurements were lower, ranging from 0.6 cm at Station NE500 to 16.5 cm at Station S375, with an overall average of 10.8 cm indicating relatively firm sediment likely due to a higher sand content relative to silt/clay sediment (Table 3-2). Underpenetration of the REMOTS® camera prevented the analysis of key parameters (e.g., RPD, successional status, surface roughness, and OSI) in 5 of the 99 total images obtained at the inner and outer stations in the July 2002 REMOTS® survey.

Replicate-averaged small-scale boundary roughness values for the inner REMOTS® stations over MIDS ranged from 0.8 cm at Station 24 to 3.5 cm at Station 04, with an average of 1.6 cm (Table 3-1). Outer station replicate-averaged boundary roughness

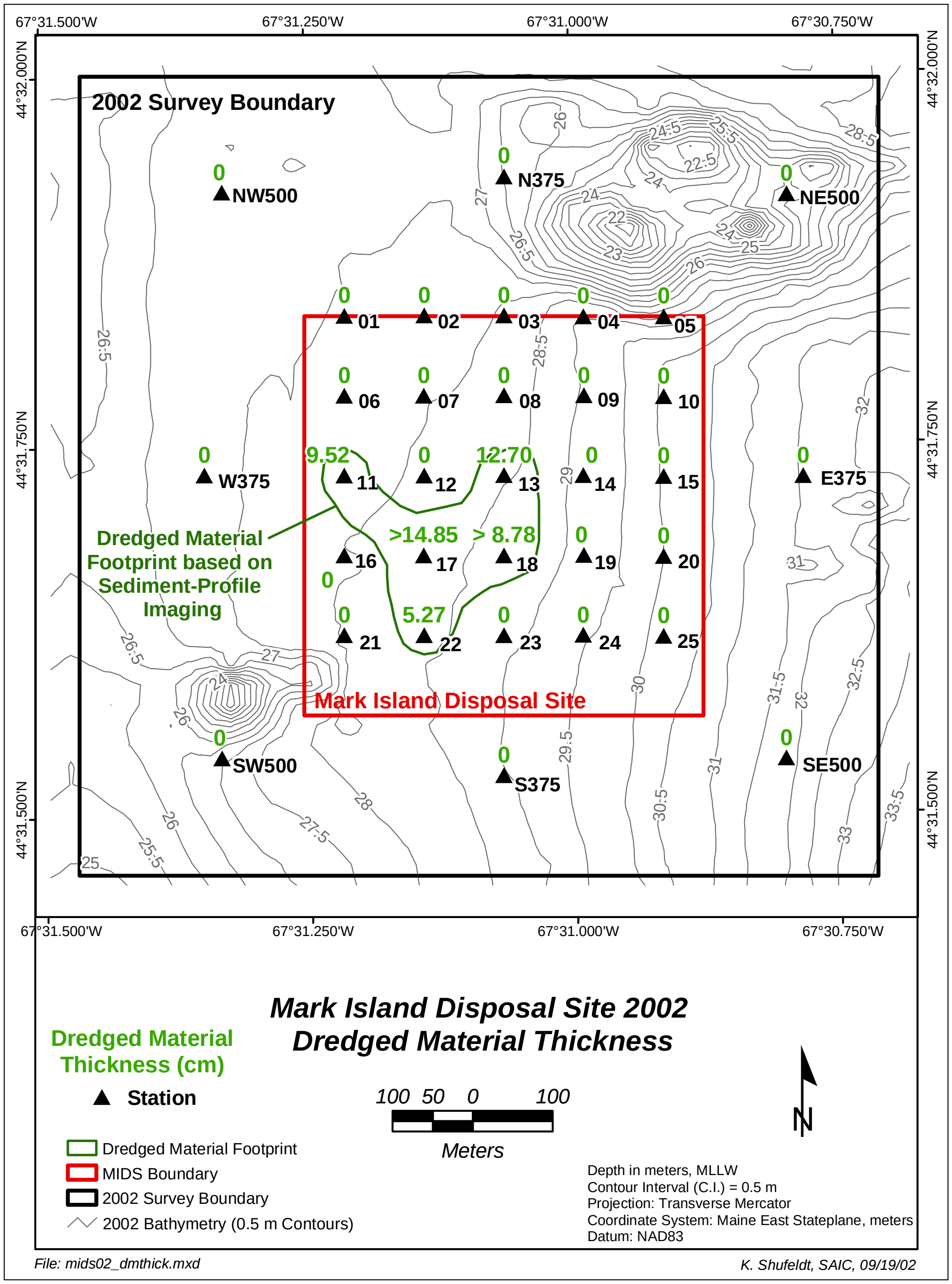


Figure 3-5. Map of replicate-averaged dredged material thickness over the Mark Island Disposal Site over July 2002 bathymetry

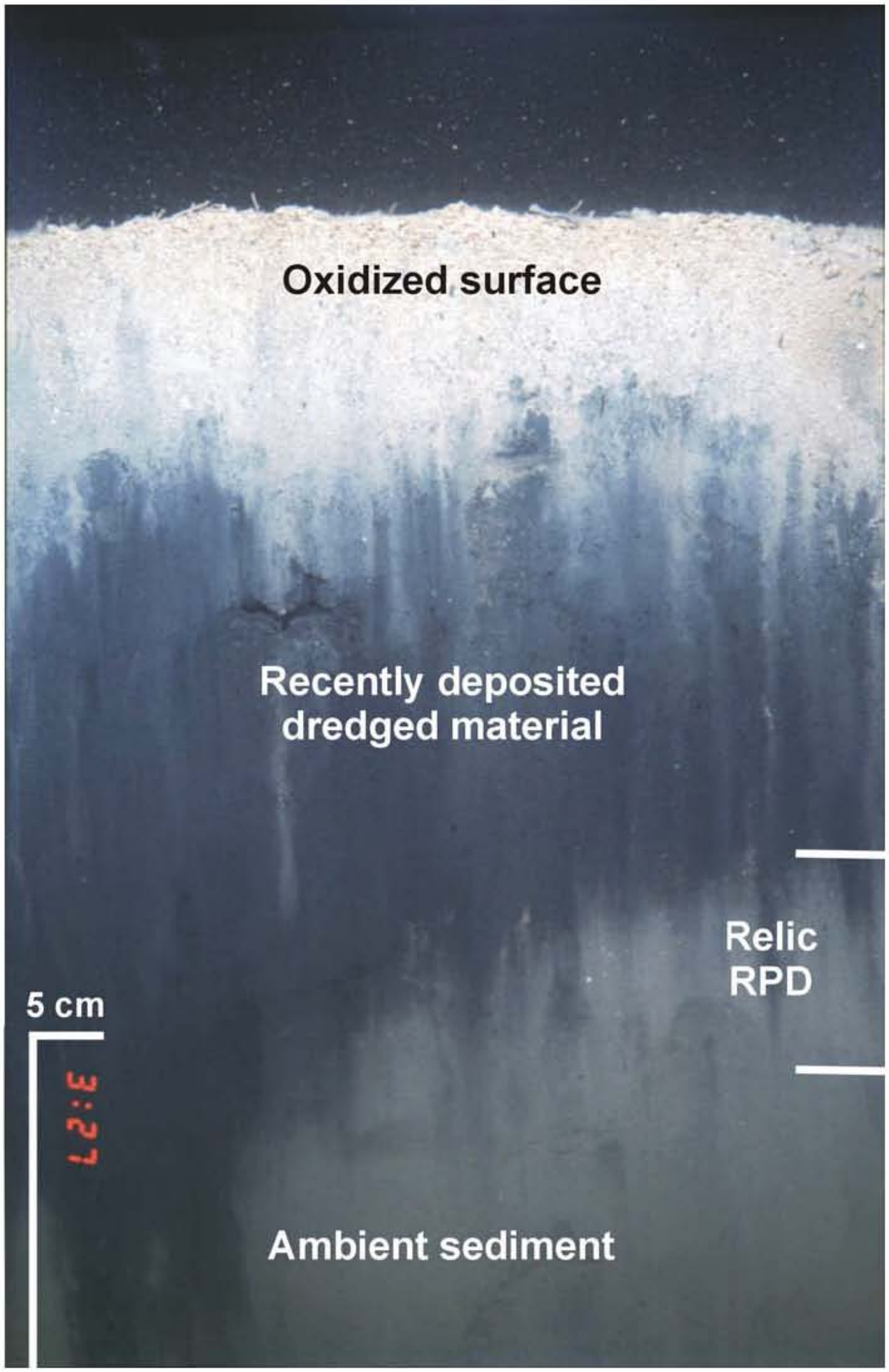


Figure 3-6. REMOTS® image from inner disposal site Station 11 displaying a discrete layer of dredged material over ambient sediment. A relic RPD representing the former RPD prior to dredged material placement appears to be present under the dredged material layer.

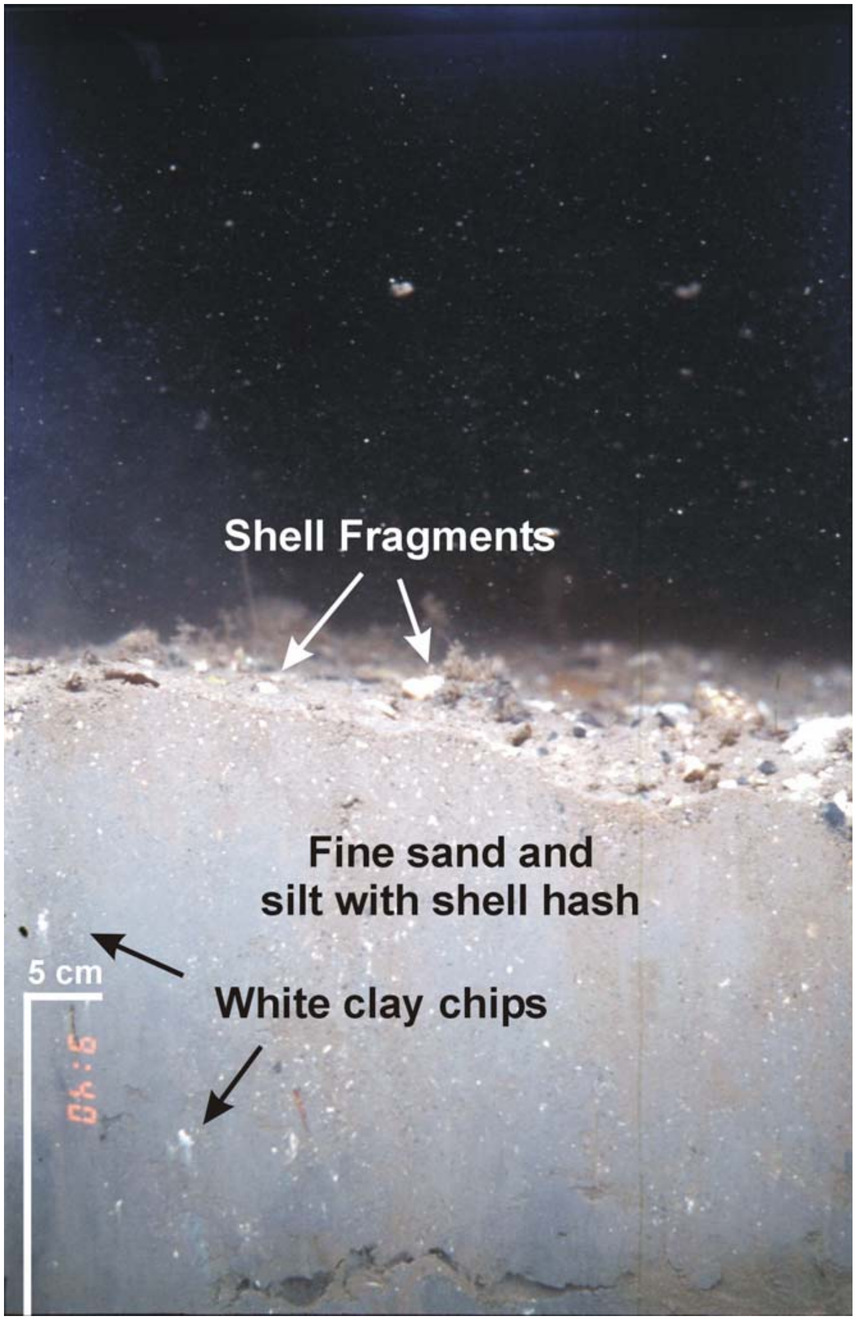


Figure 3-7. REMOTS® image obtained at inner Station 04 illustrating a higher sand fraction in the ambient sediment of the northern disposal site stations. A grain size major mode of 4 to 3 phi was determined as a result of a mix of fine sand, silt, and shell hash in the subsurface sediment. White clay chips are visible within the sediment at depth.

values varied from 0 cm at Station NE500 to 2.6 cm at Station E375, with an overall average of 1.3 cm, similar to the inner station average (Table 3-2). There was no obvious spatial pattern to these relatively low boundary roughness values at the inner, outer, and reference area stations. Surface roughness was attributed primarily to physical factors at the sediment-water interface at most inner and outer stations as evidenced by mud clasts/clumps at the sediment surface (Figure 3-8A). Several replicate images of the inner and outer stations also exhibited biogenic surface roughness as a result of dense polychaetes, biogenic mounds/fecal layers, and biological surface reworking by burrowing infauna (burrow openings) at the sediment-water interface (Figure 3-8B).

3.3.1.2 Biological Conditions and Benthic Recolonization

Three parameters were used to assess the benthic recolonization status and overall benthic habitat quality within the disposal site relative to the reference areas: apparent Redox Potential Discontinuity (RPD) depth, infaunal successional status, and Organism-Sediment Index (OSI; Figures 3-9 and 3-10).

The redox potential discontinuity (RPD) provides a measure of the apparent depth of oxygen penetration into the surface sediments and the degree of biogenic sediment mixing. The replicate-averaged RPD measurements for the inner MIDS stations ranged from 0.8 cm at Station 13 to a relatively deep 4.9 cm at Station 25, with an overall average of 2.8 cm indicative of well-aerated surface sediments (Table 3-1; Figures 3-9 and 3-11A). The outer stations generally displayed deeper RPD depths, with replicate-averaged values ranging from 2.4 cm at Station N375 to 4.7 cm at Station S375 (overall average of 3.4 cm; Table 3-2; Figures 3-9 and 3-11B). Although still relatively deep and likewise indicative of well-aerated surface sediment, the composite RPD value for the reference areas was somewhat shallower at 2.9 cm (Table 3-3). None of the stations occupied within and surrounding the disposal site boundary displayed any evidence of low sediment dissolved oxygen conditions, visible redox rebounds, or methane gas bubbles.

Although no evidence of redox rebound intervals was noted in the surficial sediment, relic RPDs (an indicator of sediment layering) appeared to be present in the images obtained from five inner stations (Figures 3-6, 3-11A, and 3-12). Relic RPDs usually occur when a relatively thin layer of dredged material is placed over an older deposit or ambient sediments. These features represent the depth of oxygenation in the underlying material prior to being covered by the fresh deposit. A new RPD is usually formed at the sediment-water interface as oxygen is incorporated into the surficial sediments from the bioturbational activity of benthic infauna. The majority of images from the July 2002 survey that displayed dredged material showed a layer of black, sulfidic sediment just below the new oxidized surface. A color contrast was evident between the

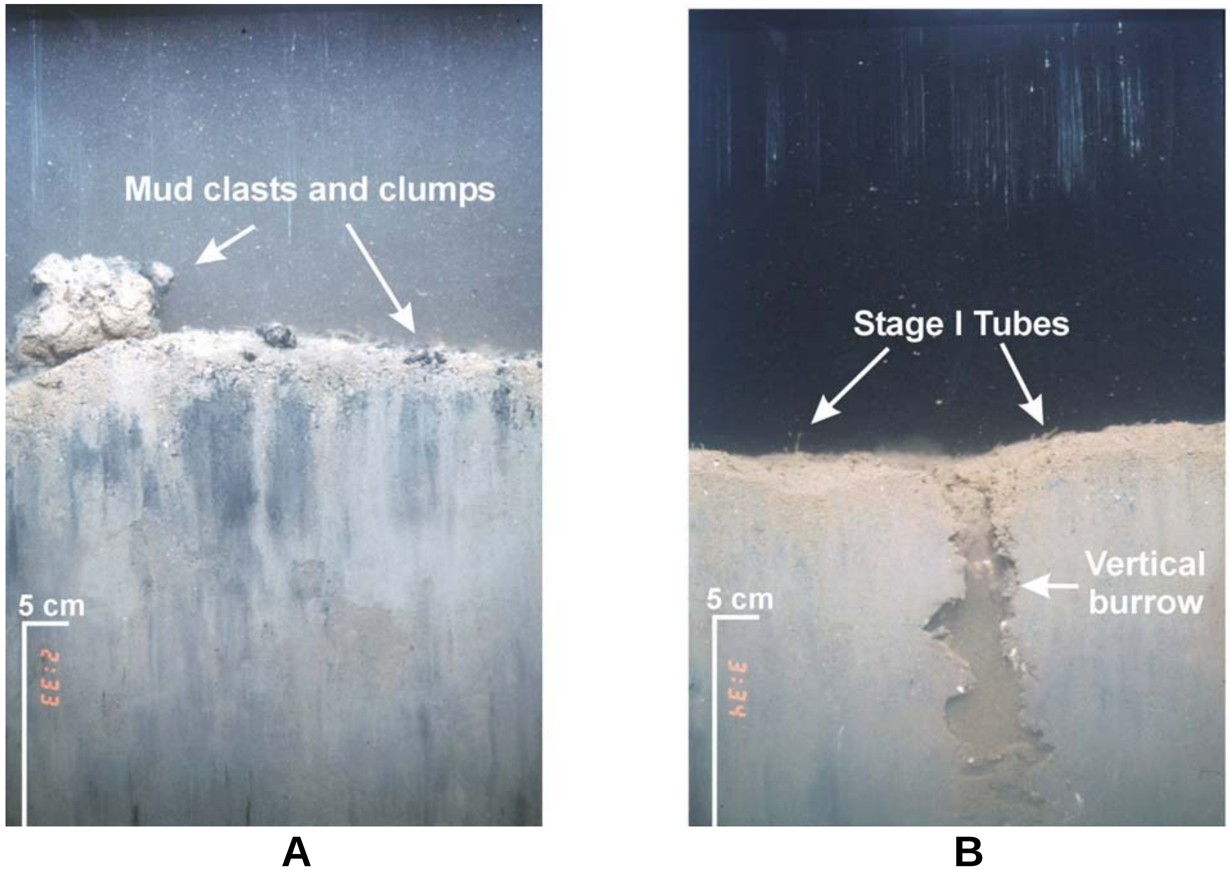


Figure 3-8. REMOTS® images from inner disposal site Station 18 (A) and outer Station W375 (B) showing examples of physical disturbance within the dredged material due to mud clasts and clumps at the sediment-water interface (A) and biogenic surface roughness in ambient sediment as a result of polychaetes and a large vertical burrow opening at the sediment-water interface (B).

