SEARSPORT HARBOR
SEARSPORT, MAINE
NAVIGATION IMPROVEMENT PROJECT

TECHNICAL REPORT 1

FINAL REPORT
MARINE GEOPHYSICAL INVESTIGATION
CHANNEL DEEPENING PROJECT

OSI REPORT NO. 06ES102-ME

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FINAL REPORT

Marine Geophysical Investigation
Channel Deepening Project
Searsport Harbor
Searsport, Maine

1.0 INTRODUCTION

Ocean Surveys, Inc. (OSI) conducted a marine geophysical investigation in Searsport Harbor, Maine from 14 to 20 December 2006 (Figure 1) in support of the United States Army Corps of Engineers (USACE), New England District, proposed channel deepening project. The investigation was designed to provide information both for marine archaeological assessment of the harbor and an evaluation of geologic conditions within the depth of interest for the project. A proposed maximum dredging depth of 45 feet below MLLW (mean lower low water) was noted in the final scope of work (SOW) dated 6 November 2006. The study was performed under contract with The Public Archaeology Laboratory, Inc. (PAL) who is responsible for the marine archaeology portion of the project.

In support of the marine archaeological and geological site assessments, the primary objectives of the marine geophysical investigation included (SOW page 11, Section 2.1):

- high resolution seismic data acquisition down to 52 feet and an overall assessment of subsurface conditions to 70 feet below MLLW.
- the identification of natural and possible man-made surficial targets on the bottom
- the identification of magnetic anomalies in the site
- the identification of areas where difficult dredging may be encountered, including isolated rock pinnacles and large glacial erratics
- discrimination of the stratigraphy (sediment layering, lithologies) where seismic profiles might permit via interpretation
- recommendations for future geotechnical investigations

The main intent of the seismic profiling was to identify the presence of coarse glacial till (cobbles, boulders) and bedrock that may adversely affect dredging operations within the depth of interest. The subbottom profile data were also meant to provide information on any seismic facies suggestive of paleo-environments, such as buried channels and shorelines, that might represent potential pre-historic cultural sites. The SOW also included an objective to locate potential buried utilities in the site from interpretation of the seismic profiles, however, it is understood that this investigation does not constitute a comprehensive utility search.

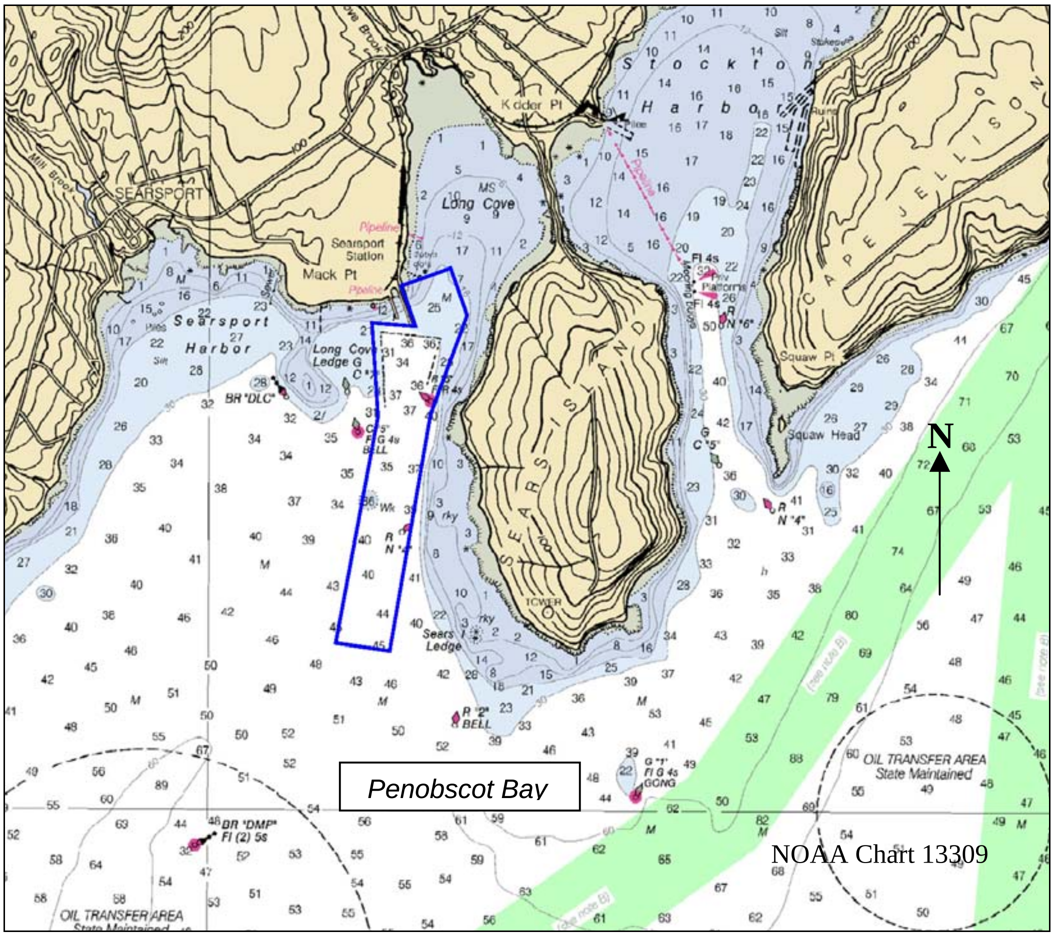

Figure 1. Location of the area investigated for this project (site limits in blue).

1.1 <u>Project Tasks</u>

To accomplish the goals and objectives discussed above, the following survey tasks were completed in support of the proposed channel deepening project in Searsport:

- **Side scan sonar survey** to identify coarse materials as well as natural and man-made acoustic targets on the bottom
- **Magnetic intensity survey** to identify objects composed of ferrous materials on and below the bottom
- **Subbottom profile survey** to map subsurface stratigraphy and large buried obstructions within the depth of interest

No hydrographic survey was performed as part of this investigation; instead, the USACE provided OSI with water depth data recorded during previous surveys of the area, as per the USACE project SOW.

2.0 GEOLOGIC SETTING

Submarine geomorphology and stratigraphic framework of the northern Penobscot Bay region encompassing Searsport Harbor has been shaped and built by the processes associated with deglaciation and repeated sea level fluctuations. Topography of the bedrock surface is a controlling factor on the morphology of overlying submarine and subaerial deposits.

The surrounding land masses adjacent to the project site contain a wide range of materials comprising the Presumpscot Formation (Quaternary Age; Qp) including mainly glaciomarine mud (silt-clay) with sand layers and gravel lenses locally (Thompson and Smith, 1986). This formation accumulated during retreat of the ice sheet as glaciomarine sediments were deposited over basement rock and glacial drift (Qdu), particularly in low lying areas. The Penobscot Formation (Ordovician-Cambrian Age; O-Cp) supports the overlying sediment column and consists of metamorphosed lithologic units, mainly sulfphitic/carbonaceous pelite (Anderson, 1985), exhibiting significant relief typical of ice scour. Devonion Age (D1) intrusive volcanic rock bodies have also been mapped in the region, but not in the immediate vicinity of Searsport.

The study area is positioned 2-4 miles north of the Turtle Head fault zone which separates the Penobscot Formation from the Ellsworth Formation (Ordovician-PreCambrian Age; OZe) to the south, a dominantly interbedded pelite and sandstone rock unit (Anderson, 1985).

The terrestrial startigraphy continues into the subaqueous environment where the uppermost layers of the Presumpscot glaciolacustrine/marine (primarily silt-clay) and glaciofluvial deposits are truncated by the Holocene ravinement surface (see Figure 7 in Section 7.3; Kelley et al., 1987). Meltwater streams developed during deglaciation cut across the subaerially exposed nearshore ramps to form fluvial channel deposits in many places. Many of these paleochannels are positioned offshore from present day rivers, valleys, and other surficial depressions where runoff would congregate. These deposits are comprised mainly of interbedded sand, gravel, and some silt. Recent marine sediments form the uppermost layer of the stratigraphic column today and consist predominantly of silt-clay and sand. Past research suggests overall unconsolidated sediment thickness increases toward the south-southeast away from Sears Island and the mainland (Knebel and Scanlon, 1985).

Previous studies of areas to the southwest of this investigation identified pockmarks (depressions) from side scan sonar data (Scanlon and Knebel, 1989). The features are circular in shape and vary between 10-125 meters in diameter with depths up to 25 meters below the ambient harbor floor. Seismic profiles reveal the pockmarks extend down to the top of the Presumpscot Formation and no deeper (Kelley and Belknap, 1989). It has been postulated that these features are associated with entrapped natural gas in organic-rich, muddy deposits and its release from the subsurface into the water column. Data show the highest concentration and largest pockmarks are located midway between Belfast Harbor and Isleboro Island and diminish toward the northeast (Figure 2).

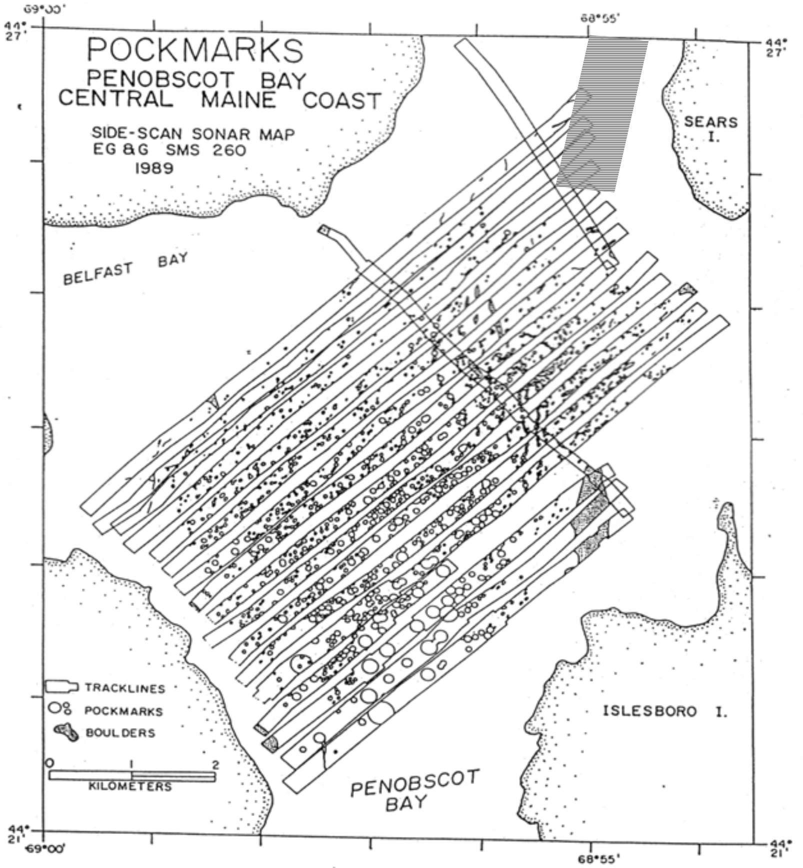

Figure 2. Pockmarks on the bottom of Penobscot Bay identified from a side scan sonar mapping conducted in 1989 in the vicinity of Searsport Harbor (Kelley et al., 1987). Tracklines surveyed for this previous work barely extend into the current study area (gray shade) in the upper right of this diagram.

3.0 SURVEY AREA AND TRACKLINES

The survey area covers the entrance channel and turning basin immediately west of Sears Island in Searsport Harbor. The table below lists the coordinates of all corners of the survey area. The site extends north a short distance into Long Cove, adjacent to and east of the Maine Port Authority pier. The site did not extend into the nearshore area between the Sprague Energy Terminal pier to the west and the Port Authority pier (see Figure 1). Coverage extends approximately 100 feet outside the channel to the west and east, equivalent to a 1,400 foot corridor. The area width increases northward with the turning basin past red nun buoy No. 6. Site width approaches 2,500 feet across the south face of the piers. East-northeast off the pier in Long Cove, survey coverage extends out approximately 1,300 feet, with lines oriented parallel to the pier. These tracklines were run separately from the channel and turning basin lines due to the large turn radius at the offshore end which would have made vessel maneuverability difficult, reduced data quality, and possibly increased offline errors. Due to shallow water depths near shore at low tide, lines extending into shore in the northwest corner of the Long Cove area were run at high tide to insure accessibility to the area provide the most site coverage possible.

Searsport Harbor Survey Area Limits

Point	Easting (feet) *	Northing (feet) *
1	881678	287375
2	882106	286177
3	881159	283650
4	880108	277663
5	878712	277860
6	879806	283611
7	879651	285896
8	880773	285896
9	880407	286921

*Note: Site limit coordinates referenced to Maine State Plane Coordinate System, East Zone 1801, NAD 83 in feet.

Primary tracklines were spaced 50 feet apart throughout the entire survey area and were oriented parallel to the main axis of the channel and turning basin (Figure 3). Magnetic intensity measurements were collected on every primary line, while side scan sonar imagery and subbottom profiles were recorded on every third line.

Tielines oriented perpendicular to the primary lines and across the channel were positioned based on a preliminary field review of subsurface profiles (see Figure 3). Tielines were concentrated more closely together where profiles suggested the presence of coarse material or bedrock in the depth of interest. As requested in the SOW, tielines were also designed to intersect existing boring locations provided by the USACE. Only subbottom profile data were collected along the tielines.

At the request of the project archaeologist, several additional lines were surveyed in the vicinity of a shipwreck within the project area to acquire side scan sonar imagery from multiple viewpoints.

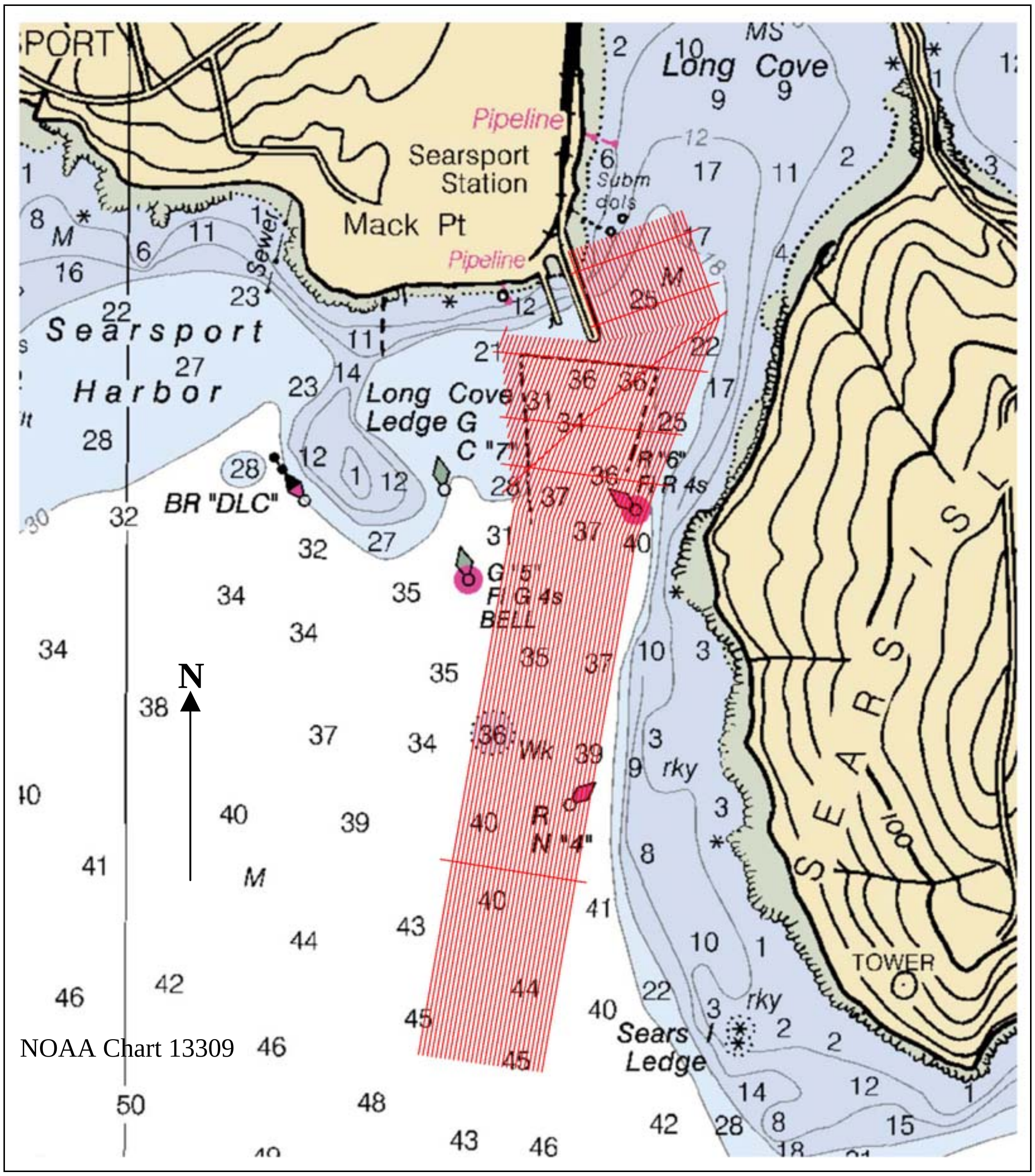

Figure 3. Planned survey tracklines in the project area.

4.0 SURVEY EQUIPMENT OVERVIEW

A brief description of the major equipment systems mobilized to Searsport Harbor for this investigation is provided below. A complete discussion of this equipment along with the operational procedures employed to collect the data for this project can be found in Appendix D. Specification sheets for all the equipment used can be found in Appendix E.

Survey Equipment

Equipment System	Description
Trimble 4000RS DGPS Receiver	Global positioning system receiver capable of tracking up to 9 satellites simultaneously; interfaced with Trimble ProBeacon receiver and HYPACK® navigation computer.
Trimble ProBeacon USCG Beacon Receiver	Beacon receiver which receives USCG differential corrections that are input to the Trimble 4000 receiver providing a reported system accuracy of +/- 1 meter.
HYPACK® navigation software and data logging computer	HYPACK® software runs on a Pentium notebook computer providing real time trackline control, digital data logging, and many survey utility functions; this package allows the efficient simultaneous acquisition of digital data from multiple systems.
Klein 3000 Dual Frequency Side Scan Sonar System	Side scan sonar system providing acoustic imagery of the bottom out to either side of the survey trackline; dual frequency technology allows the acquisition of high resolution images (500 kHz) and extended sweep ranges (100 kHz).
Geometrics G-882 Marine Cesium Magnetometer	Marine cesium magnetometer used to detect ferrous metal on and below the bottom to a 0.1 gamma accuracy. Measurements collected at a rate of 10 times per second.
Applied Acoustics Engineering "Boomer" Seismic Reflection System	Powerful low frequency 0.5-8 kHz "Boomer" system used to penetrate coarse glacial till and organic-rich, gaseous deposits to resolve subsurface layering and lithologic structures in the stratigraphic column.

The side scan sonar towfish and magnetometer sensor were deployed over the side of the vessel, each towed from a davit and winch that allowed for adjustment of sensor height above the bottom during the survey. The side scan sonar system utilized a 164 foot (50 meter) sweep range to provide high resolution imagery and over 200% coverage of the bottom, as data were collected on parallel lines spaced 150 feet apart. The side scan sonar towfish was maintained at an altitude of 10-15% of the sweep range where possible (shallow water does not permit this). Similarly, the magnetometer sensor was towed at a nominal height of 20 feet above the bottom but was actually much closer in shallow water nearshore (height verified via depth sounder transducer). Magnetic intensity measurements were collected along all survey tracklines. Subbottom profile data were obtained along every third trackline, at a 150 foot spacing (same as the side scan sonar). The “boomer” sound source (catamaran with boomer plate) and receiver (hydrophone array or “eel”) were towed off the vessel’s stern outside the boat propeller wash to minimize acoustic noise. The “boomer” seismic system used a 100 millisecond scan rate to record a total depth profile (water and stratigraphic column) of approximately 250 feet (assuming an average acoustical velocity 5,000 feet per second). The system is capable of collecting raw seismic signals in the 500-8,000 hertz range. Filtered frequencies of 800-4,000 hertz were used for final display and interpretation. Laybacks and offsets to all sensors were recorded in the field for adjustment during post-survey processing.

5.0 SUMMARY OF FIELD INVESTIGATION

The marine geophysical investigation took place on 14-20 December 2006 under favorable weather conditions for the time of year. Generally calm sea states were encountered during the survey period with a few afternoons of higher winds and sea states that did not stop operations, but required slower survey speeds to maintain high data quality. Some commercial vessel traffic inbound and outbound from the Sprague Energy Terminal forced short delays in operations as the survey vessel had to move out of the shipping channel and into areas where survey activities did not impede commercial traffic. However, complete coverage of the site was achieved with no holidays in the final data set.

Geophysical Survey Crew:

Jeffrey D. Gardner	Geophysical Project Manager
Gregory L. Schulmeister	Geophysical Technician

The R/V Ready II (26 foot Parker Sport with dual 150 Hp outboard engines) was outfitted with the required equipment to complete the geophysical survey and mobilized to Searsport on 13 December 2006. The vessel is outfitted with an enclosed cabin and full suite of electronic navigation devices to ensure safe operations under a wide range of weather conditions. David Robinson, Archaeological Principle Investigator from PAL was onboard the vessel for the duration of the field program to oversee data acquisition.

5.1 Horizontal Control

Horizontal positioning of the survey vessel was accomplished by utilizing a Trimble 4000 Differential Global Positioning System (DGPS) which calculates geodetic coordinates referenced to the WGS-84 datum (World Geodetic System established in 1984), and equivalent to NAD 83 (North American Datum established in 1983). Differential corrections were received from the U.S. Coast Guard reference beacon at Brunswick, Maine (316 kilohertz at a transmission rate of 100 bits per second) with good reliability and signal strength. This DGPS configuration typically provides better than a 3 foot (sub-meter) repeatable position accuracy, as stated by the manufacturer.

The HYPACK® navigation software utilized aboard the survey vessel converts the geodetic coordinates (latitude-longitude) to state plane coordinates (easting-northing) for navigation in real time and logs these position data at 1-second intervals along survey tracklines. The survey was conducted in the Maine State Plane Coordinate System (East Zone 1801), referenced to NAD 83 with all coordinates in feet. The table below lists information for the horizontal control check point established by OSI with DGPS at the town dock. Navigation checks were performed over this control point at the beginning and end of each field day to ensure the positioning system was functioning properly and delivering the horizontal position accuracy required for the project.

Point ID	Position *	Description
Town Dock 2006	N 286680 E 873332	Point marked by PK nail with pink survey flagging flush with the dock. Point is located mid-way along north-northeast face of the Searsport town loading dock.

*Note: Coordinates referenced to the Maine State Plane Coordinate System, East Zone 1801, NAD 83 in feet.

6.0 DATA PROCESSING AND DELIVERABLES

Data processing techniques and the methods used for analysis of the side scan sonar, magnetic intensity, and subbottom profile data are described in Appendix F. The following table details the data products that have been generated for this project. Drawings have been constructed at a scale of 1 inch = 200 feet in plan view. All horizontal data are referenced to feet in the Maine State Plane Coordinate System (East Zone 1801), NAD 83.

Product	Scale/Format	Description
As Appendices at End of Report		
Sonar Target List	NA/ Spreadsheet	Table of acoustic targets interpreted from the side scan sonar imagery, included in Appendix A
Magnetic Anomaly List	NA/ Spreadsheet	Table of magnetic anomalies interpreted from the total earth's magnetic field intensity data, included in Appendix B
Seismic Reflection Profiles	(as shown) PDF format	Interpretation of selected subbottom profiles used to determine depth to coarse glacial till or bedrock, included in Appendix C
Hard Copy and Digital Full Size Drawings, Separate Deliverable		
Drawing V-1, Sheets 1 & 2	1 inch = 200 feet	Water depth contours at a 1-foot interval developed from data provided by the USACE
Drawing V-2, Sheets 1 & 2	1 inch = 200 feet	Geophysical data results; side scan sonar targets and magnetic anomaly locations as well as areas of coarse surficial material
Drawing V-3, Sheets 1 & 2	1 inch = 200 feet	Contour map of the primary acoustic basement reflector, contour interval is 1 foot

To position survey data in the vertical plane, the USACE provided hydrographic data files referenced to the project datum, MLLW. Most of the processed hydrographic data were included in file "searport sht 1 jun13+15+1605 con 03 avg 3587.xyz" which were from a June

2005 conditions survey in Searsport Harbor. These measurements were used to define the bottom elevations throughout the area investigated for this study. This geophysical investigation extended beyond the limits of the USACE 2005 condition survey in a few areas. USACE provided a second depth data file from an earlier survey, "SEAvpsApr99.xyz" for depths in those areas. Figure 4 shows the two areas (green shaded) where depth data were based on the April 1999 survey.

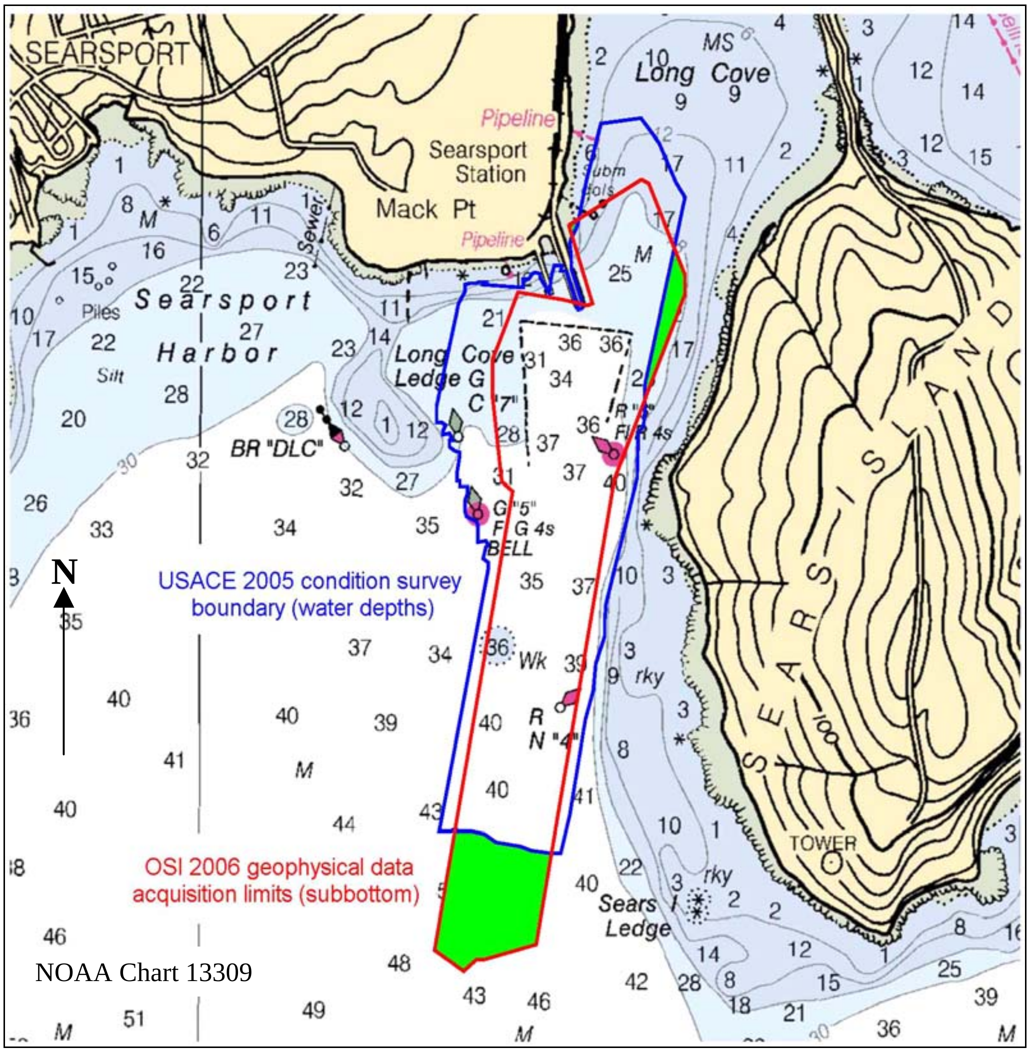

Figure 4. Illustration showing the difference between the USACE 2005 condition survey limits (blue) compared to this 2006 geophysical investigation limits (red). Green shaded areas represent areas covered by the 1999 survey but not the 2005 hydrographic survey.

Water depth measurements provided by the USACE were assessed by generating hydrographic contours of the data for future USACE review (Drawing V-1). The contours were developed for a three-dimensional surface created by a 50x50-foot TIN-GRID technique using a digital terrain modeling (DTM) software package (QuickSurf). Contours presented are simply a function of the contouring method chosen (computer generated). The TIN-GRID method is commonly used as it generally produces smoother contours that are more acceptable for display purposes, although the contours do not necessarily honor all of the input data points (see Appendix F for more detail).

The same hydrographic data files provided by the USACE were used to reference the primary acoustic basement reflector depths to the project datum. This was accomplished by adding the interpreted reflector depth below the bottom to the MLLW depth surface created from the USACE data. In this case, the two data surfaces (depth and reflector depth below the bottom) were generated using a TIN method that honors every data point, and the two surfaces were added together. The final display contours were created using the TIN-GRID method again to obtain a smoother data presentation.

7.0 SURVEY RESULTS

The following discussion of survey results references the project drawings listed previously. All subsurface reflector depths discussed in the text are referenced to the project datum, MLLW. Results were developed from interpretation of the geophysical data only. No geotechnical ground truthing of the seismic data is available beyond the borings in the northern portion of the site provided by the USACE. Surficial and subsurface sediment types discussed below are estimated solely by interpretation of the geophysical data. Bottom and subbottom sampling should be performed prior to dredging to verify interpreted material composition.

7.1 Side Scan Sonar Imagery

Review and interpretation of the side scan sonar imagery reveals acoustic reflectivity representative of different sediments and bottom features. Stronger reflectivity is related to coarser material (sand, gravel, rocks) and/or variations in bottom morphology, whereas weaker acoustic returns are typically associated with finer grained sediments (silt-clay).

