NOAA FORM 76-35A

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL OCEAN SERVICE

DESCRIPTIVE REPORT

Type of Survey Hydrographic/Lidar

Project No. OPR-B370-KRL-04

Registry No. H11224

LOCALITY

State Connecticut

General Locality Long Island Sound

Sublocality Fishers Island Sound to New London Harbor

2004

HYDROGRAPHER MARK SINCLAIR

CHIEF OF PARTY DARREN STEPHENSON

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DATE

NOAA FORM 77-28 (11-72) U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION	REGISTRY NO.
HYDROGRAPHIC TITLE SHEET	**H11224**
INSTRUCTIONS – The Hydrographic Sheet should be accompanied by this form, filled in as completely as possible, when the sheet is forwarded to the Office	FIELD No. **N/A**

State: Connecticut

General Locality: Long Island Sound

Sub-Locality: Fishers Island Sound to New London Harbor

Scale: 1:10,000 **Date of Survey:** January 20 to March 05, 2004

Instructions dated: April 28, 2003 **Project No:** OPR-B370-KRL-04

Vessel: Tenix LADS Aircraft, VH – LCL

Hydrographer: Mark Sinclair **Chief of Party:** Darren Stephenson

Surveyed by: Michael Hawkins, Tom Farrow, Jeff Young, Graeme Stringfellow, Harry Newsham, Luke Chamberlain, Hugh Parker

Soundings taken by echo sounder, hand lead, pole: Laser Airborne Depth Sounder

Graphic record scaled by: Chris Johnson

Graphic records checked by: Mark Sinclair

Protracted by: N/A **Automated plot:** HP Design Jet 800PS

Verification by:

Soundings in: Feet at MLLW

REMARKS: Contract # DG 133 C-03-CQ-0011

Contractor: Tenix LADS Incorporated, 2548 Beach Blvd, Suite 200 Biloxi, MS, 39531

Sub contractor: Science Application International Corporation, 221 Third Street, Suite 200, Newport, RI 02840

LOWE Engineers LLC, Sugar Mill Road, Suite B-150, Atlanta, GA 30350

Times: All times are recorded in UTC

Purpose: The purpose of this survey is to provide NOAA with modern, accurate hydrographic survey data with which to update the nautical charts of the assigned area

Projection is UTM Zone 18

TABLE OF CONTENTS

DESCRIPTIVE REPORT TO ACCOMPANY HYDROGRAPHIC SURVEY H11224 SCALE 1:10000, SURVEYED 2004 TENIX LADS INC (TLI) MARK SINCLAIR, HYDROGRAPHER

PROJECT
Project Number: OPR-B370-KRL-04
Dates of Instructions: April 28, 2003
Original: DG 133 C-03-CQ-0011
Task Order: 0004
Dates of Supplemental Instructions: May 7, 2003 email regarding meeting with NOAA
January 16, 2004 Amendment to Statement of Work Task Order 0004
January 21, 2004 Amendment to Statement of Work Task Order 0004
February 19, 2004 email regarding ice in the bays
February 20, 2004 email regarding navigational aids

Sheet Letter: A
Registry Number: H11224

PURPOSE

The purpose of this survey is to provide NOAA with modern, accurate hydrographic survey data with which to update the nautical charts of the assigned area.

A. AREA SURVEYED

The LADS Mk II aircraft operated out of Groton New London airport from January 20 to March 05, 2004. During this period 15 survey sorties were flown under Task Order 4 OPR-B370-KRL-04 in Long Island Sound, Connecticut.

The survey covers two sheets as follows:

a) Sheet A - H11224

b) Sheet B - H11225

Each sheet has a separate Descriptive Report. However one Data Acquisition and Processing Report, Vertical and Horizontal Control Report and Separates Report covers both sheets. This Descriptive Report covers Sheet A.

The survey area is shown in Figure 1. The survey area also includes the area around Race Point off the western end of Fishers Island. This is stated under 'Lidar Coverage' in Attachment 6 to the Statement of Work.

Environmental factors such as wind strength and direction, cloud cover, ice and water clarity influenced the area of data acquisition on a day by day basis. See section B.2

The planned and actual linear miles sounded for the areas are provided at Appendix III.

The sheets limits for H11224 are as follows:

NW Corner	41.3645209970	-72.1003955280
SE Corner	41.2410324358	-71.9911759072

The limits of Sheet A have been moved east and extended south to include Race Rock which was required in the Statement of Work. In addition, lidar data was also collected outside the survey area off part of the south coast of Fishers Island and in the bay on the east side of Groton Long Point. The sheet limits were altered in order to also provide this data.

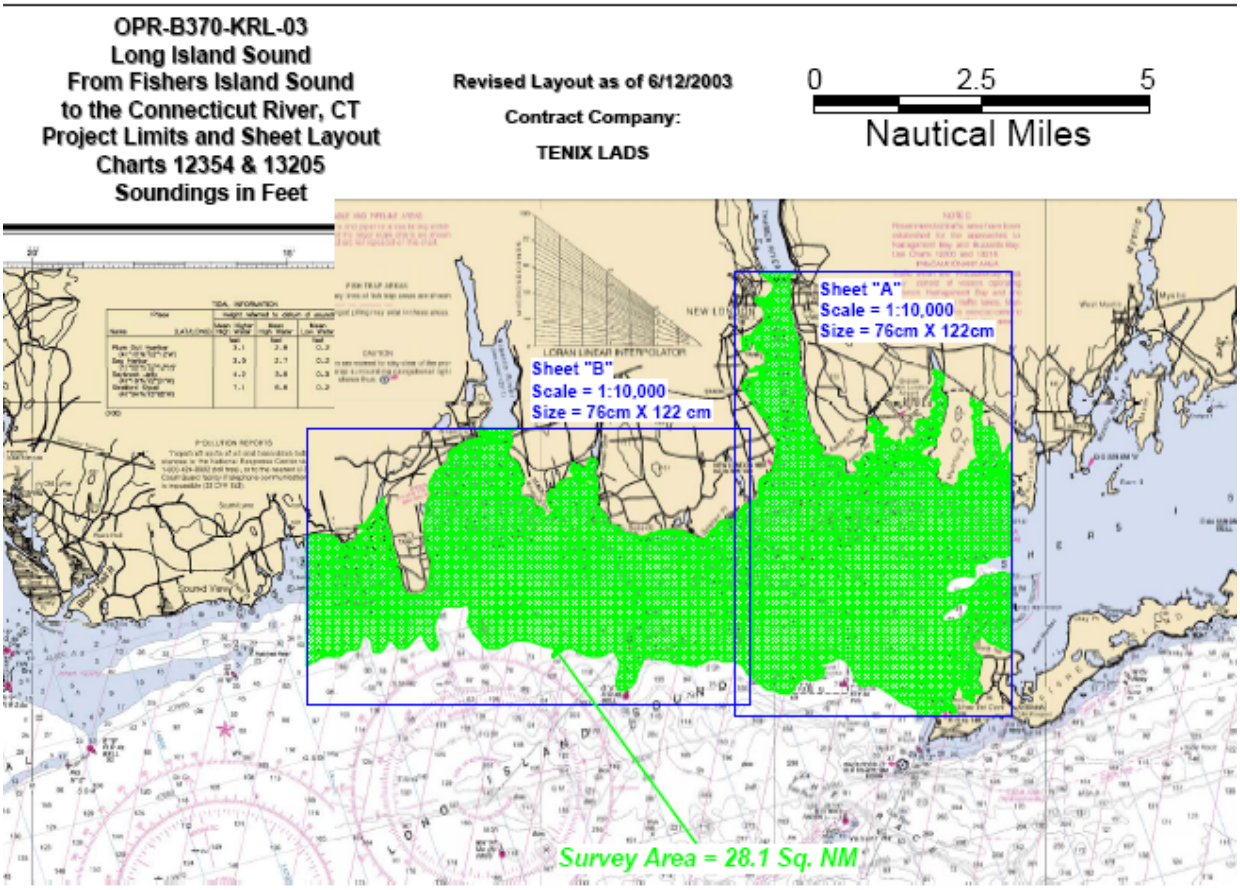


Figure 1 - Survey Area for Task Order 4

B. DATA ACQUISITION AND PROCESSING

Refer to the Data Acquisition and Processing Report for a detailed description of the equipment, processing and quality control procedures. A general description and items specific to this survey are discussed in the following sections.

B.1 EQUIPMENT

Data collection was conducted using the LADS Mk II Airborne System, data processing using the LADS Mk II Ground System and data visualization, quality control and final products using Caris HIPS 5.3, GMT/VTK, Terramodel and MicroStation version 8.

B.1.1 Airborne System

The LADS Mk II Airborne System (AS) consists of a Dash 8-200 series aircraft, which has a transit speed of 250 knots at altitudes of up to 25,000 feet and an endurance of up to eight hours. Survey operations are conducted from heights between 1,200 and 1,800 feet at ground speeds between 140 and 175 knots. The maximum operating altitude has since been increased to 2200 feet. The aircraft is fitted with a Nd: YAG laser which is eye safe in accordance with ANSI Z136.1-2000, American National Standard for Safe Use of Lasers. The laser operates at 900 Hertz to provide 5x5 or 4x4 meter laser spot spacing in the main line sounding mode of operation, and is mounted on a stabilized platform. These modes require an aircraft speed of 175 or 140 knots over the ground, and operate across a laser swath width of 240 or 192 meters. The electro-mechanical scanner also provides examination modes of sounding with laser spot spacings of 3x3 and 2x2 meters and swath widths of 100 and 50 meters respectively.