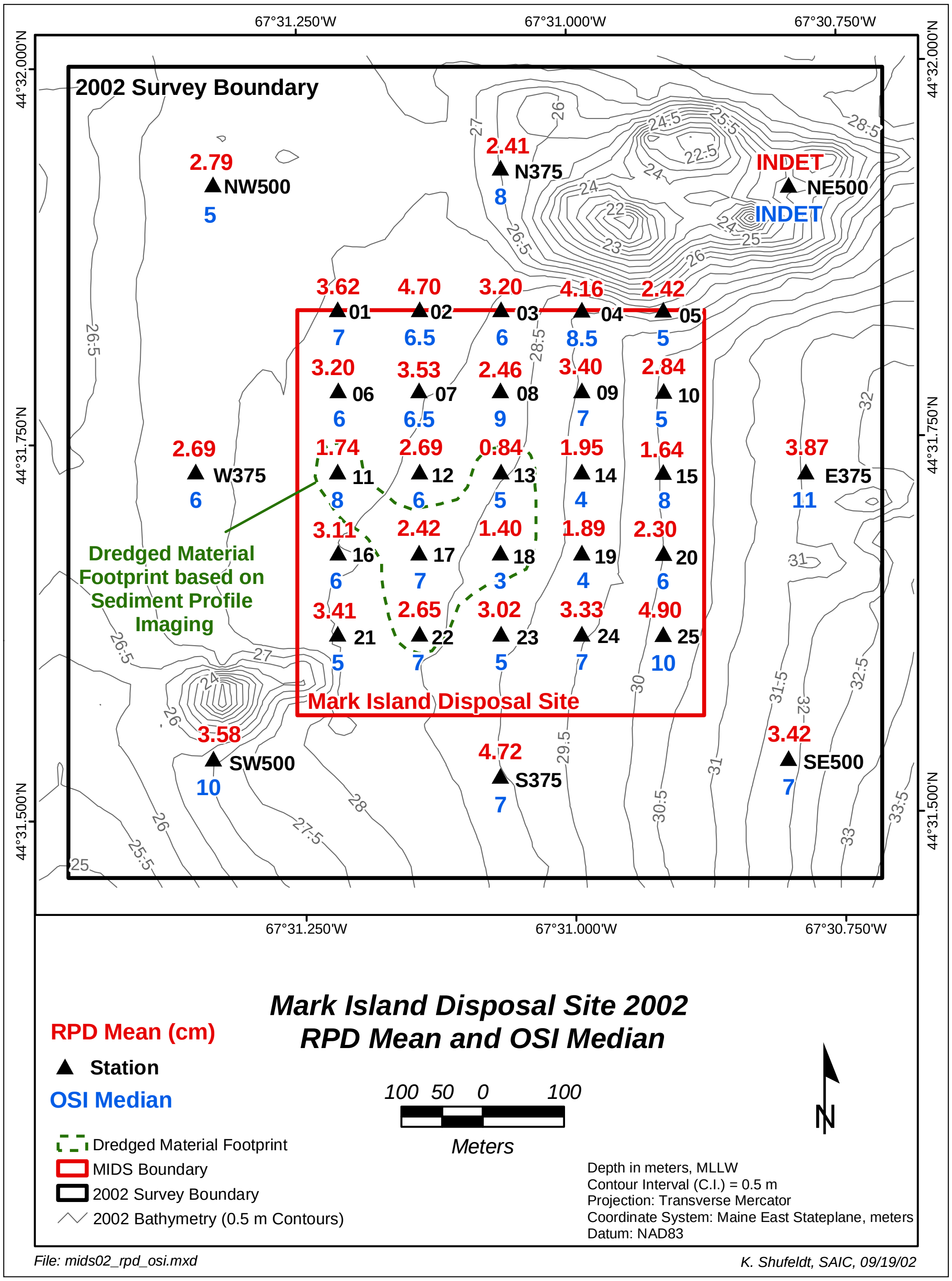


Figure 3-9. Map of replicate-averaged RPD depths (red, in centimeters) and median OSI values (blue) detected within and surrounding MIDS over July 2002 bathymetry

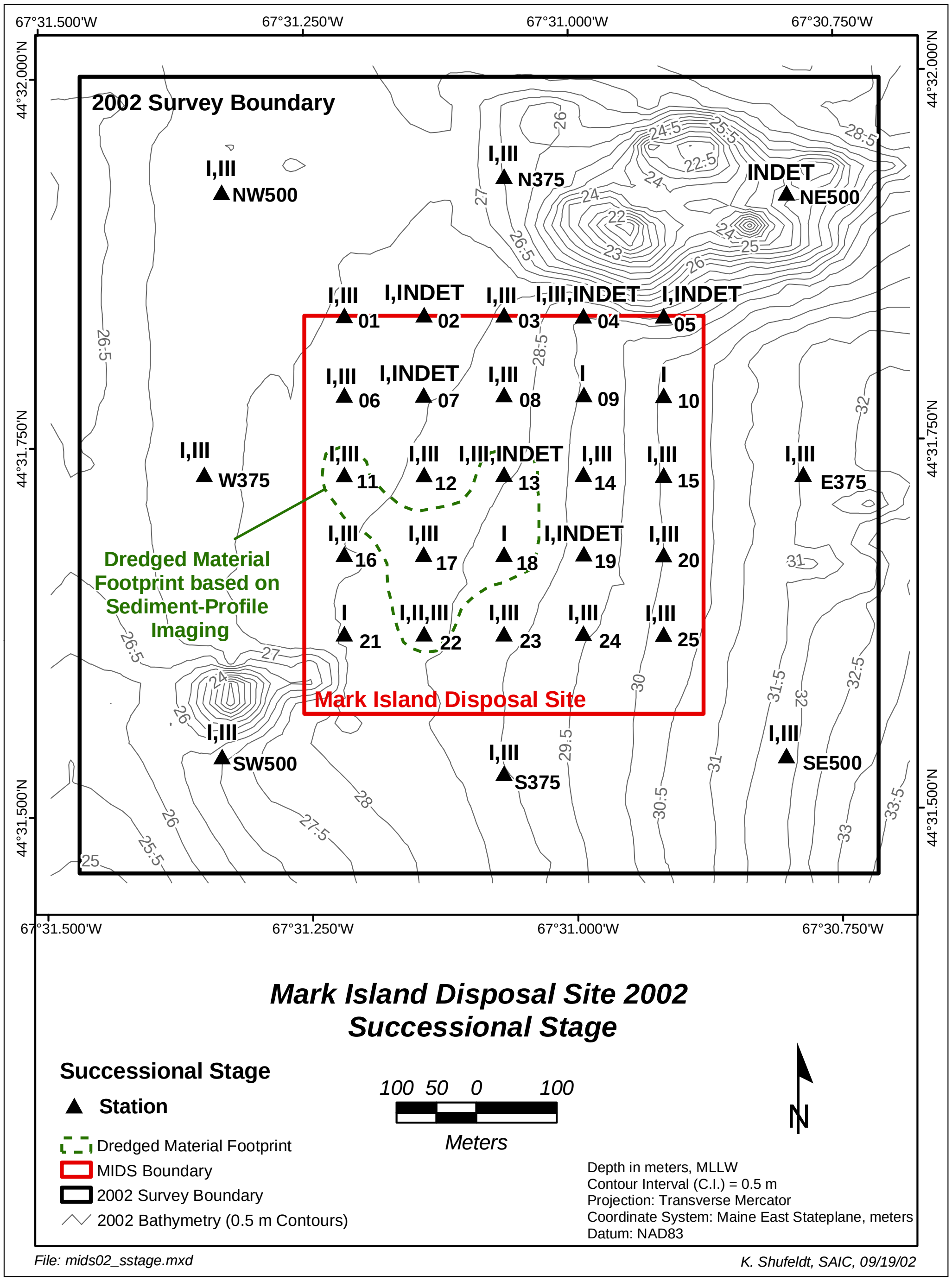


Figure 3-10. Map of successional stage status for the REMOTS® stations occupied as part of the July 2002 MIDS survey area over bathymetry

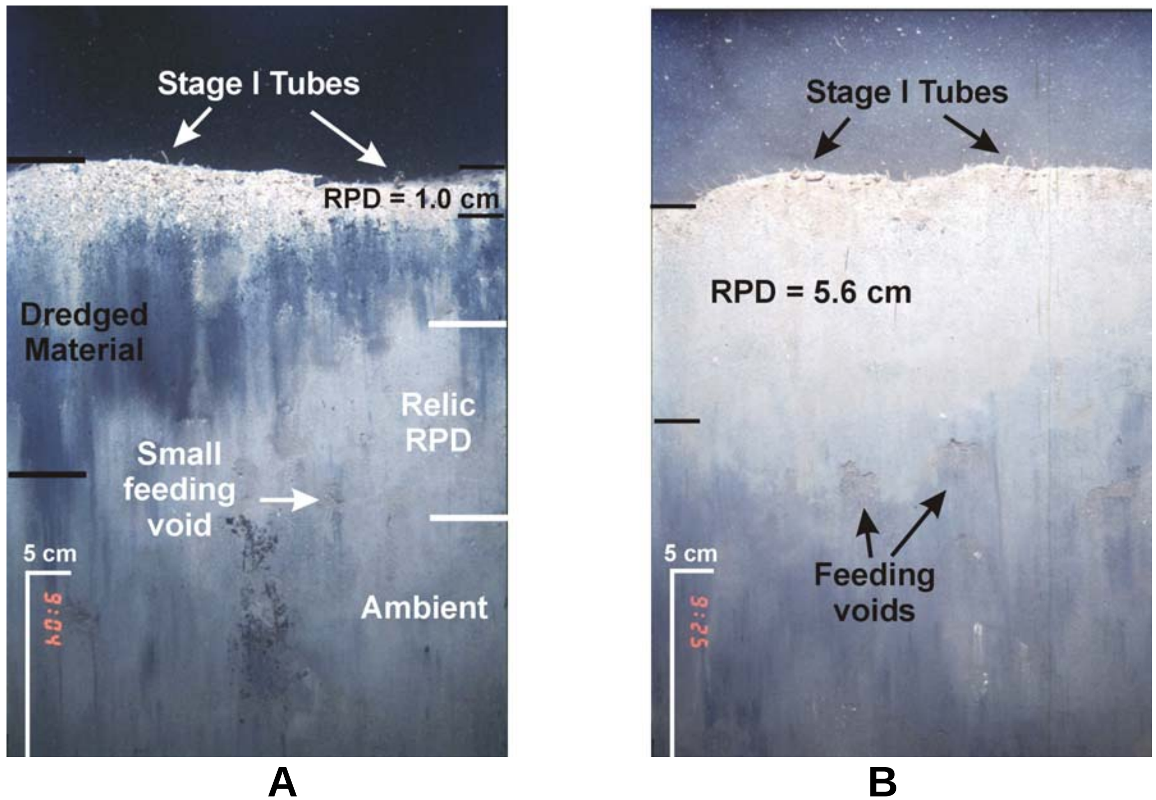


Figure 3-11. REMOTS® images collected from inner disposal site Station 13 with dredged material (A) and outer Station E375 characterized by ambient sediment (B) showing differences in the depth of oxygenation (mean RPD depths) between inner and outer stations. The dredged material within Station 13 (A) displays a relatively shallow mean RPD depth indicative of moderately oxygenated surface sediments, while the ambient surface sediments within Station E375 (B) are well aerated, with a deeper mean RPD depth. A Stage I on III successional status was determined for both images due to Stage I polychaetes tubes at the sediment surface and active feeding voids at depth.

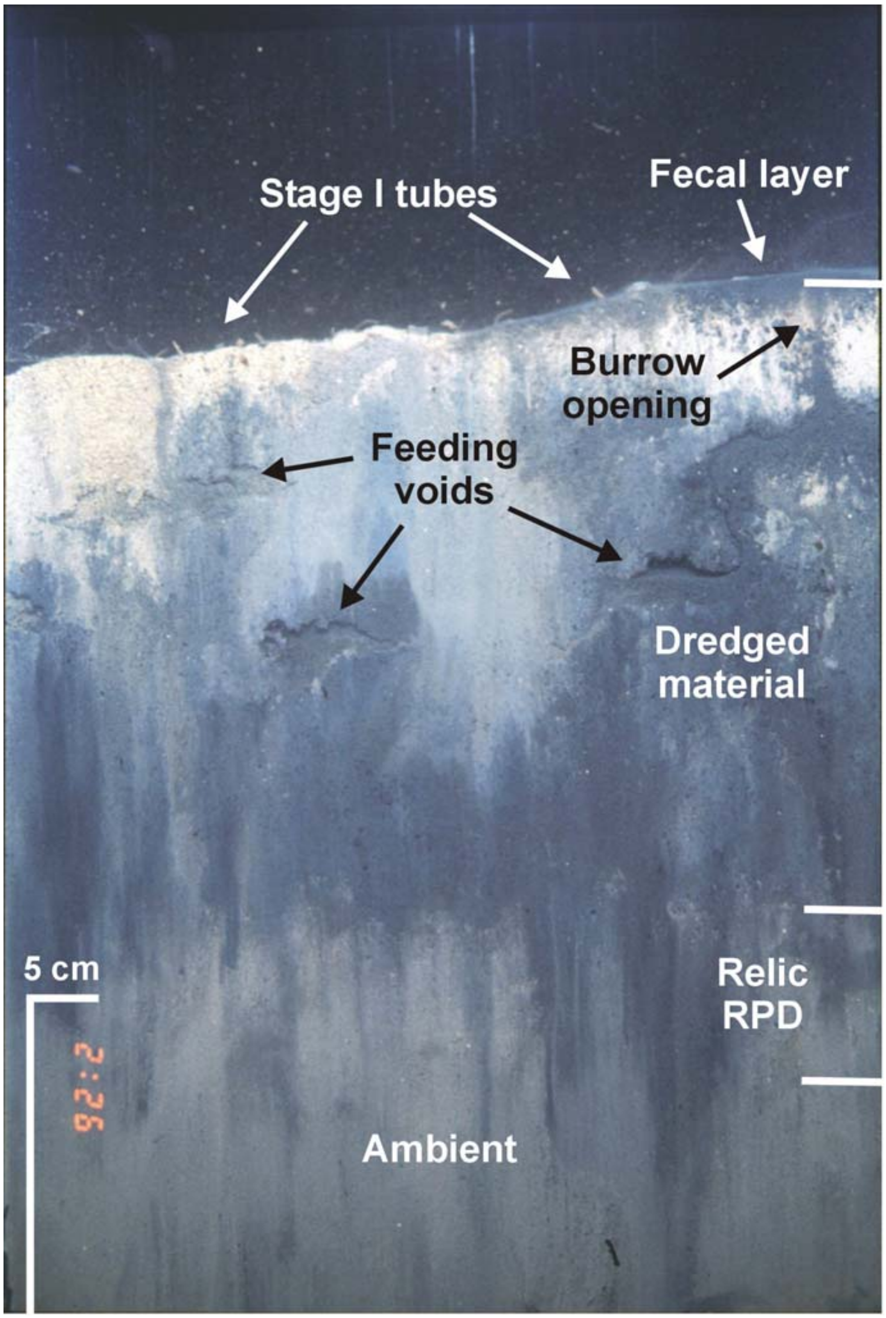


Figure 3-12. REMOTS® image from inner disposal site Station 22 displaying multiple feeding voids and Stage I polychaete tubes in the dredged material layer. A relic RPD is visible in the underlying ambient sediment. Expelled sediment by burrowing infauna and a fecal layer are present at the sediment surface near the burrow opening.

fresh dredged material layer (black sulfidic) and the underlying ambient sediment surface (high reflectance; Figures 3-6, 3-11A, 3-12). The high reflectance, oxidized band of sediment at depth likely represents the RPD prior to dredged material placement.