Based on the interpretation of the sonar images only (no ground truthing), most of the site appears to be represented by weak to moderate acoustic returns suggestive of primarily silt with sand. In addition, areas of coarser material are scattered locally around the site. One area in particular lies along the east channel slope from a point south of red nun buoy No. 6 northward to the landward limit of the dredged harbor basin (see Drawing 2, Sheet 1). Coarser sediments in this location may have slumped down from channel slope deposits which were truncated by past dredging operations (because subbottom data show the top of coarse till or bedrock deeper). The bottom morphology appears highly irregular and disturbed, possibly the result of dredging in the area. The area of disturbance has been noted on Drawing 2, and extends approximately 500 feet west of the channel slope in several places. None of the disturbed bottom areas appear to be pockmarks, as identified south of Belfast Harbor during previous studies.

Coarse material is also evident east of the Port Authority pier to the shoreline. The shore is lined with rip rap around the pier and many boulders exist in shallow water. Additional bottom disturbance is evident around the south ends of the piers as numerous markings were observed on the records. These features may be due to commercial shipping traffic, possibly impacting the bottom during lower tide conditions. The long, narrow nature of the bottom marks is not necessarily suggestive of dredging activity.

Numerous man-made objects were detected on the harbor floor; a total of 376 sonar targets have been mapped (Appendix A). The most common objects identified throughout the site are lobster pots. Since few, if any, surface buoys marking strings were observed during the survey, most or all of the traps are most likely lost or abandoned. In some places, many lobster traps are congregated by tidal currents into one larger group. Man-made objects of different shapes and sizes are scattered around the site, with a higher concentration of debris generally north of red nun buoy No. 4. Most objects appear to be at least partially buried.

The largest object identified is the charted shipwreck located near the west channel slope approximately 1,100 feet northwest of red nun buoy No. 4. The wreck is located in 39-40 feet of water and oriented with its long axis pointing approximately 285º/105º true (west-northwest to east-southeast). The outline of the sunken ship on the sonar image is generally 30 x 160 feet and exhibits less than 5 feet of relief above the bottom (Figure 5). The debris field extends outward from the wreck in all directions, but more prominently to the north. Fishing and other commercial activity in the harbor have undoubtedly scattered pieces of the wreck over the years. There are numerous lobster traps entangled in the wreckage.

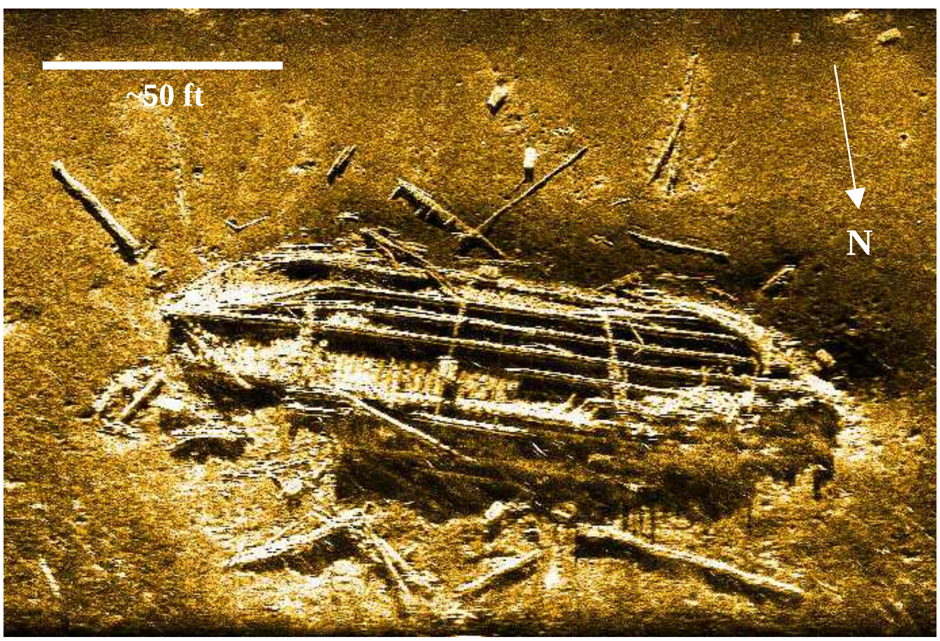

Figure 5. Section of side scan sonar imagery revealing the acoustic details of the shipwreck identified in the survey area. Lobster traps are visible in the top central portion of the image (rectangular reflections) that have been snagged on the wreck over the years.

7.2 Magnetic Intensity Data

Measurements of the earth's total magnetic field allowed the identification of local deviations in the field due to the presence of ferrous objects on or below the harbor floor. A magnetic anomaly with no associated sonar target indicates the ferrous object may be buried below the bottom. The magnetic intensity data were interpreted to identify isolated anomalies in the site that may be generated by man-made ferrous debris. A total of 152 magnetic anomalies were identified (Appendix B). Anomalies attributed to shoreline structures and subsurface geology (bedrock highs) were not included in the anomaly list.

A review of mapped anomalies reveals most are positioned near the piers and shoreline as well as along the western slope of the dredged harbor basin. The majority of these anomalies are small in amplitude, generally less than 20 gammas. Only nine anomalies over 100 gammas were detected and only three anomalies were over 500 gammas (M14, M121, M131). Anomaly amplitudes for ferrous objects located east of the Port Authority pier are skewed toward the high side because the sensor is closer to the bottom in the shallow water. No linear trends of magnetic anomalies are evident that might suggest the presence of submarine cables or pipelines in the study area.

Magnetic deviations less than 100 gammas were measured over the charted shipwreck imaged by the side scan sonar during this study. Values of this magnitude suggest limited amounts of ferrous material at the site, and in particular, a non-ferrous hull. A steel hull the size of this wreck, measured at sensor heights of 20-25 feet and directly over the remains, would generate anomalies in the thousands of gammas.

It is important to remember that anomalies are always measured at the sensor position along each trackline. The magnetic sensor cannot distinguish between offline distance and vertical distance to an object. Thus the anomaly location does not necessarily represent the exact position of the ferrous object. Anomalies detected along the survey lines may be associated with a sonar target or other feature located offline (not directly below the sensor).

7.3 Subbottom Profile Data

The seismic reflection profiling method achieved subsurface penetration in over 95% of the survey area, with only one small pocket of organic-rich, gaseous deposits at depth that limited signal penetration depth. In addition, the localized pocket of subsurface gas was observed offshore, in the southwest corner of the survey area, where depth to bedrock was far below the project depth of interest (Figure 6). Observations of gaseous sediments in Belfast Harbor from previous studies do not appear to hold true for Searsport Harbor.

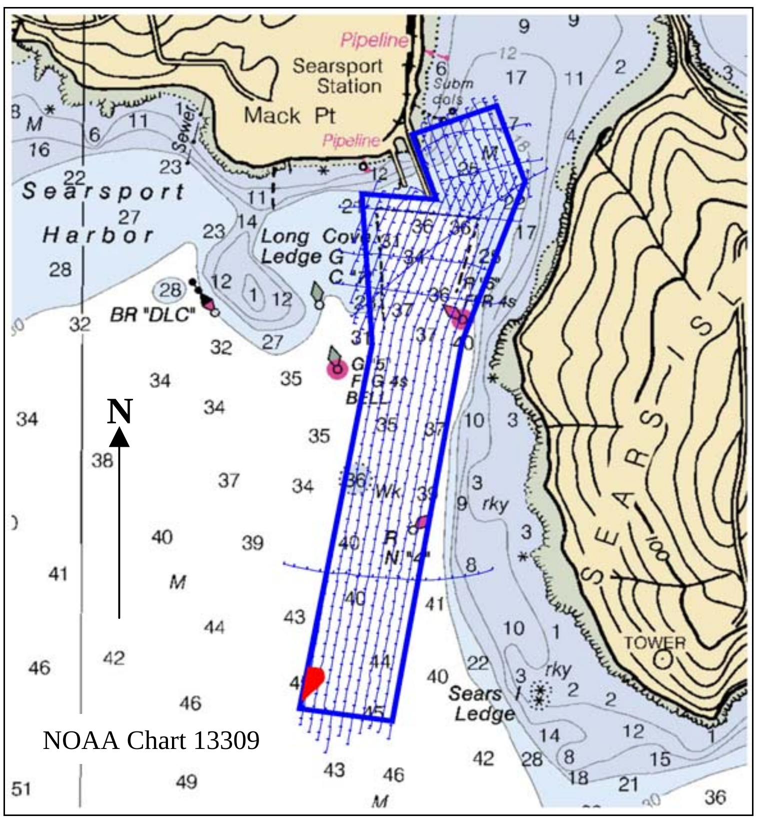

Figure 6. Area of the site where subsurface gas was interpreted on the subbottom profiles (solid red fill, only on Lines 25 and 28). Top of gaseous deposit exceeds 85 feet below MLLW. Actual "boomer" tracklines in blue with site limits marked by wider blue polyline.

A primary acoustic basement reflector was mapped from interpretation of the "boomer" subbottom profiles that is nearly continuous under the entire site. The acoustic basement reflector is believed to represent the top of coarse glacial till (mix of gravel, cobbles, boulders with sand matrix) throughout the majority of the site, and bedrock in localized areas. A deeper, discontinuous, reflector interpreted as the bedrock surface is evident on most seismic records. This deeper reflector suggests that a glacial till unit, exhibiting a variable thickness, overlies the bedrock in most of the site. Since the objective of the investigation is to map areas where difficult dredging conditions may be encountered, the coarse till was included in the acoustic basement definition. Thus, Drawing 3 presents contours of the primary acoustic basement reflector depth below MLLW at a 1-foot interval. The additional interpretation of the presumed bedrock surface was included on the seismic profiles developed for final presentation in Appendix C.

Sediment thickness was calculated using an average acoustic velocity of 5,000 feet per second, a "conservative" estimate, (i.e. resulting in shallower depth estimate). For example, if the average velocity increased from 5,000 to 6,000 feet per second an increase of 20% in the estimated sediment thickness would result. Within the depth of interest this variation could result in a change of acoustic basement depth greater than 1-foot.

A review of the subbottom contours and profiles indicates coarse glacial till and/or bedrock are present shallower than 52 feet MLLW mainly in the northern portion of the site, including around the ends of the piers, in the northwest corner, and east of the Port Authority pier (Figure 7). An isolated coarse till/rock high, which slopes down to the northwest and southeast is evident to the south along Line 13. Finally, a linear section of shallow acoustic basement is possible along the easternmost edge of the site, on a 1,300 foot stretch of Line 1 south of red nun buoy No. 6, that traverses over the channel slope. This correlates with a submerged rock ledge that extends westward from Sears Island toward the channel, as evident on the nautical chart and visible above the waterline during lower tidal stages in the field.

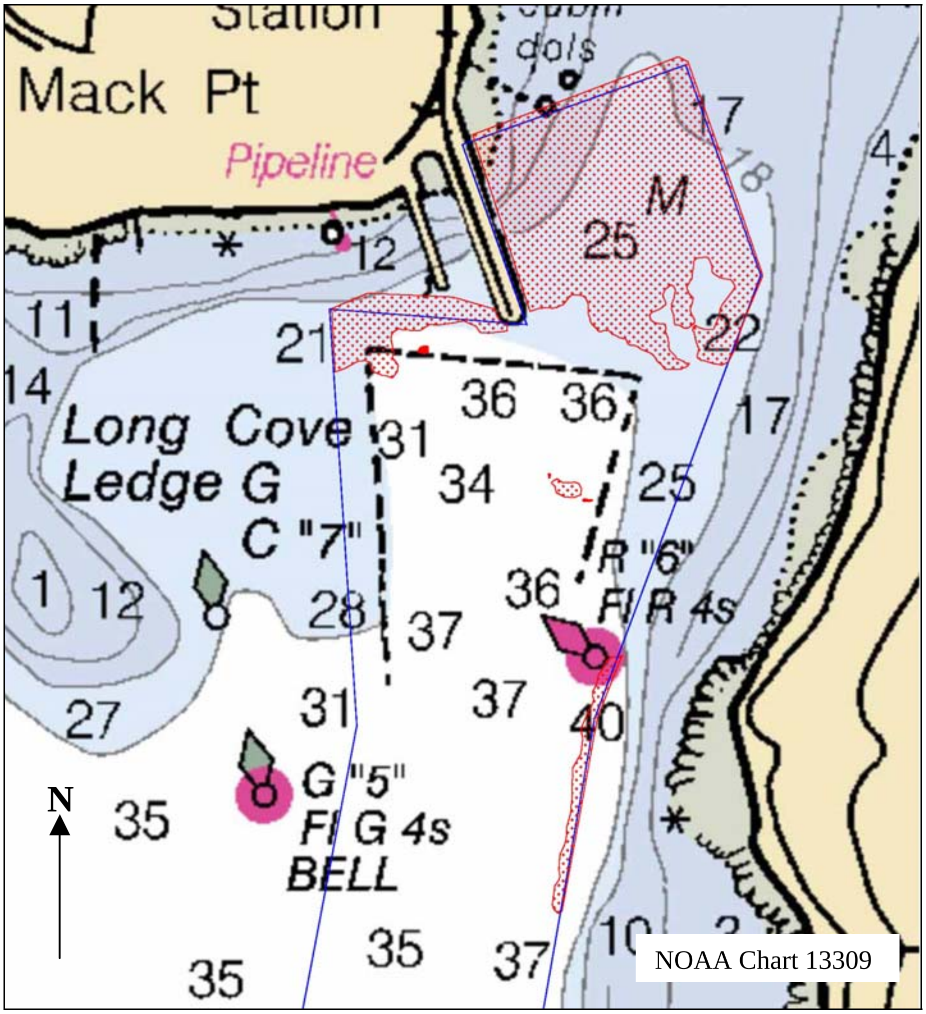

Figure 7. Areas where coarse glacial till (gravel, cobbles, boulders) and/or bedrock are present shallower than 52 feet MLLW are hatched with red cross pattern.

The interpetation of basement geologic strata (actual lithology) can be difficult because coarse glacial till and bedrock may produce similar reflective horizons, where most of the acoustic signals do not penetrate any deeper. This coarse glacial till unit may include rock pinnacles and large glacial erratics (boulders) locally. The presence of two reflectors exhibiting characteristics of a basement unit is significant evidence to suggest the shallower, more continuous primary acoustic basement reflector represents coarse glacial till, which overlies the bedrock surface evident deeper in the section as the discontinuous reflector.

Several paleochannels are evident on the seismic profiles acquired in the northeastern portion of the survey area, near the entrance to Long Cove (Figure 8 of Line 49). The relict channels, generally oriented in a west-southwest direction away from the Cove and Sears Island, represent former drainage systems during the prior sea level low stand. The channels are located within the Pleistocene coastal plain strata and are truncated by an erosional unconformity associated with the Holocene transgression. The Holocene erosional unconformity slopes upward toward shore through the site. Paleochannel depths of incision below the unconformity range from 10-20 feet into the surrounding deposits.

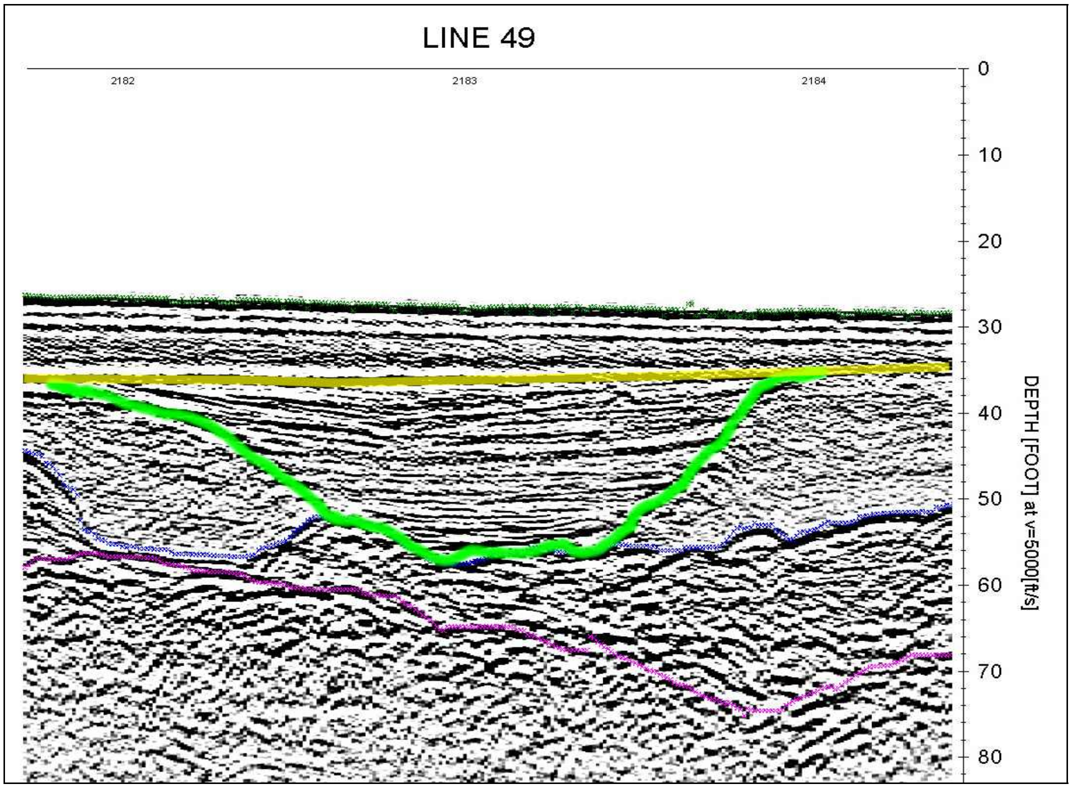

Figure 8. Example of a paleochannel evident on the seismic reflection profile. The basal, concave erosional surface of the relict channel is outlined in green. The yellow line marks the Holocene transgressive surface which truncates the top section of fluvial channel deposits. The blue line marks the top of coarse glacial till or bedrock mapped from this investigation. The magenta line is a possible lower reflector delineating the top of competent rock. Events across the top of the profile are 200 feet apart. Profile has not been tide corrected; predicted tides for Belfast Harbor were at +6.5 feet MLLW at the time this seismic data was acquired.

There was no obvious evidence of any subsurface, linear man-made features such as pipelines or cables that might be indicated by parabolic-shaped reflectors on several adjacent tracklines. A review of nautical chart 13309 also suggests there are no submarine utilities in the site.

7.4 Correlation of Geophysical and Geotechnical Data

Geotechnical information available in the survey area is limited, and existing data appear to pre-date dredging activities in Searsport Harbor. In the USACE scope of work, a legend on the boring figure which accompanies the table below shows symbols for borings completed in 1963 and earlier. The seven boring locations have been presented in Figure 9, which shows that 3 of the 7 stations (H-3, M-4, and FD-4) are outside of the survey area limits.

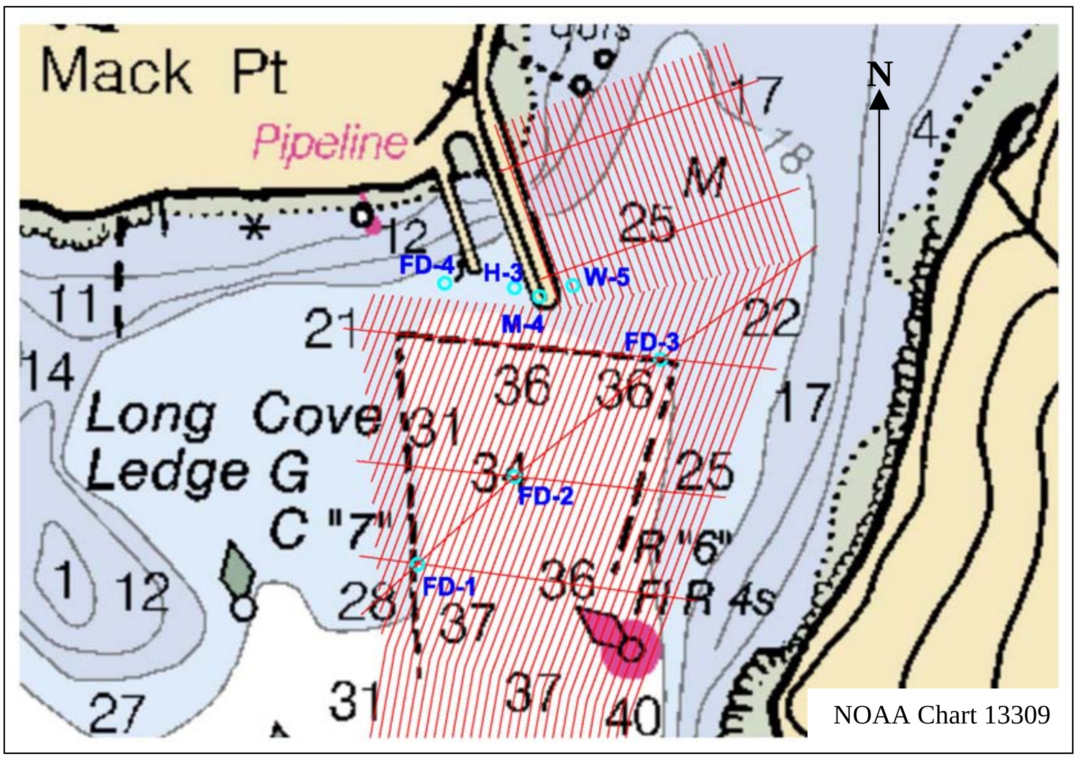

Figure 9. Previous borings conducted in the site, provided by the USACE. According to information provided in the USACE scope of work, all the borings were completed in 1963 or earlier, prior to dredging of Searsport Harbor.

The September 2002, (28th edition) nautical chart 13309 indicates Searsport Harbor was dredged to 35 feet MLLW in May 1992, and more recent channel deepening is possible. A comparison of current water depths in the harbor from the USACE 2005 condition survey and water depths included in the table below for each boring station (1963 and earlier) suggests the uppermost layers sampled by these borings have been dredged and removed from the site (see seismic profiles with overlain borings in Appendix C). Only boring W-5 due east of the south end of the Port Authority pier shows significant penetration into present day stratigraphy, and it is positioned 40 feet west of Line 70 and 85 feet northwest of Line 22 (see seismic profile in Appendix C).

Boring	Northing	Easting	Surface Depth (ft below MLW)	Total Depth of Boring (ft below MLW)	Details (depth units are in feet)
H-3	286015.161	880514.789	-22.5	-52	-22.5' to -35.5 (Mud); -35.5' to -43.5' (Gravel, rocks, clay); -43.5' to -52' (Loose sand and gravel with boulder obstruction on bottom)
M-4	285965.162	880652.789	-23.5	-60	-23.5' to -38.5' (Mud); -38.5' to -44' (Hard Clay); -44' to -60' (Sand and gravel with little clay)
W-5	286027.164	880839.786	-22	-64	-22' to - 32.5' (Mud); -32.5' to -52' (Hard Clay); -52' to -64' (Clay, sand & gravel)
FD-1	284477.17	879976.81	-30.1	-40.1	-30.1 to -40.1' (Organic SILT with occasional shells)
FD-2	284965.17	880514.8	-30.5	-40.5	-30.5' to -40.5' (Organic SILT with occasional shells)
FD-3	285615.17	881326.79	-30.9	-40.9	-30.9' to -38.9' (Organic SILT with occasional shells to organic SILT with occasional shells a trace of sand); -38.9' to -40.9' (CLAY in laminated layers)
FD-4	286040.16	880126.79	-23.2	-43.2	-23.2' to -31.8' (Organic SILT); -31.8' to -33.2' (CLAY); -33.2' to -35.2' (Organic SILT); -35.2' to -43.2' (CLAY)

Note: NOAA tidal epoch 1983-2001 suggests only 0.5 foot difference between MLW and MLLW. This suggests the following surface depths relative to MLLW: H-3 (-22 ft), M-4 (-23 ft), W-5 (-21.5 ft), FD-1 (-29.6 ft), FD-2 (-30 ft), FD-3 (-30.4 ft), and FD-4 (-22.7 ft).
Table taken from USACE SOW titled "Statement of Work, Marine Archaeology and Marine Geophysics, Searsport Harbor Maine and Portsmouth Harbor, Piscataqua River, New Hampshire and Maine", dated 6 November 2006.

Correlation of boring W-5 with Line 70 and Line 22, despite the offset distances, reveals the primary acoustic basement reflector appears to match reasonably well with the depth to a glacial till unit (clay, sand, and gravel at 52 feet) noted from the boring data (approximate MLLW). The boring indicates till down to 64 feet (12 feet thick) suggesting a till unit overlying bedrock east of the pier, as indicted on most of the seismic profiles.

Immediately west at boring M-4, likely positioned due south from the end of the pier and between the ends of Lines 25 and Line 28 (not intersected by a seismic profile), more glacial till was encountered in the 44-60 foot depth range. Continuing west to boring H-3 located west of the Port Authority pier and between the north ends of Line 28 and Line 31 (not intersected by a seismic profile), glacial till was recovered from 35-52 feet with a boulder obstruction at the bottom of the hole. Boring FD-4, located southwest from the end of the Sprague Energy pier and at the north end of Line 37, encountered unconsolidated sediments down to 43 feet. It is important to note, however, that all three borings discussed above are positioned north and west of the designated survey limits for this investigation.

Borings FD-1, FD-2, and FD-3 were only 10 feet in length prior to dredging, therefore 90-100% of the sediments recovered at those stations have been removed. All encountered organic-rich silt with some clay and a trace of sand in the 30-40 foot depth range. Unconsolidated sediments of this nature are generally consistent with those on the bottom of Searsport Harbor in that area, as imaged by the side scan sonar system.

Overall, very little geotechnical data from the borings is available for correlation with the seismic reflection profiles collected for this investigation. Seismic profiles intersecting boring locations have been included in Appendix C and recommendations for future geotechnical work are discussed in Section 8.0 that follows.

8.0 CONCLUSIONS AND RECOMMENDATIONS

The detailed marine geophysical investigation conducted in Searsport Harbor in December 2006 has provided valuable information for seafloor and subsurface characterization of site geology. Geophysical data sets acquired have also allowed the mapping of natural and man-made objects on, and possibly below, the bottom. A total of 376 side scan sonar targets and 152 magnetic anomalies have been identified from interpretation of the geophysical data sets, as well as bottom areas where sonar reflectivity suggests the presence of coarse material. Such objects and features observed on the side scan sonar and magnetic intensity data may represent obstructions to future dredging operations. Related maps and data results have also been delivered for archaeological assessment of the site, a determination of the presence of potentially significant cultural resources. The most obvious sonar target in the site is the shipwreck along the west side of the channel which the data suggests may be an older, wooden hulled vessel due to the minimal magnetic signature of the wreck.

Subsurface geologic interpretations indicate over 75% of the site is clear of coarse glacial till or bedrock down to 52 feet MLLW, mainly the offshore three quarters of the survey area. Scattered lenses of coarse material (coarse sand, gravel, cobbles) may exist within the Quaternary Presumpscot Formation, but not to the extent concentrated in the glacial drift deposits immediately overlying the bedrock surface. The following paragraphs briefly summarize seismic interpretations in the four main areas of concern to the project, where difficult geologic conditions could impact dredging operations, as illustrated in Figure 10.

It should be noted that the actual subbottom contour boundary covers a larger footprint than the designated survey area because geophysical tracklines are typically run beyond the end of each line to account for sensor laybacks and provide data beyond the survey limits for minimizing adverse boundary effects in the contour presentation.

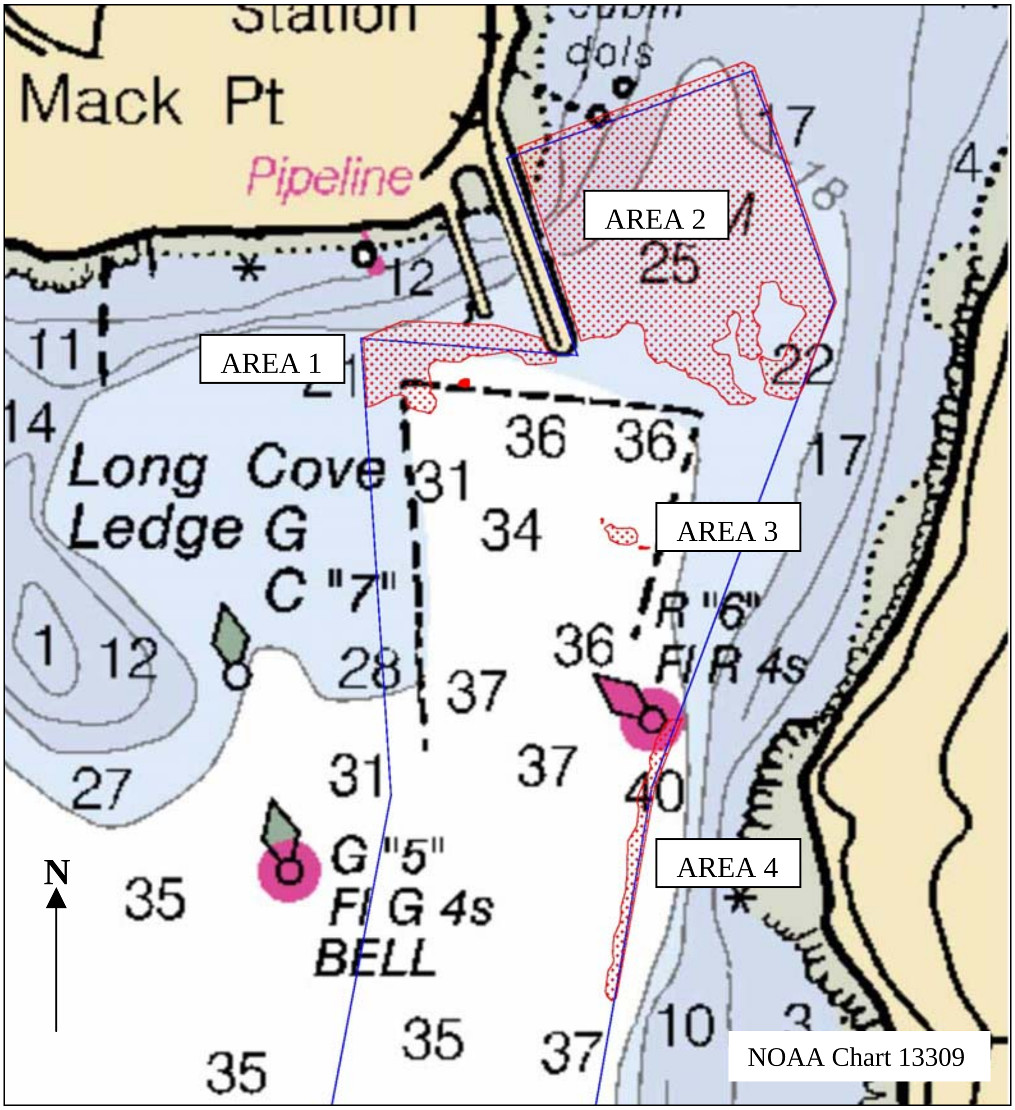

Figure 10. Four main areas where the primary acoustic basement reflector has been mapped at depths less than 52 feet MLLW (red cross pattern), suggesting potential difficult dredging conditions.