Green laser pulses are scanned beneath the aircraft in a rectilinear pattern. The pulses are reflected from the land, sea surface, within the water column and from the seabed. The green returned laser energy is captured by the green receiver and then digitized and logged onto digital linear tape. An infra-red beam is also directed vertically beneath the aircraft. The height of the aircraft is determined by the infra-red laser return, which is supplemented by the inertial height from the Attitude and Heading Reference System and GPS height. The LADS Mk II system can operate by day and night, and operations at night are enhanced by removing a daylight filter from the receiving optics. Real-time positioning is obtained by either an Ashtech GG24 GPS receiver combined with Wide Area DGPS provided by Thales GeoSolutions or an Ashtech GG24 GPS receiver providing stand-alone GPS. Ashtech Z12 GPS receivers are also provided as part of the Airborne System and Ground Systems to log GPS data on the aircraft and at a locally established base station and provide post processed KGPS position solutions.

B.1.2 Ground System

The LADS Mk II Ground System (GS) Gandalf was used to conduct data processing in the field. Gandalf consists of a three 833 MHz CPU HP (Compaq) ES40 Alpha server with 1 GB EEC RAM, 764 GB disk space, digital linear tape (DLT) drives, digital audio tape (DAT) drive, CD ROM drive and is networked to up to 12 Compaq 1.5 GHz PCs and a HP 800pd

Design Jet Plotter and QC workstations. Gandalf is transported in the LADS Mk II aircraft to the deployment site.

Quality control checks and editing of the data were conducted on Ground System Frodo or Ground System Forrest, each comprising a three 833 MHz CPU HP (Compaq) ES40 Alpha Server with 1 GB RAM, 600 GB disk space, digital linear tape (DLT) drives, digital audio tape (DAT) drive, CD ROM drive and is networked to up to 12 Compaq 1.5 GHz PCs and an HP 800ps Design Jet Plotter, printers and QC workstations.

The GS supports survey planning, data processing, quality control and data export. The GS component also includes a KGPS base station, which provides independent post-processed position and height data. A comprehensive description of the GS is provided in the Data Acquisition and Processing Report.

B.2 QUALITY

B.2.1 Data Density

The majority of the survey areas were sounded at 3x3 meter laser spot spacing with 40 meter line spacing, which provided the required 200% coverage.

The area inshore of the line from Bartlett Reef (eastern part of Sheet B) to Seaflower Reef (eastern part of Sheet A) including New London Harbor was sounded using 3x3 meter spot spacing to provide IHO target detection.

The area around Race Point off the western tip of Fisher Island was also sounded using 3x3 meter spot spacing to provide IHO target detection.

The remainder was sounded using a 4x4 meter spot spacing. This includes the offshore areas seaward of the line between Bartlett and Seaflower Reefs, the north and west coasts of Fishers Island.

At the sea surface the footprint of the laser beam is approximately 2.5 meters in diameter. As the beam passes through the water column it slowly diverges due to scattering. It should be noted that at 4x4 meter laser spot spacing there is a gap of between 1 to 1.5 meters between the illuminated area of adjacent soundings at the sea surface. There is a possibility that small objects in shallow water along the coastline may fall between consecutive 4x4 meter soundings and not be detected. To achieve IHO target detection, 3x3 meter laser spot spacing is used.

B.2.2 Water Clarity

The water clarity in the survey area was generally good for laser survey. The maximum lidar depths measured during the survey exceeded 20 meters, although 10 meters was the generally achieved depth.

Some localized areas of turbidity were experienced in the survey area due to westerly winds. The westerly wind caused the plume from the Connecticut River to be blown into the survey area causing large amounts of turbidity. A number of areas required several reflies in addition to the 200% planned coverage.

It was first envisaged to conduct this survey during the late summer of 2003. Secchi disk measurements were conducted on May 09 throughout the survey area indicated that depths to the 30-foot contour could be achieved under current conditions. This reconnaissance confirmed that the Connecticut River had a large impact in the water clarity of Long Island Sound. This eliminated the possibility of conducting lidar operations at the mouth of the Connecticut River, and Sheet C was removed from the draft statement of work.

It was planned that after lidar operations finished in Alaska that operations would commence in Long Island sound in late July however, a repeat of the secchi disk measurements on June 23 showed that the water clarity had deteriorated significantly since May 09; the commencement of operations was postponed until such time that the water clarity improved.
The secchi disk observations were repeated on June 27 and July 10 with the same results.
The secchi disk observations were conducted during the neap tide cycles and 3 hours before high tide when the tidal stream at its lowest flow to minimize sediment movement.

Further secchi disk readings were conducted on July 20 and August 09 with much the same results. Whilst in New London, the Tenix LADS Inc Survey Manager visited the Department of Marine Sciences at the University of Connecticut. A meeting was conducted with Ivar Bab who is a marine biologist and is the director of the National Undersea Research Center and James O'Donnell, Professor of Physical Oceanography, to discuss the water clarity of Long Island Sound.

It was their opinion that there are two main influences on water clarity in Long Island Sound. Firstly, the temperature of the water needs to be cold to minimize the growth of biological matter. Secondly, the flow of the Connecticut River should be at its lowest. Looking at these two factors it was determined that the months when the water would be the clearest is from the month of January through to April.

The water temperature was monitored on the Internet form a series of buoys that the University of Connecticut has deployed which among other things log water temperature. The web site is www.mysound.ucomm.edu

Further secchi disk observations conducted on October 08, November 16, November 17 and December 05 indicated that the water clarity was improving but was still not good enough to deploy and commence survey operations.

On January 11 the secchi disk readings showed that the water had cleared enough to deploy and commence survey operations. This was the eleventh water clarity reconnaissance that had been conducted in Long Island Sound. The water clarity in the survey area varied during the course of the survey. Operations were conducted in the most suitable areas. The collection of 200% coverage of the survey area provided additional data on a different day, which enabled the coverage to be improved.

The water clarity also improved towards the end of the survey. On the last three sorties the best data was obtained, and the opportunity was taken to collect additional data to improve coverage in a number of areas.

B.2.3 Data Management

The survey area was managed in one database referred to as 'Connecticut'. A detailed table of the line numbers is presented in the Data Acquisition and Processing Report.

B.2.4 Data Acquisition

Survey operations were planned when suitable weather conditions prevailed. The first survey sortie was flown on January 25, 2004. Survey sorties were conducted when there was minimal low cloud in the survey area. In general the aircraft departed at 1500 hours local time to take advantage of the better GPS satellite availability and geometry and returned at 2100 hours local time. Flying into the night enabled the day filter to be removed and the receiver gains to be increased to allow for more depth penetration. Also flying into the night allowed for minimal air traffic along the coast to cause delays due to air traffic control conflicts.

The department of Homeland security was notified of our survey operations as the Groton nuclear submarine base and Millstone nuclear power plant were in the survey area.

The final survey sortie was conducted on March 03, 2004.

B.2.5 Sea Conditions - Sea State, Waves, Swell, White Water

The sea state ranged from 1 to 2-3 throughout the survey, and was generally between states 1 and 2.

Very calm seas were experienced on occasions. Under such very calm conditions the sea may become glassy which degrades the sea surface model. When such conditions existed, survey operations were diverted to a more suitable area.

Long period swell was not significant during the survey.

B.2.6 No Bottom At (NBA)

NBA depths have been assigned to noise pulses where the water was too dirty or too deep to detect the seabed. The NBA depth is assigned based on inspection of the raw laser waveforms. In the opinion of the hydrographic surveyor the NBA depth is a depth less than which seabed returns are not expected. Areas where NBA depths have been assigned can be seen from the gray areas on the coverage plots.

In general, NBA areas in deep water have been retained in the data set. In shallow water, NBA areas have been rejected from the data where better data was collected on a subsequent flight; in this case the NBA area is superseded.

In some shallow areas, data has been collected which is partly good but contains NBA depths. In some cases this data has been retained to improve the coverage of the seabed. Where this has occurred, the gray NBA areas can be seen overlaying the seabed on the coverage plot.

B.2.7 Nature of the Seabed

The main channel into New London Harbor is dredged to 40 feet, south of approximately 41 degrees 21 minutes North, and to 36 feet north of this. In the northern part, north of Melton Ledge, relatively high turbidity prevented detection of the seabed in the main channel. The seabed in the vicinity of the two channels to the west, in the bay between New London and Ft Trumbull, and the bank to the east of these dredged channels, is sedimentary. Most of the southern part of the main channel, south of Melton Ledge, was clear and able to be surveyed by lidar. Some depths to 38 feet were measured which are already charted. Outside the dredged channel, the seabed in New London Harbour is rocky, particularly inside the 20 foot contour and in Greens Harbor.

West of New London Harbor, from Quinnipeag Rocks to Goschen Ledge, the seabed is rocky with a number of foul areas inside the 20 foot isobath with a few isolated rocks between the 20 and 30 foot isobaths.

East of New London Harbor, from Eastern Point to Groton Long Point, the seabed is generally sedimentary and deepens regularly but there are a number of rock outcrops and ledges. These are distributed throughout the area and are mostly inside the 30 foot isobath. There is a sand ridge extending NE of Seaflower reef towards Horseshoe Reef. There is a detached rocky shoal SW of Seaflower Reef.

On the north side of Fishers Island Sound, Seaflower Reef and Intrepid Rock rise out of deep water. North Dumpling, on the southern side, is steep to. East of South Dumpling, which is rocky, a large sand spit extends ENE on which there are some rocky outcrops. The littoral drift appears to be to the ENE. The north side of Fishers Island is sedimentary, with numerous rocks inside the 15 foot isobath.

The W side of Fishers Island from North Hill to Race Rock is steep too and rocky close inshore.