Due to the relatively small amount of disposed sediment, it was anticipated that the benthic community would be in a relatively advanced stage of recolonization due to vertical migration of infaunal organisms through the recently placed sediment. The recolonization status for the inner disposal site stations was relatively advanced and included Stage I pioneering polychaetes and Stage III head-down, deposit-feeding infauna (Table 3-1; Figure 3-10). Overall, evidence of Stage III activity was detected in 17 of the 25 inner stations (68%) including most of the stations displaying dredged material (Figure 3-10). With the exception of Station NE500 (characterized by hard bottom conditions), all stations located outside the MIDS boundary displayed evidence of Stage III activity. When present, Stage III activity was marked by active feeding voids in the subsurface sediments, and was consistently accompanied by Stage I taxa at the sediment-water interface (i.e., Stage I on III successional status; Figures 3-11 and 3-12). Stage II stick amphipods (Family Podoceridae), amphipods that construct thin stalks or stick-like structures at the sediment surface, were thought to be present in one replicate image of both an inner and outer station. Successional status determinations were not possible at various replicates of inner Stations 02, 04, 05, 07, 13, and 19 due to disturbed sediment surfaces or hard bottom conditions, as well as for all replicate images from outer station NE500 due to hard bottom conditions.

Most inner, soft-bottom stations supported Stage III deposit feeders (68%), while 8 out of 25 of the inner stations supported lower order seres (Stage I taxa) only (32%; Figure 3-10). Stage III activity was detected at seven of the eight outer stations, while the reference area stations exhibited Stage III activity at all stations occupied. Although Stage III activity was detected at many stations, Stage III activity was not present in all replicate images throughout each survey area (Table 3-1; Figure 3-10). Stage III activity was observed in roughly half of all the replicate images from the inner and outer stations (43% and 54% of the replicate images, respectively). A similar patchy distribution of Stage III activity was observed at the reference areas, where Stage III activity was observed in half the total replicate images.

Median OSI values for the inner disposal site stations ranged from +3 at Station 18 to +10 at Station 25 (Table 3-1; Figure 3-9). The overall average OSI value of +6.3 calculated for the inner stations is generally indicative of undisturbed benthic habitat conditions. This OSI value was slightly lower, but comparable to that calculated for the ambient sediments within the outer stations (+7.7) and reference area stations (+7; Tables 3-1 through 3-3; Figure 3-9). The OSI values at the lower end of the scale (+3 to +6) reflect a low abundance of Stage III infauna and/or shallow RPD depths. OSI values ≥+6 (non-degraded or undisturbed benthic habitat quality) were observed in 64% of the inner disposal site stations and were the result of deeper mean RPD depths and a higher occurrence of Stage III activity. Overall, OSI values were comparable within inner, outer, and reference area stations, suggesting that undisturbed benthic conditions prevail within these surveyed areas.

3.3.2 Reference Areas

3.3.2.1 Physical Sediment Characteristics

Ambient sediments at the reference area stations were similar to the sediment observed within the disposal site, consisting of layers of fine-grained tan over gray sandy silt (major modal grain size of >4 phi; Table 3-3; Figure 3-13). There was no evidence of dredged material at any of the reference area stations. A higher presence of sand contributed to a larger grain size major mode (4 to 3 phi) at Stations NEREF3 and NEREF4 where a mix of fine sand and silt was observed (Table 3-3; Figure 3-14). White or gray clay and clay chips were detected below the sediment surface in numerous replicate images of the NEREF stations (Figure 3-14). Mean camera prism penetration measurements ranged from 6.6 cm at Station NEREF3 to 14.8 cm at Station SREF1, with an overall average of 11.7 cm (Table 3-3). Camera prism penetration measurements at the reference areas were lower than the overall value observed at the inner disposal site stations (13.3 cm) and indicate the ambient sediment within Chandler Bay has a detectable sand component. Cohesive mud clumps at the sediment surface may have limited penetration of the sediment-profile camera at various reference area stations.

The average small-scale surface boundary roughness value for the reference areas (1.4 cm) was similar to that observed at the inner stations within the disposal site (1.6 cm) and outer stations surrounding the site (1.3 cm), suggesting only minor small-scale surface relief exists within the surveyed area. Similar to the inner and outer stations, the majority of reference area images displayed physical surface roughness, with only four replicates exhibiting biogenic surface roughness. Mud clasts and/or larger mud clumps were present at the sediment-water interface of most reference area stations suggesting widespread physical disturbance over the surveyed area, which could be related to fishing activity in the region (Figure 3-13). Observations of biogenic surface relief included dense polychaete assesmblages and/or biological surface reworking by burrowing infauna (burrow openings) at the sediment-water interface.

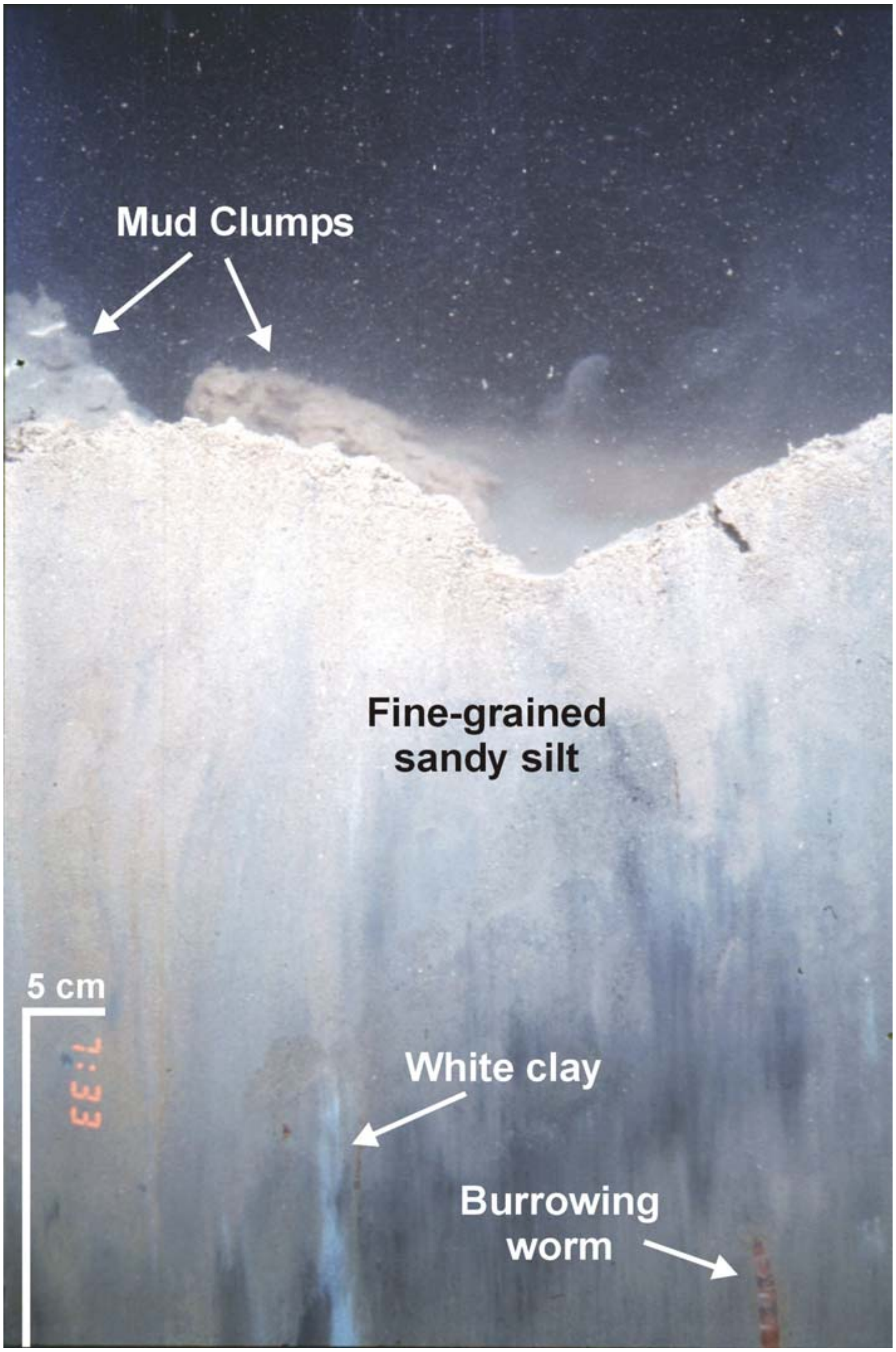


Figure 3-13. REMOTS® image collected from MIDS reference area Station NEREF2 showing similar sediment characteristics (fine-grained sandy silt) to ambient stations within the disposal site. Mud clumps are visible at the sediment-water interface suggesting past physical disturbance from fishing activity. White clay is detected within the subsurface sediments.

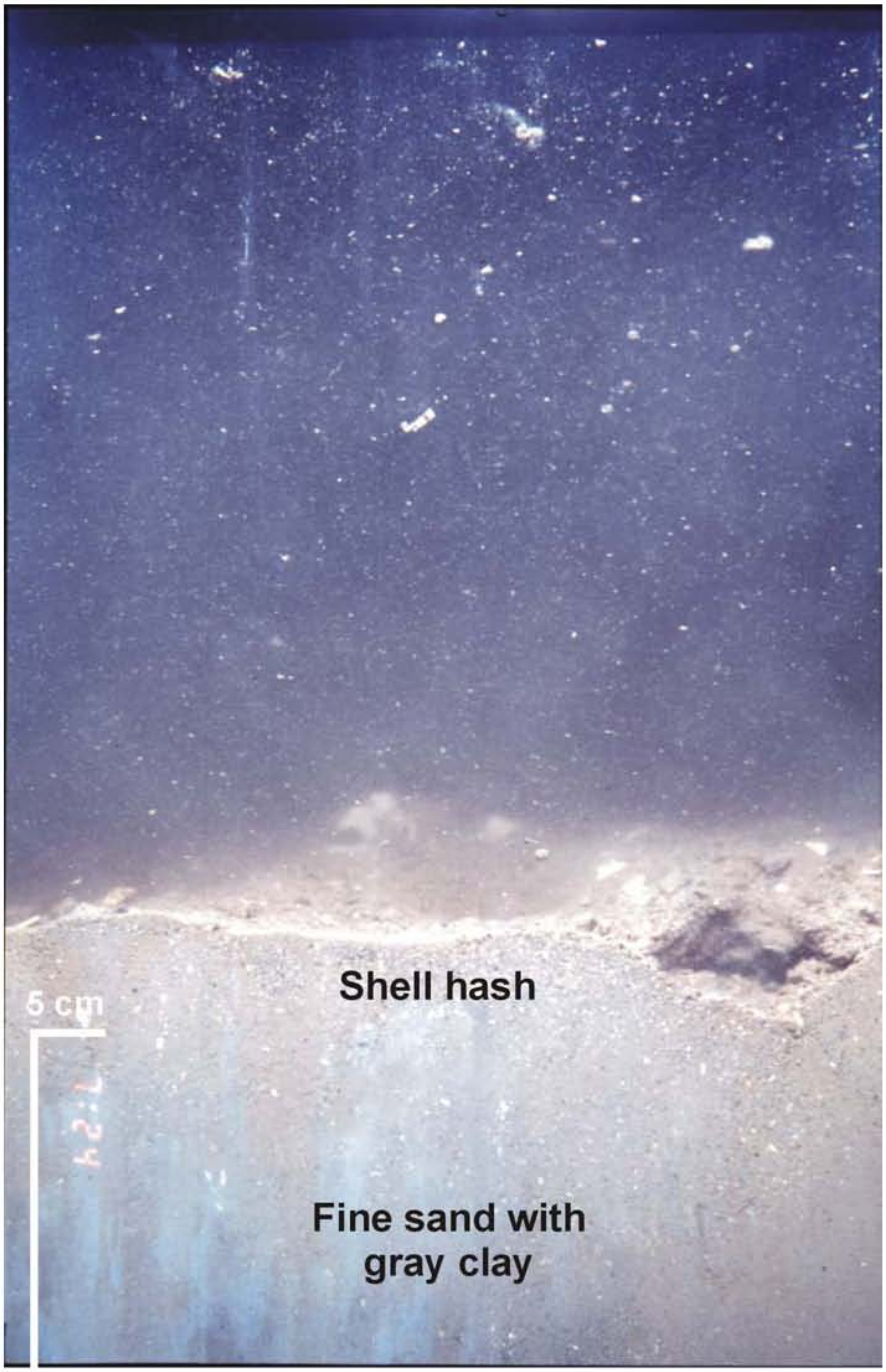


Figure 3-14. REMOTS® image from MIDS reference area Station NEREF4 illustrating light gray clay in a fine sand and shell matrix (grain size major mode of 4 to 3 phi).

3.3.2.2 Biological Conditions

Replicate-averaged RPD measurements at the reference areas ranged from 1.9 cm at Station NEREF CTR to 3.4 cm at Station SREF2 (Table 3-3). The overall value of 2.9 cm, indicative of well-aerated surface sediments, was slightly lower than the overall value observed at the outer stations (3.4 cm), but comparable to the overall value of the inner disposal site stations (2.8 cm). There was no indication of low sediment dissolved oxygen conditions, methane gas bubbles, or visible redox rebounds at the reference area stations.

Similar to the inner disposal site and surrounding outer stations, both Stage I and Stage III taxa were observed at the reference area stations (Table 3-3). Advanced Stage III taxa were present in 15 of the 30 replicate images obtained at the reference areas (50%). When present, Stage III activity was consistently accompanied by Stage I taxa at the sediment-water interface (Figure 3-15). Results indicated that the successional status within the reference areas was relatively advanced at the time of the survey.

Median OSI values for the reference area stations ranged from +5 at Station SREF4, to +10 at Station SREF1 (Table 3-3). The composite OSI value of +7 for the reference areas, indicative of undisturbed benthic habitat conditions, was slightly higher than the overall value observed at the inner disposal site stations (+6.3), but lower than the value observed at the outer stations (+7.7) mainly due to shallower RPD depths relative to those of the outer stations.

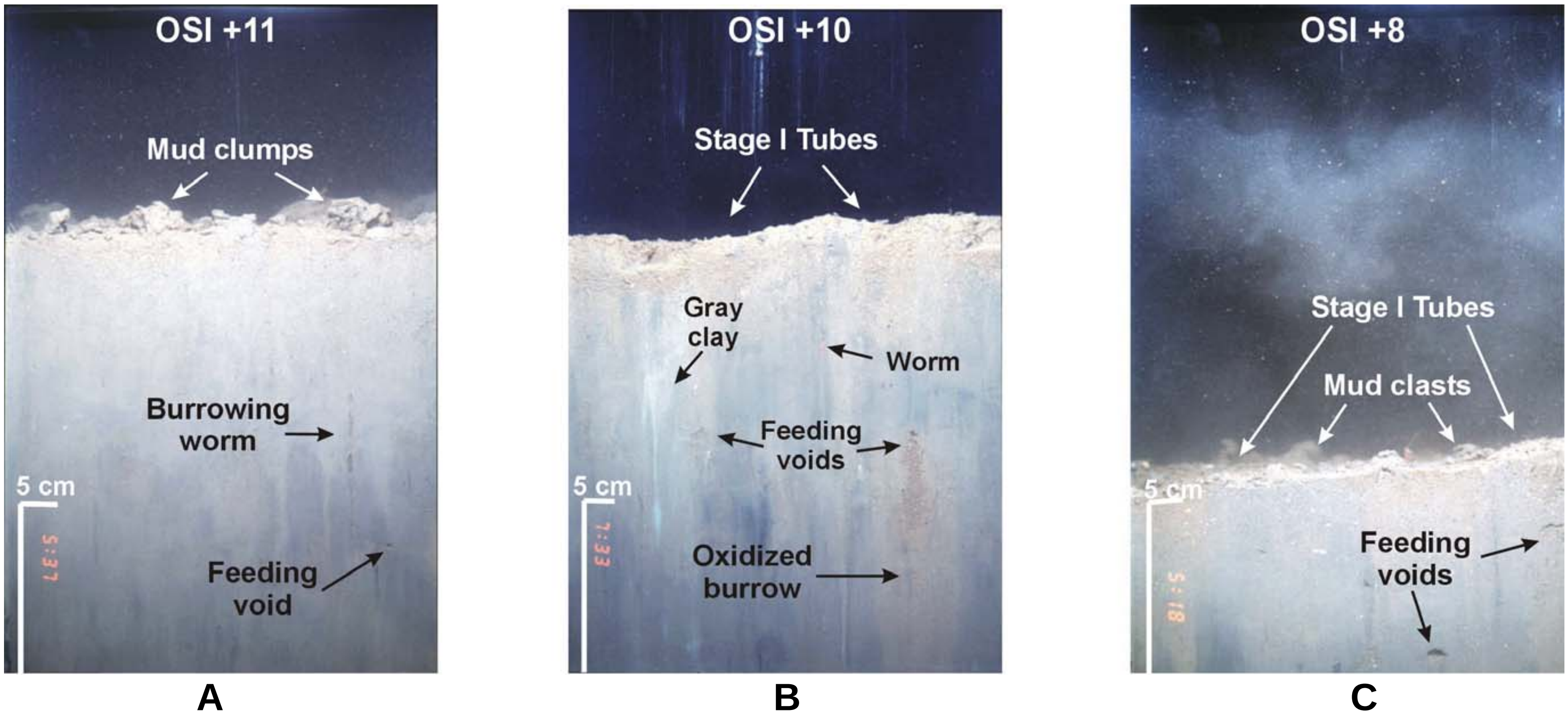


Figure 3-15. REMOTS® images from reference area Stations SREFCTR (A), NEREF2 (B), and NEREFCTR (C) illustrating undisturbed benthic habitat quality, with OSI values of +11, +10, and +8, respectively. A Stage I on III successional status was determined in all three images. Burrowing polychaetes are visible within the subsurface sediments (A and B). Mud clasts and mud clumps suggestive of physical disturbance (i.e., fishing activity) are present in two images (A and C).