Area 1—South-Southwest of the Piers Close to Mack Point Shoreline

In the northwest corner of the site, southwest of the Sprague Energy pier, seismic profiles suggest that coarse glacial till is the dominant material shallower than 52 feet MLLW, and that bedrock is deeper. Data from this investigation indicate the primary basement reflector attains elevations of 25 feet MLLW or shallower, sloping up toward the northwest corner of the site.

Area 2—East of the Port Authority Pier in Long Cove

East of the Port Authority pier, the strong primary acoustic basement reflector slopes up close to the bottom, with a secondary deeper basement reflector also present. In general, coarse glacial till thickness of less than 5 feet to 15-20 feet are interpreted in this area with the bedrock surface generally deeper than 52 feet MLLW. As depths shallow in the northwest corner of the area and the basement reflector slopes up close to the bottom, increased coarse till thickness exists. The possibility of bedrock shallower than the depth of interest appears more likely in this corner of the survey area, with localized pinnacles possible in this portion of Long Cove.

Area 3—Isolated Basement High Along Line 13

An isolated topographic high spot or pinnacle of the primary acoustic basement reflector reaches an apparent depth of 46-47 feet MLLW at this location. This horizon, believed to represent the top of coarse glacial till in this area, slopes down to the northwest and southeast below project depth of interest on adjacent seismic lines (Line 10 and Line 16).

Area 4—East Edge of Survey Limit, South of Red Nun Buoy No. 6

Along Line 1 on the east edge of the channel, the highly irregular bottom surface and coarse surficial material combine to attenuate enough of the acoustic signal so the nature of the nearsurface reflector is difficult to determine. However, interpretation of the subbottom profiles suggests that coarse glacial till deposits exist shallower than 52 feet MLLW. Bedrock could be positioned within that vertical range as well, but site conditions do not allow the detection of both till and rock reflectors.

Geotechnical investigations are recommended in all areas where seismic profiles indicate coarse glacial till or bedrock in the upper 52 feet below MLLW. Techniques employed could include vibracoring to acquire a physical sample down to the top of rock or jet probing to indirectly estimate the material types at depth. However, given the thickness of coarse glacial till in the area, these methods may or may not penetrate down to the rock surface, and neither is capable of sampling the bedrock itself. Depending on the requirements for geotechnical information, a boring plan to sample all the lithologies present below the bottom may be warranted. Figure 11 below shows a possible geotechnical plan to acquire physical samples of subsurface lithologies as well as ground truth the seismic profile data.

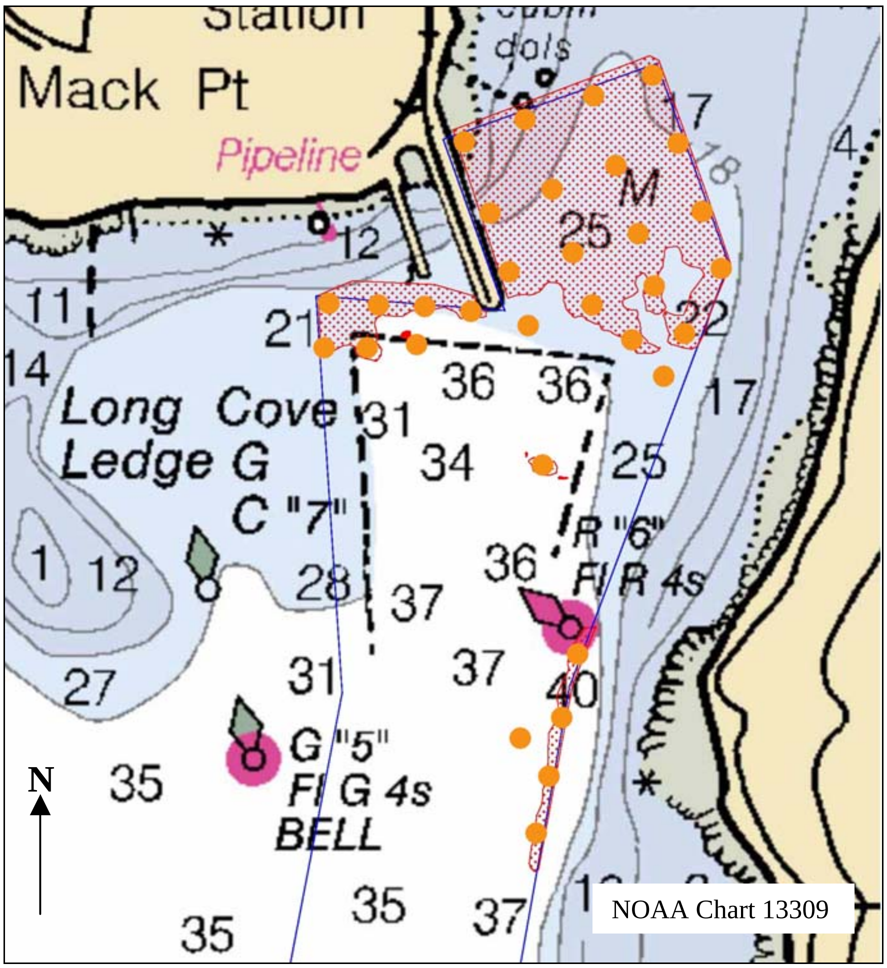

Figure 11. Schematic of possible geotechnical sampling plan with sample stations shown by the solid orange circles. Stations outside of the shallow acoustic basement zones (red cross pattern) are important to map the vertical trend of the primary acoustic basement and differentiate the overburden in adjacent areas.

9.0 REFERENCES

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APPENDICES

A Side Scan Sonar Target Listing
B Magnetic Anomaly Listing
C Seismic Reflection Profiles
D Equipment Operations and Procedures
E Equipment Specification Sheets
F Data Processing and Analysis Methods

APPENDIX A

Side Scan Sonar Target Listing

Searsport Harbor Channel Deepening / Navigation Improvement Study
Side Scan Sonar Targets

DATE	Run	Line	Event	Target ID#	Easting	Northing	Length	Width	Height or Relief	Comment	Associated Magnetic Anomaly
17-Dec	69	22	1331.9	SS1	880935	285904	18.4	2.0	0.0	elongate object	
			1332.0	SS2	880806	285904	19.0	18.0	0.0	four scattered object	
			1332.9	SS3	880716	285784	63.0	47.6	0.0	area of scattered elongate debris	
			1333.2	SS4	880737	285658	7.9	6.9	0.0	angular reflection	
			1335.1	SS5	880729	285272	4.6	1.6	1.6	elongate	
			1336.0	SS6	880682	285127	5.9	3.6	0.3	lobster pot	
			1337.0	SS7	880476	284995	5.9	3.6	0.3	lobster pot	
			1339.0	SS8	880464	284560	16.1	2.0	0.0	elongate object	
			1342.0	SS9	880164	284036	5.9	3.6	0.3	lobster pot	
			1343.8	SS10	880139	283656	7.9	3.9	0.0	linear	
			1344.0	SS11	880176	283597	5.9	3.6	0.3	lobster pot	
			1344.2	SS12	880110	283570	5.9	3.6	0.3	lobster pot	
			1344.4	SS13	880197	283507	5.9	3.6	0.3	lobster pot	M37
			1344.7	SS14	880151	283466	5.9	3.6	0.3	lobster pot	
			1345.0	SS15	880146	283397	5.9	3.6	0.3	lobster pot	
			1349.5	SS16	879975	282502	5.9	3.6	0.3	lobster pot	
			1349.6	SS17	879982	282491	10.8	0.0	0.0	linear	
			1350.7	SS18	879936	282271	5.9	3.6	0.3	lobster pot	
			1351.2	SS19	879952	282158	5.9	3.6	0.3	lobster pot	
			1353.4	SS20	879657	281781	5.9	3.6	0.3	lobster pot	
			1353.5	SS21	879633	281777	23.3	7.5	0.0	three linear objects	
			1360.8	SS22	879600	280290	5.9	3.6	0.3	lobster pot	
			1361.4	SS23	879524	280181	5.9	3.6	0.3	lobster pot	
			1362.6	SS24	879603	279946	16.7	4.3	0.0	rectangular	M101
			1373.5	SS25	879129	277827	5.9	3.6	0.3	lobster pot	
	70	19	1376.0	SS26	879058	277392	5.9	3.6	0.3	lobster pot	
			1379.0	SS27	879190	278074	3.6	2.3	0.7	angular	
			1380.8	SS28	879479	278426	5.9	3.6	0.3	lobster pot	M103
			1380.8	SS29	879214	278435	5.6	2.6	0.3	two slightly rectangular objects	
17-Dec	70	19	1384.9	SS30	879441	279225	5.9	3.6	0.3	lobster pot	
			1385.4	SS31	879500	279333	5.9	3.6	0.3	lobster pot with thin linear cable	M100
			1388.5	SS32	879517	279984	5.9	3.6	0.3	lobster pot	

Searsport Harbor Channel Deepening / Navigation Improvement Study
Side Scan Sonar Targets

DATE	Run	Line	Event	Target ID#	Easting	Northing	Length	Width	Height or Relief	Comment	Associated Magnetic Anomaly
			1389.0	SS33	879549	280045	23.0	2.0	0.0	linear object	
			1389.0	SS34	879668	280031	5.9	3.6	0.3	lobster pot	
			1390.5	SS35	879699	280286	3.9	2.6	0.0	angular	
			1390.7	SS36	879763	280343	5.9	3.6	0.3	lobster pot	
			1391.0	SS37	879740	280427	5.9	3.6	0.3	lobster pot	
			1391.4	SS38	879568	280515	5.9	3.6	0.3	lobster pot	
			1392.9	SS39	879631	280824	6.2	2.0	0.0	rectangular	
			1394.2	SS40	879808	281056	5.9	3.6	0.3	lobster pot	
			1396.6	SS41	879918	281528	5.9	3.6	0.3	lobster pot	M34
			1396.6	SS42	879983	281536	5.9	3.6	0.3	several lobster pots	
			1397.0	SS43	879794	281626	28.9	2.3	1.0	linear	
			1399.0	SS44	879841	282017	36.1	34.4	0.0	area of scattered debris	M40
			1399.7	SS45	879849	282105	5.9	3.6	0.3	lobster pot	
			1400.8	SS46	880048	282340	5.9	3.6	0.3	lobster pot	
			1401.0	SS47	879873	282424	5.9	3.6	0.3	two lobster pots	M96
			1403.6	SS48	880159	282910	5.9	3.6	0.3	lobster pot	
			1403.7	SS49	880086	282946	5.9	3.6	0.3	lobster pot	M36
			1407.7	SS50	880341	283686	5.9	3.6	0.3	lobster pot	
			1409.5	SS51	880427	284024	5.9	3.6	0.3	lobster pot	
			1411.0	SS52	880341	284386	5.9	3.6	0.3	lobster pot	
			1411.5	SS53	880439	284430	5.9	3.6	0.3	lobster pot	
			1411.8	SS54	880456	284510	5.9	3.6	0.3	lobster pot with thin linear cable	
			1412.0	SS55	880581	284534	5.9	3.6	0.3	lobster pot	
			1414.8	SS56	880814	284992	5.9	3.6	0.3	lobster pot	M28
			1420.9	SS57	881174	286058	60.7	2.3	1.3	linear object	M130
	71	13	1423.0	SS58	881390	286036	9.2	0.0	0.0	linear object	
			1424.9	SS59	881229	285694	9.5	0.0	0.0	linear object	
			1427.5	SS60	881165	285161	9.2	3.6	1.3	angular	
			1427.9	SS61	881161	285090	5.9	3.6	0.3	lobster pot	
			1428.8	SS62	880989	284968	5.9	3.6	0.3	lobster pot	
			1429.4	SS63	880918	284877	5.9	3.6	0.3	two lobster pots	M23
17-Dec	71	13	1430.5	SS64	880925	284631	5.9	3.6	0.3	lobster pot	
			1431.0	SS65	880941	284519	16.7	0.0	0.0	thin linear object	
			1431.2	SS66	880936	284477	5.9	3.6	0.3	lobster pot	

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Side Scan Sonar Targets

DATE	Run	Line	Event	Target ID#	Easting	Northing	Length	Width	Height or Relief	Comment	Associated Magnetic Anomaly
			1432.0	SS67	880832	284336	5.9	3.6	0.3	lobster pot	M18
			1432.5	SS68	880784	284234	5.6	2.6	0.0	angular	
			1432.8	SS69	880717	284204	5.9	3.6	0.3	lobster pot	
			1435.7	SS70	880691	283636	7.9	5.6	0.3	angular	
			1435.9	SS71	880494	283620	5.9	3.6	0.3	lobster pot with some fish	
			1437.0	SS72	880647	283383	5.9	3.6	0.3	lobster pot	
			1437.6	SS73	880624	283298	12.5	3.6	0.7	two rectangular ob	M112
			1437.6	SS74	880445	283295	5.9	3.6	0.3	lobster pot	
			1439.5	SS75	880528	282912	5.9	3.6	0.3	lobster pot	
			1439.6	SS76	880490	282875	5.9	3.6	0.3	lobster pot	
			1440.1	SS77	880456	282776	15.4	1.6	0.7	linear	
			1440.7	SS78	880304	282721	5.9	3.6	0.3	lobster pot	
			1441.9	SS79	880293	282441	5.9	3.6	0.3	lobster pot	M22
			1442.6	SS80	880226	282286	5.9	3.6	0.3	lobster pot	
			1443.0	SS81	880207	282223	5.9	3.6	0.3	two lobster pots	
			1444.8	SS82	880187	281858	5.9	3.6	0.3	lobster pot	M21
			1446.0	SS83	880118	281647	5.9	3.6	0.3	lobster pot	
			1446.2	SS84	880103	281593	5.9	3.6	0.3	lobster pot	
			1446.8	SS85	880236	281449	5.9	3.6	0.3	lobster pot	
			1447.3	SS86	880185	281366	5.9	3.6	0.3	lobster pot	
			1449.9	SS87	879980	280903	5.9	3.6	0.3	lobster pot	
			1452.7	SS88	879846	280328	10.2	0.0	0.0	linear	
			1452.8	SS89	879904	280278	5.9	3.6	0.3	lobster pot	M20
			1453.0	SS90	879894	280233	5.9	3.6	0.3	lobster pot	
			1454.1	SS91	879825	280028	5.9	3.6	0.3	lobster pot	
			1456.3	SS92	879886	279595	5.9	3.6	0.3	lobster pot	
			1460.4	SS93	879763	278786	5.9	3.6	0.3	lobster pot	
			1464.6	SS94	879600	277956	5.9	3.6	0.3	lobster pot	
			1464.7	SS95	879647	277919	5.9	3.6	0.3	three lobster pots	
	72	16	1474.2	SS96	879571	278762	5.9	3.6	0.3	lobster pot	
			1479.0	SS97	879756	279718	4.6	3.9	0.0	circular	
			1479.9	SS98	879780	279888	5.9	3.6	0.3	lobster pot	
			1480.0	SS99	879765	279924	5.9	3.6	0.3	lobster pot	
17-Dec	72	16	1482.1	SS100	879753	280339	5.9	3.6	0.3	lobster pot	
			1482.7	SS101	879720	280452	5.9	3.6	0.3	lobster pot	

Searsport Harbor Channel Deepening / Navigation Improvement Study
Side Scan Sonar Targets

DATE	Run	Line	Event	Target ID#	Easting	Northing	Length	Width	Height or Relief	Comment	Associated Magnetic Anomaly
			1483.5	SS102	879957	280567	5.9	3.6	0.3	lobster pot	
			1486.8	SS103	879919	281255	5.9	3.6	0.3	lobster pot and circular object	M27
			1488.4	SS104	879976	281572	5.9	3.6	0.3	lobster pot and circular object	
			1499.2	SS105	880337	283708	5.9	3.6	0.3	lobster pot	
			1503.5	SS106	880615	284484	5.9	3.6	0.3	2 lobster pots	
			1507.0	SS107	880823	285171	5.9	3.6	0.3	lobster pot	
			1508.0	SS108	880873	285402	5.9	3.6	0.3	lobster pot	
			1510.1	SS109	881079	285758	6.2	1.6	1.6	elongate	
			1510.5	SS110	881066	285865	4.9	3.0	2.0	angular	M32
			1511.5	SS111	881250	285993	28.5	0.0	0.0	linear	M108
			1511.6	SS112	881138	286054	5.9	3.6	0.3	lobster pot	M130
			1511.8	SS113	881176	286097	35.4	0.3	1.0	linear	
			1511.9	SS114	881249	286088	20.3	11.2	0.0	rectangular	
			1511.9	SS115	881128	286120	5.9	3.6	0.3	lobster pot	
			1512.5	SS116	881308	286132	5.9	3.6	0.3	several lobster pots	M109
			1513.0	SS117	881241	286273	5.9	3.6	0.3	5 lobster pots	
	73	10	1518.0	SS118	881316	285586	5.9	3.6	0.3	lobster pot	
			1520.2	SS119	881331	285124	5.9	3.6	0.3	2 lobster pots	
			1520.6	SS120	881336	285062	5.9	3.6	0.3	lobster pot	M9
			1522.0	SS121	881071	284870	5.9	3.6	0.3	2 lobster pots	M15
			1522.9	SS122	881031	284660	5.9	3.6	0.3	lobster pot	
			1524.4	SS123	881019	284344	5.9	3.6	0.3	lobster pot	
			1526.0	SS124	880799	284084	5.9	3.6	0.3	lobster pot	
			1526.9	SS125	880702	283920	5.9	3.6	0.3	lobster pot	M125
			1529.3	SS126	880713	283404	3.3	4.3	3.6	angular	M12
			1533.1	SS127	880604	282667	5.9	3.6	0.3	lobster pot	
			1533.8	SS128	880470	282562	5.9	3.6	0.3	lobster pot	
			1534.6	SS129	880364	282381	9.8	1.6	0.7	linear	
			1535.3	SS130	880369	282229	5.9	3.6	0.3	lobster pot	
			1535.8	SS131	880312	282176	5.9	3.6	0.3	4 lobster pots	
			1537.5	SS132	880520	281792	5.9	3.6	0.3	lobster pot	M126
			1545.1	SS133	880084	280319	5.9	3.6	0.3	lobster pot	
			1557.3	SS134	879581	277945	5.9	3.6	0.3	lobster pot	

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DATE	Run	Line	Event	Target ID#	Easting	Northing	Length	Width	Height or Relief	Comment	Associated Magnetic Anomaly
17-Dec	73	10	1557.4	SS135	879632	277924	5.9	3.6	0.3	lobster pot	
	74	4	1564.0	SS136	880032	278299	17.4	2.6	1.0	linear	
			1576.4	SS137	880415	280685	56.4	31.5	0.0	large depression	
			1582.9	SS138	881155	284030	5.9	3.6	0.3	lobster pot	M121
			1597.0	SS139	881403	284674	5.9	3.6	0.3	lobster pot	M122
			1603.5	SS140	881774	285968	9.2	6.9	0.0	angular object	M5
18-Dec	86	70	1673.0	SS141	880892	285775	25.9	2.6	0.0	linear	
			1677.0	SS142	880604	286537	65.6	65.6	0.0	area of scattered debris	
	87	67	1684.2	SS143	880960	286559	4.9	4.3	1.6	blocky	
			1685.1	SS144	881046	286394	4.6	2.0	0.0	4 or 5 lobster pots	
	88	64	1691.1	SS145	881266	286097	20.3	9.5	0.0	rectangular frame	
			1692.0	SS146	881188	286252	13.5	0.0	0.0	linear	
			1692.7	SS147	881174	286375	16.7	1.3	0.0	linear	
			1693.0	SS148	881133	286453	9.8	2.0	0.0	linear	
			1695.1	SS149	880864	286796	5.9	3.6	0.3	lobster pot	M78,M119
			1696.6	SS150	880868	287113	0.0	0.0	0.0	scattered debris	M82
			1698.0	SS151	880739	287170	0.0	0.0	0.0	linear	M118
	89	61	1699.5	SS152	880977	287201	6.6	3.3	0.0	oblong	
			1701.9	SS153	881054	286717	5.9	3.6	0.3	lobster pot	
			1702.5	SS154	881116	286595	8.5	0.0	0.0	linear	
			1706.4	SS155	881501	285955	16.7	2.3	0.3	linear	
	90	58	1711.0	SS156	881500	286513	27.6	0.0	0.0	2 or 3 linear objects lying side by side	M85
			1713.9	SS157	881202	287057	24.0	0.0	0.0	linear feature and lobste	
			1713.9	SS158	881251	287060	24.0	11.8	0.0	2 objects appear to be	
	91	55	1719.1	SS159	881377	286971	51.5	1.3	0.0	curvilinear feature	
			1721.0	SS160	881618	286646	35.1	0.0	0.0	three linear objects sid	
			1721.3	SS161	881476	286522	35.1	3.9	0.0	two linear objects	
			1723.1	SS162	881506	286164	11.2	3.0	0.0	elongate	
			1731.5	SS163	881555	286496	6.9	1.6	0.0	linear	
	92	52	1732.9	SS164	881554	286456	10.5	7.2	0.0	triangular shaped structure	
			1733.3	SS165	881723	286593	9.5	7.2	0.0	angular	
18-Dec	92	52	1735.5	SS166	881371	286952	60.0	11.2	0.0	large structure - appears to penetrate the surface	
			1736.0	SS167	881537	287100	6.2	4.3	0.0	angular	

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DATE	Run	Line	Event	Target ID#	Easting	Northing	Length	Width	Height or Relief	Comment	Associated Magnetic Anomaly
	93	49	1739.0	SS168	881373	287497	5.9	3.6	0.3	two lobster pots	
	95	43	1759.9	SS169	879768	286006	5.9	3.6	0.3	2 lobster pots	
	97	37	1771.6	SS170	879812	285053	6.6	4.9	0.0	rectangular	M50
			1771.8	SS171	879723	285018	5.9	3.6	0.3	lobster pot	M44
			1775.9	SS172	880049	285715	5.9	3.6	0.3	lobster pot	
			1776.4	SS173	879971	285904	5.9	3.6	0.3	lobster pot	
			1776.9	SS174	880004	285809	5.9	3.6	0.3	lobster pot	
	98	34	1778.1	SS175	880292	286032	25.3	23.0	0.0	large object	
			1778.2	SS176	880277	285996	5.9	3.6	0.3	lobster pot	
			1778.6	SS177	880185	285928	5.9	3.6	0.3	lobster pot	
			1778.7	SS178	880286	285863	5.9	3.6	0.3	three lobster pots	
			1779.1	SS179	880242	285809	5.9	3.6	0.3	two lobster pots	
			1779.3	SS180	880264	285743	5.9	3.6	0.3	lobster pot	
			1779.5	SS181	880073	285788	5.9	4.9	0.0	circular - could be fish	
			1779.6	SS182	880057	285761	9.2	3.3	0.0	circular - could be fish	
			1780.0	SS183	880074	285684	5.9	3.6	0.3	lobster pot	
			1786.1	SS184	879793	284493	10.8	7.5	0.0	angular	
	99	31	1789.0	SS185	879552	283880	5.9	3.6	0.3	two lobster pots	
			1789.6	SS186	879589	283973	5.9	3.6	0.3	lobster pot	
			1790.0	SS187	879720	284024	5.9	3.6	0.3	lobster pot	
			1790.7	SS188	879827	284122	5.9	3.6	0.3	lobster pot	
			1791.0	SS189	879805	284209	20.7	2.0	0.3	linear object	
			1791.0	SS190	879711	284239	5.9	3.6	0.3	lobster pot	
			1792.0	SS191	879872	284389	5.9	3.6	0.3	lobster pot	
			1793.9	SS192	879987	284729	5.9	3.6	0.3	lobster pot	
			1794.7	SS193	879965	284917	5.9	3.6	0.3	lobster pot	
			1796.1	SS194	880193	285158	5.9	3.6	0.3	lobster pot	
			1797.8	SS195	880166	285496	5.9	3.6	0.3	lobster pot	
			1797.9	SS196	880307	285484	5.9	3.6	0.3	lobster pot	
			1798.0	SS197	880370	285543	5.9	3.6	0.3	lobster pot	
			1798.6	SS198	880359	285643	5.9	3.6	0.3	lobster pot	
			1798.8	SS199	880354	285683	5.9	3.6	0.3	lobster pot	
18-Dec	99	31	1800.1	SS200	880346	286009	5.9	3.6	0.3	large number of lobster pots	
			1800.5	SS201	880551	285984	19.4	2.0	0.3	linear object	
			1801.0	SS202	880565	286068	40.7	0.0	0.0	linear debris	

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DATE	Run	Line	Event	Target ID#	Easting	Northing	Length	Width	Height or Relief	Comment	Associated Magnetic Anomaly
			1801.0	SS203	880620	286055	65.6	65.6	0.0	area of scattered debris	
	100	4	1804.2	SS204	881107	283737	5.9	3.6	0.3	lobster pot	
			1805.6	SS205	881146	284008	5.9	4.9	2.0	square	M121
			1805.8	SS206	881180	284031	7.5	2.3	0.0	linear object appears	
			1808.4	SS207	881259	284578	5.9	3.6	0.3	lobster pot	
			1810.6	SS208	881424	284976	5.9	3.6	0.3	lobster pot	
			1811.3	SS209	881463	285121	5.9	3.6	0.3	lobster pot	
			1814.1	SS210	881828	285599	66.9	0.0	0.0	thin linear feature	
			1815.9	SS211	881745	285948	5.9	3.6	0.3	lobster pot	
			1816.8	SS212	881959	286079	9.5	2.0	0.3	linear	
	101	1	1821.6	SS213	882124	285860	6.2	6.6	0.3	three linear objects side by side	
			1823.5	SS214	881843	285546	8.9	3.0	1.6	elongate	
	102	1	1829.9	SS215	881484	284719	24.6	36.4	0.0	area of scattered debris	
			1830.0	SS216	881576	284638	5.9	3.6	0.3	lobster pot	
			1830.4	SS217	881539	284548	5.6	2.6	1.0	angular	
			1832.1	SS218	881428	284243	27.9	0.0	0.0	thin linear object	
			1833.1	SS219	881394	284034	5.9	3.6	0.3	lobster pot	
			1841.9	SS220	880894	282373	19.0	2.0	0.7	linear	
			1844.1	SS221	880747	281924	5.9	3.6	0.3	lobster pot with thin linear object - cable?	
			1847.2	SS222	880634	281314	5.9	3.6	0.3	lobster pot	
			1847.3	SS223	880721	281298	5.9	3.6	0.3	lobster pot	
			1847.5	SS224	880888	281267	5.9	3.6	0.3	lobster pot	
			1848.7	SS225	880672	281062	5.9	3.6	0.3	two lobster pots	
			1848.9	SS226	880730	280999	5.9	3.6	0.3	lobster pot	
			1850.3	SS227	880587	280731	5.9	3.6	0.3	lobster pot	
			1850.4	SS228	880684	280694	5.9	3.6	0.3	lobster pot	
			1851.0	SS229	880680	280552	4.9	3.9	1.0	angular	
			1851.7	SS230	880652	280438	6.2	3.6	0.0	angular	
18-Dec	102	1	1852.0	SS231	880508	280383	5.9	3.6	0.3	lobster pot	
			1852.3	SS232	880540	280306	5.9	3.6	0.3	lobster pot	
			1852.3	SS233	880684	280304	6.9	5.6	0.0	rectangular	
			1853.8	SS234	880441	280041	5.9	3.6	0.3	lobster pot	
			1854.8	SS235	880518	279824	5.9	3.6	0.3	lobster pot	

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DATE	Run	Line	Event	Target ID#	Easting	Northing	Length	Width	Height or Relief	Comment	Associated Magnetic Anomaly
			1854.8	SS236	880470	279819	5.9	3.6	0.3	lobster pot	M125
			1856.9	SS237	880510	279408	5.9	3.6	0.3	two lobster pots connected	
			1857.1	SS238	880359	279370	6.6	0.0	0.0	linear object	
			1857.8	SS239	880266	279253	5.9	3.6	0.3	lobster pot with thin linear object - cable?	
			1858.2	SS240	880410	279148	5.9	3.6	0.3	lobster pot	
			1861.0	SS241	880368	278586	14.8	0.0	0.0	linear object	
			1861.4	SS242	880357	278499	5.2	0.0	0.0	linear object	
			1864.2	SS243	880070	277968	5.9	3.6	0.3	lobster pot	
			1864.8	SS244	880088	277866	3.3	2.0	1.0	angular object	
			1864.9	SS245	880170	277838	5.9	3.6	0.3	lobster pot	
	103	7	1869.9	SS246	879690	277840	4.6	1.0	0.3	angular	
			1871.7	SS247	879758	278169	5.9	3.6	0.3	lobster pot	
			1872.2	SS248	880044	278293	17.7	2.3	0.3	linear object	
			1873.6	SS249	879986	278552	5.6	4.9	0.0	angular	
			1875.4	SS250	879984	278924	3.9	2.6	0.0	angular	
			1875.5	SS251	880093	278959	5.9	3.0	0.7	angular	
			1876.3	SS252	879969	279139	5.9	3.6	0.3	lobster pot	
			1877.5	SS253	879984	279336	8.5	0.0	0.0	linear object	
			1879.0	SS254	880292	279603	21.0	0.0	0.0	thin linear object	
			1880.5	SS255	880096	279955	5.9	3.6	0.3	lobster pot	
			1881.5	SS256	880200	280126	5.9	3.6	0.3	lobster pot	
			1881.8	SS257	880333	280178	5.9	3.6	0.3	lobster pot	
			1882.6	SS258	880399	280330	5.9	3.6	0.3	two lobster pots	
			1882.7	SS259	880298	280343	5.9	3.6	0.3	several lobster pots	
			1883.1	SS260	880305	280441	5.9	3.6	0.3	lobster pot with thin linear object - cable?	
			1884.0	SS261	880252	280643	5.9	3.6	0.3	lobster pot	
			1884.2	SS262	880422	280654	29.5	20.0	0.0	angular	
			1885.2	SS263	880233	280860	5.9	3.6	0.3	lobster pot	
			1886.2	SS264	880348	281065	5.2	5.9	0.0	angular	
18-Dec	103	7	1888.0	SS265	880439	281412	5.9	3.6	0.3	lobster pot	
			1889.1	SS266	880403	281646	16.7	2.3	0.0	linear	
			1893.0	SS267	880484	282412	11.5	4.3	0.0	linear	
			1901.1	SS268	880873	284016	5.9	3.6	0.3	lobster pot	