The south side of Fishers Island, from Race Rock to Wilderness Point, is regular with some minor rocky ridges extending offshore.

B.2.8 Datums

On completion of each flight the GPS data logged on the aircraft and at the base station was processed to determine the Post Processed KGPS position and height of the aircraft. This data is used in the calculation of the sea surface datum.

B.2.9 Wind

Survey operations were conducted in wind strengths of up to 25 knots during the survey. In general the wind strength during the time of survey was around 10 knots. The direction of the wind had a significant influence on the area for survey operations such that a day of calm winds was required after strong westerlies to settle down the turbidity.

B.2.10 Cloud

Low cloud was a factor. The winter storms affected the cloud base in the survey area as they passed by. The progress of the storms and marine conditions were managed as follows from a variety of internet sites:

1. Generic weather was obtained from two sources www.weather.com and from the National Weather service for Groton at www.crh.noaa.gov/forecasts. Both of which gave 7 day forecasts which were used for planning purposes.
2. United States Coastal Marine Forecasts located at www.nws.noaa.gov/om/marine/zone/east/okxmz.html which provide marine wind speed and direction forecast for 5 days.
3. A NOAA website provided METAR data, actual wind speed and direction, cloud base and satellite cloud data for Groton New London Airport which was in the survey area. The observations were updated every hour. The site is www.srh.noaa.gov/data/obshistory/KGON.html.

B.2.11 Effects of High Ground

High ground did not affect survey operations.

B.2.12 Effects of Ice

Extremely cold temperatures caused ice to form in the sheltered rivers and bays along the coast.

Ice caused the NOAA tide gauge in New London Harbor to cease operation, and the gauge at Silver Eel Pond had to be used for tide control on a number of occasions.

In addition, the formation of ice in Mumford Cove, Poquowock River and Baker Cove, limited the lidar coverage in parts of these areas. See Appendix V, Supplemental Survey Records and Correspondence.

B.2.13 Drying Heights and Topographic Data

Topographic data has been collected up to a height of approximately 20 meters above the water level at the time of acquisition.

In the digital data, drying heights and topographic heights are above the MLLW datum in negative meters. On the hardcopy smooth sheet and MicroStation files, drying heights are expressed in negative feet above MLLW and topographic heights above 2.3 feet above MHW are expressed in feet above MHW.

It should be noted that on islets which have a height above 20 meters, the maximum height of the island may not have been measured. In such cases in the Results and Recommendations section the annotation 'Height of islet > 33 feet' would be used.

The topographic height range of the LADS MkII system has since been extended to 50 meters.

B.2.14 Receiver Gain

Changes in gain levels in the Airborne System automatically accommodate for changes in the sea surface, water column and seabed conditions. In some areas after long over-land passages low gains levels were initially set on passing back over the water. Where this has been identified in the data these lines were reflown from the opposite direction to improve the coverage.

B.2.15 Data Processing

The data was processed at the operating site in Mystic on return from each sortie. Initial validation of the data was conducted at this site. Final validation, checking and approval by hydrographic surveyors were then conducted back at either the Tenix LADS depot in Biloxi, MS or Adelaide, South Australia.

The data quality improved on the last three flights due to a lowering of turbidity in late February and early March.

At this time, a number of areas were reflown to obtain better coverage. In areas where this has been achieved, the later data has been retained, and any turbid data from earlier flights that has been superceded has been rejected from the final data set.

B.2.16 Progress Sketches

Progress sketches were provided to NOAA on a bi-weekly basis from the commencement of operations.

B.2.17 Final Data

Final data for Task Order 4 was delivered on December 29, 2004.

B.3 DIGITAL DATA FORMATS

Refer to the Data Acquisition and Processing Report Appendices I and II.

B.4 BENCHMARK AND CROSS TIE RESULTS

B.4.1 Benchmark Areas

Four depth benchmark areas were created from the LADS data. Two benchmarks lay along a line south of Fishers Island and through Fishers Island Sound on sheet A and two more benchmarks on a line across Goshen Reef offshore Goshen Point on sheet B. These benchmarks were surveyed to check the system accuracy.

Center coordinates for the benchmark areas are as follows:

Fisher Island Benchmark Line (Sheet A)

Benchmark Name	Nominal Depth	Easting (NAD 83)	Northing (NAD 83)
BM_1	4.7 m	750 526	4 571 125
BM_2	5 m	745 344	4 577 175

Table 1 – Benchmarks

Either one or both benchmark lines were flown during each sortie. The total number of benchmarks compared during the survey was 38. The tidal model in use for the comparison of benchmarks was the same as for main line sounding and benchmark comparisons were conducted after the application of verified tides. Comparison summaries are provided in the Separates.

The LADS data is compared against the gridded benchmark surface in the GS and statistics are generated which include the number of points compared, the Mean Depth Difference (MDD) and the Standard Deviation (SD) between the data sets. The benchmark comparison function compares the data against the benchmark surface, and as this data is unedited it may contain noise normally removed during the validation process which is flagged as the shoalest and deepest differences.

B.4.1.1 Mean Depth Differences (MDD) and Standard Deviation (SD)

The averages of the mean depth differences and standard deviation for each benchmark run are as follows:

Fisher Island Benchmarks (Sheet A)

GS ID	BM Name	Nominal Depth	MDD	SD
1	BM_1	4.7 m	0.19 +/- 0.05	0.05 +/- 0.02
2	BM_2	5 m	-0.03 +/- 0.19	0.16 +/- 0.07

Table 2 – Benchmark Results

These results are excellent and show that the depth difference means and the standard deviation of all the benchmarks are very consistent. These results indicate that the LADS Mk II system operated correctly.

B.4.2 Cross Tie Comparisons

Crosslines were planned after the majority of main lines had been completed. Areas were selected where the seabed was reasonably flat. This minimizes the apparent differences in depths due to minor positional differences, which occurs in steeper areas of seabed.

Five crosslines were sounded at 4x4 meter laser spot spacing, two of which are on Sheet A:

Sheet A

Line 53.0.1	103 crossline intersections.	Into Mumford Point
Line 54.0.1	174 crossline intersections.	Across Fishers Island into Mumford Point

B.4.2.1 Mean Depth Differences (MDD) and Standard Deviation (SD)

The averages of the mean depth differences and standard deviation for each crossline are as follows:

Reference Line Number	Sortie Flown	Lines Compared	Soundings Compared	Mean Depth Difference at Intersection	Standard Deviation	Mean Normalised Confidence
Sheet A						
53.0.1	13	12	25443	-0.08 +/- 0.05	0.11 +/- 0.06	3.8
54.0.1	13	52	95507	-0.04 +/- 0.07	0.08 +/- 0.04	6.4

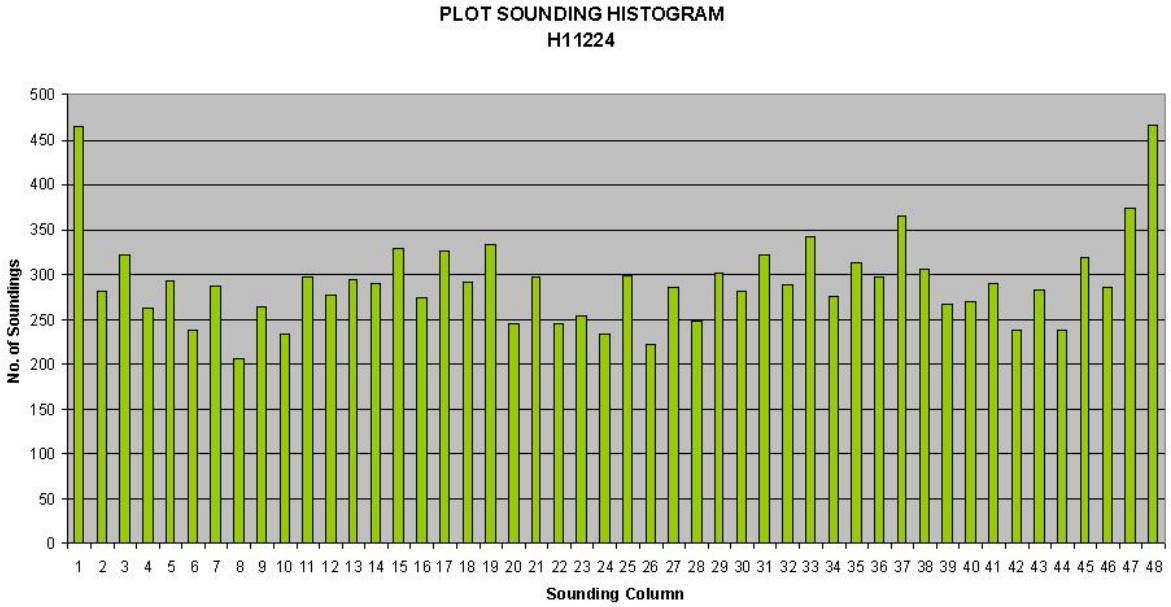
Table 3 – Crossline Comparison Results

Crossline comparison details are provided in the Separates Report.

These results are consistent with IHO Order-1 depth accuracy.

B.5 ANALYSIS OF RESULTS

A sounding histogram has been produced of the column and occurrence of each sounding shown on the smooth sheet. The graph shows there is no significant scan angle bias in the data, however a higher yield from columns 1 and 48 is observable.



Graph 1 – Sounding Histogram Smooth Sheet H11224

B.6 POSITION CHECKS

Two independent positioning systems were used during the survey. Real-time positions were determined by stand-alone GPS with differential corrections input from the Thales LandStar system using the Auburn Wide Area Differential GPS reference station. A post processed KGPS position was also determined relative to a local GPS base station which was established on the rooftop of a hanger at the Groton New London Airport. The post processed KGPS position and height were applied to soundings during post-processing.