4.0 DISCUSSION

4.1 Dredged Material Distribution

One objective of the July 2002 survey over the MIDS was to document the distribution of recently placed dredged material from the US Coast Guard base in Moosabec Reach onto the seafloor of MIDS. Since the March 2000 survey of MIDS, there have been 18 small-volume disposal events leading to a deposit with a total volume of 4,300 m^3. Bathymetric depth difference calculations indicated no detectable mound was formed by the disposal activity. The minimal volume of dredged material distributed within the disposal site resulted in a deposit that was less than 20 cm in height and not detectable in the bathymetry. As a result, the seafloor has remained relatively featureless within the disposal site since the March 2000 survey despite recent disposal activity. However, evidence of discrete disposal events can be seen in the side-scan sonar mosaic. The features seen in the side-scan mosaic generally correspond with both the reported disposal locations from barge logs, as well as REMOTS® dredged material distribution data (Figure 4-1).

The relatively large, uncharted reef (rock ledge) found in the northeast quadrant of the March 2000 baseline survey area (Figure 1-3) was visible in the northeast corner of the new surveyed area in July 2002 (Figure 3-1). In addition, a smaller rock reef, located outside the disposal site boundary in the southwest corner of the 2002 survey area, was also visible in the 2000 bathymetry. The location of the current disposal site boundary was specifically selected to avoid these bottom features.

The features detected in the side-scan sonar survey over MIDS in July 2002 were enhanced when the 2002 colorized bathymetry data was overlaid (Figure 4-2). The rock outcrops seen separately in the bathymetry and the mosaic were especially distinct. The dimensions measured from the side-scan mosaic were very similar to those measured on the bathymetric map. In addition, other possible higher-relief, higher-reflectance, rock outcrops in the eastern portion of the survey area, outside the disposal site boundary, were more evident from the bathymetry/side-scan mosaic overlay.

The July 2002 REMOTS® results over MIDS were useful in delineating the distribution of dredged material. The REMOTS® results agreed relatively well with the side-scan results over MIDS and indicated that the majority of the small dredged material deposit was contained within the confines of the disposal site (Figure 4-1). Side-scan data suggests that at least one disposal event occurred in an area northwest of the disposal site. Sediment deposits in the side-scan mosaics appeared as circular features typical of those

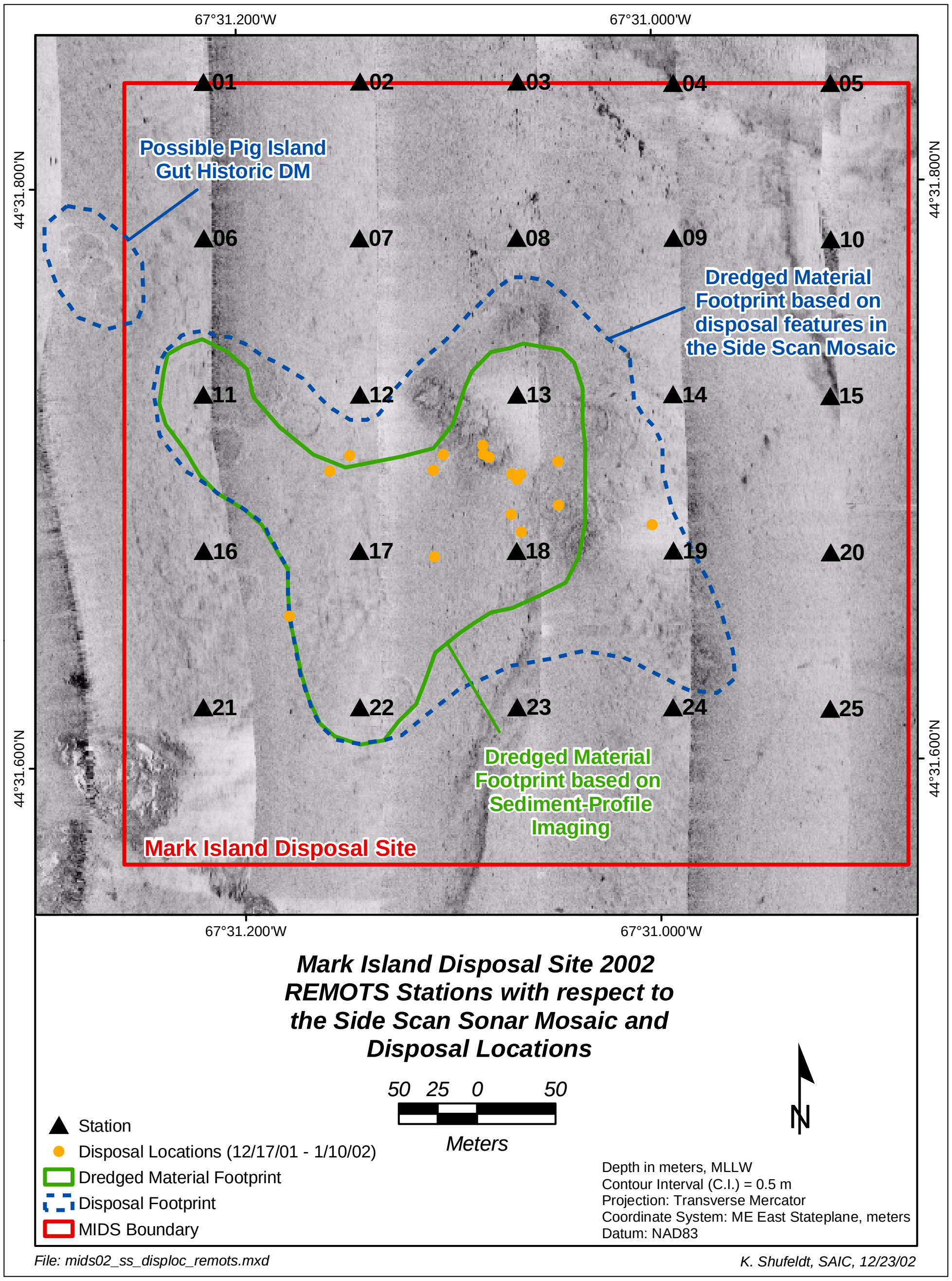


Figure 4-1. Map showing the REMOTS® stations with respect to the side-scan sonar mosaic. Graphic shows differences in dredged material footprint as detected by sediment-profile imaging (green) and the side-scan sonar (blue), relative to the reported disposal locations within MIDS

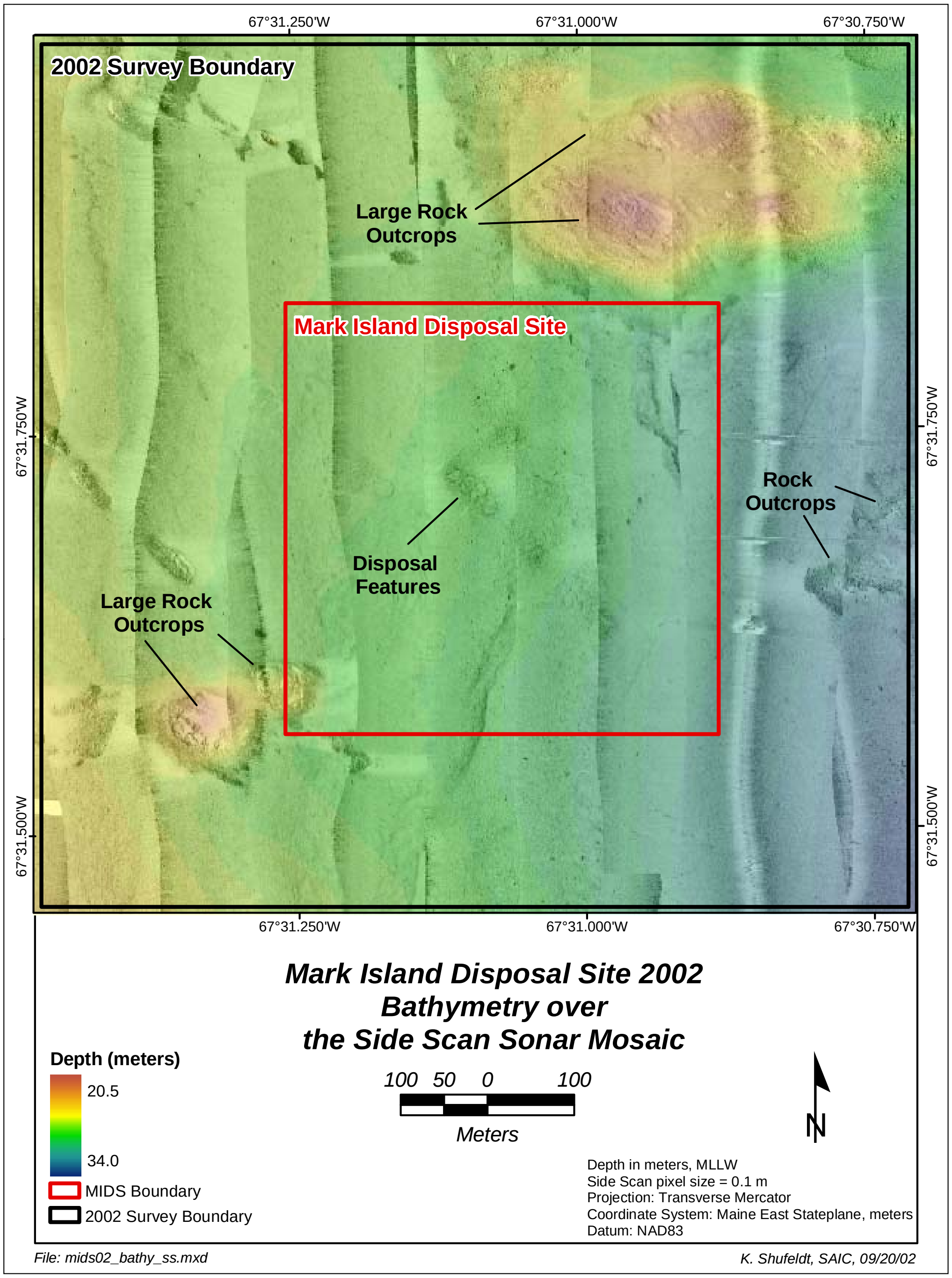


Figure 4-2. Composite graphic showing the bathymetric data overlaid on the side-scan sonar mosaic to demonstrate the correlation between seafloor composition and topography

produced by pocket-type disposal barges (Figure 3-4). Because of obvious disposal features outside the disposal site boundary, perhaps the product of a historic disposal, the dredged material footprint as detected from side-scan appears to extend beyond the disposal site boundary (Figure 4-1). The presence of these rings indicates this area has been subjected to dredged material disposal; however, the acoustic signature of these artifacts differs from those in the center of MIDS. The lighter appearance of these rings suggests these features were formed more than six months ago, and may be the product of historic disposal operations associated with the dredging of Pig Island Gut in 1966.

The REMOTS® images indicated that the dredged material present at 5 of the 25 inner disposal site stations was mostly fine-grained sediment (silt). The measured average thickness of the dredged material layer exceeded the penetration depth of the sediment-profile camera in all replicate images of Stations 17 and 18, and in one replicate image of Station 13. Discrete dredged material layers between 5.1 cm and 17 cm thick were observed in all replicate images of Stations 11 and 22 and in the remaining replicate image of Station 13. Sediment-profile imaging allowed measurement of relatively thin (i.e., less than 20 cm) dredged material layers that were not acoustically detectable in the bathymetry. As a result, the spatial distribution or "footprint" of the dredged material deposit, as determined by REMOTS®, was evident despite the lack of an acoustically detectable footprint in the bathymetric data (Figure 4-1).

When overlaid with the REMOTS® results, the side-scan sonar suggests the actual dredged material footprint may be larger than depicted by sediment-profile imaging (Figure 4-1). The darker sonar returns adjacent to Stations 19 and 24 indicate a change in sediment texture and/or composition. Although the side-scan mosaic displays dredged material encompassing Station 19, the REMOTS® data did not indicate dredged material layers present at this station. If a thin layer of dredged material was present, it has since been actively and biologically reworked by benthic infauna within the last six months and as a result, presently resembles ambient sediment. In addition, there was a significant presence of mud clumps at the sediment-water interface at Station 19, suggesting there was increased physical disturbance possibly due to dredged material placement or recent fishing activity. Furthermore, the side-scan sonar mosaic displayed a series of concentric rings analogous to dredged material disposal artifacts approximately 25 m outside the western disposal site boundary. Although there were no REMOTS® images corresponding to this area, dredged material was not detected in any of the outer sampling stations. Future studies over the Mark Island Disposal Site should consider sampling in this region to confirm the presence of historic dredged material outside the disposal site boundary.

Similar to the July 2002 survey, ambient sediments within and immediately surrounding the disposal site were characterized as well-sorted silt-clay in the March 2000 baseline survey, with a major modal grain size classification of >4 phi, except at stations positioned near the apparent rock ledge. No historic dredged material was found during the March 2000 baseline survey (SAIC 2000).

The MIDS study area lies within a relatively deep area located at the mouth of Chandler Bay and appears to be predominately a depositional environment. The MIDS has some exposure to the effects of ocean swell from the east and southeast. First order wave/resupsension modeling during the 2000 baseline survey suggested some possibility that storm induced waves could have an impact on soft sediments placed at this site (SAIC 2000). However, several reefs/ledges (e.g., Little Breaking Ledge, Jumper Ledge, Misery Ledge) located to the east and south of MIDS probably afford protection from ocean swells by disrupting surface waves and reducing the effects of longitudinal currents on the seafloor. Near bottom tidal currents were discovered not to be sufficiently strong to resuspend fine-grained sediments during the 2000 baseline study (SAIC 2000). The bedforms (ripples) detected in various replicates of three stations (Stations S, CTR, and WNW750) during the 2000 survey were not observed at the coinciding stations during the 2002 survey (Stations 13, 3, and NW500, respectively), suggesting that these ripples were probably produced by the waves of a winter storm event, rather than the product of a constant, high-energy environment.

The presence of relatively large, cohesive mud clumps and smaller mud clasts at the sediment-water interface (e.g., Figures 3-8A and 3-13) were the primary evidence of physical surface roughness at MIDS and the surrounding reference areas. Such mud clumps and clasts in both the disposal site and reference area stations are likely evidence of widespread physical disturbance in the area and are probably the product of fishing activity. This area is known to support both the local scallop and lobster fishing industries with scallops harvested primarily during the fall months and lobsters caught in the spring and summer. Dredging and dredged material placement operations at MIDS were intentionally scheduled to occur during the winter months to coincide with the hiatus in fishing activity over MIDS (T. Fredette, pers. comm.). Scallops are harvested with the use of a specialized dredge that is towed across the seafloor, while lobsters are caught in weighted wire traps, or pots. The deployment, operation, and retrieval of this fishing gear (i.e., scallop dredges and lobster pots) have likely disturbed the sediment surface within the surveyed area, serving to break muddy, cohesive surface sediments into discrete clumps or clasts like those observed in the sediment-profile images obtained in July 2002 within and surrounding the disposal site (Messieh et al. 1991; Thrush et al. 1995).

4.2 Biological Conditions and Benthic Recolonization

A second objective of the July 2002 survey over MIDS was to assess the benthic community status within the confines of the disposal site relative to existing seafloor conditions at two nearby reference areas. The July 2002 monitoring survey at MIDS was conducted approximately six months following the cessation of the 2001/2002 winter disposal activities. Because of the small amount of dredged material deposited within the MIDS (approximately 4,300 m^3), recolonization of this thin dredged material layer was expected to be relatively advanced at six months postdisposal. This is due to minimal effects of the benthic disturbance and the ability of Stage III organisms to migrate up through the thin layers (<10 cm) of fresh dredged material.

Because the deposit was relatively thin, vertical migration of infaunal organisms up through the recently placed sediment was expected for much of the benthic community affected by the disposal. The presence of Stage III activity in all but one inner disposal site station (Station 18) displaying dredged material supports this prediction (see Figure 3-12). It appears that the dredged material deposit had a minimal impact on the benthic environment. Dredged material placement mounds often recover faster than ambient disturbed areas, since newly deposited sediments frequently support higher population densities of foraging invertebrates by providing a concentrated food source (organically enriched sediment) within a competition free space, relative to ambient material (Germano et al. 1994).

Overall, the presence of both Stage I and Stage III taxa at the inner disposal site stations indicated that benthic recolonization over the dredged material deposit was relatively advanced at the time of the survey and that the benthic community was recovering quite well from recent dredged material placement. Evidence of advanced succession (Stage III) was observed at 68% of the inner stations, 88% of the outer stations, and 100% of the reference area stations. However, Stage III organisms rarely occurred in all replicate images of any one station. This suggests that although evidence of Stage III activity was detected at many of the sampled stations, the actual abundance of larger bodied infaunal deposit-feeding organisms would be classified as low to moderate. As similar conditions were evident at the reference areas, this appeared to be reflective of ambient conditions and is likely not the result of recent dredged material disposal activities.