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DATE	Run	Line	Event	Target ID#	Easting	Northing	Length	Width	Height or Relief	Comment	Associated Magnetic Anomaly
			1902.1	SS269	880969	284201	5.9	3.6	0.3	two lobster pots	
			1902.4	SS270	881114	284231	5.9	3.6	0.3	lobster pot	
			1902.5	SS271	880989	284272	5.9	3.6	0.3	lobster pot	
			1902.5	SS272	880931	284291	8.5	0.0	0.0	linear object	
			1903.1	SS273	881184	284398	5.9	3.6	0.3	lobster pot	
			1903.8	SS274	881059	284502	19.0	0.0	0.0	linear feature	
			1904.4	SS275	881160	284585	5.9	3.6	0.3	lobster pot	
			1905.0	SS276	881261	284720	5.9	3.6	0.3	lobster pot with thin linear object - cable?	
			1905.6	SS277	881405	284776	53.8	9.2	0.0	three "legged" structure	
			1906.9	SS278	881402	285036	5.9	5.2	0.0	angular	
			1908.0	SS279	881473	285243	5.9	3.6	0.3	lobster pot	
			1908.5	SS280	881510	285335	5.9	3.6	0.3	lobster pot	
			1910.2	SS281	881506	285707	20.0	4.3	0.0	linear feature	
	104	28	1918.1	SS282	880431	285396	5.9	3.6	0.3	lobster pot	
			1921.0	SS283	880322	284812	5.9	3.6	0.3	lobster pot	
			1922.4	SS284	880042	284645	5.9	3.6	0.3	lobster pot	
			1922.7	SS285	880107	284545	5.9	3.6	0.3	lobster pot	
			1923.0	SS286	880187	284470	5.9	3.6	0.3	two lobster pots	
			1923.8	SS287	880039	284359	5.9	3.6	0.3	lobster pot	
			1924.9	SS288	879886	284184	5.9	3.6	0.3	lobster pot	
			1927.0	SS289	879751	283752	5.9	2.0	0.0	linear	
			1927.8	SS290	879898	283599	5.9	3.6	0.3	scattered lobster pots	M65
			1927.9	SS291	879703	283597	5.9	3.6	0.3	lobster pot	
			1928.1	SS292	879794	283524	5.2	1.0	0.7	linear	
			1928.7	SS293	879727	283437	5.9	3.6	0.3	lobster pot	
			1928.7	SS294	879674	283442	5.9	3.6	0.3	lobster pot	
			1929.8	SS295	879760	283202	5.9	3.6	0.3	lobster pot	
			1930.8	SS296	879628	283018	5.9	3.6	0.3	lobster pot	
			1930.9	SS297	879574	282989	5.9	3.6	0.3	two lobster pots	
			1931.0	SS298	879650	282924	5.9	3.6	0.3	three lobster pots	M129
			1931.0	SS299	879727	282930	5.9	3.6	0.3	lobster pot	
			1931.4	SS300	879799	282855	5.9	3.6	0.3	two lobster pots	
18-Dec	104	28	1931.5	SS301	879742	282839	5.9	3.6	0.3	lobster pot	
			1931.7	SS302	879599	282826	5.9	3.6	0.3	lobster pot	

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			1932.8	SS303	879718	282592	5.9	3.6	0.3	lobster pot	
			1932.9	SS304	879493	282602	5.9	3.6	0.3	lobster pot	
			1933.6	SS305	879501	282479	5.9	3.6	0.3	lobster pot	
			1933.7	SS306	879611	282426	5.9	3.6	0.3	lobster pot	
			1935.7	SS307	879549	282026	6.9	1.3	0.7	linear	
			1935.9	SS308	879376	282013	5.9	3.6	0.3	lobster pot	
			1936.0	SS309	879356	281973	5.9	3.6	0.3	lobster pot	
			1936.1	SS310	879596	281922	5.9	3.6	0.3	lobster pot	M63
			1936.5	SS311	879428	281898	5.9	3.6	0.3	lobster pot	
			1936.7	SS312	879388	281837	5.9	3.6	0.3	lobster pot	
			1939.4	SS313	879337	281325	10.5	1.6	0.0	linear	
			1939.5	SS314	879435	281261	5.9	3.6	0.3	lobster pot	
			1941.8	SS315	879453	280823	35.4	12.1	0.0	linear - slightly curved	
			1942.2	SS316	879236	280751	5.9	3.6	0.3	lobster pot	
			1942.8	SS317	879223	280664	5.9	3.6	0.3	lobster pot	
			1943.6	SS318	879295	280469	5.9	3.6	0.3	lobster pot	M69
			1945.2	SS319	879220	280137	5.9	3.6	0.3	lobster pot	M67
			1945.9	SS320	879125	280036	5.9	3.6	0.3	lobster pot	
			1946.3	SS321	879219	279927	5.9	3.6	0.3	lobster pot	
			1947.0	SS322	879013	279828	5.9	3.6	0.3	lobster pot	
			1947.0	SS323	879071	279823	7.9	4.6	0.0	rounded	
			1947.7	SS324	879200	279666	5.9	3.6	0.3	lobster pot	
			1949.7	SS325	878986	279320	5.9	3.6	0.3	lobster pot	
			1949.8	SS326	878944	279305	4.9	0.0	0.0	linear	
			1949.9	SS327	878979	279248	5.9	3.6	0.3	lobster pot	
			1950.4	SS328	879094	279105	5.9	3.6	0.3	lobster pot	
			1952.9	SS329	878817	278678	4.3	2.6	1.0	linear	
			1955.4	SS330	878920	278136	5.9	3.6	0.3	lobster pot	
	105	25	1960.5	SS331	878827	277788	5.9	3.6	0.3	lobster pot	
			1961.0	SS332	878964	277861	5.9	3.6	0.3	lobster pot	
			1962.9	SS333	879064	278223	5.9	3.6	0.3	lobster pot	
			1964.0	SS334	879077	278438	11.8	0.0	0.0	linear	
			1965.6	SS335	879196	278751	3.6	2.6	1.0	circular	
			1967.0	SS336	879245	279037	5.9	3.6	0.3	lobster pot	M52
			1970.6	SS337	879270	279754	5.9	3.6	0.3	lobster pot	

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DATE	Run	Line	Event	Target ID#	Easting	Northing	Length	Width	Height or Relief	Comment	Associated Magnetic Anomaly
18-Dec	105	25	1972.2	SS338	879173	280082	5.9	3.6	0.3	lobster pot	
			1972.5	SS339	879300	280122	10.2	1.6	0.7	linear	
			1972.5	SS340	879357	280104	5.9	3.6	0.3	lobster pot	
			1976.0	SS341	879458	280808	20.0	4.6	0.0	curvi-linear object	M131
			1976.1	SS342	879498	280813	5.9	3.6	0.3	lobster pot	M61
			1976.6	SS343	879433	280948	3.0	3.9	1.6	circular	
			1978.9	SS344	879638	281363	5.9	3.6	0.3	lobster pot	
			1981.5	SS345	879678	281875	5.9	3.6	0.3	lobster pot	
			1982.7	SS346	879611	282104	8.2	2.0	0.7	linear	
			1982.8	SS347	879707	282126	5.9	3.6	0.3	lobster pot	
			1983.1	SS348	879552	282220	5.9	3.6	0.3	several lobster pots	
			1983.5	SS349	879735	282283	7.5	0.7	0.7	linear	
			1984.5	SS350	879682	282475	2.0	1.6	0.7	angular	
			1988.2	SS351	879956	283246	5.9	3.6	0.3	lobster pot	M93
			1988.5	SS352	879953	283298	5.9	3.6	0.3	lobster pot	
			1988.6	SS353	879817	283283	6.2	3.3	0.0	elongate	
			1988.7	SS354	879954	283330	5.9	3.6	0.3	lobster pot	
			1989.2	SS355	879828	283413	5.9	3.6	0.3	lobster pot	
			1990.9	SS356	880003	283737	5.9	3.6	0.3	several lobster pots	
			1991.2	SS357	880040	283818	5.9	3.6	0.3	two lobster pots	
			1992.2	SS358	880069	284025	5.9	3.6	0.3	several lobster pots	
			1992.8	SS359	880183	284088	5.9	3.6	0.3	several lobster pots	
			1993.1	SS360	880119	284193	5.9	3.6	0.3	lobster pot	
			1994.6	SS361	880066	284483	5.9	3.6	0.3	five lobster pots	
			1994.6	SS362	880305	284421	5.9	3.6	0.3	lobster pot	
			1995.0	SS363	880222	284512	5.9	3.6	0.3	lobster pot	
			1997.0	SS364	880322	284906	5.9	3.6	0.3	lobster pot	
19-Dec	115	25	2079.3	SS365	880204	284614	5.9	3.6	0.3	lobster pot	
			2080.1	SS366	880277	284763	5.9	3.6	0.3	lobster pot	
			2080.1	SS367	880213	284780	5.9	3.6	0.3	lobster pot	
			2080.8	SS368	880293	284866	5.9	3.6	0.3	lobster pot	
			2081.4	SS369	880326	284985	5.9	3.6	0.3	lobster pot	
			2081.8	SS370	880336	285077	5.9	2.3	1.0	two lobster pots	
			2083.4	SS371	880438	285354	5.9	2.0	0.0	three lobster pots	
			2085.4	SS372	880719	285698	50.9	43.3	0.0	area of scattered debris	

Searsport Harbor Channel Deepening / Navigation Improvement Study
Side Scan Sonar Targets

DATE	***Run***	***Line***	***Event***	***Target ID#***	***Easting***	***Northing***	***Length***	***Width***	***Height or Relief***	***Comment***	***Associated Magnetic Anomaly***
19-Dec	117	23	2094.0	SS373	879680	280980	12.1	15.1	0.0	angular shape two legged structure	
			2097.6	SS374	879796	281784	5.9	3.6	0.3	lobster pot	M51
	118	24	2101.5	SS375	879582	281549	145.0	37.7	0.0	Shipwreck	M132
			2102.5	SS376	879731	281371	8.2	1.3	0.0	linear piece of debris	

NOTES:

1. Coordinates are referenced to the Maine State Plane system, East Zone 1801, NAD83, in feet.
2. Target sizes and dimensions are based on acoustic measurements only and have not been verified directly.
3. The side scan sonar method only identifies features located on (not below) the bottom.
4. Only targets evident on more than one side scan sonar image / trackline were mapped; targets located outside the survey areas were not mapped.

APPENDIX B

Magnetic Anomaly Listing

Searsport Harbor Channel Deepening / Navigation Improvement Study
Magnetic Anomalies

Date	Run	Line	Event	Anomaly ID#	Easting	Northing	Size	Type	Duration	Sensor Altitude	Dipolar ferrous mass	Monopolar ferrous mass	Associated Side Scan Target
14-Dec	2	2	40.7	M1	881488	284669	7.9	CD	60	21.1	77.1	3.7	
	3	3	55.6	M2	881741	285497	16.1	M+	20	23	203.4	8.8	
			59.9	M3	881433	284666	31.3	M-	40	21.3	314.1	14.7	
			63.4	M4	881237	284114	69.2	M-	120	21.8	744.5	34.2	
	5	6	145.8	M5	881768	285998	123.4	D	100	21.9	1345.9	61.5	SS140
			159.8	M6	880851	283362	8.5	M-	50	20.4	74.9	3.7	
			161.5	M7	880791	283013	30	M+	80	20.6	272.3	13.2	
15-Dec	6	8	203.7	M8	880973	284143	6.5	M+	40	22.43	76.2	3.4	
			208.8	M9	881327	285088	7.6	M-	30	17.55	42.7	2.4	SS120
	7	9	218.6	M10	881513	285738	9.7	D	20	15.95	40.9	2.6	
			222.9	M11	881208	284930	50.4	M+	100	23.67	694.1	29.3	
			230.8	M12	880714	283431	23.4	M+	40	19.12	169.8	8.9	SS126
			233.5	M13	880621	282902	9.2	M-	40	18.64	61.9	3.3	
	8	11	289.3	M14	880533	282945	579.4	D	150	19.89	4734.3	238.0	
			299.2	M15	881073	284845	8.3	M+	20	19.33	62.3	3.2	SS121
			304.5	M16	881446	285820	18.3	M+	50	11.54	29.2	2.5	
	9	12	313.8	M17	881131	285133	5.4	M+	20	15.95	22.8	1.4	
	10	12	321.7	M18	880825	284334	21.5	M-	20	13.19	51.2	3.9	SS067
			326.5	M19	880566	283409	14.7	M+	30	10.62	18.3	1.7	
	12	14	374.4	M20	879908	280284	13.8	CD	60	17.27	73.8	4.3	SS089
			382.4	M21	880188	281862	10.6	D	40	15.17	38.4	2.5	SS082
			385.3	M22	880287	282436	10.7	M+	20	13.28	26.0	2.0	SS079
	14	14	402.2	M23	880927	284883	16.7	CD	60	21.63	175.5	8.1	SS063
	15	15	410.5	M24	881312	286051	8.9	M+	40	7.76	4.3	0.6	
			412.2	M25	881200	285749	90.1	CD	100	9.66	84.3	8.7	
			412.7	M26	881162	285643	28.7	M+	20	15.7	115.3	7.3	
	16	17	473.5	M27	879927	281247	5.9	M+	30	19.04	42.3	2.2	SS103
			492.8	M28	880816	285003	10.1	M+	20	17.63	57.5	3.3	SS056
			498.5	M29	881209	286056	21.5	M+	20	9.41	18.6	2.0	
	17	18	500.3	M30	881156	286053	21.8	CD	40	5.7	4.2	0.7	
			500.7	M31	881109	285951	31.3	D	40	5.7	6.0	1.1	
			501.4	M32	881066	285836	10.4	M+	20	10.5	12.5	1.2	SS110
			501.7	M33	881042	285758	5.5	M-	20	10.95	7.5	0.7	
			523.8	M34	879923	281535	28.1	CD	80	15.78	114.7	7.3	SS041

Searsport Harbor Channel Deepening / Navigation Improvement Study
Magnetic Anomalies

Date	Run	Line	Event	Anomaly ID#	Easting	Northing	Size	Type	Duration	Sensor Altitude	Dipolar ferrous mass	Monopolar ferrous mass	Associated Side Scan Target
	18	20	556.9	M35	879554	280007	12.2	M+	20	19.73	97.3	4.9	
			571.9	M36	880087	282970	4.9	M+	20	15.22	17.9	1.2	SS049
			574.6	M37	880177	283523	6.4	D	20	17.07	33.1	1.9	SS013
			576.6	M38	880236	283894	18.3	CD	120	16.38	83.5	5.1	
	19	21	604.2	M39	880071	283199	19.6	M+	40	16.87	97.7	5.8	
			610.1	M40	879863	282030	36	M+	40	19.33	270.0	14.0	SS044
	21	33	626.4	M41	880080	285349	15.6	M+	40	14.22	46.6	3.3	
			629.5	M42	879873	284778	35.4	M+	30	10.7	45.0	4.2	
	22	38	633.3	M43	879664	284941	21	D	40	13.61	55.0	4.0	
			633.7	M44	879695	285016	33.9	M+	50	15.37	127.8	8.3	SS171
			634.7	M45	879768	285209	6.6	M+	20	12.76	14.2	1.1	
			634.8	M46	879777	285238	8.9	M+	20	12.4	17.6	1.4	
			635.4	M47	879824	285349	9	D	30	11.43	14.0	1.2	
			637.3	M48	879940	285684	8.9	M-	50	18.52	58.7	3.2	
	22	36	640.2	M49	880152	285991	142.6	D	40	16.59	676.1	40.8	
			645.2	M50	879819	285044	12.2	M+	20	11.34	18.5	1.6	SS170
	24	21	650.1	M51	879817	281793	10.1	M-	40	19.04	72.4	3.8	SS374
	25	23	679.8	M52	879236	279024	5.6	M+	40	24.93	90.1	3.6	SS336
			682.8	M53	879338	279617	6.6	M+	40	21.13	64.7	3.1	
			692.3	M54	879666	281506	27.3	D	100	20.49	243.9	11.9	
16-Dec	28	42	722.3	M55	879628	285402	13.2	M+	20	11.26	19.6	1.7	
			725.0	M56	879822	285929	9.1	M-	20	8.44	5.7	0.7	
	29	39	730.6	M57	879771	285363	10.3	M+	20	13.77	27.9	2.0	
			731.7	M58	879697	285149	17.5	M+	40	15.29	65.0	4.2	
			732.3	M59	879667	285071	70.7	M+	50	15.26	260.9	17.1	
	33	24	771.4	M60	879622	281536	89.7	D	120	22.72	1092.4	48.1	
			775.1	M61	879488	280805	56.1	M-	100	26.59	1095.2	41.2	SS342
	34	26	811.9	M62	879535	281584	32.8	D	40	19.2	241.1	12.6	
			813.5	M63	879591	281909	52.7	D	80	16.82	260.4	15.5	SS310
			814.0	M64	879602	281993	9.9	D	40	16.02	42.3	2.6	
			822.2	M65	879880	283597	7.2	CD	60	16.35	32.7	2.0	SS290
			828.5	M66	880257	284808	118.2	D	60	21.99	1305.2	59.4	
	36	27	892.9	M67	879218	280128	7	M+	20	16.79	34.4	2.0	SS319
			894.0	M68	879261	280347	5.6	M-	20	15.34	21.0	1.4	
			894.5	M69	879292	280464	22.6	M+	40	15.29	83.9	5.5	SS318

Searsport Harbor Channel Deepening / Navigation Improvement Study
Magnetic Anomalies

Date	Run	Line	Event	Anomaly ID#	Easting	Northing	Size	Type	Duration	Sensor Altitude	Dipolar ferrous mass	Monopolar ferrous mass	Associated Side Scan Target
			899.8	M70	879464	281486	6.5	M+	20	19.25	48.1	2.5	
			900.3	M71	879483	281601	6.4	D	20	17.63	36.4	2.1	
			901.6	M72	879529	281852	12.6	M+	20	16.59	59.7	3.6	
			904.8	M73	879637	282480	37.1	D	60	20.09	312.4	15.5	
			906.5	M74	879696	282826	7.8	M+	40	19.08	56.3	2.9	
	40	69	963.2	M75	880696	286729	24	D	40	8.94	17.8	2.0	
	41	66	966.1	M76	880849	286691	53	M+	40	13.8	144.6	10.5	
			966.5	M77	880883	286618	42.2	M+	60	16.79	207.4	12.4	
	43	65	980.0	M78	880871	286814	9.7	M+	20	16.23	43.1	2.7	SS149
	45	59	997.4	M79	881186	286823	49.6	M+	40	20.62	451.6	21.9	
	46	63	1009.6	M80	880940	286897	17.2	CD	100	15.37	64.9	4.2	
			1010.1	M81	880913	286985	31.3	D	20	14.81	105.6	7.1	
			1010.7	M82	880870	287105	50.8	CD	40	12.68	107.5	8.5	SS150
	48	56	1025.1	M83	881466	286479	90.7	M+	100	25.57	1574.6	61.6	
	55	46	1089.8	M84	881951	286616	126.9	M-	60	20.37	1113.8	54.7	
	57	55	1107.5	M85	881507	286518	263.9	D	120	24.37	3966.2	162.8	SS156
	58	64	1117.0	M86	880935	286789	30.1	M+	20	15.59	118.4	7.6	
			1117.3	M87	880916	286834	97.4	M-	40	15.37	367.2	23.9	
			1118.7	M88	880834	287074	11.6	M+	20	10.7	14.8	1.4	
	59	61	1120.6	M89	880971	287129	39.7	CD	60	13.33	97.6	7.3	
			1121.4	M90	881023	286968	40.3	M+	40	15.06	142.9	9.5	
	64	23	1150.9	M91	879907	282845	14.1	M+	20	17.96	84.8	4.7	
			1151.4	M92	879925	282946	4.8	D	20	17.38	26.2	1.5	
			1152.8	M93	879962	283220	6.3	M+	20	16.54	29.6	1.8	SS351
17-Dec	69	22	1343.7	M94	880094	283680	18.4	M-	20	15.01	64.6	4.3	
			1345.9	M95	880031	283249	34.9	D	20	13.85	96.3	7.0	
			1350.0	M96	879875	282438	18	M+	40	16.38	82.1	5.0	SS047
			1355.6	M97	879695	281353	25.3	D	20	16.46	117.2	7.1	
			1367.2	M98	879290	279045	21.1	D	40	20.82	197.7	9.5	
	70	19	1383.7	M99	879431	279005	10.2	M-	20	17.52	57.0	3.3	
			1385.4	M100	879500	279349	8.8	D	20	16.1	38.1	2.4	SS031
			1388.4	M101	879599	279939	22.8	M+	20	14.41	70.8	4.9	SS024
			1396.3	M102	879874	281492	13.3	M+	20	21.13	130.3	6.2	
	72	16	1472.5	M103	879489	278446	6.2	M+	20	21.86	67.3	3.1	SS028
			1473.6	M104	879525	278676	8.6	M+	40	20.85	80.9	3.9	

Searsport Harbor Channel Deepening / Navigation Improvement Study
Magnetic Anomalies

Date	Run	Line	Event	Anomaly ID#	Easting	Northing	Size	Type	Duration	Sensor Altitude	Dipolar ferrous mass	Monopolar ferrous mass	Associated Side Scan Target
			1487.9	M105	880017	281484	8.2	M+	40	18.75	56.1	3.0	
			1495.8	M106	880294	283053	29.3	D	100	19.45	223.9	11.5	
			1509.9	M107	881132	285723	22.7	CD	150	23.08	289.8	12.6	
			1511.5	M108	881240	286015	7.7	M-	20	14.05	22.2	1.6	SS111
			1512.5	M109	881297	286147	28	D	40	13.44	70.6	5.3	SS116
	73	10	1521.3	M110	881173	284956	41	M-	60	18.44	267.0	14.5	
			1529.4	M111	880664	283416	8	M-	40	20.65	73.2	3.5	
			1530.0	M112	880641	283290	5.8	M-	40	20.21	49.7	2.5	SS073
			1531.9	M113	880576	282928	221.8	D	200	20.57	2004.6	97.5	
18-Dec	78	69	1631.9	M114	880683	286735	32.5	M-	20	15.95	136.9	8.6	
	79	66	1637.7	M115	880857	286692	36.1	M+	30	22.07	403.0	18.3	
			1638.3	M116	880898	286584	12.4	M-	40	26.61	242.6	9.1	
	80	70	1644.1	M117	880559	286956	11.4	D	40	10.02	11.9	1.2	
	81	65	1646.5	M118	880740	287175	20.2	CD	80	13.19	48.1	3.6	SS151
			1648.4	M119	880881	286803	24.6	D	80	23.95	350.9	14.7	SS149
	85	67	1667.8	M120	880763	286815	13.2	M+	20	16.15	57.7	3.6	
	100	4	1805.5	M121	881137	284036	608	D	150	21.91	6640.6	303.1	SS138,SS205
			1809.1	M122	881393	284675	4.8	CD	40	19.56	37.3	1.9	SS139
	102	1	1830.8	M123	881467	284481	12.8	M+	20	15.98	54.2	3.4	
			1852.7	M124	880564	280221	4.3	M+	40	20.09	36.2	1.8	
			1854.9	M125	880481	279805	4.9	M+	20	20.06	41.1	2.0	SS236
	103	7	1889.8	M126	880527	281785	7.4	M+	30	20.54	66.6	3.2	SS132
	104	28	1919.7	M127	880265	285119	11	D	40	20.06	92.2	4.6	
			1929.6	M128	879711	283240	6.2	M+	20	17.27	33.2	1.9	
			1931.1	M129	879665	282925	10.8	M+	40	18.36	69.4	3.8	SS298
			1937.0	M130	879460	281774	5	M+	20	20.45	44.4	2.2	SS112, SS057
	105	25	1975.9	M131	879444	280804	715	D	200	20.01	5948.7	297.3	SS341
			1979.8	M132	879576	281560	47.3	M+	80	18.36	304.0	16.6	SS375
			1981.6	M133	879637	281941	7	M+	50	17.43	38.5	2.2	
			1982.2	M134	879652	282026	6.7	M+	20	16.51	31.3	1.9	
			1986.2	M135	879788	282823	20.1	D	60	18.72	136.9	7.3	
			1987.5	M136	879836	283093	7.8	M-	20	18.36	50.1	2.7	
			1989.6	M137	879912	283497	5.6	M-	20	19	39.9	2.1	
			1990.0	M138	879928	283586	3.8	M+	20	18.47	24.9	1.3	
			1991.6	M139	879982	283899	5.7	D	50	31.33	182.0	5.8	

Searsport Harbor Channel Deepening / Navigation Improvement Study
Magnetic Anomalies

Date	Run	Line	Event	Anomaly ID#	Easting	Northing	Size	Type	Duration	Sensor Altitude	Dipolar ferrous mass	Monopolar ferrous mass	Associated Side Scan Target
			1996.8	M140	880333	284879	15.3	M+	20	22.39	178.3	8.0	
	106	34	2003.3	M141	879887	284967	7	D	40	17.75	40.7	2.3	
	107	31	2017.7	M142	879930	284645	9.1	M+	40	24.89	145.7	5.9	
	108	40	2022.6	M143	879681	285253	7.5	M+	20	15.01	26.3	1.8	
			2024.0	M144	879782	285528	13.9	M+	40	13.77	37.7	2.7	
			2026.1	M145	879924	285918	15.2	M+	20	16.18	66.9	4.1	
	109	37	2028.7	M146	880084	285903	18.2	M+	20	16.06	78.3	4.9	
			2029.9	M147	879992	285661	21	M+	40	17.55	117.9	6.7	
			2033.1	M148	879770	285078	65.1	M+	40	13	148.5	11.4	
	112	50	2055.4	M149	881718	286667	11.3	M+	50	23	142.8	6.2	
	114	49	2069.8	M150	881505	287410	25.1	M+	30	29.6	676.0	22.8	
			2074.4	M151	881820	286537	13.5	M+	40	22.35	156.5	7.0	
			2075.1	M152	881863	286403	5.1	M+	30	31.3	162.4	5.2	

NOTES

1. Positions are referenced to the Maine State Plane Coordinate System, East Zone 1801, NAD83, in feet.
2. Estimated ferrous masses (pounds) calculated using the following formulas:
   $W = T r^2 / 963$ for monopoles
   $W = T r^3 / 963$ for dipoles
   where W = weight of ferrous object, T = anomaly amplitude, r = distance between magnetic sensor and object
   *Magnetic moment is assumed at a median value of 963, but may vary by an order of magnitude between 175 and 1750.
3. Anomaly types: M+ = positive monopole, M- = negative monopole, D = dipole, CD = complex dipole

APPENDIX C

Seismic Reflection (Subbottom) Profiles

Lines 22, 70, 74T, 75T, 76T, 77T, 78T, and 79T

NOTES ON SEISMIC PROFILES:

1. Assumed seismic velocity of 5,000 feet per second used to correct the raw time sections to geologic profiles versus depth.

2. MLLW approximated using predicted tide values for Belfast Harbor, Maine. Tides at the time of the survey may have been higher than normal, as the water depths on the boomer profiles are generally deeper than the USACE 2005 condition survey.