Position checks were conducted prior to, during and following data collection, as follows:

a. DGPS Site Confirmation. A 24-hour certification was conducted of the local GPS base station established at the Groton New London Airport.

b. Static Position Check. Prior to commencing data collection the coordinates of the aircraft GPS antenna were determined relative to three marks, which were surveyed on the tarmac at the Groton New London Airport. Data was then logged by each LADS Mk II positioning system enabling the positions to be checked against the known surveyed points. The accuracy of the KGPS (PNAV C/A code + carrier phase) during the static position check was 0.08 meters (95% confidence). The results and details of the static position check are enclosed in Vertical and Horizontal Control Report.

c. Dynamic Position Check. During each sortie GPS data was logged on the aircraft and at the local GPS base station. This provided a check between the real-time GPS and post-processed positions. The mean difference between the real-time and post-processed position ranged from 0.706 to 1.173 meters, with the mean standard deviation from 0.142 to 0.283 meters. Details are provided in the Vertical and Horizontal Control Report.

d. Position Confidence. The position quality was also monitored by checking a post-processed position confidence (C3), which is determined from the AS platform error, GPS error and residual errors between the actual GPS positions and aircraft position as determined from the line of best fit. No position anomalies were detected.

The position checks provided results that were within the expected tolerances and showed that the positioning systems were functioning as expected.

B.7 CORRECTIONS TO SOUNDINGS

Refer to the Data Acquisition and Processing Report for a description of corrections to soundings, which demonstrates that corrections to the soundings were being applied correctly.

There were no deviations from the corrections described therein.

C. VERTICAL AND HORIZONTAL CONTROL

Refer to the Vertical and Horizontal Control Report for a detailed description of the vertical and horizontal control used during this survey. A summary of vertical and horizontal control for the survey follows.

C.1 VERTICAL CONTROL

Vertical control for the survey was based on the Mean Lower Low Water tidal datum (MLLW) from the NOAA station at New London Harbor (8461490) and when this was frozen the NOAA station Silver Eel Pond (8510719) was used.

Station details are as follows:

			WGS84	
Gauge	Location	GS No.	Latitude	Longitude
8461490	New London Harbor	TS1	41° 21.3' N	072° 05.2' W

Table 4 – New London Harbor Tide Gauge

			WGS84	
Gauge	Location	GS No.	Latitude	Longitude
8510719	Silver Eel Pond	TS2	41° 15.4' N	072° 01.8' W

Table 5 – Silver Eel Pond Tide Gauge

C.2 ZONING

Tide zones that cover the extent of the survey area were supplied by NOAA with time and range correctors relative to New London Harbor NOAA gauge (8461490) and Silver Eel Pond (8510719).

During the course of the survey, the gauge at New London Harbor stopped operating due to the formation of ice. During these periods, the NOAA gauge at Silver Eel Pond (8510719) was used. NOAA provided new time and range correctors for all tide zones relative to the Silver Eel Pond gauge.

A list of tide zones and correctors is provided on page A-3 of Vertical and Horizontal Control Report.

A table of sortie information including which tide gauge was used at what time is provided in Appendix IV in the Abstract of Times of Hydrography.

When soundings are exported, there is a datum change from MLLW and MHW between soundings and heights. The Silver Eel Pond gauge was used as datum control for the project, and used to determine the MHW value within each tide zone.

Prior to the commencement of the survey, a tidal zoning analysis of the areas was conducted by surveying company 'Science Applications International Corporation' in Newport Rhode Island. The result of this analysis concluded that the zoning provided by NOAA should be adequate to meet the accuracy specifications for soundings and the datum jump between tide zones should be below 0.09 meters with the majority of the differences in the 5 centimeter range. A complete copy of this analysis can be found in Appendix VI of the Vertical and Horizontal Control Report.

The verified tides supplied by NOAA were independently checked by SAIC. The tides were compared to predictions at the time of survey to ensure that there were no meteorological effects at the tide gauge. Once the data was checked a fifth degree polynomial was applied to the tidal data and this data was then supplied to Tenix LADS Inc.

For final processing, tidal correctors were applied to the tidal data provided by SAIC. The time and height correctors listed above were used for processing the data for tides.

Data across zone boundaries showed no data steps, the crosslines also showed no data deviation across the tidal zones. The preliminary tidal zoning has been considered adequate and therefore the preliminary tide zoning correctors have been considered to be the final zoning correctors.

C.3 HORIZONTAL CONTROL

Data collection and processing were conducted on the Airborne and Ground Systems in World Geodetic System (WGS84) on Universal Transverse Mercator (Northern Hemisphere) projection UTM(N) in Zone 18, Central Meridian 075° West. All units are in meters. This data was post-processed and all soundings are relative to the North American Datum 1983 (NAD83).

C.3.1 LADS Local GPS Base Station – Groton

A local GPS base station was established by LOWE Engineers on the roof of a hanger at Groton New London Airport, Connecticut on June 19 2003. A 24 hour DGPS site certification was conducted on the local GPS base station prior to survey operations.

The derived NAD83 coordinates for the local GPS base station, are:

NAD83		UTM (N)		
Latitude (N)	Longitude (W)	Easting (m)	Northing (m)	Ellipsoidal Height (m)
41°19’57.09717”	072° 02’53.52459”	747 013.089	4 579 876.001	-21.139

Table 5 – GPS Base Station

Real-time WADGPS positions were determined using an Ashtech GG24 GPS receiver, and differential corrections received via the Thales LandStar system from the Auburn Wide Area Differential GPS reference station.

Post-processed positions were determined off-line using data logged at the base station and on the aircraft. This data was processed through Ashtech PNAV software to calculate both a DGPS and Coarse Acquisition (C/A) code + carrier phase smoothed position solution. The C/A code + carrier phase smoothed positions were then imported into the GS and were applied to all soundings. This provided increased sounding position accuracy and horizontal redundancy.

A static position check was conducted at New London airport. Real-time and post-processed positions were compared against marks surveyed on the tarmac. The check demonstrated the systems were operating correctly.

A dynamic position check was also conducted between the real-time and post-processed positions during survey operations. This check also demonstrated the two position solutions were consistent throughout the survey. Details of the geodetic observations, position checks and assessment of position accuracy are provided in the Vertical and Horizontal Control Report.

D. RESULTS AND RECOMMENDATIONS

Recommendations for charting action are provided in D.1.

During the checking and approval of the data, some features were identified which require further investigation. These are provided in D.2.

A number of Navigation Aids were detected during the survey. These are provided in D.3.

The recommended overlap for boatwork is provided in D.4.

A number cultural features were detected in the data and verified by the downward looking video are shown as solid black lines on the smooth sheet.

D.1 CHART COMPARISON – H11224

Sheet A was compared to charts:

- 13212 36th Edition, March 6/04
- 13213 41st Edition, March 13/04

The chart comparison was conducted by reviewing the chart, the lidar sun-illuminated image and the lidar smooth sheet in MicroStation. For each item identified, screen dumps of the Local Area Display and Raw Waveform Display were extracted from the LADS Mk II Ground System. These have been reviewed in order to make the following assessments:

a. Type of Feature
b. Kelp Area
c. Further Examination Recommended
d. Charting Recommendation
e. Remarks

Each chart comparison was categorized as follows:

1. New shoal found
2. Charted shoal disproved
3. Charted shoal not found / disproved

There are 154 items in the chart comparison. They are provided in the chart comparison table on pages D-4 top D-19. To assist in data handling, a full digital version of the chart comparison spreadsheet is also provided on CD in Excel format with the digital data (SheetA_V4_ChartComp.xls). The screen dumps of the Local Area Display and Raw Waveform Display are provided with the digital data to assist review. They are in a sub-directory *Screen_Dumps* as .jpg files which are hyperlinked to the spreadsheet to assist review.

The items in the chart comparison have been given a unique identifier (A1 to A157). This identifier with its associated position is also provided as a .dgn file to assist in data handling. It is provided with the digital data (SheetA_V4_ChartComp.pzip) in MicroStation Version 7 format.

The fields in Chart Comparison spreadsheet have been developed from experiences learned and feedback received from previous lidar surveys in Alaska, witnessing survey operations in NOAA ship RAINIER and from meetings at PHB and UNH. They have been designed for ease of use and to minimize double handling of data and transcription. Feedback is welcomed in order to develop these formats in order to achieve further efficiencies in data handling.

