Monitoring Cruise at the
Western Long Island Sound
Disposal Site
July 1996

Disposal Area Monitoring System DAMOS

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13. ABSTRACT

A monitoring survey was conducted at the Western Long Island Sound Disposal Site (WLIS) from 16 to 18 July 1996 as part of the Disposal Area Monitoring System (DAMOS) Program. The field efforts were concentrated over the active southwestern quadrant of WLIS and consisted of precision bathymetry and Remote Ecological Monitoring of the Seafloor (REMOTS®). These surveying techniques were used to monitor the development, stability, and benthic recolonization of the disposal mounds formed on the WLIS seafloor from 1992 through 1996.

Currently, a total of eight discrete disposal mounds exist on the WLIS seafloor within an east-west trending trough that extends through the center of the site. The latest survey activity was concentrated over the three most recent dredged material deposits, the WLIS H, WLIS G, and WLIS F mounds, as well as the southern flank of the older WLIS D mound.

The WLIS H mound is the most recent bottom feature formed within WLIS. The WDA buoy received approximately 15,300 m^3 of sands, silts, and clays from 15 April to 29 May 1996. The deposition of this material resulted in the formation of a 1.5 m high disposal mound, approximately 230 m in width. REMOTS® sediment-profile photography detected a solid Stage I pioneering polychaete community with some evidence of Stage III activity, as well as deep Redox Potential Discontinuity (RPD) depths over the majority of the H mound.

An estimated barge volume of 52,500 m^3 of sediment, originating from coastal New York and Connecticut, was disposed during the 1994-95 disposal season. The resulting dredged material deposit, the WLIS G mound, was found to be 2.5 m high and connected to adjacent disposal mounds (D and F) by a wide apron of dredged material. The infaunal population consists mainly of Stage I individuals with some evidence of Stage III activity.

The WLIS F mound is the product of modest dredged material deposition at WLIS over a three-year period. The DAMOS disposal buoy WDA was positioned in nearly the same location during the 1991-92, 1992-93, and 1993-94 disposal seasons. The final product of three years of dredged material deposition was a sediment mound with a height of 3.0 m at the apex and an overall width of approximately 250 m. Limited REMOTS® sediment-profile data collected over WLIS F found a healthy benthic environment with deep RPD depths and Stage I and Stage III organisms.

The WLIS D mound was developed during the 1989-90 disposal season by the deposition of approximately 185,000 m^3 of material. Annual monitoring efforts with REMOTS® sediment-profile photography in 1991, 1992, and 1993 detected anomalous conditions over the southern flank of the WLIS D mound. Two stations, D200S and D300S, were occupied during the July 1996 survey at WLIS to verify improvement in benthic conditions.

Station D300S displayed dramatic improvement with a median Organism-Sediment Index (OSI) value of 8.0, attributable to deep RPDs and presence of Stage III individuals. Two of the three replicate photographs collected at D200S determined that a localized problem still exists within the surface sediments. However, this problem could be resolved by developing a new disposal mound southwest of the WLIS G mound center. The new material would cover the southern flank of the D mound and isolate this apparently small patch of problematic surface sediments.

Although determined to be feasible, subaqueous capping operations have not occurred at WLIS. However, efficient and controlled disposal of large volumes of dredged material could easily be facilitated within the disposal site. The strongly sloping terminal moraine margin present in the southern region of the disposal site could be utilized as a natural ridge for the development of lateral containment cells.

Historic dredged material disposal activity has led to a broad distribution of dredged material over the western Long Island Sound seafloor. As a result, the detection of dredged material within WLIS reference areas is possible, even though special care is taken at their initial selection. The results of the July 1996 REMOTS® survey over the current WLIS reference areas suggest that the use of 2000W for comparison with WLIS disposal mounds should be discontinued. The presence of dark, reduced sediments and methane gas bubbles indicate the surface sediments are not representative of the ambient sediment, free from the effects of anthropogenic activity.

Upon review of the benthic community assessment data collected at WLIS since 1984, a trend of shallow RPD depths, indications of low DO, and poor benthic habitat can be associated with mid-summer monitoring efforts. The results obtained during the July 1996 and other recent surveys (June 1991, July 1992) suggest the completion of benthic community assessment operations in early summer, before the development of hypoxia and the deterioration of conditions, yields a more realistic perspective into the year round condition of the benthic environment.

14. SUBJECT TERMS precision bathymetry, Remote Ecological Monitoring (REMOTS), organism sediment index (OSI), disposal mounds

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Science Applications International Corporation (SAIC) conducted a monitoring survey at the Western Long Island Sound Disposal Site (WLIS) from 16 to 18 July 1996 aboard the M/V *Beavertail* as part of the Disposal Area Monitoring System (DAMOS) Program. The field efforts were concentrated over the active southwestern quadrant of WLIS and consisted of precision bathymetry and Remote Ecological Monitoring of the Seafloor (REMOTS®). These surveying techniques were used to monitor the development, stability, and benthic recolonization of the disposal mounds formed on the WLIS seafloor from 1992 through 1996.

Buoys have been deployed to control disposal operations within the boundaries of WLIS since its selection as a dredged material disposal site in 1982 (WLIS III). Upon receiving the first volumes of sediment dredged from coastal Connecticut and New York in 1982, WLIS has been monitored on a semi-annual basis for the US Army Corps of Engineers, New England District (NED). Currently, a total of eight discrete disposal mounds exist on the WLIS seafloor within an east-west trending seafloor depression that extends through the center of the disposal site. The latest survey activity was concentrated over the three most recent dredged material deposits, the WLIS H, WLIS G, and WLIS F mounds, as well as the southern flank of the older WLIS D mound.

The WLIS H mound is the most recent bottom feature formed within the boundaries of WLIS. In September 1995, the WDA buoy was deployed at 40°59.228' N, 73°28.732' W and received approximately 15,300 m^3 of sands, silts, and clays dredged from harbors and creeks along the Connecticut coast and the North Shore of Long Island, New York, from 15 April to 29 May 1996. The deposition of this material resulted in the formation of a 1.5 m high disposal mound, approximately 230 m in width. REMOTS® sediment-profile photography detected a solid Stage I pioneering polychaete community with some evidence of Stage III activity, as well as deep Redox Potential Discontinuity (RPD) depths over the majority of the H mound.

The WDA buoy was placed at 40°59.158' N, 73°29.020' W, and received an estimated barge volume of 52,500 m^3 of sediment originating from coastal New York and Connecticut, during the 1994-95 disposal season. The resulting dredged material deposit, the WLIS G mound, was found to be 2.5 m high and connected to adjacent disposal mounds (D and F) by a wide apron of dredged material. The infaunal population consists mainly of Stage I individuals with some evidence of Stage III activity. Sediment-profile photography also determined the RPD depths to be relatively deep, suggesting the area has been free from the effects of seasonal hypoxia.

The WLIS F mound is the product of modest dredged material deposition at WLIS over a three-year period. The DAMOS disposal buoy WDA was positioned in nearly the same location during the 1991-92, 1992-93, and 1993-94 disposal seasons. A total of 80,300 m^3 of dredged material was deposited at the buoy from September 1991 through May of 1994. A bathymetric survey conducted in July 1992, after the deposition of 38,700 m^3 of sediment, determined the F mound to be 1.9 m high and approximately 200 m wide.

Over the next two disposal seasons, approximately 41,600 m^3 of material was added to the existing F mound. The July 1996 survey found that two years of disposal activity produced a 2.0 m increase in mound height and shifted the apex of the mound approximately 30 m to the south. The final product of three years of dredged material deposition was a sediment mound with a height of 3.0 m at the apex and an overall width of approximately 250 m. Limited REMOTS® sediment-profile data collected over WLIS F found a healthy benthic environment with deep RPD depths and Stage I and Stage III organisms.

The WLIS D mound was developed during the 1989-90 disposal season by the deposition of approximately 185,000 m^3 of material generated by seven small dredging projects in New York and Connecticut waters. An initial benthic community assessment documented signs of rapid recovery over the new mound. However, annual monitoring efforts with REMOTS® sediment-profile photography in 1991, 1992, and 1993 detected anomalous conditions over the southern flank of the WLIS D mound. Two stations, D200S and D300S, were occupied during the July 1996 survey at WLIS to verify improvement in benthic conditions.

Station D300S displayed dramatic improvement with a median Organism-Sediment Index (OSI) value of 8.0, attributable to deep RPDs and presence of Stage III individuals. Two of the three replicate photographs collected at D200S determined that a localized problem still exists within the surface sediments. However, this problem could be resolved by developing a new disposal mound southwest of the WLIS G mound center. The new material would cover the southern flank of the D mound and isolate this apparently small patch of problematic surface sediments.

Although determined to be feasible, subaqueous capping operations have not occurred at WLIS due to concerns about impact on a thriving lobster fishery. However, efficient and controlled disposal of large volumes of dredged material could easily be facilitated within the disposal site. The strongly sloping terminal moraine margin present in the southern region of the disposal site could be utilized as a natural ridge for the development of lateral containment cells. By strategically constructing sediment mounds in a semi-circular pattern north of the terminal moraine, large volumes of dredged material could be confined, minimizing the development of a wide, thin apron and maximizing the capacity of WLIS.

Historic dredged material disposal activity has led to a broad distribution of dredged material over the western Long Island Sound seafloor. As a result, the detection of dredged material within WLIS reference areas is possible, even though special care is taken at their initial selection. In the past, reference areas EAST, WLIS-REF, and 2000S in the vicinity of WLIS have been abandoned due to the presence of historic dredged material. The results of the July 1996 REMOTS® survey over the current WLIS reference areas suggest that the use of 2000W for comparison with WLIS disposal mounds should be discontinued as well. The presence of dark, reduced sediments and methane gas bubbles indicate the surface sediments are not representative of the ambient sediment, free from the effects of anthropogenic activity.

Seasonal hypoxia in the western Long Island Sound region was identified as an obstacle to benthic recolonization at WLIS as early as 1985. Hypoxia, a condition of low dissolved oxygen (DO; $\leq 3.0\ mg \cdot l^{-1}$) in the water column, generally develops within the bottom waters of western and central Long Island Sound in mid to late August. However, the onset and severity of seasonal hypoxia are directly dependent on many other environmental factors (i.e., nutrient input, frequency of storms, rainfall, fresh water input, water temperature, etc.).

Upon review of the benthic community assessment data collected at WLIS since 1984, a trend of shallow RPD depths, indications of low DO, and poor benthic habitat can be associated with mid-summer monitoring efforts. The results obtained during the July 1996 and other recent surveys (June 1991, July 1992) suggest the completion of benthic community assessment operations in early summer, before the development of hypoxia and the deterioration of conditions, yields a more realistic perspective into the year round condition of the benthic environment.

1.0 INTRODUCTION

Western Long Island Sound can be defined as the estuarine waters that extend from Middle Ground Rocks, westward to the mouth of the East River (Figure 1-1). The urbanized coastlines of Connecticut and New York converge to form a basin approximately 1008 km^2 in area, influenced by tidal flow from the East River as well as the Atlantic Ocean. Numerous tributaries discharge freshwater runoff from the watershed areas along the north shore of Long Island, New York, and the south shore of Connecticut, mixing with the influx of seawater.

The many ports that line the Long Island Sound coast have supported commerce, transportation, and military activity in the Northeast since colonial times. In order to ensure the navigational and operational depths necessary to facilitate private, commercial, and military vessels, sediments washed into harbors by rivers and tides must be mechanically removed from ship channels, anchorage areas, and docking facilities. As a result, a long history of maintenance dredging within the harbors, rivers, and creeks of New York and Connecticut has developed.

For many years these excess sediments have been transported to open water and deposited at a variety of dredged material disposal sites in western Long Island Sound (Figure 1-1). In 1977, the New England Division of the US Army Corps of Engineers (NED) developed the Disposal Area Monitoring System (DAMOS) Program in response to the recognized need for the management of the volumes of sediments dredged from the ports and harbors of western Long Island Sound, as well as the remainder of the northeastern United States.

In 1978, disposal at the historic Eatons Neck Disposal Site (a.k.a. Cable and Anchor Reef Disposal Site) was discontinued in order to reduce the impact on a thriving American lobster fishery (NUSC 1979). The DAMOS Program initiated a series of investigations in an attempt to find an alternative dredged material disposal site in the region. Intensive survey operations were conducted over two proposed disposal sites, WLIS I and WLIS II (Figure 1-1). However, conflicts with an equally successful lobster fishery and submarine cable routing, respectively, caused these sites to be removed from consideration (SAI 1982). From 1978 through 1981, all sediments dredged from the western Long Island Sound region were transported and disposed at the Central Long Island Sound Disposal Site (CLIS), approximately 48 km east-northeast of Cable and Anchor Reef. By transporting the excavated sediments over such a long distance, the cost of dredged material disposal was doubled.

Driven by a great demand for economically efficient harbor maintenance in the region, a new dredged material disposal site was established in the western Long Island

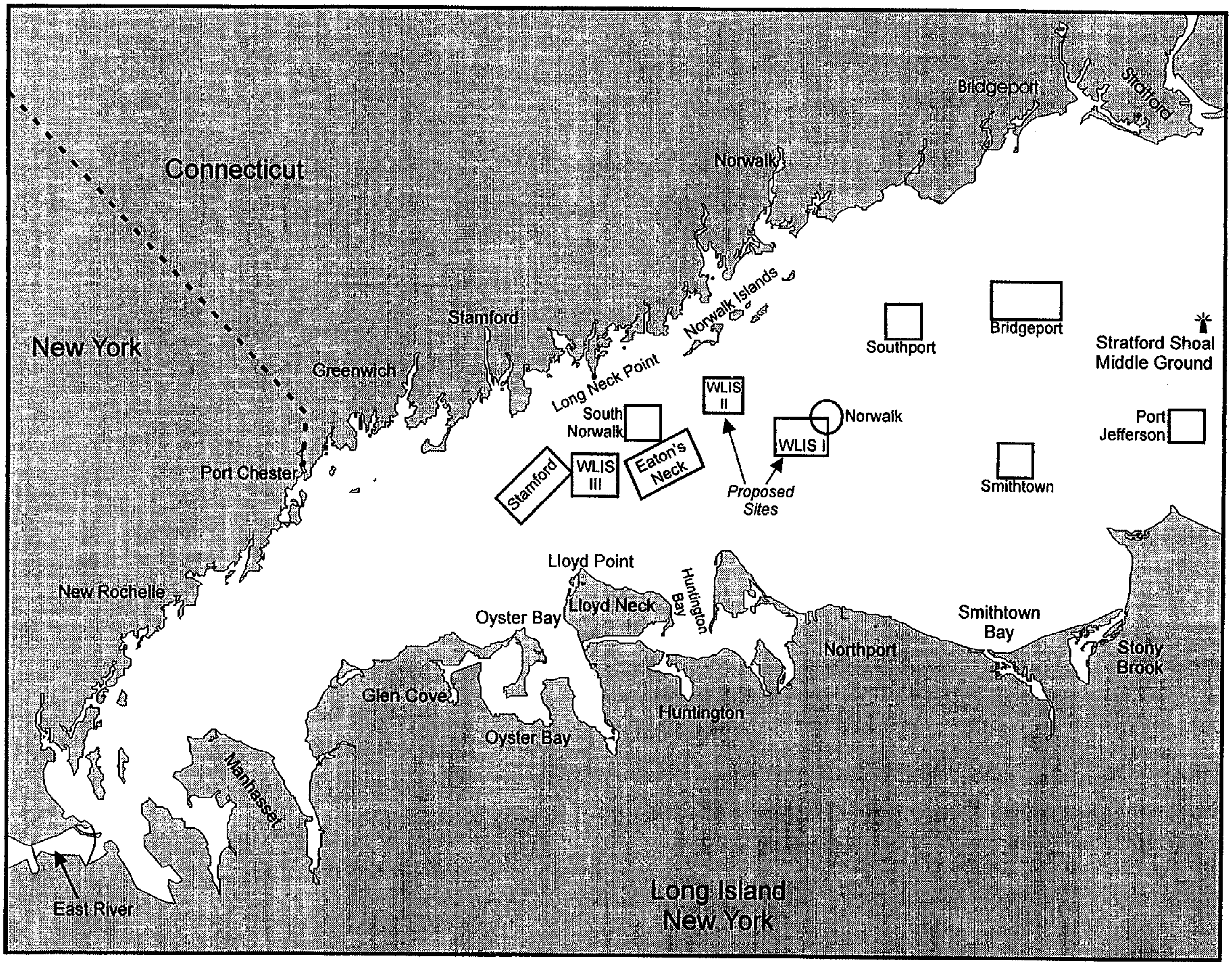


Figure 1-1. Locations of past, present, and proposed disposal sites within the western Long Island Sound region

Sound in January 1982. The Western Long Island Sound Disposal Site (WLIS) was originally deemed WLIS III, a 2384 m × 2221 m rectangular area defined as the area between 41°00.000' N; 40°58.800' N latitudes, and 73°29.500' W; 73°27.800' W longitudes (USACE 1982). These boundaries were established within a final environmental impact statement (FEIS) completed by NED in 1982. WLIS resides in close proximity to the historic Stamford, Eatons Neck, and Norwalk historic dredged material disposal sites (Figure 1-2). Since 1982, the 5.29 km^2 area has accepted small to moderate volumes of dredged material originating from Stamford, Norwalk, and other coastal communities of Connecticut and New York through systematic deposition.

After 1992, DAMOS erroneously utilized a secondary description of WLIS (Eller and Williams 1996; Charles and Tufts 1996). This DAMOS site description was based on a 1 nmi^2 (3.42 km^2) area with a center point of 40°59.400' N latitude and 73°28.700' W longitude, and a location 5.13 km south of Long Neck Point, Noroton, Connecticut (Figure 1-2).

This secondary description also tended to standardize the dimensions of WLIS, promoting a common unit of measure in relation to the other DAMOS disposal sites within Long Island Sound (i.e., CLIS 2 nmi^2, CSDS 1 nmi^2, NLDS 1 nmi^2; Morris 1996). However, the use of this secondary description will be discontinued and all present and future DAMOS documents will refer to WLIS as the larger 5.29 km^2 area as defined by the 1982 FEIS.

As of July 1996 a total of eight discrete dredged material disposal mounds (A through H) occupy the seafloor at WLIS (Figure 1-3). Although no sediment capping operations have been proposed at WLIS for the near future, the mounds are being strategically placed to form a series of rings or containment cells within the disposal site. This management strategy proved to be a highly successful method of containing large volumes of dredged material ($>$1,100,000 m^3) at the Central Long Island Sound Disposal Site (CLIS; Morris et al. 1996). As a result, the process of constructing networks of containment cells has been employed at many of the ten DAMOS disposal sites to facilitate disposal of fine-grained dredged materials with minimal lateral spread of aprons, as well as to maximize the overall capacities of the disposal sites.

The H mound is the most recent disposal mound formed at WLIS. The WDA 95 buoy was deployed in September 1995 at 40°59.228' N, 73°28.732' W approximately 240 m northeast of the historic F mound (Figure 1-4; Appendix A, Table 1-1). The H mound is composed of 15,300 m^3 of sands, silts, and clays dredged from harbors and creeks along the Connecticut coast and the North Shore of Long Island, New York. An estimated barge volume of 10,060 m^3 of dredged material originating from Connecticut's Wilson Cove, Norwalk and Stamford Harbors, and Pratt's Cove was deposited at WLIS in

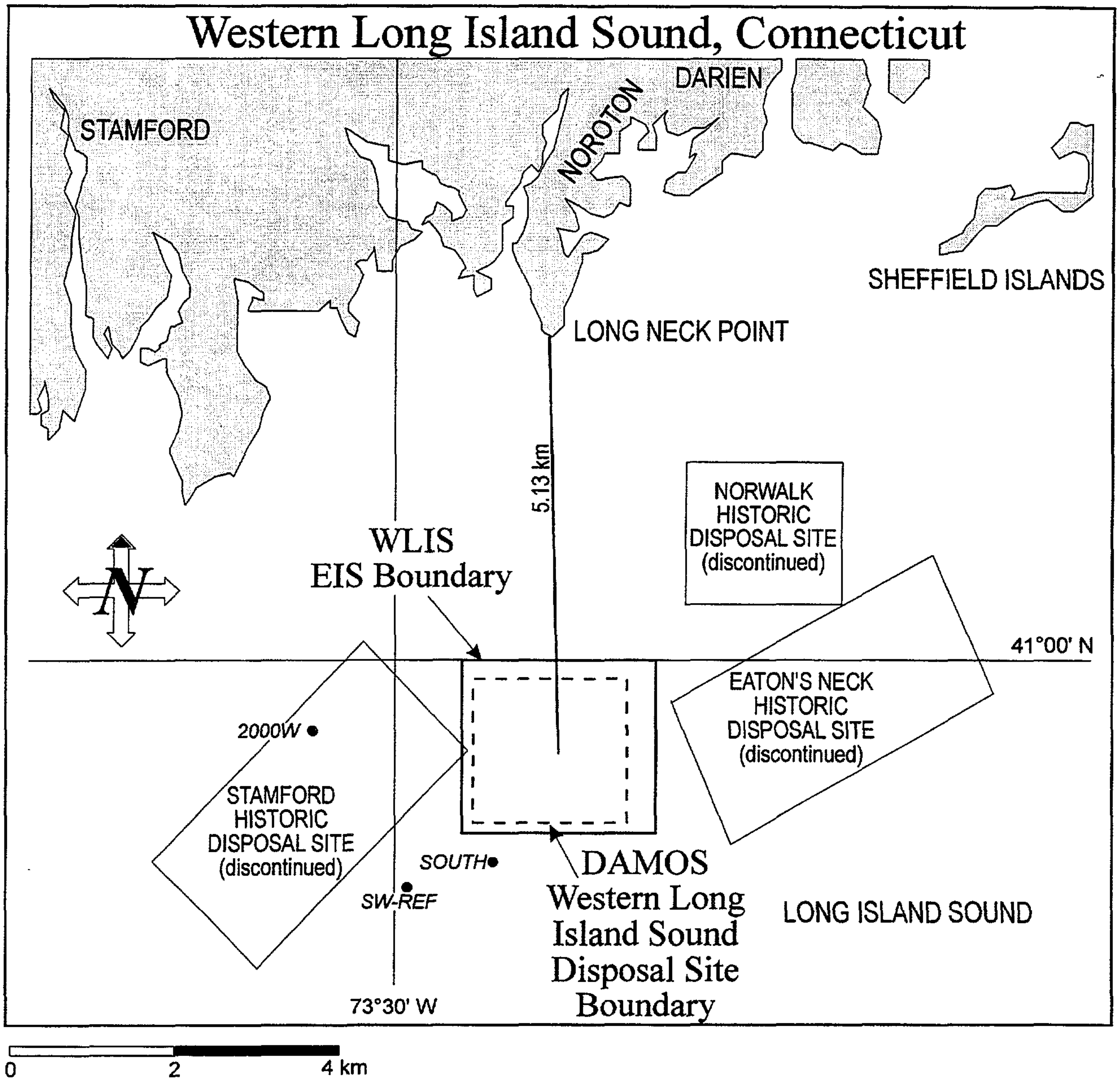


Figure 1-2. Location, boundaries, and current reference areas for the Western Long Island Sound Disposal Site (WLIS)

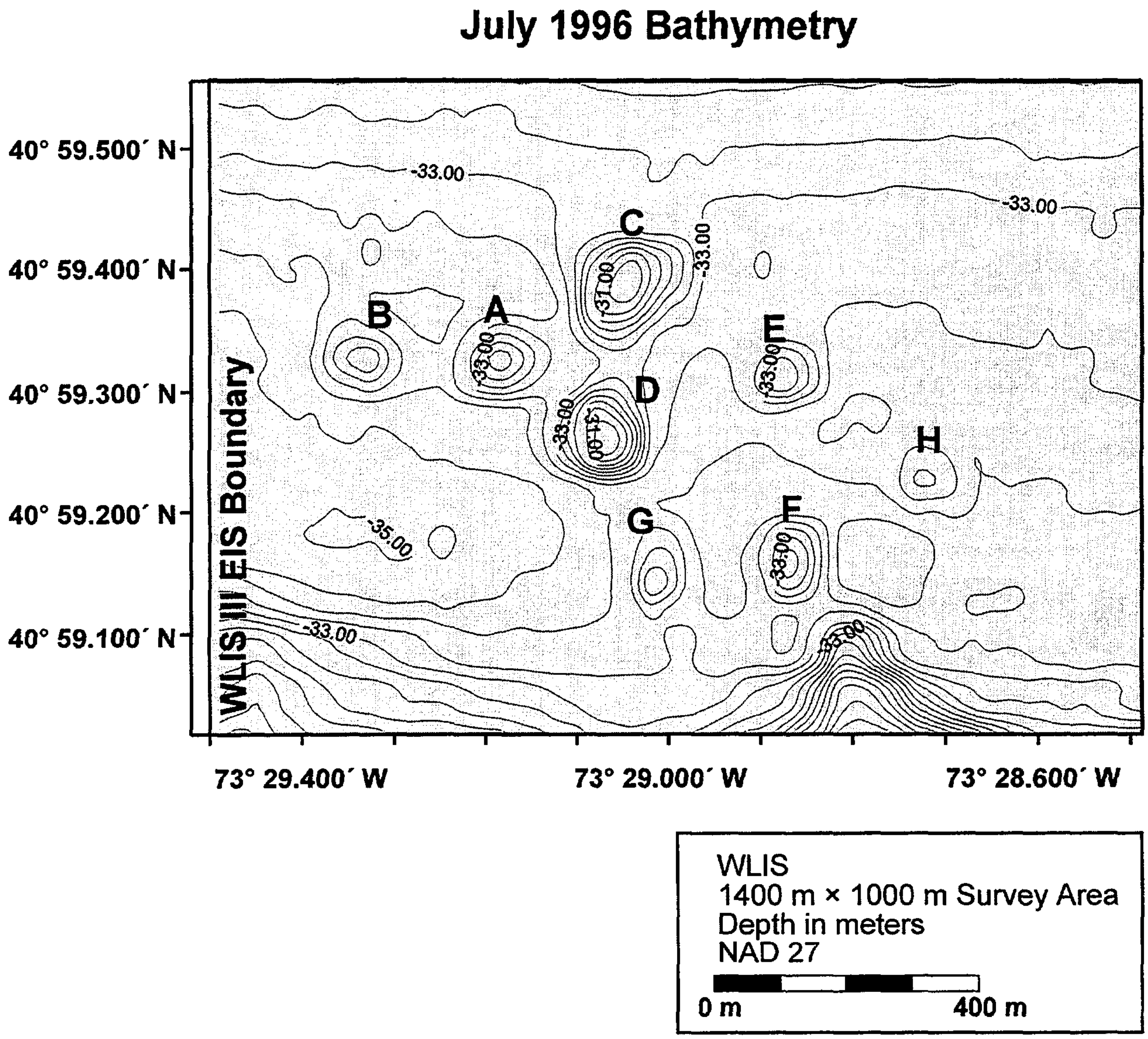


Figure 1-3. Bathymetric chart of the July 1996, 1400 m × 1000 m survey area depicting the eight disposal mounds (A through H) at WLIS relative to the western disposal site boundaries, 0.5 m contour interval

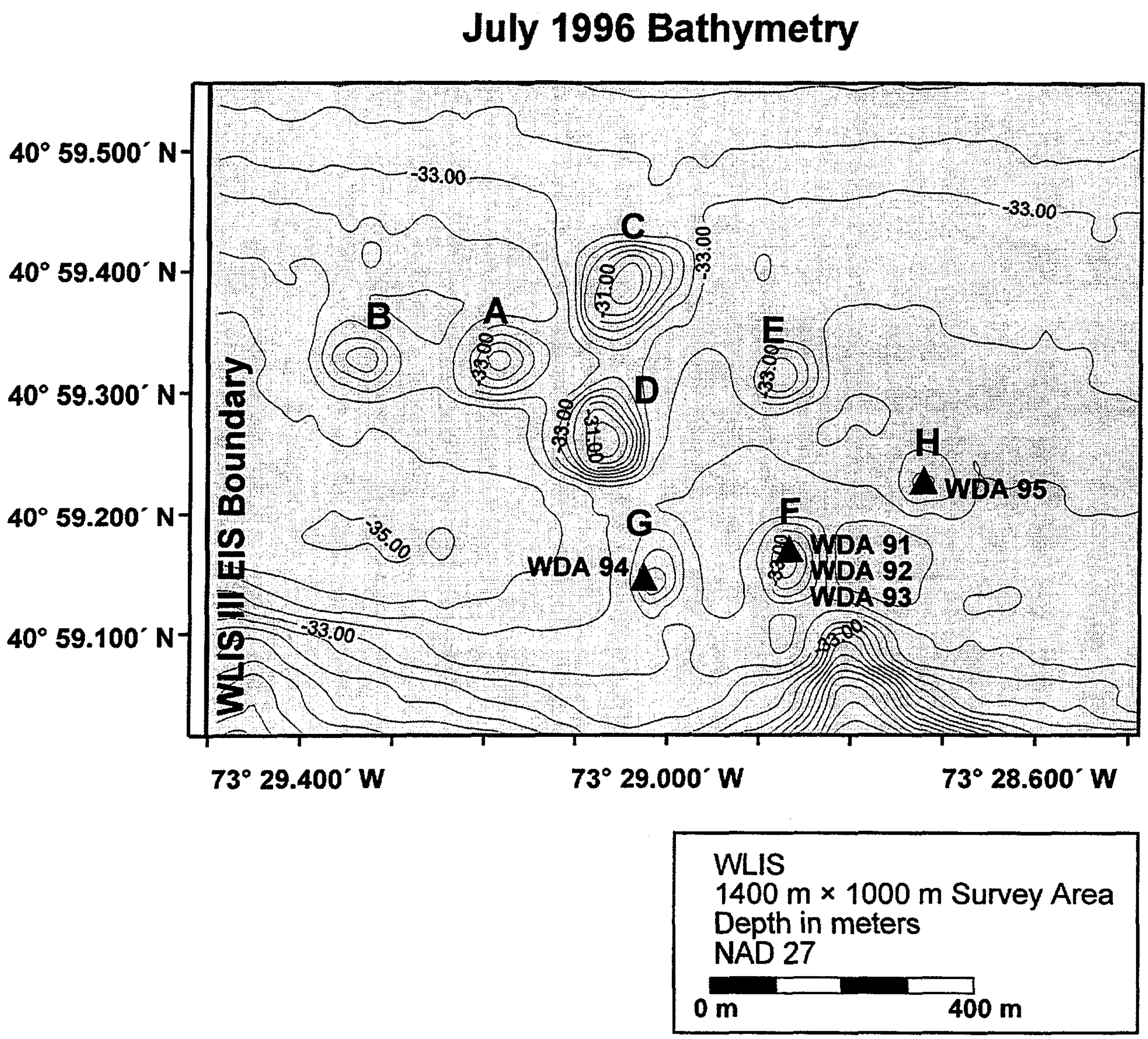


Figure 1-4. Chart of the DAMOS disposal buoy positions at WLIS during the 1991-92, 1992-93, 1993-94, 1994-95, and 1995-96 disposal seasons over July 1996 bathymetry, 0.5 m contour interval

April and May of 1996. An additional 5,240 m^3 of material generated by two small dredging projects in Manhasset Bay, New York, was also incorporated into the H mound during the spring of 1996.

The G mound at WLIS was formed during the 1994-95 disposal season. In September 1994, the WDA buoy was placed at 40°59.158' N, 73°29.020' W, 210 m west of the F mound (Figure 1-4; Appendix A, Table 1-1). Disposal logs indicate a total of 52,500 m^3 of dredged material was deposited at the WDA 94 buoy from 19 January to 31 May 1995. An estimated barge volume of 49,500 m^3 of material was dredged from Norwalk Cove; Saugatuck and Darien Rivers; and Greenwich, Stamford, and Sheffield Island Harbors in Connecticut. In addition, an estimated 3,000 m^3 of material was deposited from dredging operations at the Tom's Point Marina, Manhasset Bay, New York.

The F mound is the result of modest dredged material deposition at WLIS over a three-year period. The WDA buoy was positioned in nearly the same location during the 1991-92, 1992-93, and 1993-94 disposal seasons (Figure 1-4; Appendix A, Table 1-1). A total of 80,300 m^3 of dredged material was deposited at the DAMOS buoy positions from September 1991 through May of 1994. During the 1991-92 disposal season a total estimated barge volume of 38,700 m^3 of dredged material (13,300 m^3 from New York projects) was disposed at 40°59.162' N, 73°28.880' W. The resulting sediment mound was detected by the July 1992 bathymetric survey at WLIS (Figure 1-5).

Disposal over the F mound continued during the 1992-93 disposal season with an additional 21,600 m^3 of sediment being incorporated into the bottom feature. Approximately 8,260 m^3 of dredged material that was deposited at WLIS originated from small projects in New York waters. The 1993-94 disposal season represented the final year of disposal over the F mound. A total of 20,000 m^3 of material generated by five small dredging projects was disposed at WLIS during the 1993-94 season. The majority of the new material, 13,800 m^3, originated from dredging operations along the Connecticut coast. The remaining 6,200 m^3 was dredged from Glen Cove Creek and New Rochelle Harbor, New York.

Relative to present disposal techniques, past dredged material deposition operations (pre-1970s) at the historic disposal sites within western Long Island Sound were not as tightly controlled. This has led to a broad distribution of historic dredged material on the seafloor surrounding WLIS (Eller and Williams 1996). As a result, the detection of dredged material within the WLIS reference areas has become a common occurrence in recent years. Reference area data are collected to provide a baseline against which results from the dredged material mounds are compared. However, the lack of ambient western

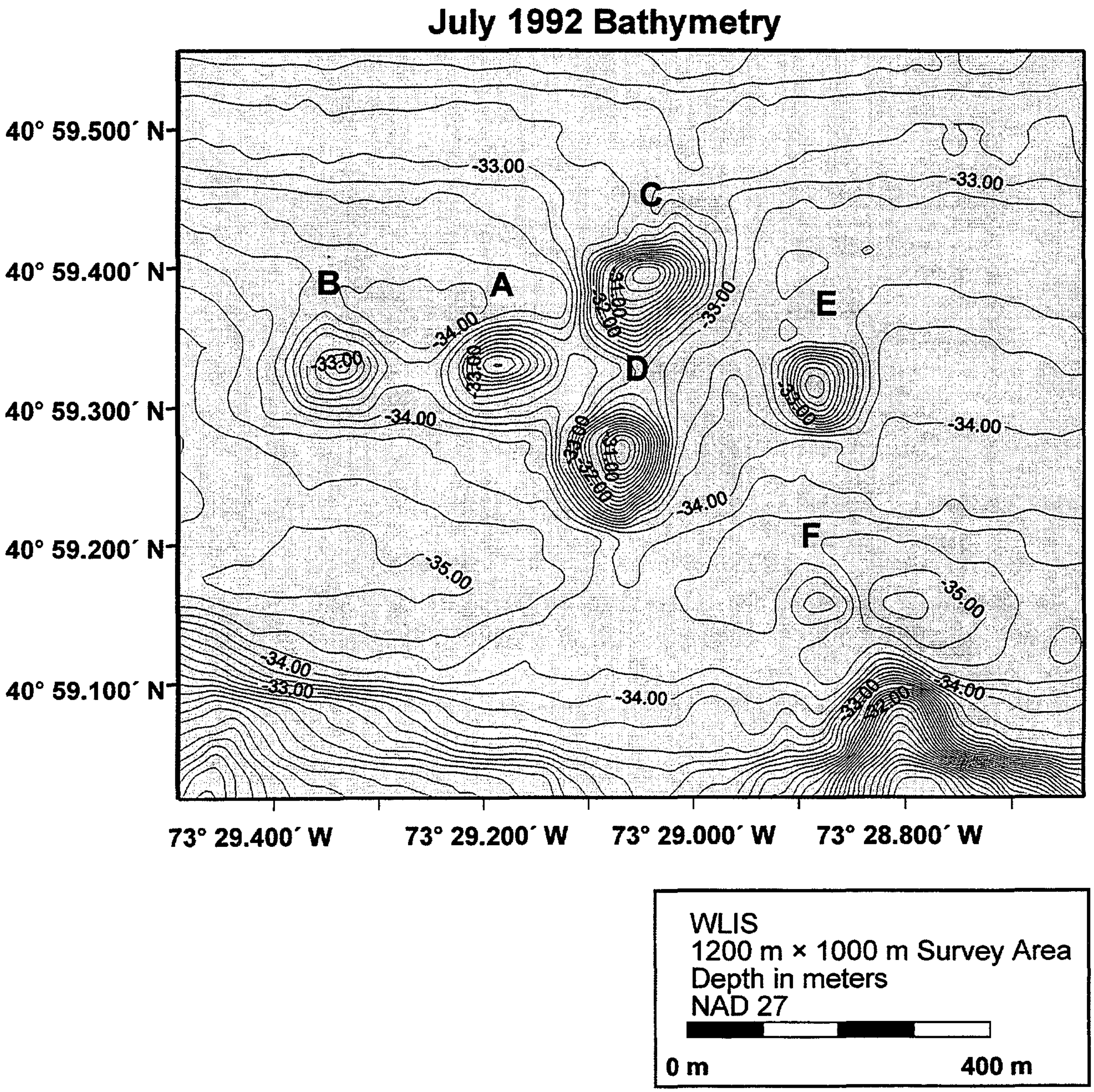


Figure 1-5. Bathymetric chart of the July 1992, 1200 m × 1000 m survey area depicting the five historic disposal mounds (A through E) and the developing F mound, 0.25 m contour interval

Long Island Sound sediments within predefined reference areas has complicated this process.

From 1991 to 1993, reference areas EAST, WLIS-REF, and 2000S in the vicinity of WLIS have been abandoned due to detection of the presence of dredged material (Eller and Williams 1996; Charles and Tufts 1996). The July 1996 REMOTS® survey over the current WLIS reference areas (2000W, SOUTH, and SW-REF) found evidence of historic dredged materials at reference area 2000W, an area utilized since 1987. The presence of dark, reduced sediments and methane gas bubbles indicate the sediments are not representative of the ambient sediment, free from the effects of anthropogenic activity. These are generally isolated patches of historic dredged materials that are not detected by the previous sampling conducted at reference areas.

The specific objectives of the July 1996 Western Long Island Sound Disposal Site monitoring cruise were to

- document and delineate the changes in bottom topography in the area of concentrated disposal since July 1992;
- assess the benthic recolonization status of the G and H mounds, as well as two stations on the southern flank of the historic D mound, relative to three reference areas surrounding WLIS; and
- conduct a qualitative analysis of the newly defined southwest reference area (SW-REF).

The July 1996 field effort at WLIS tested the following predictions:

1. The past four years of disposal activity at WLIS will result in the formation of two new discrete sediment mounds (G and H), while the older WLIS F mound will display significant accumulation of new material since 1992.
2. Benthic recolonization at the H mound will be in the early stages of recovery with a Stage I assemblage predominant on the mound surface. Evidence of Stage I, II, and III activity will be displayed in the surficial sediment layers of the WLIS G mound. The southern flank of the D mound (Stations D200S and D300S) will show improvement in benthic conditions relative to previous surveys.
3. Seasonal hypoxia in the western Long Island Sound region is not expected to affect the results of the benthic community assessment due to the timing of survey operations.