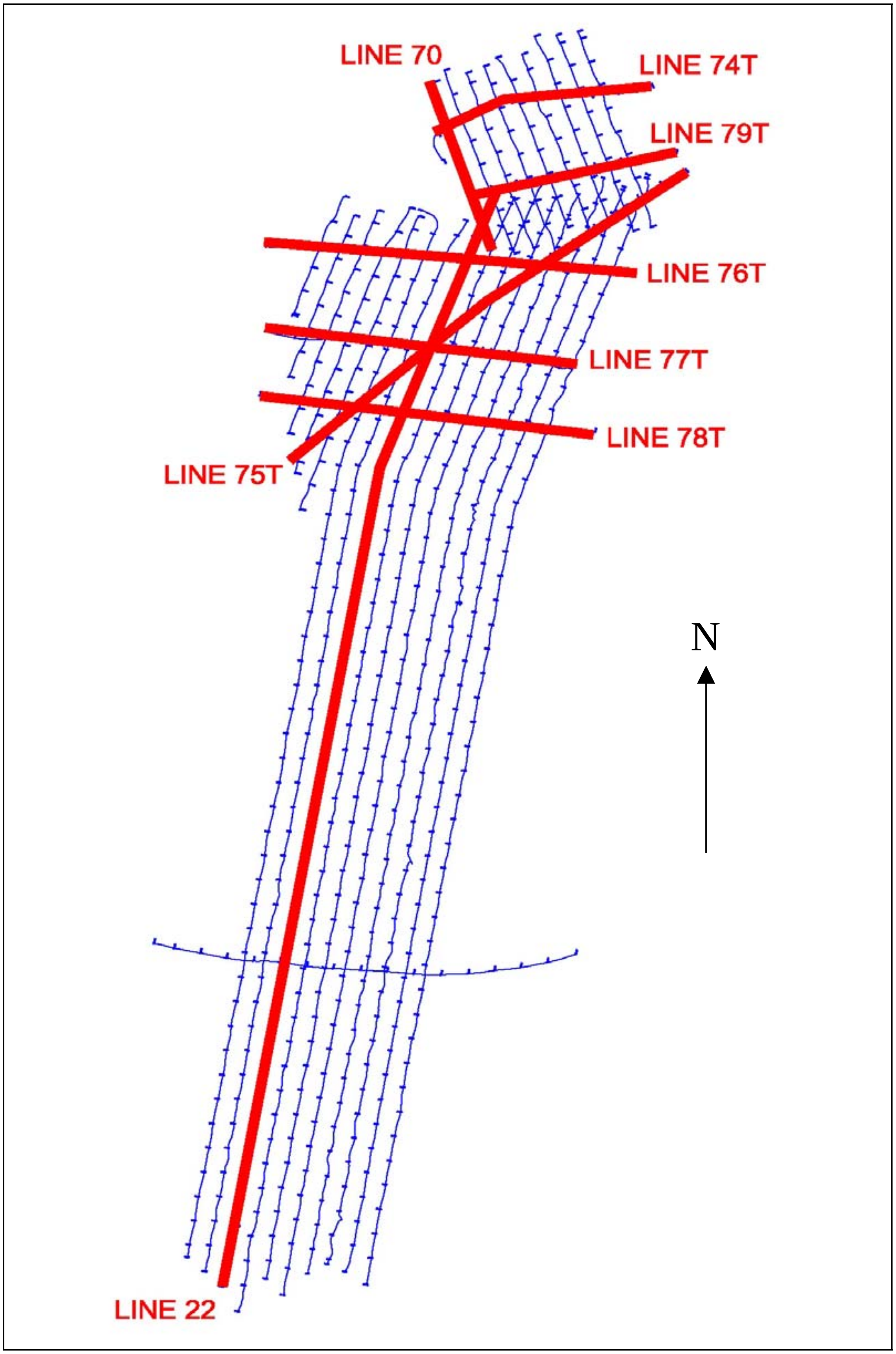
3. ReflexW Seismic Processing Software used to pick acoustic reflectors and export x,y,z values for contouring.

4. Boring locations and descriptions were provided by the USACE.

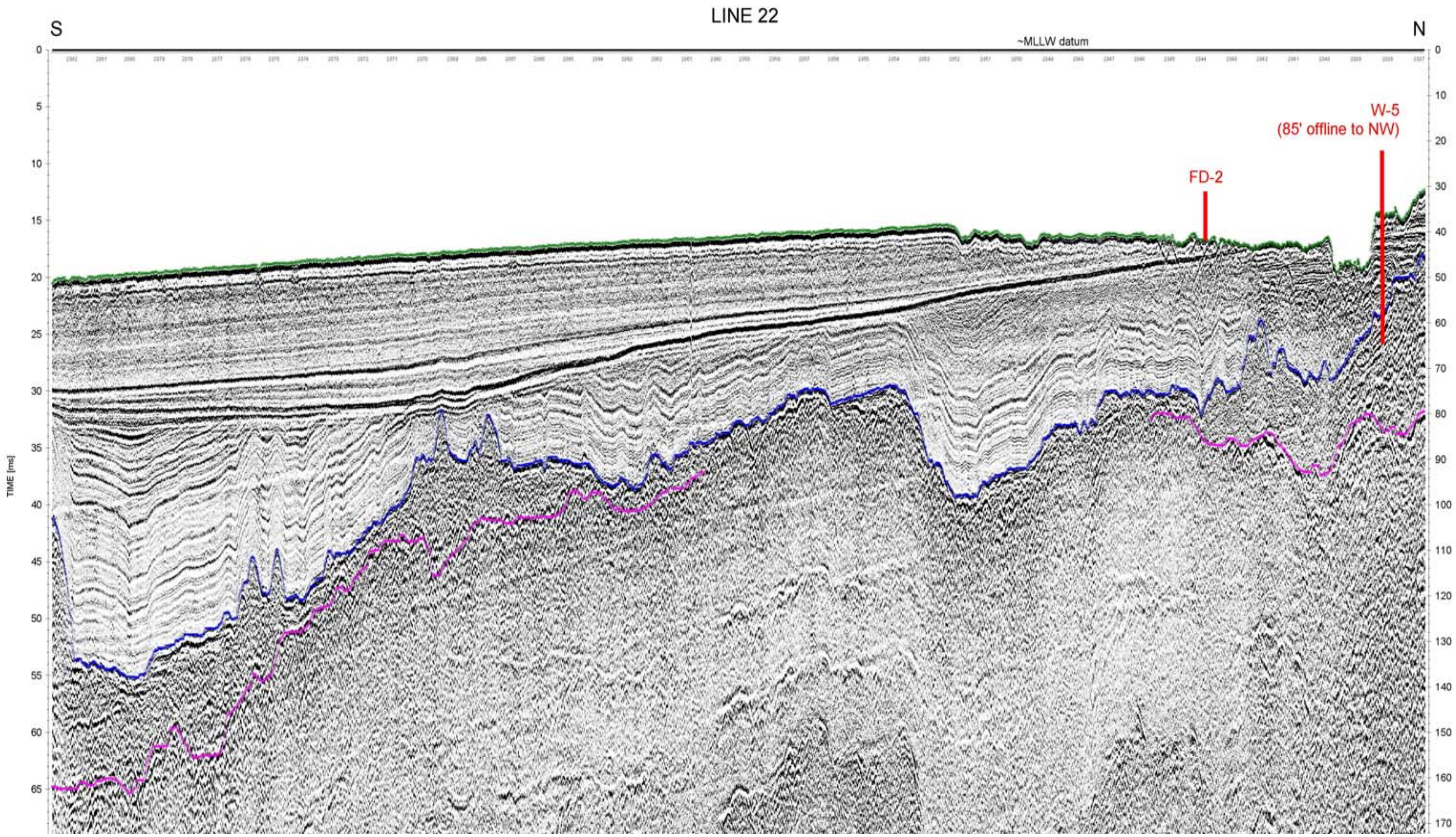
5. Event numbers across the top of each profile are spaced 200 feet apart.

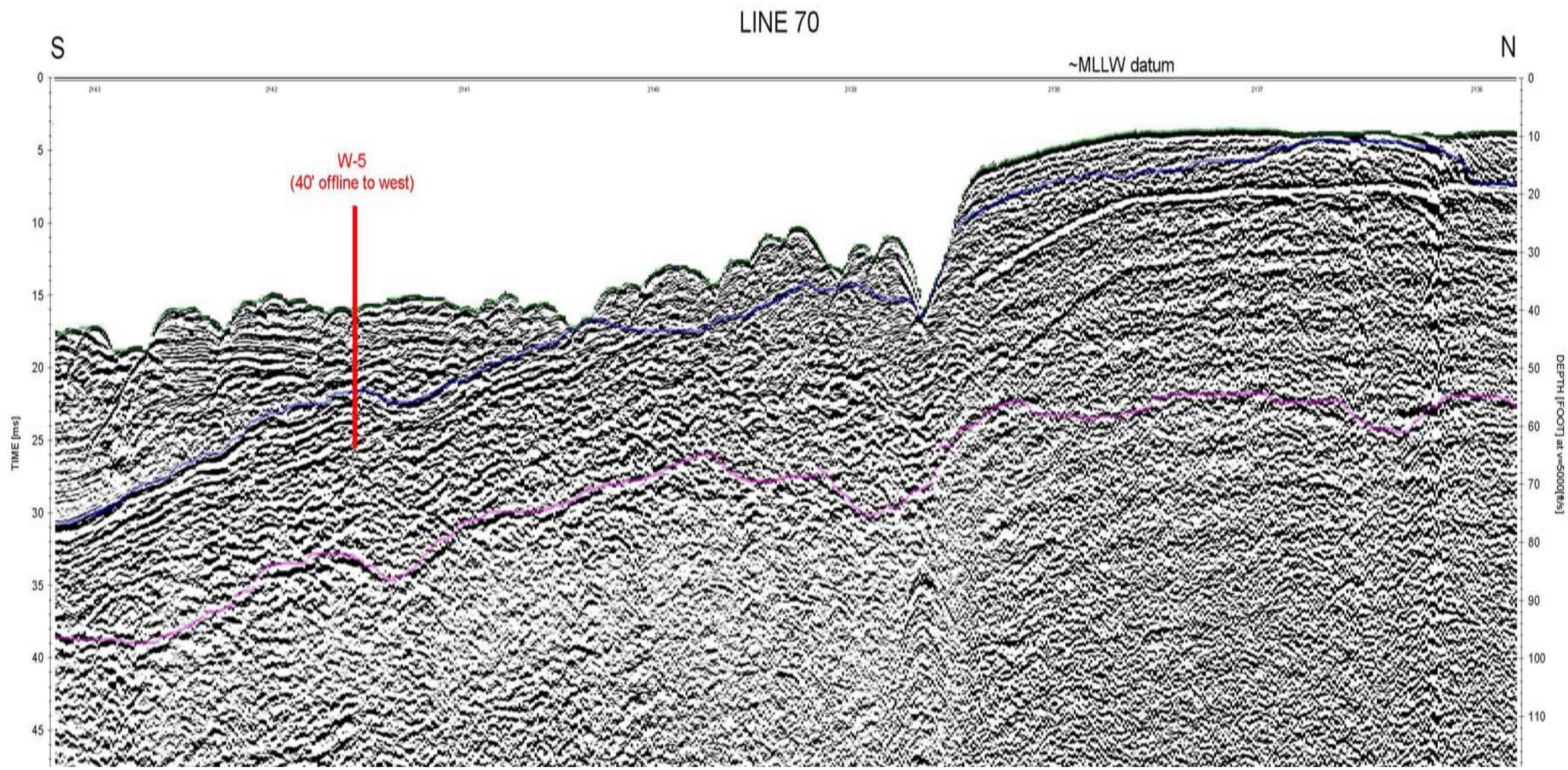
6. Reflector color codes are:
   green = sediment-water interface / harbor floor
   blue = top of coarse glacial till or bedrock / primary acoustic basement reflector
   pink = possible bedrock surface / secondary acoustic basement reflector

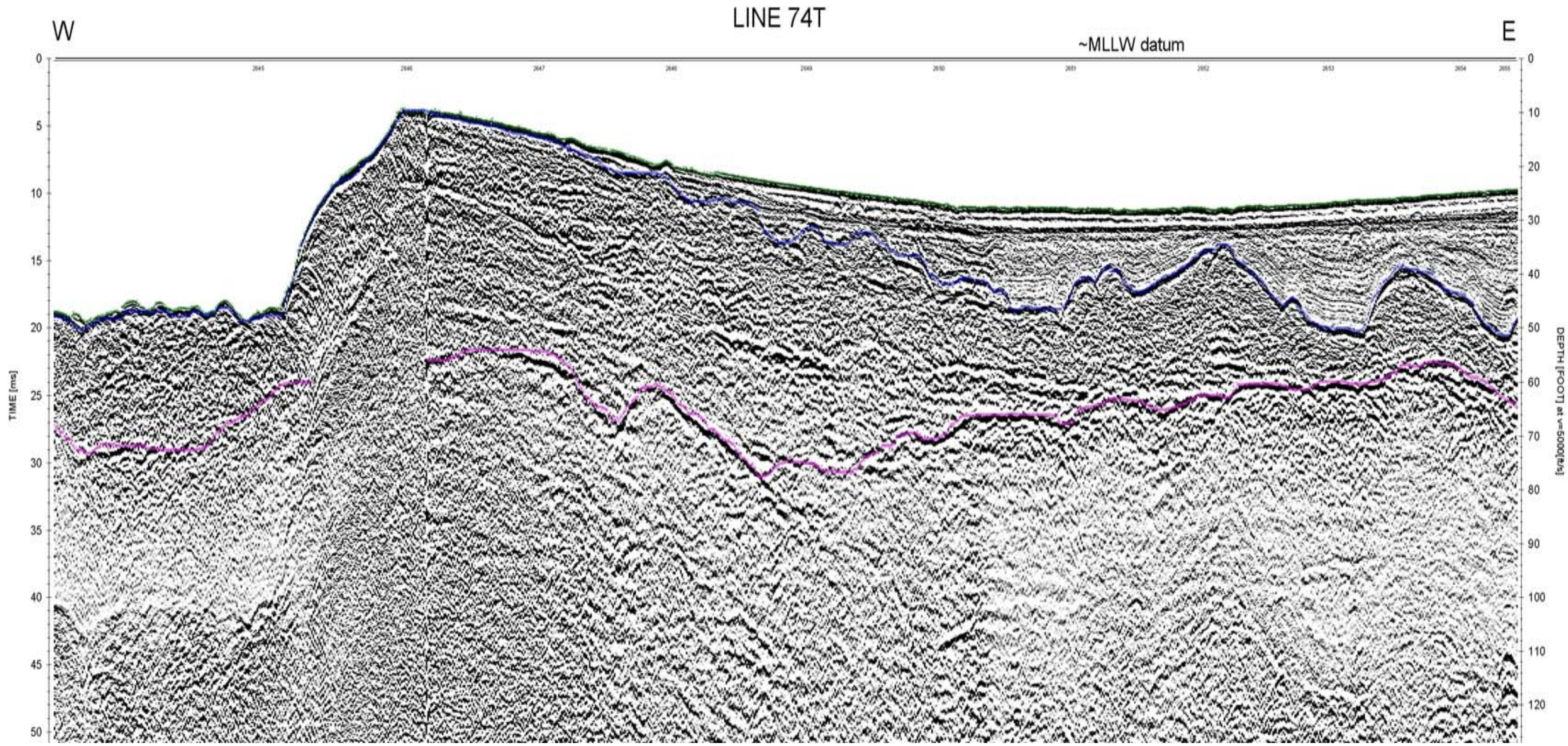
   *Note: it is possible in some areas that the primary acoustic basement reflector (blue) marks the bedrock surface.

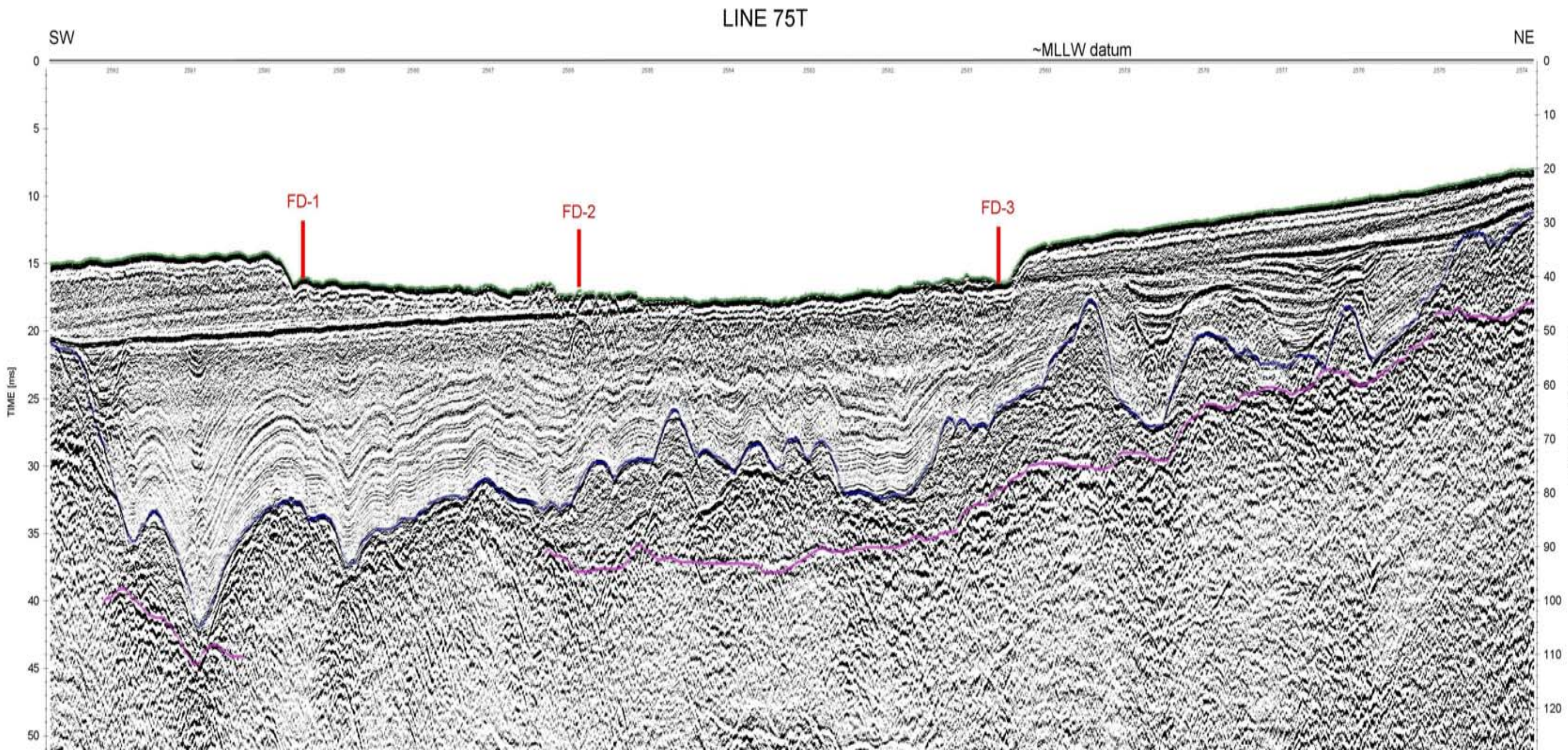


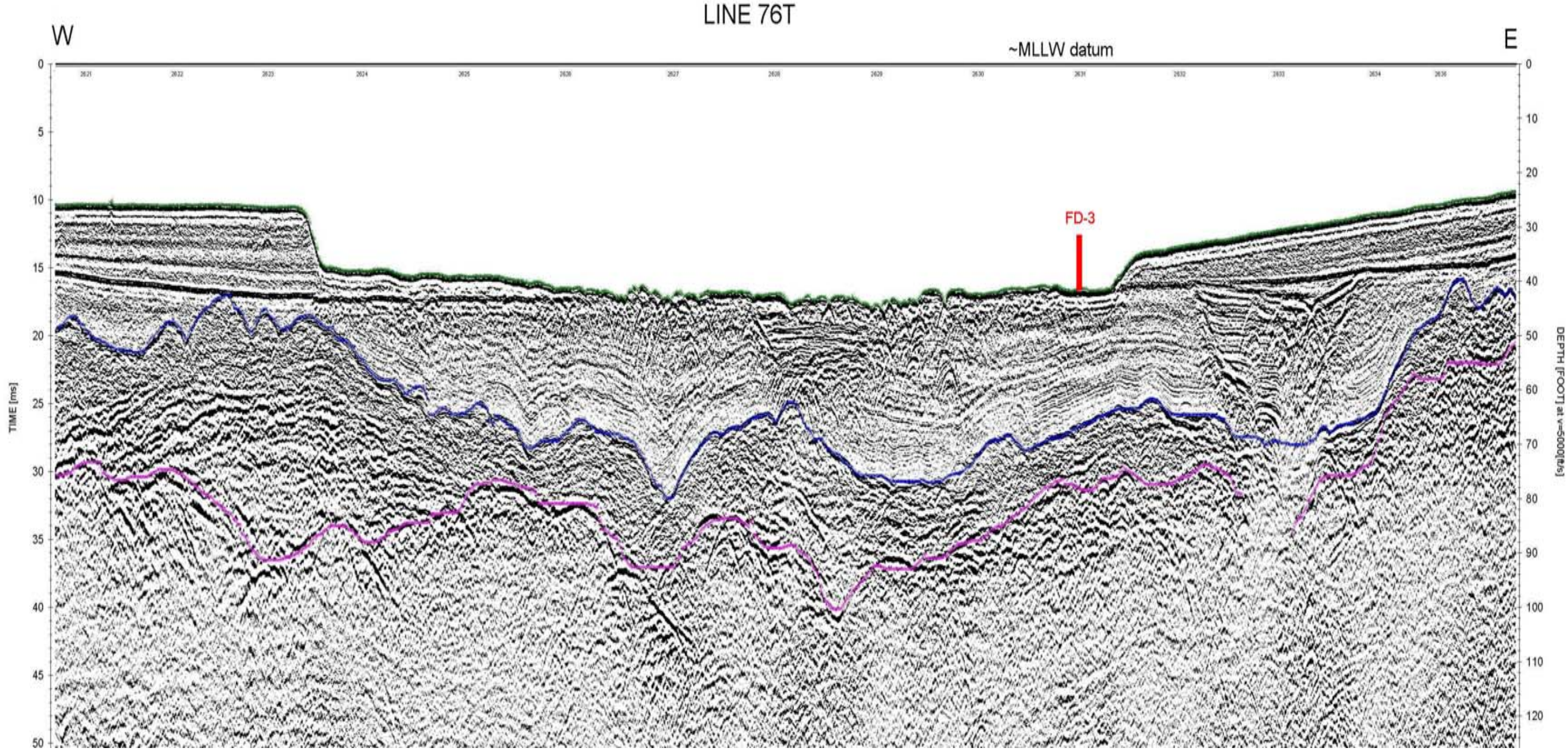
Location map for seismic reflection "boomer" profiles presented in this report.

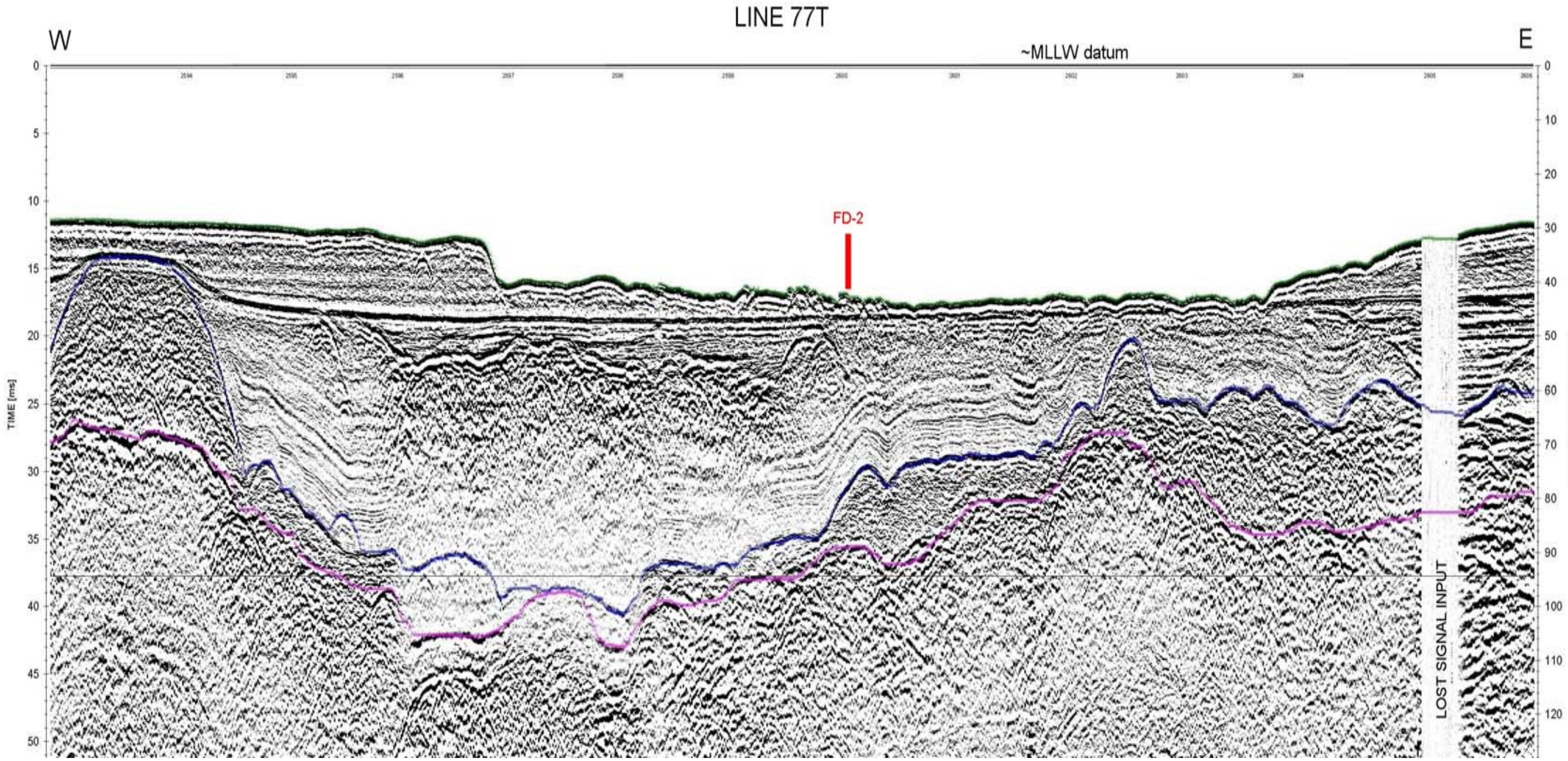

LINE 22
S
N
~MLLW datum
W-5
(85' offline to NW)
FD-2
TIME [ms]
DEPTH [FOOT at v=5000ft/s]

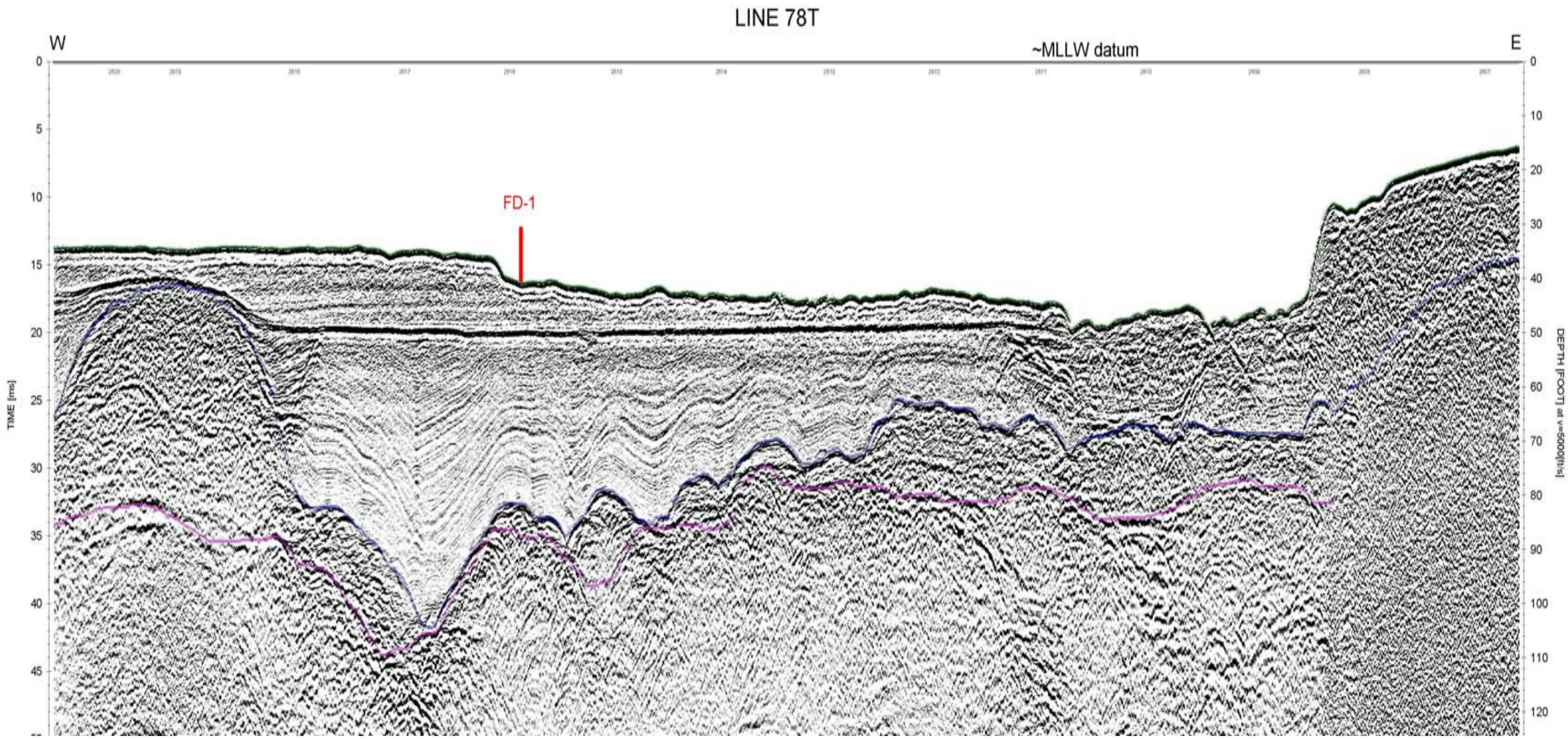

LINE 70
S
N
~MLLW datum
W-5
(40' offline to west)
TIME [ms]
DEPTH [FOOT] at v=5000[ft/s]