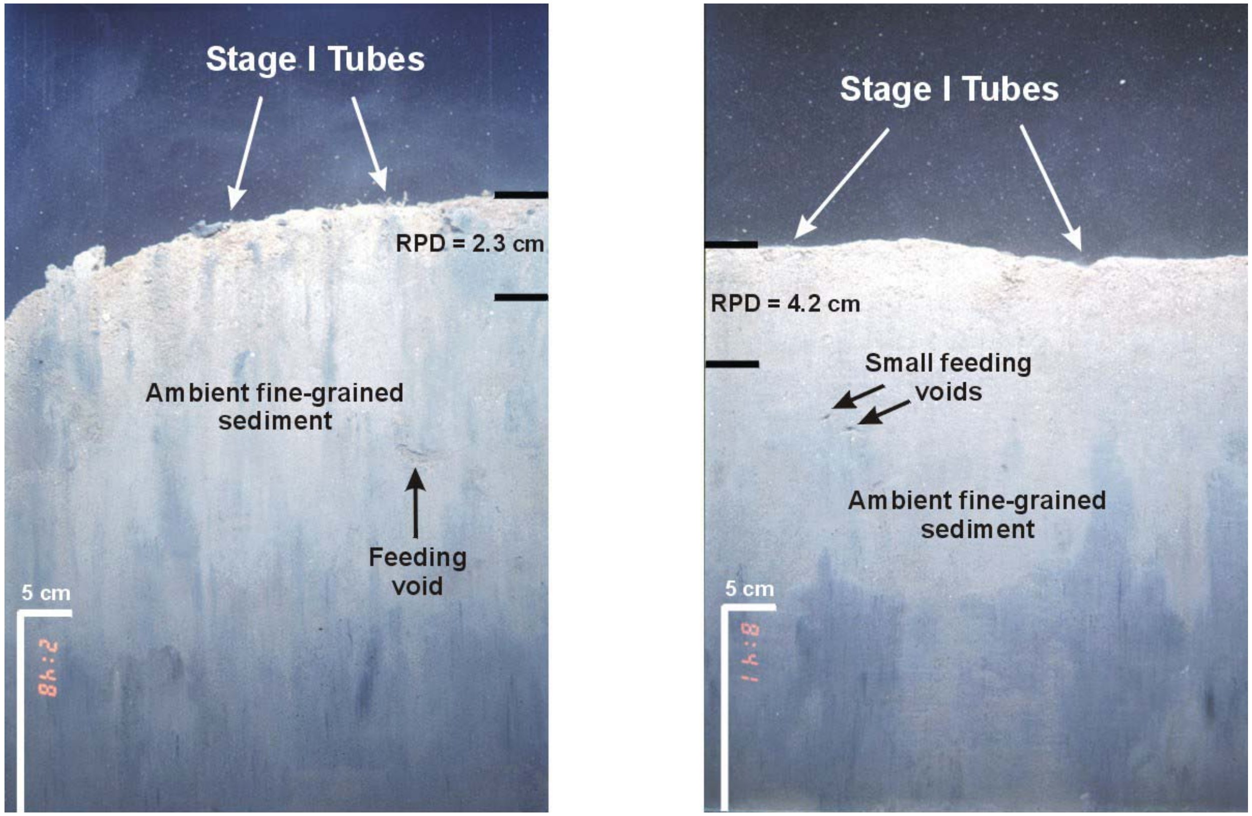
The RPD represents an important time-integrator of dissolved oxygen conditions within sediment pore waters and is also a useful indicator for assessing the condition of a benthic ecosystem. Due to the shift in the survey area center relative to March 2000, 6 of the 25 inner stations coincided with the positions previously occupied during the

March 2000 baseline survey. Mean RPD depths were slightly shallower at the six inner stations (Stations 1, 3, 5, 11, 13, and 15) in July 2002 (2.2 cm) than in the six corresponding stations (Stations CTR, E, S, SE, SW, and W) sampled within the disposal site in March 2000 (3.1 cm), but were still indicative of good sediment aeration attributed to extensive bioturbation by larger-bodied infauna (Figure 4-3). Generally, the 2002 REMOTS® stations that showed signs of dredged material placement activity tended to display lower RPD depths. The slight reduction in RPD depths from the 2000 survey may reflect a higher sediment oxygen demand (SOD) within the dredged material.

Sediments dredged from river channels and inner harbor areas often contain elevated levels of organic matter relative to ambient conditions on the seafloor surrounding an open-water disposal site. Chemical and biological decomposition of this organic matter acts to consume oxygen incorporated within the sediment. The consumption of available oxygen in the sediment pore water is reflected in slightly shallower RPD depths noted within the disposal site (but still indicative of well-aerated surface sediments) in the July 2002 post-disposal survey than what was previously observed in the March 2000 predisposal survey (SAIC 2001). The 2000 and 2002 surveys were conducted during different seasons (2000 survey in winter versus 2002 survey in summer); however, seasonality likely has no major effects on benthic infaunal metabolic activity (i.e., bioturbation) in this region because bottom waters are generally cold for much of the year. As a result, the metabolic rates and bioturbational activities of the resident infauna remain low, slowing the incorporation of oxygenated bottom waters below the sediment-water interface. It is expected that the RPD depths will gradually deepen over time as the organic matter is consumed and the dredged material continues to experience bioturbation by the resident infauna.

The OSI provides a summary measure of overall benthic habitat conditions. Benthic conditions within the disposal site (20% of the stations sampled appeared to be impacted by dredged material disposal) were comparable to the ambient sediment at both the outer and reference area stations, with relatively moderate RPD depths and a considerable presence of Stage III organisms. The disposal site stations showed variable benthic habitat conditions, with median OSI values ranging from +3 (marginally degraded) to +10 (non-degraded), however, the overall OSI value of +6.3 indicates that undisturbed benthic habitat conditions exist within the disposal site. Median OSI values at the outer MIDS and reference area stations (+7.7 and +7, respectively) were slightly higher than at the inner MIDS stations, and are similarly indicative of undisturbed benthic habitat conditions.

The higher OSI values at the outer and reference stations were mainly a function of relatively deeper RPD depths (3.4 cm at outer stations and 2.9 cm at reference area



A B

Figure 4-3. REMOTS® images from July 2002 inner sampling Station 15 (A) and corresponding March 2000 baseline Station SE (B) displaying similar benthic habitat quality. Both images depict a Stage I on III successional status due to polychaete tubes at the sediment-water interface and Stage III feeding voids at depth; however, the RPD is shallower in the July 2002 survey. OSI values of +9 (A) and +11 (B), indicative of undisturbed benthic habitat quality, were calculated for these images.

stations) and a slightly higher occurrence of Stage III activity. However, variability in benthic habitat conditions were observed among replicate images and between stations across all three survey areas (inner and outer MIDS stations and reference area stations). For example, replicate images from some stations displayed a fairly broad range of OSI values (< +6 to +11; Figure 4-4).

The March 2000 and July 2002 REMOTS® surveys did not occupy the same station grids due to the southerly shift of the disposal site boundary. However, the position of several stations did coincide with those of the 2000 baseline stations, including the six inner MIDS stations with dredged material observed in the 2002 survey. Based upon comparisons made between the 2000 and 2002 data sets, the overall average median OSI value calculated for the six corresponding inner disposal site stations in 2002 (+6.5) was slightly higher, but comparable to that observed within the same six stations during the March 2000 baseline survey (+6 in March 2000; SAIC 2001) and suggests that undisturbed benthic habitat conditions have prevailed over much of the surveyed area since 2000 despite the recent placement of dredged material. Furthermore, based on comparisons between the six stations, it appears that the organic matter entrained within the dredged material (a food source for primary consumers) may have stimulated productivity in areas subjected to dredged material deposition (Figure 4-5).

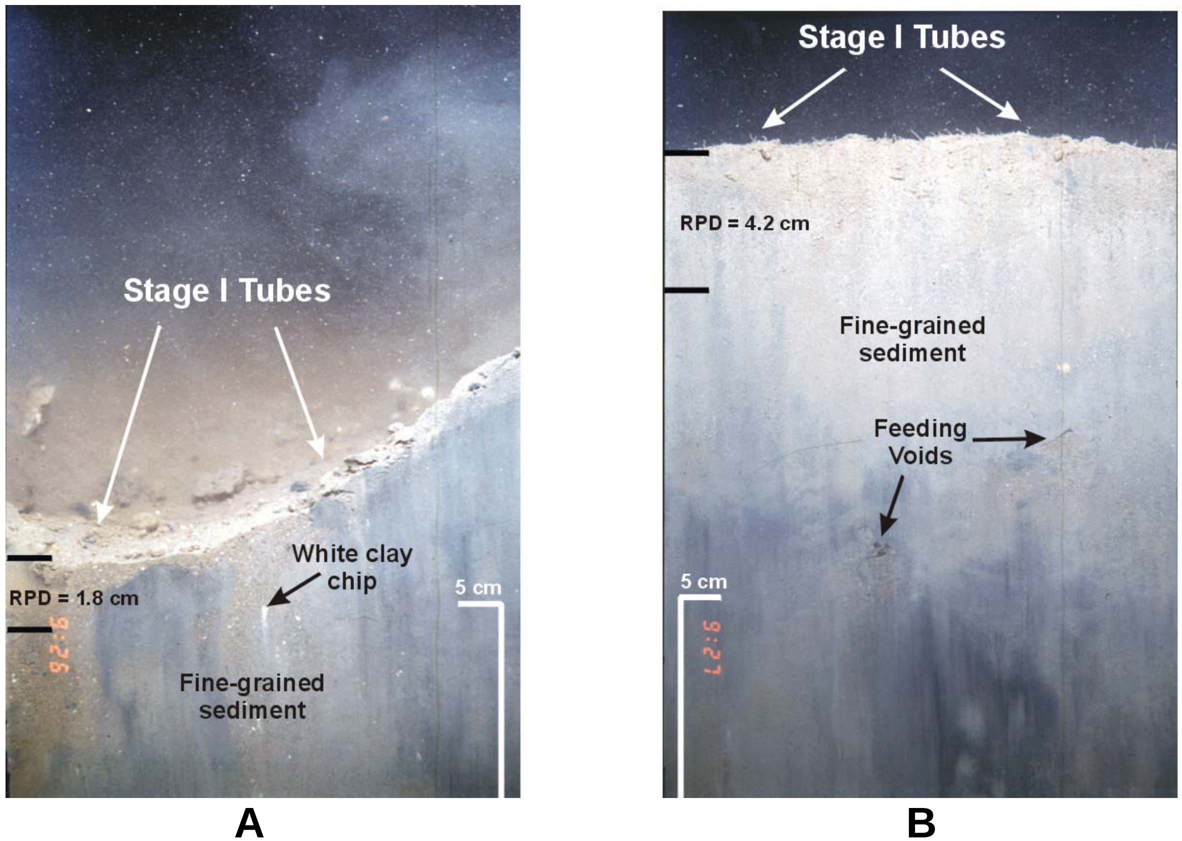
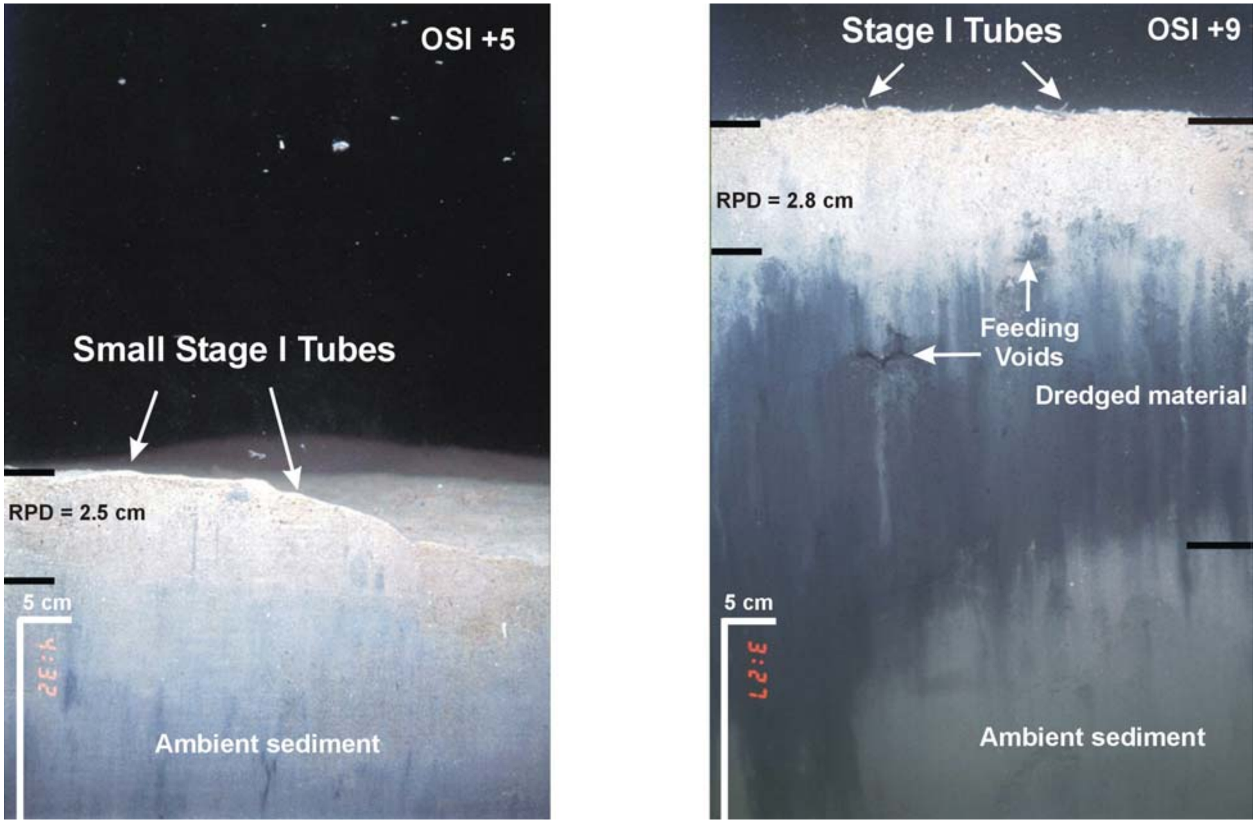


Figure 4-4. REMOTS® images collected from Outer Station E375 during the July 2002 survey illustrating variability in benthic habitat quality within the station sampling radius. The ambient sediment within image A shows only Stage I tubes at the sediment-water interface and a moderate RPD depth, resulting in an OSI of +4. Conversely, the ambient sediment within image B depicts a Stage I on III successional status and a well-developed RPD depth, resulting in an OSI value of +11.



A B

Figure 4-5. REMOTS® images obtained from the March 2000 baseline Station SW (A) and corresponding July 2002 survey Station 11 (B) showing benthic recolonization of the fresh dredged material layer. Benthic habitat quality has improved since placement of dredged material at this station, with a slightly deeper RPD depth and the occurrence of Stage III feeding voids at sediment depth (B). As a result, the OSI value has increased from +5 in 2000 (A) to +9 in 2002 (B).

5.0 CONCLUSIONS

- Following the disposal of a small volume of dredged material (4,300 m^3) from Moosabec Reach during the winter of 2001/2002, the July 2002 bathymetry documented no acoustically detectable disposal mound. However, the side-scan sonar mosaic does display evidence of disposal events and corresponds relatively well with REMOTS® results. Additional bottom features including rock outcrops and rock ledges were also visible in the bathymetry/side-scan mosaic overlay, and agreed well with features detected in the 2000 baseline survey.

- The REMOTS® images indicate that the dredged material constituting the Mark Island Disposal Site deposit was present at 5 of the 25 stations established within the site boundaries and composed of mostly fine-grained sediment (silt). Dredged material deposits were primarily concentrated in the interior portions of the survey grid. While some replicate images displayed dredged material layers with thicknesses exceeding camera penetration, discrete, measurable dredged material layers were visible in the majority of the replicates collected from these five stations.

- Cohesive mud clumps or clasts were observed at the sediment surface at both the disposal site and surrounding reference area stations, and were likely attributed to widespread physical seafloor disturbance from fishing activity.

- Benthic recolonization over the surface of the thin dredged material layers at MIDS was relatively advanced, with Stage III organisms occurring at 68% of the inner stations, compared to 88% of the outer and 100% of the reference area stations. Stage III taxa rarely occurred in all replicate images of any one station, suggesting that Stage III organisms were not abundant within the stations of the surveyed area.

- Benthic habitat conditions over the inner stations of MIDS were determined to be undisturbed or non-degraded (OSI value of +6.3) and were similar to values observed at the surrounding outer MIDS (+7.7) and reference area stations (+7).

- The overall average median OSI calculated for the six inner stations during the 2002 survey (+6.5) was slightly higher, but comparable to that observed at the six corresponding stations in the 2000 survey (+6) prior to disposal of dredged material. Both values are indicative of undisturbed benthic habitat conditions. The placement of dredged material has had a minimal impact on the benthic environment within MIDS.