2.0 METHODS

2.1 Survey Area

In order to fulfill the objectives of the 1996 WLIS monitoring survey, SAIC conducted a comprehensive field effort consisting of precision bathymetry and REMOTS® sediment-profile photography surveys. The bathymetric survey at WLIS was performed over a 1400 m × 1000 m area centered at 40°59.555' N, 73°28.990' W. The July 1996 survey area extends 200 m east of the July 1992 (1200 m × 1000 m) survey boundary to ensure adequate coverage of the flanks of the H mound. A total of 41 survey lanes at 25 m lane spacing were required to delineate the topography of the active southwestern quadrant of WLIS (Figure 2-1). Detailed bathymetric charts were generated for the 1.4 km^2 area to quantify mound height, lateral spread of dredged material, and position relative to other disposal mounds.

2.2 Navigation

In an effort to provide strong comparisons with historic data sets, bathymetric data were collected with the use of SAIC's Integrated Navigation and Data Acquisition System (INDAS). This system utilizes a Hewlett-Packard 9920® series computer to provide real-time navigation, as well as collect position, depth, and time data for later analysis. A Del Norte Trisponder® System provided positioning data to an accuracy of ±3 m in the horizontal control of North American Datum of 1927 (NAD 27). Shore stations were established along the Connecticut coast at the known benchmarks of Norwalk Harbor Power Plant (41°04.248' N, 73°24.501' W) and Greenwich Point (41°00.580' N, 73°34.193' W). A detailed description of the navigation system and its operation can be found in SAIC Report No. 290 (Murray and Selvitelli 1996).

In order to maximize the efficiency of survey operations at WLIS, differential Global Positioning System (DGPS) data in conjunction with SAIC's Portable Integrated Navigation and Survey System (PINSS) were used to position the survey vessel over the July 1996 REMOTS® camera stations. A Magnavox 4200D GPS receiver and a Magnavox MX50R differential beacon receiver provided DGPS positioning data to PINSS in the horizontal control of North American Datum of 1983 (NAD 83) to an accuracy of ±5 m. The Coast Guard differential beacon broadcasting from Sandy Hook, New Jersey, (286 kHz) was utilized for satellite corrections due to its geographic position relative to WLIS.

The target REMOTS® station locations were calculated in NAD 27, then converted to NAD 83 for real-time navigation with the use of the US Army Topographic Engineering Center's CORPSCON version 3.01. The actual positions of the REMOTS® replicate

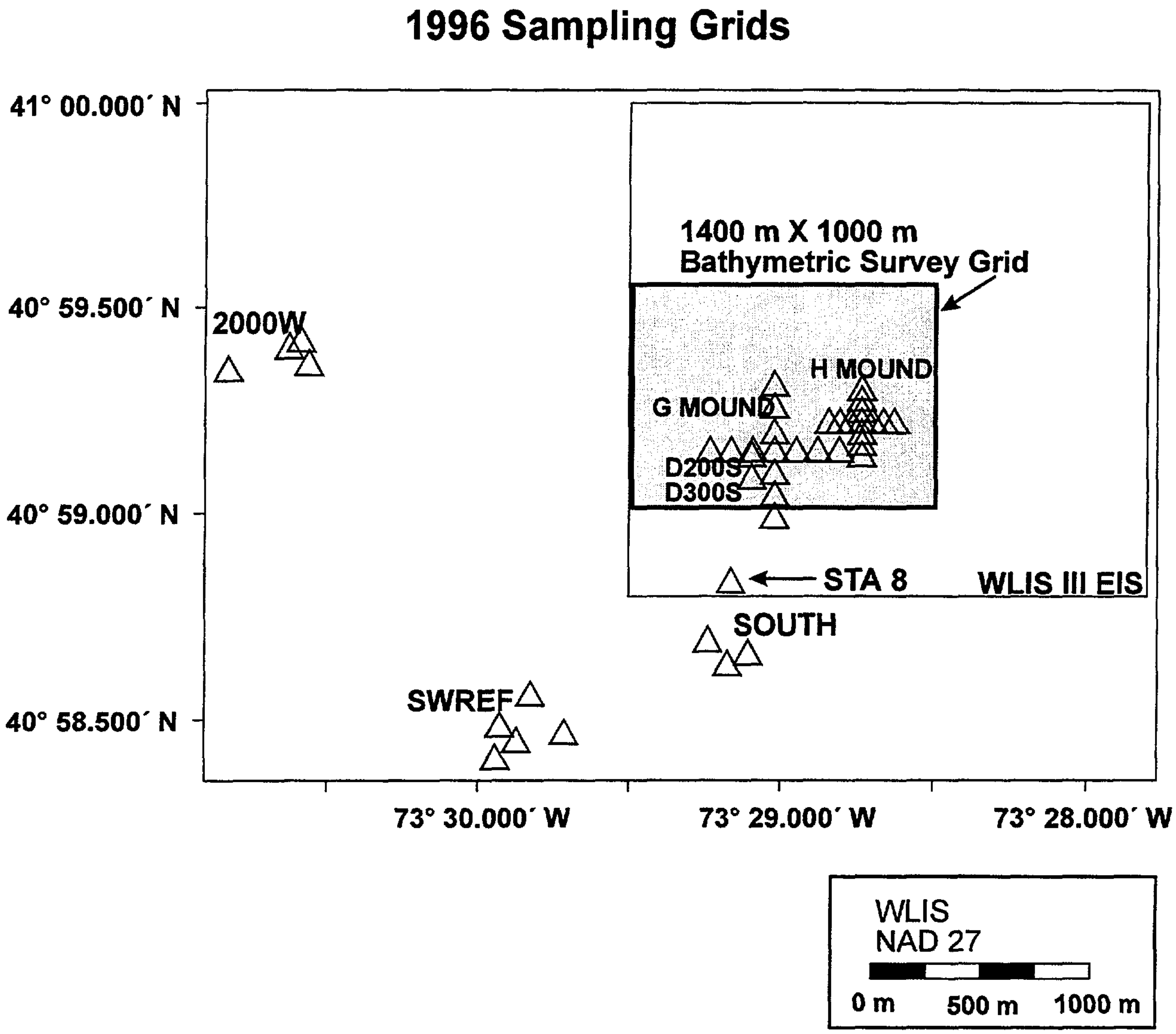


Figure 2-1. Chart of the bathymetric survey area and REMOTS® stations (△) relative to the Western Long Island Sound Disposal Site (WLIS) boundary

photographs were later reconverted to NAD 27 with CORPSCON for DAMOS database entry and reporting.

2.3 Bathymetric Data Collection and Processing

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

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

Observed tide data are available 1 to 6 hours from the time of collection in a station datum or referenced to Mean Lower Low Water (MLLW) and based on Coordinated Universal Time (UTC). For the 1996 WLIS survey, data from NOAA tide station 8467150 in Bridgeport Harbor, Bridgeport, CT, was used for tidal calculations. The NOAA 6-minute tide data was downloaded in the MLLW datum, corrected to local time, and tidal differences based on Greens Ledge, Sheffield Island, Connecticut, were applied.

In order to make valid comparisons between present and past bathymetric surveys of the area, the July 1992 and June 1990 bathymetry models were recorrected to observed MLLW. The OLLD database also provides historic NOAA observed tidal data (31 December 1993 and earlier) as hourly water heights. Through interpolation, a smooth tidal curve was developed to allow for accurate tidal corrections of historic bathymetric data sets.

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

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

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

2.4 REMOTS® Sediment-Profile Photography

REMOTS® photography was used to detect the distribution of dredged material layers, map benthic disturbance gradients, and monitor the benthic infaunal recolonization and/or successional status of the G mound, H mound, and stations 200 and 300 m south of the D mound center, as well as the WLIS reference areas. Cross-sectional photographs of the top 20 cm of sediment were taken for analysis and intercomparison with the ambient sediments of the adjacent WLIS reference areas (2000W, SOUTH, and SW-REF).

Three replicate photographs were taken at 13 stations over the WLIS G and WLIS H mounds (Figure 2-1). The REMOTS® sampling grids formed a cross-shaped pattern with three stations along each of four arms and one station in the center. The REMOTS® survey over the G mound was centered at 40°59.158' N, 73°29.020' W with station spacing at 100 m. The H mound grid, centered at 40°59.228' N, 73°28.732' W, was based on the same cross-shaped pattern, but sampled every 50 m (Figure 2-1; Appendix A, Table 2-1).

In addition, Stations D200S (40°59.146' N, 72°29.095' W) and D300S (40°59.092' N, 72°29.095' W) were revisited during the 1996 field operations at WLIS. These two stations were identified as areas of concern during the August 1993 REMOTS® survey. Environmental conditions at D200S and D300S (shallower than expected Redox Potential Discontinuity [RPD] depths and slow benthic recolonization) suggested that continued monitoring of the southern flank of the D mound was required (Charles and Tufts 1996).

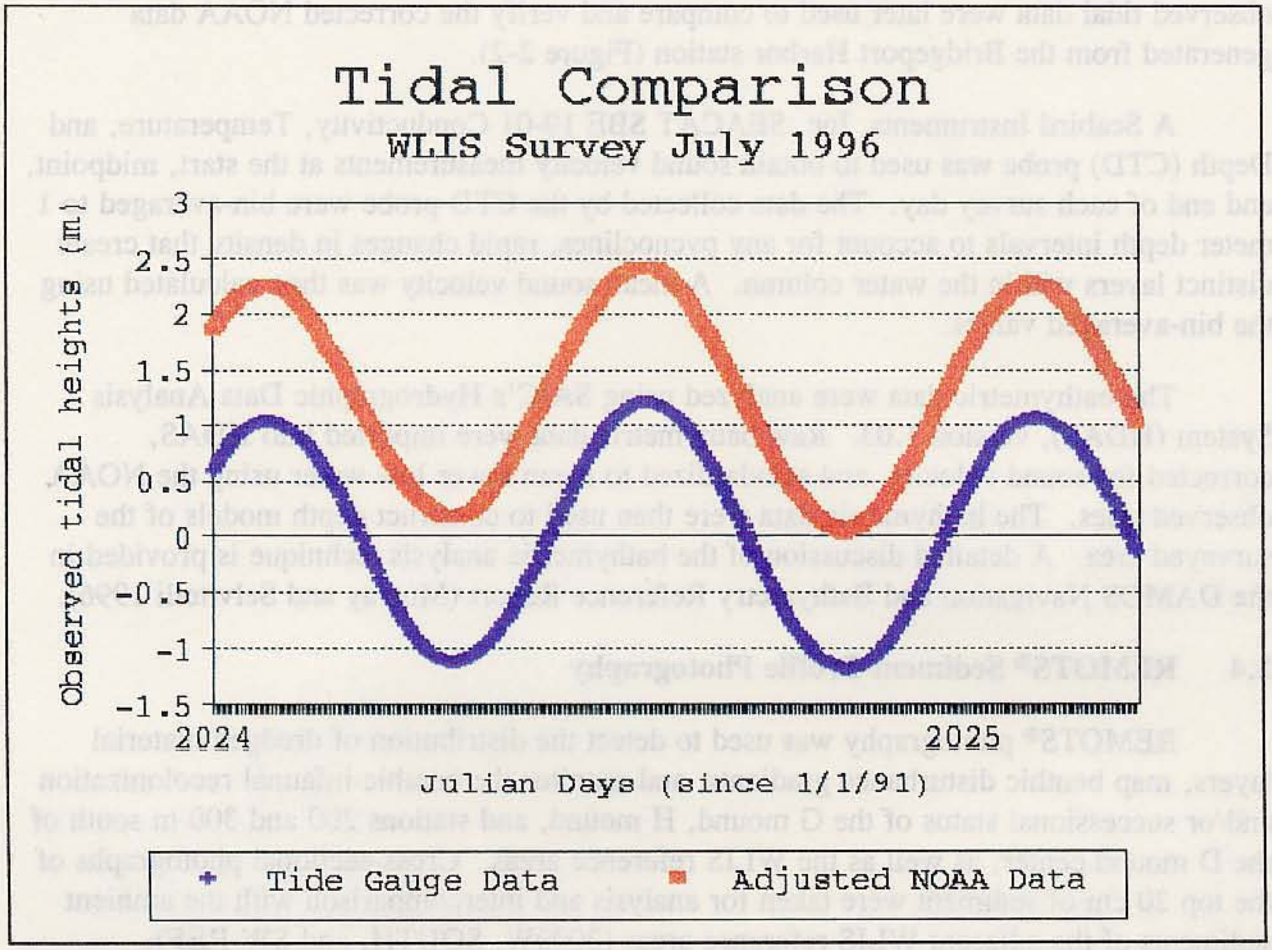


Figure 2-2. Tidal datum, phase, and height comparison of the SAIC tide gauge and adjusted NOAA observed tides data sets

Data from 2000W, SOUTH, and SW-REF were used for comparison of ambient western Long Island Sound sediments relative to the sediments deposited at WLIS through disposal operations. Reference areas SOUTH (40°58.688' N, 73°29.201' W) and 2000W (40°59.393' N, 73°30.632' W) were sampled at four randomly selected stations. SW-REF (40°58.688' N, 73°29.909' W) was sampled at five randomly selected stations (Figure 2-1; Appendix A, Table 2-1).

3.0 RESULTS

Since 1982, all disposal activity at WLIS has been directed to the southwest quadrant of the disposal site into the east-west trending bottom depression. The July 1996 bathymetric survey at WLIS detected a total of eight dredged material disposal mounds on the WLIS seafloor (Figure 3-1). Mound C remains the largest disposal mound with an approximate width of 250 m and a maximum height of 4 m. The water depth over the C mound was 29.5 m at MLLW, with slightly deeper depths being recorded over mound D (29.75 m) 240 m to the south. A maximum depth of 35.25 m was found at 40°59.180' N, 73°29.350' W within the east-west trending trough.

During the 1400 m × 1000 m bathymetric survey of WLIS, a minimum depth of 27.5 m was detected over a strongly sloping bottom feature along the southern edge of the bathymetric survey area. The color contour plot displays the distinct, shoaling bottom feature, visible approximately 210 m north of the southern limit of the bathymetric survey area. The strong slopes are representative of the northern margins of the terminal moraine which forms Long Island, New York, produced by the advance of the southwest lobe of the Wisconsian Ice Sheet approximately 18,000 years before present (Sugden and John 1976). Three-dimensional imagery of the WLIS seafloor displays the possible beneficial uses (i.e., lateral containment) of this glacial feature and the excellent depositional environment it tends to produce (Figure 3-2).

The three newest disposal mounds at WLIS were constructed around taut-wire disposal buoys deployed in close proximity to the strongly sloping bottom feature. To provide valid comparisons with previous data sets, the 1996 bathymetric data was re-gridded to a 1200 m × 1000 m area (Figure 3-3). Depth difference comparisons with the July 1992 bathymetry data show the development of two new bottom features (G and H) as well as the deposition of additional material over the F and D mounds (Figure 3-4). Due to the relatively close placement, all three mounds are interconnected by a 0.25 m thick layer of dredged material resulting from the overlapping aprons of the three independent disposal mounds.

Several survey artifacts that correspond to the margins of the terminal moraine are visible to the south of the disposal mounds. Slight differences in the 1992 and 1996 survey vessel tracks over the strong slopes tend to appear as accumulation of material although no disposal activity occurred in this area. The apparent accumulation of 0.5 m of material north of the G mound may be the result of actual disposal activity during early March 1994, when the WDA 93 buoy was dragged more than 2,500 m off station. The buoy was off-station for six days (1 March to 6 March 1994), during the deposition of 1,375 m³ of material dredged from the Glen Cove and Charles Creeks. Without a DAMOS buoy to

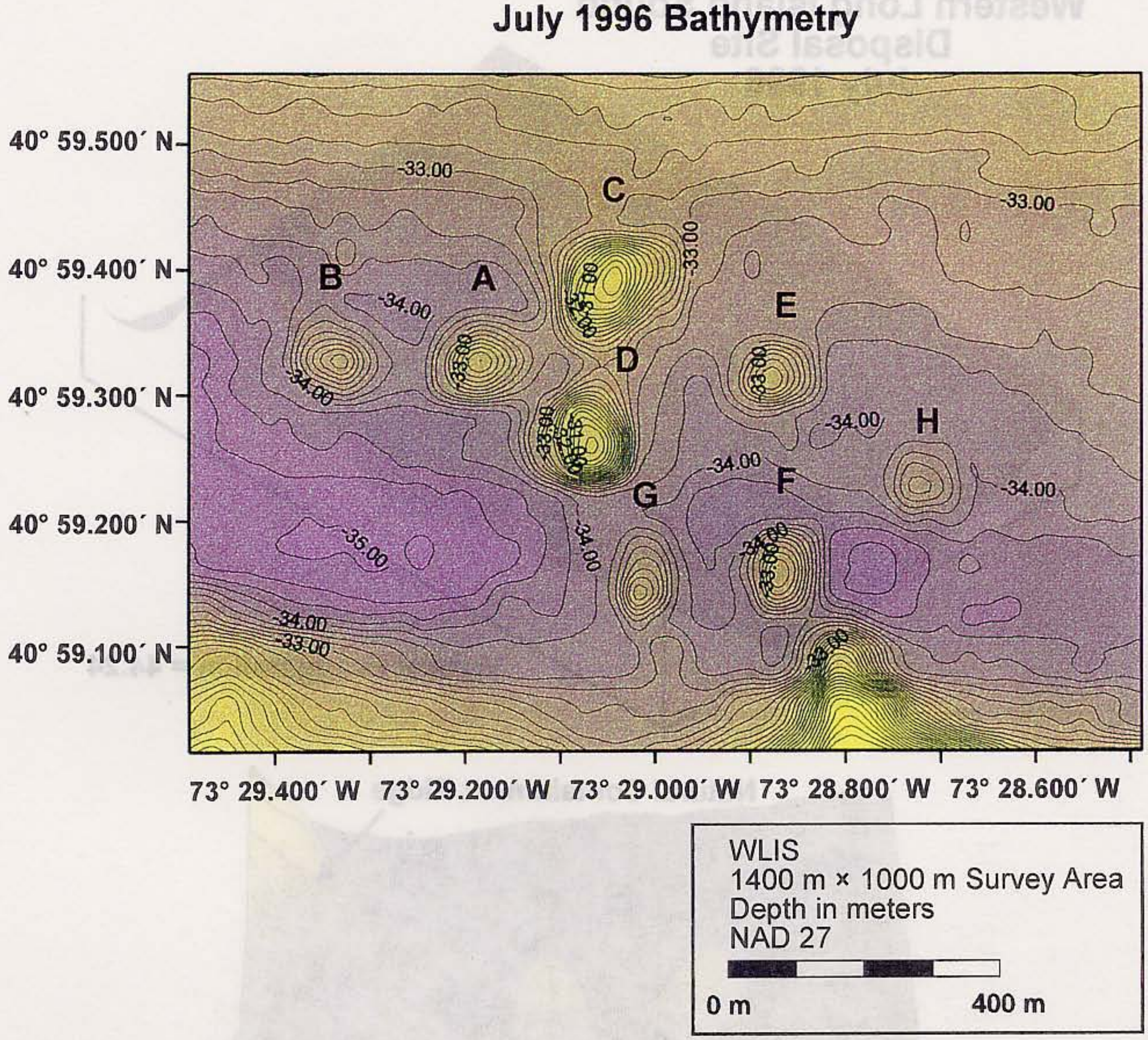


Figure 3-1. Bathymetric chart of the July 1996, 1400 m × 1000 m survey area over WLIS, 0.25 m contour interval

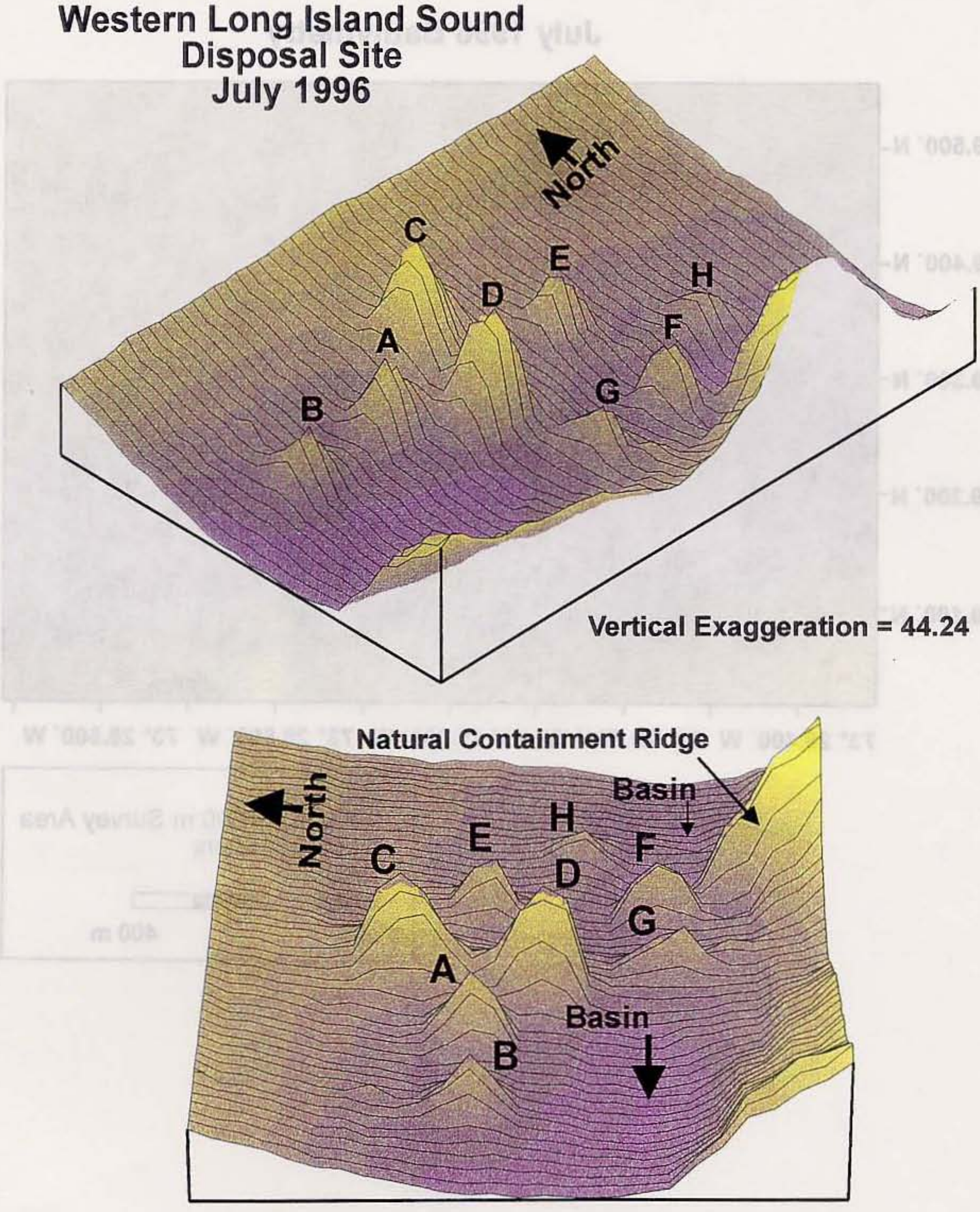


Figure 3-2. Three-dimensional view of the 1996 survey area over WLIS depicting eight disposal mounds, basins, and containment ridge in southwestern and western perspectives

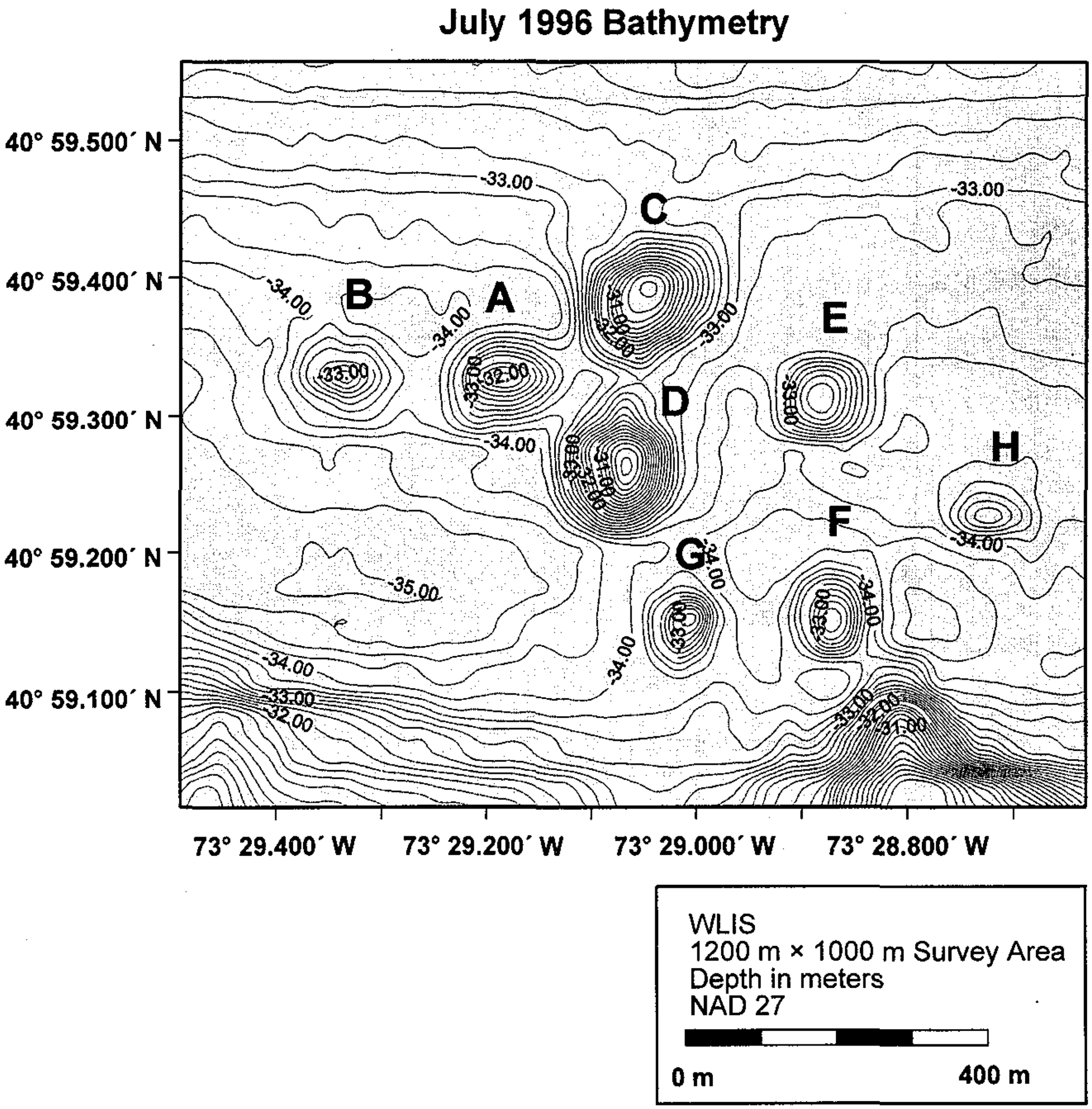


Figure 3-3. Bathymetric chart of the July 1996 bathymetric data gridded to 1200 m × 1000 m for comparison with the July 1992 data set, 0.25 m contour interval

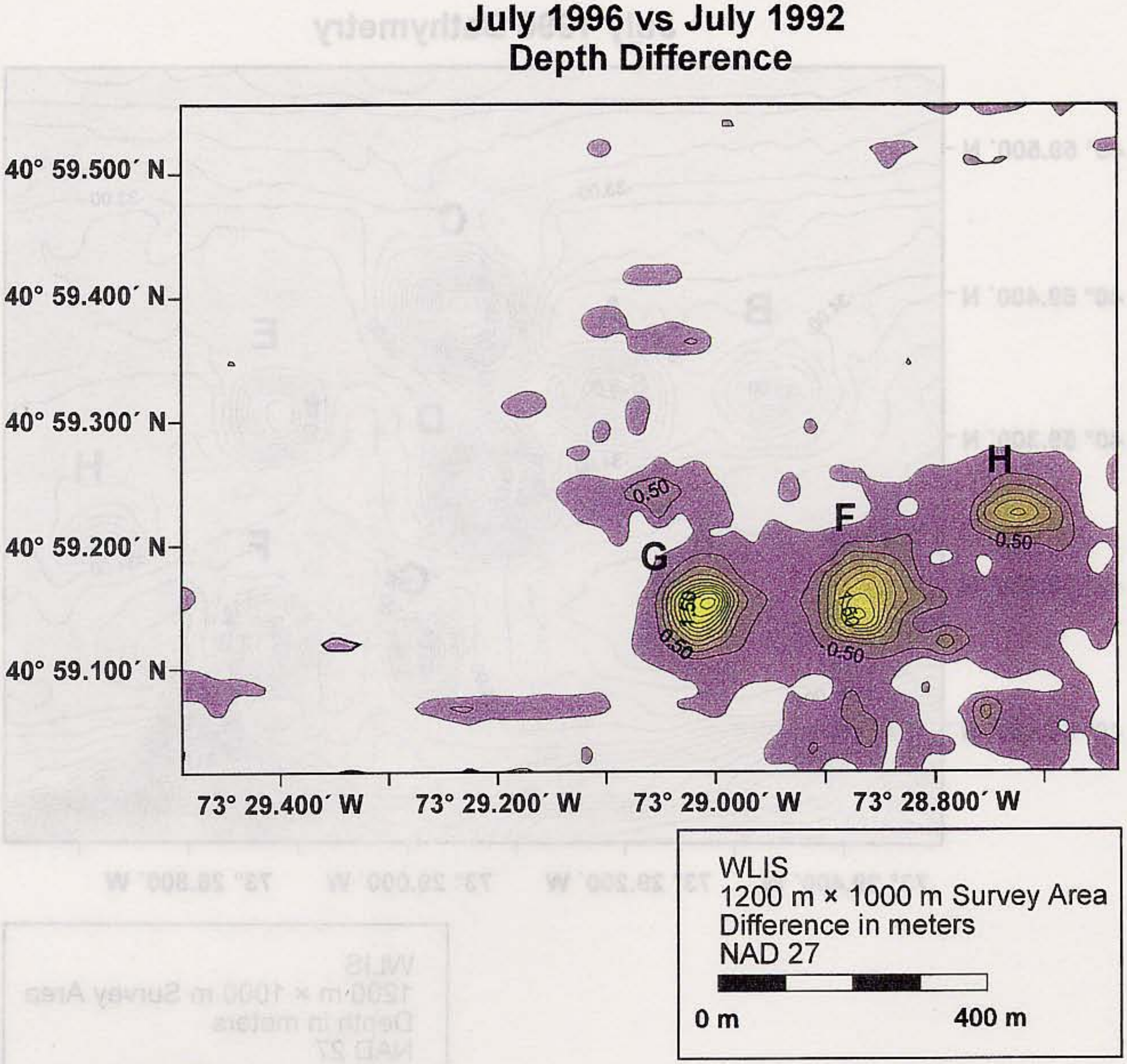


Figure 3-4. Depth difference plot of the July 1996 survey versus the July 1992 survey over the southwestern quadrant of WLIS, 0.25 m contour interval

mark the disposal point, towboats were required to navigate to the desired location via LORAN-C time delay signals (TDs). Slight errors in the LORAN-C receivers used in the 1994 disposal operations may have resulted in the deposition of material to the northwest of the F mound over the historic WLIS D mound.

3.1 WLIS H Mound

3.1.1 Bathymetry

The H mound was developed during the 1995-96 disposal season by the deposition of dredged material approximately 250 m northeast of the historic F mound. Composed of an estimated barge volume of 15,300 m^3 of sands, silts, and clays dredged from Connecticut and New York waterways in the spring of 1996, it represents the newest bottom feature at WLIS. Based on the relatively small volume of dredged material disposed, a 400 m × 400 m analysis area was defined around the WDA 95 buoy position.

The bathymetric chart of this smaller area displays a sediment mound with a minimum depth of 32.5 m over the apex of the H mound at MLLW (Figure 3-5). Depth difference plots based on comparisons with 1992 data indicate the bottom feature is approximately 230 m wide, and 1.5 m high at the apex (Figures 3-6 and 3-7). The apron of the WLIS H mound has apparently coalesced with the northern and eastern flanks of the historic F mound.

3.1.2 REMOTS® Sediment-Profile Photography

REMOTS® sediment-profile photography was used to document benthic recolonization as well as track the thin layers of dredged material and assess the overall impact of deposition over the surface of the WLIS H mound. Complete REMOTS® results for the new disposal mound are available in Appendix B.

3.1.2.1 Sediment Grain Size and Stratigraphy

Fresh dredged material was detected and measured at every station over the H mound. Redox rebound intervals, areas showing evidence of intermittent or seasonal oxidation below the currently oxidized surface layer, were noted at every station over the H mound. The presence of a redox rebound interval in a new sediment deposit suggests a gradual decline in pore water oxygen content, which could be attributable to a decrease in regional bottom water DO concentrations.

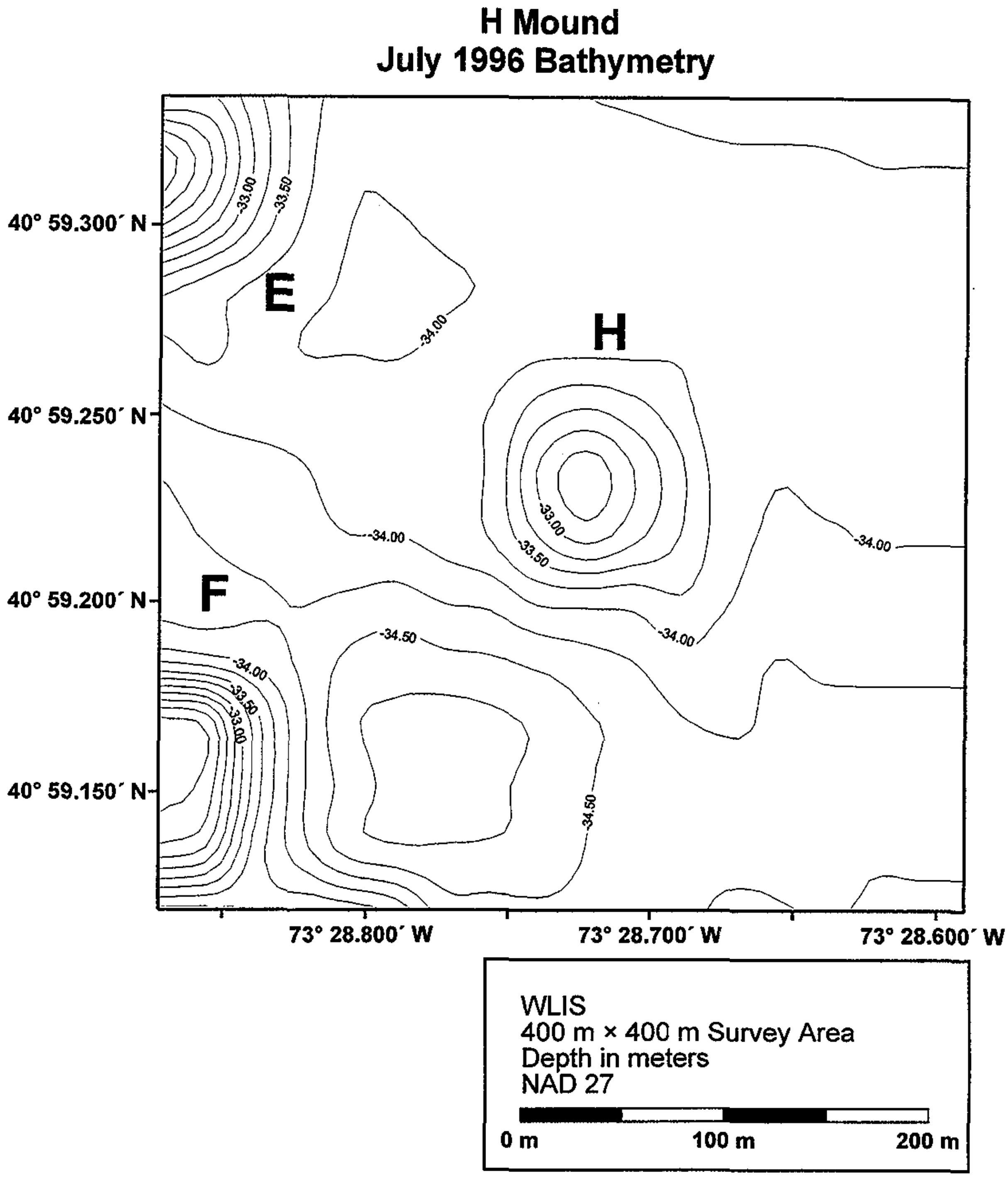


Figure 3-5. Bathymetric chart of the July 1996, 400 m × 400 m analysis area around the H mound, 0.25 m contour interval

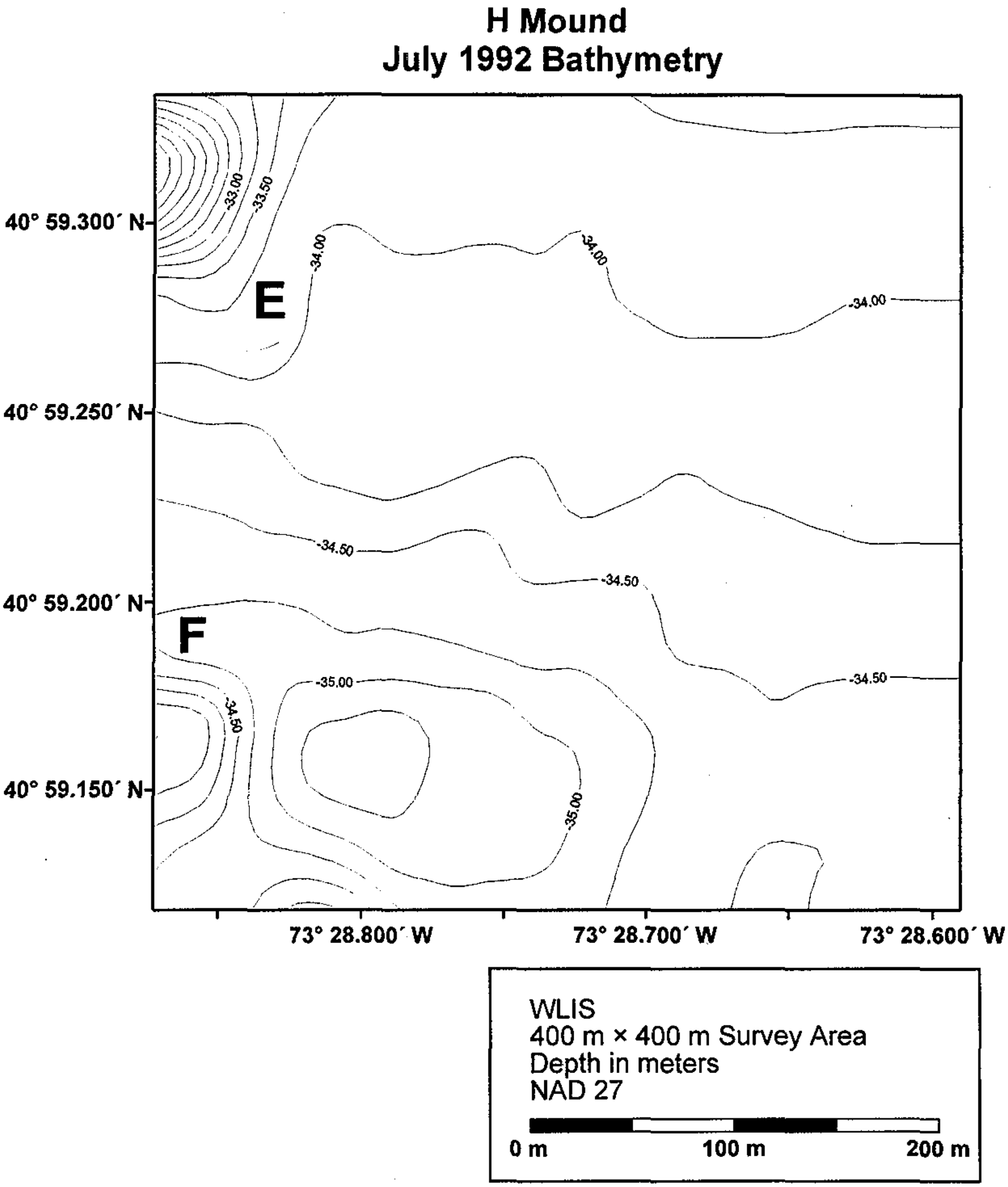


Figure 3-6. Bathymetric chart of the July 1992, 400 m × 400 m analysis area around the H mound, 0.25 m contour interval

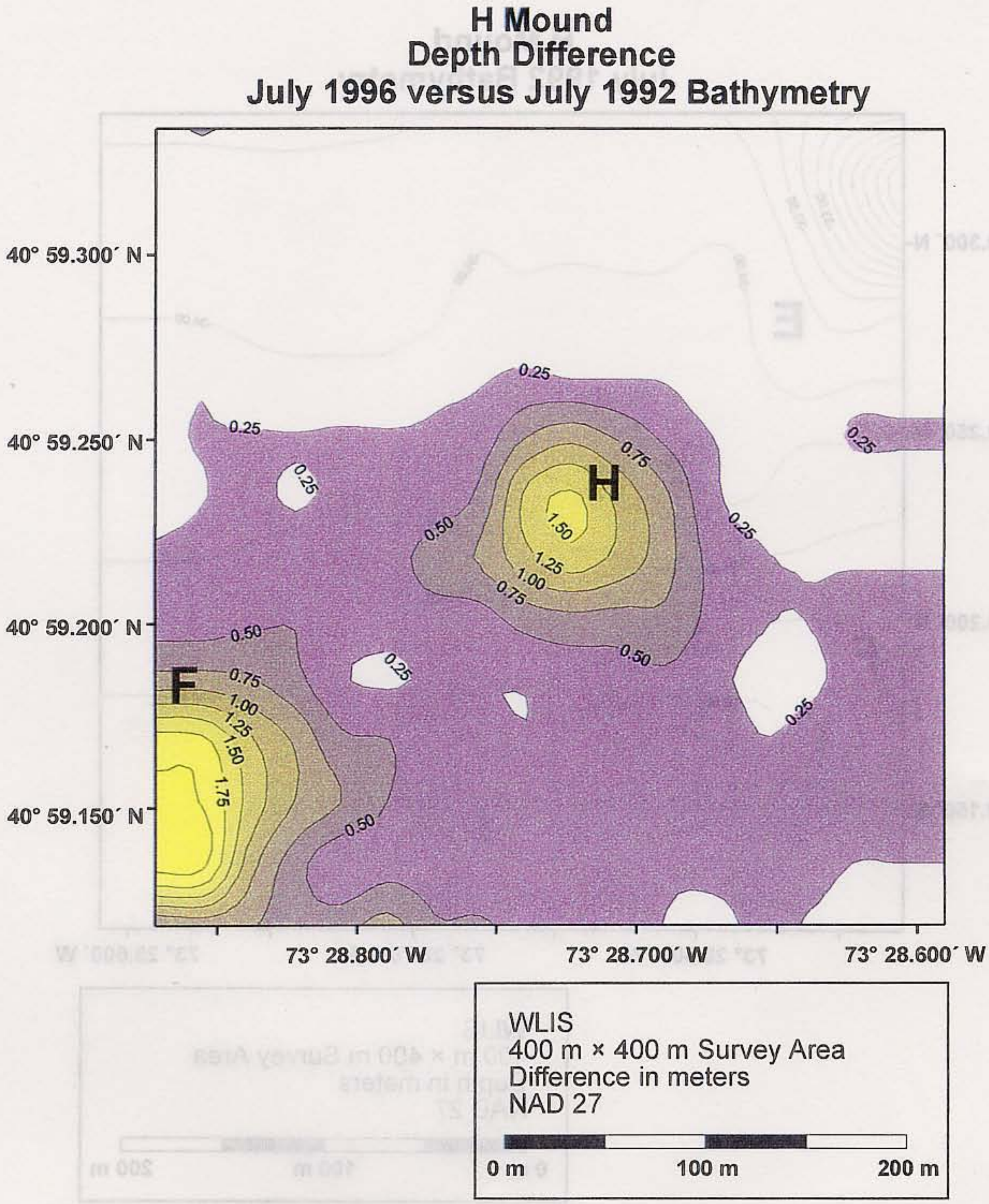


Figure 3-7. Depth difference plot of the 400 m × 400 m analysis area, July 1996 versus July 1992, 0.25 m contour interval

Physical REMOTS® parameters indicated the surface and near surface layers of the mound were mainly composed of silts and clays with the major modal grain size consistently reported at >4 phi. Mean camera penetration over the H mound showed no distinct pattern, with the shallowest penetration (12.98 cm) at 100W and the deepest penetration (18.57 cm) at 50N (Appendix A, Table 3-1). Replicate-averaged surface roughness values for the REMOTS® camera stations over the H mound ranged from 0.64 cm at 100E to 3.24 cm at 100S. The surface disturbances were classified as indeterminate in the majority of replicates; however, several replicates displayed evidence of surface roughness due to physical effects and biogenic activity.