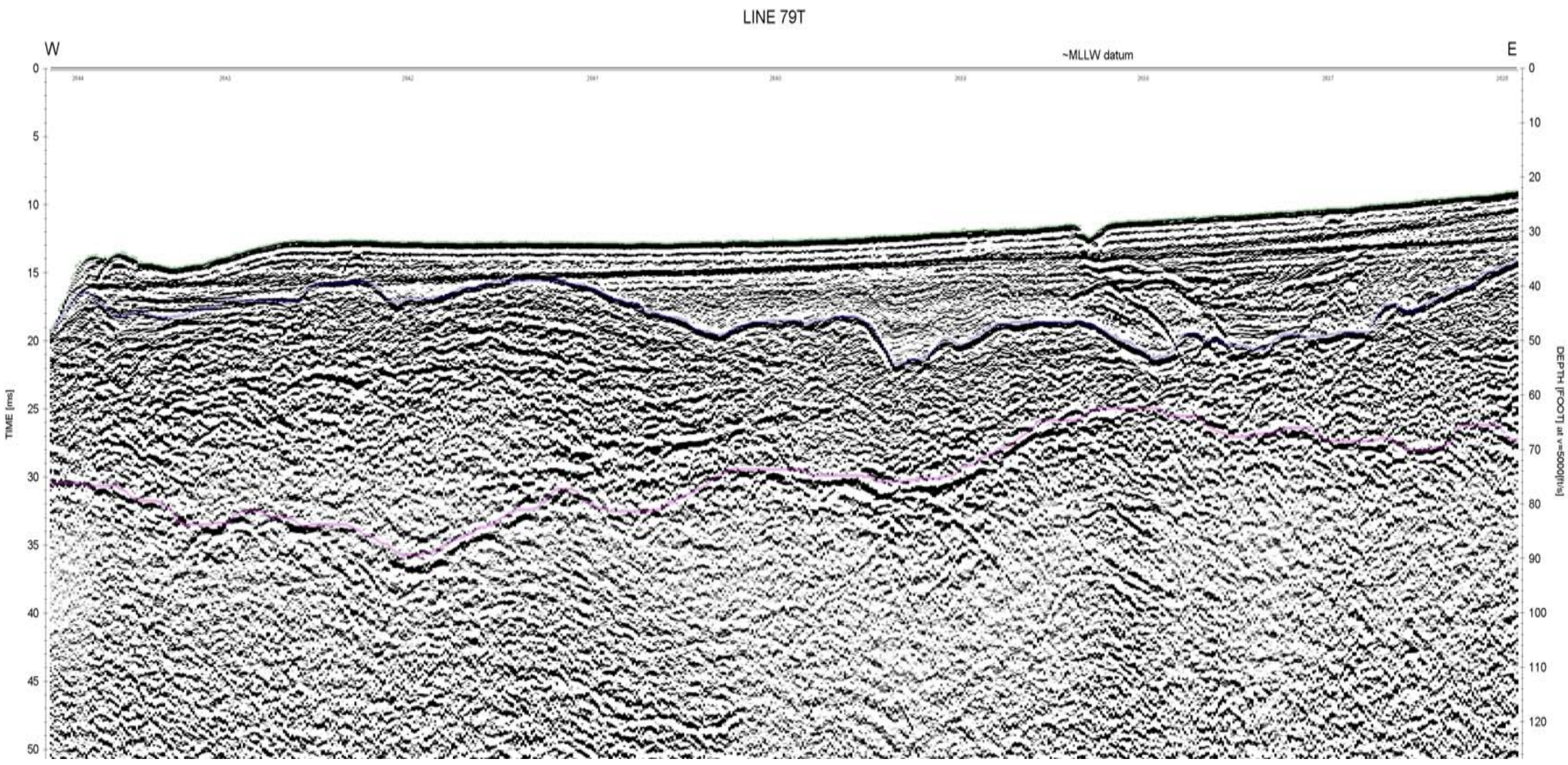

LINE 74T
W
E
~MLLW datum
TIME [ms]
DEPTH [FOOT] at v=5000[ft/s]


LINE 75T
SW
NE
~MLLW datum
FD-1
FD-2
FD-3
TIME [ms]
DEPTH [FOOT] at v=5000[ft/s]
0
5
10
15
20
25
30
35
40
45
50
0
10
20
30
40
50
60
70
80
90
100
110
120


LINE 76T
W
E
~MLLW datum
FD-3
TIME [ms]
DEPTH [FOOT] at v=5000[ft/s]


LINE 77T
W
E
~MLLW datum
FD-2
TIME [ms]
0
5
10
15
20
25
30
35
40
45
50
DEPTH [FOOT] at v=5000[ft/s]
10
20
30
40
50
60
70
80
90
100
110
120
LOST SIGNAL INPUT


LINE 78T
W
E
~MLLW datum
FD-1
TIME [ms]
DEPTH [FOOT] at v=5000[ft/s]
0
5
10
15
20
25
30
35
40
45
0
10
20
30
40
50
60
70
80
90
100
110
120


LINE 79T
W
E
~MLLW datum
TIME [ms]
0
5
10
15
20
25
30
35
40
45
50
DEPTH [FOOT] at v=5000[ft/s]
0
10
20
30
40
50
60
70
80
90
100
110
120

APPENDIX D

Equipment Operations and Procedures

Trimble 4000 and ProBeacon Differential GPS
HYPACK® Navigation Software
Klein 3000 Dual Frequency Side Scan Sonar System
Geometrics G-882 Marine Cesium Magnetometer
Applied Acoustics Engineering “Boomer” Seismic Reflection System

EQUIPMENT OPERATIONS AND PROCEDURES

Trimble 4000 and ProBeacon Differential GPS

The Trimble 4000 satellite positioning system provides reliable, high-precision positioning and navigation for a wide variety of operations and environments. The system consists of a GPS receiver, a GPS volute antenna and cable, RS232 output data cables, and a secondary reference station receiver, in this case a Trimble ProBeacon receiver. The beacon receiver consists of a small control unit, a volute antenna and cable, and RS232 interface to the Trimble GPS unit.

Fully automated, the Trimble 4000 provides means for 9 channel simultaneous satellite tracking with real time display of geodetic position, time, date, and boat track if desired. The Trimble unit is mounted on the survey vessel with the ProBeacon receiver which continuously receives differential satellite correction factors via radio link from one of the DGPS United States Coast Guard beacons. The Trimble 4000 accepts the correction factors via the ProBeacon interface and applies the differential corrections to obtain continuous, high accuracy, real time position updates. The Trimble 4000 system is interfaced to the OSI data logging computer and HYPACK® navigation software for trackline control. The output data string from the Trimble receiver can be modified to send all or part of the data parameters to the computer for logging.

The Coast Guard beacon located at Brunswick, Maine (frequency of 316 kHz, @ 100 bps) was used during this project with good reliability and signal strength.

HYPACK MAX® Navigation Software

Survey vessel trackline control and position fixing were obtained by utilizing an OSI computer-based data logging package running HYPACK® navigation software. The Pentium computer is interfaced with the Trimble 4000 DGPS system onboard the survey vessel. Vessel position data from the Trimble 4000 were updated at 1.0 second intervals and input to the HYPACK® navigation system which processes the geodetic positions into State Plane coordinates used to guide the survey vessel accurately along preselected tracklines. The incoming data are logged on disk and processed in real time allowing the vessel position to be displayed on a video monitor and compared to each preplotted trackline as the survey progresses. A nautical chart background shows the shoreline, general water depths, and locations of existing structures, buoys, and control points on the monitor in relation to the vessel position. The OSI computer logging system combined with the HYPACK® software thus provide an accurate visual representation of survey vessel location in real time, combined with highly efficient data logging capability and post-survey data processing and plotting routines.

Klein 3000 Dual Frequency Side Scan Sonar System

Side scan sonar images of the bottom were collected using a Klein 3000 dual frequency, high resolution sonar system operating at frequencies of 100 and 500 kilohertz. The system consists of a topside notebook computer, external VGA monitor, keyboard, mouse, an EPC1086NT dual channel thermal graphic recorder, a Kevlar tow cable and sonar towfish. The system contains an integrated navigational plotter which accepts standard NMEA 0183 input from a GPS system. This allows vessel position and sonar sweep to be displayed on the monitor and speed information to be used for controlling the sonar ping rate.

All sonar images are stored digitally and can be enhanced real-time or post-survey by numerous mathematical filters available in the program software. Other software functions that are available during data acquisition include; changing range scale and delay, display color, automatic or manual gain, speed over bottom, multiple enlargement zoom, target length, height, and area measurements, logging and saving of target images, and annotation frequency and content. The power of this system is its real-time processing capability for determining precise dimensions of targets and areas on the bottom.

As with many other marine geophysical instruments, the side scan sonar derives its information from reflected acoustic energy. A set of transducers mounted in a compact towfish generate the short duration acoustic pulses required for extremely high resolution. The pulses are emitted in a thin, fan-shaped pattern that spreads downward to either side of the fish in a plane perpendicular to its path. As the fish progresses along the trackline, the acoustic beam is capable of scanning the bottom from a point beneath the fish, outward as far as 200 meters on each side of the survey trackline, depending on towfish height above the seabed.

Acoustic energy reflected from any bottom discontinuities is received by the set of transducers in the towfish, amplified and transmitted to the survey vessel via the tow cable where it is further amplified, processed, and converted to a graphic record by the side scan recorder. The sequence of reflections from the series of pulses is displayed on the dual-channel graphic recorder on which paper is incrementally advanced prior to printing each acoustic pulse. The resulting output is essentially analogous to a high angle oblique "photograph" providing detailed representation of the bottom features and characteristics.

Geometrics G-882 Marine Cesium Magnetometer

Total magnetic field intensity measurements were acquired along the survey tracklines using an Geometrics G-882 cesium magnetometer which has an instrument sensitivity of 0.1 gamma. The G-882 magnetometer system includes the sensor head with a coil and optical component tube, a sensor electronics package which houses the AC signal generator and mini-counter that converts the Larmor signal into a magnetic anomaly value in gammas, and a RS-232 data cable for transmitting digital measurements to a data logging system. The cesium-based method of magnetic detection allows the sensor to be towed off the side of the survey vessel, simultaneously with other remote sensing equipment, while maintaining high quality, quiet magnetic data with ambient fluctuations of less than 1 gamma. The G-882 features an altimeter that provides digital height above the bottom in real time thus allowing the sensor height to be precisely maintained along line. The altimeter and magnetic intensity data were recorded at a 10 hertz sampling rate on the OSI data logging computer by HYPACK®.

The G-882 magnetometer acquires information on the ambient magnetic field strength by measuring the variation in cesium electron energy states. The presence of only one electron in the cesium atom’s outermost electron shell (known as alkali metals) makes cesium ideal for optical pumping and magentometry.

In operation, a beam of infrared light is passed through a cesium vapor chamber producing a Larmor frequency output in the form of a continuous sine wave. This radio frequency field is generated by an H1 coil wound around a tube containing the optical components (lamp oscillator, optical filters and lenses, split-circular polarizer, and infrared photo detector). The

Larmor frequency is directly proportional to the ambient magnetic intensity measurements, and is exactly 3.49872 times the ambient magnetic field measured in gammas or nano-Teslas. Changes in the ambient magnetic field cause different degrees of atomic excitation in the cesium vapor which in turn allows variable amounts of infrared light to pass, resulting in fluctuations in the Larmor frequency.

Although the earth's magnetic field does change with both time and distance, over short periods and distances the earth's field can be viewed as relatively constant. The presence of magnetic material and/or magnetic minerals, however, can add to or subtract from the earth's magnetic field creating a magnetic anomaly. Rapid changes in total magnetic field intensity which are not associated with normal background fluctuations mark the locations of these anomalies.

Determination of the location of an object producing a magnetic anomaly depends on whether or not the magnetometer sensor passed directly over the object and if the anomaly is an apparent monopole or dipole. A magnetic dipole can be thought of simply as a common bar magnet having a positive and negative end or pole. A monopole arises when the magnetometer senses only one end of a dipole as it passes over the object. This situation occurs mainly when the distance between opposite poles of a dipole is much greater than the distance between the magnetometer and the sensed pole, or when a dipole is oriented nearly perpendicular to the ambient field thus shielding one pole from detection. For dipolar anomalies, the location of the object is at the point of maximum gradient between the two poles. In the case of a monopole, the object associated with the anomaly is located below the maximum or minimum magnetic value.

Applied Acoustics Engineering "Boomer" Seismic Reflection System

Subbottom information from deeper below the seafloor was gathered using an Applied Acoustics Engineering seismic reflection system. The AAE "boomer" system consists of a variable 100-300 joule power supply, a catamaran boomer plate for sound source, a 10 element hydrophone array (eel) as receiver, and a graphic recorder for printing the acoustic returns. For this project, an Octopus Model 760 Marine Seismic Processor with universal amplifier and filter was used inline with the system, which includes TVG (time varied gain) with bottom tracking, automatic gain control, and a swell filter. A Kronhite Model 3200 analog filter was also used to band pass the signals for unwanted electrical and tow noise. The entire system was interfaced with an EPC Model 1086NT thermal recorder for displaying the seismic profiles.

The Octopus 760 seismic processor adds significant power and versatility to the system. Besides the typical amplification and filtering options (band pass filter, time varied gain (TVG)), it also includes a number of time varied filtering (TVF) features such as signal stacking and swell filtering which help minimze noise in the horizontal plane. The system has the ability to save data in a variety of digital formats.

Operationally, a seismic source is used to create an intense, short duration acoustic pulse or signal in the water column. This signal propagates downward to the seafloor where it is partially reflected at the sediment-water interface, while the rest of the signal continues into the subbottom. As the downward propagating signal encounters successive interfaces between layers of different material, similar partial reflections occur. The types of sediment which cause acoustic signals to behave in such a manner are defined primarily by the cross-product of the bulk density and the compressional wave velocity of each material, a quantity known as the acoustic impedance. As a first approximation, the percentage of an acoustic signal which is reflected from an interface is directly proportional to the change in acoustic impedance across that interface.

The return signal consists of a continuous sequence of reflected energy which has a series of "peaks" correlative in intensity with the magnitude of the change in acoustic impedance of the materials on either side of the interface. These return signals received by the transducer array are subsequently converted to electrical voltages which are proportional to the intensity of the return and hence dictate how strongly the return is printed by the graphic recorder. Ambient noise is filtered out and the signal is then amplified with overall gain and/or TVG and displayed trace-by-trace iteratively on the recorder to yield a continuous display somewhat analogous to a geologic cross section. The lower frequency and increased band width of the boomer waveform is designed to achieve greater penetration into the subsurface for resolution of deeper stratigraphy.

APPENDIX E

Equipment Specification Sheets

4000RSi & 4000DSi

DGPS Reference Surveyor and Differential Surveyor

Key features and benefits

- **Sub 0.5 meter accuracy**
- **Real time QA/QC**
- **Everest Multipath Rejection Technology**
- **Super-trak Signal Processing Technology**

The 4000RSi™ Reference Surveyor receiver and 4000DSi™ Differential Surveyor receiver incorporate the latest in GPS technology, offering true, real-time positioning accuracy better than 0.5 meter. Based on Trimble's advanced Maxwell processing technology, these DGPS receivers provide the highest level of accuracy even when operating in the most challenging conditions.

The 4000RSi receiver operates as an autonomous reference station, generating DGPS corrections in the RTCM SC-104 standard format for transmission to mobile GPS receivers.

The 4000DSi receiver is designed to use DGPS corrections in the RTCM SC-104 standard format broadcast by the 4000RSi receiver. The 4000DSi's standard NMEA-0183 messages, navigation firmware, data, and 1PPS outputs allow for optimal flexibility for system integration and interfacing with other instruments.

The signal processing of the two reeivers incorporates Trimble's Super-trak™ technology. This technology enhances low power satellite signal acquisition, improves signal tracking capabilities under less than ideal conditions and provides increased immunity to signal jamming from radio frequency interference (RFI). These improvements are derived from integrating complex RF circuitry onto a single chip and by using state-of-the-art Surface Acoustic Wave filter technology.

Super-trak technology increases productivity and facilitates continual operations in demanding environments, such as ports, harbors, along riverbanks and near RFI sources that would normally interfere with satellite signals.

The 4000RSi and 4000DSi receivers also incorporate Trimble's latest advance in multipath rejection through enhanced signal processing: the patented EVEREST™ Multipath Rejection Technology. This technology eliminates multipath error before the receiver calculates GPS measurements. When combined with Trimble's advanced carrier-aided filtering and smoothing techniques applied to exceptionally low noise C/A code measurements, the result is real-time positioning accuracy on the order of a few decimeters.

The two receivers are ideal for hydrographic and navigation systems, vessel tracking, dynamic positioning systems, dredging, and other dynamic positioning and navigation applications. Both receivers feature nine channels of continuous satellite tracking (12 channels optional); a lightweight, rugged, weatherproof housing; and low power consumption for extending the field operation time from batteries.

During operation, both receivers can output binary and ASCII data for archiving or post-mission analysis. In addition, the 4000RSi receiver can operate as a mobile receiver with the same features, functionality and options as the 4000DSi receiver. For optimum DGPS performance, combine the receivers with any of Trimble's data communication systems and QA/QC firmware to ensure the integrity of positioning accuracy.

4000RSi & 4000DSi

DGPS Reference Surveyor and Differential Surveyor

4000 RSI FEATURES

- RTCM Input
- RTCM Output; filtered and carrier-smoothed RTCM differential corrections (version 1.0 and 2.X) (4000RSi)
- EVEREST Multipath Rejection Technology
- Super-trak Signal Processing Technology
- Better than 0.5 meter DGPS accuracy using 4000RSi receiver corrections
- 0.5 second measurement rate
- Weighted-least squares solution
- Autonomous operation - automatic mode restoration after power-cycle
- Data integrity provision
- 2 RS-232 I/O ports with flow control for data recording and data link (4 RS-232/422 on rack mount)
- Triple DC input
- Low power; lightweight; portable; environmentally protected
- 1 PPS output; NMEA-0183 outputs
- L1 geodetic antenna; 30m antenna cable (4000RSi)
- Compact Dome antenna; 30m antenna cable (4000Dsi)
- 1-year warranty
- Firmware upgrades via serial port

OPTIONS AND ACCESSORIES

- Firmware update service - 1 and 4 year
- Extended hardware warranty
- L1 Carrier Phase
- 12 L1 channels
- L1/L2 Carrier Phase (rackmount)
- 12 L1/L2 channels (rackmount)
- Internal Memory for datalogging
- Event Marker input (requires memory option)
- QA/QC feature
- Rackmount Version
- 4 serial I/O ports (standard on rackmount)
- L1 and Ll/L2 Geodetic antennas
- 30m antenna cable extension, with in-line amplifier
- Office Support Module: OSM II (CE Marked)
- Receiver transport case
- TRIMTALK™ Series radio links
- ProBeacon™ MSK receiver
- LEMO to dual BNC sockets adapter

PHYSICAL CHARACTERISTICS

Receiver

Size	9.8" W x 11.0" D x 4.0" H (portable) (24.8cm X 28.0cm x 10.2cm) 16.8" W x 16.0" D x 5.25" H (rackmount) (42.7cm x 40.6cm x 13.3cm)
Weight	6 lbs (2.7kg) (portable), 15 lbs. (6.8kg) (rackmount) 0.5 lbs (0.2kg) compact dome antenna 5.7 lbs (2.6kg) L1 geodetic antenna
Power	Nominal 10.5-35 VDC, 7 Watts (portable) 100, 120, 220, 240 VAC, 40 Watts (rack mount) DC: 10-36 Volts, 30 Watts
Operating temperature	-20°C to +55°C (portable), 0°C to +50°C (rack mount)
Storage temperature	-30°C to +75°C (portable) -20°C to +60°C (rack mount)
Humidity	100%, fully sealed, buoyant (portable) 95%, non-condensing (rack mount)

Geodetic Antenna

Size	16" D x 3.5" H
Weight	5.7 lbs.
Operating temperature	-40°C to +65°C
Storage temperature	-55°C to +75°C
Humidity	100%, fully sealed

Interface

Keyboard	Alphanumeric, function and softkey entry
Display	Backlit LCD, four lines of forty alphanumeric characters; Large, easy-to-read– 2.8mm x 4.9mm; Viewing area: 32 cm²; adjustable backlight and viewing angle
Serial Ports	Port 1 and 3: up to 57600 bps, software flow control Port 2 and 4: up to 57600 bps, hardware/software flow control RS-232 / RS-422 user configurable (rack mount)
Data recording	RTCM and GPS data available via serial port
Remote control	Trimble Data Collector Interface
Antenna	External, LEMO socket connector (portable), N-Type Socket connector (rack mount)
RTCM Messages	Types 1, 2, 3, 6, 9, 16; Version 1.0 and 2.X
1 PPS	LEMO 7-pin, adapter to BNC available (portable) BNC socket (rack mount)
Event Marker	LEMO 7-pin, adapter to BNC available (portable) BNC socket (rack mount)
NMEA-0183	ALM, BWC, GGA, GLL, GRS, GSA, GST, GSV, RMB, RMC, VTG, WPL, ZDA

PERFORMANCE CHARACTERISTICS

Signal Processing	Multibit Super-trak technology; Maxwell architecture with EVEREST Multipath Rejection Technology; very low noise C/A code processing
Tracking (Standard)	9 channels L1 C/A code and carrier
(Optional)	12 L1, 12 L1 + 12 L2; C/A, P and/or cross-correlation code and carrier (rack mount)
Startup time	< 2 minutes after cold start
Measurement rate	0.5 second per independent measurement
Accuracy	Typically better than 0.5 m RMS: assumes at least 5 satellites, PDOP less than 4, and using 4000RSi corrections.
RTCM Corrections	4000RSi corrections can be applied to all differential-equipped RTCM compatible GPS receivers.

ORDERING INFORMATION

4000RSi Reference Surveyor	P/N 29443-75
4000RSi Reference Surveyor pair	P/N 29561-00
4000DSi Differential Surveyor	P/N 29443-70
4000RSi Reference Surveyor Rackmount	P/N 26541-80

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ProBeacon

Marine Radiobeacon MSK Receiver

Key features and benefits

- High noise immunity
- Rapid signal aquisition
- Automatic and manual modes
- FFT signal analysis

Differential GPS correction data broadcast from marine radiobeacons provides GPS users with the improved accuracy of DGPS without setting up and maintaining a reference station. Depending on the DGPS receiver being used in conjuction with the ProBeacon™, the combination can provide position and navigation accuracies of less than a meter to land surveyors, dredge operators, resource management agencies, crop dusters, and many others operating on land, offshore or in the air. Anyone within the range of a radiobeacon, whose application requires real-time positions, time, or velocity can benefit from this form of DGPS.

Differential GPS using MSK radiobeacon broadcasts.

RTCM and IALA complaint

The International Association of Lighthouse Authorities (IALA), the U.S. Coast Guard and the Radio Technical Commission for Maritime Services (RTCM) have developed standards for the broadcast of DGPS correction data for public access.

All digital design

Obtaining the highest levels of DGPS performance requires a superior MSK receiver. Trimble's ProBeacon is an all-digital design, proven in independent testing to have the best overall performance, even under conditions of low signal strength and/or high noise levels. This all-digital design facilitates rapid signal acquisition and superior tracking capabilities. In addition, the ProBeacon signal processing is based upon a proprietary (patented) "noise cancellation" technique utilizing multiple channels to further improve data reception by rejecting the "impulsive" type of noise commonly found in this frequency band.

The ProBeacon also utilizes advanced logic, working in conjunction with the DGPS receiver to select the most appropriate beacon. The ProBeacon constantly monitors Message Error Ratio, switching to a different beacon if the signal degrades. By utilizing the broadcast beacon almanacs and receiving the position data from the DGPS receiver, the ProBeacon switches to the nearest beacon to maintain the highest accuracy possible.

H-field loop antenna

These features, combined with an advanced, high sensitivity H-field antenna, ensure that the DGPS user realizes the best performance under all conditions.

Trimble

ProBeacon

Marine Radiobeacon MSK Receiver

DESCRIPTION

Differential GPS (DGPS) is the most accurate long range form of GPS for surveying, positioning and navigation. GPS receivers that are differential capable use the correction data to counter the effects of Selective Availability, errors induced by the ionosphere and troposphere and other correlated errors that degrade the GPS solution. The ProBeacon is designed to provide this correction data in the RTCM SC-104 standard format to any compatible DGPS receiver, using standard RS-232 and RS-422 serial connections. Accuracy will depend on the type of DGPS receiver utilized. Trimble offers several GPS receivers with DGPS capability designed to meet all types of application requirements.

PERFORMANCE CHARACTERISTICS

General

Frequency range	283.5 kHz to 325.0 kHz
Channel spacing	500 Hz
MSK modulation	25, 50, 100 & 200 bits/second
Signal strength	10 µV/meter minimum
Dynamic range	100 dB
Channel selectivity	60 dB @ 500 Hz offset
Frequency offset	10 ppm maximum (200 bits/second)
	40 ppm maximum (100, 50 & 25 bits/second)
3rd order intercept	+15 dBm @ RF input (min. AGC setting)

PHYSICAL CHARACTERISTICS

Receiver

Size	5.6″ W x 2.7″ H x 7.5″ D
	(14.2 cm x 6.9 cm x 19.0 cm)
Weight	2.5 lbs. (1.1 kg)
Power consumption	3.5 watts
Voltage	10 to 32 volts DC
Operating temperature	–20°C to +60°C
Humidity	95% non-condensing

Antenna

Dimensions	5.8″ D x 4.5″ H (14.7 cm x 11.4 cm)
Weight	1.4 lbs. (0.63 kg)
Operating temp	–30°C to +65°C
Humidity	100% – fully sealed
Cable length	50 ft. (15 meters)

FEATURES

Automatic

The ProBeacon serves as a stand-alone receiver of DGPS correction data. Once on, it automatically selects and tracks the best differential beacon in your area. If you lose reception of a differential beacon, the ProBeacon automatically switches to another beacon for continuous DGPS coverage.

Manual

Manual mode allows the operator to select a specific beacon, to pre-program a list of preferred beacons, and to request signal levels, SNR data, PLL offsets, RTCM message errors, and tracking history.

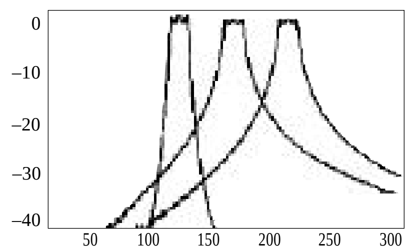
Fast acquisition

The ProBeacon uses a proprietary spectral search algorithm which enables exceptionally fast identification and acquisition of differential beacons under all operating conditions.

Jamming immunity

Only a subset of all marine radiobeacons will be differential beacons. The ProBeacon is able to track a weaker differential beacon signal in the presence of multiple jamming signals from nearby standard radiobeacons.

Normalized Frequency



Integrity monitoring

The ProBeacon continuously monitors the integrity of incoming RTCM messages. If it observes parity errors, the ProBeacon will automatically switch to an adjacent beacon to ensure RTCM data integrity.

Noise immunity

Using advanced digital signal processing, the ProBeacon reliably tracks even in the presence of heavy atmospheric noise (e.g. lightning). Using algorithms based on a proprietary (patented) noise cancellation technique, the ProBeacon realizes improved performance in the presence of impulsive noise. As shown in the above figure, the signal channel plus two additional channels are monitored by the MSK receiver. These two noise-only, or pilot, channels facilitate noise reduction as the output from all the channels is highly correlated. Reduction in noise in the signal channel improves the performance of the ProBeacon in all operating environments.

Almanac monitoring

Each differential beacon broadcasts an almanac message with the identity (frequency, data rate, etc.) for adjacent differential beacons. The ProBeacon uses this message to accelerate the switch between beacons. This minimizes the interruption in DGPS data when you lose reception of a beacon.

Dual serial ports

The ProBeacon offers two bi-directional serial ports and multiple baud rates (1200, 2400, 4800, 9600). Both RS-232 and RS-422 are supported. One port supports modem operation, allowing remote control of the ProBeacon

THE GPS SOLUTION

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Singapore PTE Limited
79 Anson Road #05-02
Singapore 079906
SINGAPORE
+65-325-5668
+65-225-9989 Fax

HYPACK®

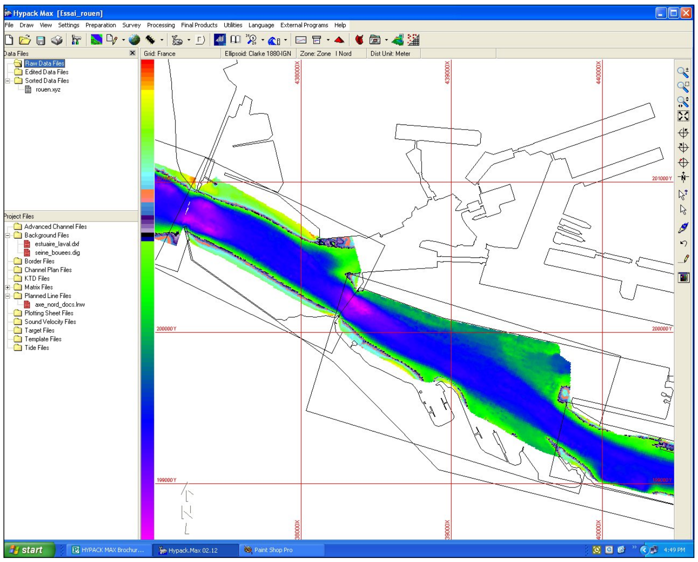
HYPACK

SOUNDING BETTER!

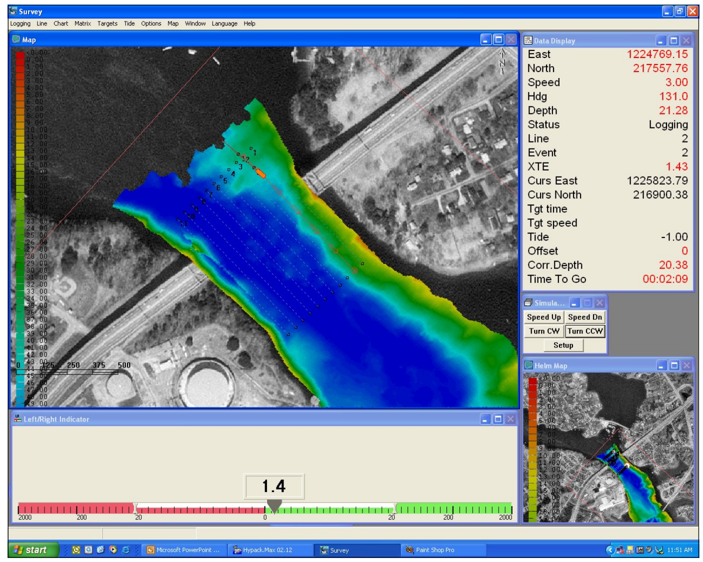
HYDROGRAPHIC SURVEY SOFTWARE

HYPACK®

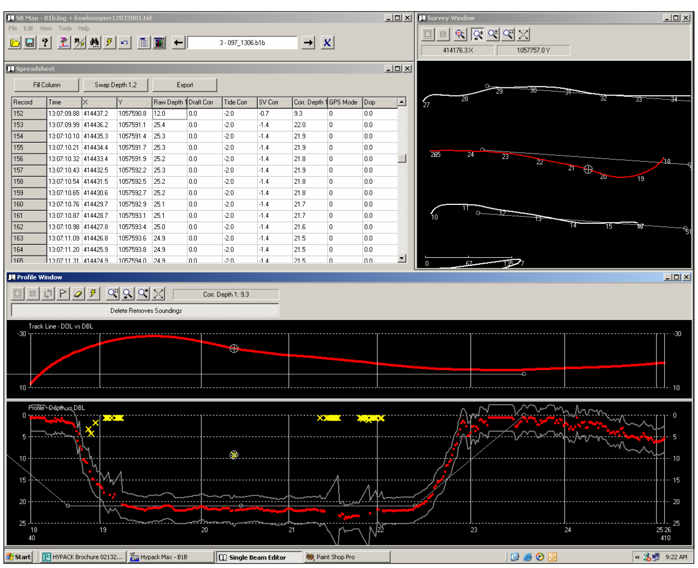
HYPACK® is one of the most widely used hydrographic surveying packages in the world, with over 3,000 users. It provides the surveyor with all of the tools needed to design their survey, collect data, process it, reduce it, and generate final products. Whether you are collecting hydrographic survey data or environmental data, or positioning your vessel in an engineering project, HYPACK® provides the tools needed to complete your job. With users spanning the range from small vessel surveys with just a GPS and single beam echosounder to large survey ships with networked sensors and systems, HYPACK® gives you the power needed to accomplish your task in a system your surveyors can master.