			CHARTED			SURVEYED								
Sequence No	**Shoal No**	**Category**	**Charted Depth** (feet)	**NAD 83 Latitude** (decimal degrees)	**NAD 83 Longitude** (decimal degrees)	**Surveyed Depth** (meters)	**Surveyed Depth** (feet)	**NAD 83 Latitude** (decimal degrees)	**NAD 83 Longitude** (decimal degrees)	**Type of Feature**	**Kelp Area**	**Further Examination Recommended**	**Charting Recommendation**	**Remarks**
1	A1	1	25	41.299229	-72.094120	6.23	20	41.298852	-72.093974	Rk			Replace	See item 1. Danger to Navigation Report.
2	A2	3	10	41.298781	-72.098701	4.70	15	41.298725	-72.098762				Remove	Disproved
3	A3	2	24	41.291009	-72.097878	6.83	22	41.290844	-72.097614	Rk			Insert	Turbid
4	A4	2	16	41.290277	-72.099152	6.42	21	41.290222	-72.099029	Rk			Remove	Disproved
5	A5	2	17	41.289146	-72.100097	4.75	15	41.289185	-72.100236	Rk			Replace	
6	A6	3	42	41.287876	-72.086121							Y	Retain	In NBA area
7	A7	3	43	41.287711	-72.083073							Y	Retain	In NBA area
8	A8	3	44	41.286507	-72.084256							Y	Retain	In NBA area
9	A9	3	43	41.285669	-72.082223							Y	Retain	In NBA area
10	A10	3	44	41.284807	-72.081813							Y	Retain	In NBA area

			CHARTED			SURVEYED								
Sequence No	**Shoal No**	**Category**	**Charted Depth** (feet)	**NAD 83 Latitude** (decimal degrees)	**NAD 83 Longitude** (decimal degrees)	**Surveyed Depth** (meters)	**Surveyed Depth** (feet)	**NAD 83 Latitude** (decimal degrees)	**NAD 83 Longitude** (decimal degrees)	**Type of Feature**	**Kelp Area**	**Further Examination Recommended**	**Charting Recommendation**	**Remarks**
11	A11	3	40	41.283818	-72.074299							Y	Retain	In NBA area
12	A12	3	33	41.298421	-72.070722	11.59	38	41.298404	-72.071061			Y	Retain	Not Found
13	A13	1				9.79	32	41.299294	-72.070315	Rk		Y	N/A	Turbid. See item 3. Danger to Navigation Report.
14	A14	2	22	41.290108	-72.042462	6.51	21	41.290786	-72.043230				Replace	NW of charted shoal
15	A15	1	31	41.297869	-72.040589	6.84	22	41.297780	-72.040863	Rk			Replace	See item 4. Danger to Navigation Report.
16	A16	1	31	41.298352	-72.041675	8.80	29	41.298265	-72.041406	Rk			Replace	
17	A17	2	12	41.295899	-72.034044	2.43	8	41.296092	-72.033943	Rk	Y		Replace	
18	A18	2	10	41.283556	-72.016892	3.60	12	41.283275	-72.016773	Slope	Y		Replace	Move 12 foot contour SE
19	A19	2	22	41.304764	-72.020008	6.07	20	41.304803	-72.019662	Rk			Replace	See item 23. Danger to Navigation Report
20	A20	1	33	41.303836	-72.021660	8.08	26	41.303664	-72.021890	Rk		Y	N/A	Turbid. See item 6. Danger to Navigation Report.

			CHARTED			SURVEYED								
Sequence No	**Shoal No**	**Category**	**Charted Depth** (feet)	**NAD 83 Latitude** (decimal degrees)	**NAD 83 Longitude** (decimal degrees)	**Surveyed Depth** (meters)	**Surveyed Depth** (feet)	**NAD 83 Latitude** (decimal degrees)	**NAD 83 Longitude** (decimal degrees)	**Type of Feature**	**Kelp Area**	**Further Examination Recommended**	**Charting Recommendation**	**Remarks**
21	A21	1	33	41.305441	-72.021707	7.46	24	41.305329	-72.021231			Y	N/A	Turbid. See item 7. Danger to Navigation Report.
22	A22	2	27	41.304230	-72.024023	6.12	20	41.304141	-72.023856	Rk		Y	N/A	Turbid. See item 8. Danger to Navigation Report.
23	A23	2	17	41.308155	-72.018938	4.60	15	41.308029	-72.018933	Rk			Replace	
24	A24	2	14	41.307864	-72.021874	3.47	11	41.307810	-72.021933	Rk			Replace	See item 9. Danger to Navigation Report.
25	A25	1				4.64	15	41.308903	-72.021109	Rk			Insert	
26	A26	2	11	41.312416	-72.017769	3.79	12	41.312601	-72.017912				Replace	
27	A27	2	Rk awash	41.306996	-72.024938	1.36	4	41.307028	-72.024938	Rk	Y		Retain	Area of Poor Coverage
28	A28	2	Rk awash	41.307818	-72.024457	0.98	3	41.307750	-72.024688	Rk	Y		Retain	Area of Poor Coverage
29	A29	2	6	41.309088	-72.023141	2.55	8	41.309078	-72.023217	Rk	Y		Retain	
30	A30	1				1.46	5	41.311196	-72.025276	Rk	Y		Insert	Area of Poor Coverage

			CHARTED			SURVEYED								
Sequence No	**Shoal No**	**Category**	**Charted Depth** (feet)	**NAD 83 Latitude** (decimal degrees)	**NAD 83 Longitude** (decimal degrees)	**Surveyed Depth** (meters)	**Surveyed Depth** (feet)	**NAD 83 Latitude** (decimal degrees)	**NAD 83 Longitude** (decimal degrees)	**Type of Feature**	**Kelp Area**	**Further Examination Recommended**	**Charting Recommendation**	**Remarks**
31	A31	3	6	41.313530	-72.025632	3.49	11	41.313326	-72.025845	Bank			Remove	Disproved
32	A32	3	Subm Rk	41.309122	-72.030512	7.89	26	41.309082	-72.030326	Bank			Remove	Disproved
33	A33	2	13	41.308951	-72.032306	3.53	11	41.309002	-72.032582	Rk			Replace	See item 21. Danger to Navigation Report
34	A34	2	2	41.311478	-72.032644	1.21	4	41.311547	-72.032714	Rk			Retain	
35	A35	3	Rk which covers, uncovers	41.311390	-72.029601	2.03	6	41.311305	-72.029508			Y	Retain	Not Found
36	A36	2	27	41.301322	-72.043644	7.71	25	41.301275	-72.043913	Rk			Replace	
37	A37	2	22	41.305838	-72.039731	6.52	21	41.305755	-72.039911	Rk			Replace	
38	A38	3	Obstn PA (Fish Haven)	41.313852	-72.036152	4.69	15	41.313637	-72.036441			Y	Retain	Not Found
39	A39	1	31	41.302236	-72.057845	6.69	22	41.302920	-72.057567	Rk	Y	Y	N/A	Turbid. See item 10. Danger to Navigation Report
40	A40	2	11	41.309279	-72.054086	4.15	13	41.309470	-72.054417	Rk			Replace	

			CHARTED			SURVEYED								
Sequence No	**Shoal No**	**Category**	**Charted Depth** (feet)	**NAD 83 Latitude** (decimal degrees)	**NAD 83 Longitude** (decimal degrees)	**Surveyed Depth** (meters)	**Surveyed Depth** (feet)	**NAD 83 Latitude** (decimal degrees)	**NAD 83 Longitude** (decimal degrees)	**Type of Feature**	**Kelp Area**	**Further Examination Recommended**	**Charting Recommendation**	**Remarks**
41	A41	3	7	41.309771	-72.054120	7.17	23	41.309859	-72.054020				Replace	Disproved
42	A42	3	11	41.314056	-72.052240	4.94	16	41.313911	-72.052240				Replace	
43	A43	1				2.98	10	41.314338	-72.051842	Rk			Insert	
44	A44	2	12	41.309325	-72.062009	4.56	15	41.309331	-72.061976	Rk	Y		Retain	Turbid
45	A45	2	10	41.310710	-72.062894	3.88	12	41.310708	-72.062857	Rk	Y	Y	Retain	Low amplitude pulse
46	A46	3	16	41.312015	-72.066185	6.22	20	41.312240	-72.066428					
47	A47	2	Islet	41.315583	-72.056532	-1.00	-3	41.315578	-72.056548	Rk			Retain	Also Rk awash charted close NW and Rk close SE in area of poor coverage.
48	A48	3	28	41.300520	-72.072113	10.35	34	41.300815	-72.072169			Y	Retain	Turbid
49	A49	1				9.91	32	41.301239	-72.072485	Rk	Y		Insert	Turbid
50	A50	2	28	41.301910	-72.071969	7.55	25	41.301758	-72.072178	Rk		Y	N/A	Turbid. See item 11. Danger to Navigation Report.

			CHARTED			SURVEYED								
Sequence No	**Shoal No**	**Category**	**Charted Depth** (feet)	**NAD 83 Latitude** (decimal degrees)	**NAD 83 Longitude** (decimal degrees)	**Surveyed Depth** (meters)	**Surveyed Depth** (feet)	**NAD 83 Latitude** (decimal degrees)	**NAD 83 Longitude** (decimal degrees)	**Type of Feature**	**Kelp Area**	**Further Examination Recommended**	**Charting Recommendation**	**Remarks**
51	A51	2	6	41.306927	-72.072020	2.49	8	41.306680	-72.071819	Rk			Retain	
52	A52	2	2	41.306468	-72.067944	1.51	5	41.306465	-72.067814	Rk			Retain	Area of Poor Coverage
53	A53	1				1.68	5	41.307589	-72.069305	Rk	Y		Insert	Area of Poor Coverage
54	A54	2	5	41.308029	-72.069677	2.65	8	41.308069	-72.069476				Replace	
55	A55	2	11	41.309004	-72.070383	4.12	13	41.309133	-72.070637				Replace	
56	A56	2	17	41.306297	-72.076669	4.73	15	41.306238	-72.076821	Rk			Replace	Turbid
57	A58	2	14	41.312619	-72.072414	3.67	12	41.312452	-72.072203	Rk	Y		Replace	
58	A59	2	15	41.306495	-72.097032	4.87	16	41.306130	-72.097285	Rk	Y		Replace	Ridge extending SSE
59	A60	2	15	41.308042	-72.093155	2.92	9	41.308079	-72.093125	Rk	Y		Replace	See item 12. Danger to Navigation Report
60	A61	2	11	41.312742	-72.090324	2.58	8	41.312685	-72.090528	Rk	Y		Replace	See item 28. Danger to Navigation Report