3.1.2.2 Benthic Community Assessment

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

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

The mapping of successional stages is based on the theory that organism-sediment interactions follow a predictable sequence after a major seafloor disturbance (Rhoads and Germano 1982). This sequence is defined by end-member assemblages of benthic organisms. Stage I is made up of pioneering assemblages usually consisting of dense aggregations of near-surface, tube-dwelling polychaetes. If left undisturbed, Stage II infaunal deposit feeders such as shallow-dwelling bivalves or tubicolous amphipods then colonize the recovering seafloor. Stage III organisms are generally head-down deposit-feeding invertebrates whose presence results in distinctive subsurface feeding voids. Stage III taxa are associated with relatively low-disturbance regimes (Rhoads and Germano 1986).

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

The replicate-averaged mean RPD depths ranged from 0.39 cm at 50W to 2.91 cm at 150N (Figure 3-8). Conditions indicative of a low dissolved oxygen (DO) environment, no discernible RPD, were displayed by one replicate from Station 50W (Figure 3-9A). No traces of methane gas were observed in any replicate over the H mound.

As anticipated with a recent dredged material deposit, the successional stage recolonization status of the H mound was limited to Stage I pioneering polychaetes with occasional evidence of Stage III individuals (Figure 3-10; Germano et al. 1994). Stage III activity was noted in the subsurface sediments at Stations CTR, 50S, 100N, 100E, 100W, and 150W (Figure 3-9B). Due to the presence of Stage III individuals, median OSI values were elevated to 8.0 at 100W, 7.0 at CTR and 50S, and 4.0 at 100N, 100E, and 150W (Figure 3-8). With the exception of 50W, deep RPD depths (>2.5 cm) in conjunction with mature Stage I populations contributed to higher OSI values (5.0 to 6.5) at the remaining REMOTS® camera stations.

The shallower RPD depths and lower OSI values associated with Station 50W are due to the presence of low DO conditions in one replicate and indeterminate RPD data in a second replicate. One photograph of the three collected over 50W displayed a moderate RPD depth of 0.78 cm, Stage I recolonization status, and an OSI value of 3.0. The environmental conditions displayed in this single replicate are acceptable for a two-month-old dredged material deposit.

3.2 WLIS G Mound

3.2.1 Bathymetry

The G mound was the product of moderate disposal activity at WLIS during the 1994-95 season. An estimated barge volume of 52,500 m^3 of material was deposited in close proximity to the WDA 94 buoy. The resulting mound of sediment is approximately 220 m wide, with a minimum depth of 32.0 m, and situated 180 m west of the F mound center (Figure 3-11). The G mound appears to be slightly elongated along its north-south axis. This irregular shape is likely due to the disposal pattern, as well as the effects of the east-west trending trough and a subtle ridge projecting south from the base of the D mound.

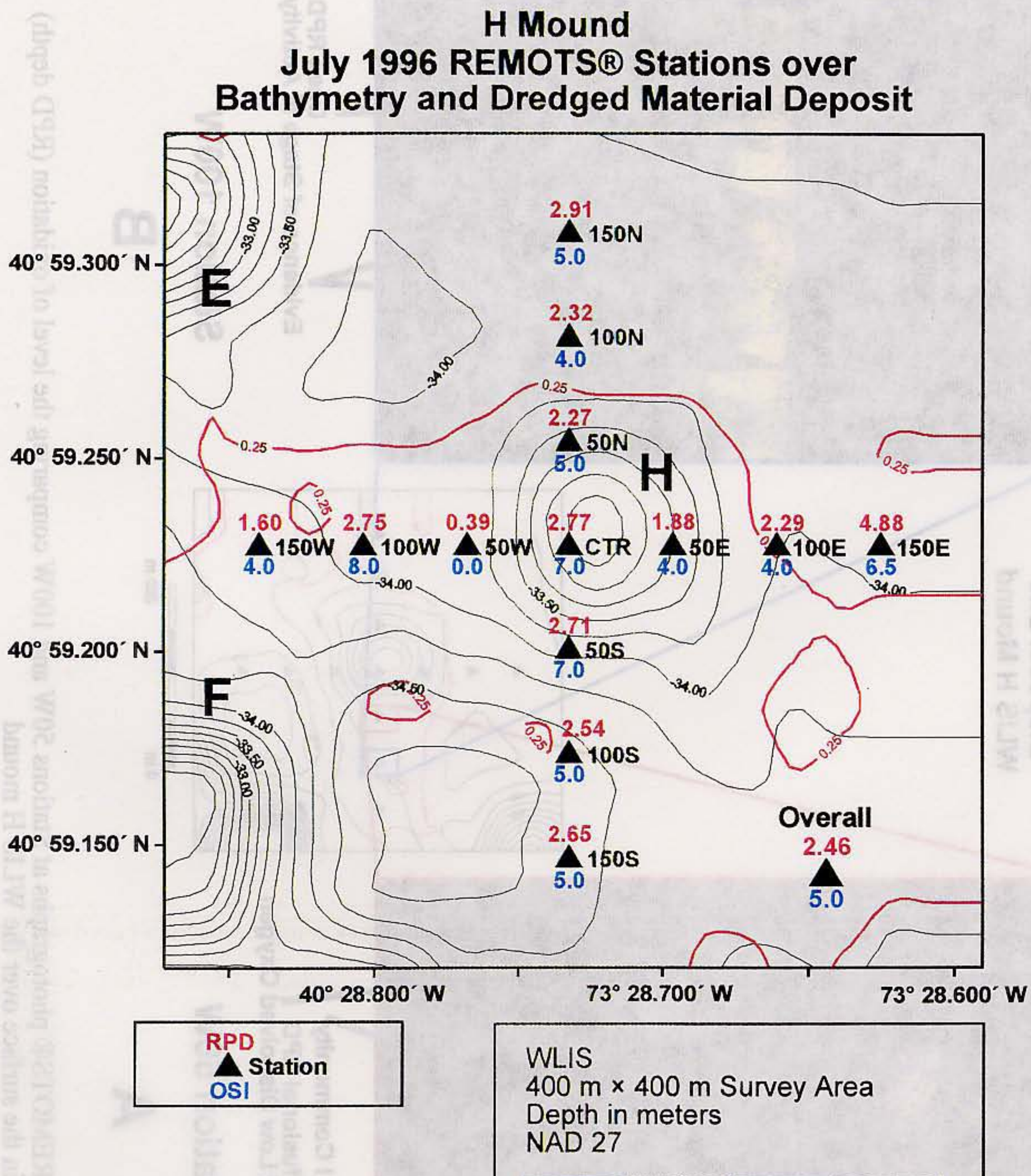


Figure 3-8. Bathymetric chart of the 400 m × 400 m analysis area overlaid with footprint of fresh dredged material detected by depth difference (see Figure 3-8) and dredged material thickness

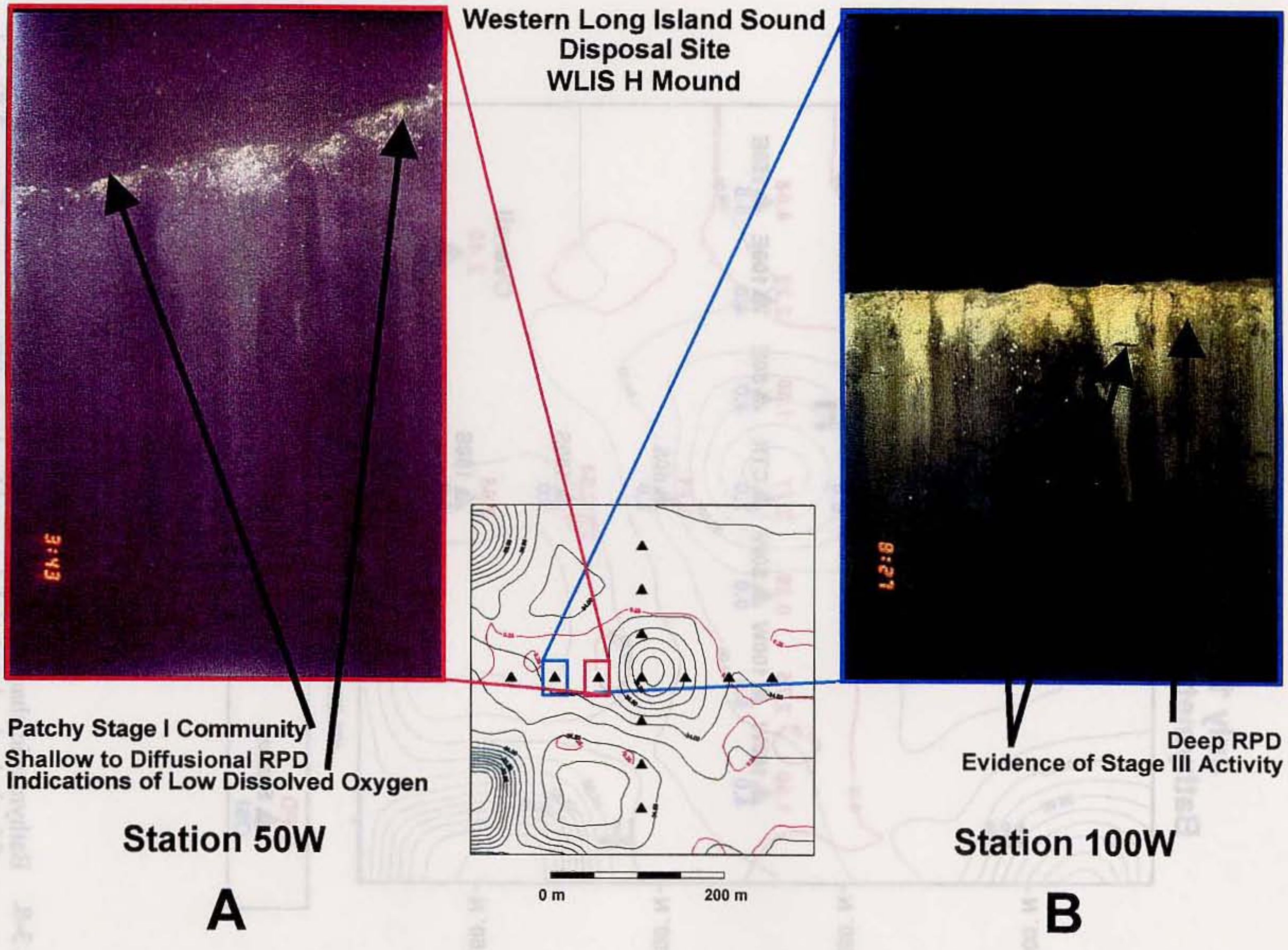


Figure 3-9. REMOTS® photographs at Stations 50W and 100W comparing the level of oxidation (RPD depth) in the surface over the WLIS H mound

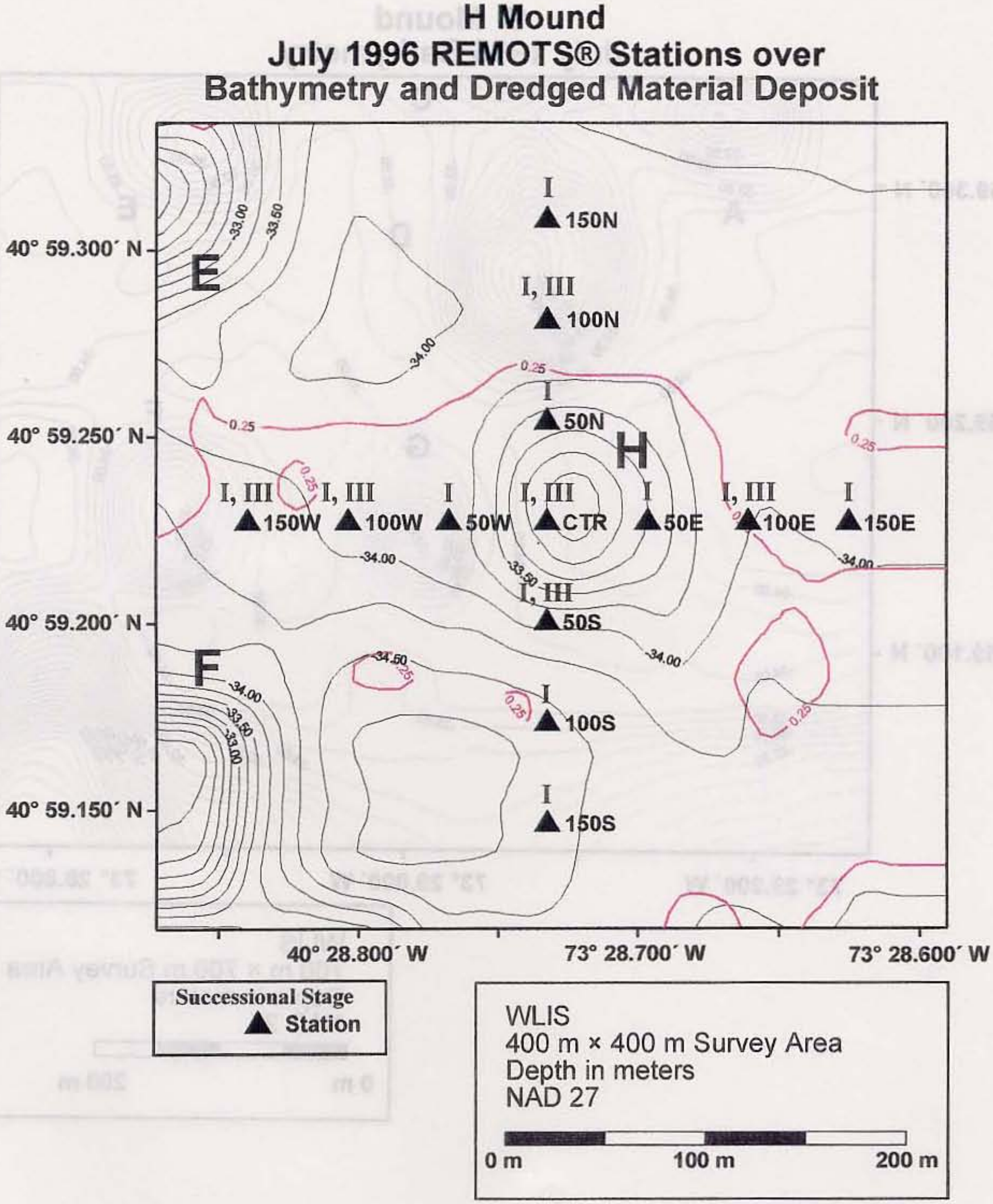


Figure 3-10. Distribution of successional stage assemblages over the WLIS H mound, overlaid on July 1996 bathymetry and final detectable margin of the mound

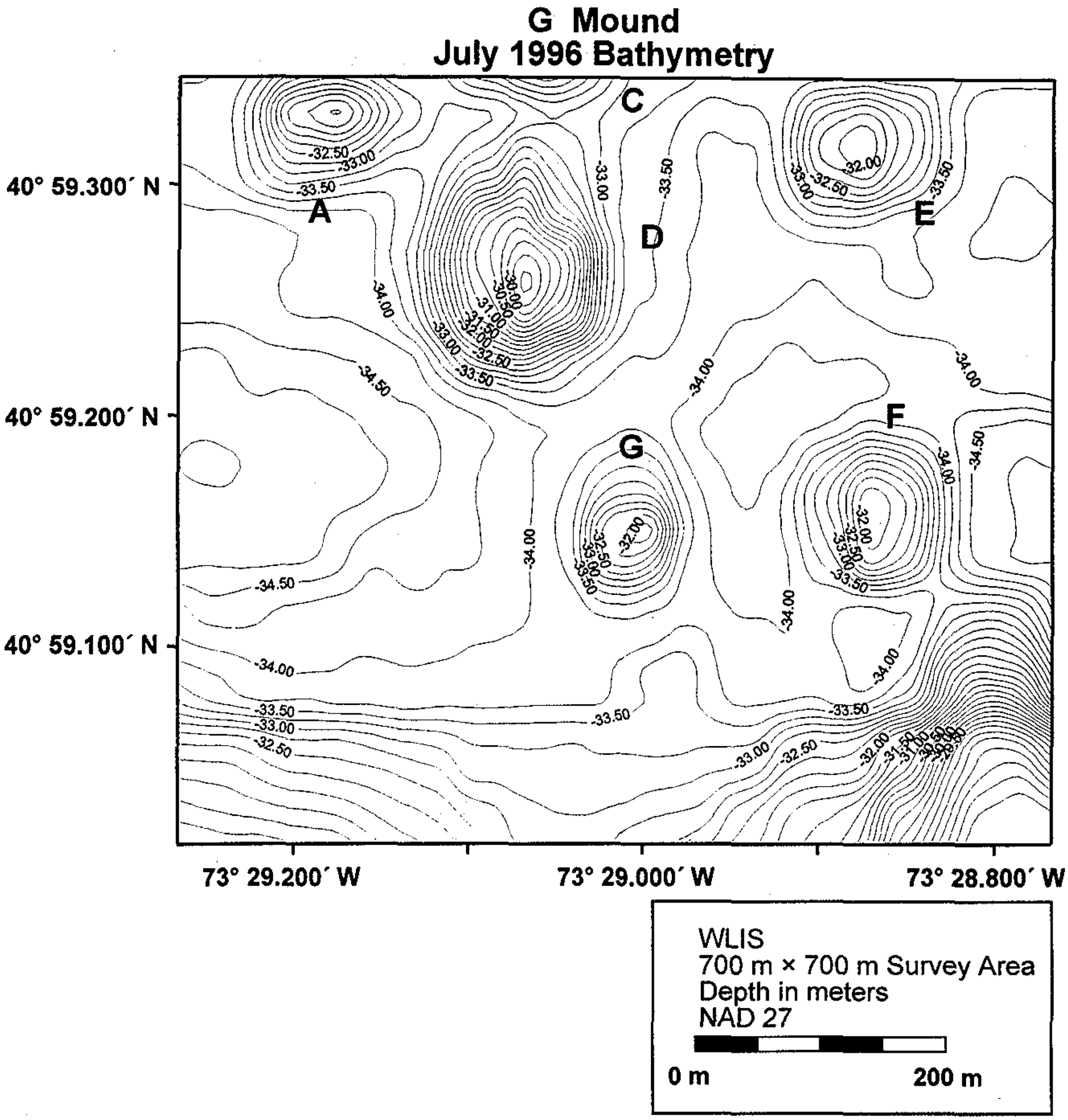


Figure 3-11. Bathymetric chart of the July 1996, 700 m × 700 m analysis area around the G mound, 0.25 m contour interval

Depth difference plots with the July 1992 bathymetry display the 2.5 m high WLIS G mound connected to the adjacent D and F mounds by a wide apron of material 0.25 m thick (Figures 3-12 and 3-13). The 0.25 m apron surrounding the G mound extends north and east to the flanks of the historic D mound. A pocket of accumulation 0.5 m thick over the southern slope of the D mound may be the result of errant deposition during the 1993-94 disposal season. Approximately 1,375 m^3 of dredged material was released using only LORAN-C TDs to guide disposal operations. However, the apparent accumulation in the southeast corner of the plot corresponds to the margin of the terminal moraine and is considered to be a survey artifact.

3.2.2 REMOTS® Sediment-Profile Photography

REMOTS® sediment-profile photography over the G mound was primarily used to document benthic recolonization and track the layers of dredged material over the WLIS G mound. Formed during the 1994-95 disposal season, the mound surface has been undisturbed for an entire year, allowing ample time to establish a stable benthic community. Complete REMOTS® results for the WLIS G mound are available in Appendix C.

3.2.2.1 Sediment Grain Size and Stratigraphy

As with the H mound, dredged material was detected and measured at every station over the WLIS G mound. Redox rebound intervals were noted in one or two replicates at Stations CTR, 100S, 100W, 200N, and 300N over the G mound, indicating a gradual reduction in available oxygen.

Major modal grain size reported >4 phi sediments (silts and clays) in the surface and near surface layers, with a small pocket of fine sand at Station 100N (4 to 3 phi). Mean camera penetration over the G mound suggested a more consolidated surface, relative to the H mound. Penetration depths ranged from 10.32 cm at Station 300S to 17.76 cm at Station 200E, slightly shallower than the H mound (Appendix A, Table 3-2). Replicate-averaged surface roughness values for the REMOTS® camera stations over the G mound ranged from 0.47 cm at 100S to 2.24 cm at 100N. As with the H mound, the surface disturbances were classified as indeterminate in the majority of replicates, with several replicates displaying evidence of surface roughness due to physical effects and biogenic activity.

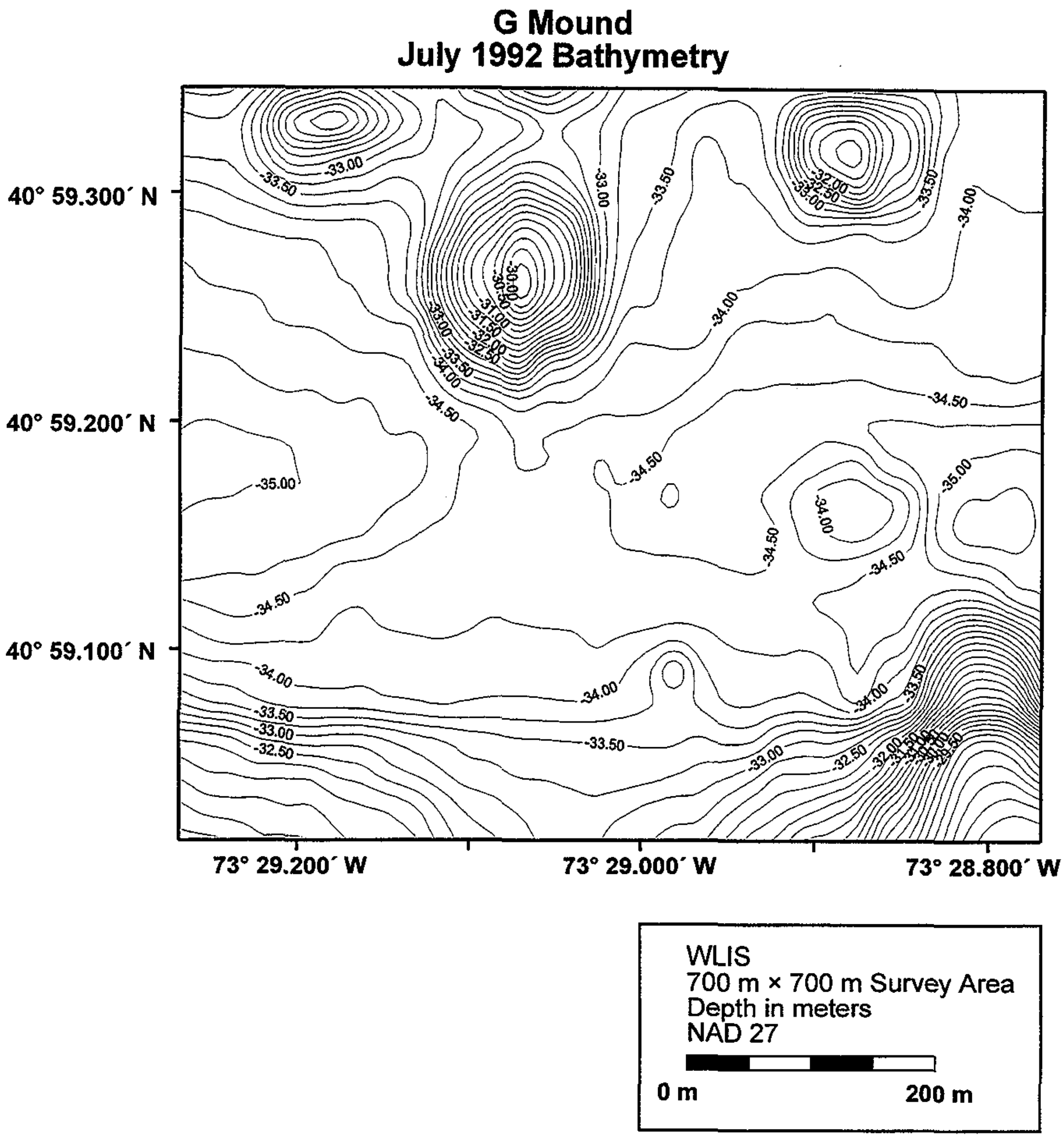


Figure 3-12. Bathymetric chart of the July 1992, 700 m × 700 m analysis area around the G mound, 0.25 m contour interval

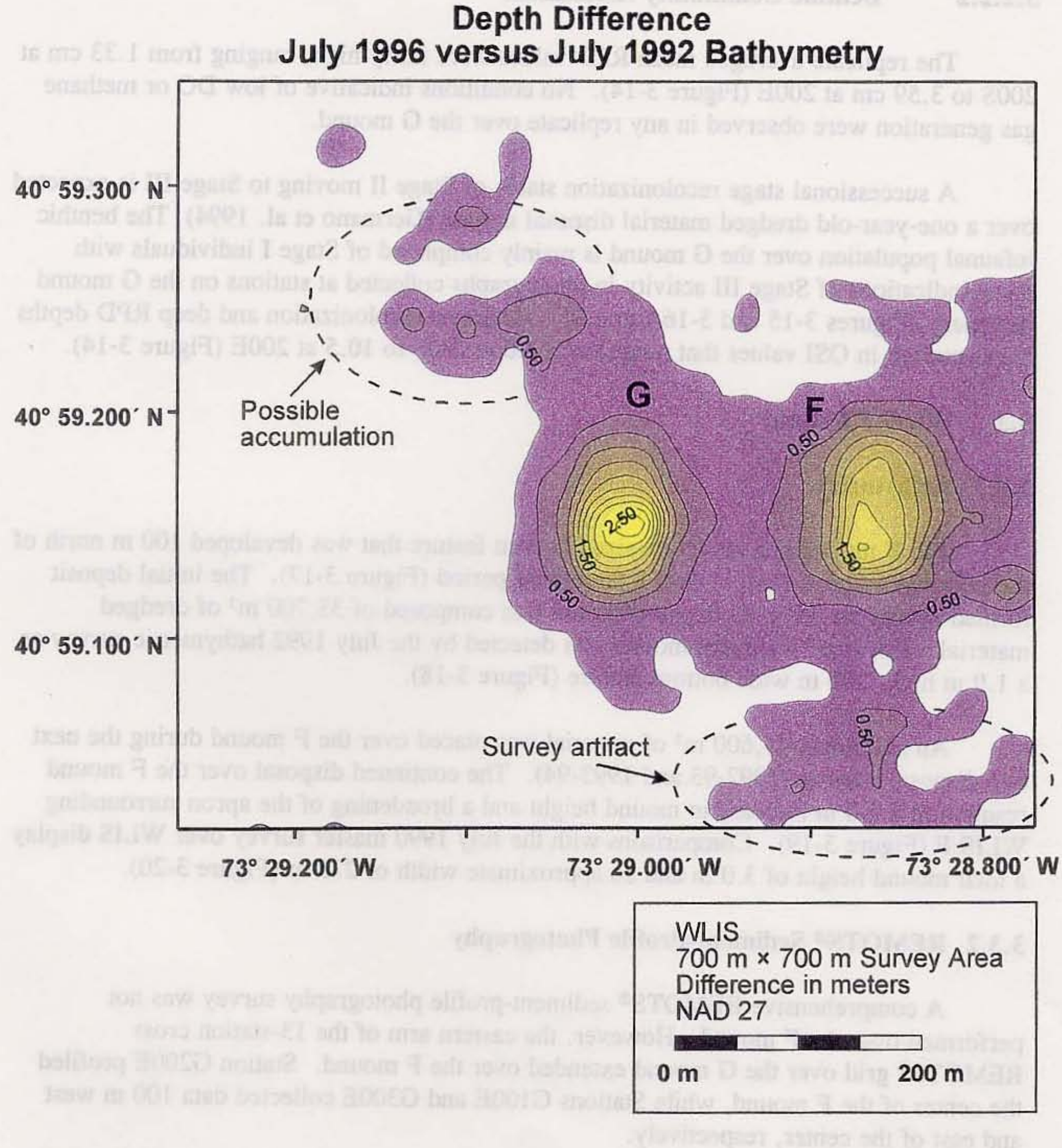


Figure 3-13. Depth difference plot of the 700 m × 700 m analysis area, July 1996 versus July 1992, 0.25 m contour interval

3.2.2.2 Benthic Community Assessment

The replicate-averaged mean RPD values were fairly high, ranging from 1.33 cm at 200S to 3.59 cm at 200E (Figure 3-14). No conditions indicative of low DO or methane gas generation were observed in any replicate over the G mound.

A successional stage recolonization status of Stage II moving to Stage III is expected over a one-year-old dredged material disposal mound (Germano et al. 1994) The benthic infaunal population over the G mound is mainly comprised of Stage I individuals with some indications of Stage III activity in photographs collected at stations on the G mound periphery (Figures 3-15 and 3-16A and B). Moderate recolonization and deep RPD depths have resulted in OSI values that range from 3.0 at 200S to 10.5 at 200E (Figure 3-14).

3.3 WLIS F Mound

3.3.1 Bathymetry

The F mound is a moderate-sized bottom feature that was developed 100 m north of the terminal moraine margin over a three-year period (Figure 3-17). The initial deposit formed during the 1991-92 disposal season was composed of 38,700 m³ of dredged material. The small sediment mound was detected by the July 1992 bathymetric survey as a 1.9 m high, 200 m wide bottom feature (Figure 3-18).

An additional 41,600 m³ of material was placed over the F mound during the next two disposal seasons (1992-93 and 1993-94). The continued disposal over the F mound resulted in a 2.0 m increase in mound height and a broadening of the apron surrounding WLIS F (Figure 3-19). Comparisons with the July 1990 master survey over WLIS display a total mound height of 3.0 m and an approximate width of 275 m (Figure 3-20).

3.3.2 REMOTS® Sediment-Profile Photography

A comprehensive REMOTS® sediment-profile photography survey was not performed over the F mound. However, the eastern arm of the 13-station cross REMOTS® grid over the G mound extended over the F mound. Station G200E profiled the center of the F mound, while Stations G100E and G300E collected data 100 m west and east of the center, respectively.