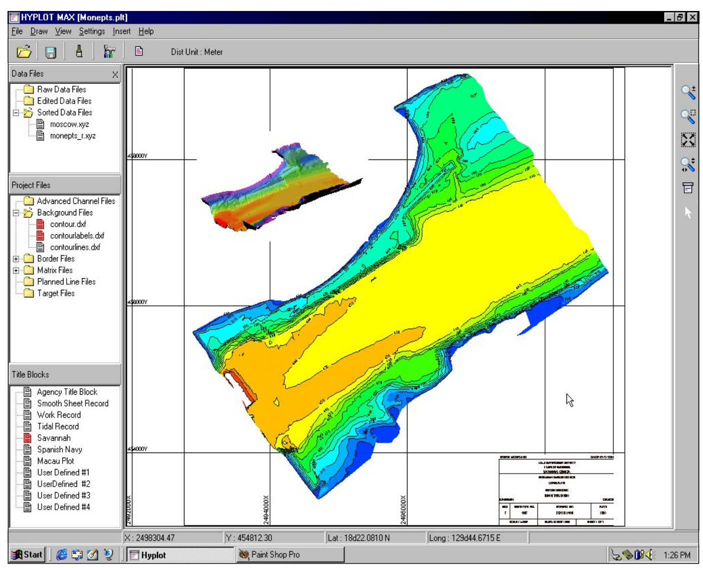
SURVEY DESIGN: **HYPACK®** allows you to create a 'Project' that contains all of your survey information for each job. You can easily define your geodetic basis, selecting from existing national grids or defining your own projection or local grid. HYPACK® also allows you to import background files in a variety of formats, including S-57, OrthoTif, ARCS, DXF, DGN, BSB and VPF. These files can be displayed while you create your planned lines, survey, edit and plot your results.



SURVEY: **HYPACK®** contains interface drivers to over 200 devices includings positioning systems, echosounders, heave-pitch-roll sensors, gyros and other types of equipment. SURVEY supports a single vessel or multiple vessels, along with towfish and ROVs. Data is logged with incredible precision (<1mSec). Survey data and windows can be broadcast over a network to any other computer or saved to a file using our Shared Memory Output routines.



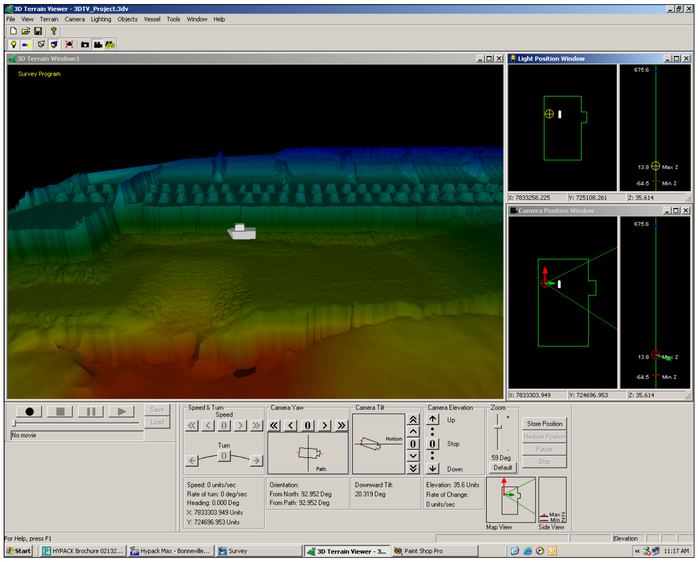
EDITING: The SINGLE BEAM EDITOR program is used to quickly review your survey data and to automatically and/or manually remove outliers. Sounding data is simultaneously displayed in plan, spreadsheet, and profile views with the channel design info drawn in the backgrounds. Routines developed by **HYPACK®** from collaboration with the U.S. Army Corps of Engineers to integrate water level corrections based on RTK GPS elevation info are a standard part of package.



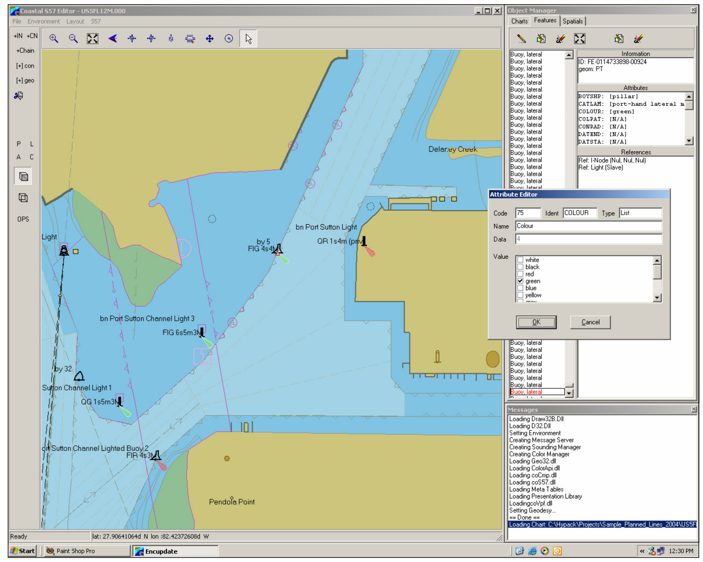
FINAL PRODUCTS: The ability to create the final products you need separates **HYPACK®** from the rest. The plotting program generates professional smooth sheets with soundings, grids, graphics and contours in a WYSIWYG display. The VOLUMES program is the de facto standard of the U.S. Army Corps of Engineers for the computation of quantities in dredging projects. TIN MODEL creates surface models that can be used for contouring, volume computations and surface visualization.

HYPACK®

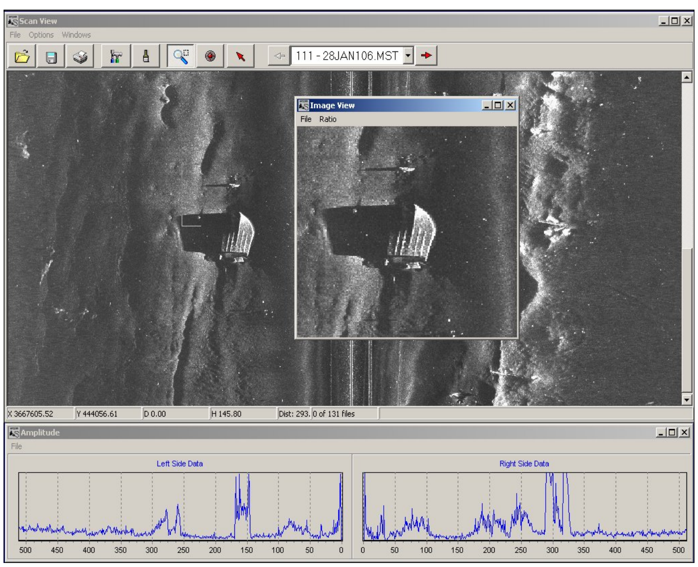
Support: An important factor in the purchase of any hydrographic survey system is the support provided to the end-user. **HYPACK®** prides itself on taking good care of our users. A trained, professional staff is on-call to answer your questions, develop custom device drivers or modify programs to meet your needs. **HYPACK®** training seminars are held annually in many countries to provide you with the latest information. We continue to update our training materials every year to make it easier for you to get the most out of our products. Our latest training material contains PowerPoint presentations with embedded AVI demonstrations on over 100 topics. Our bi-monthly newsletter, 'Sounding Better' is published on our web site (www.hypack.com) and contains technical articles on how to get the most out of your package.



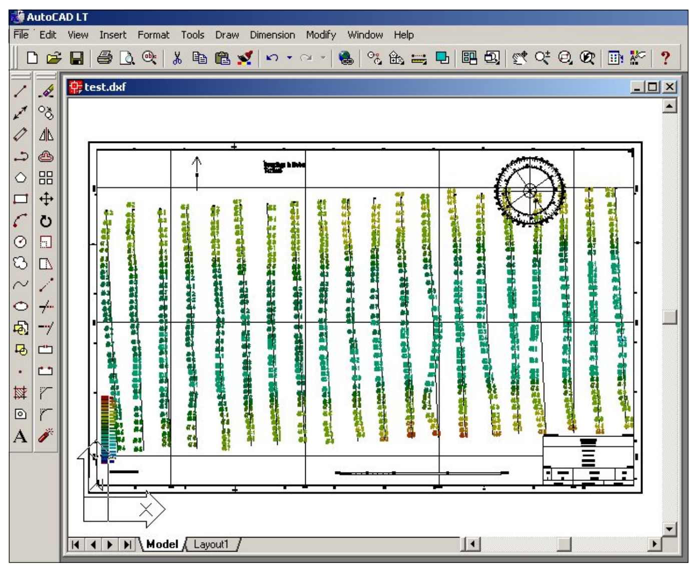
DATA VISUALIZATION: The TIN MODEL and 3D TERRAIN VIEWER (3DTV) programs of **HYPACK®** provide fantastic tools to view and present your data. 3DTV allows you to fly a 'camera' across your edited XYZ surface and display the results or save them to a AVI file for distribution to your clients. 3DTV also allows you to position the camera relative to the actual vessel position, showing the vessel in real time against the bottom surface.



ENCEdit is a new **HYPACK®** module that allows you to create, modify and verify ENC data in S-57 format. ENCEdit provides you with tools to re-attribute, create, move or delete existing features. You can also create new features by manually entering coordinates, by importing data from DXF/DGN, or by transferring targets in real time from SURVEY directly into ENCEdit.



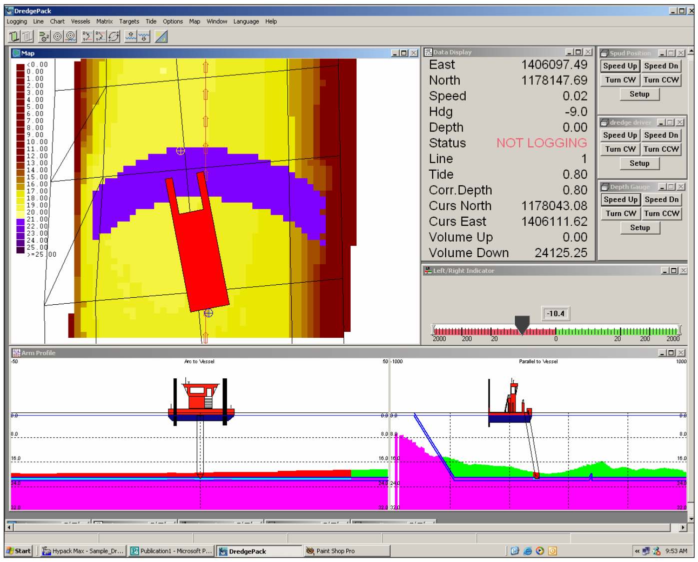
Side Scan Sonar (SSS) Support: **HYPACK®** provides support of SSS systems in its basic package. All analog and several digital side scan systems can be utilized with the SIDE SCAN SURVEY program. Users can display the real time data and perform targeting in real time or post-processing. A program that generates side scan mosaics in GeoTIF format allows you to plot your results in **HYPACK®** or export them to your GIS.



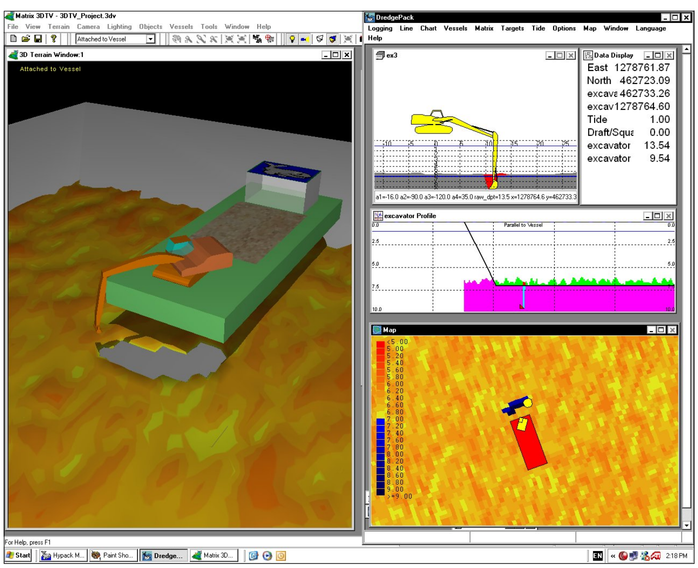
Export to CAD: Many of our users are interested in exporting their survey data into their CAD/GIS package. **HYPACK®** has several tools to import/export via DXF/DGN. The EXPORT TO CAD program takes all of the our files and converts them to DXF and DGN. The plotting sheets and sectional plots can also be exported directly to DXF. Users can create planned lines in their CAD/GIS program and import them into **HYPACK®**.

DREDGEPACK®

DREDGEPACK® is a specially modified version of **HYPACK®** used for providing precise digging information on dredges. It allows you to see exactly where you are digging, how deeply you are digging and how deeply you need to dig. With the ADVANCED CHANNEL DESIGN program, you can create complex dredging plans. Real time cross sections are provided to show you the design profile, the depth of the cutting tool and the material that has to be removed.

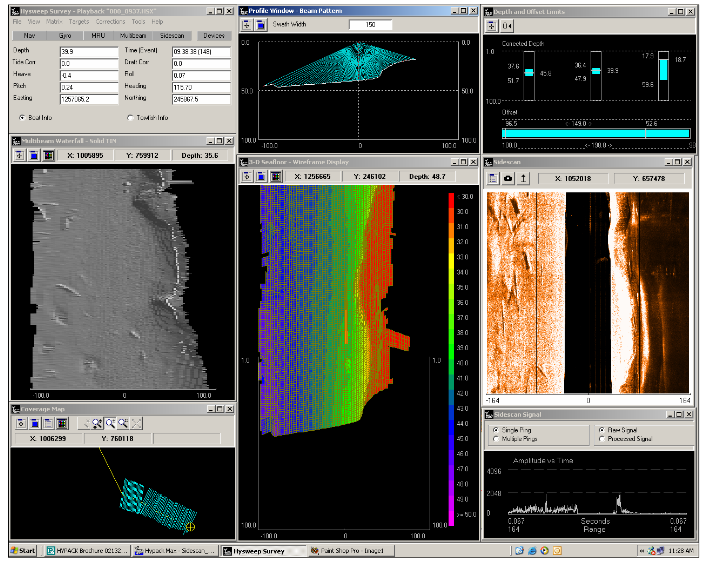


DREDGEPACK® runs on cutter suction, hopper, excavator and bucket-style dredges. It can store a history of the dredge's position, draft, digging tool depth and digging status in order to meet reporting requirements. DREDGEPACK® has been designed to run with a minimum of user intervention. Make sure you are maximizing your dredge's efficiency with DREDGEPACK®

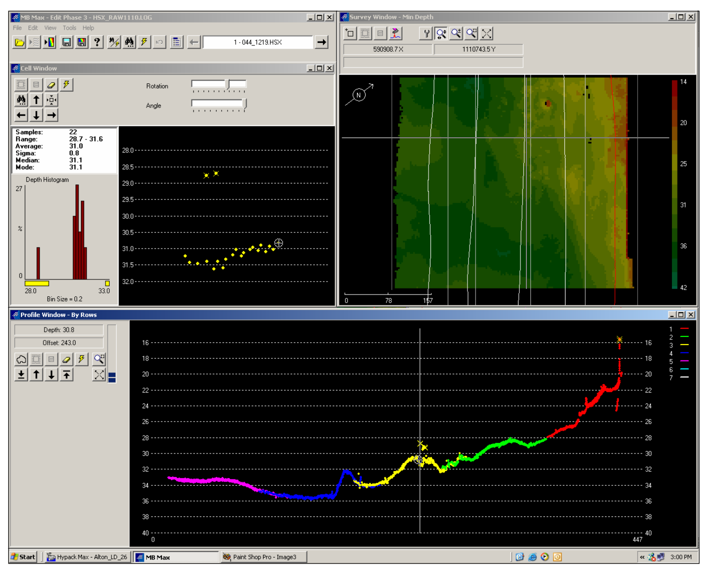


HYSWEEP®

HYSWEEP® is an optional module that integrates the collection and processing of multibeam and multiple transducer sonar systems into **HYPACK®**. Time and again, surveyors switch to HYSWEEP® due to the powerful tools and the ease-of-use of the package. Survey data collected in **HYSWEEP®** is fully integrated with the final products of **HYPACK®**. More surveyors use **HYSWEEP®** for multibeam data collection and processing than any other multibeam software package.



HYSWEEP® SURVEY: The data collection program of **HYSWEEP®** runs simultaneously with the SURVEY program of **HYPACK®**. It provides real time display, QC functions and data logging for most commercially available multibeam systems, including those from Atlas, Odom, Reson, Sea Beam and Simrad. A coverage map lets you examine the bottom coverage in real time, ensuring that you have 100% or 200% coverage before leaving the area.



MULTIBEAM EDITING: Multibeam data editing, sonar alignment calibration and system performance testing are all provided in the powerful MULTIBEAM EDITOR of **HYSWEEP®**. The program performs automatic or manual filtering, using geometric and statistical methods. It also contains the Performance Test that measures the overall performance of your system versus beam angle as required by USACE. **HYSWEEP®** can also use water level corrections created from RTK GPS elevations.

HYPACK
SOUNDING BETTER!

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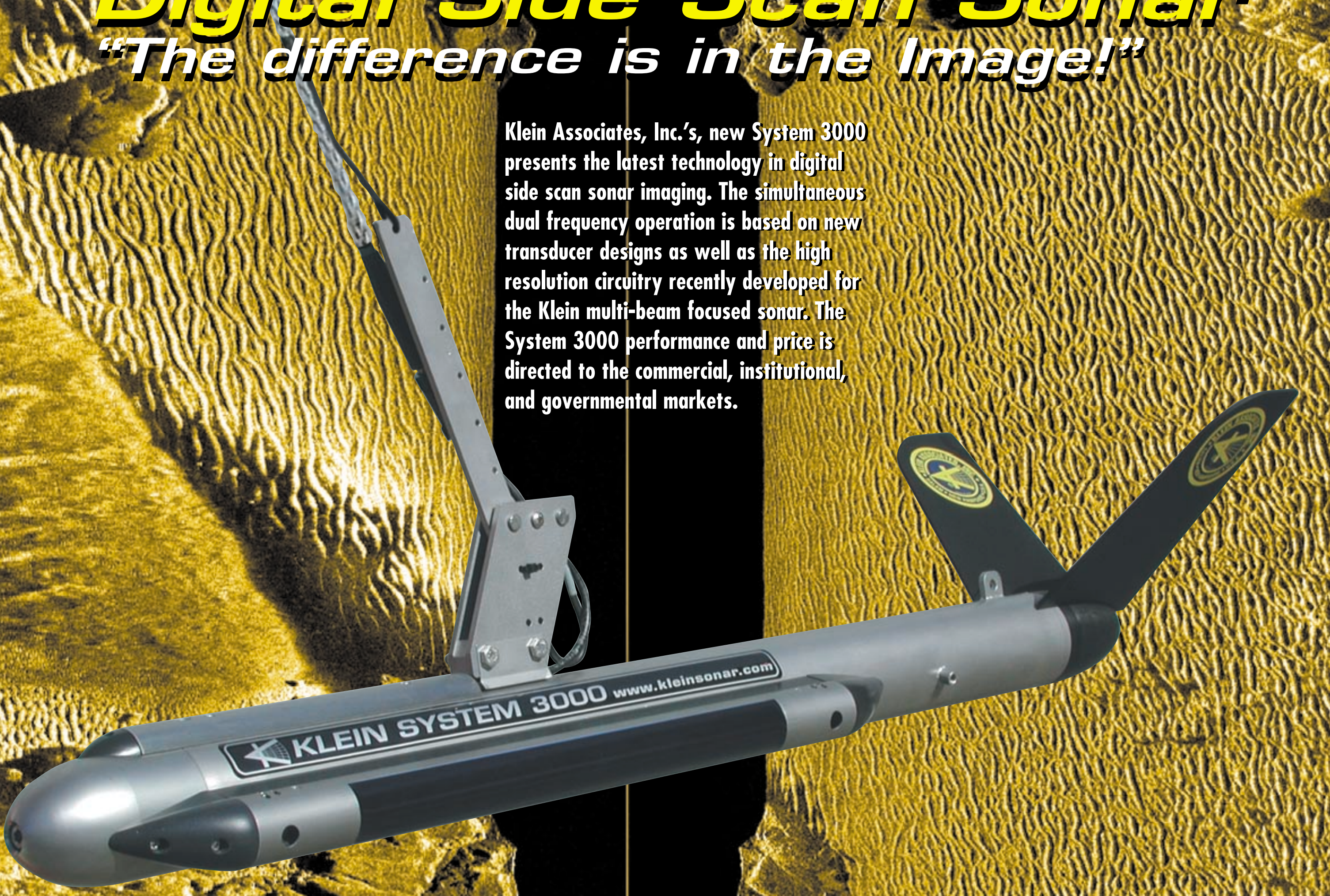
L3 communications
Klein Associates, Inc.

11 Klein Drive, Salem, N.H. 03079-1249, U.S.A.
Phone: (603) 893-6131 Fax: (603) 893-8807
E-mail: sales@L-3com.com
Web site: www.L-3Klein.com

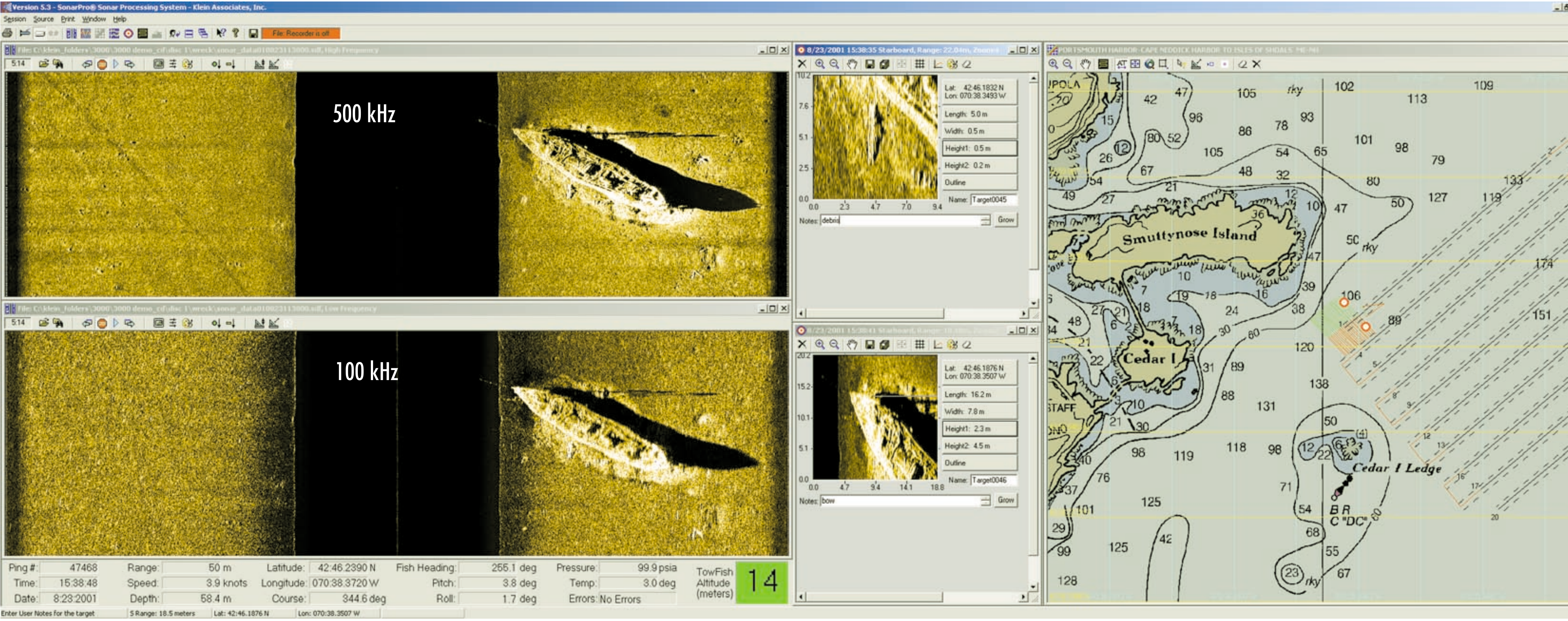
Klein System 3000 Digital Side Scan Sonar

"The difference is in the Image!"

Klein Associates, Inc.'s, new System 3000 presents the latest technology in digital side scan sonar imaging. The simultaneous dual frequency operation is based on new transducer designs as well as the high resolution circuitry recently developed for the Klein multi-beam focused sonar. The System 3000 performance and price is directed to the commercial, institutional, and governmental markets.



- ***ADVANCED SIGNAL PROCESSING AND TRANSDUCERS PRODUCE SUPERIOR IMAGERY***
- ***COST EFFECTIVE, AFFORDABLE***
- ***PC BASED OPERATION WITH SONARPRO® SOFTWARE, DEDICATED TO KLEIN SONARS***
- ***SMALL, LIGHTWEIGHT, AND SIMPLE DESIGNS - EASY TO RUN AND MAINTAIN***
- ***EASILY ADAPTED TO ROVS, AND CUSTOM TOWFISH***



SPECIFICATIONS

Towfish

Frequencies	100 kHz (132 kHz +/- 1% act.), 500 kHz (445 kHz, +/- 1% act.)
Transmission Pulse	Tone Burst, operator selectable from 25 to 400 μsecs. **Independent pulse controls for each frequency**
Beams	Horizontal - 0.7 deg. @ 100 kHz, 0.21 deg. @ 500 kHz Vertical - 40 deg.
Beam Tilt	5, 10,15, 20, 25 degrees down, adjustable
Range Scales	15 settings - 25 to 1,000 meters
Maximum Range	600 meters @ 100 kHz; 150 meters @ 500 kHz
Depth Rating	1,500 meters standard, other options available
Construction	Stainless Steel
Size	122 cm long, 8.9 cm diameter
Weight	29 kg in air
Standard Sensors	Roll, pitch, heading
Options	Magnetometer Interface, pressure, Acoustic Positioning Responder, and Responder Interface Kits

Transceiver Processor Unit (TPU)

Operating System	vxWorks® with custom application
Basic Hardware	19-inch rack or table mount, VME bus structure
Outputs	100 Base-Tx, Ethernet LAN
Navigation Input	NMEA 0183
Power	120 watts @ 120/240 VAC, 50/60 Hz
Interfacing	Interfaces to all major Sonar Data Processors
Options	Splash proof packaging option available

Klein Sonar Workstation

Basic Operating System	Windows NT®, 2000®, XP® or equiv.
Sonar Software	SonarPro®
Data Format	SDF or XTF or both selectable
Data Storage	Internal hard drive, optional devices available
Hardware	Industrial PC with technically advanced components
Options	Optional waterproof laptops available

Tow Cables

Klein offers a selection of coaxial, Kevlar® reinforced, lightweight cables, double armored steel cables, and interfaces to fiber optic cables. All cables come fully terminated at the towfish end.

L3 communications
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E-mail: sales@L-3com.com Web site: www.L-3Klein.com

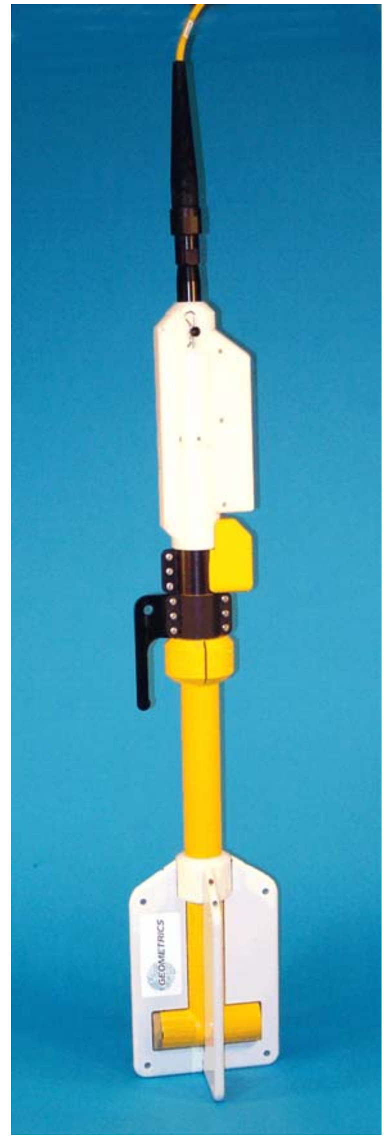
SonarPro® Software

Custom developed software by users and for users of Klein side scan sonar systems operating on Windows NT®, 2000® & XP®. Field proven for many years on Klein's Multi-Beam Focused Sonar Series 5000 Systems and adapted to the System 3000 single-beam system. SonarPro® is a modular package combining ease of use with advanced sonar features.