			CHARTED			SURVEYED								
Sequence No	**Shoal No**	**Category**	**Charted Depth** (feet)	**NAD 83 Latitude** (decimal degrees)	**NAD 83 Longitude** (decimal degrees)	**Surveyed Depth** (meters)	**Surveyed Depth** (feet)	**NAD 83 Latitude** (decimal degrees)	**NAD 83 Longitude** (decimal degrees)	**Type of Feature**	**Kelp Area**	**Further Examination Recommended**	**Charting Recommendation**	**Remarks**
61	A62	2	14	41.314365	-72.089810	3.31	11	41.314791	-72.089564	Rk	Y	Y	N/A	Low amplitude pulse / Turbid waveform See item 15. Danger to Navigation Report
62	A63	2	17	41.316985	-72.086974	4.39	14	41.316827	-72.086930	Rk	Y	Y	N/A	Low amplitude pulse. See item 5. Danger to Navigation Report
63	A64	1	28	41.316838	-72.086106	6.49	21	41.316634	-72.086409	Rocky ridge	Y		Replace	
64	A65	2	13	41.320386	-72.087125	2.52	8	41.320603	-72.087206	Rk	Y	Y	N/A	Low amplitude pulse
65	A66	1	20	41.320311	-72.076901	4.63	15	41.320382	-72.076774	Rk			Replace	
66	A67	2	19	41.321792	-72.077286	5.03	16	41.322014	-72.077760	Rk			Replace	
67	A68	2	8	41.324483	-72.076539	1.74	5	41.324531	-72.076729	Rk	Y		Replace	Area of Poor Coverage
68	A69	2	11	41.324903	-72.077596	2.06	7	41.324767	-72.077384	Rk	Y		Replace	Area of Poor Coverage
69	A71	1	13	41.326672	-72.078371	2.11	7	41.326777	-72.078257	Rk			Replace	
70	A72	3	18	41.326275	-72.081210	6.91	22	41.326178	-72.081062				Remove	Disproved

			CHARTED			SURVEYED								
Sequence No	**Shoal No**	**Category**	**Charted Depth** (feet)	**NAD 83 Latitude** (decimal degrees)	**NAD 83 Longitude** (decimal degrees)	**Surveyed Depth** (meters)	**Surveyed Depth** (feet)	**NAD 83 Latitude** (decimal degrees)	**NAD 83 Longitude** (decimal degrees)	**Type of Feature**	**Kelp Area**	**Further Examination Recommended**	**Charting Recommendation**	**Remarks**
71	A73	3	18	41.327448	-72.080895	6.19	20	41.327442	-72.081095	Rk			Replace	
72	A74	3	Wk PA	41.331542	-72.090376	4.93	16	41.331549	-72.090366			Y	Retain	Not Found
73	A75	2	11	41.336686	-72.089886	2.38	8	41.336618	-72.090023	Rk	Y	Y	N/A	Low amplitude pulse. See item 2. Danger to Navigation Report
74	A76	3	Rks awash, Hog Back	41.336109	-72.093109	1.79	6	41.336130	-72.092861	Rk		Y	Retain	Area of Poor Coverage / Rock awash in Kelp
75	A77	3	0.5	41.339972	-72.090934	1.38	4	41.339988	-72.090894	Rk		Y	Retain	Area of Poor Coverage
76	A78	3	Rks (3 total)	41.341832	-72.092663	-1.34	-5	41.341756	-72.092710	Rk		Y	Retain	Charted Rock close by in Area of Poor Coverage
77	A79	1				5.18	17	41.335181	-72.088559	Bank			Amend Contour	
78	A80	2	16	41.347748	-72.091117	4.28	14	41.347898	-72.090802	Bank			Replace	
79	A81	3	Obstn	41.314750	-72.002467	0.53	1	41.314500	-72.002628	Bank		Y	Retain	Not Found
80	A82	3	Obstn	41.313421	-72.002856	0.51	1	41.313045	-72.002991	Bank		Y	Retain	Not Found

			CHARTED			SURVEYED								
Sequence No	**Shoal No**	**Category**	**Charted Depth** (feet)	**NAD 83 Latitude** (decimal degrees)	**NAD 83 Longitude** (decimal degrees)	**Surveyed Depth** (meters)	**Surveyed Depth** (feet)	**NAD 83 Latitude** (decimal degrees)	**NAD 83 Longitude** (decimal degrees)	**Type of Feature**	**Kelp Area**	**Further Examination Recommended**	**Charting Recommendation**	**Remarks**
81	A83	2	12	41.306542	-72.000590	4.30	14	41.306720	-72.000426	Bank			Replace	
82	A84	2	Rk which covers, uncovers	41.306390	-72.012468	1.74	5	41.306435	-72.012431	Rk	Y	Y	Retain	Area of Poor Coverage
83	A85	3	7	41.306980	-72.008081	3.60	12	41.306997	-72.008379	Bank			Replace	Disproved
84	A86	2	13	41.299246	-72.004564	5.96	19	41.299159	-72.004567	Rk		Y	Retain	Intrepid Rock surveyed 6 feet deeper than charted
85	A87	3	24	41.296019	-72.003312							Y	Retain	In NBA area
86	A88	3	Rk	41.286769	-72.019411							Y	Retain	Area of Poor Coverage
87	A89	2	10	41.285010	-72.000732	4.08	13	41.284937	-72.000564	Bank			Replace	
88	A90	1				3.86	12	41.285416	-72.001086	Bank			Insert	
89	A91	2	14	41.286093	-72.004877	4.92	16	41.285960	-72.004758	Bank			Replace	
90	A92	1				4.68	15	41.286362	-72.005133	Rk	Y	Y	N/A	Low amplitude pulse

			CHARTED			SURVEYED								
Sequence No	**Shoal No**	**Category**	**Charted Depth** (feet)	**NAD 83 Latitude** (decimal degrees)	**NAD 83 Longitude** (decimal degrees)	**Surveyed Depth** (meters)	**Surveyed Depth** (feet)	**NAD 83 Latitude** (decimal degrees)	**NAD 83 Longitude** (decimal degrees)	**Type of Feature**	**Kelp Area**	**Further Examination Recommended**	**Charting Recommendation**	**Remarks**
91	A93	2	6	41.282369	-72.013786	2.71	9	41.282338	-72.013794	Bank			Replace	
92	A94	1				0.87	3	41.282490	-72.014428	Bank			Insert	
93	A95	2	12	41.279251	-72.015957	3.23	10	41.279167	-72.016016	Rk			Replace	
94	A96	2	11	41.281681	-72.005289	4.60	15	41.281868	-72.005354	Bank			Delete	Disproved
95	A97	3	14	41.283106	-72.000858	6.08	20	41.282962	-72.001042	Bank			Delete	Disproved
96	A98	2	13	41.277182	-71.999428	4.72	15	41.277022	-71.999048	Bank			Replace	
97	A99	2	13	41.276134	-72.001903	4.89	16	41.276079	-72.002279	Bank			Replace	
98	A100	2	5	41.272901	-71.996436	2.26	7	41.272957	-71.996837				Extend 12 foot contour west	
99	A101	1				1.38	4	41.270102	-71.998724	Rk			Insert and extend 6 foot contour west	Area of poor coverage to NE
100	A102	3	4	41.269617	-72.002790	2.69	9	41.269328	-72.002600	Rk	Y	Y	Retain	Not found with 4*4 metre laser spot spacing

			CHARTED			SURVEYED								
Sequence No	**Shoal No**	**Category**	**Charted Depth** (feet)	**NAD 83 Latitude** (decimal degrees)	**NAD 83 Longitude** (decimal degrees)	**Surveyed Depth** (meters)	**Surveyed Depth** (feet)	**NAD 83 Latitude** (decimal degrees)	**NAD 83 Longitude** (decimal degrees)	**Type of Feature**	**Kelp Area**	**Further Examination Recommended**	**Charting Recommendation**	**Remarks**
101	A103	3	6	41.268341	-72.006000	3.47	11	41.268204	-72.005966	Bank			Remove	Disproved
102	A104	1				1.94	6	41.265459	-72.005840	Rk			Insert	See item 27. Danger to Navigation Report
103	A105	1				1.58	5	41.265817	-72.009340	Bank		Y		Noisy data
104	A107	2	Rk	41.277381	-72.021667	1.49	5	41.277059	-72.021475	Rk	Y	Y	Retain	Area of Poor Coverage
105	A108	2	5	41.278644	-72.022114	2.67	9	41.278414	-72.021909	Rk	Y	Y	Retain	Area of Poor Coverage
106	A109	1				5.40	17	41.275729	-72.015507	Bank			Amend 18 foot contour	
107	A110	2	6	41.279032	-72.022938	2.40	8	41.279127	-72.022990	Rk	Y	Y	Retain	Area of Poor Coverage
108	A111	2	6	41.278323	-72.023661	2.57	8	41.277980	-72.023954	Rk	Y	Y	Retain	Area of Poor Coverage / Kelp area
109	A112	1				5.36	17	41.278869	-72.025645	Rk	Y		Insert	
110	A113	2	12	41.278080	-72.025896	3.83	12	41.277894	-72.025312	Rk	Y		Replace	Amend contour

			CHARTED			SURVEYED								
Sequence No	**Shoal No**	**Category**	**Charted Depth** (feet)	**NAD 83 Latitude** (decimal degrees)	**NAD 83 Longitude** (decimal degrees)	**Surveyed Depth** (meters)	**Surveyed Depth** (feet)	**NAD 83 Latitude** (decimal degrees)	**NAD 83 Longitude** (decimal degrees)	**Type of Feature**	**Kelp Area**	**Further Examination Recommended**	**Charting Recommendation**	**Remarks**
111	A114	2	15	41.275830	-72.027527	3.85	12	41.275644	-72.027264	Rk	Y		Replace	See item 13. Danger to Navigation Report.
112	A115	2	12	41.274866	-72.027123	3.40	11	41.274604	-72.026749	Rk	Y		Replace	
113	A116	2	16	41.270659	-72.024747	4.95	16	41.270754	-72.024334	Rk	Y	Y	Retain	Area of Poor Coverage to seaward
114	A117	1	28	41.264584	-72.029472	5.38	17	41.264480	-72.029625	Rk	Y	Y	N/A	Turbid. See item 16. Danger to Navigation Report.
115	A118	3	Rk awash	41.255199	-72.036933	4.06	13	41.255305	-72.036784		Y	Y	Retain	Not found in Area of Poor Coverage
116	A119		12	41.249835	-72.040517	4.42	14	41.249967	-72.040639	Rk	Y	Y	Retain	Area of Poor Coverage
117	A120	3	38	41.248256	-72.048056	15.61	51	41.248032	-72.048114			Y	Retain	Edge of area coverage
118	A121	3	36	41.247259	-72.044908	12.89	42	41.247515	-72.045230			Y	Retain	Edge of area coverage
119	A122	2	20	41.245819	-72.043755	7.16	23	41.245683	-72.043923	Rk	Y	Y	N/A	Possible Rock in Turbid area
120	A123	2	18.5	41.244715	-72.042049	6.39	21	41.244652	-72.041754	Rk	Y	Y	Retain	Possible Rk in kelp.