Overall, the F mound appears healthy with replicate-averaged RPD depths ranging from 2.15 cm at G300E to 3.59 cm at G200E (Figure 3-14). The OSI value of 10.5 at G200E is a result of the deep RPD and the observation of Stage III organisms in two of the

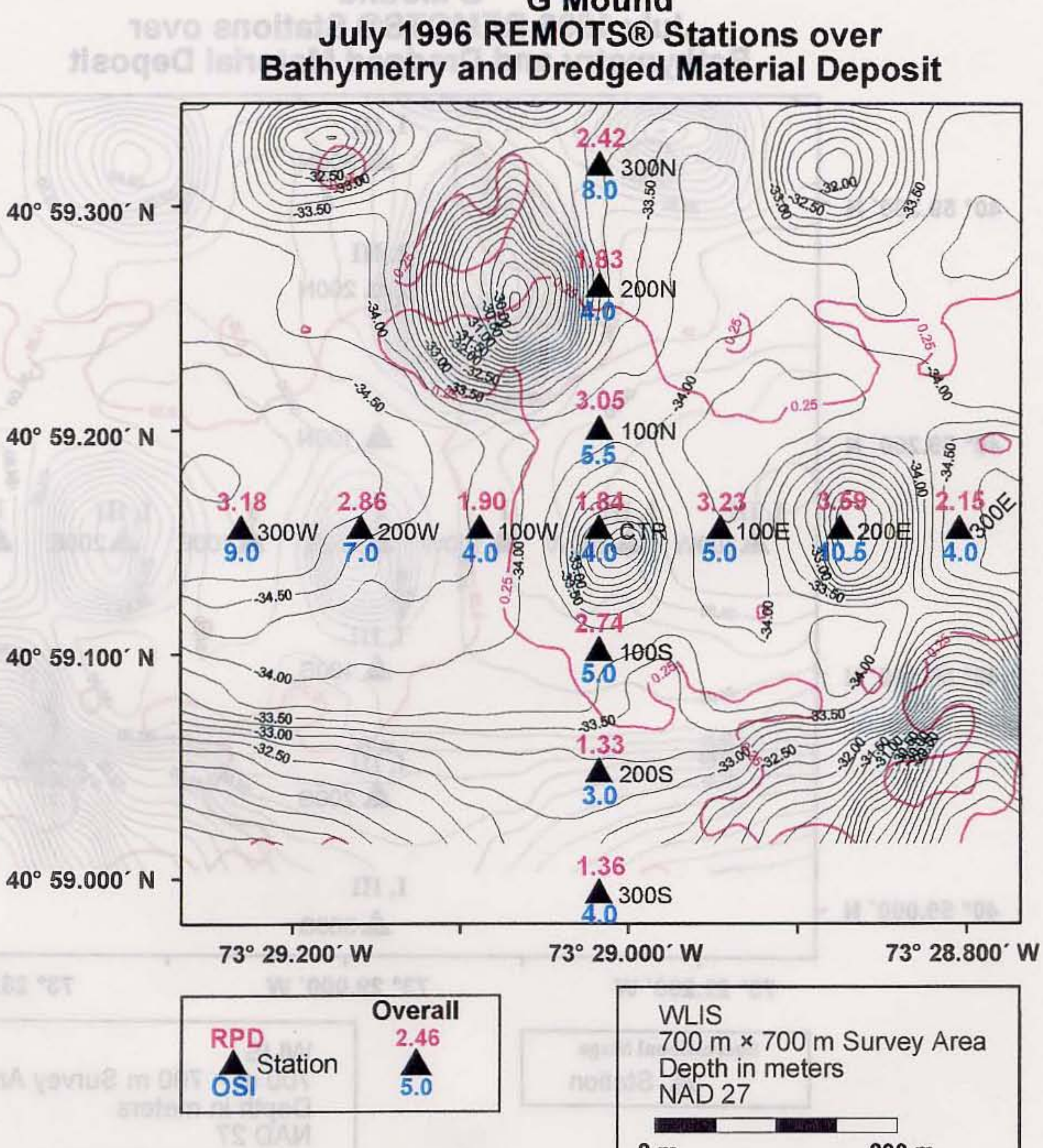


Figure 3-14. Distribution of RPD and OSI values over the WLIS G mound, overlaid on July 1996 bathymetry and final detectable margin of the mound (see Figure 3-13)

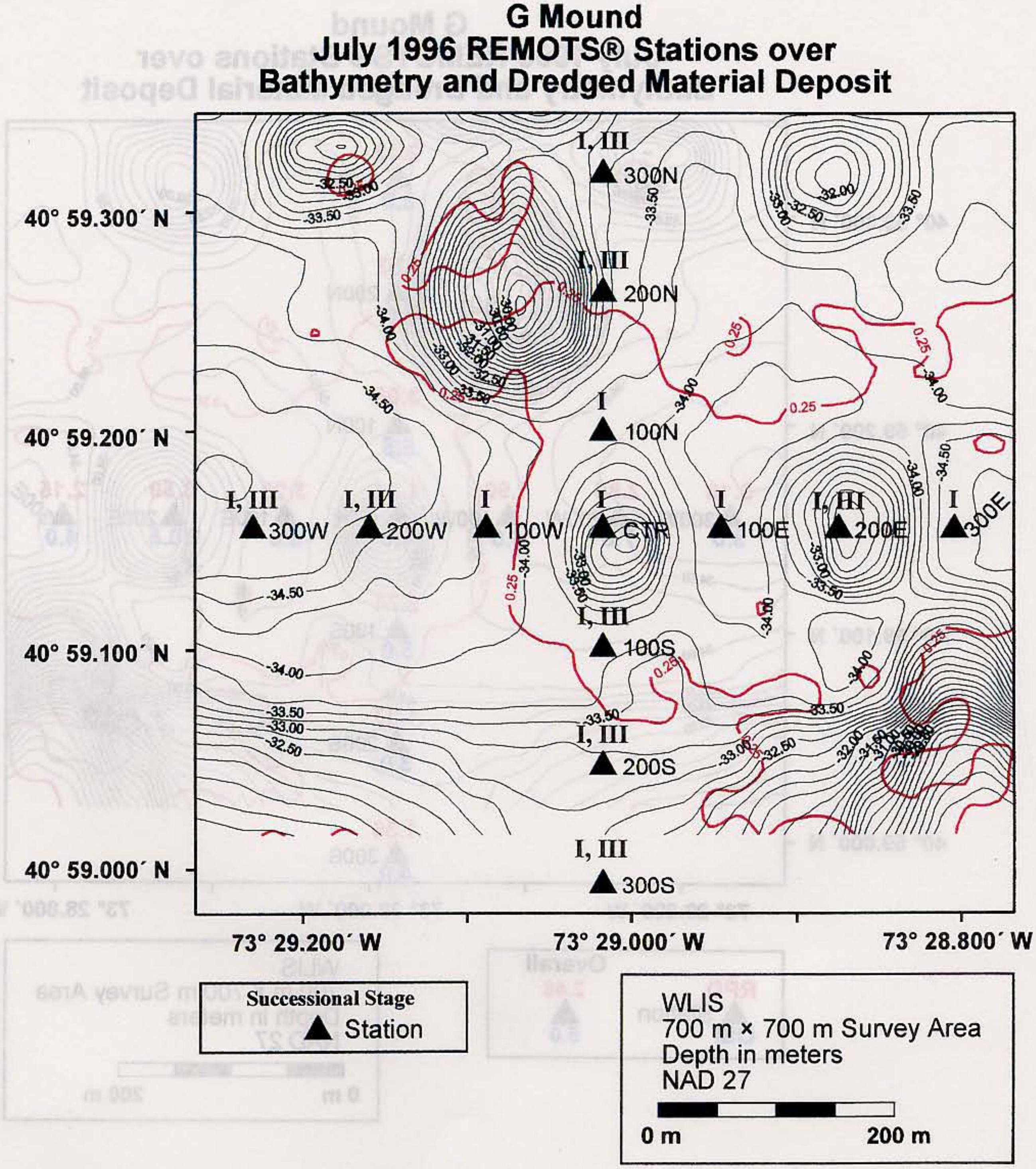


Figure 3-15. Distribution of successional stage assemblages over the WLIS G mound, overlaid on July 1996 bathymetry and final detectable margin of the mound

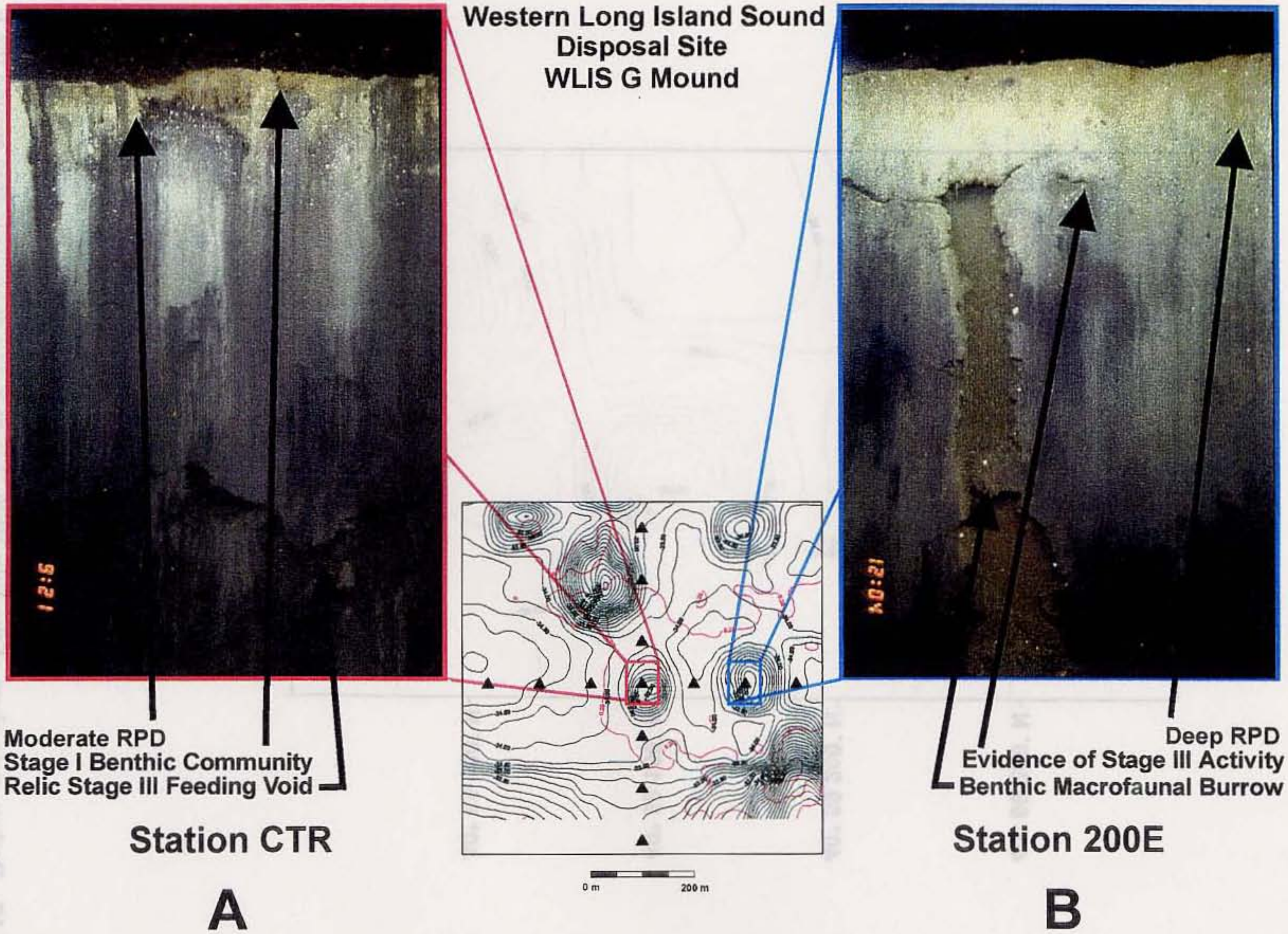


Figure 3-16. REMOTS® photographs at Stations CTR and 200E comparing the level of oxidation (RPD depth) and benthic recolonization within the surface sediments over the WLIS G mound

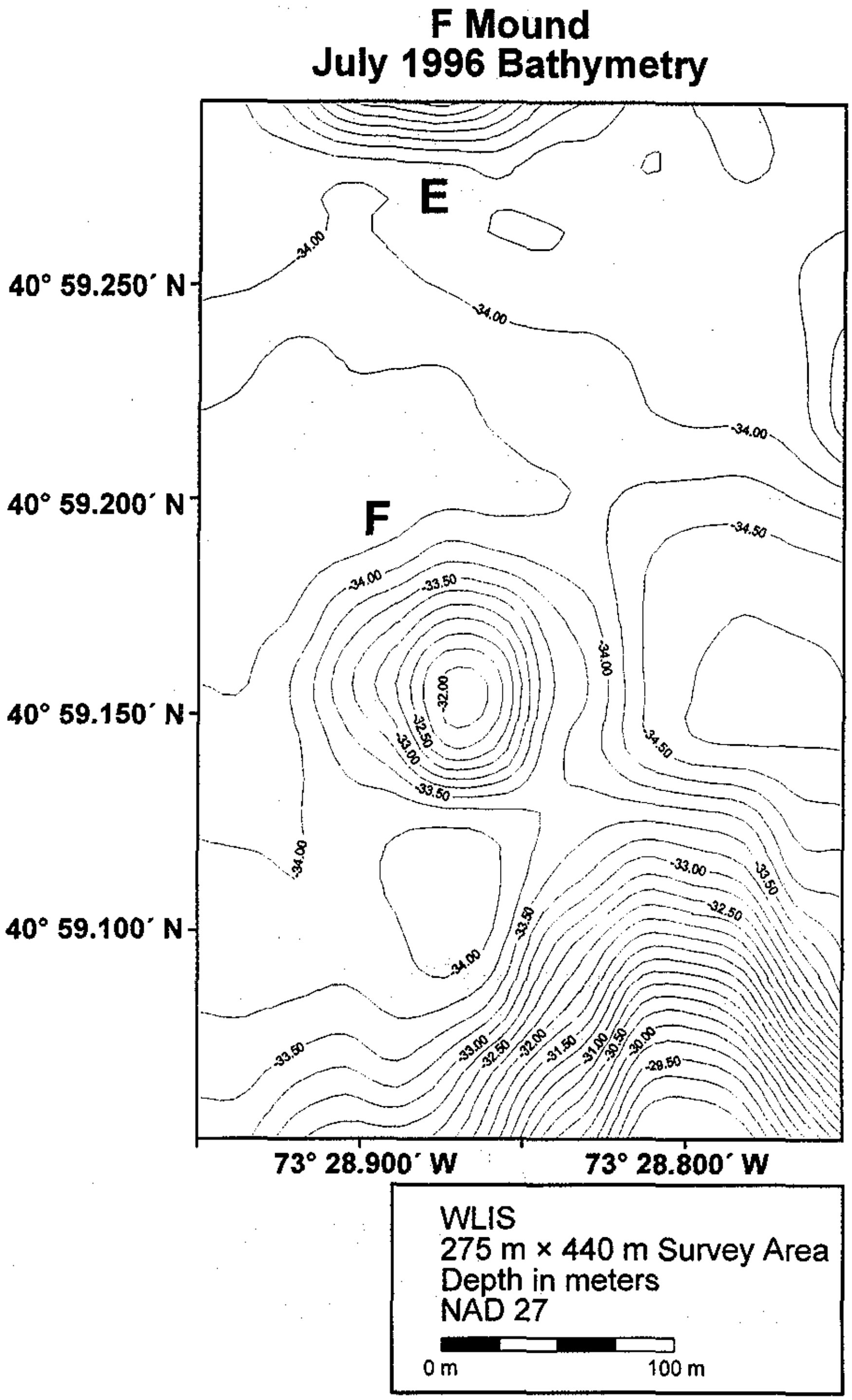


Figure 3-17. Bathymetric chart of the July 1996, 275 m × 440 m analysis area around the F mound, 0.25 m contour interval

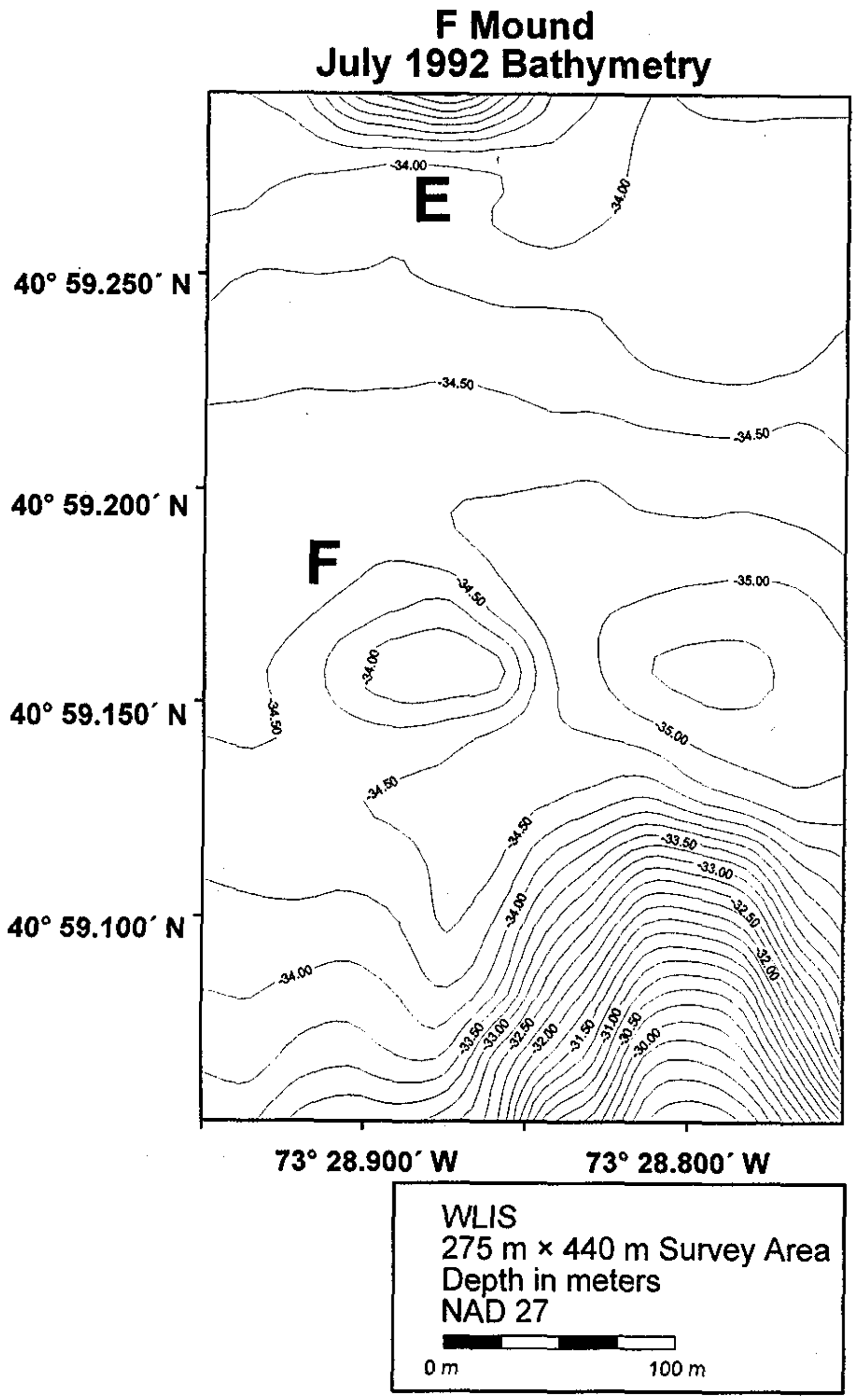


Figure 3-18. Bathymetric chart of the July 1992, 275 m × 440 m analysis area around the F mound, 0.25 m contour interval

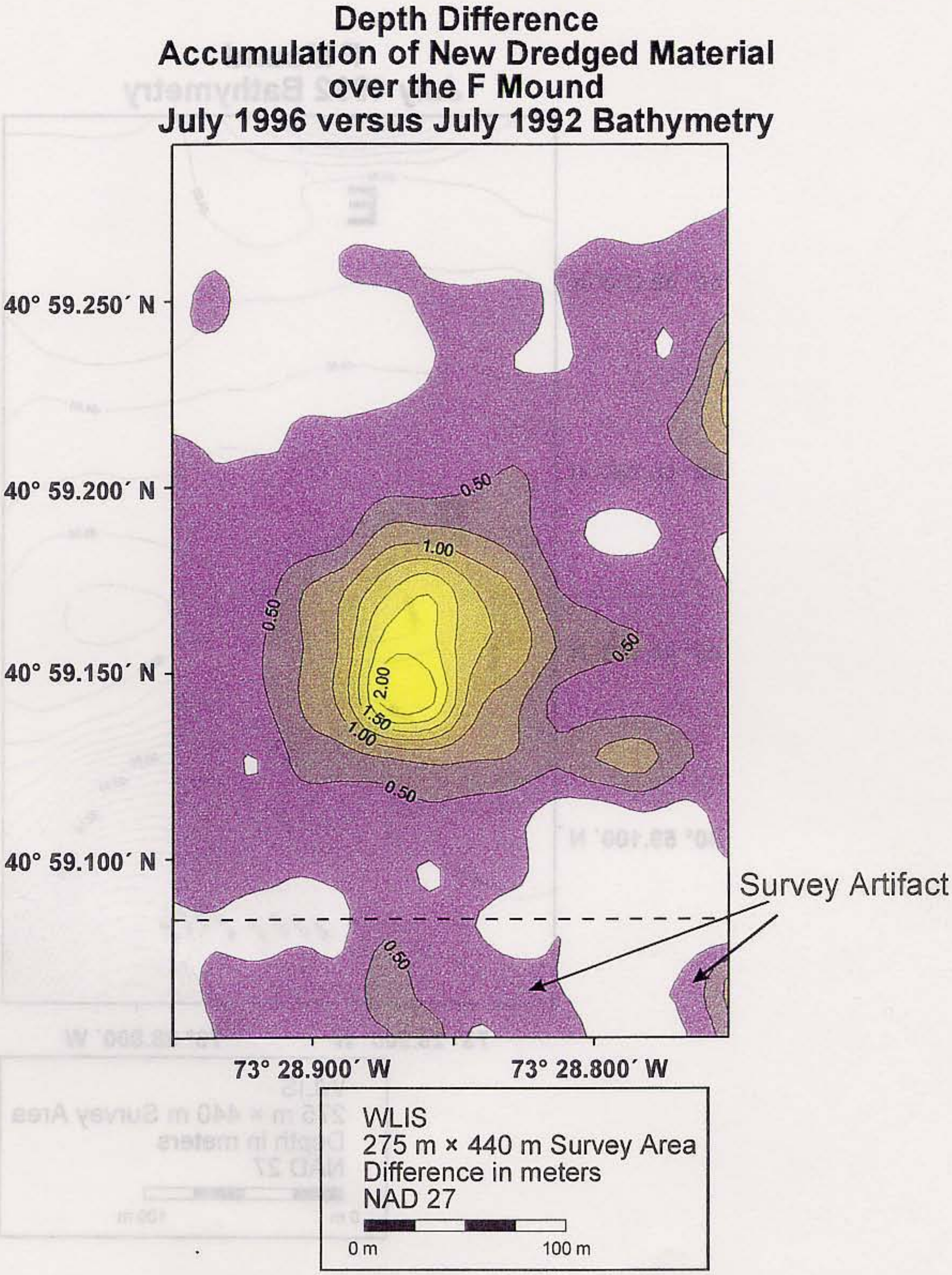


Figure 3-19. Depth difference plot of the 275 m × 440 m analysis area, July 1996 versus July 1992, 0.25 m contour interval

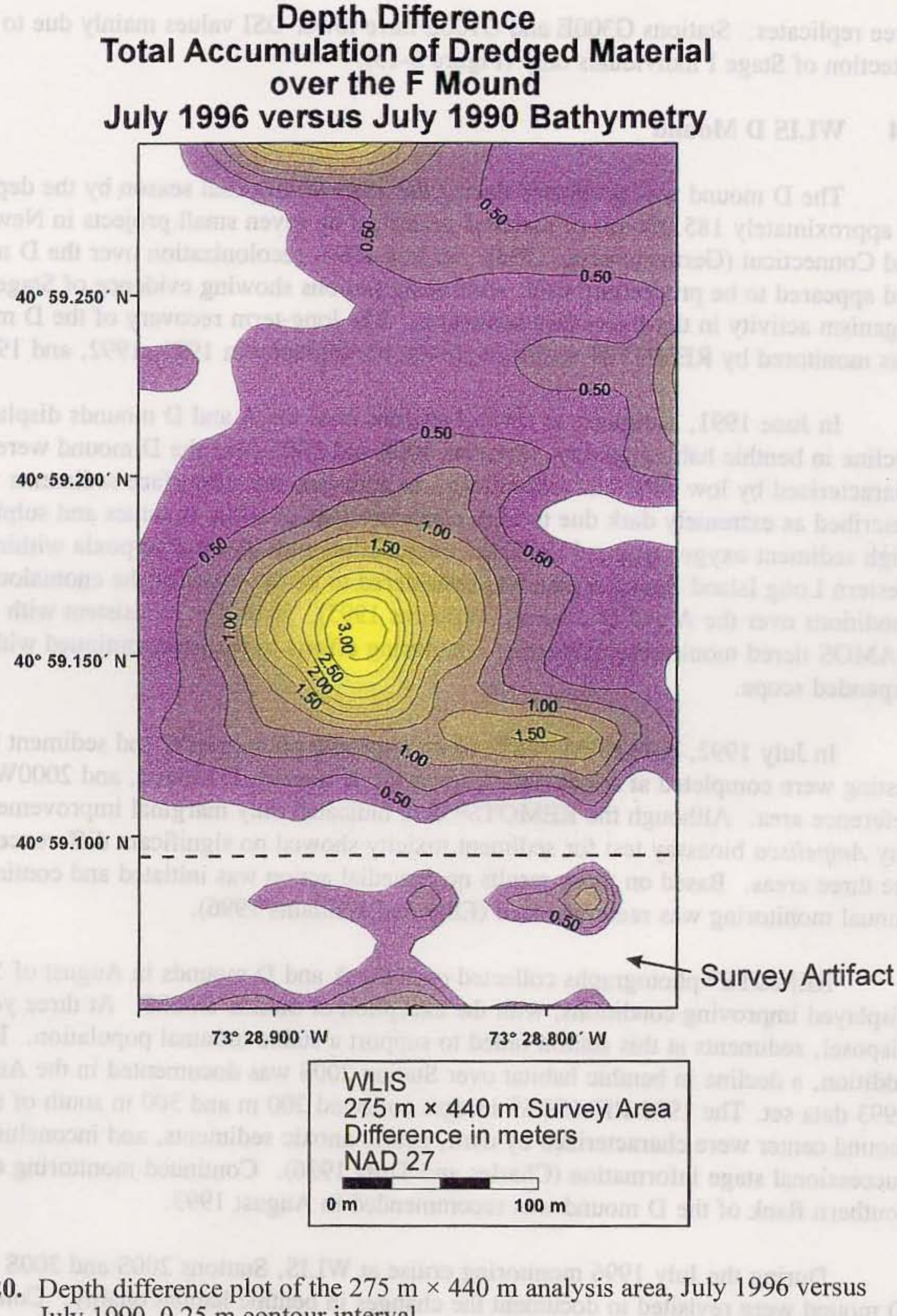


Figure 3-20. Depth difference plot of the 275 m × 440 m analysis area, July 1996 versus July 1990, 0.25 m contour interval

three replicates. Stations G300E and G100E have lower OSI values mainly due to the detection of Stage I individuals only (Figure 3-15).

3.4 WLIS D Mound

The D mound was developed during the 1989-90 disposal season by the deposition of approximately 185,000 m^3 of material generated by seven small projects in New York and Connecticut (Germano et al. 1993). In July 1990, recolonization over the D mound had appeared to be proceeding well, with many stations showing evidence of Stage III organism activity in the subsurface sediments. The long-term recovery of the D mound was monitored by REMOTS® sediment-profile photography in 1991, 1992, and 1993.

In June 1991, sediments at several stations over the A and D mounds displayed a decline in benthic habitat quality. Stations 100S and 300S over the D mound were characterized by low RPD and OSI values. In addition, the subsurface sediments were described as extremely dark due to high concentrations of labile organics and sulphides. High sediment oxygen demand (SOD) in conjunction with seasonal hypoxia within the western Long Island Sound region was considered to be the cause of the anomalous conditions over the A and D mounds (Williams 1995). However, consistent with the DAMOS tiered monitoring protocols, monitoring efforts in the area continued with an expanded scope.

In July 1992, both REMOTS® sediment-profile photography and sediment toxicity testing were completed at select stations over the A mound, D mound, and 2000W reference area. Although the REMOTS® data indicated only marginal improvement, a 10-day *Ampelisca* bioassay test for sediment toxicity showed no significant difference between the three areas. Based on those results no remedial action was initiated and continued annual monitoring was recommended (Eller and Williams 1996).

REMOTS® photographs collected over the A and D mounds in August of 1993 displayed improving conditions, with the exception of Station D300S. At three years post-disposal, sediments at this station failed to support a stable infaunal population. In addition, a decline in benthic habitat over Station 200S was documented in the August 1993 data set. The 1993 REMOTS® images collected 200 m and 300 m south of the D mound center were characterized by dark, nearly anoxic sediments, and inconclusive successional stage information (Charles and Tufts 1996). Continued monitoring of the southern flank of the D mound was recommended in August 1993.

During the July 1996 monitoring cruise at WLIS, Stations 200S and 300S over the D mound were revisited to document the changes in benthic habitat quality. Complete

REMOTS® results for the WLIS D mound are available in Appendix D. The results of the 1996 survey showed significant variability between the three replicates at each station. In general, Station 300S showed strong improvement with a median OSI of 8.0 and RPD depth of 2.74 cm (Figure 3-21; Appendix A, Table 3-3). Stage III individuals were detected in the subsurface sediments in two of three replicates, and biogenic activity was responsible for surface roughness.

One replicate at Station D200S showed excellent benthic conditions with the presence of Stage III activity, an RPD depth of 3.61 cm, and an OSI value of 10. However, the two remaining replicates displayed indications of low DO, Stage I individuals only, and negative OSI values (Figure 3-22). As a result, the replicate-averaged values, and the overall impression of benthic community health were degraded for Station 200S.

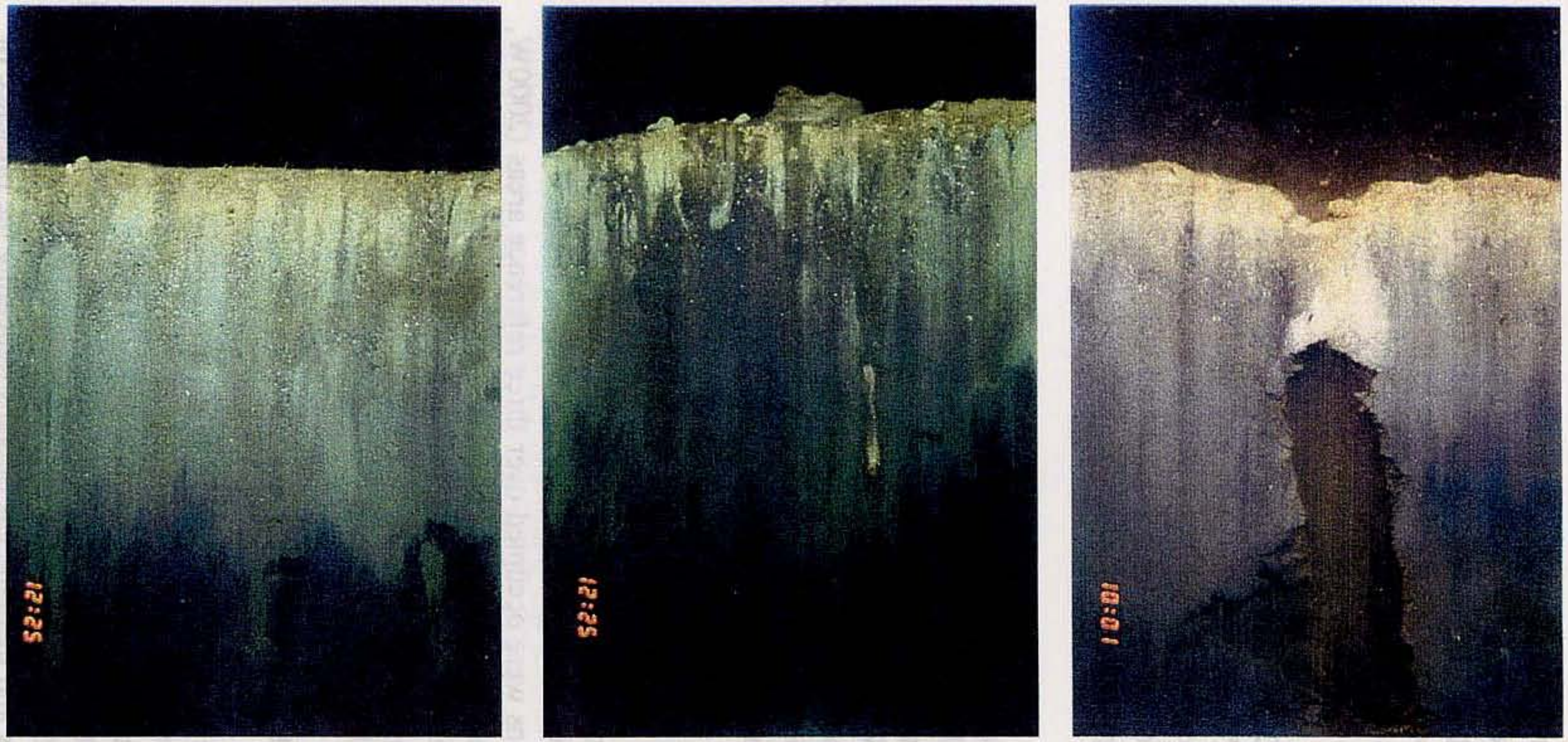
The variability between replicates within a 25 m watch circle suggests that the poor benthic conditions are part of a localized problem between the stations 200 m and 300 m south of the D mound center. Further evidence of this isolation are the favorable conditions detected at Station G100W, approximately 25 m north-northeast of D200S (Figure 3-23). Depth difference plots indicated the apron of the newly developed G mound may have spread over D200S and D300S. However, the accumulation was not sufficient to establish a healthy benthic environment in some areas.

3.5 WLIS Reference Areas

As part of the DAMOS tiered monitoring protocols, reference area data are collected to provide a baseline against which results from the dredged material mounds are compared. A total of thirteen stations were occupied over three reference areas (2000W, SOUTH, and SW-REF). Reference area 2000W has been used for comparisons with WLIS sediments since the November 1987 monitoring cruise; SOUTH and SW-REF are recent additions to the DAMOS Program (SAIC 1990). Complete REMOTS® results for the WLIS reference areas are available in Appendix E.

3.5.1 Sediment Grain Size and Stratigraphy

In the past, several reference areas (EAST, WLIS-REF, and 2000S) in the vicinity of WLIS have been abandoned due to detection of the presence of dredged material resulting from earlier deposition at the surrounding historic disposal sites. Unfortunately, the latest REMOTS® data set collected over the 2000W reference area, which is positioned inside the northwestern boundary of the historic Stamford Disposal Site, has detected the presence of dark, reduced sediments and methane gas bubbles indicating the presence of



Replicate B

Replicate C

Replicate D

Station D300S

Figure 3-21. Three REMOTS® photographs collected at Station 300S over the WLIS D mound, depicting the favorable benthic conditions and the level of variability between replicates

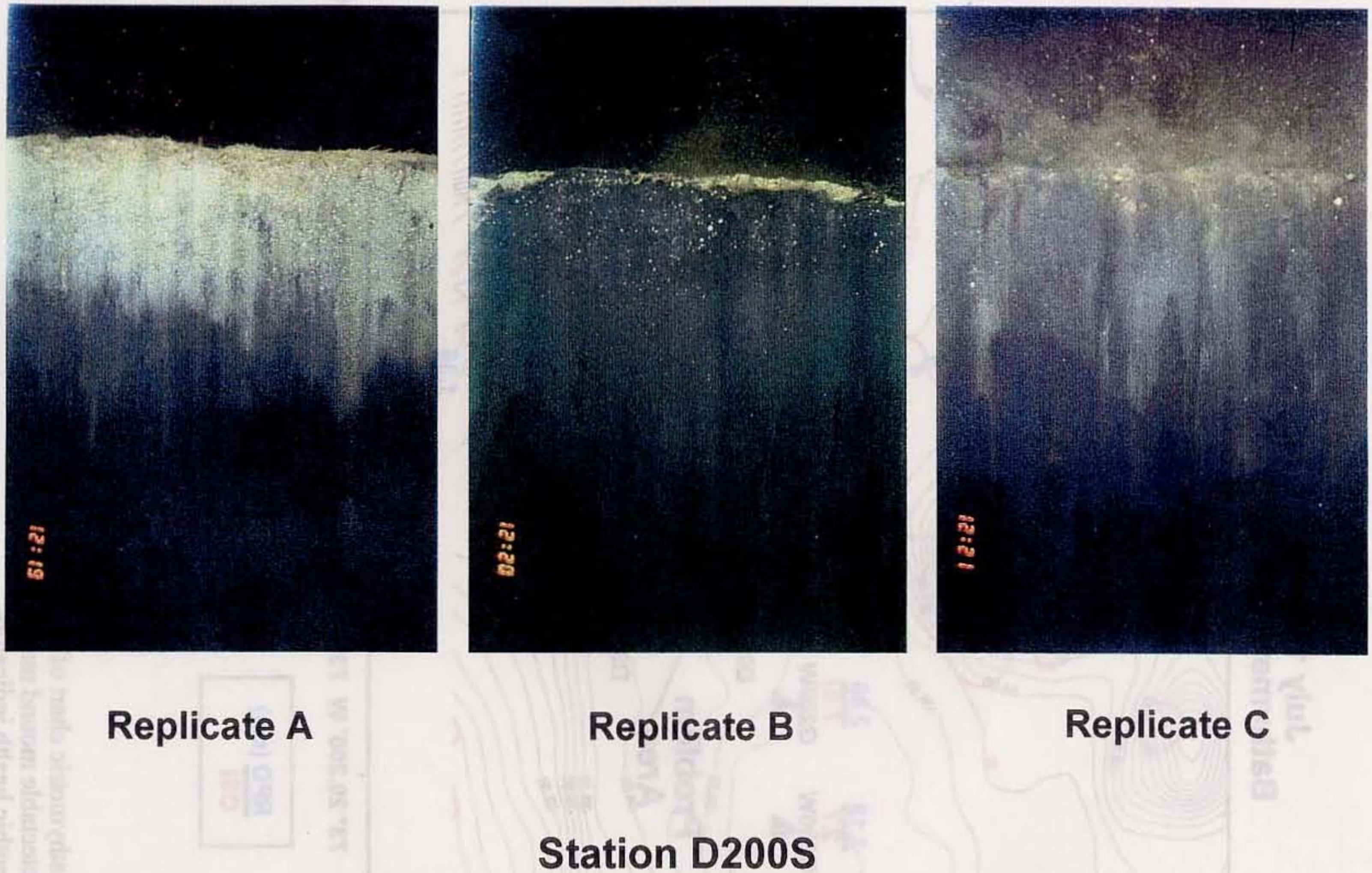


Figure 3-22. Three REMOTS® photographs collected at Station 200S over the WLIS D mound, depicting the poor benthic conditions and the level of variability between replicates

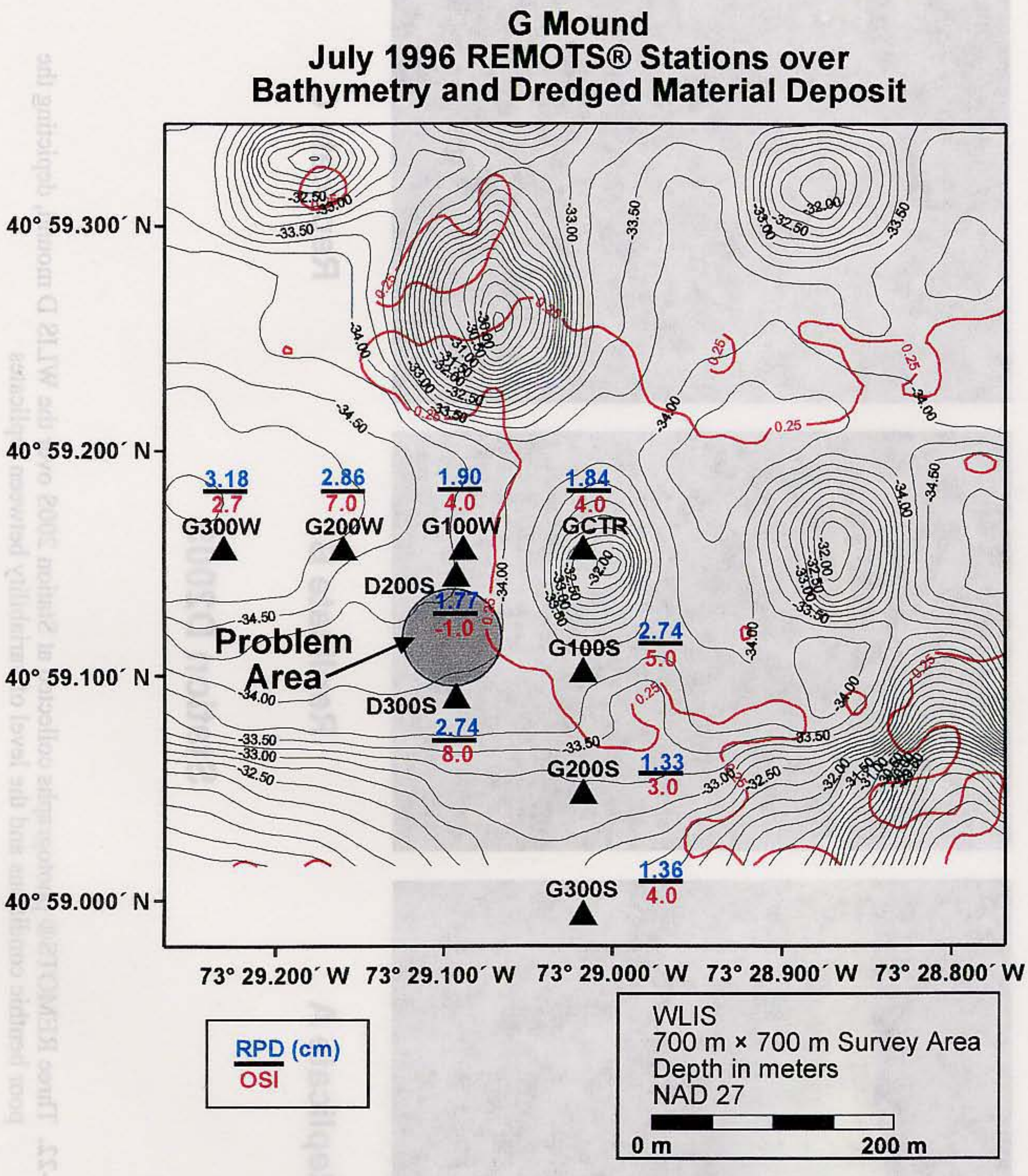


Figure 3-23. Bathymetric chart of the 700 m × 700 m analysis area overlaid by the final detectable mound margin, WLIS D and G mound REMOTS® stations and benthic health indicators

weathered dredged material (Figure 3-24A and B). These dark sediments were detected at all four stations sampled within the vicinity of the 2000W reference area.