Basic Modules	Main Program, Data Display, Information, Target Management, Navigation, Data Recording & Playing, and Sensor Display.
Multiple Display Windows	Permits multiple windows to view different features as well as targets in real time or in playback modes. Multi-Windows for sonar channels, navigation, sensors, status monitors, targets, etc.
Survey Design	Quick & easy survey set up with ability to change parameters, set tolerances, monitor actual coverage, and store settings.
Target Management	Independent windows permitting mensuration, logging, comparisons, filing, classification, positioning, time & survey target layers, and feature enhancements. Locates target in navigation window.
Sensor Window	Displays all sensors in several formats (includes some alarms) and responder set up to suit many frequencies and ping rates.
Networking	Permits multiple, real time processing workstations via a LAN including "master and slave" configurations.
"Wizards"	To help operator set up various manual and default parameters.
Data Comparisons	Target and route comparisons to historical data.

G-882 MARINE MAGNETOMETER

- ***CESIUM VAPOR HIGH PERFORMANCE – Highest detection range and probability of detecting all sized ferrous targets***
- ***NEW STREAMLINED DESIGN FOR TOW SAFETY – Low probability of fouling in lines or rocks***
- ***NEW QUICK CONVERSION FROM NOSE TOW TO CG TOW – Simply remove an aluminum locking pin, move tow point and reinsert. New built in easy carry handle!***
- ***NEW INTERNAL CM-221 COUNTER MODULE – Provides Flash Memory for storage of default parameters set by user***
- ***NEW ECHOSOUNDER / ALTIMETER OPTION***
- ***NEW DEPTH RATING – 4,000 psi !***
- ***HIGHEST SENSITIVITY IN THE INDUSTRY – 0.004 nT/Hz RMS with the internal CM-221 Mini-Counter***
- ***EASY PORTABILITY & HANDLING – no winch required, single man operation, only 44 lbs with 200 ft cable (without weights)***
- ***COMBINE TWO SYSTEMS FOR INCREASED COVERAGE – Internal CM-221 Mini-Counter provides multi-sensor data concatenation allowing side by side coverage which maximizes detection of small targets and reduces noise***


G-882 with Weight Collar Depth Option & Altimeter

Very high resolution Cesium Vapor performance is now available in a low cost, small size system for professional surveys in shallow or deep water. High sensitivity and sample rates are maintained for all applications. The well proven Cesium sensor is combined with a unique and new CM-221 Larmor counter and ruggedly packaged for small or large boat operation. Use your computer and standard printer with our MagLogLite™ software to log, display and print GPS position and magnetic field data. The G–882 is the lowest priced high performance full range marine magnetometer system ever offered.

The G-882 offers flexibility for operation from small boat, shallow water surveys as well as deep tow applications (4,000 psi rating, telemetry over steel coax available to 10Km). The G-882 also directly interfaces to all major Side Scan manufacturers for tandem tow configurations. Being small and lightweight (44 lbs net, without weights) it is easily deployed and operated by one person. But add several streamlined weight collars and the system can quickly weigh more than 100 lbs. for deep tow applications. Power may be supplied from a 24 to 30 VDC battery power or the included 110/220 VAC power supply. The tow cable employs high strength Kevlar strain member with a standard length of 200 ft (61 m) and optional cable length up to 500m with no telemetry required.

A rugged fiber-wound fiberglass housing is designed for operation is all parts of the world allowing sensor rotation for work in equatorial regions. The shipboard end of the tow cable is attached to an included junction box or optional on-board cable for quick and simple hookup to power and output of data into any Windows 98, ME, NT, 2000 or XP computer equipped with RS-232 serial ports.

The G-882 Cesium magnetometer provides the same operating sensitivity and sample rates as the larger deep tow model G-880. MagLogLite™ Logging Software is offered with each magnetometer and allows recording and display of data and position with Automatic Anomaly Detection and automatic anomaly printing on Windows™ printer! Additional options include: MagMap2000 plotting and contouring software and post acquisition processing software MagPick™ (free from our website.)

The G-882 system is particularly well suited for the detection and mapping of all sizes of ferrous objects. This includes anchors, chains, cables, pipelines, ballast stone and other scattered shipwreck debris, munitions of all sizes (UXO), aircraft, engines and any other object with magnetic expression. Objects as small as a 5 inch screwdriver are readily detected provided that the sensor is close to the seafloor and within practical detection range. (Refer to table at right).

The design of this high sensitivity G-882 marine unit is directed toward the largest number of user needs. It is intended to meet all marine requirements such as shallow survey, deep tow through long cables, integration with Side Scan Sonar systems and monitoring of fish depth and altitude.

Typical Detection Range For Common Objects

Ship 1000 tons	0.5 to 1 nT at 800 ft (244 m)
Anchor 20 tons	0.8 to 1.25 nT at 400 ft (120 m)
Automobile	1 to 2 nT at 100 ft (30 m)
Light Aircraft	0.5 to 2 nT at 40 ft (12 m)
Pipeline (12 inch)	1 to 2 nT at 200 ft (60 m)
Pipeline (6 inch)	1 to 2 nT at 100 ft (30 m)
100 KG of iron	1 to 2 nT at 50 ft (15 m)
100 lbs of iron	0.5 to 1 nT at 30 ft (9 m)
10 lbs of iron	0.5 to 1 nT at 20 ft (6 m)
1 lb of iron	0.5 to 1 nT at 10 ft (3 m)
Screwdriver 5 inch	0.5 to 2 nT at 12 ft (4 m)
1000 lb bomb	1 to 5 nT at 100 ft (30 m)
500 lb bomb	0.5 to 5 nT at 50 ft (16 m)
Grenade	0.5 to 2 nT at 10 ft (3 m)
20 mm shell	0.5 to 2 nT at 5 ft (1.8 m)

MODEL G-882 CESIUM MARINE MAGNETOMETER SYSTEM SPECIFICATIONS

OPERATING PRINCIPLE:	Self-oscillating split-beam Cesium Vapor (non-radioactive)
OPERATING RANGE:	20,000 to 100,000 nT
OPERATING ZONES:	The earth's field vector should be at an angle greater than 6° from the sensor's equator and greater than 6° away from the sensor's long axis. Automatic hemisphere switching.
CM-221 COUNTER SENSITIVITY:	<0.004 nT/ √Hz rms. Up to 20 samples per second
HEADING ERROR:	±1 nT (over entire 360° spin)
ABSOLUTE ACCURACY:	<2 nT throughout range
OUTPUT:	RS-232 at 1,200 to 19,200 Baud
MECHANICAL:	
Sensor Fish:	Body 2.75 in. (7 cm) dia., 4.5 ft (1.37 m) long with fin assembly (11 in. cross width), 40 lbs. (18 kg) Includes Sensor and Electronics and 1 main weight. Additional collar weights are 14lbs (6.4kg) each, total of 5 capable
Tow Cable:	Kevlar Reinforced multiconductor tow cable. Breaking strength 3,600 lbs, 0.48 in OD, 200 ft maximum. Weighs 17 lbs (7.7 kg) with terminations.
OPERATING TEMPERATURE:	-30°F to +122°F (-35°C to +50°C)
STORAGE TEMPERATURE:	-48°F to +158°F (-45°C to +70°C)
ALTITUDE:	Up to 30,000 ft (9,000 m)
WATER TIGHT:	O-Ring sealed for up to 4,000 psi (9000 ft or 2750 m) depth operation
POWER:	24 to 32 VDC, 0.75 amp at turn-on and 0.5 amp thereafter
ACCESSORIES:	
Standard:	View201 Utility Software operation manual and ship kit
Optional:	Telemetry to 10Km coax, gradiometer (longitudinal or transverse), reusable shipping case
MagLog Lite™ Software:	Logs, displays and prints Mag and GPS data at 10 Hz sample rate. Automatic anomaly detection and single sheet Windows printer support

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE ***12/03***

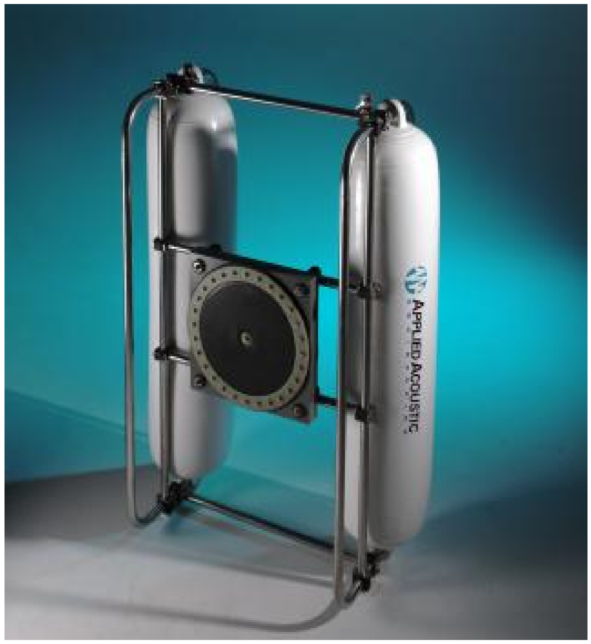
GEOMETRICS, INC. 2190 Fortune Drive, San Jose, California 95131
408-954-0522 □ Fax 408-954-0902 □ Internet: sales@mail.geometrics.com

GEOMETRICS Europe Manor Farm Cottage, Galley Lane, Great Brickhill, Bucks,
England MK179AB □ 44-1525-261874 □ Fax 44-1525-261867

GEOMETRICS China Laurel Industrial Co. Inc. - Beijing Office, Room 2509-2511, Full Link Plaza
#18 Chaoyangmenwai Dajie, Chaoyang District, Beijing, China 100020
10-6588-1126 (1127..1130), 10-6588-1132 □ Fax 010-6588-1162

Sub Bottom Profiling

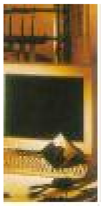
AA200 Boomer Plate and CAT200 catamaran



The Model AA200 is a proven design in boomer plates which encompasses precision moulding techniques to give a rugged design with a stable and repeatable signature. Designed specifically for use with our CSP range of energy sources, (although others can be used) the efficiency of the AA200 transducer ensures high output with an excellent pulse shape.

Designed for ease of use in the real world offshore, we have ensured that the flying lead connectors can be replaced in the field in case of damage. Diaphragm replacement is also straightforward. The lightweight design allows easy transportation. The unit is shown fitted to our 'CAT200' small sized catamaran which has been praised for its towing characteristics. Spectral content information is available.

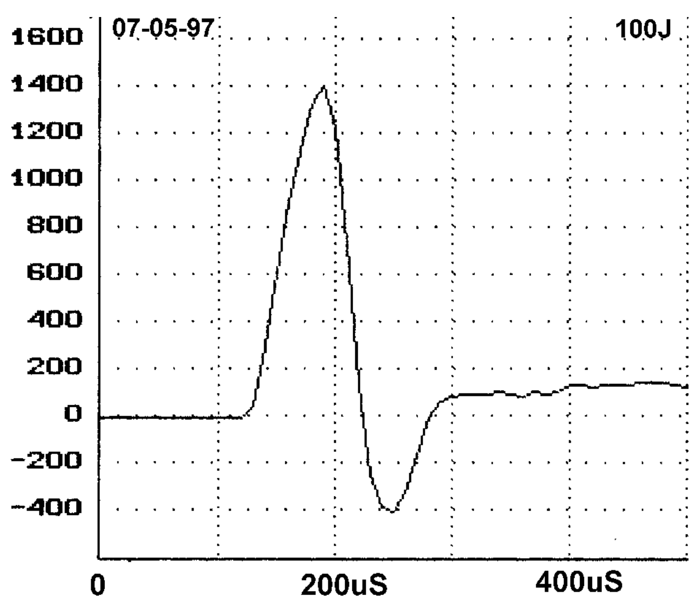
- **Small Size and weight**
- **Repeatable high output pulse**
- **Rugged mechanical design**
- **Proven Performance**



TECHNICAL SPECIFICATION

Size	: 38cm x 38 cm x 5cm thick 9cm including connectors.
Weight in air / water	: 18 / 10 kg.
Fixing centres	: 31.5cm square.
Recommended use	: 100-200J / shot.
Maximum energy input	: 300J / shot.
Source Level	: 215dB re 1uPa @1m at 200J.
Pulse Length	: See graph below.
Reverberation	: <1/10 x initial pulse.
Connector type	: Joy plug male & female.

AA200 Pulse Shape



Part of our integrated Sub-bottom Profiler system. Sample data is available upon request.

December 2001

APPLIED ACOUSTIC ENGINEERING
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Tel: + 44 (0) 1493 440355 Fax: + 44 (0) 1493 440720
www.appliedacoustics.com email: general@appliedacoustics.com

760 Geophysical Acquisition System

The simple digital solution for simultaneous sidescan and sub-bottom profiler

The OCTOPUS 760 GEOPHYSICAL ACQUISITION SYSTEM is an all-new multi-channel acquisition package for sidescan sonar and sub-bottom profiler in a single instrument.

Building on the reputation of the industry leading Octopus 360 Sub-Bottom Processor and the 460 Sonar Acquisition Systems, the 760 brings the Octopus geophysical acquisition range right up to date, whilst retaining the simplicity of operation and rugged, reliable design familiar to Octopus users around the world.

Combining Octopus design philosophy focussing on ease of use, with the latest hardware and software and technology, the 760 guarantees compatibility with other systems and peripherals. Incorporating a large high resolution display and the familiar Octopus key-driven user interface in a rugged instrument, the 760 is simple to use in all survey scenarios and is ideally suited to use on small and large vessels alike. Adopting the latest features and familiarity of Windows XP in an instrument package provides all of the benefits with none of the problems. With a simple layout taken from the existing 360 and 460, the 760 combines ease of use with maximum flexibility and performance. Designed and packaged specifically for geophysical acquisition, the 760 is ready to use out-of-the-box and requires minimal training and no special hardware configuration, whilst the optional in-built UPS capability guards against power failure ensuring all data is kept safe. Adding optional internal GPS makes the 760 fully self-contained, for added simplicity.

The Octopus 760 is compatible with all standard sidescan sonars, including the latest digital towfish, and all standard sub-bottom profilers, pingers, boomers, sparkers and chirp, in one compact package.

FEATURES

- 4 channel analogue sidescan acquisition
- 2 channel analogue sub-bottom acquisition
- Analogue output
- Dual SIMULTANEOUS sidescan and sub-bottom acquisition
- Simultaneous display of sidescan and sub-bottom
- Asynchronous sidescan and sub-bottom trigger timing
- Standard formats, XTF, SEGY, CODA, GeoPro
- Internal recording to hard disk and DVD RAM disks
- Simple 7-key interface
- Serial inputs for navigation and standard fix strings
- High resolution 15” screen
- High speed network connectivity
- 19” rack mountable or freestanding
- Supports all standard printers
- In-built UPS

BENEFITS

- Simple to use
- Reduced operating costs
- Reduced hardware
- Minimal user training
- Maximum flexibility
- Fully compatible with all popular post processing systems
- Extends the life of analogue sonars
- Data stored internally is easily and quickly downloaded

OCTOPUS
LeadingGeoSurveySolutions

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760 Geophysical Acquisition System
Technical Specification

INPUTS AND OUTPUTS

	760 Standard	760 Dual Acquisition
	760 Standard - single acquisition card.	**760 Dual Acquisition** - as standard 760 with the following additional features.
	Note: *With single acquisition card, the 760 is user configurable for sub-bottom* ***or*** *sidescan acquisition. With dual acquisition cards, the 760 supports simultaneous sub-bottom* ***and*** *sidescan sonar acquisition.*	
Analogue inputs	4 independent 16 bit channels scalable from 125mV to 5V configurable as 4 x sidescan sonar **OR** 1 x sub-bottom + analogue heave input	2 independent 16 bit channels scalable from 125mV to 5V configured as 1 x sub-bottom + analogue heave input.
Analogue outputs	2 analogue outputs, selectable source, synchronous with trigger out.	1 analogue output, synchronous with trigger out.
Trigger input	Single trigger input with variable threshold, synchronises all channels.	Single trigger input with variable threshold. Can operate asynchronously to main trigger.
Trigger outputs	Internal trigger (5v) user selectable range, 25-1000m. Delayed trigger synced to start of sub-bottom acquisition.	Internal trigger (5v), user selectable range 50 – 1000mS. Delayed trigger synced to start of sub-bottom acquisition.
Navigation & fix data	2 x RS232 serial inputs (9 pin D-type) for NMEA navigation (GGA, GLL, VTG, RMC etc.) or Octopus fix and annotation strings. Additional inputs on request.	
GPS	Optional in-built GPS (with DGPS and/or WASS) for fully self contained operation. Antenna connection at rear. *Available mid 2004*	
Printer interfaces	Centronics (25 way D-type) interface for EPC, Ultra and Isys printers. SCSI interface for Alden/GeoPrinter (SCSI interface optional)	
Network	10/100/1000 $MbitS^{-1}$ Ethernet interface (RJ45).	
Other interfaces	USB x 2 (standard) SCSI II (optional), others available on request.	

DATA RECORDING

Recording devices	Internal 2.5" shock mounted hard disk (60Gb) Single DVD RAM/CD-R drive as standard. Optional second DVD RAM/CD-R. Other devices such as DAT, removable HDD etc. available on request.
Recording formats	Sidescan sonar – XTF, Coda, GeoPro Sub-bottom profiler – SEGY, Coda, XTF All data is recorded raw (without gain or processing applied).

DISPLAY MODES

Sidescan	Up to 4 channels of sidescan in vertical scrolling waterfall display with co-registered oscilloscope. All gain and processing controls on-screen.
Sub-bottom	Single channel sub-bottom profiler display, horizontal scrolling with co-registered oscilloscope display. Pan and zoom functions for optimum data view. All gain and processing controls on-screen.
Dual format	Simultaneous vertically scrolling sidescan AND horizontally scrolling sub-bottom.
Navigation	All navigation, fix, annotation and status information shown on all screens.

CONTROLS

User Interface	Familiar Octopus 7 key interface allowing quick and easy navigation to all functions without the need for a mouse. Arrow keys snap between groups of controls and allow selection of specific functions. Y & N keys allow settings to be saved or cancelled. PAGE key allows rapid selection of display screens.

PROCESSING

Sidescan	Channel-independent gain & TVG. Bottom tracking, slant-range correction.
Sub-bottom	Gain, three stage TVG, high & low pass time varied filters (TVF), time varied stacking, swell compensation (automatic or external heave input).

PHYSICAL

Dimensions	443mm(w) x 355mm(h) x 235mm(d) (19" rack compatible).
Weight	15kg
Power	90-250Vac 47-400Hz, 200Watts. Optional 24Vdc Automatic power management and controlled-shutdown. In-built UPS capability further guards against power loss. *NB. requires optional 24V battery pack in place of second DVD drive*
Construction	Rugged but lightweight aluminium chassis with anodised front panel
Display	High-brightness 15" TFT screen, 1024x768 resolution
Controls	Octopus 7 key user controls for all functions

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OCTOPUS
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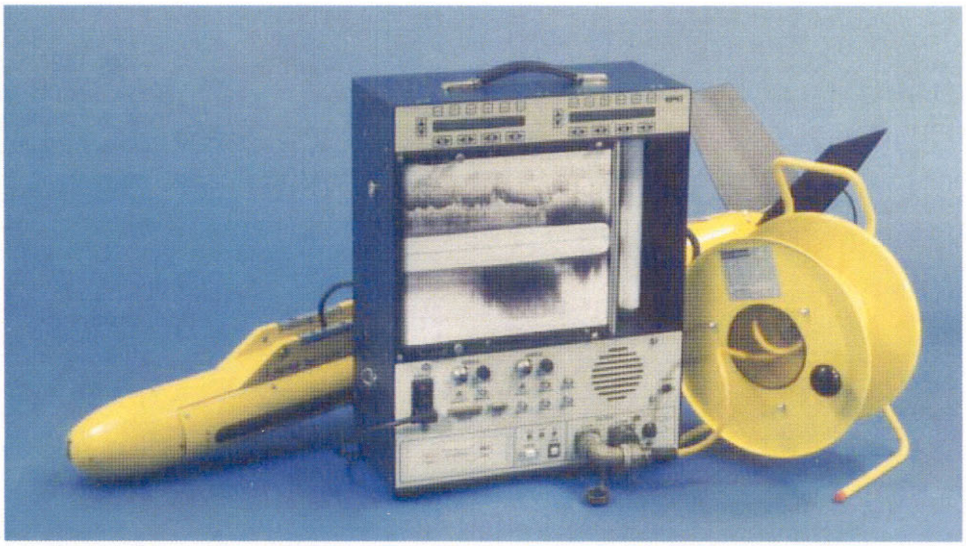
EPC

MODEL MP-1086

Multi-Purpose Recording System



The EPC Model MP-1086 is a multi-purpose recording system that serves as a continuous gray scale printer, analog tow fish interface, mass storage device, and signal processor.

Photographic quality images are produced using the direct thermal printing expertise that has made EPC the industry leader in this field. The analog tow fish interface allows users to connect commonly used side-scan sonars directly to the MP-1086, with no need for external components. Data can be easily logged for post processing directly to the removable disk or sent to a network server for storage.

Real-time acquisition is robust. By incorporating slant range correction, speed correction, TVG, band-pass filtering, and GPS/NMEA decoding, the MP1086 provides a total top-side solution. So, forget about all those extra boxes and cables — the MP1086 Recording System has everything you need.

HARDWARE

CPU Bus
32 Bit PCI/ISA Bus
Control Panel
Sealed membrane type, software defined
Displays
Twin 2x40 LCD displays, LED backlights

POWER

Power Supply
350 Watt, auto-sensing, universal input
84-265 VAC, 50-60 Hz
Power Consumption
80 Watts non-printing
130 Watts Peak

PHYSICAL

Dimensions & Weight
17.6"W x 23.1"H x 8.9"D
55 LBS.
Media
Heat sensitive thermal paper or high grade plastic film - 23dB dynamic range
Paper Length: 150 feet
Film Length: 130 feet
Temperature (non-condensing)
0°C to 65°C - Operating
-28°C to 65°C - Storage

PRINTING

Gray Levels & Resolution
Selectable: 2, 16, 64, 256 Levels
Printhead: 2048 Pixels @ 203 DPI
Maximum Line Speeds (nominal)
@ 2 Shades: 12 ms
@ 16 Shades: 14 ms
@ 64 Shades: 42 ms
@ 256 Shades: 170 ms
Chart Speeds (Lines Per Inch)
Fixed: 80, 100, 120,150, 200, 240, 300
Variable: Preset automatically configured by speed input from gps/nav computer

ANALOG INTERFACE

Dual Signal Input
0V to 10V SIGNAL BNC inputs
(2Kohm Input Impedance)
External Trigger Input (slave)
TTL EXT TRIG BNC with slope-sense
Internal Key Output (master)
TTL KEY OUT BNC with polarity selection
(62.5us pulse width)
Gain, Threshold, Polarity
Independent controls for each channel
Minimum printable signal 150 mV
Time Bases
High B/W A/D with 8 Bit resolution
Scan - 5 ms to 10 secs, 1 ms resolution
Key - 5 ms to 10 secs, 1 ms resolution
Delay - 0 secs to 8 secs, 1 ms resolution

PARALLEL INTERFACE

Interconnect
25 Pin Sub D, metal shell
Data Input (Pins 2-9)
Eight Bit Centronics Compatible
2048 bytes per raster line
Burst Rate Bandwidth: Over 250 kHz
Sustained Bandwidth: Based on gray levels

NETWORK INTERFACE

Interconnect
RJ-45 on front panel
Method
Winsock type Socket Interface for data & commands. High-level programmer's API available

COMMAND INTERFACE

QWERTY Keyboard
Jack for commands and annotation
RS-232 Serial Data Input (DCE)
9 Pin Sub 'D' for commands and GPS
RJ-45 for Socket/Ethernet API

ACCESSORIES

Top Cover Assembly (optional)
Custom mini keyboard
Water proof, Heavy duty keyboard (optional)
Rack mount kit (optional)
Spares kit (optional)

ENHANCED ANALOG FEATURES

Time Varied Gain
255 Logarithmic curves to choose from
Band Pass Filtering
LOW PASS:
1kHz, 1.2kHz, 2kHz, 2.4kHz, 3kHz, 4kHz, 6 kHz, 12 kHz

HIGH PASS:
83Hz, 100Hz, 166Hz, 200Hz, 250Hz, 333Hz, 500Hz, and 1kHz

TOW FISH OUTPUTS

E-type High Voltage
750Vdc short circuit proof indefinately
E-Type Trigger Pulse
100kHz- +12V pulse duration 125us
500kHz- +12V pulse duration 250us
E-Type Compatibility
Edgetech 272T ans 272TD
E-Type Connector
Amp MS3102E20 EG&G 259, 960 & 260

K-Type High Voltage
750Vdc short circuit proof indefinately
K-Type Trigger Pulse
12-15Vdc carrier with riding 12V pulse
Pulse duration 1ms
K-Type Compatibility
Klein 100kHz, 500kHz or dual frequency
K-Type Connector
Amp MS3102E22-19 (Klein 595)

DIGITAL DATA PROCESSING

Slant Range Correction
Controls for bottom tracking algorithm, and fish height alarm.

STORAGE

High Capacity Removable Disk
DVD Ram, IDE hard drive
Storage Format
XTF (standard)
SEGY,RAW (consult EPC)

Warranty: One Year Limited Parts & Labor. Specifications subject to change.

EPC

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APPENDIX F

Data Processing and Analysis Methods

Navigation Files
Side Scan Sonar Imagery
Magnetic Intensity Measurements
Seismic Reflection Profile Data

DATA PROCESSING AND ANALYSIS METHODS

Navigation Files

Upon completion of the field work, the digital files of vessel position were processed using HYPACK® software to facilitate post-survey reconstruction of vessel tracklines to assist data interpretation. Event marks generated by HYPACK® during the field survey are plotted along each track and correlate all data by vessel position and time. These event marks are spaced 200 feet apart and are sequentially numbered throughout the duration of the entire field investigation. Events are stored digitally in the HYPACK® navigation files as well as printed on all hard copy data records.

USACE Depth Data

Processed x, y, z hydrographic data were provided by the USACE from their 2005 conditions survey in Searsport Harbor. Data were provided in a final processed format, having been tide adjusted and referenced to the MLLW datum by the USACE. These data points were input to QuickSurf digital terrain modeling software (Schreiber Instruments, Inc.) operating within the AutoCAD 2004 program to generate depth contours of the harbor floor.

The points were first used to develop a bottom surface within QuickSurf. A TIN surface, which honors all data points, was generated and used as the base surface for calculating depth to top of acoustic basement, as described below. A second surface, using the TIN-GRID method was used for drawing contours. This TIN-GRID surface, "bins" the data in 50 x 50-foot cells, averaging all data points within the cell. This method generally produces smoother contours that are more acceptable for display purposes, although the contours do not always honor all of the input data points. Contours were generated at a 1-foot interval and presented in a plan view format on the final drawings.

Side Scan Sonar Imagery

During interpretation of the side scan sonar records, areas on the seabed exhibiting different acoustical properties were identified and mapped. The variation in acoustical characteristics on the bottom represents changes in surficial lithology and/or the presence of benthic communities and foreign material. Areas of large natural seabed features were identified by the increased topographic relief and morphologic variations observed on the records. In particular, areas of different surficial lithology of importance to the project were plotted on the plan view drawings. In general, coarser and harder materials show increased reflectivity whereas finer sediments exhibit weaker reflective characteristics.

Imagery were also reviewed to identify individual acoustic targets representative of natural or man made objects resting on the bottom. An object exhibiting some relief (or height) above the bottom will generate a strong reflection on the sonar image from the side of the object facing the side scan towfish. Shape and textures associated with an object may be interpreted, depending on the acoustic signal angle of incidence, geometry of the object, line orientation with respect to the object, and site conditions at the time of the survey, among other variables.

Files were reviewed and targets picked using the Klein SonarPro software which was also used for acquisition. The SonarPro software files apply the proper sensor layback and ground range correction when positioning a target on the bottom. Individual acoustic targets identified have been compiled and described in detail in an Excel spreadsheet. These targets are also plotted on a plan view drawing of the site relative to mapped surficial materials and magnetic anomalies.

Magnetic Intensity Measurements

Digital records of the magnetic data were reviewed using HYPACK® software to determine the presence of ferrous material on or below the harbor floor. Anomalous readings above the geologic background gradient were identified. Anomalies are essentially a disturbance in the earth's total magnetic field, created by a more pronounced local field generated by a ferrous object. The object's local, induced field causes a deviation of the earth's total field in its immediate vicinity which is measured by the sensor passing nearby. The magnetic anomalies were then plotted in their proper location on the plan view trackline sheets taking layback of the sensor into account. The magnetic anomalies have been presented on the final drawings in plan view format and also summarized in detail in an Excel spreadsheet included at the end of this report.

Seismic Reflection Profile Data

The processed navigation data were used to generate a plan view survey trackline sheet as part of the overall review of seismic reflection coverage and subsurface conditions. Digital seismic data was imported to the seismic processing program REFLEXW (Sendmeier Software) Version 2.5 for analysis, interpretation, final data formatting. REFLEXW is a 32 bit software package running in a Windows 2000 environment. As raw seismic reflection data is measured in time travel of the acoustic signals, a time to distance/depth conversion is required. Acoustic velocities for subsurface layers can be obtained directly from seismic refraction methods or assumed from physical sampling of materials. Historical research shows most marine sediment types and compositions fall into certain velocity ranges. An average acoustic sediment velocity of 5,000 feet per second was used for this project, a typical value for saturated marine sediments tending toward the finer grain sizes.

The seismic reflector depths or sediment thicknesses were exported by the REFLEXW program in a x, y, z format and imported to the QuickSurf digital terrain modeling software. A surface was developed for the sediment thickness "z" value interpreted from the seismic profiles, which was then added to the USACE MLLW depth surface to obtain a final subbottom surface referencing the reflector to the project datum. In this manner, depths to the primary acoustic basement reflector were developed relative to MLLW.

Contours of the depth to acoustic basement were generated using the TIN-GRID method at a 1 foot interval and presented in plan view on a final drawing. This TIN-GRID surface "bins" the data in 50 x 50-foot cells, averaging all data points within the cell. This method generally produces smoother contours that are more acceptable for display purposes, although the contours do not always honor all of the input data points.