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APPENDIX A

Disposal Logs

Appendix A, Disposal Logs

2001 **MIDS**

Project: MOOSABEC REACH

Permit Number: 199900444 **Permittee:** US COAST GAURD

Buoy	Departure	Disposal	Return	Latitude	Longitude	Buoy's Vector	Volume (CY)
NA	12/17/2001	12/17/2001	12/17/2001	44.5275	-67.51967	50 FT W	312
NA	12/17/2001	12/17/2001	12/17/2001	44.52842	-67.51842	70 FT W	312
NA	12/20/2001	12/20/2001	12/20/2001	44.52833	-67.5185	50 W	312
NA	12/20/2001	12/20/2001	12/20/2001	44.52833	-67.5185	75 W	312
NA	12/26/2001	12/26/2001	12/26/2001	44.52783	-67.5185	75 FT W	312
NA	12/28/2001	12/28/2001	12/28/2001	44.52842	-67.51917	50 FT	312
NA	12/28/2001	12/28/2001	12/28/2001	44.52807	-67.51788	10 FT	312
				Project Total Volume:		**1,670 CM**	**2,184 CY**
				Yearly Total Volume:		**1,670 CM**	**2,184 CY**

2002 **MIDS**

Project: MOOSABEC REACH

Permit Number: 199900444 **Permittee:** US COAST GAURD

Buoy	Departure	Disposal	Return	Latitude	Longitude	Buoy's Vector	Volume (CY)
NA	1/2/2002	1/2/2002	1/2/2002	44.52833	-67.51933	40 FT	312
NA	1/2/2002	1/2/2002	1/2/2002	44.52797	-67.5178	50 FT	312
NA	1/3/2002	1/3/2002	1/3/2002	44.52842	-67.5181	0	312
NA	1/3/2002	1/3/2002	1/3/2002	44.52847	-67.5181	0	312
NA	1/4/2002	1/4/2002	1/4/2002	44.5284	-67.51805	0	312
NA	1/8/2002	1/8/2002	1/8/2002	44.528	-67.51675	0	312
NA	1/8/2002	1/8/2002	1/8/2002	44.52837	-67.5175	0	312
NA	1/9/2002	1/9/2002	1/9/2002	44.52812	-67.5175	0	312
NA	1/9/2002	1/9/2002	1/9/2002	44.5283	-67.51787	0	312
NA	1/10/2002	1/10/2002	1/10/2002	44.52827	-67.51783	0	312
NA	1/10/2002	1/10/2002	1/10/2002	44.5283	-67.5178	0	312
				Project Total Volume:		**2,624 CM**	**3,432 CY**
				Yearly Total Volume:		**2,624 CM**	**3,432 CY**

APPENDIX B

REMOTS® Sediment-Profiling Imaging Data

Appendix B1

Mark Island Disposal Site (MIDS) REMOTS® Sediment-Profile Imaging Data from the July 2002 Survey

Station	Replicate	Date	Time	Successional	Grain Size (phi)			Mud Clasts		Camera Penetration (cm)				Dredged Material Thickness (cm)			Redox Rebound Thickness (cm)		
				Stage	Min	Max	Maj Mode	Count	Avg. Diam	Min	Max	Range	Mean	Min	Max	Mean	Min	Max	Mean
INNER																			
01	A	7/4/2002	15:51	ST I	> 4 phi	4 to 3 phi	> 4 phi	12	0.31	12.88	13.46	0.58	13.17	0	0	0	0	0	0
01	B	7/4/2002	15:52	ST I	> 4 phi	4 to 3 phi	> 4 phi	7	0.16	14.45	15.25	0.8	14.85	0	0	0	0	0	0
01	C	7/4/2002	15:52	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	2	1.33	13.25	14.48	1.23	13.86	0	0	0	0	0	0
02	A	7/4/2002	15:45	INDET	> 4 phi	4 to 3 phi	> 4 phi	4	1.88	6.62	9.14	2.52	7.88	0	0	0	0	0	0
02	B	7/4/2002	15:46	ST I	> 4 phi	4 to 3 phi	> 4 phi	0	0	16.8	17.57	0.77	17.18	0	0	0	0	0	0
02	C	7/4/2002	15:47	ST I	> 4 phi	4 to 3 phi	> 4 phi	4	0.42	14.16	15.3	1.14	14.73	0	0	0	0	0	0
03	A	7/4/2002	16:32	ST I	> 4 phi	4 to 3 phi	> 4 phi	0	0	12.48	14.29	1.81	13.39	0	0	0	0	0	0
03	B	7/4/2002	16:33	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	3	0.57	13.62	15.93	2.31	14.77	0	0	0	0	0	0
03	C	7/4/2002	16:34	ST I	> 4 phi	4 to 3 phi	> 4 phi	4	0.16	14.7	15.66	0.96	15.18	0	0	0	0	0	0
04	A	7/3/2002	21:40	ST I on III	> 4 phi	3 to 2 phi	4 to 3 phi	0	0	8.48	10.46	1.98	9.47	0	0	0	0	0	0
04	D	7/4/2002	16:40	INDET	> 4 phi	4 to 3 phi	> 4 phi	0	0	1.59	8.32	6.73	4.95	0	0	0	0	0	0
04	E	7/3/2002	16:42	ST I	> 4 phi	3 to 2 phi	3 to 2 phi	1	1.21	8.89	10.71	1.82	9.8	0	0	0	0	0	0
05	B	7/3/2002	21:34	INDET	1 to 0 phi	< -1 phi	0 to -1 phi	0	0	0.59	0.59	.	0.59	0	0	0	0	0	0
05	D	7/4/2002	16:48	INDET	> 4 phi	3 to 2 phi	4 to 3 phi	0	0	2.95	3.88	0.93	3.41	0	0	0	0	0	0
05	F	7/4/2002	16:50	ST I	> 4 phi	3 to 2 phi	4 to 3 phi	0	0	5.82	7.71	1.89	6.77	0	0	0	0	0	0
06	A	7/3/2002	21:11	ST I	> 4 phi	3-2 phi	>4 phi	9	1.51	11.91	13.55	1.64	12.73	0	0	0	0	0	0
06	B	7/3/2002	21:12	ST I	> 4 phi	4 to 3 phi	> 4 phi	0	0	9.43	12.71	3.28	11.07	0	0	0	0	0	0
06	C	7/3/2002	21:13	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	12	0.4	13.43	14.04	0.61	13.74	0	0	0	0	0	0
07	A	7/4/2002		INDET	> 4 phi	4 to 3 phi	> 4 phi	0	0	7.39	11.04	3.65	9.22	0	0	0	0	0	0
07	B	7/4/2002	15:40	ST I	> 4 phi	4 to 3 phi	> 4 phi	0	0	10	12.89	2.89	11.44	0	0	0	0	0	0
07	C	7/4/2002	15:41	ST I	> 4 phi	4 to 3 phi	> 4 phi	4	0.67	14.8	16.21	1.41	15.5	0	0	0	0	0	0
08	A	7/4/2002	16:18	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	10	0.38	13.45	15	1.55	14.23	0	0	0	0	0	0
08	B	7/4/2002	16:19	ST I	> 4 phi	4 to 3 phi	> 4 phi	5	0.35	9.29	12.86	3.57	11.07	0	0	0	0	0	0
08	C	7/4/2002	16:20	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	4	0.48	9.98	14.62	4.64	12.3	0	0	0	0	0	0
09	A	7/3/2002	21:18	ST I	> 4 phi	4 to 3 phi	> 4 phi	3	0.24	13.39	14.09	0.7	13.74	0	0	0	0	0	0
09	B	7/3/2002	21:19	ST I	> 4 phi	4 to 3 phi	> 4 phi	6	0.3	11.21	12.12	0.91	11.66	0	0	0	0	0	0
09	C	7/3/2002	21:19	ST I	> 4 phi	4 to 3 phi	> 4 phi	6	0.59	12.34	14.2	1.86	13.27	0	0	0	0	0	0
10	A	7/4/2002	16:25	ST I	> 4 phi	4 to 3 phi	> 4 phi	2	0.24	12.86	14.29	1.43	13.57	0	0	0	0	0	0
10	B	7/4/2002	16:26	ST I	> 4 phi	4 to 3 phi	> 4 phi	2	0.25	12.75	13.84	1.09	13.3	0	0	0	0	0	0
10	C	7/4/2002	16:27	ST I	> 4 phi	4 to 3 phi	> 4 phi	0	0	15.79	16.38	0.59	16.08	0	0	0	0	0	0
11	B	7/4/2002	15:27	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	0	0	8.91	10.59	1.68	9.75	0	0	0	0	0	0
11	C	7/4/2002	15:27	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	0	0	17.46	17.95	0.49	17.7	0	0	13.08	0	0	0
11	E	7/5/2002	14:37	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	0	0	19.21	20.07	0.86	19.64	0	0	15.47	0	0	0
12	B	7/4/2002	15:21	ST I	> 4 phi	4 to 3 phi	> 4 phi	1	0.38	12.14	14.07	1.93	13.1	0	0	0	0	0	0
12	D	7/5/2002	14:42	ST I	> 4 phi	4 to 3 phi	> 4 phi	8	0.34	11.96	12.43	0.47	12.19	0	0	0	0	0	0
12	E	7/5/2002	14:43	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	5	0.38	12.27	13.18	0.91	12.73	0	0	0	0	0	0
13	A	7/3/2002	21:04	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	3	0.22	16.04	16.77	0.73	16.41	0	0	8.07	0	0	0
13	D	7/4/2002	15:16	INDET	> 4 phi	4 to 3 phi	> 4 phi	2	1.2	14.95	16.55	1.6	15.75	> 14.95	> 16.55	> 15.75	0	0	0
13	F	7/4/2002	15:17	ST I	> 4 phi	4 to 3 phi	> 4 phi	0	0	17.91	19.3	1.39	18.6	0	0	14.27	0	0	0
14	A	7/4/2002	15:10	ST I	> 4 phi	4 to 3 phi	> 4 phi	8	0.96	15.16	16.52	1.36	15.84	0	0	0	0	0	0
14	B	7/4/2002	15:11	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	1	0.26	11.93	14.98	3.05	13.45	0	0	0	0	0	0
14	C	7/4/2002	15:12	ST I	> 4 phi	4 to 3 phi	> 4 phi	3	0.31	13.18	16.27	3.09	14.73	0	0	0	0	0	0
15	C	7/4/2002	15:06	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	9	0.43	14.82	16.21	1.39	15.51	0	0	0	0	0	0
15	D	7/5/2002	14:47	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	6	0.57	9.46	10.27	0.81	9.86	0	0	0	0	0	0
15	E	7/5/2002	14:48	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	4	0.26	13.23	16.21	2.98	14.72	0	0	0	0	0	0
16	A	7/4/2002	14:21	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	0	0	7.43	10.14	2.71	8.78	0	0	0	0	0	0
16	B	7/4/2002	14:21	ST I	> 4 phi	4 to 3 phi	> 4 phi	0	0	12.88	13.93	1.05	13.41	0	0	0	0	0	0
16	C	7/4/2002	14:22	ST I	> 4 phi	4 to 3 phi	> 4 phi	3	0.94	11.29	12.86	1.57	12.07	0	0	0	0	0	0
17	A	7/4/2002	14:26	ST I	> 4 phi	4 to 3 phi	> 4 phi	3	0.65	11.68	12.46	0.78	12.07	> 11.68	> 12.46	> 12.07	0	0	0
17	B	7/4/2002	14:27	ST I	> 4 phi	4 to 3 phi	> 4 phi	2	0.14	14.14	16.79	2.65	15.47	> 14.14	> 16.79	> 15.47	0	0	0
17	C	7/4/2002	14:28	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	0	0	20.23	20.98	0.75	20.6	0	0	17.00	0	0	0
18	A	7/4/2002	14:32	ST I	> 4 phi	4 to 3 phi	> 4 phi	6	0.65	13.66	14.71	1.05	14.18	> 13.66	> 14.71	> 14.18	0	0	0
18	B	7/4/2002	14:33	ST I	> 4 phi	4 to 3 phi	> 4 phi	5	3.56	11.32	13.02	1.7	12.17	> 11.32	> 13.02	> 12.17	0	0	0
18	E	7/5/2002	14:31	ST I	> 4 phi	4 to 3 phi	> 4 phi	3	1.04	10.66	11.88	1.22	11.27	0	0	0	0	0	0
19	A	7/4/2002	14:38	INDET	> 4 phi	4 to 3 phi	> 4 phi	8	1.68	10.75	13.07	2.32	11.91	0	0	0	0	0	0
19	B	7/4/2002	14:39	ST I	> 4 phi	4 to 3 phi	> 4 phi	3	3.55	12.52	15.52	3	14.02	0	0	0	0	0	0
19	C	7/4/2002	14:39	ST I	> 4 phi	4 to 3 phi	> 4 phi	4	2.45	14.96	16.43	1.47	15.69	0	0	0	0	0	0
20	A	7/4/2002	14:57	ST I	> 4 phi	4 to 3 phi	> 4 phi	17	0.31	15.38	16.23	0.85	15.81	0	0	0	0	0	0
20	B	7/4/2002	14:58	ST I	> 4 phi	4 to 3 phi	> 4 phi	3	0.43	12.32	13.34	1.02	12.83	0	0	0	0	0	0
20	C	7/4/2002	14:59	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	0	0	12.04	12.82	0.78	12.43	0	0	0	0	0	0
21	A	7/4/2002	14:15	ST I	> 4 phi	4 to 3 phi	> 4 phi	4	0.52	12.36	13.27	0.91	12.82	0	0	0	0	0	0
21	B	7/4/2002	14:15	ST I	> 4 phi	4 to 3 phi	> 4 phi	5	0.33	9.12	11.7	2.58	10.41	0	0	0	0	0	0
21	C	7/4/2002	14:16	ST I	> 4 phi	4 to 3 phi	> 4 phi	10	0.73	12.29	14.29	2	13.29	0	0	0	0	0	0
22	A	7/4/2002	14:09	ST I to II	> 4 phi	4 to 3 phi	> 4 phi	0	0	15.34	17.25	1.91	16.3	0	0	0	0	0	0
22	B	7/4/2002	14:09	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	0	0	17.11	18.05	0.94	17.58	0	0	5.06	0	0	0
22	E	7/5/2002	14:26	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	0	0	15.25	16.89	1.64	16.07	0	0	10.74	0	0	0
23	A	7/4/2002	14:03	ST I on III	> 4 phi	3-2 phi	> 4 phi	0	0	14.54	15.29	0.75	14.91	0	0	0	0	0	0
23	B	7/4/2002	14:03	ST I	> 4 phi	4 to 3 phi	> 4 phi	10	0.42	13.02	14.38	1.36	13.7	0	0	0	0	0	0
23	C	7/4/2002	14:04	ST I	> 4 phi	3-2 phi	> 4 phi	5	0.26	8.12	10.43	2.31	9.27	0	0	0	0	0	0
24	B	7/3/2002	20:58	ST I	> 4 phi	4 to 3 phi	> 4 phi	24	0.44	15.54	16.38	0.84	15.96	0	0	0	0	0	0
24	C	7/3/2002	20:59	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	5	0.27	14.77	15.62	0.85	15.19	0	0	0	0	0	0
24	D	7/4/2002	13:58	ST I	> 4 phi	4 to 3 phi	> 4 phi	0	0	15.54	16.16	0.62	15.85	0	0	0	0	0	0
25	A	7/4/2002	13:52	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	0	0	15.5	16.02	0.52	15.76	0	0	0	0	0	0
25	B	7/4/2002	13:53	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	0	0	15.36	16.5	1.14	15.93	0	0	0	0	0	0
25	C	7/4/2002	13:53	ST I	> 4 phi	4 to 3 phi	> 4 phi	6	0.39	15.34	16.96	1.62	16.15	0	0	0	0	0	0
OUTER																			
E375	A	7/3/2002	21:25	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	10	0.34	15.43	16.89	1.46	16.16	0	0	0	0	0	0
E375	B	7/3/2002	21:26	ST I	> 4 phi	3-2 phi	> 4 phi	10	0.38	6.55	12.16	5.61	9.35	0	0	0	0	0	0
E375	C	7/3/2002	21:27	ST I on III	> 4 phi	3-2 phi	> 4 phi	3	0.29	17.25	17.86	0.61	17.56	0	0	0	0	0	0
N375	A	7/3/2002	21:53	ST I on III	> 4 phi	2-1 phi	3-2 phi	6	0.3	5.48	6.64	1.16	6.06	0	0	0	0	0	0
N375	B	7/3/2002	21:54	ST I on III	> 4 phi	3 to 2 phi	4 to 3 phi	0	0	8.48	9.16	0.68	8.82	0	0	0	0	0	0
N375	C	7/3/2002	21:55	ST I	> 4 phi	4 to 3 phi	4 to 3 phi	12	1.34	7.5	8.62	1.12	8.06	0	0	0	0	0	0
NE500	C	7/3/2002	21:47	INDET	< -1 phi	< -1 phi	< -1 phi	0	0	0.54	0.55	0.01	0.55	0	0	0	0	0	0
NE500	E	7/4/2002	16:57	INDET	< -1 phi	< -1 phi	< -1 phi	0	0	0.54	0.57	0.03	0.56	0	0	0	0	0	0
NE500	F	7/4/2002	16:58	INDET	0 to -1 phi	< -1 phi	< -1 phi	0	0	0.54	0.54	.	0.54	0	0	0	0	0	0
NW500	A	7/4/2002	15:57	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	7	2.04	10.98	12.59	1.61	11.78	0	0	0	0	0	0
NW500	B	7/4/2002	15:58	ST I	> 4 phi	4 to 3 phi	> 4 phi	3	2.01	10.21	11.38	1.17	10.8	0	0	0	0	0	0
NW500	C	7/4/2002	15:58	ST I	> 4 phi	4 to 3 phi	> 4 phi	0	0	8.5	10.12	1.62	9.31	0	0	0	0	0	0
S375	A	7/4/2002	13:34	ST I	> 4 phi	4 to 3 phi	> 4 phi	0	0	17.93	19.8	1.87	18.86	0	0	0	0	0	0
S375	B	7/4/2002	13:34	ST I	> 4 phi	4 to 3 phi	> 4 phi	2	0.38	14.34	14.64	0.3	14.49	0	0	0	0	0	0
S375	C	7/4/2002	13:35	ST I on III	> 4 phi	3-2 phi	> 4 phi	2	0.71	15.68	16.66	0.98	16.17	0	0	0	0	0	0
SE500	A	7/4/2002	13:44	ST I	> 4 phi	4 to 3 phi	> 4 phi	0	0	11.11	12.43	1.32	11.77	0	0	0	0	0	0
SE500	B	7/4/2002	13:44	ST I	> 4 phi	3-2 phi	> 4 phi	12	0.32	13.89	14.77	0.88	14.33	0	0	0	0	0	0
SE500	C	7/4/2002	13:45	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	5	0.17	8.25	9.41	1.16	8.83	0	0	0	0	0	0
SW500	A	7/4/2002	13:26	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	9	0.77	17.57	19.43	1.86	18.5	0	0	0	0	0	0
SW500	B	7/4/2002	13:27	ST I	> 4 phi	4 to 3 phi	> 4 phi	6	0.39	15.23	16.48	1.25	15.85	0	0	0	0	0	0
SW500	C	7/4/2002	13:28	ST I on III	> 4 phi	2-1 phi	> 4 phi	5	0.29	12.68	14.32	1.64	13.5	0	0	0	0	0	0
W375	A	7/4/2002	15:33	ST I	> 4 phi	4 to 3 phi	> 4 phi	0	0	8.23	8.98	0.75	8.6	0	0	0	0	0	0
W375	B	7/4/2002	15:33	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	0	0	8.38	9.73	1.35	9.06	0	0	0	0	0	0
W375	C	7/4/2002	15:34	ST I	> 4 phi	4 to 3 phi	> 4 phi	0	0	8.32	10.29	1.97	9.31	0	0	0	0	0	0