The presence of dredged material in stations sampled at 2000W appeared to alter the characterization of the benthic environment, relative to SOUTH and SW-REF. The major modal grain size at 2000W was consistently classified as >4 phi (silts and clays), and replicate-average boundary roughness measurements ranged from 0.41 cm to 5.02 cm. The sediments at SOUTH and SW-REF displayed more of a fine sand component with many replicates classified as 4 to 3 phi major modal grain size. In addition, the boundary roughness range was considerably narrower, relative to 2000W, with replicate-averaged values from 0.46 cm to 1.75 cm (Appendix A, Table 3-4). The most common type of surface roughness within all three reference areas appeared to be physical in nature.

3.5.2 Benthic Community Assessment

Overall, the mean RPD values at the 2000W stations seemed to be affected by the presence of historic dredged material, with shallower depths relative to SOUTH and SW-REF. The replicate-averaged RPD depths at 2000W ranged from 0.92 cm to 2.88 cm, with low DO conditions detected in replicates of STA 1 and STA 4. In comparison, the replicate-averaged RPD depths at SOUTH and SW-REF were deeper, ranging from 1.61 cm to 3.89 cm. However, low DO conditions were also discovered in one replicate of STA 7 within reference area SOUTH.

The successional stage status of reference area 2000W appears to be adversely affected as well. Four replicate photographs collected over 2000W were classified as azoic or indeterminate. The remaining six replicates showed Stage I organisms in the surface sediments with two of the six photographs displaying evidence of Stage III activity in the subsurface layers. In addition to dark sulphidic sediments and a shallow RPD, methane gas was detected in one replicate of STA 4 (Figure 3-24A). As a result of the poor benthic conditions at STA 1 and STA 4 within 2000W, median OSI values for the reference area ranged from -2.0 to 5.0 (Appendix A, Table 3-4).

Reference area SOUTH can be characterized as Stage I, with limited Stage III activity detected at STA 7 and STA 8. Deep RPD depths served to elevate the median OSI values to a range of 3.5 to 9.0 (Appendix A, Table 3-4). A thin layer of recently deposited reduced sediment was detected in one replicate of STA 8, but had no adverse impact on benthic conditions. At first, the gray, reduced clasts appear to be camera artifacts, sediments carried from previous replicate locations and deposited by the REMOTS® camera base frame or housing. However, closer examination of this recently deposited material detected the presence of oxidized particles and Stage I pioneering

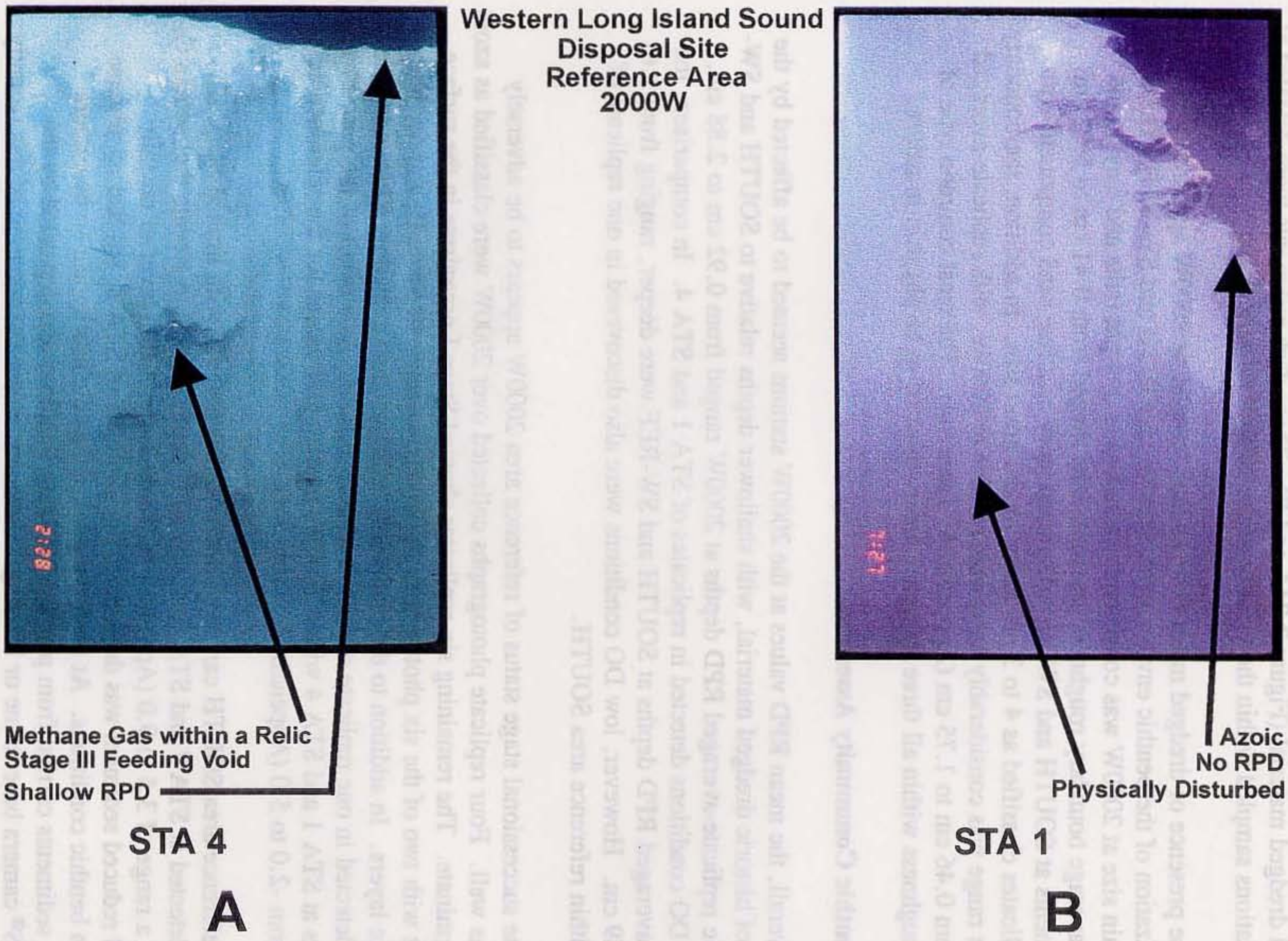


Figure 3-24. REMOTS® photographs collected at STA 4 and STA 1 over reference area 2000W depicting dark, sulphidic sediments, poor benthic conditions, and evidence of physical disturbance

polychaete worm tubes, indicative of the early stages of benthic recolonization (Figure 3-25A). Sediments supporting Stage I individuals usually require two weeks or more in a zero to low disturbance regime to establish an infaunal population. In addition, Stage III foraging activity appears to have incorporated a portion of the new material into the subsurface sediments. Thus, the observed mud clasts appear related to other forms of physical disturbance.

Overall, the newest WLIS reference area, SW-REF, appeared to be relatively undisturbed and supporting a stable benthic infaunal population. The REMOTS® photographs detected Stage I organisms in all fourteen replicates with evidence of Stage III activity represented in eight photographs. Median OSI values for SW-REF ranged from 4.0 at STA 13 (moderate RPD/Stage I population only) to 11.0 at STA 9 (deep RPD/Stage I on III population; Figure 3-25B).

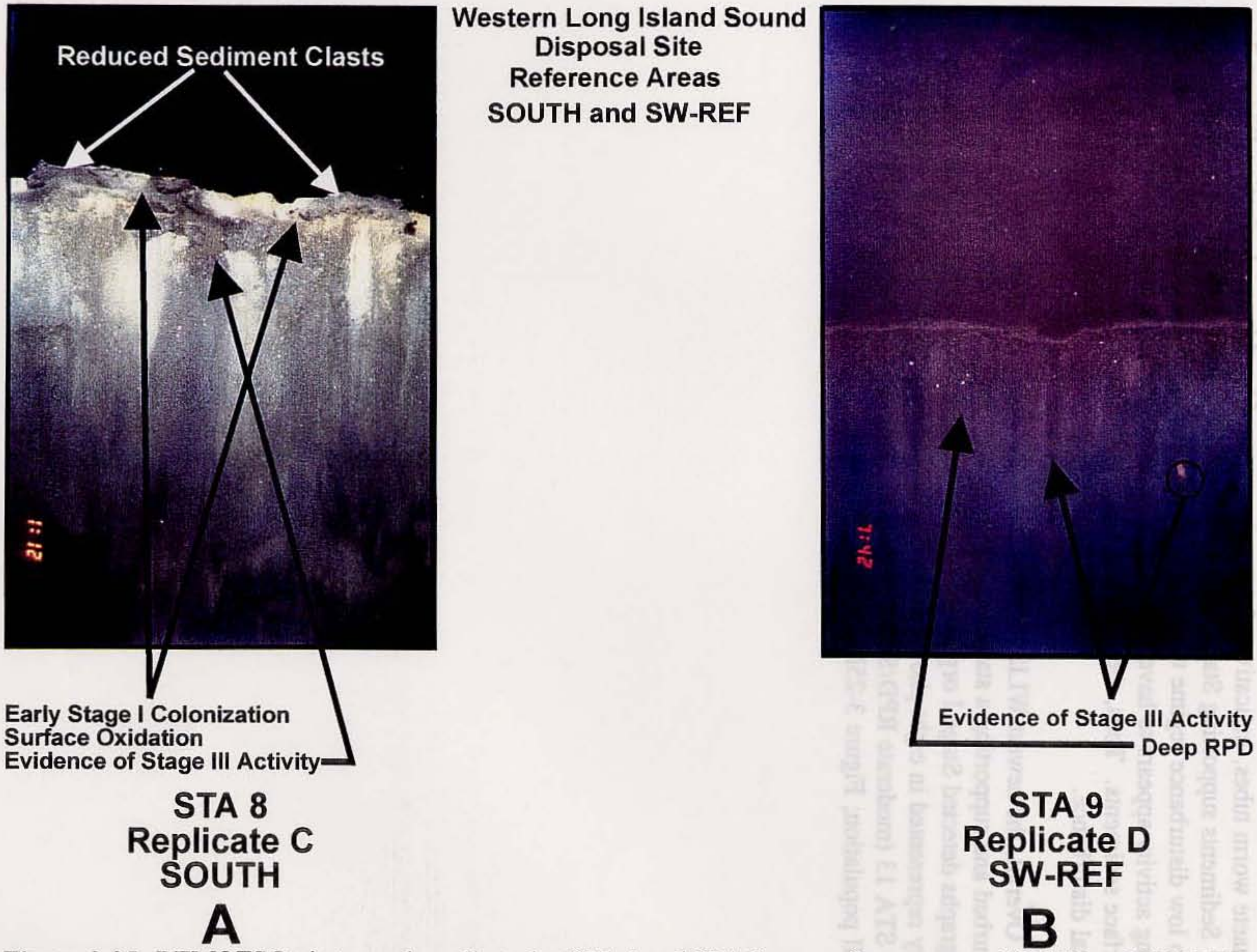


Figure 3-25. REMOTS® photographs collected at STA 8 and STA 9 over reference areas SOUTH and SW-REF, respectively, depicting a thin layer of reduced material at the sediment-water interface (STA 8) and conditions indicative of an OSI value of +11 (STA 9)

4.0 DISCUSSION

The July 1996 survey operation represents the first monitoring effort conducted at WLIS, since the 1993 REMOTS® sediment-profile photography survey. Within this three-year period, two new disposal mounds were developed on the WLIS seafloor and a third mound received a considerable volume of supplemental dredged material. Depth difference comparisons with the 1992 and 1990 bathymetric surveys display the new sediment mounds as discrete bottom features connected by a ridge of material 0.25 m thick, formed by overlapping mound aprons (Figure 3-4).

In accordance with the successful management strategy demonstrated at CLIS, the recent disposal activity at WLIS has been tightly controlled in order to construct rings of disposal mounds. Upon completion, these rings of mounds will provide large cells of lateral containment and maximize the available space within the 5.29 km^2 area of the disposal site. As of July 1996, the first cell nears completion as the WLIS D, E, F, G, and H mounds begin to form an artificial containment ridge. The development of small dredged material disposal mounds between D-E; E-H; and H-F will close the ring in the near future (Figure 4-1).

Supplementary lateral containment measures could be achieved by utilizing the natural containment ridge provided by the steep slopes of the terminal moraine margin. Large volumes of dredged material could be confined by strategically constructing sediment mounds in a semi-circle pattern north of the terminal moraine margin. The placement of one additional mound approximately 150 m southwest of WLIS G would complete such a structure (Figure 4-2). The resulting cell could facilitate the deposition of a large volume of fine-grained dredged material and minimize the development of a wide, thin apron.

Records pertaining to dredging and sediment deposition in the Long Island Sound region between 1954 and 1976 indicate sediments excavated from the channels and harbors that border Long Island Sound were transported to as many as 19 open water disposal sites. In most cases, dredging operations within each harbor utilized a distinct area of seafloor for the disposal of sediments (Fredette et al. 1992). A total of eight disposal sites (Bridgeport, Eaton's Neck, Norwalk, Port Jefferson, Smithtown, South Norwalk, Southport, and Stamford) were established between the East River and Stratford Shoal from 1954 to 1972 (Figure 1-1). The nearly two decades of disposal activity over these sites led to relatively broad distribution of dredged material within western Long Island Sound prior to the institution of the DAMOS Program (estimated total of 22 million cubic yards, with close to 60% released at Eaton's Neck).

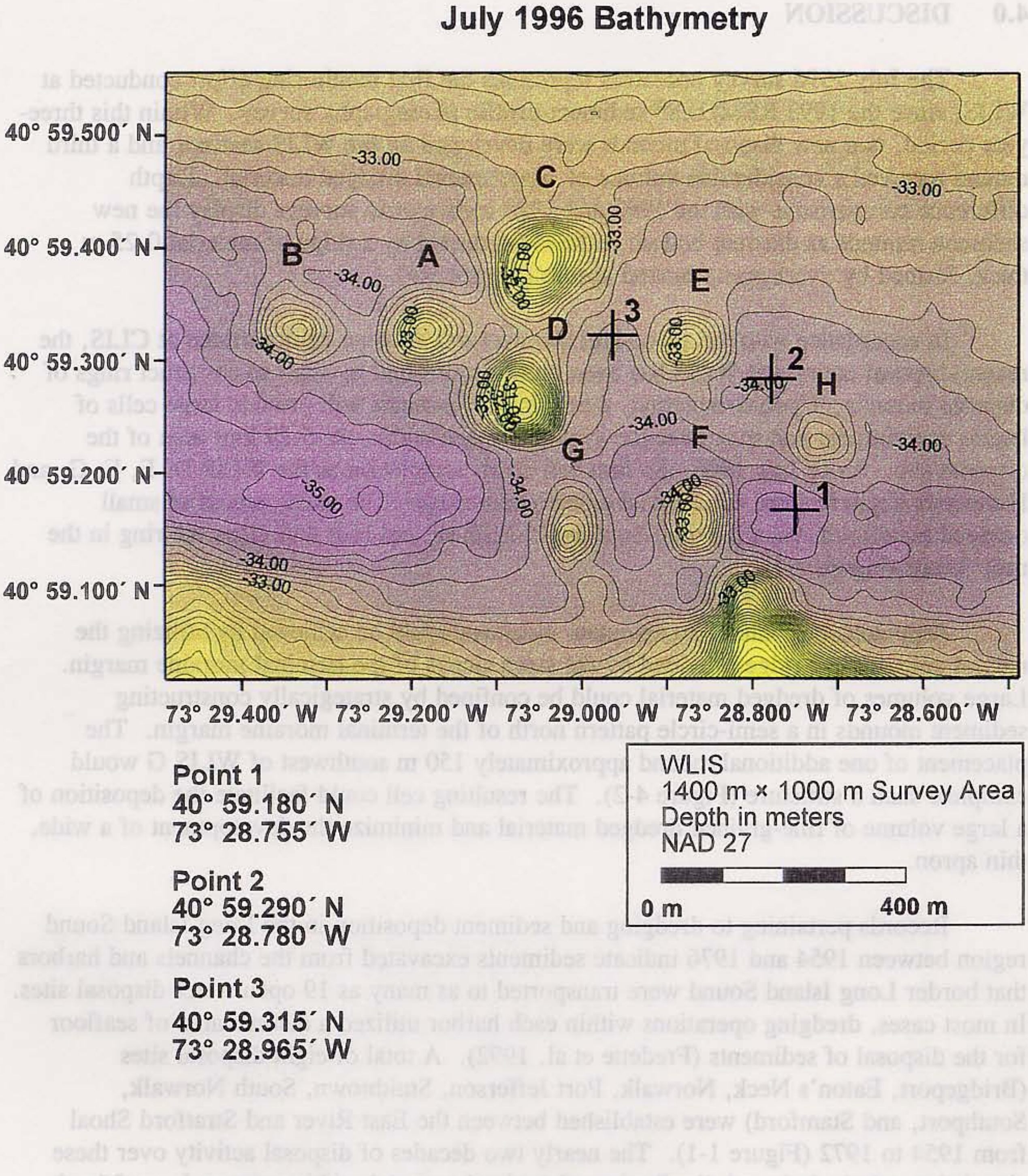


Figure 4-1. Bathymetric chart of the July 1996, 1400 m × 1000 m survey area over WLIS, with recommended disposal locations for future disposal seasons, 0.25 m contour interval

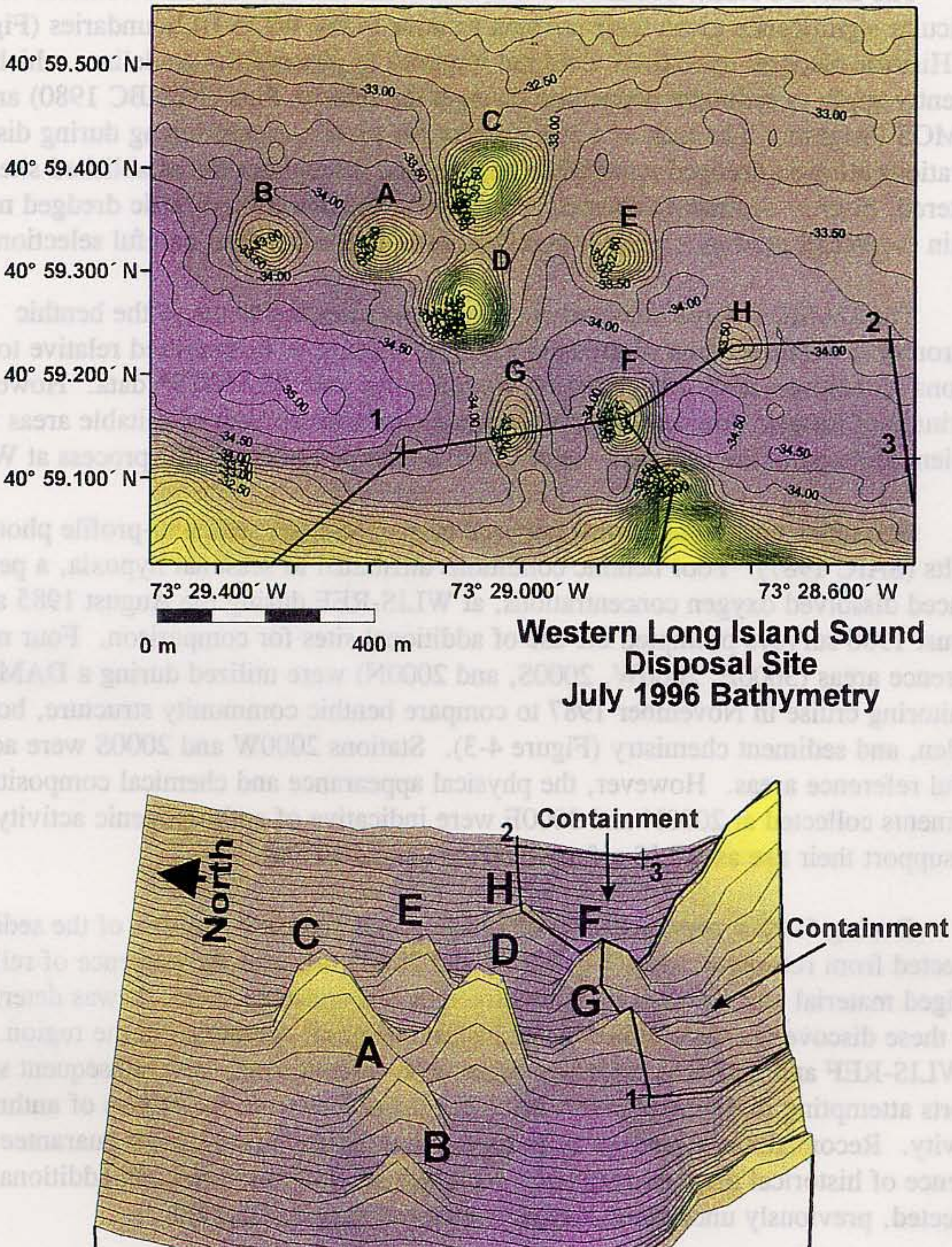


Figure 4-2. Bathymetric chart and three-dimensional view of the 1996 survey area over WLIS with recommended disposal locations to complete supplemental containment areas

The Eaton's Neck, South Norwalk, and Stamford disposal sites continue to be of particular significance given their position relative to the WLIS III boundaries (Figure 4-3). Historic disposal operations were not required to observe the guidelines which currently apply to sediment deposition through the Interim Plan (NERBC 1980) and the DAMOS Program. The lack of a requirement for precision positioning during disposal operations allowed dredged material to be disposed throughout the established sites as scattered, discrete sediment deposits. As a result, the detection of relic dredged material within the WLIS reference areas is possible, even following their careful selection.

The DAMOS tiered monitoring protocol requires the status of the benthic environment within an area of dredged material disposal to be analyzed relative to the regional conditions as characterized by the reference area REMOTS® data. However, the multitude of historic dredged material disposal sites and the lack of suitable areas with ambient material at the sediment-water interface has complicated this process at WLIS.

Reference area comparisons are used to ground-truth sediment-profile photography results (SAIC 1987). Poor benthic conditions attributed to seasonal hypoxia, a period of reduced dissolved oxygen concentrations, at WLIS-REF during the August 1985 and August 1986 surveys prompted the use of additional sites for comparison. Four new reference areas (3000E, 2000W, 2000S, and 2000N) were utilized during a DAMOS monitoring cruise in November 1987 to compare benthic community structure, body burden, and sediment chemistry (Figure 4-3). Stations 2000W and 2000S were accepted as useful reference areas. However, the physical appearance and chemical composition of the sediments collected at 2000N and 3000E were indicative of anthropogenic activity and did not support their use as WLIS reference areas (SAIC 1990a).

During 1991 survey, REMOTS® imagery and chemical analysis of the sediments collected from reference areas WLIS-REF and 2000S detected the presence of relic dredged material and elevated PAH and trace metals concentrations. It was determined that these discoveries were linked to the historic disposal operations in the region. The use of WLIS-REF and 2000S as reference areas were discontinued, with subsequent survey efforts attempting to define two new reference areas free from the effects of anthropogenic activity. Reconnaissance surveys of prospective reference areas cannot guarantee the absence of historical dredged material. As reference areas are used and additional data are collected, previously undetected historical material may be sampled.

In 1992, more detailed physical and chemical analysis of western Long Island Sound sediments led to the acceptance of reference area SOUTH (40°58.688' N latitude, 73°29.201' W longitude) as a replacement for 2000S. A second prospective reference area, EAST (alternate to WLIS-REF), was utilized for comparison with WLIS sediments once (in 1992) before being abandoned due to the subsequent discovery of relic dredged

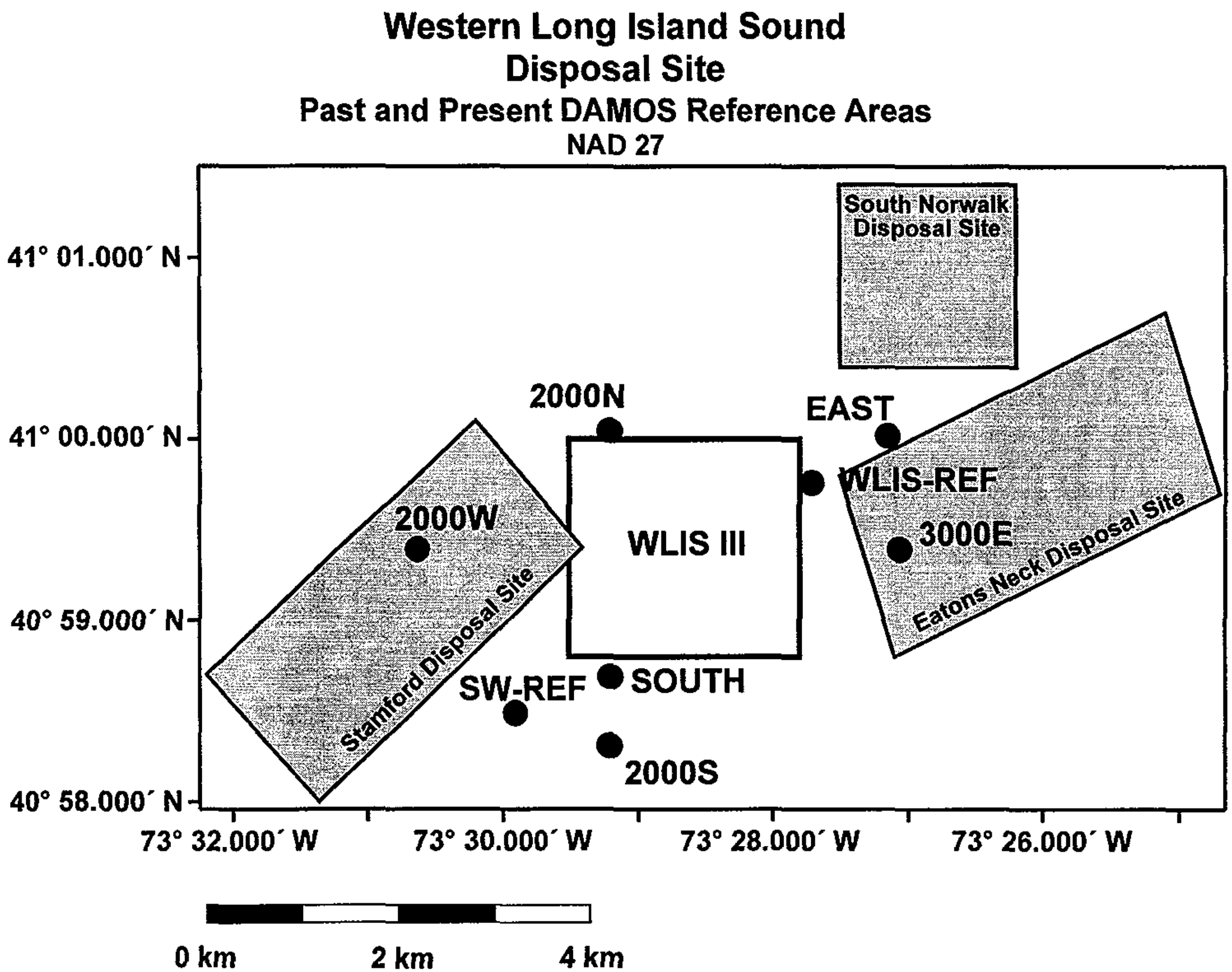


Figure 4-3. Location of past and present WLIS reference areas relative to WLIS III and discontinued disposal site boundaries

material (Eller and Williams 1996). In August 1993, efforts to establish a third reference area at WLIS led to the acceptance of SW-REF (40°58.688' N, 73°29.909' W) as a permanent replacement for WLIS-REF (Charles and Tufts 1996).

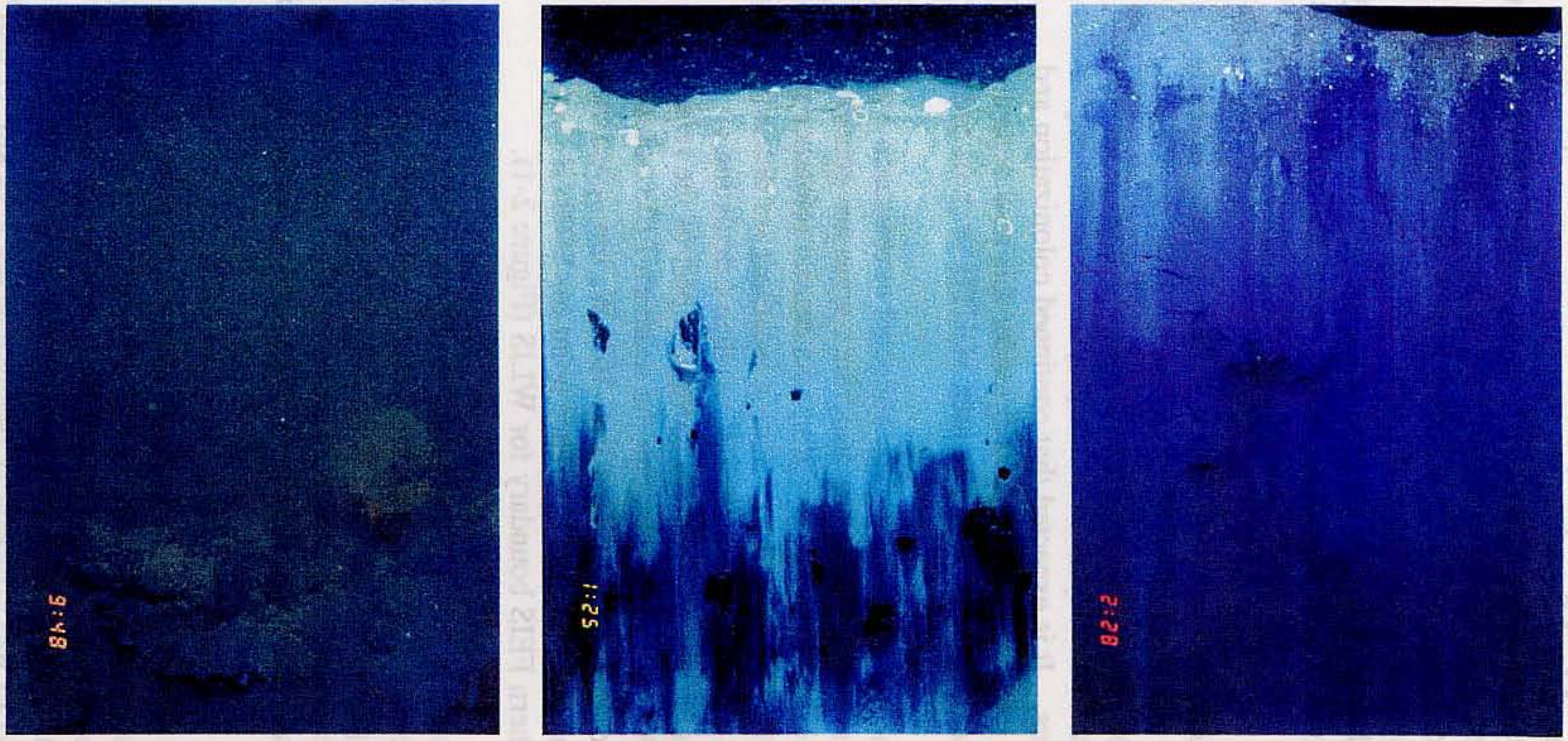
During the 1996 REMOTS® survey, photographs collected over the WLIS reference areas indicated the presence of ambient sediments at SW-REF and SOUTH, as well as dark, reduced sediments and methane gas pockets (indicative of dredged material deposition) at 2000W.

Reference area 2000W lies within the boundaries of the historic Stamford Disposal Site and has been utilized for sediment and benthic habitat comparison with the material deposited at WLIS since 1987. Although not directly linked to recent (1982 to present) dredged material deposition, conditions indicative of anthropogenic activity have been detected during REMOTS® surveys in 1991 and 1992 (Eller and Williams 1996; Figure 4-4). The July 1996 survey found darker and finer grained sediments at 2000W relative to SOUTH and SW-REF stations. Although the majority of replicate photographs obtained over 2000W display a well-defined RPD and Stage I or Stage I on III benthic infaunal community, data collected at STA 1 and STA 4 raise questions concerning the validity of this reference area.

High boundary roughness measurements, no discernible RPD, successional stage classifications of indeterminate or azoic, and correspondingly low OSI values were detected in one replicate of STA 1 and two replicates of STA 4 at 2000W. These conditions could be attributable to recent physical disturbances at the sediment-water interface (i.e., trawling, dragging of lobster gear across the bottom, etc.). However, the dark appearance of the subsurface sediments, the presence of methane gas, and the questionable history of the reference area suggest the poor benthic conditions could be due to chronic problems below the penetration limit of the REMOTS® camera.

Without detailed physical and chemical analysis of the 2000W sediments through comprehensive grab sampling and geotechnical coring, a definitive cause for the poor benthic conditions will not be found. Despite this lack of data, visual comparisons between the three reference areas show that portions of 2000W presently do not reflect the benthic conditions displayed in ambient western Long Island Sound sediments. To date, a total of three WLIS reference areas (EAST, WLIS-REF, and 2000S) have been abandoned due to the presence of dredged material. The same course of action is recommended for 2000W, with a replacement reference area being delineated to the southeast of WLIS, away from present and historic disposal activity.

The discovery of a thin layer of reduced material over oxidized sediments in one replicate of STA 8 may also be attributed to dredged material disposal in the region. It is possible that a small amount of disposal barge spillage had occurred over reference area SOUTH during the final phase of deposition at the WDA 95 buoy position (WLIS H



June 1991

Physically Disturbed Surface Layers
Presence of Non-Ambient, Larger Grains

July 1992

Shell Fragments
Deep RPD
Dark, Sulphidic Sub-Surface Sediments
Abundance of Methane Gas

July 1996

Shell Hash
Low DO Conditions
Dark, Sulphidic Sub-Surface Sediments
Methane Gas

Reference Area 2000W

Figure 4-4. REMOTS® photographs collected over reference area 2000W depicting effects of anthropogenic activity detected during survey operations in June 1991, July 1992, and July 1996 mound). However, the western Long Island Sound region supports an extremely active American lobster fishery, with thousands of traps, or "pots", deployed and recovered on a daily basis. Given the size, angular shape, and gray color of the sediment clasts, the deposit detected in one replicate photograph collected at STA 8 is probably attributable to the recent (one to two weeks) deployment or recovery of lobster fishing gear within the confines of the reference area. As lobster traps are dragged along the bottom, silt and clay collect in the wire mesh and will eventually be dislodged, falling to the seafloor as clumps of sediment.

The gray clasts of recently deposited sediment appear to be supporting an early Stage I population with small tubes and areas of oxidized sediment visible over their surfaces (Figure 3-25A). In addition, Stage III foraging activity has begun to incorporate this new material into the surficial sediment layers as errant polychaete worms exploit the organic content of the sediment clasts. It is expected that continued colonization and bioturbation activity by the benthic infaunal community will render this new deposit indistinguishable from the surface sediments of reference area SOUTH in short order.

The scrutiny given to this one replicate photograph collected at reference area SOUTH has resulted in the discovery of another issue. Reference areas are generally sampled at randomly selected stations within a 300 m radius of a central reference point (SOUTH: 40°58.688' N, 73°29.201' W; Figure 4-5). Station locations are determined by assigning a range and bearing from the central reference point, then calculating a geographic location (latitude and longitude) in NAD 27. Although part of the reference area random sampling scheme, STA 8 actually lies within the southern FEIS boundary of WLIS (Figure 2-1). STA 8, located at 40°58.839' N, 73°29.162' W, lies approximately 285 m north-northeast (11° azimuth) of the central reference point for SOUTH, but falls approximately 72 m inside the southern FEIS boundary for WLIS (Figure 2-1).

Reference area selection criteria in July 1992 required finding a suitable area with a comparable water depth to WLIS, located outside active or discontinued disposal sites, and in relatively close proximity to the previously utilized 2000S reference area (Eller and Williams 1996). The geographic locations of the several proposed WLIS reference areas were selected from a NOAA nautical chart (No. 12363) and compared to the boundaries of the disposal site.

The results of the July 1992 field investigations determined the proposed SOUTH reference area to be a suitable replacement for 2000S, free of dredged material deposition and other indications of anthropogenic activity. The new reference point was located 392 m south of the disposal site with a water depth of approximately 23 m (75 ft) at MLLW. However, in July 1992 WLIS was erroneously reported as the 3.42 km^2 (1 nmi^2) area by the DAMOS Program, not taking into account the description of the disposal site

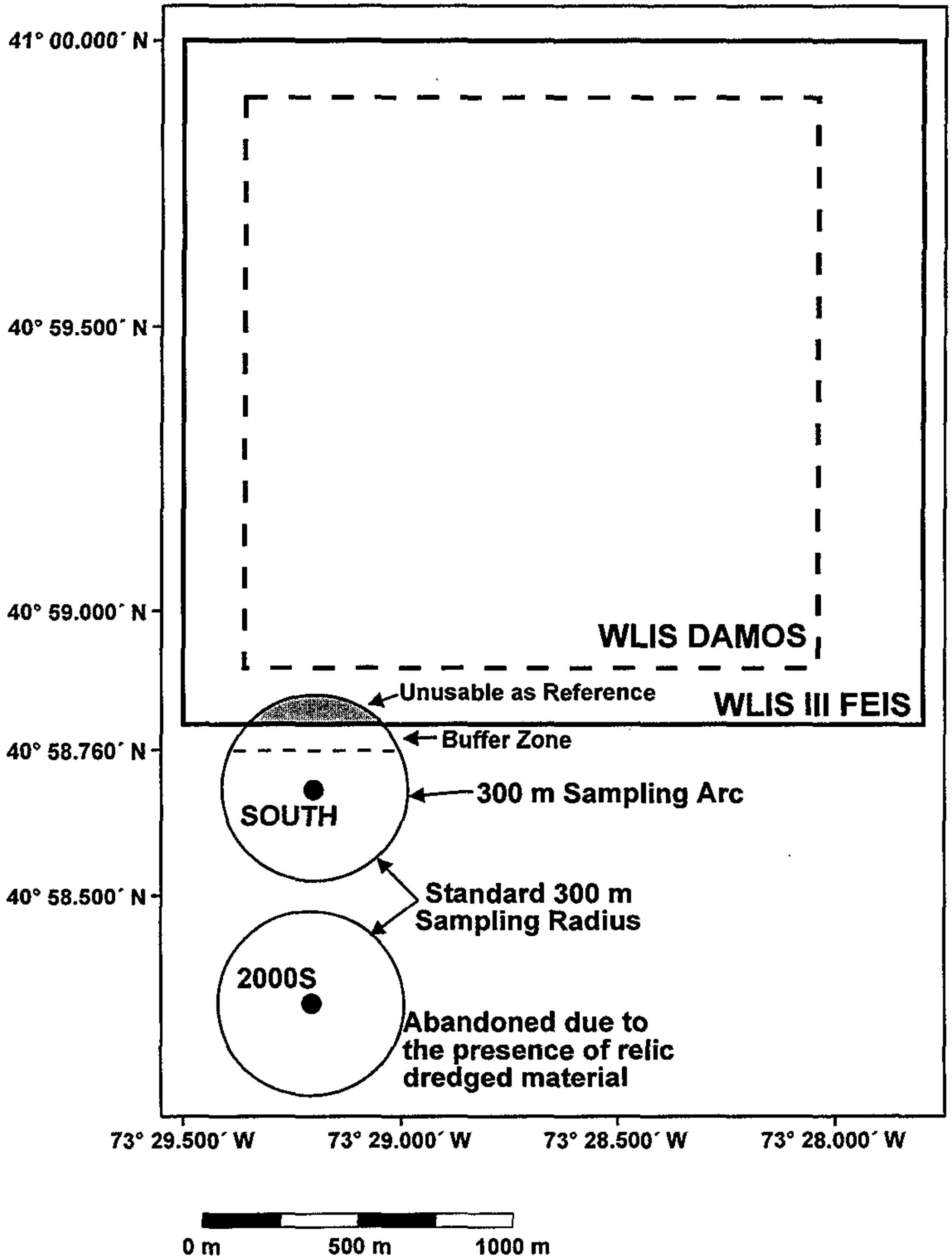


Figure 4-5. Base map displaying the FEIS and previously used DAMOS disposal site boundaries relative to the sampling radii of reference area SOUTH, and former reference area 2000S

as outlined in the 1982 FEIS. The use of the WLIS III boundaries, in conjunction with the SOUTH reference area location, provides only 207 m of separation between the disposal site and the central reference point (Figure 4-5).