			CHARTED			SURVEYED								
Sequence No	**Shoal No**	**Category**	**Charted Depth** (feet)	**NAD 83 Latitude** (decimal degrees)	**NAD 83 Longitude** (decimal degrees)	**Surveyed Depth** (meters)	**Surveyed Depth** (feet)	**NAD 83 Latitude** (decimal degrees)	**NAD 83 Longitude** (decimal degrees)	**Type of Feature**	**Kelp Area**	**Further Examination Recommended**	**Charting Recommendation**	**Remarks**
121	A124	2	25	41.241824	-72.048311	8.33	27	41.241940	-72.048033	Rk	Y		Replace	
122	A125	2	55	41.241501	-72.043258	15.59	51	41.241821	-72.043473				Replace	Rep 1984
123	A126	2	19	41.249264	-72.021691	5.02	16	41.249223	-72.021805	Ridge	Y		Replace	
124	A127	2	15	41.253273	-72.012023	3.45	11	41.253568	-72.011648	Rk	Y		Replace	
125	A128	1				5.85	19	41.251065	-72.003246	Rk	Y		Insert	See item 29. Danger to Navigation Report.
126	A129	1				4.36	14	41.253021	-72.000463	Ridge	Y		Insert	
127	A130	3	55	41.245593	-72.022971							Y	Retain	NBA area
128	A131	3	42	41.247174	-72.005284							Y	Retain	NBA area
129	A132	3	58	41.253558	-72.050562							Y	Retain	NBA area
130	A133	3	28	41.254481	-72.041322							Y	Retain	NBA area

			CHARTED			SURVEYED								
Sequence No	**Shoal No**	**Category**	**Charted Depth** (feet)	**NAD 83 Latitude** (decimal degrees)	**NAD 83 Longitude** (decimal degrees)	**Surveyed Depth** (meters)	**Surveyed Depth** (feet)	**NAD 83 Latitude** (decimal degrees)	**NAD 83 Longitude** (decimal degrees)	**Type of Feature**	**Kelp Area**	**Further Examination Recommended**	**Charting Recommendation**	**Remarks**
131	A134	1	59	41.274061	-72.069223	14.92	49	41.274327	-72.069033			Y	N/A	Edge of area surveyed. 100% coverage only. See item 17. Danger to Navigation Report.
132	A135	3	53	41.275283	-72.063186	17.29	56	41.275063	-72.063601			Y	Retain	Edge of area surveyed
133	A136	3	43	41.279856	-72.074634							Y	Retain	NBA area
134	A137	3	58	41.263385	-72.090884							Y	Retain	NBA area
135	A138	3	52	41.265615	-72.088259							Y	Retain	NBA area
136	A139	3	48	41.278664	-72.098680							Y	Retain	NBA area
137	A140	3	35	41.279848	-72.099204							Y	Retain	NBA area
138	A141	3	38	41.282731	-72.097465							Y	Retain	NBA area
139	A142	3	44	41.283082	-72.094127							Y	Retain	NBA area
140	A143	3	65	41.269219	-72.075958	16.75	55	41.269212	-72.076154	Bank			Replace	Dumping Ground. See item 18. Danger to Navigation Report.

			CHARTED			SURVEYED								
Sequence No	**Shoal No**	**Category**	**Charted Depth** (feet)	**NAD 83 Latitude** (decimal degrees)	**NAD 83 Longitude** (decimal degrees)	**Surveyed Depth** (meters)	**Surveyed Depth** (feet)	**NAD 83 Latitude** (decimal degrees)	**NAD 83 Longitude** (decimal degrees)	**Type of Feature**	**Kelp Area**	**Further Examination Recommended**	**Charting Recommendation**	**Remarks**
141	A144	3	63	41.271260	-72.070307	15.43	50	41.271254	-72.070592	Bank			Replace	Dumping Ground. See item 19. Danger to Navigation Report
142	A145	3	66	41.269430	-72.070097	17.37	57	41.269617	-72.070601	Bank		Y	N/A	Edge of area surveyed.
143	A146	3	66	41.270060	-72.068085	17.57	57	41.270191	-72.067744	Bank		Y	N/A	Edge of area surveyed
144	A147	1	10	41.327505	-72.078222	1.74	5	41.327492	-72.078227	Rk			Insert	
145	A148	1				1.96	6	41.281848	-72.013832	Rk			Insert	
146	A149	3	Rock awash	41.264783	-72.005445	1.90	6	41.264801	-72.005054	Bank		Y	Retain	Area of Poor Coverage
147	A150	3	Wk PA	41.265627	-72.003785	2.72	9	41.265549	-72.004162	Bank		Y	Retain	Not Found
148	A151	3	Rock	41.264988	-72.004517	2.40	8	41.264892	-72.004400	Bank		Y	Retain	Area of Poor Coverage
149	A152	1	17	41.315163	-72.089233	4.19	14	41.314974	-72.088648	Rock		Y	N/A	Turbid. See item 14. Danger to Navigation Report
150	A153	1	26	41.296133	-72.095590	6.69	22	41.295914	-72.094946	Shoal		Y	N/A	Turbid. See item 20. Danger to Navigation Report
151	A154	1	26	41.303764	-72.018854	7.04	23	41.303612	-72.019226	Shoal			Replace	See item 24. Danger to Navigation Report

			CHARTED			SURVEYED								
Sequence No	**Shoal No**	**Category**	**Charted Depth** (feet)	**NAD 83 Latitude** (decimal degrees)	**NAD 83 Longitude** (decimal degrees)	**Surveyed Depth** (meters)	**Surveyed Depth** (feet)	**NAD 83 Latitude** (decimal degrees)	**NAD 83 Longitude** (decimal degrees)	**Type of Feature**	**Kelp Area**	**Further Examination Recommended**	**Charting Recommendation**	**Remarks**
152	A155	1	31	41.302106	-72.023551	8.67	28	41.302084	-72.023115	Rk		Y	N/A	Possible Rock. 100% coverage only. See item 25. Danger to Navigation Report
153	A156	1	9	41.282672	-72.012639	2.27	7	41.282276	-72.013004	Shoal			Replace	See item 26. Danger to Navigation Report
154	A157	1	17	41.308155	-72.018938	4.84	16	41.308559	-72.018721	Rk			Replace	See item 22. Danger to Navigation Report. Note: 18ft 70m to N and 15ft 60m to S

D.2 FEATURES REQUIRING INVESTIGATION – H11224

During the approval of the data a number of features were identified where it was considered that lesser depths may exist or that the surveyed depth was doubtful. A table of these items is provided on pages D-21 and D-22.

Depths associated with the features may coincide with shoaler depths on the smooth sheet. The depths obtained for the features were done during the approval stage which is prior to any data outputs which have undergone a shoal biased clash.

The full spreadsheet is also provided in Excel format with the digital data (SheetA_V4_Features_Inv.xls).

		SURVEYED								
Sequence No	**Shoal No**	**Surveyed Depth** (meters)	**Eastings**	**Northings**	**Sortie No**	**Run No**	**Frame**	**Row**	**Column**	**Remarks**
1	FA1	7.00	744040	4580804	11	525.1.1	52	7	16	In area of poor coverage
2	FA2	-0.42	743137	4580528	14	79.0.1	76	10	12	Insufficient coverage
3	FA3	1.67	743355	4580207	14	79.0.1	71	10	26	Kelp area / insufficient coverage
4	FA4	-0.31	743039	4580381	14	77.0.1	75	15	15	Possible Rock in Kelp
5	FA5	-0.17	743282	4580130	14	78.0.2	71	13	35	See item A76. Chart Comparison. Rock awash in Kelp.
6	FA6	1.67	742999	4580261	14	76.0.1	74	17	28	Kelp area / insufficient coverage
7	FA7	-0.45	742782	4580243	14	74.0.1	77	3	41	Kelp area / insufficient coverage
8	FA8	-0.44	750114	4577071	8	662.0.1	187	1	19	See item A84. Chart Comparison. Rock in Kelp.
9	FA9	0.83	750127	4577323	8	657.0.1	29	13	10	Turbid / kelp area
10	FA13	2.35	748003	4571130	11	336.0.1	19	7	48	Turbid waveform
11	FA15	5.36	747923	4570298	7	417.0.1	75	2	18	Possible Rk in turbid area
12	FA17	7.16	747700	4570245	7	417.0.1	78	2	20	See item A122. Chart Comparison. Possible Rk in turbid area.
13	FA18	6.07	747406	4570086	7	420.0.1	29	16	41	Possible Rk - turbid waveform
14	FA26	7.17	743106	4576937	5	628.1.1	102	15	18	Turbid. 100% coverage only
15	FA28	6.54	743510	4577401	9	620.0.1	108	15	39	Possible Rk - turbid waveform
16	FA29	3.59	743428	4577562	10	616.0.1	108	1	48	Possible Rk in kelp area / insufficient coverage
17	FA30	4.62	743604	4577725	13	221.0.1	30	18	15	Possible Rk in kelp area / insufficient coverage
18	FA31	3.40	743615	4577791	12	609.0.1	116	1	48	See item A62. Chart Comparison. Low amplitude pulse / turbid waveform.
18	FA37	6.12	749159	4576794	18	665.0.2	43	15	7	See item A22. Chart Comparison. Turbid waveform
20	FA39	6.83	743238	4575679	18	661.0.2	120	15	1	See item A153. Chart Comparison. Turbid / possible object.
21	FA40	-0.30	750110	4577183	18	660.0.2	188	2	34	Turbid area / low amplitude pulse