Appendix B1 (continued)

Mark Island Disposal Site (MIDS) REMOTS® Sediment-Profile Imaging Data from the July 2002 Survey

Station	Replicate	Date	Time	Apparent RPD Thickness (cm) Min	Max	Mean	Methane Count	Mean Depth	Diam	OSI	Surface Roughness	Low DO	Comments
INNER													
01	A	7/4/2002	15:51	2.00	5.12	3.19	0	0	0	6	Physical	NO	Ambient tan/gry m, sm tubes, ox & red clasts, lg m clumps-far
01	B	7/4/2002	15:52	2.06	7.36	4.89	0	0	0	7	Physical	NO	Ambient tan/gry m, tubes, ox & red clasts, worms @z, biogenic surface reworking
01	C	7/4/2002	15:52	1.18	5.17	2.77	0	0	0	9	Physical	NO	Ambient tan/gry m, sm tubes, sm void, lg m clump
02	A	7/4/2002	15:45	-99.00	-99.00	-99.00	0	0	0	99	Physical	NO	Ambient tan/gry sandy m, pull away
02	B	7/4/2002	15:46	3.85	7.91	5.88	0	0	0	7	Biogenic	NO	Ambient tan m, dense Stg 1 surf tubes, one lg surf tube
02	C	7/4/2002	15:47	0.44	6.13	3.51	0	0	0	6	Physical	NO	Ambient tan/gry m, tubes, burrows, burrowing worm @z
03	A	7/4/2002	16:32	0.07	5.08	2.30	0	0	0	5	Physical	NO	Ambient tan/gry m, tubes, sm burrow-opening
03	B	7/4/2002	16:33	0.59	6.33	3.88	0	0	0	11	Biogenic	NO	Ambient tan/gry m, tubes, ox & red clasts, burrow opening, voids, biogenic surf reworking
03	C	7/4/2002	16:34	0.07	6.57	3.42	0	0	0	6	Physical	NO	Ambient tan/gry m, tubes, ox & red clasts, sm burrow-opening
04	A	7/3/2002	21:40	0.81	5.86	3.24	0	0	0	10	Physical	NO	Ambient tan/gry fine sand & silt, shell hash, wht clay chips @z, tubes, worms @z, voids, burrows, org detritus @ surf
04	D	7/4/2002	16:40	-99.00	-99.00	-99.00	0	0	0	99	Indeterminate	NO	Ambient reddish-tan silty clay, shell frags, tubes, dist surf, m clumps
04	E	7/3/2002	16:42	3.89	6.90	5.07	0	0	0	7	Physical	NO	Ambient tan/gry fine sand & silt, shell hash, flock layer, tubes, ox clast
05	B	7/3/2002	21:34	-99.00	-99.00	-99.00	0	0	0	99	Indeterminate	NO	Hard bottom, underpen, shell (mussel) layer/sand
05	D	7/4/2002	16:48	-99.00	-99.00	-99.00	0	0	0	99	Physical	NO	Ambient tan&gry fine sand &silt, shell hash, underpen
05	F	7/4/2002	16:50	0.37	4.24	2.42	0	0	0	5	Physical	NO	Ambient tan&gry fine sand & silt, shell hash, wht clay chips @z
06	A	7/3/2002	21:11	0.77	5.39	3.28	0	0	0	6	Physical	NO	Ambient reddish-tan/gry&blk fine sand & silt, red clasts, tubes, worms @z, wht clay chip @z, m clumps-far
06	B	7/3/2002	21:12	0.62	5.57	2.94	0	0	0	5	Biogenic	NO	Ambient reddish-tan/gry&blk streaky fine sand & silt, sm tubes, lg burrow opening, lg worms @z,
06	C	7/3/2002	21:13	0.90	6.01	3.38	0	0	0	10	Physical	NO	Ambient tan/gry & blk sandy m, sm tubes, ox & red clasts, void, burrows-openings, biogenic reworked surf lyr, m clumps-far
07	A	7/4/2002		-99.00	-99.00	-99.00	0	0	0	99	Physical	NO	pull away = indeterminate RPD and SS. Tan/blk mud, worm @z, tubes
07	B	7/4/2002	15:40	1.18	5.39	3.02	0	0	0	6	Physical	NO	Ambient tan/gry sandy m, irreg topo, m clumps-far, tubes, burrow opening, fecal layer?, wiper clast
07	C	7/4/2002	15:41	2.29	6.05	4.03	0	0	0	7	Physical	NO	Ambient tan/gry m, tubes, ox & red clasts
08	A	7/4/2002	16:18	0.08	4.74	2.68	0	0	0	9	Physical	NO	Ambient tan/gry m, dense surf tubes, ox & red clasts, void, worms @z
08	B	7/4/2002	16:19	0.08	4.89	2.11	0	0	0	4	Physical	NO	Ambient tan/gry m, sm tubes, ox & red clasts, m clumps-far, surf reworking
08	C	7/4/2002	16:20	0.38	5.28	2.59	0	0	0	9	Physical	NO	Ambient tan/gry m, sloping topo, ox & red clasts, void
09	A	7/3/2002	21:18	3.73	6.79	4.52	0	0	0	7	Physical	NO	Ambient tan/gry m, tubes, ox clasts, faint void?
09	B	7/3/2002	21:19	0.29	4.23	1.57	0	0	0	4	Biogenic	NO	Ambient tan/gry sandy m, tubes, ox & red clasts, fecal layer, sm burrow openings, patchy rpd
09	C	7/3/2002	21:19	2.48	6.93	4.11	0	0	0	7	Physical	NO	Ambient tan/gry sandy m, tubes, ox & red clasts, surf reworking, sm burrow
10	A	7/4/2002	16:25	0.37	4.01	1.82	0	0	0	4	Physical	NO	Ambient tan/gry m, tubes, ox clasts, condensation
10	B	7/4/2002	16:26	0.07	5.24	2.87	0	0	0	5	Physical	NO	Ambient tan/gry m, tubes, worm @z, ox clasts
10	C	7/4/2002	16:27	2.73	6.13	3.84	0	0	0	7	Biogenic	NO	Ambient tan/gry m, dense surf tubes
11	B	7/4/2002	15:27	0.07	3.65	1.70	0	0	0	8	Physical	NO	Ambient tan/gry sandy m, wht clay chips @z, lg burrow, void, sm tubes, worm @z, m clump or shell-farfield
11	C	7/4/2002	15:27	2.13	4.11	2.77	0	0	0	9	Physical	NO	DM over ambient, distinct sed horizons- oxidized tan/blk sulfidiic m/tan m, relic RPD, red sed band, tubes, voids
11	E	7/5/2002	14:37	0.07	3.86	0.76	0	0	0	7	Physical	NO	DM lyr over ambient, tan/sulfidic blk/tan m, red sed band, sm tubes, voids, relic RPD=bottom of surface dm lyr!
12	B	7/4/2002	15:21	0.07	4.54	2.10	0	0	0	4	Physical	NO	Ambient tan/gry m,slight surface pull away, tubes, red clast, burrow, surf reworking
12	D	7/5/2002	14:42	0.07	5.82	3.26	0	0	0	6	Physical	NO	Ambient tan/gry m, tubes, ox clasts,worm @z
12	E	7/5/2002	14:43	0.37	5.95	2.72	0	0	0	9	Physical	NO	Ambient tan/gry m, tubes, red clasts, void @bottom, worms @z, stick amp (Podicerid)?, surf reworking
13	A	7/3/2002	21:04	0.07	2.43	1.04	0	0	0	7	Physical	NO	DM/ambient, sed horizons-tan/sulfidic blk&tan m, red sed band, tubes, ox & red clasts, sm voids
13	D	7/4/2002	15:16	0.00	0.00	0.00	0	0	0	99	Physical	NO	DM>P, thin tan lyr/blk sulfidic m,dist surf, red clasts, expelled sed?, thin & patchy RPD,dewatering channels?,wht sulfur bacteria mats?
13	F	7/4/2002	15:17	0.07	3.97	1.48	0	0	0	3	Physical	NO	DM lyr over ambient, dm=tan/blk sulfidic m, relic RPD, wiper clasts, surf tubes, voids/burrows??
14	A	7/4/2002	15:10	0.07	4.01	2.03	0	0	0	4	Physical	NO	Ambient tan/gry m, tubes, ox clasts
14	B	7/4/2002	15:11	0.07	4.55	1.96	0	0	0	8	Physical	NO	Ambient tan/gry m, tubes, red clast, void lwr left, biogenic mound, wiper clast
14	C	7/4/2002	15:12	0.22	4.78	1.86	0	0	0	4	Physical	NO	Ambient tan/gry m, tubes, red clasts, void @ bottom?, red sed @ surf
15	C	7/4/2002	15:06	0.07	5.08	2.15	0	0	0	8	Biogenic	NO	Ambient tan/gry silt, tubes, ox & red clasts, void, lg vertical burrow-opening
15	D	7/5/2002	14:47	0.07	2.08	0.48	0	0	0	6	Physical	NO	Reddish-tan/gry & blk m, shallow RPD, surface disturbance=camera frame artifact??,ox & red clasts, lg burrow, worm @z
15	E	7/5/2002	14:48	0.07	6.19	2.29	0	0	0	9	Physical	NO	Ambient reddish-tan/gry m, surf tubes, red clasts, void, wiper clasts, shell bits
16	A	7/4/2002	14:21	0.07	4.61	2.44	0	0	0	9	Physical	NO	Ambient tan/gry sandy m, tubes, voids, sm worms @z
16	B	7/4/2002	14:21	0.88	7.08	3.66	0	0	0	6	Physical	NO	Ambient tan/gry sandy m, tubes, sm burrows, wiper clast, fecal/flock layer?
16	C	7/4/2002	14:22	0.07	6.76	3.24	0	0	0	6	Physical	NO	Ambient tan/gry m, tubes, ox & red clasts
17	A	7/4/2002	14:26	1.92	6.72	4.70	0	0	0	7	Biogenic	NO	DM>P, reddish-tan/gry sandy m, tubes, lg tube, ox & red clasts, surf reworking, red sed @ surf, worm @z, sm burrows
17	B	7/4/2002	14:27	0.07	3.75	1.50	0	0	0	3	Physical	NO	DM>P, tan/tan&blk streaky m, tubes, red sed band, ox & red clasts, shell bits
17	C	7/4/2002	14:28	0.07	3.15	1.05	0	0	0	7	Physical	NO	Surface DM lyr over ambient, sed horizons-tan/sulfidic blk/tan m, red sed band, relic RPD, tubes, sm void, sm burrow, worm @z
18	A	7/4/2002	14:32	0.07	1.32	0.27	0	0	0	2	Biogenic	NO	DM>P, sed horizons-tan/blk/tan&gry m, red sed band @ surf, red clasts, clast layer, tubes, worms @z, sm , relic RPD??
18	B	7/4/2002	14:33	0.07	3.28	1.07	0	0	0	3	Physical	NO	DM>P, Sed horizons-tan/blk/tan&gry m, red sed band, ox & red clasts, tubes, relic RPD, worm @z
18	E	7/5/2002	14:31	0.07	5.77	2.86	0	0	0	5	Physical	NO	Ambient tan/gry sandy m, ox & red clasts, sm tubes,
19	A	7/4/2002	14:38	-99.00	-99.00	-99.00	0	0	0	99	Indeterminate	NO	Ambient tan/gry sandy m, pull away
19	B	7/4/2002	14:39	0.73	5.06	2.25	0	0	0	4	Physical	NO	Ambient tan/gry & blk streaky m, tubes, lg ox clasts
19	C	7/4/2002	14:39	0.22	4.34	1.53	0	0	0	4	Physical	NO	Ambient tan/gry sandy m, lg ox & red m clumps, lg worm @z, sm tubes
20	A	7/4/2002	14:57	0.07	5.76	3.68	0	0	0	6	Physical	NO	Ambient tan/gry m, tubes, ox & red clasts, condensation, sm burrow opening
20	B	7/4/2002	14:58	0.15	2.22	1.14	0	0	0	3	Physical	NO	Ambient tan/gry m, tubes, red clasts, condensation, surf reworking
20	C	7/4/2002	14:59	0.07	4.37	2.09	0	0	0	8	Physical	NO	Ambient tan/gry m, tubes, void @ bottom, condensation, sm burrow openings
21	A	7/4/2002	14:15	3.51	6.44	4.55	0	0	0	7	Physical	NO	Ambient reddish-tan/gry sandy m, tubes, ox & red clasts, worms @z
21	B	7/4/2002	14:15	0.29	5.04	2.81	0	0	0	5	Physical	NO	Ambient tan/gry sandy m, tubes, ox & red clasts, burrow, biogenic rwrking of surface
21	C	7/4/2002	14:16	0.37	5.99	2.88	0	0	0	5	Biogenic	NO	Ambient tan/gry m, dense surf tubes, ox & red clasts, burrow openings?, biogenic surface reworking
22	A	7/4/2002	14:09	3.07	8.05	5.54	0	0	0	8	Biogenic	NO	Ambient tan/gry m, sm tubes, burrow or void?, biogenic surf mound, surf reworking
22	B	7/4/2002	14:09	0.29	2.41	1.32	0	0	0	7	Physical	NO	Surf relic dm lyr/ambient, Tan/gry &blk sandy m,red sed band=bttom of relic dm lyr, tubes,voids,burrow, org@surf,relic RPD
22	E	7/5/2002	14:26	0.07	3.12	1.08	0	0	0	7	Biogenic	NO	DM/ambient, tan/sulfidic blk&gry sandy m,sed horizons,tubes,voids,burrows-opning,expelled sed@surf, fecal layer,red sed band,relic RPD
23	A	7/4/2002	14:03	2.71	7.92	5.03	0	0	0	11	Physical	NO	Ambient tan/gry sandy m, sm tubes, void, worms @z
23	B	7/4/2002	14:03	0.22	6.29	2.50	0	0	0	5	Physical	NO	Ambient tan/gry m, sm tubes, ox & red m clasts, burrow-opening?, surf reworking
23	C	7/4/2002	14:04	0.07	3.59	1.53	0	0	0	4	Physical	NO	Ambient tan/gry m, tubes, sm voids?, ox & red clasts, worms @z
24	B	7/3/2002	20:58	1.71	6.11	3.78	0	0	0	7	Physical	NO	Ambient reddish-tan/gry&blk sandy m, tubes, ox & red clasts, red sed @z, worms @z
24	C	7/3/2002	20:59	0.07	4.84	2.16	0	0	0	8	Physical	NO	Ambient reddish-tan/gry&blk sandy m, tubes, voids, ox & red m clasts, lg worm @z, burrow
24	D	7/4/2002	13:58	2.49	6.29	4.06	0	0	0	7	Biogenic	NO	Ambient tan/gry m, tubes, vertical oxidized burrow-opening, worms @z
25	A	7/4/2002	13:52	3.64	7.94	5.59	0	0	0	11	Physical	NO	Ambient tan/gry sandy m, dense surf tubes, burrow-opening,indistinct voids, surf reworking
25	B	7/4/2002	13:53	0.80	6.51	3.73	0	0	0	10	Biogenic	NO	Ambient tan/gry m, tubes, voids, biogenic surface mound
25	C	7/4/2002	13:53	4.38	7.89	5.38	0	0	0	7	Physical	NO	Ambient tan/gry m, tubes, red m clasts, worms @z
OUTER													
E375	A	7/3/2002	21:25	0.67	7.98	5.59	0	0	0	11	Biogenic	NO	Ambient tan/gry m, dense surf tubes, ox clasts, voids, wht clay chips @z, worms @z
E375	B	7/3/2002	21:26	0.29	4.86	1.78	0	0	0	4	Physical	NO	Ambient tan&gry sandy m,irreg&sloping topo,patchy RPD,ox&red clasts,sm worms@z,burrow opening, red sed@surf &@ z,wht clay chips@z
E375	C	7/3/2002	21:27	0.88	7.27	4.24	0	0	0	11	Physical	NO	Ambient tan/gry m, tubes, ox clasts, voids, red sed @z, worms @z, surf reworking
N375	A	7/3/2002	21:53	0.74	4.12	2.10	0	0	0	8	Physical	NO	Ambient tan/gry fine sand & silt with many small shell bits, tubes, red clasts, voids@z, burrow opening
N375	B	7/3/2002	21:54	0.37	5.28	2.38	0	0	0	9	Physical	NO	Ambient tan/gry fine sand&silt,shell hash,dense tubes, voids/ fracture@z,shell frag&org detritus @surf, encrusted shell/rock-far?,sm wht clay chips@z
N375	C	7/3/2002	21:55	0.88	4.61	2.76	0	0	0	5	Physical	NO	Ambient tan/gry fine sand&silt, lg m clumps@surf, void@ bottom?, wht clay chips/shell bits@z, tubes, burrow-opening, worm@z
NE500	C	7/3/2002	21:47	-99.00	-99.00	-99.00	0	0	0	99	Indeterminate	NO	Hard bottom, underpen, hydroid??
NE500	E	7/4/2002	16:57	-99.00	-99.00	-99.00	0	0	0	99	Indeterminate	NO	Hard bottom, underpen, hydroid
NE500	F	7/4/2002	16:58	-99.00	-99.00	-99.00	0	0	0	99	Indeterminate	NO	Hard bottom, underpen, rocks, pebbles, shells
NW500	A	7/4/2002	15:57	2.66	5.68	3.79	0	0	0	11	Physical	NO	Ambient tan/gry m, lg m clumps, void, worm @z, shell frags @ surf, sm tubes
NW500	B	7/4/2002	15:58	0.74	5.08	2.67	0	0	0	5	Physical	NO	Ambient tan/gry m, tubes, ox & red m clasts, burrow-opening
NW500	C	7/4/2002	15:58	0.07	3.85	1.92	0	0	0	4	Physical	NO	Ambient reddish-tan/gry m, tubes, sm wht clay chips @z
S375	A	7/4/2002	13:34	5.54	9.19	6.73	0	0	0	7	Physical	NO	Ambient tan m, stg 1 surf tubes, stick amp (Podicerid)?
S375	B	7/4/2002	13:34	0.44	5.57	3.01	0	0	0	6	Physical	NO	Ambient tan/gry sandy m, tubes, ox & red clasts, biogenic rewrked suf lyr, burrowing worm?
S375	C	7/4/2002	13:35	2.49	7.48	4.42	0	0	0	11	Physical	NO	Ambient tan/gry sandy m, tubes, voids, ox & red clasts, burrow -opening, surf reworking
SE500	A	7/4/2002	13:44	3.59	5.27	3.95	0	0	0	7	Physical	NO	Ambient reddish-tan/gry sandy m, tubes
SE500	B	7/4/2002	13:44	0.29	7.00	4.13	0	0	0	7	Physical	NO	Ambient tan & gry sandy m, tubes, ox & red clasts, worms @z, red sed patch @z, m clumps-far
SE500	C	7/4/2002	13:45	0.37	4.46	2.19	0	0	0	8	Physical	NO	Ambient tan/gry & blk sandy m, red clasts, sm tubes, voids, worms @z, red sed @ surf & @ z
SW500	A	7/4/2002	13:26	3.04	8.23	5.21	0	0	0	11	Physical	NO	Ambient tan/gry m, tubes, ox & red clasts, voids, shell bits, worms @z, red sed @z
SW500	B	7/4/2002	13:27	0.73	4.77	2.29	0	0	0	5	Physical	NO	Ambient tan/gry m, tubes, ox & red clasts
SW500	C	7/4/2002	13:28	1.17	5.21	3.25	0	0	0	10	Biogenic	NO	Ambient tan/gry sandy m, dense surf tubes, worm @ surf, ox clasts, void, wht clay chips or shell bits @z, burrow, surf reworking
W375	A	7/4/2002	15:33	1.03	4.40	2.71	0	0	0	5	Physical	NO	Ambient tan/gry m, surf tubes, wht clay chips @z
W375	B	7/4/2002	15:33	0.59	3.82	2.17	0	0	0	8	Physical	NO	Ambient tan/gry sandy m, tubes, void
W375	C	7/4/2002	15:34	0.44	5.01	3.20	0	0	0	6	Biogenic	NO	Ambient reddish-tan/gry sandy m, tubes, lg vertical burrow-opening, wht clay chips @z