The satisfaction of a minimum distance requirement has not been part of the selection criteria for the reference areas utilized by the DAMOS Program. In fact, the DAMOS tiered monitoring protocols recommend that reference areas and disposal sites should be as near to one another as possible without subjecting the reference stations to the possibility of corruption by disposal operations or postdisposal transport (Germano et. al. 1994). Given the depositional nature of the area surrounding WLIS, and the confinement of disposal operations to the east-west trending bottom depression, SOUTH is expected to remain free of dredged material deposits and valid for comparison with conditions on the WLIS seafloor.

Therefore, it is recommended that future sampling schemes at SOUTH be designed to restrict REMOTS® sediment-profile photography and the collection of surface sediment grabs samples. This would require the institution of a 300 m arc around the central reference point of SOUTH, terminating at a latitude of 40° 58.760′ N (Figure 4-5). Although this approach does not conform to the standard operating procedures followed at other DAMOS reference areas, the semi-circular configuration would provide a better areal representation of the western Long Island Sound seafloor, relative to a reduced sampling radius. In addition, the proposed 300 m arc would establish a 75 m buffer zone between the southern boundary of WLIS and the reference sediments of SOUTH. An alternative would be to move the center of SOUTH 150 m south to eliminate overlap with the disposal site boundary. However, this would require investigation of the area between SOUTH and 2000S, to rule out the presence of relic dredged material. Given the difficulty of finding suitable reference stations for WLIS, the continued use of 2000S, as discussed, is recommended.

Although the results of Stations 1 through 4 over 2000W and STA 8 over SOUTH cannot be used for comparison with the sediments of the WLIS disposal mounds, the remaining stations over WLIS reference areas SOUTH and SW-REF remain valid. The ambient Long Island Sound sediments appeared to be relatively undisturbed with stable benthic infaunal populations and deep RPDs. OSI values of >6 are generally considered indicative of a healthy benthic environment, and the majority of REMOTS® stations over SOUTH and SW-REF met or exceeded that criterion. With respect to all of the physical and biological parameters used to assess the benthic environment through REMOTS® sediment-profile photography, SW-REF exhibited the highest indices of the three reference areas.

Relative to the reference areas, data collected over the majority of the WLIS H, G, and F mounds indicate they are consistent with the normal pattern of recolonization following dredged material disposal. The newest bottom features at WLIS appear to be recolonizing as expected, with the exception of sediments at Station H50W. The WLIS H and G mounds should continue to be monitored on an annual or every other year basis, respectively, to ensure complete recolonization, including the presence of stable, mature, benthic assemblages consistent with the DAMOS tiered monitoring protocol.

Stations 200S and 300S over the D mound were revisited in 1996 due to concern over slow recolonization rates. Station D300S has shown dramatic improvement since the 1993 REMOTS® survey, while slow recolonization at 200S persists (Figures 3-21 and 3-22). The variability between replicates of D200S and D300S and the satisfactory benthic conditions over the nearby G mound indicate that the problem is localized.

In July 1992, it was determined that elevated levels of labile organics were responsible for the poor benthic conditions observed over the southern flank of the WLIS D mound. Dredged material mounds with elevated levels of organic material tend to recover at a slower rate due to the increased chemical oxygen demand (COD) caused by oxidation of the labile organics. Monitored periodically, the southern flank of the D mound has been given six years to allow microbial action and chemical oxidation to break down the organic load in the subsurface sediments. Within those six years, limited improvement in benthic conditions has been documented in the surficial sediment layers. The progression in habitat quality documented at D300S during the July 1996 survey is most likely due to the construction of WLIS G approximately 60 m to the northeast. The development of a wide apron around the G mound provided 10 cm to 20 cm of new sediment to overlay the historic dredged material composing the southern flank of the D mound.

A final solution to the localized problem between D200S and D300S that would facilitate the improvement of benthic conditions, as well as complement a recommended management plan for the disposal site, is the development of a new disposal mound southwest of the G mound center (Figure 4-2). A new sediment deposit composed of high quality dredged material with a lower primary nutrient and organic detritus content would overlie the southern flank of the D mound, covering any existing problems in the subsurface sediment layers. In addition, the new material would assist in closing the supplemental lateral containment cell described above, while promoting a healthy benthic environment through faster recolonization and increased bioturbation.

Sediments with low COD tend to facilitate the development of a healthy benthic environment. By reducing the COD in the subsurface sediments, a higher percentage of the available bottom water dissolved oxygen (DO) can be utilized for biological processes, promoting rapid benthic recolonization. The availability of oxygen in the bottom waters of western Long Island Sound is always a major concern during the summer months. In comparison to other Long Island Sound disposal sites (CLIS, NLDS) benthic recolonization at WLIS tends to be slower, due to the profound effects of seasonal hypoxia.

Hypoxia is a condition of reduced DO concentrations in the water column, generally occurring within the western and central regions of Long Island Sound in mid to late August. The complications associated with seasonal hypoxia and benthic recolonization at WLIS has been documented by DAMOS monitoring efforts since 1985 (SAIC 1987). This annual decrease in DO is the direct result of eutrophication, the influx of primary nutrients from terrestrial sources into the protected waters of western and central Long Island Sound. Although the cause of hypoxia is clearly defined, its onset and severity are directly dependent on many other environmental factors (i.e., nutrient input, frequency of storms, fresh water input, water temperature, etc.).

The Long Island Sound Study (LISS), a US Environmental Protection Agency (EPA) monitoring program, officially recognizes the onset of hypoxia at a DO concentration of 3.0 $mg \cdot l^{-1}$. However, the appearance of hypoxic conditions in the bottom waters and surficial sediment layers has been documented with DO concentrations as high as 5.0 $mg \cdot l^{-1}$ (LISS 1990). Furthermore, bottom water DO concentrations in the East River and extreme western Long Island Sound have been known to fall to anoxic levels (0.0 $mg \cdot l^{-1}$) during the month of August, decimating the entire infaunal population.

During prior monitoring efforts at WLIS, a CTD probe equipped with a DO sensor was used to monitor oxygen concentrations at the disposal site and reference areas (Williams 1995; Eller and Williams 1996). In recent field operations, this practice has been discontinued due to the shortcomings associated with the instantaneous measurement of DO. The collection of DO profiles of the water column during the relatively short survey period did not provide the data necessary to discern the possible influences of dredged material deposition from the seasonal effects within the region.

In order to track the development of hypoxic conditions in Long Island Sound, a comprehensive DO data set for stations located throughout the region was obtained from the Connecticut Department of Environmental Protection (CTDEP), Bureau of Water Management. The data was collected as part of the CTDEP Long Island Sound Summer Hypoxia Monitoring Program and consisted of surface and bottom water DO values for eighteen primary stations monitored throughout 1996, as well as a number of secondary summer stations (June through September). Seasonal monitoring stations 5, 8, and 9, and annual monitoring stations C2 and D3 were chosen due to their location relative to WLIS (Figure 4-6).

The CTDEP water quality data indicate DO concentrations steadily declined from 12.2 $mg \cdot l^{-1}$ in mid-March (Julian Day 75) to approximately 2.5 $mg \cdot l^{-1}$ in early September (Julian Day 250). The July 1996 monitoring cruise (Julian Day 198) was completed before the expected seasonal reduction in available oxygen within the western Long Island Sound region (Figure 4-6). In mid-July, bottom water DO concentrations at the primary (C2 and D3) and secondary (5, 8, and 9) water quality monitoring stations ranged from 4.8 $mg \cdot l^{-1}$ to 6.75 $mg \cdot l^{-1}$.

Oxygen concentrations of ≥5.0 $mg \cdot l^{-1}$ are thought to be protective of most Long Island Sound marine life (LISS 1990). Warm bottom waters and a consistent supply of molecular oxygen (O_2) promote increased bioturbational activity within the infaunal populations of the disposal mounds and reference areas. The feeding and foraging efforts of errant polychaete worms composing a Stage III assemblage incorporate oxygen-rich bottom waters into the surficial sediments, resulting in deeper RPD depths and elevated OSI values. As DO concentrations decrease through the spring and summer months, the level of oxygenation within the surface sediments also decreases, resulting in shallower RPDs and the appearance of redox rebound intervals. Environmental stress and mortality within the infaunal populations and resident macrofauna result in a reduction in habitat quality, decreased biological productivity, and lower OSI values.

As expected, the CTDEP data recorded the start of the seasonal hypoxia event in the bottom waters of the western Long Island Sound region approximately four weeks after the 1996 survey activity. DO concentrations dropped below 3.0 $mg \cdot l^{-1}$ (Julian Day 225) and remained at hypoxic levels for an additional four weeks, reaching a seasonal low on Julian Day 250. Bottom water DO concentrations in early September ranged from 2.2 $mg \cdot l^{-1}$ at C2 to 2.8 $mg \cdot l^{-1}$ at Station 9. Near anoxic conditions (0.7 $mg \cdot l^{-1}$) were found over the seafloor at Stations A4 and B3 in extreme western Long Island Sound during the same time period. By the third week in September, bottom water DO concentrations in the region had returned to levels greater than 6.0 $mg \cdot l^{-1}$, favorable for reestablishing a solid benthic community.

In the past, annual monitoring surveys at the Long Island Sound disposal sites were performed in mid-summer, allowing four or more weeks between the end of the disposal season (31 May) and any benthic community assessment operations. In addition, the summer months provide warmer bottom water temperatures (17 to 21°C), which increase the metabolic rates and bioturbation activity of the benthic infaunal populations. However, the occurrence of seasonal hypoxia in the western Long Island Sound region in mid-summer has been identified as an obstacle to benthic recolonization at WLIS since 1985 (SAIC 1988).

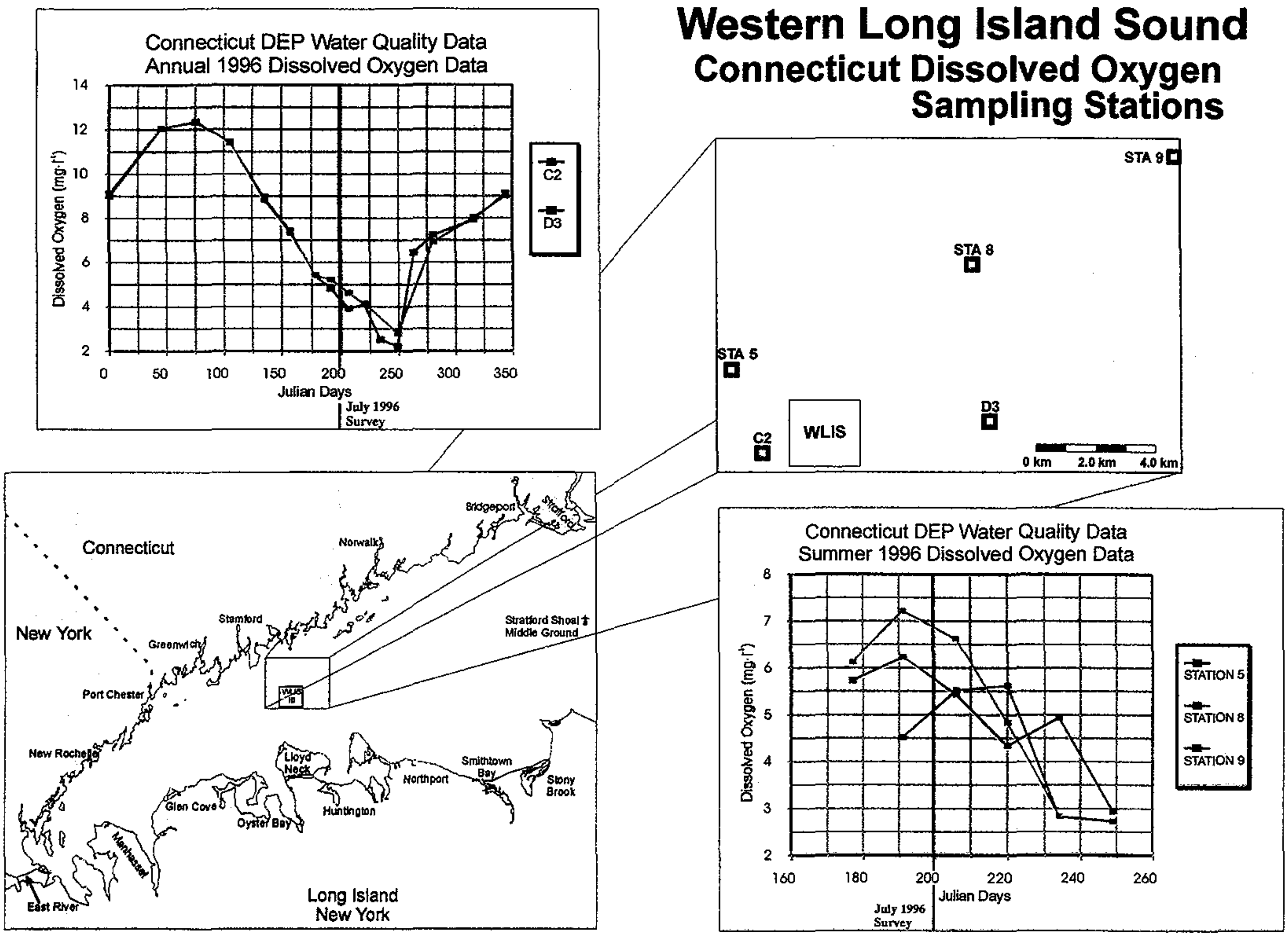


Figure 4-6. Position of the Connecticut Department of Environmental Protection Dissolved Oxygen Sampling Stations and bottom DO trends at both the annual and seasonal monitoring stations

Upon review of the benthic community assessment data collected at WLIS since 1984, a trend of shallow RPD depths, indications of low DO, and poor benthic habitat can be associated with mid-summer monitoring efforts. The results obtained during the July 1996 and other recent surveys (June 1991 and July 1992) suggest the completion of benthic community assessment operations in early summer, before the development of hypoxia and the deterioration of conditions provide a more realistic perspective into the condition of the benthic environment.

Prior DAMOS experience has determined that intensive recruitment of opportunistic, pioneering polychaetes (Stage I individuals) occurs 1-2 weeks after the completion of disposal activity (Germano et al. 1994). Therefore, it is recommended that future survey operations at WLIS requiring the assessment of benthic infaunal recolonization be scheduled for late June or early July. Monitoring surveys conducted within this time frame should provide adequate recruitment time on the surface of a new dredged material deposit, as well as avoid the negative effects of summer hypoxia in the region.

5.0 CONCLUSIONS

Since 1992, the WLIS seafloor has seen light to moderate disposal activity, receiving a total estimated barge volume of 148,000 m^3 of sediment dredged from the ports and harbors of coastal Connecticut and New York. In accordance with the successful management strategy demonstrated at CLIS, the recent disposal activity at WLIS has been tightly controlled to construct rings of disposal mounds in order to form an artificial containment cell (Morris et al. 1996). The implementation and long-term use of this management strategy will facilitate the deposition of large volumes of dredged material, minimizing its lateral spread on the seafloor, and maximizing the available space within the 5.29 km^2 area of the disposal site. The July 1996 field efforts allowed SAIC and NAE to document the development of three individual disposal mounds as well as examine the status of the artificial containment cell and observe changes in the benthic environment resulting from the deposition of new material.

The controlled disposal of this material was successful in forming two new sediment mounds, WLIS G and H, as well as further developing the preexisting WLIS F mound. Depth difference comparisons between with the 1996, 1992, and 1990 bathymetric surveys display the three disposal mounds as discrete bottom features connected by a ridge of material 0.25 m thick, formed by overlapping mound aprons. As of July 1996, the first artificial containment cell on the WLIS seafloor nears completion as the historic WLIS D and E mounds, in conjunction with the F, G, and H mounds, begin to form an artificial containment ridge. Supplemental containment facilities could also be formed by employing the properties of the naturally occurring ridges and basins within the boundaries of WLIS.

As the most recent bottom feature on the WLIS seafloor, the H mound displayed evidence of moderate to deep RPD depths over most of the mound surface, as well as strong benthic recolonization. Stage I individuals were discovered in every replicate photograph, and Stage III activity was documented at six of the thirteen stations occupied. With the exception of Station H50W, OSI values ranging from 4.0 to 8.0, suggesting benthic recovery over this disposal mound, should continue as expected. Disposal operations over WLIS H were completed on 29 May 1996 (Julian Day 149). According to the 1996 CTDEP data set, benthic recovery over the surface of this sediment deposit progressed for approximately six weeks before declining bottom water DO concentrations would have caused elevations in environmental stress levels. Given the history of the WLIS A and D mounds and the severity of recurring seasonal hypoxia in the region, continued monitoring of this new sediment deposit on an annual or every other year basis is recommended to ensure long-term benthic recovery.

The sediments of WLIS G were subjected to hypoxic conditions during the summer of 1995 and allowed to recover over the fall and winter months. This one-year-old sediment deposit now supports a stable Stage I infaunal population over the center of the mound with progression to Stage III on the mound periphery. The solid successional stage status and moderate to deep RPD depths indicate this sediment deposit is continuing to recover despite the reduction of bottom water DO concentrations during the summer months. The G mound should display a mature benthic assemblage over its entire surface in future monitoring efforts. In order to verify this prediction, an additional REMOTS® sediment-profile photography survey should be conducted over WLIS G during the 1998 monitoring cruise.

Although found to be recovering as expected in the initial benthic community assessment survey in 1990, the southern flank of the historic WLIS D mound displayed signs of benthic habitat degradation during subsequent survey operations. Two stations over WLIS D, 200 m and 300 m south of the mound center, were revisited in July 1996 to document improvement in the benthic environment. The results of the 1996 survey show dramatic improvement in benthic conditions at D300S while OSI values for 200S remain quite low.

The variability between replicates, as well as the strong signs of benthic recovery detected over the eastern and southern G mound REMOTS® stations, suggest the problem area is localized between the Stations D200S and D300S. The progression in habitat quality documented at D300S during the July 1996 survey is most likely due to the construction of WLIS G approximately 60 m to the northeast. The development of a wide apron around the G mound provided 10 cm to 20 cm of new sediment to overlay the historic dredged material composing the southern flank of the D mound.

A final solution to the localized problem between D200S and D300S that would facilitate the improvement of benthic conditions, as well as complement a recommended management plan for the disposal site, is the development of a new disposal mound southwest of the G mound center. The new sediment would overlie the southern flank of the D mound, covering any existing problems in the subsurface sediment layers. In addition, the new material would assist in closing the supplemental lateral containment cell described above while promoting benthic conditions comparable to those of the WLIS reference areas.

The DAMOS Program uses reference areas to provide a baseline against which results from the dredged material mounds are compared. However, the lack of ambient western Long Island Sound sediments within some of the previously selected reference areas has complicated this process. Benthic conditions at reference area 2000W, as detected at STA 1 and STA 4, appear to be highly disturbed due to the presence of dark, sulphidic sediments, larger grains, and pockets of methane gas. These indicators can be linked to past dredged material disposal operations at the historic Stamford Disposal Site. To date, a total of three WLIS reference areas (EAST, WLIS-REF, and 2000S) have been abandoned due to the presence of dredged material. Due to recurring indications of anthropogenic activity, and the lack of comparability between 2000W and the two other DAMOS reference areas at WLIS, it is recommended that 2000W be abandoned and a replacement reference area be sought to the southeast of the current WLIS boundaries.

Clasts of reduced sediments were also discovered at the sediment-water interface in one replicate of STA 8 over reference area SOUTH. The presence of two gray clasts of newly deposited silts may be attributable to a small amount of disposal barge spillage during the final phase of deposition over the WLIS H mound. However, the area surrounding WLIS is subjected to intense lobster fishing activity throughout the spring, summer, and fall. Furthermore, the gray color and angular shape of the clumps of fine-grained material suggest these reduced clasts are linked to the recent deployment or recovery of lobster fishing gear.

There were no adverse impacts detected in association with the presence of clumps of reduced material, but the attention focused on STA 8 and reference area SOUTH, did reveal a second issue. Reference area SOUTH was accepted for comparison with WLIS sediments in July 1992 when the disposal site was erroneously reported as the 3.42 km^2 (1 nmi^2) area by the DAMOS Program. The new reference point was located 392 m south of the disposal site with a water depth of approximately 23 m (75 ft) at MLLW. The use of the WLIS III boundaries provides only 207 m of separation between the disposal site and the center of SOUTH, reducing the available sampling area to the north of the central reference point. In order to maintain a random sampling scheme for statistical validity, it is recommended that future sampling activity at SOUTH be confined to a 300 m semi-circular area to maintain a buffer zone between the reference area and the southern boundary of WLIS or relocate SOUTH 150 m south to eliminate overlap.

The newest WLIS reference area, SW-REF, appeared to be healthy, relatively undisturbed, and supporting a stable benthic infaunal population. REMOTS® photographs detected Stage I organisms in all fourteen replicates with evidence of Stage III individuals represented in eight photographs, as well as deep RPD depths, resulting in high OSI values. Physical and biological indicators suggest SW-REF remains valid for continued use as a DAMOS reference area for WLIS without modification to its location or sampling radius.

Past DAMOS monitoring activity at the Long Island Sound disposal sites was conducted in mid-summer, allowing four or more weeks for benthic recovery after the completion of the disposal activity. This practice tended to promote the completion of community assessment activities during a period of hypoxia or near-hypoxia (5.0 $mg \cdot l^{-1}$ to 3.0 $mg \cdot l^{-1}$), skewing the entire data set. The July 1996 survey at WLIS was successful in avoiding the profoundly negative effects associated with the seasonal hypoxia event in central Long Island Sound. By conducting the benthic community assessment activities in early summer, a more realistic perspective into the condition of the benthic environment was gained.

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Appendix A

Tables

Appendix A, Table 1-1

1991 through 1996 DAMOS Disposal Buoy Locations at WLIS

WLIS Disposal Site Buoy Positions NAD 1927			
Disposal Season	Latitude	Longitude	Mound
1991-92	40° 59.162′ N	73° 28.880′ W	F
1992-93	40° 59.161′ N	73° 28.880′ W	F
1993-94	40° 59.161′ N	73° 28.879′ W	F
1994-95	40° 59.158′ N	73° 29.020′ W	G
1995-96	40° 59.228′ N	73° 28.732′ W	H

Appendix A, Table 2-1

REMOTS® Sediment-Profile Photography Stations over the D Mound, G Mound, H Mound, and Reference Areas

WLIS 1996 REMOTS® Stations NAD 1927			
Area	Station	Latitude	Longitude
WLIS H MOUND 40° 59.228′ N 73° 28.732′ W (1995-96)	CTR	40° 59.228′ N	73° 28.732′ W
	50N	40° 59.255′ N	73° 28.732′ W
	100N	40° 59.282′ N	73° 28.732′ W
	150N	40° 59.309′ N	73° 28.732′ W
	50S	40° 59.201′ N	73° 28.732′ W
	100S	40° 59.174′ N	73° 28.732′ W
	150S	40° 59.147′ N	73° 28.732′ W
	50E	40° 59.228′ N	73° 28.696′ W
	100E	40° 59.228′ N	73° 28.661′ W
	150E	40° 59.228′ N	73° 28.625′ W
	50W	40° 59.228′ N	73° 28.768′ W
	100W	40° 59.228′ N	73° 28.803′ W
	150W	40° 59.228′ N	73° 28.839′ W
WLIS G MOUND 40° 59.158′ N 73° 29.020′ W (1994-95)	CTR	40° 59.158′ N	73° 29.020′ W
	100N	40° 59.212′ N	73° 29.020′ W
	200N	40° 59.266′ N	73° 29.020′ W
	300N	40° 59.320′ N	73° 29.020′ W
	100S	40° 59.103′ N	73° 29.020′ W
	200S	40° 59.049′ N	73° 29.020′ W
	300S	40° 58.995′ N	73° 29.020′ W
	100E	40° 59.158′ N	73° 28.948′ W
	200E	40° 59.158′ N	73° 28.877′ W
	300E	40° 59.158′ N	73° 28.806′ W
	100W	40° 59.158′ N	73° 29.091′ W
	200W	40° 59.158′ N	73° 29.162′ W
	300W	40° 59.158′ N	73° 29.233′ W
Reference Areas			
2000W 40° 59.393′ N 73° 30.632′ W	STA 1	40° 59.410′ N	73° 30.625′ W
	STA 2	40° 59.426′ N	73° 30.586′ W
	STA 3	40° 59.370′ N	73° 30.559′ W
	STA 4	40° 59.356′ N	73° 30.825′ W
SOUTH 40° 58.688′ N 73° 29.201′ W	STA 5	40° 58.699′ N	73° 29.239′ W
	STA 6	40° 58.641′ N	73° 29.173′ W
	STA 7	40° 58.677′ N	73° 29.105′ W
	STA 8	40° 58.839′ N	73° 29.162′ W
SWREF 40° 58.487′ N 73° 29.909′ W	STA 9	40° 58.489′ N	73° 29.927′ W
	STA 10	40° 58.409′ N	73° 29.942′ W
	STA 11	40° 58.451′ N	73° 29.872′ W
	STA 12	40° 58.471′ N	73° 29.714′ W
	STA 13	40° 58.566′ N	73° 29.827′ W
Supplemental Areas			
D MOUND 40° 59.254′ N 73° 29.095′ W	D200S	40° 59.146′ N	73° 29.095′ W
	D300S	40° 59.092′ N	73° 29.095′ W

Appendix A, Table 3-1

WLIS H Mound REMOTS® Parameters Summary Table

Station	Mean RPD (cm)	Median OSI	Mean Camera Penetration (cm)	Mean Boundary Roughness (cm)
CTR	2.77	7.0	13.03	1.17
50N	2.27	5.0	18.57	1.71
50S	2.71	7.0	16.68	1.94
50E	1.88	4.0	17.46	1.51
50W	0.39	0.0	18.35	1.59
100N	2.32	4.0	17.63	0.75
100S	2.54	5.0	15.96	3.24
100E	2.29	4.0	16.32	0.64
100W	2.75	8.0	12.98	2.42
150N	2.91	5.0	17.87	1.22
150S	2.65	5.0	17.48	1.76
150E	4.88	6.5	15.03	1.22
150W	1.60	4.0	16.83	0.77

Appendix A, Table 3-2

WLIS G Mound REMOTS® Parameters Summary Table

Station	Mean RPD (cm)	Median OSI	Mean Camera Penetration (cm)	Mean Boundary Roughness (cm)
CTR	1.84	4.0	13.58	1.41
100N	3.05	5.5	10.70	2.24
100S	2.74	5.0	14.80	0.47
100E	3.23	5.0	16.66	0.71
100W	1.90	4.0	13.36	0.42
200N	1.83	4.0	16.07	2.20
200S	1.33	3.0	14.67	1.02
200E	3.59	10.5	17.76	1.47
200W	2.86	7.0	12.24	1.03
300N	2.42	8.0	15.36	0.71
300S	1.36	4.0	10.32	0.75
300E	2.15	4.0	13.61	1.49
300W	3.18	9.0	17.31	0.66

Appendix A, Table 3-3

WLIS D Mound REMOTS® Parameters Summary Table

Station	Mean RPD (cm)	Median OSI	Mean Camera Penetration (cm)	Mean Boundary Roughness (cm)
200S	1.77	-1.0	14.94	0.47
300S	2.74	8.0	15.34	1.20

Appendix A, Table 3-4

WLIS Reference Areas REMOTS® Parameters Summary Table

Station	Mean RPD (cm)	Median OSI	Mean Camera Penetration (cm)	Mean Boundary Roughness (cm)
2000W				
STA 1	1.62	4.0	17.68	2.71
STA 2	2.88	5.0	18.37	1.49
STA 3	2.59	5.0	19.98	0.41
STA 4	0.92	-2.0	15.64	5.02
SOUTH				
STA 5	2.51	5.0	11.89	0.93
STA 6	1.61	3.5	10.03	0.83
STA 7	2.37	7.0	7.57	0.79
STA 8	2.66	9.0	14.09	0.84
SW-REF				
STA 9	3.89	11.0	9.82	0.46
STA 10	3.10	6.0	9.97	0.49
STA 11	3.81	7.0	9.22	1.67
STA 12	3.19	10.0	11.36	0.84
STA 13	1.86	4.0	4.60	1.75

Appendix B

Appendix B

REMOTS® Data from the WLIS H MOUND

Station	Replicate	Date	Time	Successional	Grain Size (phi)			Mud Clasts		Camera Penetration				Dredged Material Thickness				Redox Rebound Thickness			Apparent RPD Thickness				Methane	OSI	Surface	Low	Comments
				Stage	Min	Max	Maj. Mode	Count	Avg. Diam	Min	Max	Range	Mean	Area	Min	Max	Mean	Min	Max	Mean	Area	Min	Max	Mean			Roughness	DO	
HCTR	E	7/18/96	8:55	ST_I	3	>4	>4	0	0	9.43	9.46	0.05	9.46	128.39	9.12	9.54	9.34	0	0	0	28.088	1.13	5.68	2.96	No	5	BIOGENIC	NO	large macrofaunal burrow
HCTR	F	7/18/96	8:56	ST_I	3	>4	>4	0	0.52	12.99	15.15	2.16	14.07	184.93	7.99	15	13.45	2.32	8.02	5.67	53.499	2.08	10.05	3.94	No	7	PHYSICAL	NO	DGP,possible unidentified organism on reduced clast
HCTR	G	7/18/96	8:58	ST_I_ON_III	3	>4	>4	0	0.36	14.9	15.2	1.3	15.55	219.5	4.17	16.7	15.33	2.32	6.49	4.41	19.318	0.81	2.44	1.39	No	7	INDET	NO	DGP,possible relic voids
50N	A	7/17/96	16:32	ST_I	3	>4	>4	8	0.38	18.04	19.64	0.61	19.34	262.3	16.88	19.75	19.08	2.58	7.72	5.15	31.066	1.52	2.89	2.27	No	5	INDET	NO	DGP,some shell hash
50N	C	7/17/96	16:33	ST_I	3	>4	>4	5	0.37	18.4	19.2	2.8	17.8	258.18	1.55	19.53	18.13	0	0	0	NA	NA	NA	NA	No	99	PHYSICAL	NO	wiper steak over RPD,stage I near camera artifact,DGP,S/M
50S	B	7/17/96	16:28	ST_I_ON_III	3	>4	>4	0	0.52	12.79	15.79	3.01	14.29	217.24	4.87	18.23	15.11	5.96	9.89	7.92	16.49	0.56	3.2	1.61	No	8	PHYSICAL	NO	DGP,relic voids;S/M
50S	C	7/17/96	16:29	ST_I	3	>4	>4	3	0.33	18.63	19.51	0.87	19.07	284.41	18.69	19.45	19.11	4.84	8.31	6.48	50.429	1.26	5.25	3.81	No	6	INDET	NO	DGP,relic voids
50E	B	7/17/96	15:55	ST_I	3	>4	>4	3	0.43	16.78	19.89	3.14	18.32	252.1	16.81	19.78	18.47	0	0	0	27.093	0.99	2.46	1.88	No	4	PHYSICAL	NO	DGP; sloping topography,rebounded RPD?
50E	C	7/17/96	15:55	ST_I	3	>4	>4	0	0	18.45	19.41	0.96	18.93	254.48	7.75	19.38	18.66	4.38	7.33	5.86	25.238	1.36	2.15	1.75	No	4	BIOGENIC	NO	DGP; relic voids at depth; possible mulina?
50E	E	7/18/96	9:00	ST_I	3	>4	>4	4	0.3	14.92	15.35	0.43	15.13	203.29	3.85	15.29	14.78	4.38	7.06	5.72	32.451	0.5	3.02	2	No	4	BIOGENIC	NO	DGP;possible relic voids mid depth
50W	A	7/17/96	15:43	ST_I	3	>4	>4	2	0.21	14.71	17.88	3.18	16.28	212.99	3.85	17.81	15.77	0	0	0	0	0	0	0	No	-3	PHYSICAL	YES	sulfidic to surface;DGP
50W	B	7/17/96	15:43	ST_I	3	>4	>4	0	0.29	19.04	19.89	0.86	19.47	258.83	18.72	19.84	19.2	3.32	10	6.66	10.185	0.05	1.27	0.78	No	3	PHYSICAL	NO	DGP,relic feeding voids
50W	C	7/17/96	15:44	ST_I	3	>4	>4	4	0.32	18.93	19.68	0.75	19.3	261.25	16.68	19.84	19.18	0	0	0	NA	NA	NA	NA	No	99	INDET	NO	DGP,wiper smear over RPD
100N	A	7/17/96	18:37	ST_I_ON_III	3	>4	>4	1	0.25	17.87	18.12	0.48	17.89	242.08	4.47	18.22	17.68	2.03	7.92	4.97	43.497	1.32	4.62	3.32	No	10	INDET	NO	DGP,large feeding void(not oxidized)
100N	B	7/17/96	18:38	ST_I	3	3	>4	1	0.43	15.84	16.4	0.48	16.17	224.42	5.38	18.85	18.09	2.54	11	6.77	28.521	0.05	3.5	1.94	No	4	PHYSICAL	NO	possible relic feeding voids,DGP,object dragged down by camera at bottom frame
100N	C	7/17/96	18:38	ST_I	3	>4	>4	4	0.47	18.17	19.49	1.32	18.83	255.78	18.17	19.54	18.84	0	0	0	24.295	1.27	3.25	1.71	No	4	INDET	NO	2 small craters at sediment surface with clasts;DGP;S/M
100S	A	7/17/96	16:21	ST_I	3	>4	>4	0	0	17.98	18.63	0.66	18.31	250.07	9.78	18.42	17.97	3.17	7.54	5.36	38.537	0.16	4.54	2.89	No	5	INDET	NO	DGP,large relic feeding voids
100S	B	7/17/96	16:22	ST_I	3	>4	>4	0	0.82	6.12	14.37	8.25	10.25	164.81	5.41	14.54	12.83	0	0	0	19.856	0.27	2.73	1.73	No	4	PHYSICAL	NO	chaotic fabric
100S	C	7/17/96	16:22	ST_I	3	>4	>4	1	0.26	18.91	19.73	0.82	19.32	282.48	9.4	19.84	18.95	3.11	9.51	6.31	41.903	2.13	3.83	2.99	No	5	INDET	NO	DGP,relic feeding void,grey mud clast at depth
100E	A	7/17/96	15:58	ST_I_ON_III	3	>4	>4	0	0	17.93	18.79	0.86	18.36	245.87	17.93	18.54	18.22	3.69	6.82	5.25	47.192	1.97	4.95	3.66	No	10	BIOGENIC	NO	DGP,feeding void at depth,relic void middepth
100E	D	7/18/96	9:03	ST_I	3	>4	>4	1	0.26	14.14	14.95	0.81	14.55	193.81	14.04	14.65	14.43	2.73	4.29	3.51	28.538	1.51	2.24	1.9	No	4	INDET	NO	DGP,stage I tube
100E	E	7/18/96	9:04	ST_I	3	>4	>4	0	0	15.91	16.18	0.25	16.04	214.52	15.66	16.18	15.96	1.82	8.54	5.18	17.945	0.25	2.83	1.3	No	3	BIOGENIC	NO	DGP,stage I tube,some smearing
100W	A	7/17/96	15:19	ST_I_ON_III	3	>4	>4	5	0.4	17.38	18.34	0.96	17.86	240.13	15.51	18.4	17.67	2.46	5.72	4.09	60.374	2.44	6.14	4.62	No	11	BIOGENIC	NO	DGP,feeding voids
100W	E	7/17/96	8:27	ST_I	3	>4	>4	2	0.27	6.04	11.93	5.88	8.98	122.7	6.1	12.03	8.98	2.51	5.45	3.98	24.992	1.02	2.57	1.79	No	4	PHYSICAL	NO	DGP,sloping topography,hermit crab?
100W	F	7/18/96	8:27	ST_I_ON_III	3	>4	>4	0	0	11.87	12.3	0.43	12.08	182.03	11.66	12.3	12.01	2.41	4.65	3.53	26.124	1.18	2.87	1.84	No	8	INDET	NO	DGP,relic and active feeding voids,stage I assemblage,S/M
150N	A	7/17/96	16:42	ST_I	2	>4	>4	0	0.19	13.74	15.5	1.76	14.62	206.39	13.72	16.12	14.98	2.61	7.19	5	31.147	0.41	3.72	2.28	No	5	PHYSICAL	NO	surface layer disturbed; black subsurface streak due to markerpen,sulfidic
150N	B	7/17/96	16:43	ST_I	3	>4	>4	2	0.39	19.5	20.28	0.77	19.89	278.51	4.48	20.39	19.85	3.09	8.18	5.64	31.804	0.33	3.09	2.24	No	4	biogenic	NO	DGP,sulfidic streak over RPD
150N	C	7/17/96	16:44	ST_I	3	>4	>4	8	0.32	18.54	19.68	1.14	19.11	252.84	12.99	18.68	18.23	3.3	6.43	4.86	51.807	0.49	5.89	4.21	No	7	INDET	NO	possible camera dragdown center of slide;DGP
150S	A	7/17/96	16:14	ST_I	3	>4	>4	0	0	18.69	19.23	0.55	18.96	258.99	4.43	19.4	18.67	3.17	6.5	4.84	39.445	1.69	5.38	3.68	No	8	INDET	NO	less compact; reworked surface layer;possible relic void,DGP
150S	B	7/17/96	16:15	ST_I	3	>4	>4	0	0	11.78	15.11	3.33	13.44	192.16	7.17	14.94	13.75	2.01	5.58	3.78	27.232	1	2.56	1.89	No	4	PHYSICAL	NO	sloping topography; relic feeding void,DGP,S/M
150S	C	7/17/96	16:15	ST_I	3	>4	>4	0	0	19.33	20.72	1.39	20.03	282.05	19.33	20.72	20.11	4.11	8.89	6.5	33.871	1.87	3.94	2.37	No	5	INDET	NO	DGP,dark brown DM at depth,near OPen,S/M
150E	D	7/18/96	9:07	ST_I	3	>4	>4	0	0	15.56	16.11	0.56	15.83	210.93	5.51	16.06	15.45	6.5	7.5	7	45.434	0.81	4.29	3.46	No	6	BIOGENIC	NO	DGP,stage I tubes;S/M
150E	E	7/18/96	9:08	ST_I	3	3	>4	0	0	8.58	11.16	2.58	9.87	131.55	4.44	10.68	9.7	0	0	0	NA	NA	NA	NA	No	99	BIOGENIC	NO	DGP,smearing over RPD,dense stage I,S/M,pullaway
150E	F	7/18/96	9:09	ST_I	3	>4	>4	0	0.94	19.14	19.65	0.51	19.39	259.17	6.99	19.6	19.09	7.66	10.05	8.96	83.739	0.3	7.83	6.29	No	7	INDET	NO	DGP,near OP,reduced clasts at surface
150W	D	7/18/96	8:39	ST_I	3	>4	>4	0	0	18.18	18.97	0.81	18.57	252.58	7.03	18.81	18.19	0	0	0	19.147	0.48	2.35	1.46	No	3	INDET	NO	DGP,possible collapsed void,some shell hash,S/M
150W	F	7/18/96	8:46	ST_I	3	>4	>4	1	0.32	14.97	15.35	0.37	15.16	204.28	3.37	15.45	14.82	2.87	5.4	4.04	20.304	0.27	3.37	1.58	No	4	BIOGENIC	NO	DGP;relic feeding void;S/M
150W	G	7/18/96	8:47	ST_I_ON_III	3	>4	>4	1	0.22	16.2	17.33	1.12	16.76	225.95	15.4	17.33	16.72	3.16	5.51	4.33	24.149	0.48	2.83	1.77	No	8	INDET	NO	DGP; several relic feeding voids;one active