		SURVEYED								
Sequence No	**Shoal No**	**Surveyed Depth** (meters)	**Eastings**	**Northings**	**Sortie No**	**Run No**	**Frame**	**Row**	**Column**	**Remarks**
22	FA41	4.70	742880	4575921	18	651.0.2	126	9	43	Wreck-like feature
23	FA42	6.39	748810	4577261	18	651.0.2	48	10	21	Possible Rk - turbid waveform
24	FA43	7.23	746999	4576955	18	648.0.2	147	8	14	Object on seabed
25	FA44	4.24	745187	4576625	18	648.0.2	123	15	44	Possible object on seabed
26	FA46	4.19	743693	4577813	18	221.0.1	29	9	46	See item A152. Chart Comparison. Turbid waveform
27	FA47	0.11	743696	4578014	18	221.0.1	26	18	25	Kelp area / poor coverage
28	FA48	-0.90	750097	4577898	19	643.1.1	31	3	6	Possible pontoon / structure - deleted from data
29	FA53	2.25	749264	4573908	20	304.2.1	45	4	32	See item A111. Chart Comparison. Area of poor coverage / Kelp area
30	FA56	-0.13	746602	4577723	20	87.0.1	25	1	44	Insufficient coverage
31	FA57	4.58	746762	4577727	20	87.0.1	26	2	12	Possible object on seabed
32	FA58	8.95	744015	4578520	18	223.0.1	19	5	40	Possible object on seabed
33	FA59	6.05	744944	4577898	13	614.0.1	125	14	13	Possible object on seabed

D.3 NAVIGATION AIDS – H11224

During the survey a number of navigation aids were detected in the data. These have been identified as buoys, beacons and lights from the chart.

Some of these items were detected a number of times on different lines. In these cases, a mean position has been adopted.

There are some minor differences in the surveyed positions of the buoys when compared with the chart. It should be noted that as the buoys were not necessarily surveyed on both the flood and ebb streams, no recommendations for charting action has been made.

Not all buoys and beacons were detected. This is expected, as some of the objects are quite small. In particular, at 4x4 meter laser spot spacing, laser pulses may have fallen either side of them.

Where these Navigation Aids were detected, they are depicted on the smooth sheet.

A table is provided on pages D-24 and D-25.

The full spreadsheet is also provided in Excel format with the digital data (SheetA_V4_Nav_Aids.xls).

Nav Aid No.	NAD 83 Latitude (decimal degrees)	NAD 83 Longitude (decimal degrees)	Eastings	Northings	Year	JD	Time	Run No	Frame	Row	Column	Remarks
NA1	41.28785	-72.0192157	749583.06	4574980.4	2004	36	23:30:05	711.0.1.1	38	8	9	North Dumpling Light
NA2	41.27168	-72.0056096	750804.87	4573224.6	2004	32	23:13:32	316.0.1.4	124	6	12	Buoy
NA3	41.33978	-72.0901811	743466.67	4580544.3	2004	56	20:58:58	509.1.1.2	63	8	21	Buoy
NA4	41.30307	-72.0545026	746590.77	4576569	2004	55	1:19:58	656.0.2.8	140	3	36	Buoy
NA5	41.30034	-72.0658374	745651.97	4576233.6	2004	63	16:18:09	658.1.1.1	124	2	14	Buoy
NA6	41.32209	-72.0832313	744103.39	4578599.5	2004	54	23:35:43	225.0.1.1	18	1	2	Buoy
NA7	41.32215	-72.0807722	744309.41	4578613.6	2004	54	23:45:01	227.0.1.1	16	4	22	Buoy
NA8	41.29501	-72.0899271	743644.21	4575573.9	2004	54	23:49:53	228.0.1.1	29	16	37	Buoy
NA9	41.29602	-72.0332736	748375.16	4575847	2004	54	22:58:00	247.0.1.1	42	3	13	Seaflower Reef Light
NA10	41.27993	-72.0227446	749325.88	4574091	2004	63	17:41:46	302.1.1.1	126	16	24	Buoy
NA11	41.2706	-72.0812939	744457.46	4572888.7	2004	32	21:18:55	303.0.1.2	113	5	39	Buoy
NA12	41.26437	-72.0827766	744356.99	4572192	2004	48	23:50:04	311.0.3.1	115	18	44	Buoy
NA13	41.26028	-72.0363748	748254.89	4571869.8	2004	38	14:40:53	326.0.1.1	70	5	17	Buoy
NA14	41.33868	-72.0853125	743867.61	4580436.5	2004	56	20:31:06	519.1.1.1	54	8	21	Buoy
NA15	41.31127	-72.0757445	744770.16	4577419.1	2004	55	2:23:25	522.0.2.1	23	13	10	Buoy
NA16	41.35956	-72.0886552	743509.59	4582745.3	2004	56	20:26:20	523.2.1.1	94	14	17	Buoy
NA17	41.33985	-72.0825824	744082.29	4580573.6	2004	56	20:20:15	525.1.1.1	55	4	24	Buoy
NA18	41.33787	-72.0826029	744096.99	4580354	2004	56	20:20:17	525.1.1.1	57	18	1	Buoy
NA19	41.31051	-72.0608594	746014.56	4577377.7	2004	56	17:20:32	632.1.1.6	136	2	12	Buoy
NA20	41.30588	-72.0774366	744640.09	4576816.8	2004	34	20:38:14	638.0.1.8	120	13	2	New London Ledge Light

Nav Aid No.	NAD 83 Latitude (decimal degrees)	NAD 83 Longitude (decimal degrees)	Eastings	Northings	Year	JD	Time	Run No	Frame	Row	Column	Remarks
NA21	41.29383	-72.0771691	744711.49	4575479	2004	44	1:57:01	671.0.1.2	102	1	48	Buoy
NA22	41.2937	-72.0795079	744515.66	4575458.5	2004	44	1:57:03	671.0.1.2	104	11	37	Buoy
NA23	41.35146	-72.0869236	743679.66	4581850.2	2004	48	1:19:12	800.0.1.1	39	7	24	Buoy
NA24	41.30786	-72.0814963	744302.21	4577024.5	2004	49	0:22:33	801.0.2.4	100	16	4	Buoy
NA25	41.28108	-72.0180245	749728.65	4574232.3	2004	32	21:05:20	301.0.1.1	39	18	33	Buoy
NA26	41.2744	-72.0140593	750086.67	4573502.2	2004	32	22:50:00	312.0.1.2	117	4	39	Buoy
NA27	41.26319	-72.0663876	745745.37	4572107.4	2004	32	23:12:19	316.0.1.2	51	11	10	Buoy
NA28	41.34546	-72.0901394	743448.97	4581175.8	2004	56	20:48:31	513.2.1.3	76	10	33	Buoy
NA29	41.34296	-72.0870642	743715.67	4580906.4	2004	56	20:37:50	517.1.1.1	71	6	14	Buoy
NA30	41.34627	-72.0877457	743645.85	4581272.4	2004	56	20:30:55	519.1.1.1	43	11	5	Buoy
NA31	41.30477	-72.0727464	745056.45	4576706.7	2004	44	1:00:58	645.0.1.5	97	14	6	Buoy
NA32	41.24595	-72.0410074	747936.55	4570265.3	2004	47	22:58:04	840.0.1.1	37	12	10	Buoy
NA33	41.24348	-72.0470969	747416.48	4569974.4	2004	33	23:02:53	422.0.1.2	30	7	32	Race Rock Light

D.4 SURVEY POLYGONS – H11224

A recommendation for overlap with the lidar data by surface vessel has been made. This recommendation is provided as a .dgn file (SheetA_ V4_Overlap.pzip). It is provided with the digital data in MicroStation 7 format.

In the Chart Comparison section (D.1) there are also some recommendations for investigation by surface vessel for some items.

In the Features Requiring Investigation section (D.2) there are also some recommendations for some other items where it was considered that lesser depths may exist or that the surveyed depth was doubtful.

E. APPROVAL SHEET

LETTER OF APPROVAL – OPR-B370-KRL-04

This report and the accompanying smooth sheets are respectfully submitted.

Field operations contributing to the accomplishment of this survey were conducted under my direct supervision with frequent personal checks of progress and adequacy. This report and the accompanying smooth sheets have been closely reviewed and are considered complete and adequate as per the Statement of Work.

Report	**Submission Date**
Descriptive Report – H11224	December 24, 2004

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Mark Sinclair
Hydrographer
Tenix LADS Incorporated

Date_____