Appendix B2

Mark Island Disposal Site (MIDS) Reference Area REMOTS® Sediment-Profile Imaging Data from the July 2002 Survey

Station	Replicate	Date	Time	Successional Stage	Grain Size (phi) Min	Grain Size (phi) Max	Grain Size (phi) Maj Mode	Mud Clasts Count	Mud Clasts Avg. Diam	Camera Penetration (cm) Min	Camera Penetration (cm) Max	Camera Penetration (cm) Range	Camera Penetration (cm) Mean	Redox Rebound Thickness (cm) Min	Redox Rebound Thickness (cm) Max	Redox Rebound Thickness (cm) Mean
NEREF																
NEREF CTR	A	7/4/2002	17:17	ST I	> 4 phi	4 to 3 phi	> 4 phi	8	1.11	5.64	7.23	1.59	6.43	0	0	0
NEREF CTR	B	7/4/2002	17:18	ST I on III	> 4 phi	2-1 phi	> 4 phi	12	0.32	7.09	8.71	1.62	7.9	0	0	0
NEREF CTR	C	7/4/2002	17:19	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	8	0.5	7.79	8.66	0.87	8.23	0	0	0
NEREF1	A	7/3/2002	19:38	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	5	1.05	12.88	13.62	0.74	13.25	0	0	0
NEREF1	B	7/3/2002	19:39	ST I	> 4 phi	4 to 3 phi	> 4 phi	3	0.78	13.11	14.23	1.12	13.67	0	0	0
NEREF1	C	7/3/2002	19:39	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	0	0	9.86	10.62	0.76	10.24	0	0	0
NEREF2	A	7/3/2002	19:32	ST I	> 4 phi	4 to 3 phi	> 4 phi	0	0	14.77	15.62	0.85	15.19	0	0	0
NEREF2	B	7/3/2002	19:33	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	0	0	13.88	14.82	0.94	14.35	0	0	0
NEREF2	C	7/3/2002	19:33	ST I	> 4 phi	4 to 3 phi	> 4 phi	0	0	12.59	15.02	2.43	13.81	0	0	0
NEREF3	B	7/3/2002	19:19	ST I	> 4 phi	3 to 2 phi	4 to 3 phi	0	0	7.16	7.96	0.8	7.56	0	0	0
NEREF3	C	7/3/2002	19:20	ST I on III	> 4 phi	4 to 3 phi	4 to 3 phi	1	0.12	7.23	7.68	0.45	7.45	0	0	0
NEREF3	D	7/4/2002	17:06	ST I on III	> 4 phi	4 to 3 phi	4 to 3 phi	0	0	3.88	4.88	1	4.38	0	0	0
NEREF4	A	7/3/2002	19:23	ST I on III	> 4 phi	3 to 2 phi	4 to 3 phi	15	0.24	7.5	8.82	1.32	8.16	0	0	0
NEREF4	B	7/3/2002	19:24	ST I	> 4 phi	3 to 2 phi	4 to 3 phi	0	0	5.91	7.32	1.41	6.61	0	0	0
NEREF4	C	7/3/2002	19:25	ST I	> 4 phi	3 to 2 phi	4 to 3 phi	0	0	6.61	7.48	0.87	7.05	0	0	0
SREF																
SREF1	B	7/4/2002	18:12	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	4	0.43	14.89	17.18	2.29	16.03	0	0	0
SREF1	C	7/4/2002	18:13	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	2	0.36	14.75	17.57	2.82	16.16	0	0	0
SREF1	D	7/4/2002	18:17	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	0	0	11.48	12.89	1.41	12.18	0	0	0
SREF2	A	7/4/2002	18:23	ST I	> 4 phi	4 to 3 phi	> 4 phi	0	0	13.43	14.32	0.89	13.88	0	0	0
SREF2	B	7/4/2002	18:24	ST I	> 4 phi	4 to 3 phi	> 4 phi	0	0	9.75	12.25	2.5	11	0	0	0
SREF2	C	7/4/2002	18:25	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	0	0	12.39	15.55	3.16	13.97	0	0	0
SREF3	A	7/4/2002	18:29	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	12	0.28	13.25	14.34	1.09	13.8	0	0	0
SREF3	B	7/4/2002	18:30	ST I	> 4 phi	4 to 3 phi	> 4 phi	5	0.41	13.3	15.25	1.95	14.27	0	0	0
SREF3	C	7/4/2002	18:31	ST I	> 4 phi	4 to 3 phi	> 4 phi	2	0.27	12.52	14.04	1.52	13.28	0	0	0
SREF4	B	7/4/2002	17:46	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	0	0	11.95	12.84	0.89	12.4	0	0	0
SREF4	C	7/4/2002	17:47	ST I	> 4 phi	4 to 3 phi	> 4 phi	10	0.52	12.52	13.57	1.05	13.05	0	0	0
SREF4	E	7/5/2002	14:16	ST I	> 4 phi	4 to 3 phi	> 4 phi	6	0.29	15.96	17.09	1.13	16.52	0	0	0
SREFCTR	B	7/4/2002	17:37	ST I on III	> 4 phi	4 to 3 phi	> 4 phi	12	1.03	13.96	14.68	0.72	14.32	0	0	0
SREFCTR	C	7/4/2002	17:40	ST I	> 4 phi	4 to 3 phi	> 4 phi	0	0	12.04	14.16	2.12	13.1	0	0	0
SREFCTR	D	7/4/2002	17:41	ST I	> 4 phi	4 to 3 phi	> 4 phi	12	0.35	12.07	14.11	2.04	13.09	0	0	0

Appendix B2 (continued)

Mark Island Disposal Site (MIDS) Reference Area REMOTS® Sediment-Profile Imaging Data from the July 2002 Survey

Station	Replicate	Date	Time	Apparent RPD Thickness (cm) Min	Max	Mean	Methane Count	Mean Depth	Diam	OSI	Surface Roughness	Low DO	Comments
NEREF													
NEREF CTR	A	7/4/2002	17:17	0.38	4.03	2.02	0	0	0	4	Physical	NO	Ambient reddish-tan/gry sandy m, tubes, ox & red clasts, lg m clumps-far, wht shell frags @ surf
NEREF CTR	B	7/4/2002	17:18	0.15	5.17	1.77	0	0	0	8	Physical	NO	Ambient reddish-tan/gry sandy m, tubes, ox & red clasts, m clumps-far, voids, burrow-opening, shell bits/clay chips
NEREF CTR	C	7/4/2002	17:19	0.22	4.86	1.91	0	0	0	8	Physical	NO	Ambient reddish-tan/gry sandy m, tubes, ox & red clasts, voids, org or shell @ surf
NEREF1	A	7/3/2002	19:38	0.60	5.82	3.23	0	0	0	10	Physical	NO	Ambient tan/gry sandy m, tubes, ox & red clasts, shells @ surf, indistinct voids, worms @z, wht clay chip @z
NEREF1	B	7/3/2002	19:39	0.81	6.29	2.98	0	0	0	5	Physical	NO	Ambient tan/gry sandy m, tubes, red clasts
NEREF1	C	7/3/2002	19:39	0.07	4.74	1.86	0	0	0	8	Physical	NO	Ambient tan/gry sandy m, tubes, wiper smear, wht clay chips @z, small indistinct voids, worm @z
NEREF2	A	7/3/2002	19:32	0.22	4.64	2.82	0	0	0	5	Biogenic	NO	Ambient tan/gry sandy mud w/ wht clay, tubes, biogenic reworked surface, worm @z
NEREF2	B	7/3/2002	19:33	1.85	6.73	3.26	0	0	0	10	Physical	NO	Ambient tan/gry sandy m w/ wht clay, tubes, void, worm @z, oxidized burrow, surf reworking
NEREF2	C	7/3/2002	19:33	1.43	6.46	3.40	0	0	0	6	Biogenic	NO	Ambient tan/gry sandy m, wht clay @z, irreg topo, burrow opening, m clumps-far, lg worms @z, sm tubes, red sed @z
NEREF3	B	7/3/2002	19:19	0.29	5.26	2.84	0	0	0	5	Physical	NO	Ambient tan/gry fine sand & silt, shell bits, wht clay chips @z, tubes
NEREF3	C	7/3/2002	19:20	0.30	3.40	1.60	0	0	0	8	Physical	NO	Ambient tan/gry fine sand & silt, wht clay chips @z, shell bits, tubes, red clast, void or burrow@z?
NEREF3	D	7/4/2002	17:06	0.51	3.08	2.04	0	0	0	8	Physical	NO	Ambient tan/gry fine sand & silt, underpen, shell bits, shells @ surf, void
NEREF4	A	7/3/2002	19:23	2.19	4.68	3.16	0	0	0	10	Physical	NO	Ambient tan/gry fine sand & silt, wht clay, shell bits, ox & red clasts, tubes, voids
NEREF4	B	7/3/2002	19:24	0.88	5.04	3.07	0	0	0	6	Physical	NO	Ambient tan/gry fine sand w/ wht clay, shell hash, tubes, burrow opening?, m clumps-far
NEREF4	C	7/3/2002	19:25	1.40	4.34	2.72	0	0	0	5	Biogenic	NO	Ambient tan/gry fine sand w/ wht clay, shell hash, shell frags @ surf, tubes, burrow-opening
SREF													
SREF1	B	7/4/2002	18:12	0.07	6.60	3.21	0	0	0	10	Physical	NO	Ambient tan/gry m, tubes, ox & red clasts, voids left
SREF1	C	7/4/2002	18:13	0.30	6.35	3.81	0	0	0	11	Physical	NO	Ambient tan/gry m, tubes, red clasts, void right
SREF1	D	7/4/2002	18:17	1.11	4.15	2.88	0	0	0	9	Physical	NO	Ambient tan/gry m, dist surf=pull away, tubes, voids
SREF2	A	7/4/2002	18:23	0.82	6.67	4.80	0	0	0	7	Physical	NO	Ambient tan/gry m, surf tubes
SREF2	B	7/4/2002	18:24	0.37	4.79	2.03	0	0	0	4	Physical	NO	Ambient tan/gry m, sm tubes, worm @z
SREF2	C	7/4/2002	18:25	0.07	6.21	3.26	0	0	0	10	Physical	NO	Ambient tan/gry m, sloping topo, sm tubes, void, worm @z
SREF3	A	7/4/2002	18:29	0.07	3.92	2.70	0	0	0	9	Biogenic	NO	Ambient tan/gry m, dense surf tubes, ox & red clasts, voids
SREF3	B	7/4/2002	18:30	0.74	4.89	2.23	0	0	0	4	Physical	NO	Ambient tan/gry m, tubes, ox & red clasts, sm worm @z, m clumps-far
SREF3	C	7/4/2002	18:31	1.00	5.17	3.02	0	0	0	6	Physical	NO	Ambient tan/gry m, tubes, ox & red clasts, wiper clasts, sm burrow
SREF4	B	7/4/2002	17:46	0.81	5.84	3.33	0	0	0	10	Physical	NO	Ambient tan/gry m, tubes, voids, sm worm @z?
SREF4	C	7/4/2002	17:47	1.04	5.18	2.89	0	0	0	5	Physical	NO	Ambient tan/gry m, tubes, ox & red clasts, surf reworking, m clump-far?
SREF4	E	7/5/2002	14:16	0.38	5.62	2.81	0	0	0	5	Physical	NO	Ambient tan/gry m, tubes, ox & red clasts, burrow- opening, shell frags
SREFCTR	B	7/4/2002	17:37	2.07	5.91	3.89	0	0	0	11	Physical	NO	Ambient tan/gry m, tubes, ox & red clasts, void, lg burrowing worms @z, shell frag, m clumps-far
SREFCTR	C	7/4/2002	17:40	0.96	6.05	3.62	0	0	0	6	Physical	NO	Ambient tan/gry sandy m, tubes, worm @z
SREFCTR	D	7/4/2002	17:41	0.52	4.43	2.23	0	0	0	4	Physical	NO	Ambient tan/gry sandy m, tubes, ox & red clasts, sm worm @z, surf reworking, burrow opening?

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Appendix A, Disposal Logs

2001 **MIDS**

Project: MOOSABEC REACH

Permit Number: 199900444 **Permittee:** US COAST GAURD

Buoy	Departure	Disposal	Return	Latitude	Longitude	Buoy's Vector	Volume (CY)
NA	12/17/2001	12/17/2001	12/17/2001	44.5275	-67.51967	50 FT W	312
NA	12/17/2001	12/17/2001	12/17/2001	44.52842	-67.51842	70 FT W	312
NA	12/20/2001	12/20/2001	12/20/2001	44.52833	-67.5185	50 W	312
NA	12/20/2001	12/20/2001	12/20/2001	44.52833	-67.5185	75 W	312
NA	12/26/2001	12/26/2001	12/26/2001	44.52783	-67.5185	75 FT W	312
NA	12/28/2001	12/28/2001	12/28/2001	44.52842	-67.51917	50 FT	312
NA	12/28/2001	12/28/2001	12/28/2001	44.52807	-67.51788	10 FT	312
				Project Total Volume:		**1,670 CM**	**2,184 CY**
				Yearly Total Volume:		**1,670 CM**	**2,184 CY**

2002 **MIDS**

Project: MOOSABEC REACH

Permit Number: 199900444 **Permittee:** US COAST GAURD

Buoy	Departure	Disposal	Return	Latitude	Longitude	Buoy's Vector	Volume (CY)
NA	1/2/2002	1/2/2002	1/2/2002	44.52833	-67.51933	40 FT	312
NA	1/2/2002	1/2/2002	1/2/2002	44.52797	-67.5178	50 FT	312
NA	1/3/2002	1/3/2002	1/3/2002	44.52842	-67.5181	0	312
NA	1/3/2002	1/3/2002	1/3/2002	44.52847	-67.5181	0	312
NA	1/4/2002	1/4/2002	1/4/2002	44.5284	-67.51805	0	312
NA	1/8/2002	1/8/2002	1/8/2002	44.528	-67.51675	0	312
NA	1/8/2002	1/8/2002	1/8/2002	44.52837	-67.5175	0	312
NA	1/9/2002	1/9/2002	1/9/2002	44.52812	-67.5175	0	312
NA	1/9/2002	1/9/2002	1/9/2002	44.5283	-67.51787	0	312
NA	1/10/2002	1/10/2002	1/10/2002	44.52827	-67.51783	0	312
NA	1/10/2002	1/10/2002	1/10/2002	44.5283	-67.5178	0	312
				Project Total Volume:		**2,624 CM**	**3,432 CY**
				Yearly Total Volume:		**2,624 CM**	**3,432 CY**