Appendix C

Appendix C

REMOTS® Data from the WLIS G Mound

Station	Replicate	Date	Time	Successional	Grain Size (phi)			Mud Clasts		Camera Penetration				Dredged Material Thickn			Redox Rebound Thickness				Apparent RPD Thickness			Methane	OSI	Surface	Low	Comments
				Stage	Min	Max	Maj Mode	Count	Avg. Diam	Min	Max	Range	Mean	Area	Max	Mean	Min	Max	Mean	Area	Min	Max	Mean			Roughness	DO	
GCTR	A	7/16/96	9.20	ST_I	3	>4	>4	0	0	6.97	9.44	2.47	8.2	113.56	9.34	8.32	0	0	0	NA	NA	NA	NA	No	99	PHYSICAL	NO	DGP;rocks;hydriods; crepidula shell;S/M
GCTR	B	7/16/96	9.20	ST_I	3	>4	>4	0	0	14.04	15.15	1.11	14.59	197.93	15.1	14.71	0	0	0	17.708	0.05	2.63	1.41	No	3	INDET	NO	DGP,relic void;sulfidic
GCTR	C	7/16/96	9.21	ST_I	3	>4	>4	2	1.97	17.62	18.28	0.66	17.95	243.73	18.28	17.68	2.8	9.68	6.5	31.16	0.5	3.79	2.26	No	5	PHYSICAL	NO	DGP;reduced wiper clasts in sed,relict feeding voids
100N	A	7/16/96	9.03	ST_I	3	>4	>4	0	0	13.38	13.38	0	13.38	179.83	13.53	13.16	0	0	4	39.413	0.91	4.19	2.04	No	4	BIOGENIC	NO	DGP,sulfidic,S/M
100N	B	7/16/96	9.04	ST_I	3	>4	>4	2	0.64	10.96	12.52	1.57	11.74	158.3	12.47	11.65	0	0	0	NA	NA	NA	NA	No	99	INDET	NO	DGP;reduced clast at surface;RPD obscured by wiper residue
100N	C	7/16/96	9.04	ST_I	3	>4	4 to 3	0	0	4.39	9.54	5.15	6.97	90.51	9.44	6.74	0	0	0	56.264	0.86	5.2	4.06	No	7	INDET	NO	
100S	A	7/16/96	9.27	ST_I	3	>4	>4	0	0	15.13	15.23	0.1	15.18	206.13	15.23	15.18	3.81	5.48	4.65	38.358	0.96	4.11	2.99	No	5	BIOGENIC	NO	relic voids at depth,ambient?
100S	B	7/16/96	9.28	ST_I	3	>4	>4	0	0	14.72	15.23	0.51	14.97	204.78	15.38	14.89	3.12	11.13	7.12	35.444	0.15	6.4	2.99	No	5	INDET	NO	DGP,relic feeding voids;sulfidic
100S	C	7/16/96	9.28	ST_I_ON_III	3	>4	>4	0	0	13.66	14.67	0.81	14.26	189.71	14.67	13.93	0	0	0	28.312	0.1	5.03	2.25	No	8	INDET	NO	DGP,feeding voids at depth;sulfidic;ambient
100E	A	7/17/96	11.59	ST_I	3	>4	>4	0	0	18.12	18.22	0.1	18.17	243.8	18.32	17.72	3	7	4	68.025	2.28	5.74	4.95	No	7	BIOGENIC	NO	DGP,mulinia?,forams
100E	B	7/17/96	11.59	ST_I	3	>4	>4	1	1.65	15.12	16.7	1.57	15.91	213.82	16.49	15.7	8.5	11.5	8	NA	NA	NA	NA	No	99	PHYSICAL	NO	DGP,wiper clast over RPD
100E	C	7/17/96	12.00	ST_I	3	>4	>4	4	0.84	15.68	16.14	0.46	15.91	226.46	16.65	15.97	0	0	0	18.668	0.1	3.1	1.5	No	3	INDET	NO	DGP,sulfidic,reduced wiper clasts at surface
100W	A	7/17/96	11.51	ST_I	3	>4	>4	0	0	12.54	12.69	0.15	12.61	167.71	12.69	12.36	2.49	4.67	3.58	20.08	0.71	2.49	1.56	No	4	BIOGENIC	NO	DGP,sulfidic,water spots on film,S/M,forams
100W	B	7/17/96	11.51	ST_I	3	>4	>4	0	0	12.84	13.75	0.91	13.3	180.51	13.86	13.28	3.15	5.18	4.16	28.37	0.61	3.05	2.04	No	4	BIOGENIC	NO	DGP,sulfidic;S/M
100W	C	7/17/96	11.52	ST_I	3	>4	>4	0	0	14.08	14.28	0.2	14.16	188.26	14.28	13.88	0	0	0	28.74	1.07	2.89	2.09	No	4	INDET	NO	DGP,sulfidic,relic void at depth,S/M,forams
200N	A	7/16/96	8.44	ST_I_ON_III	3	>4	>4	0	0	10.96	12.32	1.36	11.64	158.2	12.32	11.64	4.03	7.22	5.5	21.088	0.1	4.29	1.77	No	6	BIOGENIC	NO	DGP,feeding void,S/M,ambient?
200N	D	7/18/96	10.06	ST_I	3	>4	>4	0	0	15.91	20.15	4.24	18.03	251.98	20.15	18.44	0	0	0	21.953	0.5	2.83	1.54	No	4	PHYSICAL	NO	DGP,slight OP,feeding void midleft,sulfidic,slight wiper smearing
200N	E	7/18/96	10.07	ST_I	3	>4	>4	1	0.77	18.02	19.03	1.01	18.53	247.58	18.78	18.25	0	0	0	29.808	0.81	3.53	2.17	No	4	INDET	NO	DGP,no direct evidence stageIII;stage I tube;sulfidic
200S	A	7/16/96	9.33	ST_I	3	>4	>4	3	0.48	13.71	15.58	1.88	14.64	197.79	15.48	14.55	0	0	0	18.255	0.36	2.03	1.18	No	3	INDET	NO	DGP,sulfidic,S/M
200S	B	7/16/96	9.34	ST_I	3	>4	>4	0	0	12.94	13.3	0.36	13.12	174.25	13.3	12.82	0	0	0	18.255	0.36	2.03	1.18	No	3	BIOGENIC	NO	DGP;SULFIDICsome wiper smearing over RPD
200S	C	7/16/96	9.34	ST_I_ON_III	3	>4	>4	4	0.64	15.84	16.65	0.81	16.24	219.04	16.65	16.13	0	0	0	18.836	0.36	3.3	1.62	No	8	PHYSICAL	NO	DGP;sulfidic,void at base of oxidized zone(left)
200E	A	7/17/96	12.04	ST_I_ON_III	3	>4	>4	0	0	17.92	18.78	0.86	18.35	223.52	18.98	17.38	6	9	3	50.553	0.56	5.89	3.98	No	11	BIOGENIC	NO	DGP,large macrofaunal burrow;old DM?
200E	B	7/17/96	12.05	ST_I_ON_III	3	>4	>4	2	0.52	14.46	17.05	2.59	15.76	225.22	17	16.58	0	0	0	35.474	0.05	6.24	3.2	No	10	PHYSICAL	NO	DGP
200E	C	7/17/96	12.05	ST_I	3	>4	>4	3	0.91	18.68	19.64	0.96	19.16	258.9	19.54	18.88	0	0	0	NA	NA	NA	NA	No	99	PHYSICAL	NO	DGP,reduced wiper clast
200W	A	7/17/96	11.46	ST_I_ON_III	3	>4	>4	0	0	13.35	14.52	1.17	13.93	189.29	14.41	13.91	4.47	7.16	5.81	50.559	1.88	5.18	3.66	No	10	INDET	NO	DGP,active feeding void,old DM ?
200W	B	7/17/96	11.46	ST_I	3	>4	>4	0	0	14.67	15.02	0.36	14.85	199.47	15.07	14.6	0	0	0	25.032	0.2	4.62	2.06	No	4	BIOGENIC	NO	DGP,relic void at depth,sulfidic;mulinia?,forams
200W	C	7/17/96	11.47	ST_I	3	>4	>4	0	0	7.16	8.73	1.57	7.94	108.32	8.68	7.95	0	0	0	NA	NA	NA	NA	No	99	PHYSICAL	NO	DGP,little RPD;wiper smear
300N	A	7/16/96	8.32	ST_I	3	>4	>4	2	0.55	16.62	17.93	1.11	17.37	235.76	17.98	17.09	6.17	8.75	7.46	23.002	0.15	6.31	3.45	No	6	INDET	NO	DGP?,possible relic void,detritus
300N	B	7/16/96	8.32	ST_I_ON_III	3	>4	>4	0	0.67	13.03	13.78	0.76	13.4	203.73	14.61	13.98	0	0	0	24.207	0.05	2.52	1.75	No	8	PHYSICAL	NO	DGP,feeding voids;sulfidic S/M,methane?
300N	C	7/16/96	8.33	ST_I_ON_III	3	>4	>4	0	0.25	15.2	15.45	0.25	15.32	162.53	12.37	11.97	0	0	0	25.168	0.1	4.39	2.05	No	8	INDET	NO	DGP,feeding voids at depth;sulfidic
300S	A	7/16/96	9.40	ST_I	3	>4	>4	0	0	18.7	19.53	0.83	19.11	260.01	19.64	19.09	0	0	0	20.157	0.57	2.55	1.54	No	4	INDET	NO	DGP,sulfidic,possible relic voids,forams upper 3 cm
300S	E	7/18/96	9.49	ST_I_ON_III	3	>4	>4	0	0	8.04	8.2	0.16	8.12	80.87	8.2	8.12	0	0	0	15.385	0.62	2.55	1.57	No	8	INDET	NO	DGP,active feeding void
300S	F	7/18/96	9.50	ST_I	3	>4	>4	0	0	5.1	6.35	1.25	5.73	81.1	6.51	5.79	0	0	0	14.339	0.36	1.55	0.97	No	3	PHYSICAL	NO	DGP,erosional
300E	C	7/17/96	12.12	ST_I	3	>4	>4	3	0.84	18.12	19.08	0.96	18.6	253.79	19.08	18.36	0	0	0	12.971	1.49	2.58	2.17	No	4	PHYSICAL	NO	DGP,reduced wiper clasts,S/M,forams
300E	D	7/18/96	9.38	ST_I	3	>4	>4	0	0	14.77	15.78	1.02	15.28	253.79	19.08	18.36	0	0	0	40.375	0.1	4.57	3.06	No	6	BIOGENIC	NO	DGP,relic voids;old Dm
300E	E	7/18/96	9.39	ST_I	4	>4	>4	0	0	5.71	8.21	2.5	6.96	96	8.42	7.15	0	0	0	18.643	0.15	4.34	1.21	No	3	INDET	NO	DGP;shallow RPD;S/M
300W	A	7/16/96	9.50	ST_I_ON_III	3	>4	>4	0	0	18.32	18.73	0.41	18.52	249.29	18.88	18.29	0	0	0	69.874	2.94	6.29	5.26	No	11	BIOGENIC	NO	DGP,mulinia,forams
300W	B	7/16/96	9.51	ST_I_ON_III	3	>4	>4	3	0.76	16.14	16.75	0.61	16.44	225.08	17.05	16.47	0	0	0	18.057	0.05	5.79	2.7	No	9	INDET	NO	DGP,active void ?,reduced mud clasts
300W	C	7/16/96	9.52	ST_I	3	>4	>4	1	1.4	16.49	17.46	0.96	15.98	231.5	17.31	18.93	0	0	0	10.352	0.05	4.11	1.59	No	4	BIOGENIC	NO	DGP,sulfidic,light leak/processing error

Appendix D

Appendix D

REMOTS® Data from the WLIS D Mound

Station	Replicate	Date	Time	Successional Stage	Grain Size (phi) Min	Grain Size (phi) Max	Grain Size (phi) Major Mode	Mud Clasts Count	Mud Clasts Avg Diam	Camera Penetration Min	Camera Penetration Max	Camera Penetration Range	Camera Penetration Mean	Dredged Material Thickness Area	Dredged Material Thickness Min	Dredged Material Thickness Max	Dredged Material Thickness Mean
D200S	A	7/17/96	12 19	ST_I_ON_III	3	>4	>4	0	0	15.73	15.99	0.25	15.86	212.41	6.19	16.09	15.55
D200S	B	7/17/96	12 20	ST_I	3	>4	>4	0	0	13.4	14.46	1.07	13.93	169.9	11.32	14.46	13.88
D200S	C	7/17/96	12 21	ST_I	3	>4	>4	0	0	14.97	15.07	0.1	15.02	203.51	7.82	15.28	15.02
D300S	B	7/17/96	12 25	ST_I	3	>4	>4	0	0	14.31	14.57	0.25	14.44	192.64	14.06	14.52	14.28
D300S	C	7/17/96	12 25	ST_I_ON_III	3	>4	>4	3	1.05	15.83	17.56	1.73	16.7	229.48	15.94	17.56	16.95
D300S	D	7/18/96	10 01	ST_I_ON_III	3	>4	>4	0	0	14.06	15.68	1.62	14.87	178.02	3.65	15.68	13.68

Station	Replicate	Redox Rebound Thickness Min	Redox Rebound Thickness Max	Redox Rebound Thickness Mean	Apparent RPD Thickness Area	Apparent RPD Thickness Min	Apparent RPD Thickness Max	Apparent RPD Thickness Mean	Methane	OSI	Surface Roughness	Low DO	Comments
D200S	A	0	0	0	49.501	1.32	4.31	3.61	No	10	BIOGENIC	NO	DGP,forams
D200S	B	0	0	0	6.033	0.05	1.73	0.4	No	-2	BIOGENIC	YES	DGP,sulfidic to surface,shallow RPD;S/M,forams
D200S	C	0	0	0	18.64	0.73	2.02	1.29	No	-1	INDET	YES	DGP,smearing over RPD ?
D300S	B	6.4	9.85	8.12	21.136	1	3	1.5	No	3	BIOGENIC	NO	DGP,S/M
D300S	C	0	0	0	25.363	0.71	3.66	1.65	No	8	PHYSICAL	NO	DGP,large worm;clasts on surface
D300S	D	0	0	0	62.863	2.79	6.45	4.87	No	11	BIOGENIC	NO	DGP,large macrofaunal burrow,S/M,old Dm?

Appendix E

Appendix E

REMOTS® Data from the WLIS Reference Areas

Station	Replicate	Date	Time	Successional Stage	Grain Size (phi) Min	Grain Size (phi) Max	Maj Mode	Mud Clasts Count	Mud Clasts Avg. Diam	Camera Penetration Min	Camera Penetration Max	Camera Penetration Range	Camera Penetration Mean	Dredged Material Thickness Area	Dredged Material Thickness Min	Dredged Material Thickness Max	Dredged Material Thickness Mean	Redox Rebound Thickness Min	Redox Rebound Thickness Max	Redox Rebound Thickness Mean	Area	Apparent RPD Thickness Min	Apparent RPD Thickness Max	Apparent RPD Thickness Mean	Methane	OSI	Surface Roughness	Low DO	Comments
2000W																													
STA1	C	7/17/96	14.38	ST_I	3	>4	>4	2	1.16	18.84	18.99	0.15	18.91	999	18.84	18.99	18.91	0	0	0	21.326	1.5	5	2.02	No	4	BIOGENIC	NO	clasts of DM,smearing of RPD by wiper,DGP
STA1	D	7/18/96	7:26	ST_I_ON_III	3	>4	>4	0	0	18.08	18.08	0	18.08	0	0	0	0	0	0	0	35.163	0.91	4.19	2.83	No	9	BIOGENIC	NO	feeding void at depth;mulinia?,ambient or older DM
STA1	E	7/18/96	7.27	AZOIC	4	>4	>4	0	0	12.07	20.05	7.98	16.06	252.2	3.71	20.32	17.76	0	0	0	0	0	0	0	No	-8	PHYSICAL	YES	large reduced Dm clast
STA2	B	7/17/96	14.40	ST_I	3	>4	>4	0	0	16.06	18.28	2.22	17.17	10.13	16.06	18.28	17.17	0	0	0	40.659	2	4.14	2.89	No	5	INDET	NO	reduced wiper clasts of DM in RPD
STA2	C	7/17/96	14.41	ST_I	3	>4	>4	0	0	19.19	19.95	0.76	19.57	17.11	19.19	19.95	19.57	5.76	8.64	7.2	38.121	1.87	3.74	2.88	No	5	PHYSICAL	NO	reduced wiper clasts of DM,possible relic void
STA3	B	7/17/96	14.47	INDET	3	>4	>4	0	0	20.05	20.2	0.15	20.13	9999	20.05	20.2	20.13	0	0	0	NA	NA	NA	NA	No	99	INDET	NO	overpen,IND RPD;surface conditions;some shell,dgp
STA3	C	7/17/96	14.48	ST_I	3	>4	>4	5	0.76	19.49	20.15	0.66	19.82	999	19.49	20.15	19.82	0	0	0	35.332	0.61	5.4	2.59	No	5	INDET	NO	clasts of reduced Dm in RPD,possible relic voids at depth,slight OP,dgp
STA4	A	7/17/96	14.28	ST_I_ON_III	3	>4	>4	0	0	19.55	20.1	0.56	19.82	0	0	0	0	0	0	0	30.857	0.56	3.33	2.25	Yes	6	INDET	NO	slight OP,feeding void with air bubble;possible traces DM
STA4	B	7/17/96	14.29	INDET	3	>4	>4	1	1.29	7.53	14.24	6.71	10.89	0	0	0	0	0	0	0	6.457	0.21	1.3	0.51	No	-2	PHYSICAL	YES	bottom physically disturbed,some evidence of patchy RPD
STA4	C	7/17/96	14.29	AZOIC	4	>4	>4	0	0	12.32	20.1	7.78	16.21	215.26	10.11	20.27	15.88	0	0	0	0	0	0	0	No	-10	PHYSICAL	YES	large reduced DM clasts
SOUTH																													
STA5	A	7/17/96	12.34	ST_I	3	4	>4	3	0	12.76	13.93	1.17	13.34	0	0	0	0	3.22	4.7	3.96	43.685	1.02	4.44	3.11	No	6	PHYSICAL	NO	clats of reduced Dm in RPD,worm mid depth
STA5	B	7/17/96	12.35	ST_I	3	>4	>4	2	0.79	8.52	9.18	0.66	8.85	0	0	0	0	0	0	0	NA	NA	NA	NA	No	99	PHYSICAL	NO	wiper clasts in RPD,retracted anemone
STA5	C	7/17/96	12.35	ST_I	3	>4	>4	1	1.16	12.99	13.95	0.96	13.47	0	0	0	0	2.54	4.31	4.5	24.987	0.91	2.84	1.9	No	4	INDET	NO	large clast on surface,S/M
STA6	D	7/18/96	8.12	ST_I	3	>4	4 to 3	3	0.41	8.84	9.6	0.76	9.22	0	0	0	0	0	4	3.75	15.626	0.35	2.42	1.21	No	3	INDET	NO	some shell hash,reduced clast probable camera artifact,S/M
STA6	E	7/18/96	8.13	ST_I	3	>4	>4	0	0	10.61	11.62	1.01	11.11	0	0	0	0	0	0	0	27.714	0.35	2.83	2.01	No	4	INDET	NO	some shell,S/M
STA6	F	7/18/96	8.13	ST_I	3	>4	>4	0	0	9.39	10.1	0.71	9.75	0	0	0	0	0	0	0	NA	NA	NA	NA	No	99	INDET	NO	some shell,S/M,wiper smearing
STA7	A	7/17/96	12.44	ST_I	3	>4	4 to 3	0	0	6.36	8.33	1.97	7.35	0	0	0	0	0	0	0	65.323	2.98	7.53	4.99	No	7	PHYSICAL	NO	S/M,rippled
STA7	B	7/17/96	12.45	ST_I_ON_III	3	>4	>4	0	0	8.33	8.54	0.2	8.43	0	0	0	0	0	0	4.5	20.341	0.68	2.55	1.4	No	7	PHYSICAL	NO	active feeding voids at depth,gastropods;S/M
STA7	C	7/17/96	12.45	ST_I	3	>4	>4	0	0	6.82	7.02	0.2	6.92	0	0	0	0	0	0	0	10.359	0.15	1.16	0.73	No	-2	PHYSICAL	YES	shallow RPD,mercenaria shell,gastropod
STA8	A	7/17/96	13.11	ST_I_ON_III	3	>4	>4	0	0	13.89	14.24	0.35	14.07	0	0	0	0	0	0	0	35.991	0.05	4.19	2.66	No	9	BIOGENIC	NO	S/M
STA8	B	7/17/96	13.12	ST_I	3	>4	>4	4	0.63	13.43	13.84	0.4	13.64	0	0	0	0	0	0	0	NA	NA	NA	NA	No	99	PHYSICAL	NO	reduced wiper clasts at surface;some shell hash
STA8	C	7/17/96	13.12	ST_I	3	>4	>4	0	0	13.69	15.46	1.77	14.57	10.07	0.15	1.11	0.77	0	0	0	NA	NA	NA	NA	No	99	PHYSICAL	NO	large reduced wiper clasts DM,possible feeding void
SW-REF																													
STA9	B	7/17/96	13.54	ST_I_ON_III	3	>4	4 to 3	1	0.64	11.16	11.51	0.35	11.34	0	0	0	0	0	0	0	47.159	1.16	4.14	3.47	No	10	INDET	NO	worm middepth;stage I tubes;S/M
STA9	C	7/17/96	13.54	ST_I_ON_III	3	>4	4 to 3	2	0.38	7.88	8.38	0.51	8.13	0	0	0	0	0	0	0	53.694	1.26	4.29	3.91	No	11	BIOGENIC	NO	worm at depth;smearing over RPD,S/M
STA9	D	7/18/96	7:42	ST_I_ON_III	3	>4	4 to 3	0	0	9.75	10.25	0.51	10	0	0	0	0	0	0	0	56.295	2.27	5.86	4.3	No	11	BIOGENIC	NO	active feeding void,worm;S/M
STA10	B	7/17/96	13.54	ST_I_ON_III	3	>4	>4	1	0.64	11.16	11.51	0.35	11.34	0	0	0	0	0	0	0	47.159	1.16	4.14	3.47	No	10	INDET	NO	worm middepth;stage I tubes;S/M
STA10	C	7/17/96	13.44	ST_I	3	>4	4 to 3	0	0	9.44	10.25	0.81	9.85	0	0	0	0	0	0	0	40.666	1.07	5.15	3.15	No	6	BIOGENIC	NO	S/M;gastropods;smearing over RPD,S/M
STA10	D	7/18/96	7:47	ST_I_ON_III	3	>4	4 to 3	0	0	9.85	10.05	0.2	9.95	0	0	0	0	0	0	0	35.181	1.52	4.39	2.74	No	5	PHYSICAL	NO	worm at mid depth;dense stage I,gastropods,S/M,erosion(stranded tubes)
STA10	E	7/18/96	7.48	ST_I	3	>4	4 to 3	0	0	8.43	9.04	0.61	8.74	0	0	0	0	0	0	0	42.251	1.07	4.55	3.05	No	6	PHYSICAL	NO	stage I tubes;gastropods;S/M,erosional;wiper smear
STA11	C	7/17/96	13:49	ST_I	3	>4	4 to 3	0	0	8.38	10.05	1.67	9.22	0	0	0	0	0	0	0	49.162	2.07	5.66	3.81	No	7	PHYSICAL	NO	s/m;some shell; S/M,erosional
STA12	D	7/18/96	7.56	ST_I_ON_III	3	>4	>4	0	0	11.46	11.87	0.4	11.67	0	0	0	0	3.43	5.05	4.24	51.697	1	4	2	No	8	BIOGENIC	NO	S/M,active feeding voids;dense stage I tube mat,S/M
STA12	E	7/18/96	7.57	ST_III	3	>4	>4	0	0	10.1	10.76	0.66	10.43	0	0	0	0	0	0	0	41.21	0.05	4.9	3.61	No	10	INDET	NO	S/M,feeding voids;clast of reduced clay background?
STA12	F	7/18/96	7.58	ST_I_ON_III	3	>4	>4	3	1.04	11.26	12.73	1.46	11.99	0	0	0	0	3.13	4.39	3.76	40.882	0.1	6.72	3.96	No	11	INDET	NO	S/M,macrofaunal burrow,active feeding voids,wiper clasts
STA13	A	7/17/96	14.13	ST_I	3	>4	>4	0	0	2.58	5.51	2.93	4.04	0	0	0	0	0	0	0	14.098	0.56	3.79	1.75	No	4	PHYSICAL	NO	Shallow RPD,macrofaunal burrow
STA13	B	7/17/96	14.14	ST_I	3	>4	>4	0	0	3.54	4.65	1.11	4.09	0	0	0	0	0	0	0	24.113	0.05	3.13	2.04	No	4	BIOGENIC	NO	stageI tubes; burrow;mercenaria shell,S/M
STA13	C	7/17/96	14.15	ST_I	3	>4	>4	0	0	5.05	6.26	1.21	5.66	0	0	0	0	0	0	0	24.552	0.05	4.04	1.8	No	4	PHYSICAL	NO	S/M,wiper smear over RPD,tubes

Appendix F

Disposal Logs

Appendix F, Table 1

permittee	project	disparea	dispdate	wtd	xtd	ytd	ztd	latdeg	latmin	longdeg	longmin	cyvol
VILLAGE CREEK HOMEOWNERS ASSOC	VILLAGE CREEK CHANNEL, CT	WLIS	15-Apr-96	0	26826.5	43973.5	0	40	59.256	73	28.755	970
VILLAGE CREEK HOMEOWNERS ASSOC	VILLAGE CREEK CHANNEL, CT	WLIS	17-Apr-96	0	26826.3	43973.2	0	40	59.225	73	28.742	923
VILLAGE CREEK HOMEOWNERS ASSOC	VILLAGE CREEK CHANNEL, CT	WLIS	18-Apr-96	0	26826.1	43973.3	0	40	59.242	73	28.713	885
MR & MRS ALBERT ZESIGNER	WILSON COVE DARIEN, CT	WLIS	18-Apr-96	0	26826.4	43973.3	0	40	59.235	73	28.75	700
VILLAGE CREEK HOMEOWNERS ASSOC	VILLAGE CREEK CHANNEL, CT	WLIS	19-Apr-96	0	26826.3	43973.5	0	40	59.261	73	28.73	948
MR & MRS ALBERT ZESIGNER	WILSON COVE DARIEN, CT	WLIS	19-Apr-96	0	26826.4	43973.3	0	40	59.235	73	28.75	700
VILLAGE CREEK HOMEOWNERS ASSOC	VILLAGE CREEK CHANNEL, CT	WLIS	20-Apr-96	0	26826.3	43973.3	0	40	59.237	73	28.738	914
MR & MRS ALBERT ZESIGNER	WILSON COVE DARIEN, CT	WLIS	20-Apr-96	0	26826.3	43973.3	0	40	59.237	73	28.738	450
MR & MRS ALBERT ZESIGNER	WILSON COVE DARIEN, CT	WLIS	21-Apr-96	0	26826.4	43973.3	0	40	59.235	73	28.75	650
VILLAGE CREEK HOMEOWNERS ASSOC	VILLAGE CREEK CHANNEL, CT	WLIS	22-Apr-96	0	26826.3	43973.5	0	40	59.261	73	28.73	969
MR & MRS ALBERT ZESIGNER	WILSON COVE DARIEN, CT	WLIS	23-Apr-96	0	26826.3	43973.3	0	40	59.237	73	28.738	450
VILLAGE CREEK HOMEOWNERS ASSOC	VILLAGE CREEK CHANNEL, CT	WLIS	25-Apr-96	0	26826.2	43973.4	0	40	59.251	73	28.721	800
TOM'S POINT MARINA	MANHASSET BAY VILLAGE OF MANORHAVEN, NY	WLIS	26-Apr-96	0	26826.3	43973.3	0	40	59.237	73	28.738	450
TOM'S POINT MARINA	MANHASSET BAY VILLAGE OF MANORHAVEN, NY	WLIS	27-Apr-96	0	26826.4	43973.3	0	40	59.235	73	28.75	450
TOM'S POINT MARINA	MANHASSET BAY VILLAGE OF MANORHAVEN, NY	WLIS	28-Apr-96	0	26826.4	43973.3	0	40	59.235	73	28.75	450
TOM'S POINT MARINA	MANHASSET BAY VILLAGE OF MANORHAVEN, NY	WLIS	29-Apr-96	0	26826.3	43973.3	0	40	59.237	73	28.738	450
TOM'S POINT MARINA	MANHASSET BAY VILLAGE OF MANORHAVEN, NY	WLIS	01-May-96	0	26826.4	43973.3	0	40	59.235	73	28.75	350
MANHASSET BAY MARINA	MANHASSET BAY, NY	WLIS	02-May-96	0	26826.3	43973.3	0	40	59.237	73	28.738	800
MANHASSET BAY MARINA	MANHASSET BAY, NY	WLIS	03-May-96	0	26826.4	43973.3	0	40	59.235	73	28.75	550
MANHASSET BAY MARINA	MANHASSET BAY, NY	WLIS	04-May-96	0	26826.3	43973.3	0	40	59.237	73	28.738	850
MANHASSET BAY MARINA	MANHASSET BAY, NY	WLIS	05-May-96	0	26826.4	43973.3	0	40	59.235	73	28.75	750
MANHASSET BAY MARINA	MANHASSET BAY, NY	WLIS	06-May-96	0	26826.5	43973.3	0	40	59.233	73	28.763	700
MANHASSET BAY MARINA	MANHASSET BAY, NY	WLIS	07-May-96	0	26826.3	43973.3	0	40	59.237	73	28.738	750
MANHASSET BAY MARINA	MANHASSET BAY, NY	WLIS	08-May-96	0	26826.3	43973.3	0	40	59.237	73	28.738	300
STAMFORD YACHT CLUB	STAMFORD HARBOR, CT	WLIS	09-May-96	0	26826.4	43973.3	0	40	59.235	73	28.75	800
STAMFORD YACHT CLUB	STAMFORD HARBOR, CT	WLIS	10-May-96	0	26826.5	43973.3	0	40	59.233	73	28.763	600
STAMFORD YACHT CLUB	STAMFORD HARBOR, CT	WLIS	11-May-96	0	26826.4	43973.3	0	40	59.235	73	28.75	350
PETER WARD	PRATT'S COVE, CT	WLIS	25-May-96	0	0	0	0	40	59.228	73	28.732	500
PETER WARD	PRATT'S COVE, CT	WLIS	26-May-96	0	0	0	0	40	59.228	73	28.732	450
PETER WARD	PRATT'S COVE, CT	WLIS	29-May-96	0	0	0	0	40	59.228	73	28.732	550
PETER WARD	PRATT'S COVE, CT	WLIS	29-May-96	0	0	0	0	40	59.228	73	28.732	550
											WLIS H Mound	
											Total YD³	20009
											Total m³	15299

Appendix F, Table 2

permittee	project	disparea	dispdate	wtd	xtd	ytd	ztd	latdeg	latmin	longdeg	longmin	cyvol
ANNE C. CAMBELL	DARIEN RIVER	WLIS	19-Jan-95	0	26828.8	43973.2	0	40	59.171	73	29.056	725
ANNE C. CAMBELL	DARIEN RIVER	WLIS	21-Jan-95	0	26828.4	43973.2	0	40	59.179	73	29.006	550
ANNE C. CAMPBELL	NORWALK COVE MARINA	WLIS	20-Apr-95	0	26828.8	43973.3	0	40	59.182	73	29.052	400
TOWN OF GREENWICH	GREENWICH HARBOR	WLIS	03-Jan-95	0	26828.7	43973.4	0	40	59.196	73	29.036	750
TOWN OF GREENWICH	GREENWICH BOAT & YACHT CLUB	WLIS	04-Jan-95	0	26828.5	43973.5	0	40	59.213	73	29.006	675
TOWN OF GREENWICH	GREENWICH BOAT & YACHT CLUB	WLIS	05-Jan-95	0	26828.9	43973.4	0	40	59.192	73	29.061	700
TOWN OF GREENWICH	GREENWICH BOAT & YACHT CLUB	WLIS	06-Jan-95	0	26828.8	43973.5	0	40	59.206	73	29.044	700
TOWN OF GREENWICH	GREENWICH BOAT & YACHT CLUB	WLIS	07-Jan-95	0	26828.8	43973.3	0	40	59.182	73	29.052	800
TOWN OF GREENWICH	GREENWICH BOAT & YACHT CLUB	WLIS	09-Jan-95	0	26828.7	43973.4	0	40	59.196	73	29.036	525
TOWN OF GREENWICH	GREENWICH BOAT & YACHT CLUB	WLIS	10-Jan-95	0	26828.7	43973.3	0	40	59.185	73	29.04	650
TOWN OF GREENWICH	GREENWICH HARBOR	WLIS	11-Jan-95	0	26828.6	43973.5	0	40	59.21	73	29.019	650
TOWN OF GREENWICH	GREENWICH HARBOR	WLIS	12-Jan-95	0	26828.7	43973.3	0	40	59.185	73	29.04	700
TOWN OF GREENWICH	GREENWICH HARBOR	WLIS	13-Jan-95	0	26828.8	43973.4	0	40	59.194	73	29.048	675
TOWN OF GREENWICH	GREENWICH HARBOR	WLIS	16-Jan-95	0	26828.7	43973.1	0	40	59.161	73	29.048	675
TOWN OF GREENWICH	GREENWICH HARBOR	WLIS	17-Jan-95	0	26828.7	43973.3	0	40	59.185	73	29.04	350
J ARTHUR URCIUOLI	GREENWICH COVE	WLIS	26-Jan-95	0	26828.7	43972.8	0	40	59.126	73	29.06	400
TOWN OF WESTPORT	LONG ISLAND SOUND	WLIS	26-Jan-95	0	26828.3	43973.1	0	40	59.17	73	28.997	850
TOWN OF WESTPORT	LONG ISLAND SOUND	WLIS	27-Jan-95	0	26828.1	43973	0	40	59.163	73	28.976	850
TOWN OF WESTPORT	LONG ISLAND SOUND	WLIS	28-Jan-95	0	26828.4	43973	0	40	59.156	73	29.014	930
TOWN OF WESTPORT	LONG ISLAND SOUND	WLIS	30-Jan-95	0	26828.4	43973.3	0	40	59.191	73	29.002	500
TOWN OF WESTPORT	LONG ISLAND SOUND	WLIS	31-Jan-95	0	26828.3	43973.4	0	40	59.205	73	28.985	925
TOWN OF WESTPORT	LONG ISLAND SOUND	WLIS	01-Feb-95	0	26828.3	43973.1	0	40	59.17	73	28.997	855
TOWN OF WESTPORT	LONG ISLAND SOUND	WLIS	02-Feb-95	0	26828.4	43973	0	40	59.156	73	29.014	850
TOWN OF WESTPORT	LONG ISLAND SOUND	WLIS	03-Feb-95	0	26828.4	43973.2	0	40	59.179	73	29.006	800
TOWN OF WESTPORT	LONG ISLAND SOUND	WLIS	07-Feb-95	0	26828.3	43973.2	0	40	59.182	73	28.993	850
J ARTHUR URCIUOLI	GREENWICH COVE	WLIS	07-Feb-95	0	26828	43973	0	40	59.165	73	28.964	250
TOWN OF WESTPORT	LONG ISLAND SOUND	WLIS	08-Feb-95	0	26828.3	43973	0	40	59.158	73	29.001	900
TOWN OF WESTPORT	LONG ISLAND SOUND	WLIS	09-Feb-95	0	26828.2	43973.3	0	40	59.196	73	28.977	900
TOWN OF WESTPORT	LONG ISLAND SOUND	WLIS	10-Feb-95	0	26828.3	43973.3	0	40	59.193	73	28.989	925
TOWN OF WESTPORT	LONG ISLAND SOUND	WLIS	10-Feb-95	0	26828.3	43973.3	0	40	59.193	73	28.989	650
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	11-Feb-95	0	26828.3	43973.2	0	40	59.182	73	28.993	875
TOWN OF WESTPORT	LONG ISLAND SOUND	WLIS	13-Feb-95	0	26828.3	43973.2	0	40	59.182	73	28.993	750
TOWN OF WESTPORT	LONG ISLAND SOUND	WLIS	14-Feb-95	0	26828.5	43973.3	0	40	59.189	73	29.014	750
TOWN OF WESTPORT	LONG ISLAND SOUND	WLIS	15-Feb-95	0	26828.5	43973.4	0	40	59.201	73	29.01	875
TOWN OF WESTPORT	LONG ISLAND SOUND	WLIS	16-Feb-95	0	26828.4	43973.2	0	40	59.179	73	29.006	850
TOWN OF WESTPORT	LONG ISLAND SOUND	WLIS	17-Feb-95	0	26828.4	43973.2	0	40	59.179	73	29.006	825
TOWN OF WESTPORT	LONG ISLAND SOUND	WLIS	18-Feb-95	0	26828.4	43973.3	0	40	59.191	73	29.002	500
TOWN OF WESTPORT	LONG ISLAND SOUND	WLIS	20-Feb-95	0	26828.4	43973.3	0	40	59.191	73	29.002	825
TOWN OF WESTPORT	LONG ISLAND SOUND	WLIS	22-Feb-95	0	26828.7	43973.4	0	40	59.196	73	29.036	650
J ARTHUR URCIUOLI	GREENWICH COVE	WLIS	22-Feb-95	0	26828.4	43973.1	0	40	59.168	73	29.01	425
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	23-Feb-95	0	26828.6	43973.4	0	40	59.199	73	29.023	600
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	25-Feb-95	0	26828.5	43973.4	0	40	59.201	73	29.01	600
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	28-Feb-95	0	26828.4	43973.3	0	40	59.191	73	29.002	500
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	01-Mar-95	0	26828.5	43973.3	0	40	59.189	73	29.014	800
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	02-Mar-95	0	26828.5	43973.1	0	40	59.166	73	29.022	800
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	03-Mar-95	0	26828.4	43973.3	0	40	59.191	73	29.002	750
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	04-Mar-95	0	26828.5	43973.4	0	40	59.201	73	29.01	825
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	04-Mar-95	0	26828.4	43973.3	0	40	59.191	73	29.002	750
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	05-Mar-95	0	26828.6	43973.4	0	40	59.199	73	29.023	650
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	06-Mar-95	0	26828.2	43972.5	0	40	59.102	73	29.009	875
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	06-Mar-95	0	26828.6	43972.9	0	40	59.14	73	29.043	750
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	07-Mar-95	0	26828.3	43973.1	0	40	59.17	73	28.997	875
J. ARTHUR URCIVOLI	GREENWICH COVE	WLIS	07-Mar-95	0	26828.3	43973.3	0	40	59.193	73	28.989	400
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	08-Mar-95	0	26828.1	43972.5	0	40	59.104	73	28.996	875
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	08-Mar-95	0	26828.6	43973.4	0	40	59.199	73	29.023	825
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	09-Mar-95	0	26828.3	43972.4	0	40	59.088	73	29.025	825
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	09-Mar-95	0	26828.6	43973.1	0	40	59.163	73	29.035	500
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	10-Mar-95	0	26828.4	43973.1	0	40	59.168	73	29.01	500
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	11-Mar-95	0	26828.2	43973.4	0	40	59.207	73	28.973	825
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	11-Mar-95	0	26828.3	43972.6	0	40	59.111	73	29.017	825
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	12-Mar-95	0	26828.4	43972.1	0	40	59.05	73	29.05	850
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	13-Mar-95	0	26828.4	43972.3	0	40	59.074	73	29.042	875
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	14-Mar-95	0	26828.1	43972.6	0	40	59.116	73	28.992	800
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	14-Mar-95	0	26828.2	43972.8	0	40	59.137	73	28.997	800
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	15-Mar-95	0	26828.2	43972.4	0	40	59.09	73	29.013	800
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	15-Mar-95	0	26828.3	43972.6	0	40	59.111	73	29.017	850
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	16-Mar-95	0	26828.1	43972.5	0	40	59.104	73	28.996	725
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	16-Mar-95	0	26828.3	43972.6	0	40	59.111	73	29.017	900
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	17-Mar-95	0	26828.1	43972.4	0	40	59.092	73	29	800
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	17-Mar-95	0	26828.3	43972.3	0	40	59.076	73	29.029	750
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	18-Mar-95	0	26828.3	43973.2	0	40	59.182	73	28.993	700
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	18-Mar-95	0	26828.5	43973.1	0	40	59.166	73	29.022	750
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	20-Mar-95	0	26828.5	43973.3	0	40	59.189	73	29.014	900
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	20-Mar-95	0	26828.5	43973.4	0	40	59.201	73	29.01	700
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	21-Mar-95	0	26828.3	43972.1	0	40	59.052	73	29.037	700
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	21-Mar-95	0	26828.5	43973.1	0	40	59.166	73	29.022	700
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	22-Mar-95	0	26828.1	43973.4	0	40	59.21	73	28.96	850
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	22-Mar-95	0	26828.5	43973.3	0	40	59.189	73	29.014	600
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	23-Mar-95	0	26828.4	43972.7	0	40	59.121	73	29.026	500
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	23-Mar-95	0	26828.7	43973.3	0	40	59.185	73	29.04	700
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	25-Mar-95	0	26828.3	43973.2	0	40	59.182	73	28.993	400
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	27-Mar-95	0	26828.5	43973.3	0	40	59.189	73	29.014	800
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	28-Mar-95	0	26828.4	43973.1	0	40	59.168	73	29.01	750
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	29-Mar-95	0	26828.6	43973.3	0	40	59.187	73	29.027	700
TOWN OF WESTPORT	NORWALK COVE MARINA	WLIS	31-Mar-95	0	26828.4	43973.1	0	40	59.168	73	29.01	500
TOM'S POINT MARINA	MANHASSET BAY/VILLAGE OF MANORHAVEN, NY	WLIS	22-Apr-95	0	26828.8	43972.3	0	40	59.065	73	29.092	500
TOM'S POINT MARINA	MANHASSET BAY/VILLAGE OF MANORHAVEN, NY	WLIS	24-Apr-95	0	26828.2	43972.7	0	40	59.125	73	29.001	650
TOM'S POINT MARINA	MANHASSET BAY/VILLAGE OF MANORHAVEN, NY	WLIS	25-Apr-95	0	26828.9	43972.5	0	40	59.086	73	29.097	475
TOM'S POINT MARINA	MANHASSET BAY/VILLAGE OF MANORHAVEN, NY	WLIS	26-Apr-95	0	26838.4	43972.8	0	40	58.914	73	30.281	550
TOM'S POINT MARINA	MANHASSET BAY/VILLAGE OF MANORHAVEN, NY	WLIS	27-Apr-95	0	26828.9	43973.4	0	40	59.192	73	29.061	625
TOM'S POINT MARINA	MANHASSET BAY/VILLAGE OF MANORHAVEN, NY	WLIS	28-Apr-95	0	26828.6	43972.9	0	40	59.14	73	29.043	650
TOM'S POINT MARINA	MANHASSET BAY/VILLAGE OF MANORHAVEN, NY	WLIS	29-Apr-95	0	26828.4	43972.5	0	40	59.097	73	29.034	450
MILT COMPANY	LI SOUND - STAMFORD CT	WLIS	25-Apr-95	0	26828.5	43972.9	0	40	59.142	73	29.03	450
MILT COMPANY	LI SOUND - STAMFORD CT	WLIS	26-Apr-95	0	26828.5	43972.9	0	40	59.142	73	29.03	450
MILT COMPANY	LI SOUND - STAMFORD CT	WLIS	26-Apr-95	0	26828.5	43972.9	0	40	59.142	73	29.03	450
MILT COMPANY	LI SOUND - STAMFORD CT	WLIS	27-Apr-95	0	26828.5	43972.9	0	40	59.142	73	29.03	450
ROTON POINT ASSOC	SHEFFIELD ISLAND HARBOR AT NORWALK CT	WLIS	23-May-95	0	26828.5	43972.9	0	40	59.142	73	29.03	250
ROTON POINT ASSOC	SHEFFIELD ISLAND HARBOR AT NORWALK CT	WLIS	25-May-95	0	26828.5	43972.7	0	40	59.119	73	29.038	400
ROTON POINT ASSOC	SHEFFIELD ISLAND HARBOR AT NORWALK CT	WLIS	26-May-95	0	26828.6	43972.5	0	40	59.093	73	29.059	500
ROTON POINT ASSOC	SHEFFIELD ISLAND HARBOR AT NORWALK CT	WLIS	31-May-95	0	26828.4	43972.7	0	40	59.121	73	29.026	400

1994-95	WLIS G Mound	
	Total YD³	66685
	Total m³	52516.55

Appendix F, Table 3

permittee	project	disparea	dispdate	wtd	xtd	ytd	ztd	latdeg	latmin	longdeg	longmin	cyvol
TIDE MILL YACHT BASIN	TIDE MILL YACHT BASIN	WLIS	11-Dec-91	0	26827.9	43973.1	0	40	59.179	73	28.947	650
TIDE MILL YACHT BASIN	TIDE MILL YACHT BASIN	WLIS	12-Dec-91	0	26827.8	43973.2	0	40	59.193	73	28.93	800
TIDE MILL YACHT BASIN	TIDE MILL YACHT BASIN	WLIS	13-Dec-91	0	26827.7	43973.2	0	40	59.195	73	28.918	800
TIDE MILL YACHT BASIN	TIDE MILL YACHT BASIN	WLIS	16-Dec-91	0	26827.7	43973.2	0	40	59.195	73	28.918	700
TIDE MILL YACHT BASIN	TIDE MILL YACHT BASIN	WLIS	17-Dec-91	0	26827.7	43973.3	0	40	59.207	73	28.914	750
TIDE MILL YACHT BASIN	TIDE MILL YACHT BASIN	WLIS	18-Dec-91	0	26827.7	43973.2	0	40	59.195	73	28.918	750
TIDE MILL YACHT BASIN	TIDE MILL YACHT BASIN	WLIS	19-Dec-91	0	26827.7	43973.3	0	40	59.207	73	28.914	600
TIDE MILL YACHT BASIN	TIDE MILL YACHT BASIN	WLIS	20-Dec-91	0	26827.7	43973.2	0	40	59.195	73	28.918	700
TIDE MILL YACHT BASIN	TIDE MILL YACHT BASIN	WLIS	21-Dec-91	0	26827.6	43973.2	0	40	59.197	73	28.905	500
TIDE MILL YACHT BASIN	TIDE MILL YACHT BASIN	WLIS	23-Dec-91	0	26827.6	43973.2	0	40	59.197	73	28.905	500
TIDE MILL YACHT BASIN	TIDE MILL YACHT BASIN	WLIS	27-Dec-91	0	26827.7	43973.3	0	40	59.207	73	28.914	500
TIDE MILL YACHT BASIN	TIDE MILL YACHT BASIN	WLIS	30-Dec-91	0	26827.7	43973.2	0	40	59.195	73	28.918	650
TIDE MILL YACHT BASIN	TIDE MILL YACHT BASIN	WLIS	06-Jan-92	0	26827.7	43973.2	0	40	59.195	73	28.918	600
TIDE MILL YACHT BASIN	TIDE MILL YACHT BASIN	WLIS	07-Jan-92	0	26827.6	43973.2	0	40	59.197	73	28.905	550
TIDE MILL YACHT BASIN	TIDE MILL YACHT BASIN	WLIS	08-Jan-92	0	26827.7	43973.2	0	40	59.195	73	28.918	450
TIDE MILL YACHT BASIN	TIDE MILL YACHT BASIN	WLIS	09-Jan-92	0	26827.7	43973.3	0	40	59.207	73	28.914	400
TIDE MILL YACHT BASIN	TIDE MILL YACHT BASIN	WLIS	10-Jan-92	0	26827.6	43973.2	0	40	59.197	73	28.905	350
TRUST OF J. McMICHAEL	MAMARONECK	WLIS	16-Jan-92	0	26827.6	43973.2	0	40	59.197	73	28.905	475
TRUST OF J. McMICHAEL	MAMARONECK	WLIS	16-Jan-92	0	26827.7	43973.3	0	40	59.207	73	28.914	475
TRUST OF J. McMICHAEL	MAMARONECK	WLIS	22-Jan-92	0	26827.8	43973.2	0	40	59.193	73	28.93	350
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	25-Jan-92	0	26829.4	43979.2	0	40	59.863	73	28.892	500
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	31-Jan-92	0	26827.3	43973.1	0	40	59.192	73	28.871	500
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	31-Jan-92	0	26827.6	43973.2	0	40	59.197	73	28.905	500
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	01-Feb-92	0	26827.3	43973	0	40	59.18	73	28.875	450
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	01-Feb-92	0	26827.2	43973.4	0	40	59.229	73	28.847	500
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	03-Feb-92	0	26827.7	43973.1	0	40	59.183	73	28.922	450
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	03-Feb-92	0	26827.6	43973.1	0	40	59.185	73	28.909	500
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	04-Feb-92	0	26827.5	43973.7	0	40	59.258	73	28.873	200
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	04-Feb-92	0	26827.7	43973.7	0	40	59.254	73	28.898	600
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	05-Feb-92	0	26827.7	43973.1	0	40	59.183	73	28.922	50
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	05-Feb-92	0	26827.7	43973.2	0	40	59.195	73	28.918	500
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	06-Feb-92	0	26827.6	43973.1	0	40	59.185	73	28.909	500
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	06-Feb-92	0	26827.7	43973.2	0	40	59.195	73	28.918	400
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	07-Feb-92	0	26827.7	43973.1	0	40	59.183	73	28.922	400
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	10-Feb-92	0	26827.7	43973.1	0	40	59.183	73	28.922	500
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	11-Feb-92	0	26827.3	43973.1	0	40	59.192	73	28.871	500
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	11-Feb-92	0	26827.6	43973.2	0	40	59.197	73	28.905	250
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	12-Feb-92	0	26827.6	43973.3	0	40	59.209	73	28.901	375
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	12-Feb-92	0	26827.6	43973.1	0	40	59.185	73	28.909	500
TRUST OF J. McMICHAEL	MAMARONECK	WLIS	13-Feb-92	0	26827.7	43973.2	0	40	59.195	73	28.918	300
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	14-Feb-92	0	26827.7	43973.2	0	40	59.195	73	28.918	500
VILLAGE CREEK HOMEOWNERS ASSOC	NOR COVE	WLIS	14-Feb-92	0	26827.6	43973.2	0	40	59.197	73	28.905	376
TRUST OF J. McMICHAEL	MAMARONECK	WLIS	19-Feb-92	0	26827.6	43973.2	0	40	59.197	73	28.905	400
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	14-Feb-92	0	0	0	0	0	0	0	0	485
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	14-Feb-92	0	26827.7	43975.2	0	40	59.43	73	28.838	500
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	14-Feb-92	0	0	0	0	0	0	0	0	500
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	17-Feb-92	0	26827.6	43973.1	0	40	59.185	73	28.909	200
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	18-Feb-92	0	26827.5	43973	0	40	59.176	73	28.901	400
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	18-Feb-92	0	26827.6	43973.1	0	40	59.185	73	28.909	500
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	18-Feb-92	0	26827.1	43973.7	0	40	59.267	73	28.822	500
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	19-Feb-92	0	26827.7	43973.2	0	40	59.195	73	28.918	500
HARBOR VILLAGE LTD PARTNERSHIP	COS CCB HARBOR	WLIS	19-Feb-92	0	26827.7	43973.2	0	40	59.195	73	28.918	500
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	20-Feb-92	0	26827.2	43973.2	0	40	59.206	73	28.855	550
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	20-Feb-92	0	26827.2	43973.2	0	40	59.206	73	28.855	425
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	20-Feb-92	0	26827.2	43973.2	0	40	59.206	73	28.855	500
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	21-Feb-92	0	26827.6	43973.2	0	40	59.197	73	28.905	250
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	21-Feb-92	0	26827.6	43973.1	0	40	59.185	73	28.909	500
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	21-Feb-92	0	26877.8	43973.7	0	40	58.165	73	35.221	500
TRUST OF J. McMICHAEL	MAMARONECK	WLIS	21-Feb-92	0	26827.7	43973.2	0	40	59.195	73	28.918	300
TRUST OF J. McMICHAEL	MAMARONECK	WLIS	22-Feb-92	0	26827.7	43973.1	0	40	59.183	73	28.922	300
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	22-Feb-92	0	26827.7	43973.2	0	40	59.195	73	28.918	500
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	22-Feb-92	0	26827.7	43973.2	0	40	59.195	73	28.918	500
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	24-Feb-92	0	26827.7	43973.2	0	40	59.195	73	28.918	450
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	24-Feb-92	0	26827.5	43973	0	40	59.176	73	28.901	250
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	25-Feb-92	0	26827.7	43973.4	0	40	59.218	73	28.91	400
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	25-Feb-92	0	26827.7	43973.1	0	40	59.183	73	28.922	400
TRUST OF J. McMICHAEL	MAMARONECK	WLIS	25-Feb-92	0	26827.6	43973.2	0	40	59.197	73	28.905	350
TRUST OF J. McMICHAEL	MAMARONECK	WLIS	26-Feb-92	0	26827.6	43973.2	0	40	59.197	73	28.905	300
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	26-Feb-92	0	26827.7	43973.2	0	40	59.195	73	28.918	500
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	26-Feb-92	0	26827.7	43973.2	0	40	59.195	73	28.918	300
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	26-Feb-92	0	26827.7	43973.6	0	40	59.242	73	28.902	500
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	26-Feb-92	0	26827.7	43973.2	0	40	59.195	73	28.918	300
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	26-Feb-92	0	26827.7	43973.2	0	40	59.195	73	28.918	500
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	27-Feb-92	0	26827.7	43973.2	0	40	59.195	73	28.918	475
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	27-Feb-92	0	26827.7	43973.2	0	40	59.195	73	28.918	300
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	27-Feb-92	0	26827.7	43973.1	0	40	59.183	73	28.922	400
TRUST OF J. McMICHAEL	MAMARONECK	WLIS	27-Feb-92	0	26827.7	43973.1	0	40	59.183	73	28.922	300
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	28-Feb-92	0	26827.7	43973.2	0	40	59.195	73	28.918	475
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	28-Feb-92	0	26827.7	43973.2	0	40	59.195	73	28.918	300
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	28-Feb-92	0	26827.7	43973.2	0	40	59.195	73	28.918	300
HARBOR VILLAGE LTD PARTNERSHIP	COS CCB HARBOR	WLIS	28-Feb-92	0	26827.7	43973.2	0	40	59.195	73	28.918	500
TRUST OF J. McMICHAEL	MAMARONECK	WLIS	01-Mar-92	0	26827.7	43973.3	0	40	59.207	73	28.914	300
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	02-Mar-92	0	26827.7	43973.2	0	40	59.195	73	28.918	500
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	02-Mar-92	0	26827.7	43973.2	0	40	59.195	73	28.918	350
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	03-Mar-92	0	26827.7	43973.2	0	40	59.195	73	28.918	500
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	03-Mar-92	0	26827.7	43973.2	0	40	59.195	73	28.918	375
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	04-Mar-92	0	26827.7	43973.2	0	40	59.195	73	28.918	400
HARBOR VILLAGE LTD PARTNERSHIP	COS CCB HARBOR	WLIS	04-Mar-92	0	26827.7	43973.2	0	40	59.195	73	28.918	325
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	05-Mar-92	0	26827.7	43973.2	0	40	59.195	73	28.918	300
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	05-Mar-92	0	26827.7	43973.2	0	40	59.195	73	28.918	200
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	06-Mar-92	0	26827.7	43973.1	0	40	59.183	73	28.922	250
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	06-Mar-92	0	26827.7	43973.2	0	40	59.195	73	28.918	200
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	09-Mar-92	0	26827.7	43973.2	0	40	59.195	73	28.918	400
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	09-Mar-92	0	26827.7	43973.3	0	40	59.207	73	28.914	425
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	10-Mar-92	0	26827.7	43973.2	0	40	59.195	73	28.918	375
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	10-Mar-92	0	26827.7	43973.2	0	40	59.195	73	28.918	425
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	11-Mar-92	0	26827.7	43973.2	0	40	59.195	73	28.918	475
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	12-Mar-92	0	26827.7	43973.7	0	40	59.254	73	28.898	200
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	13-Mar-92	0	26827.7	43973.2	0	40	59.195	73	28.918	350
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	13-Mar-92	0	26827.7	43973.2	0	40	59.195	73	28.918	375
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	16-Mar-92	0	26827.7	43973.2	0	40	59.195	73	28.918	300
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	17-Mar-92	0	26827.7	43973.2	0	40	59.195	73	28.918	275
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	18-Mar-92	0	26827.6	43973.1	0	40	59.185	73	28.909	75
HARBOR VILLAGE LTD PARTNERSHIP	COS COB HARBOR	WLIS	27-Mar-92	0	26827.7	43973.2	0	40	59.195	73	28.918	500
TALLMADGE BROTHERS	SONO SEAFOOD	WLIS	04-Mar-92	0	26827.6	43973.2	0	40	59.197	73	28.905	850
TALLMADGE BROTHERS	SONO SEAFOOD	WLIS	14-Mar-92	0	26827.6	43973.2	0	40	59.197	73	28.905	850
L. SCOTT FRANTZ	GREEN C.	WLIS	06-Apr-92	0	26822.7	43973.1	0	40	59.293	73	28.293	200
L. SCOTT FRANTZ	GREEN C.	WLIS	07-Apr-92	0	26827.6	43973.2	0	40	59.197	73	28.905	200
L. SCOTT FRANTZ	GREEN C.	WLIS	08-Apr-92	0	26827.6	43973.1	0	40	59.185	73	28.909	175
L. SCOTT FRANTZ	GREEN C.	WLIS	09-Apr-92	0	26827.6	43973.2	0	40	59.197	73	28.905	175
L. SCOTT FRANTZ	GREEN C.	WLIS	10-Apr-92	0	26827.5	43973.2	0	40	59.199	73	28.893	150
L. SCOTT FRANTZ	GREEN C.	WLIS	15-Apr-92	0	26827.6	43973.2	0	40	59.197	73	28.905	150
L. SCOTT FRANTZ	GREEN C.	WLIS	15-Apr-92	0	26827.5	43973	0	40	59.176	73	28.901	75
L. SCOTT FRANTZ	GREEN C.	WLIS	17-Apr-92	0	26827.4	43973.2	0	40	59.201	73	28.88	50
PAUL HOFFMAN	LARCHMONT	WLIS	28-Apr-92	0	26827.8	43973.1	0	40	59.181	73	28.934	550
PAUL HOFFMAN	LARCHMONT	WLIS	29-Apr-92	0	26827.7	43973.2	0	40	59.195	73	28.918	400
ALLEN GREEN	LARCHMONT	WLIS	30-Apr-92	0	26727.7	43973.2	0	41	1.417	73	16.418	650
ALLEN GREEN	LARCHMONT	WLIS	01-May-92	0	26827.7	43973.1	0	40	59.183	73	28.922	650
ALLEN GREEN	LARCHMONT	WLIS	04-May-92	0	26827.7	43973.2	0	40	59.195	73	28.918	200

1991-92 WLIS F Mound
Total Y 50611
Total m³ 38697.2

Appendix F, Table 4

permittee	project	disparea	dispdate	wtd	xtd	ytd	ztd	latdeg	latmin	longdeg	longmin	cyvol
TOWN OF GREENWICH	BYRAM HARBOR	WLIS	15-Jan-93	0	26827.3	43972.8	0	40	59.157	73	28.883	500
TOWN OF GREENWICH	BYRAM HARBOR	WLIS	16-Jan-93	0	26827.7	43973.1	0	40	59.183	73	28.922	500
TOWN OF GREENWICH	BYRAM HARBOR	WLIS	18-Jan-93	0	26827.3	43973.3	0	40	59.215	73	28.864	500
TOWN OF GREENWICH	BYRAM HARBOR	WLIS	19-Jan-93	0	26828	43973.1	0	40	59.176	73	28.96	500
TOWN OF GREENWICH	BYRAM HARBOR	WLIS	20-Jan-93	0	26827.4	43972.9	0	40	59.166	73	28.892	450
TOWN OF GREENWICH	BYRAM HARBOR	WLIS	21-Jan-93	0	26827.7	43973.1	0	40	59.183	73	28.922	725
TOWN OF GREENWICH	BYRAM HARBOR	WLIS	23-Jan-93	0	26827.7	43973.1	0	40	59.183	73	28.922	775
TOWN OF GREENWICH	BYRAM HARBOR	WLIS	23-Jan-93	0	26827.7	43973.1	0	40	59.183	73	28.922	700
TOWN OF GREENWICH	BYRAM HARBOR	WLIS	25-Jan-93	0	26827.7	43973.1	0	40	59.183	73	28.922	450
TOWN OF GREENWICH	BYRAM HARBOR	WLIS	26-Jan-93	0	26827.6	43973.2	0	40	59.197	73	28.905	700
TOWN OF GREENWICH	BYRAM HARBOR	WLIS	27-Jan-93	0	26827.4	43972.9	0	40	59.166	73	28.892	750
TOWN OF GREENWICH	BYRAM HARBOR	WLIS	28-Jan-93	0	26827.7	43973.1	0	40	59.183	73	28.922	600
TOWN OF GREENWICH	BYRAM HARBOR	WLIS	30-Jan-93	0	26827.6	43973	0	40	59.173	73	28.913	550
TOWN OF GREENWICH	BYRAM HARBOR	WLIS	02-Feb-93	0	26827.6	43973.1	0	40	59.185	73	28.909	600
TOWN OF GREENWICH	BYRAM HARBOR	WLIS	03-Feb-93	0	26827.3	43973.2	0	40	59.204	73	28.867	750
TOWN OF GREENWICH	BYRAM HARBOR	WLIS	04-Feb-93	0	26827.4	43973.1	0	40	59.19	73	28.884	600
TOWN OF GREENWICH	BYRAM HARBOR	WLIS	04-Feb-93	0	26827.7	43973.1	0	40	59.183	73	28.922	500
TOWN OF GREENWICH	BYRAM HARBOR	WLIS	05-Feb-93	0	26827.7	43973.1	0	40	59.183	73	28.922	600
TOWN OF GREENWICH	*BYRAM HARBOR*	*WLIS*	*06-Feb-93*	*0*	*26827.8*	*43973.1*	*0*	*40*	*59.181*	*73*	*28.934*	*500*
TOWN OF GREENWICH	BYRAM HARBOR	WLIS	08-Feb-93	0	26827.4	43973	0	40	59.178	73	28.888	750
TOWN OF GREENWICH	BYRAM HARBOR	WLIS	09-Feb-93	0	26827.8	43973.3	0	40	59.204	73	28.926	750
TOWN OF GREENWICH	BYRAM HARBOR	WLIS	10-Feb-93	0	26827.3	43973.1	0	40	59.192	73	28.871	800
TOWN OF GREENWICH	BYRAM HARBOR	WLIS	11-Feb-93	0	26827.7	43973.2	0	40	59.195	73	28.918	700
TOWN OF GREENWICH	BYRAM HARBOR	WLIS	13-Feb-93	0	26827.8	43973.3	0	40	59.204	73	28.926	650
TOWN OF GREENWICH	BYRAM HARBOR	WLIS	16-Feb-93	0	26827.3	43973.1	0	40	59.192	73	28.871	650
TOWN OF GREENWICH	BYRAM HARBOR	WLIS	17-Feb-93	0	26827.4	43973	0	40	59.178	73	28.888	700
TOWN OF GREENWICH	BYRAM HARBOR	WLIS	18-Feb-93	0	26827.7	43973.2	0	40	59.195	73	28.918	600
TOWN OF GREENWICH	BYRAM HARBOR	WLIS	18-Feb-93	0	26827.6	43973	0	40	59.173	73	28.913	600
TOWN OF GREENWICH	BYRAM HARBOR	WLIS	19-Feb-93	0	26827.3	43973.1	0	40	59.192	73	28.871	400
TOWN OF GREENWICH	BYRAM HARBOR	WLIS	20-Feb-93	0	26827.7	43973.1	0	40	59.183	73	28.922	400
TOWN OF GREENWICH	BYRAM HARBOR	WLIS	22-Feb-93	0	26827.4	43973.1	0	40	59.19	73	28.884	300
TOWN OF GREENWICH	BYRAM HARBOR	WLIS	23-Feb-93	0	26827.4	43973.3	0	40	59.213	73	28.876	300
TOWN OF GREENWICH	BYRAM HARBOR	WLIS	24-Feb-93	0	26827.7	43973.1	0	40	59.183	73	28.922	250
TOWN OF GREENWICH	BYRAM HARBOR	WLIS	26-Feb-93	0	26827.6	43973.2	0	40	59.197	73	28.905	350
MR MRS GARY L. SWENSON	BYRAM HBR	WLIS	01-Mar-93	0	26827.6	43973.1	0	40	59.185	73	28.909	500
L. SCOTT FRANTZ	GREENWICH COVE	WLIS	07-Apr-93	0	26827.3	43973.1	0	40	59.192	73	28.871	50
PONINGO NECK APTS CORP	MILTON HBR, RYE NY	WLIS	07-Apr-93	0	26827.3	43973.1	0	40	59.192	73	28.871	885
PONINGO NECK APTS CORP	MILTON HBR, RYE NY	WLIS	08-Apr-93	0	26827.4	43973.1	0	40	59.19	73	28.884	920
PONINGO NECK APTS CORP	MILTON HBR, RYE NY	WLIS	09-Apr-93	0	26827.8	43973.3	0	40	59.204	73	28.926	900
PONINGO NECK APTS CORP	MILTON HBR, RYE NY	WLIS	10-Apr-93	0	26827.3	43972.9	0	40	59.168	73	28.879	900
PONINGO NECK APTS CORP	MILTON HBR, RYE NY	WLIS	12-Apr-93	0	26827	43972.8	0	40	59.163	73	28.846	940
PONINGO NECK APTS CORP	MILTON HBR, RYE NY	WLIS	14-Apr-93	0	26827.9	43973.2	0	40	59.19	73	28.943	950
PONINGO NECK APTS CORP	MILTON HBR, RYE NY	WLIS	15-Apr-93	0	26827.4	43973.1	0	40	59.19	73	28.884	940
PONINGO NECK APTS CORP	MILTON HBR, RYE NY	WLIS	16-Apr-93	0	26827.5	43973.1	0	40	59.187	73	28.897	700
PONINGO NECK APTS CORP	MILTON HBR, RYE NY	WLIS	29-Apr-93	0	26827.3	43973.2	0	40	59.204	73	28.867	900
BREWER MARINA, INC	GLEN COVE CREEK	WLIS	06-Jun-93	0	26827.2	43973.1	0	40	59.194	73	28.859	225

1992-93 WLIS F Mound	
Total YD³	28260
Total m³	21607.6

Appendix F, Table 5

permittee	project	disparea	dispdate	wtd	xtd	ytd	ztd	latdeg	latmin	longdeg	longmin	cyvol
NORWALK BOAT CLUB	NORWALK RIVER, SO. NORWALK CT	WLIS	05-Jan-94	0	26827.2	43973.1	0	40	59.395	73	28.741	925
NORWALK BOAT CLUB	NORWALK RIVER, SO. NORWALK CT	WLIS	06-Jan-94	0	26827.2	43973.1	0	40	59.395	73	28.741	775
NORWALK BOAT CLUB	NORWALK RIVER, SO. NORWALK CT	WLIS	06-Jan-94	0	26827.1	43973.2	0	40	59.409	73	28.725	600
NORWALK BOAT CLUB	NORWALK RIVER, SO. NORWALK CT	WLIS	11-Jan-94	0	26824.3	43972.8	0	40	59.423	73	28.388	875
NORWALK BOAT CLUB	NORWALK RIVER, SO. NORWALK CT	WLIS	13-Jan-94	0	268270	43973	0	40	59.387	73	28.72	900
INDIAN COVE PROPERTY OWNERS	INDIAN COVE ASSOC	WLIS	15-Dec-93	0	26837.1	43972.9	0	40	58.954	73	30.113	850
INDIAN COVE PROPERTY OWNERS	INDIAN COVE ASSOC	WLIS	17-Dec-93	0	26827.2	43973.1	0	40	59.194	73	28.859	900
INDIAN COVE PROPERTY OWNERS	INDIAN COVE ASSOC	WLIS	17-Dec-93	0	26827.3	43973	0	40	59.18	73	28.875	800
INDIAN COVE PROPERTY OWNERS	INDIAN COVE ASSOC	WLIS	18-Dec-93	0	26827.2	43973.2	0	40	59.206	73	28.855	800
INDIAN COVE PROPERTY OWNERS	INDIAN COVE ASSOC	WLIS	20-Dec-93	0	26827.3	43973.1	0	40	59.192	73	28.871	700
DANIEL A SPERANDIO, JR	13 NAUTILUS PL, NEW ROCHELLE, NY	WLIS	11-Jan-94	0	26827.4	43973.1	0	40	59.19	73	28.884	400
DANIEL A SPERANDIO, JR	13 NAUTILUS PL, NEW ROCHELLE, NY	WLIS	13-Jan-94	0	26827.3	43973	0	40	59.18	73	28.875	400
DANIEL A SPERANDIO, JR	13 NAUTILUS PL, NEW ROCHELLE, NY	WLIS	14-Jan-94	0	26827.2	43972.9	0	40	59.17	73	28.867	400
DANIEL A SPERANDIO, JR	13 NAUTILUS PL, NEW ROCHELLE, NY	WLIS	29-Jan-94	0	26827.5	43973.2	0	40	59.199	73	28.893	400
DANIEL A SPERANDIO, JR	13 NAUTILUS PL, NEW ROCHELLE, NY	WLIS	02-Feb-94	0	29827.2	43972.9	0	40	59.17	73	28.867	400
DANIEL A SPERANDIO, JR	13 NAUTILUS PL, NEW ROCHELLE, NY	WLIS	07-Feb-94	0	26827.4	43973	0	40	59.178	73	28.888	400
BREWER MARINA, INC	GLEN COVE CREEK	WLIS	01-Mar-94	0	26820.1	43973	0	40	59.338	73	27.97	350
BREWER MARINA, INC	GLEN COVE CREEK	WLIS	02-Mar-94	0	26857.1	43972.9	0	40	58.519	73	32.635	350
BREWER MARINA, INC	GLEN COVE CREEK	WLIS	05-Mar-94	0	26827.2	43972.8	0	40	59.159	73	28.871	275
SHORE AND COUNTRY CLUB	CHARLES CREEK, E. NORWALK, CT.	WLIS	06-Mar-94	0	26827.2	43972.9	0	40	59.371	73	28.749	825
SHORE AND COUNTRY CLUB	CHARLES CREEK, E. NORWALK, CT.	WLIS	07-Mar-94	0	26827.1	43972.5	0	40	59.326	73	28.752	850
SHORE AND COUNTRY CLUB	CHARLES CREEK, E. NORWALK, CT.	WLIS	08-Mar-94	0	26827	43972.9	0	40	59.376	73	28.724	825
BREWER MARINA, INC	GLEN COVE CREEK	WLIS	08-Mar-94	0	26827.2	43973.1	0	40	59.194	73	28.859	300
SHORE AND COUNTRY CLUB	CHARLES CREEK, E. NORWALK, CT.	WLIS	11-Mar-94	0	26827.4	43973	0	40	59.379	73	28.77	750
SHORE AND COUNTRY CLUB	CHARLES CREEK, E. NORWALK, CT.	WLIS	12-Mar-94	0	26827.1	43972.8	0	40	59.362	73	28.74	850
BREWER MARINA, INC	GLEN COVE CREEK	WLIS	12-Mar-94	0	26827.2	43972.9	0	40	59.17	73	28.867	275
BREWER MARINA, INC	GLEN COVE CREEK	WLIS	13-Mar-94	0	26827.1	43972.9	0	40	59.173	73	28.854	275
BREWER MARINA, INC	GLEN COVE CREEK	WLIS	14-Mar-94	0	26827.1	43972.9	0	40	59.173	73	28.854	275
BREWER MARINA, INC	GLEN COVE CREEK	WLIS	15-Mar-94	0	26827.2	43972.9	0	40	59.17	73	28.867	300
SHORE AND COUNTRY CLUB	CHARLES CREEK, E. NORWALK, CT.	WLIS	15-Mar-94	0	26827.2	43972.9	0	40	59.371	73	28.749	825
BREWER MARINA, INC	GLEN COVE CREEK	WLIS	18-Mar-94	0	26827.1	43972.9	0	40	59.173	73	28.854	250
BREWER MARINA, INC	GLEN COVE CREEK	WLIS	21-Mar-94	0	26827.2	43973	0	40	59.182	73	28.863	275
BREWER MARINA, INC	GLEN COVE CREEK	WLIS	21-Mar-94	0	26827.2	43973.1	0	40	59.194	73	28.859	275
SHORE AND COUNTRY CLUB	CHARLES CREEK, E. NORWALK, CT.	WLIS	21-Mar-94	0	26827.2	43972.9	0	40	59.371	73	28.749	800
BREWER MARINA, INC	GLEN COVE CREEK	WLIS	22-Mar-94	0	26827.2	43973.1	0	40	59.194	73	28.859	275
SHORE AND COUNTRY CLUB	CHARLES CREEK, E. NORWALK, CT.	WLIS	23-Mar-94	0	26827.3	43972.9	0	40	59.369	73	28.762	600
BREWER MARINA, INC	GLEN COVE CREEK	WLIS	24-Mar-94	0	26827.2	43973.1	0	40	59.194	73	28.859	300
SHORE AND COUNTRY CLUB	CHARLES CREEK, E. NORWALK, CT.	WLIS	24-Mar-94	0	268270	43972.9	0	40	59.376	73	28.724	450
SHORE AND COUNTRY CLUB	CHARLES CREEK, E. NORWALK, CT.	WLIS	25-Mar-94	0	26827.1	43972.8	0	40	59.362	73	28.74	575
SHORE AND COUNTRY CLUB	CHARLES CREEK, E. NORWALK, CT.	WLIS	26-Mar-94	0	26857.1	43972.9	0	40	58.719	73	32.517	600
BREWER MARINA, INC	GLEN COVE CREEK	WLIS	28-Mar-94	0	268270	43973.1	0	40	59.399	73	28.716	300
SHORE AND COUNTRY CLUB	*CHARLES CREEK, E. NORWALK, CT.*	*WLIS*	*29-Mar-94*	*0*	*26827.1*	*43972.9*	*0*	*40*	*59.373*	*73*	*28.736*	*600*
BREWER MARINA, INC	GLEN COVE CREEK	WLIS	30-Mar-94	0	26827.1	439721	0	40	59.279	73	28.768	300
BREWER MARINA, INC	GLEN COVE CREEK	WLIS	31-Mar-94	0	26827.1	43972.9	0	40	59.373	73	28.736	300
BREWER MARINA, INC	GLEN COVE CREEK	WLIS	01-Apr-94	0	26827.2	43973.1	0	40	59.395	73	28.741	300
BREWER MARINA, INC	GLEN COVE CREEK	WLIS	04-Apr-94	0	26827.2	43972.9	0	40	59.17	73	28.867	300
BREWER MARINA, INC	GLEN COVE CREEK	WLIS	05-Apr-94	0	26827.2	43973.1	0	40	59.194	73	28.859	250
BREWER MARINA, INC	GLEN COVE CREEK	WLIS	11-Apr-94	0	26827.2	43972.8	0	40	59.159	73	28.871	250
NOROTON YACHT CLUB	NOROTON YACHT CLUB	WLIS	14-Apr-94	0	26827.5	43973.2	0	40	59.199	73	28.893	450
BELLE HAVEN CLUB	BELLE HAVEN CLUB	WLIS	14-Apr-94	0	26827.4	43972.9	0	43	17.861	70	27.221	400
NOROTON YACHT CLUB	NOROTON YACHT CLUB	WLIS	15-Apr-94	0	26827.5	42673.1	0	38	48.182	74	8.793	450
BELLE HAVEN CLUB	BELLE HAVEN CLUB	WLIS	15-Apr-94	0	26827.4	43973.1	0	40	59.19	73	28.884	250
NOROTON YACHT CLUB	NOROTON YACHT CLUB	WLIS	18-Apr-94	0	26827.4	43973	0	40	59.178	73	28.888	450
NOROTON YACHT CLUB	NOROTON YACHT CLUB	WLIS	19-Apr-94	0	26827.5	43973.1	0	40	59.187	73	28.897	100
BELLE HAVEN CLUB	BELLE HAVEN CLUB	WLIS	19-Apr-94	0	26827.4	43973.1	0	40	59.19	73	28.884	400
BELLE HAVEN CLUB	BELLE HAVEN CLUB	WLIS	20-Apr-94	0	26827.4	43973.1	0	40	59.19	73	28.884	400
BELLE HAVEN CLUB	BELLE HAVEN CLUB	WLIS	21-Apr-94	0	26827.3	43973.1	0	40	59.192	73	28.871	400
BELLE HAVEN CLUB	BELLE HAVEN CLUB	WLIS	22-Apr-94	0	26827.5	43973.1	0	40	59.187	73	28.897	400
BELLE HAVEN CLUB	BELLE HAVEN CLUB	WLIS	25-Apr-94	0	26827.3	43972.9	0	40	59.168	73	28.879	300
BELLE HAVEN CLUB	BELLE HAVEN CLUB	WLIS	26-Apr-94	0	26827.4	43973.2	0	40	59.201	73	28.88	400
BELLE HAVEN CLUB	BELLE HAVEN CLUB	WLIS	27-Apr-94	0	26827.5	43972.9	0	40	59.164	73	28.905	300
BELLE HAVEN CLUB	BELLE HAVEN CLUB	WLIS	28-Apr-94	0	26827.5	43972.9	0	40	59.164	73	28.905	300
BELLE HAVEN CLUB	BELLE HAVEN MARINA	WLIS	06-May-94	0	26827.4	43973.1	0	39	59.19	73	28.884	400

1993-94 WLIS F Mound

Total YD^3 26175

Total m^3 20013.4